

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460



OFFICE OF  
AIR AND RADIATION

July 8, 2010

Dear ENERGY STAR Solid-State Lighting or Integral LED Lamps Stakeholder,

This letter is intended to clarify issues surrounding LM-80 lumen maintenance testing of LED packages, arrays and modules for the current ENERGY STAR Solid-State Lighting Luminaires program, and the forthcoming ENERGY STAR Luminaires program. These clarifications are also applicable to Integral LED Lamp partners electing to leverage the early initial qualification option using LM-80 test data when the specification becomes effective August 31, 2010.

The existing ENERGY STAR Solid-State Lighting Luminaires V1.1 specification (SSL V1.1), which references IES LM-80-08, remains in effect until the ENERGY STAR Luminaires V1.0 specification replaces it in the summer of 2011.

As of March 31, 2010 EPA is only accepting data collected in compliance with the [LM-80 standard](#), with sample sizes as specified in the ENERGY STAR [Manufacturer's Guide for Qualifying Solid State Lighting Luminaires](#). Therefore data collected prior to publication of the LM-80 standard, not performed in compliance with the standard, will not be accepted for ENERGY STAR qualification of solid state lighting products. Questions about laboratory changes in equipment should be directed to the [NVLAP](#) program at the National Institute of Standards and Technology (NIST), which is the accreditation body for LM-80 testing recognized in the current lighting specifications; other accreditation bodies may be added in the future.

As of September 30, 2010 the current SSL V1.1 specification requires that LM-80 test data come from a NVLAP accredited laboratory. Applications for recognition by EPA as an accredited lab for purposes of LM-80 testing are available at [www.energystar.gov/testingandverification](http://www.energystar.gov/testingandverification). As of today, EPA understands from NVLAP that no labs have yet achieved this accreditation. Given that accreditation takes 3 to 6 months, EPA recognizes that as of September 30 access to accredited labs will be limited. On an interim basis, EPA will recognize labs that have otherwise achieved ISO/IEC 17025 accreditation through NVLAP, have demonstrated competence in conducting LM-80 testing, and can demonstrate that they are in the process of obtaining accreditation for LM-80 testing. Labs seeking this interim recognition should contact Taylor Jantz-Sell at D&R International (see below). Progress towards LM-80 accreditation for these laboratories will be closely monitored, and products qualified through labs which do not complete the accreditation process or demonstrate progress towards accreditation will be disqualified.

Regarding lumen maintenance projections, current protocols outlined in the SSL V1.1 specification and the aforementioned Manufacturers Guide remain in effect for SSL fixtures until the Luminaires specification becomes effective in the summer of 2011. Under the forthcoming Luminaires specification, lumen maintenance projections using data collected in accordance with LM-80 will be governed by the forthcoming IES technical memorandum TM-21-11.

The Agency would also like to address the testing requirements for improvements to LED packages, arrays, or modules. EPA's understanding of the intent behind IES test procedures is that LED packages should be considered new if material changes have been made which result in any sizeable change(s) in performance; these new components would not be considered "successors". New LED packages must be tested according to LM-80.

For purposes of initial ENERGY STAR qualification or maintenance of qualification status of a currently qualified fixture using successor components, until the Luminaires specification is final and effective please refer to guidance on "Lumen Maintenance -- Successor LED packages/modules/arrays" on page 4 in the aforementioned ENERGY STAR Manufacturer's Guide. A proposal about the handling of successor LED packages/arrays/modules under the new Luminaires specification will be included in a subsequent draft to be distributed this summer. All information related to the Luminaire specification development process can be found at [www.energystar.gov/luminaires](http://www.energystar.gov/luminaires).

Finally, EPA is currently working to clarify requirements pertaining to LM-80 sample sizes and acceptable variations of correlated color temperature within those samples; direction will be provided in a separate forthcoming communication to partners and stakeholders.

While the SSL V1.1 specification remains in effect, questions regarding the above topics should be directed to Taylor Jantz-Sell at D&R International at [tjsell@drintl.com](mailto:tjsell@drintl.com) or (301) 588-9387; related Integral LED Lamp questions should also be directed to Taylor. Questions regarding the above topics as they pertain to the forthcoming Luminaires specification should be directed to me at [baker.alex@epa.gov](mailto:baker.alex@epa.gov) or (202) 343-9272. Finally, questions regarding the enhanced testing and verification program EPA is implementing across all ENERGY STAR products should be directed to [ENERGYSTARVerificationProgram@energystar.gov](mailto:ENERGYSTARVerificationProgram@energystar.gov).

Sincerely,

A handwritten signature in black ink, appearing to read 'Alex Baker', with a stylized flourish at the end.

Alex Baker  
Lighting Program Manager, ENERGY STAR  
US EPA



# BE A LEADER—CHANGE OUR ENVIRONMENT FOR THE BETTER

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## Luminaires

EPA is currently developing a new product specification for Luminaires, intended to replace the Residential Light Fixtures (V4.2) and Solid State Lighting Luminaires (V1.1) specifications. Partners and other interested parties who would like to participate in this process are encouraged to send their contact information to [luminaires@energystar.gov](mailto:luminaires@energystar.gov) to be added to the distribution list for specification development updates. This webpage will be updated periodically with comments received and new drafts for review.

May 10, 2010 — Draft 1 Version 1.0 Specification

EPA welcomes your feedback on this document. **Comments on Draft 1 are due via email to [luminaires@energystar.gov](mailto:luminaires@energystar.gov) no later than Monday, June 21, 2010.**

[June 8, 2010 Webinar: Overview of Draft 1](#) (3.92MB)






































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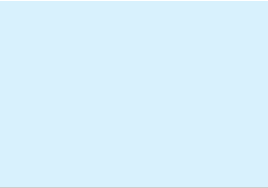
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[March 4, 2010 LRC-NEMA-ALA Round Table Meeting Notes](#) (122KB)

First Draft Comments Received (comment period closed June 21, 2010)

- [Acuity Brands Comments](#) (36KB)
- [American Lighting Association Comments](#) (857KB)
- [Aurora International Testing Laboratory Comments](#) (135KB)
- [Biglight Co. Comments](#) (136KB)
- [Biglight Co. Comments 2](#) (36KB)
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## ENERGY STAR® Program Requirements for Luminaires

### Eligibility Criteria – Version 1.0, DRAFT 1

PUBLISHED \_month\_day\_, 2010. EFFECTIVE \_month\_day\_, 2011.

#### Primary Contact Information

**Note:** For purposes of this specification development process, EPA invites stakeholders to send comments to [luminaires@energystar.gov](mailto:luminaires@energystar.gov), with "ENERGY STAR Luminaires First Draft Comments" in the subject line.

#### Your Primary Contact Information

To effectively communicate important news to our partners, the ENERGY STAR program needs your help keeping your company's contact information up to date. It is one of your partner commitments and it's easy to do: please visit [www.energystar.gov/partners](http://www.energystar.gov/partners), and use My Account Login.

#### Scope of This Specification

The ENERGY STAR Luminaires specification ("this specification") covers the luminaire types outlined below. Qualification is limited to luminaires below a total input power of 250 watts. This specification replaces the ENERGY STAR Residential Light Fixtures and Solid State Lighting specifications.

- Directional applications:
  - Residential grade luminaires, specifically:
    - cove mounts
    - downlights (recessed, pendant or surface mount)
    - outdoor post or arm-mounted luminaires
    - surface mount with directional head(s)
    - under cabinet luminaires
    - inseparable luminaires are evaluated as directional; see definitions.
  - Commercial grade luminaires, specifically:
    - downlights (recessed, pendant or surface mount) under cabinet shelf-mounted task lighting
    - portable desk task lights
- Non-directional applications:
  - Residential grade luminaires only, examples:
    - Indoor:
      - bath vanity
      - ceiling and close-to-ceiling mount
      - chandeliers
      - wrapped lens (typ. fluorescent w/ acrylic)
      - linear strips (no secondary optics)
      - pendant mounted
      - portables, including torchieres
      - wall sconces
    - Outdoor:
      - outdoor porch
      - outdoor pendant
      - outdoor security

**Note:** The above proposed approach to categorization of luminaires by directional versus non-directional performance attributes is the outgrowth of a March 4, 2010 round table discussion organized by Rensselaer Polytechnic Institute's Lighting Research Center (LRC) and hosted by the LRC, the National Electrical Manufacturers Association, and the American Lighting Association. Notes from this discussion are available for partner and stakeholder review. EPA seeks broader comment on the proposed categorization.

EPA is reviewing the ENERGY STAR program's approach to labeling of commercial luminaires. Qualification activities have centered around the above commercial luminaire types, thus these requirements have been carried forward to this specification with test procedures added so fluorescent luminaires meeting the enclosed performance requirements may also be qualified.

Regarding proposed additions to the SSL specifications, including outdoor pole-mounted area and roadway luminaires, wall packs and parking garage/canopy luminaires, development of an ENERGY STAR specification is currently on hold as DOE & EPA await industry development of a technology-neutral test procedure which will allow for evaluations of high performance luminaires, regardless of technology. NEMA is leading this development effort.

## **How to Use This Document**

To qualify a luminaire for ENERGY STAR, first determine which requirements in this document are applicable to the specific luminaire. ENERGY STAR requirements for are specific to directional and non-directional applications:

- Directional applications:
  - defined in the above Scope section
  - evaluated with luminaire photometry, accounting for luminaire optical performance
  - must also meet specified minimum light output and zonal lumen density requirements
  - residential grade luminaires featuring inseparable solid state (LED) componentry must be tested as directional
  - all other luminaire types default to non-directional, below
- Non-directional applications:
  - defined in the above Scope section
  - evaluated by source photometry
  - luminaires not defined as directional are evaluated as non-directional

Luminaire manufacturers may elect to use ENERGY STAR qualified GU24 based lamps featuring integral ballasts or drivers to meet performance requirements in this specification. See Appendix A for performance requirements for GU24 based integrated lamps. EPA intends to place GU24 requirements in the forthcoming ENERGY STAR Lamps specification, at which time Appendix A of this document will be removed.

This specification is not organized by indoor or outdoor, or by light source technology. Performance requirements comprise each section of this document, thus the first section summarizes efficacy requirements, the second color performance, etc. Partners are advised to review each section, and take note of exceptions where specific performance criteria need not be evaluated; some exceptions are in place, for instance, for outdoor luminaires.

### **In Chinese:**

**PUBLISHED SEPTEMBER XX, 2010. EFFECTIVE JUNE XX, 2011.**

### **Primary Contact Information**

### **Scope of This Specification**

### **How to Use This Document**

**Note:** EPA intends to add the above Chinese language in the final specification.

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## **Definitions**

**ALA**: American Lighting Association.

**ANSI**: American National Standards Institute.

**Aperture Size (downlights)**: The maximum distance between the points inside the luminaire where light escapes the luminaire.

**ASSIST**: Alliance for Solid State Illumination Systems and Technologies.

**ASTM**: American Society for Testing of Materials.

**Ballast Frequency**: The number of waves or cycles of electromagnetic radiation per second, usually measured in Hz. (Lighting Fundamentals Handbook, Electric Power Research Institute, 1992)

**Ballast**: A device used with an electric-discharge lamp to obtain the necessary circuit conditions (voltage, current, and waveform) for starting and operating. (IES RP-16-05)

**CFL**: A compact fluorescent lamp (pin based or self-ballasted screw base).

**CIE**: Commission Internationale de l'Eclairage (International Commission on Illumination).

**Color Rendering**: A general expression for the effect of a light source on the color appearance of objects in conscious or subconscious comparison with their color appearance under a reference light source. (IES Handbook 9<sup>th</sup> Edition)

**Color Rendering Index (CRI)**: A measure of the degree of color shift objects undergo when illuminated by the light source as compared with those same objects when illuminated by a reference source of comparable color temperature. (IES Handbook 9<sup>th</sup> Edition)

**Commercial Luminaire**: A luminaire using a Class A power supply.

**Correlated Color Temperature (CCT)**: The absolute temperature of a blackbody whose chromaticity most nearly resembles that of the light source. (IES Handbook 9<sup>th</sup> Edition).

**Cove Lighting**: Lighting comprising light sources shielded by a ledge or horizontal recess, and distributing light over the ceiling and upper wall (IES RP-16-05)

**Covered Lamp**: A lamp with an integral ballast and a translucent cover over the bare fluorescent glass tube.

**CSA**: Canadian Standards Association.

**Direct Lighting**: Lighting involving luminaires that distribute 90 to 100 percent of the emitted light in the general direction of the surface to be illuminated. This term usually refers to light emitted in a downward direction. (IES RP-16-05)

**Directional Applications**: See Direct Lighting.

**Directional Luminaires**: See Direct Lighting.

**Down Light ("downlight")**: A small direct lighting unit that directs the light downward and can be recessed, surface mounted, or suspended. (IES RP-16-05)

**Electronic Ballast**: A ballast generally involving high-frequency switching that is controlled by active components (transistor, thyristors, etc.), and with the lamp ballasting impedance provided by a series of capacitive or inductive reactance appropriate for the high switching frequency. "Ballast" also refers to other drivers or supplies that operate lamp technologies other than fluorescent. (CSA C22.2 No 1993-09 – UL 1993)

**GU24 Based Integrated Lamp**: A lamp unit that integrates the lamp and its ballast. It does not include any replaceable or interchangeable parts, and utilizes the ANSI standardized GU24 base type.

**GU24 Based Two-Piece Lamp**: A term for a lamp-ballast unit that includes a ballast with the ANSI standardized GU24 base type paired with a standard pin based lamp. The ballast and lamp are separable, with the ballast designed to accept replacement pin based lamps.

**IEC**: International Electrotechnical Commission.

**IES**: Illuminating Engineering Society.

**Initial Performance Values**: The photometric and electrical characteristics at the end of the 100-hour aging period in a 25°C test environment.

**Input Power**: The power consumption in watts of a ballast and fluorescent lamp or lamps, as determined in accordance with the test procedures specified in ANSI Standard C82.2–1984.

**Inseparable Luminaires**: Luminaires featuring solid state lighting componentry which cannot be replaced and thus require replacement of the entire luminaire.

**Lamp Ballast Platform**: A pairing of one ballast with one or more lamps that can operate simultaneously on that ballast. A unique platform is defined by the manufacturer and model number of the ballast and lamp(s) and the quantity of lamps that operate on the ballast. A lamp ballast platform also may refer to a lamp with an integral ballast, such as a GU24 based integrated lamp.

**Lamp Current Crest Factor**: For 60Hz operation, the ratio of peak lamp current to the root mean square (RMS) lamp current. For high-frequency (HF) operation, the highest peak lamp current of the modulation envelope (when evaluated over a full line voltage cycle) to the root mean square (RMS) of the lamp current.

**Lamp**: A generic term for a man-made source create to produce optical radiation. By extension, the term is also used to denote sources that radiate in regions of the spectrum adjacent to the visible." (IES Handbook 9<sup>th</sup> Edition)

**Lampholder**: A component of a luminaire, which supplies power to the lamp and also holds the lamp in place.

**LED**: See light emitting diode.

**LED Array or Module**: An assembly of LED packages (components) or dies on a printed circuit board or substrate, possibly with optical elements and additional thermal, mechanical, and electrical interfaces that are intended to connect to the load side of a LED driver. Power source and ANSI standard base are not incorporated into the device. The device cannot be connected directly to the branch circuit. (IES RP-16-05 Addendum b)

**LED Control Circuitry**: Electronic components designed to control a power source by adjusting output voltage, current or duty cycle to switch or otherwise control the amount and characteristics of the electrical energy delivered to a LED package (component) or an LED array (module). LED control circuitry does include power source. (IES RP-16-05 Addendum b)

**LED Driver**: A device comprised of a power source and LED control circuitry designed to operate a LED package (component), or an LED array (module) or an LED lamp. (IES RP-16-05 Addendum b)

**LED Driver Class II**: An LED driver that operates within Class II limits as defined by the latest version of the National Electrical Code (NEC) and the Canadian Electrical Code (CEC). (IES RP-16-05 Addendum b)

**LED Light Engine:** An integrated assembly comprised of LED packages (components) or LED arrays (modules), LED driver, and other optical, thermal, mechanical and electrical components. The device is intended to connect directly to the branch circuit through a custom connector compatible with the LED luminaire for which it was designed and does not use an ANSI standard base. (IES RP-16-05 Addendum b)

**LED Luminaire:** A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit. The LED-based light emitting elements may take the form of LED packages (components), LED arrays (modules), LED Light Engine, or LED lamps. The LED luminaire is intended to connect directly to a branch circuit. (IES RP-16-05 Addendum b)

**LED Module:** See "LED Array or Module"

**LED Package:** An assembly of one or more LED dies that includes wire bond or other type of electrical connections,, possibly with an optical element and thermal, mechanical, and electrical interfaces. Power source and ANSI standardized base are not incorporated into the device. The device cannot be connected directly to the branch circuit. (IES RP-16-05 Addendum b)

**LED Platform:** See LED Light Engine definition above

**LED Temperature Measurement Point (TMP<sub>LED</sub>):** A location on an LED package/module/array, designated by its manufacturer, which provides a surrogate temperature measurement location for the actual LED junction. The TMP<sub>LED</sub> may be a solder joint at the board attachment site, a point on the LED package case, or a location on the board of an LED module or array.

**Light Emitting Diode (LED):** A pn junction semiconductor device that emits incoherent optical radiation when forward biased. The optical emission may be in the ultraviolet, visible, or infrared wavelength regions. (IES RP-16-05 Addendum b)

**Luminaire (Light Fixture):** A complete lighting unit consisting of lamp(s) and ballast(s) (when applicable) together with the parts designed to distribute the light, position and protect the lamps, and to connect the lamp(s) to the power supply (IES RP-16-05)

**Linear Fluorescent Lamp:** Commonly made with straight, tubular bulbs varying from approximately .25" to 2.125" and in overall length from 4" to 96". The Fluorescent Lamp is a low-pressure mercury electric-discharge lamp in which a fluorescing coating (phosphor) transforms some of the UV energy generated by the discharge into light. (IES Handbook 9<sup>th</sup> Edition)

**Lumen Maintenance:** The luminous flux output remaining (typically expressed as a percentage of the maximum output) at any selected elapsed operating time. Lumen maintenance is the converse of lumen depreciation. (IES LM-80-08)

**Lumens per Watt (LPW):** The quotient of the total luminous flux emitted by the total lamp power input is the luminous efficacy of a source of light, and is expressed in LPW. (IES RP-16-05)

**Luminaire Efficacy:** The luminous flux delivered by a luminaire, divided by its input power.

**MacAdam Color Ellipse:** A series of ellipses around the chromaticity coordinates of a number of different colors. Each ellipse sets the boundary at which a given percentage of people are able to determine that two colors, one with the chromaticity coordinates at the center of the ellipse, and one with chromaticity coordinates on the ellipse, are just noticeably different. (IES Handbook 9<sup>th</sup> Edition)

**Magnetic Ballast:** A magnetic device used to control the starting and operation of discharge lamps. (IES Handbook 9<sup>th</sup> Edition)

**Manufacturer Designated Temperature Measurement Point (TMP):** The temperature measurement point designated by the manufacturer correlating to photometric, life or warranty values.

**NEMA:** National Electrical Manufacturers Association.

**NFPA:** The National Fire Protection Association (United States), which develops the National Electrical Code (NEC).

**Non-Directional Application:** For purposes of this ENERGY STAR specification, luminaire application types which are not designated directional. See Direct Lighting definition.

**Non-Directional Luminaire:** See Non-Directional Application.

**NRTL:** Nationally Recognized Testing Laboratory as recognized by OSHA's NRTL Program, which is a part of OSHA's Directorate of Technical Support.

**Optics:** Include reflectors, baffles, lenses and/or diffusers, all of which control the light distribution and the appearance of the lighted luminaire.

**OSHA:** Occupational Safety & Health Administration.

**Photo Control:** A photoelectric switch that controls lighting by the level of daylight luminance (IES RP-16-05)

**Photosensor:** See Photo Control.

**Platform:** See Lamp Ballast Platform.

**Portable Luminaire:** A luminaire whose power supply connection is made by means of a cord with a plug.

**Power Factor:** 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 Standard C82.2-1984.

**Power Source:** A transformer, power supply, battery, or other device capable of providing current, voltage, or power within its design limits. This device contains no additional control capabilities (IES RP-16-05 Addendum b)

**Rated Lumen Maintenance Life (L<sub>p</sub>):** The elapsed operating time over which the LED light source will maintain the percentage, p, of its initial light output, e.g. L<sub>70</sub> (hours): Time to 70% lumen maintenance. (IES LM-80-08)

**Residential Luminaire:** A luminaire using a Class B power supply.

**RLF:** Residential light fixture.

**Run-up Time:** The time needed after switching on the supply for the lamp to reach 80.0% of its stabilized luminous flux. (ANSI C78.5)

**Solid State Lighting (SSL):** The term "solid state" refers to the fact that the light is emitted from a solid object – a block of semiconductor – rather than from a vacuum or gas tube, as in the case of a incandescent and fluorescent lighting. There are two types of solid-state light emitters: inorganic light-emitting diodes (LEDs) or organic light-emitting diodes (OLEDs). (Sandia National Laboratories)

**Standardized Color Ellipse:** A MacAdam color ellipse defined by center chromaticity coordinates (CIE x, y) and a measure of certainty for detecting a color difference specified in standard deviation units called steps. (ANSI C78.376-2001)

**Trim:** Trim is the part of a downlight that covers the ragged edge of the ceiling cut-out. The trim may be a separate ring, or trim ring, or it may be integrated with the optics (i.e., a self-flanged reflector). Airtight or non-airtight.

**UL:** Underwriters Laboratories.

## Qualification Process

Partner must test qualifying products and obtain necessary documentation to meet the requirements listed in this specification. Refer to the “Methods of Measurement and/or Reference Standards” and “Required Documentation” columns in the performance requirements tables to determine the reference standard and required documentation applicable to each performance characteristic. Partners are advised to carefully review each section, and take note of exceptions where specific performance criteria need not be evaluated.

The following stipulations apply:

A. Directional Luminaire Applications (see front cover of spec for specific applications):

- Qualified products must be essentially identical to the tested product. Only limited variation is allowed. The table below summarizes allowable variations:

Variations Within Product Groupings	
Housing/Chassis	not allowed
Heat Sink/Heat Management	not allowed
Finish	allowed
Reflector/Trim	allowed
Shade/Diffuser	allowed
Mounting	allowed
Light Source	allowed, w/ conditions
Power Supply	allowed, w/ conditions

B. Non-Directional Luminaire Applications (see front cover of spec for examples):

- For multiple luminaire models that use the same lamp ballast platform or LED light engine, only one set of test results is required. For example, two luminaires that use the same lamp and ballast combination or LED light engine, but have different trim, lens and/or finish need only be tested once.
- For fluorescent luminaire models that may use different ballasts (either in terms of the type of ballast or manufacturer), each lamp ballast platform combination must undergo testing and the test results must be submitted for qualification. For example, if a partner plans to use ballasts from several manufacturers in any one luminaire, the luminaire must be tested with each manufacturer's ballast.
- For fluorescent luminaire models with one ballast type that can work with multiple fluorescent lamp types, the luminaires need only be tested with one lamp type. The lamp type must either be the one supplied with the luminaire at shipment or, if a lamp is not supplied, the highest power lamp of the lamp types listed on the packaging. Please note that EPA expects all lamps listed on the packaging to comply with this specification when operating on the luminaire's ballast. To ease the burden on the manufacturer, however, test data need be submitted for only one lamp type operating on the luminaire's ballast.

**Note:** The following may be used in lieu of testing for certain requirements:

- EPA approved platforms as listed in the Platform Database
- EPA approved documentation from an industry association (i.e. NEMA lamp ballast matrices)
- The model number of an ENERGY STAR qualified GU24 based integrated lamp.

**Note:** The above Qualification Process section will be completed in subsequent drafts of this specification. Further language regarding product variations and successor LED packages/modules/arrays will be provided.

## **Acceptable Sources of Documentation**

A variety of acceptable sources of documentation are referenced for each performance characteristic. For clarity, these sources are summarized below:

- **A test report from a laboratory accredited by an accreditation body recognized for luminaire testing under the ENERGY STAR Program:** Both public and private accredited laboratories may be used, so long as they meet the ENERGY STAR laboratory requirements. A list of laboratories meeting accreditation requirements will be listed on the ENERGY STAR website. (Spring 2010: Note that these requirements are currently under development - see updates on [www.energystar.gov/testingandverification](http://www.energystar.gov/testingandverification). Partners should ensure that testing is conducted by one of these listed laboratories.)
- **EPA Approved Platform Database:** The approved platform database lists lamp & ballast combinations and GU24 integrated lamps that have been submitted by a manufacturer and pre-approved to meet specific performance characteristics. Partners may cite the performance of approved platforms to satisfy some of the luminaire performance requirements listed in the database; use of an approved platform will not meet all specification requirements to qualify a luminaire. The platform database currently includes approved fluorescent lamp & ballast platforms, and may be expanded in the future to also include approved LED light engines and platforms based on other technologies. The platform database is available at [www.energystar.gov/platform](http://www.energystar.gov/platform)
- **EPA approved documentation from an industry association:** In certain instances, EPA has approved documentation from industry associations who take responsibility for specific performance characteristics of lamps and/or ballasts. When using this type of documentation, partners should contact the industry association to obtain the EPA-approved documentation that is required for use with ENERGY STAR submittals. Partners may use the NEMA-ALA Lamp and Ballast Matrices as a source for obtaining required information to qualify luminaires using fluorescent lamps. These matrices can be found at [www.nema.org/lampballastmatrix](http://www.nema.org/lampballastmatrix)
- **A test report from an OSHA NRTL laboratory:** Documentation for safety requirements must come from an OSHA NRTL laboratory, which may also be used to obtain certain additional performance characteristics.
- **Manufacturer documentation:** Documentation for certain performance characteristics (such as product packaging requirements) may come directly from the original equipment manufacturer.

**Note:** The ENERGY STAR Laboratory Accreditation Program is currently being developed through a program-wide effort in support of enhanced testing and verification for ENERGY STAR labeled products. These requirements will be developed and finalized in Spring/Summer 2010.

**All ENERGY STAR partners will receive email updates regarding the lab accreditation requirements.**

**If you are not already a partner** and would like to receive email updates on this topic, please send an email to [ENERGYSTARVerificationProgram@energystar.gov](mailto:ENERGYSTARVerificationProgram@energystar.gov).

The latest information on development of accreditation requirements is also posted at [www.energystar.gov/testingandverification](http://www.energystar.gov/testingandverification).

Finally, the EPA Approved Platform Database and the NEMA-ALA Lamp and Ballast Matrices are under review to determine ways to strengthen these processes. In subsequent drafts of this specification EPA may propose changes for partner and stakeholder review and comment.

## **Verification Testing Program**

Partners of the ENERGY STAR Luminaires program are subject to the requirements of the ENERGY STAR Third Party Lighting Product Verification Testing Program (first draft placeholder name).

**Note:** EPA is currently developing a next generation lighting verification testing program intended to consolidate ENERGY STAR's current verification testing programs, including the RLF QA4 program, the CFL Third Party Testing and Verification Program, and the programs planned for the SSL and Integral LED Lamps programs. Details about this manufacturer-funded program, including effective dates, will be developed and finalized through a separate stakeholder process focused on testing requirements across ENERGY STAR products. This process will be run in parallel to the development of the ENERGY STAR Luminaires specification.

## **Technical Notes**

The list of conditions below is referenced in the "Required Documentation" column for certain performance requirements detailed in this specification.

- [1] Laboratory test results must be produced using the specific *lamp and ballast* or *LED package(s), LED module(s) or LED array(s) and LED driver combination* that will be used in production.
- [2] Note: the laboratory used for this test must have a scope of accreditation that includes the method of measurement reference standard for this performance characteristic.
- [3] Laboratory test results must be produced using the specific *lamp* that will operate in the luminaire and either the ballast that will operate in the luminaire or a commercially-available ballast that meets the applicable ANSI ballast requirements, if applicable, for the light source being tested.
- [4] It is also intended that luminaire manufacturing partners will ensure that their fluorescent lamp vendors meet the following quality requirements during production runs of each lamp model:
  1. The lamp manufacturer must maintain color control such that a minimum of 90% of the ongoing production (as represented by samples tested from each production shift for the same color and when typically evaluated over 12 month period) will fall within the 7-step MacAdam color ellipse associated with the designated (manufacturer declared) target color.
  2. For the purposes of meeting color control, the lamp manufacturer must maintain testing equipment calibrated to international practices and standards and must compile the ongoing color control data in a manner such that it can be easily reviewed upon partner or EPA request.
  3. At a minimum, the lamp manufacturer's color quality control program must maintain the following data for a 3-year period:
    - a. Test dates and sample size (minimum of two lamps per production shift)
    - b. Test results (x,y coordinates) for each sample lamp measured
    - c. Test results (x,y coordinates) for sample lamps plotted graphically against the designated 7-step color ellipse and available for partner or EPA review on at least a quarterly basis
    - d. Records to substantiate that 90 percent of the data points (x,y coordinates) fall within the applicable 7-step MacAdam ellipse. Manufacturers are encouraged to exceed this target.
- [5] Laboratory test results must be produced using the specific *ballast* that will operate in the luminaire.
- [6] 1,000 hour lumen maintenance and lumen maintenance at 40% of rated life tests must use the same samples.
- [7] For downlights, one trim ring and one reflector may be used with the three luminaire samples.
- [8] GU24 Sample Size: ≥ 10 samples must be tested for each testing orientation selected for the submittal.

**Note:** Technical note #4 has been adjusted to indicate partner responsibility for ensuring that selected lamp vendors meet these quality requirements. The above Technical Notes section will be completed in subsequent drafts.

## **Future Specification Revisions**

EPA will revise this specification should technological and/or market changes affect its value to consumers, industry, or the environment. In keeping with current policy, revisions to this specification will be arrived at through established ENERGY STAR specification revision processes.

While this document currently refers to industry standards and test procedures for fluorescent, high intensity discharge and solid state sources, as new technologies emerge that have equal or better performance to the levels proposed here, consistent with a technology neutral approach, EPA may amend the program requirements by adding additional standards, requirements and test procedures.

Expiration of ENERGY STAR Qualification: During future specification revisions EPA may choose to require complete new test data and documentation for all performance characteristics in order for a luminaire to remain ENERGY STAR qualified. New test data may be required for new, revised and/or existing ENERGY STAR performance characteristics.

## Reference Standards and Test Procedures

Organization	Identifier	Description
ANSI	<a href="#">ANSI C78.376-2001</a>	Specifications for the Chromaticity of Fluorescent Lamps
ANSI	<a href="#">ANSI C78.377-2008</a>	Specifications for the Chromaticity of Solid State Lighting Products
ANSI	<a href="#">ANSI C78.5-2003</a>	Specifications for Performance of Self-ballasted Compact Fluorescent Lamps
ANSI	<a href="#">ANSI/ANSLG C78.81-2010</a>	Double-Capped Fluorescent Lamps—Dimensional and Electrical Characteristics
ANSI	<a href="#">ANSI/IEC C78.901-2005</a>	Single-Based Fluorescent Lamps—Dimensional and Electrical Characteristics
ANSI	<a href="#">ANSI/ANSLG C81.61-2009</a>	Specifications for Bases (Caps) for Electric Lamps
ANSI	<a href="#">ANSI/ANSLG C81.62-2009</a>	Lampholders for Electric Lamps
ANSI	<a href="#">ANSI C82.1-2004</a>	Electric Lamp Ballast - Line Frequency Fluorescent Lamp Ballast
ANSI	<a href="#">ANSI C82.11 Consolidated-2002</a>	High-Frequency Fluorescent Lamp Ballasts—Supplements
ANSI	<a href="#">ANSI C82.2</a>	Method of Measurement of Fluorescent Lamp Ballasts
ANSI	<a href="#">ANSI C82.6-2005</a>	Ballast For High Intensity Discharge Lamps - Methods Of Measurement
ANSI	<a href="#">ANSI C82.77-2002</a>	Harmonic Emission Limits—Related Power Quality Requirements for Lighting Equipment
ANSI	<a href="#">ANSI/IEEE C62.41-1991</a>	Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
ASSIST	<a href="#">ASSIST May 2008</a>	ASSIST Recommends: Recommendations for Testing and Evaluating White LED Light Engines and Integrated LED Lamps Used in Decorative Lighting Luminaires. Vol 4, Issue 1, May 2008.
ASTM	<a href="#">ASTM E 283-2004</a>	Restricted Air Movement
CIE	<a href="#">CIE Pub. No. 13.3:1995</a>	Method of Measuring and Specifying Color Rendering of Light Sources
CIE	<a href="#">CIE Pub. No. 15:2004</a>	Colorimetry
EU	<a href="#">EU Directive 2002/95/EC</a>	Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the Restriction of the use of Certain Hazardous Substances in Electrical and Electronic Equipment
FCC	<a href="#">FCC 47 CFR</a>	Electromagnetic Interference
FTC	<a href="#">FTC 16 CFR</a>	Commercial Practices
IEC	<a href="#">60061-1</a>	Lamp Caps and Holders Together with Gauges for the Control of Interchangeability and Safety – Part 1: Lamp Caps
IEC	<a href="#">60081</a>	Double-capped Fluorescent Lamps - Performance Specifications
IEC	<a href="#">60901</a>	Single-capped Fluorescent Lamps - Performance Specifications
IEC	<a href="#">61347-2-3-am2 ed1.0</a>	Amendment 2 - Lamp Control Gear - Part 2-3: Particular Requirements for A.C. Supplied Electronic Ballasts for Fluorescent Lamps
IEEE	<a href="#">C62.41</a>	Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
IES	<a href="#">IES LM-9-09</a>	Electric and Photometric Measurements of Fluorescent Lamps
IES	<a href="#">IES LM-10-96</a>	Photometric Testing of Outdoor Fluorescent Luminaires
IES	<a href="#">IES LM-16-93</a>	Correlated Color Temperature
IES	<a href="#">IES LM-40-01</a>	Approved Method for Life Performance Testing of Fluorescent Lamps
IES	<a href="#">IES LM 41-98</a>	IES Approved Method for Photometric Testing of Indoor Fluorescent Luminaries
IES	<a href="#">IES LM 47-01</a>	Life Testing of High Intensity Discharge (HID) Lamps
IES	<a href="#">IES LM-49-01</a>	Life Testing of General Lighting Incandescent Filament Lamps
IES	<a href="#">IES LM-51-00</a>	Electrical and Photometric Measurements of HID Lamps
IES	<a href="#">IES LM-58</a>	Guide to Spectroradiometric Measurements
IES	<a href="#">IES LM-58-94</a>	Color Rendering Index and Correlated Color Temperature
IES	<a href="#">IES LM-65-01</a>	Life Testing of Single-Ended Compact Fluorescent Lamps
IES	<a href="#">IES LM-66-00</a>	Electrical and Photometric Measurements of Single-Ended Compact Fluorescent Lamps.
IES	<a href="#">IES LM-79-08</a>	Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
IES	<a href="#">IES LM-80-08</a>	Approved Method: Measuring Lumen Maintenance of LED Light Sources
IES	<a href="#">IES RP 16-05</a>	Nomenclature and Definitions for Illuminating Engineering
IES	<a href="#">IES TM-21-11</a>	Projecting Long Term Lumen Maintenance of LED Packages (in draft 5/2010)
LRC	<a href="#">ACTV Test 2007</a>	Accelerated Cycling Thermal Voltage Stress Test
NFPA	<a href="#">NFPA 70-2005</a>	National Electric Code
UL	<a href="#">UL 153-2002</a>	Portable Electric Luminaires
UL	<a href="#">UL 935-2001</a>	Fluorescent-Lamp Ballasts
UL	<a href="#">UL 1012-2005</a>	Power Units Other Than Class 2
UL	<a href="#">UL 1310-2005</a>	Class 2 Power Units
UL	<a href="#">UL 1598-2008</a>	Luminaires
UL	<a href="#">UL 1838-2003</a>	Low Voltage Landscape Lighting Systems
UL	<a href="#">UL 1993-2009</a>	Self-Ballasted Lamps and Lamp Adapters
UL	<a href="#">UL 1994-2004</a>	Luminous Egress Path Marking Systems
UL	<a href="#">UL 8750-2009</a>	Light Emitting Diode (LED) Light Sources for Use in Lighting Products

## Measurement Tolerances

**Note:** In a subsequent draft EPA will detail acceptable tolerances for measurement values required in this specification.

## Photometric Performance Requirements

### Luminous Efficacy and Output Requirements: Non-Directional Luminaires

Source Type	ENERGY STAR Requirements		Methods of Measurement and/or Reference Standards	Required Documentation
	Source Efficacy	Minimum Light Output		
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul>	$\geq 70$ LPW per lamp/ballast platform  <u>Exception:</u> Covered and dimmable versions of GU24 based integrated lamps are required to meet reduced efficacy requirements as outlined in appendix A.	Lamp-ballast platform must provide a minimum of 850 lumens.  <u>Exception:</u> chandeliers featuring more than 5 heads must provide a minimum of 450 lumens per head.	Linear & circline: IES LM-9-09  Compact & self ballasted compact: IES LM-66-00	Provide: 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or 2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a> ; or 3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a> .  Sample Size: $\geq 3$ lamp/ballast combination samples must be tested [1], [8]  Passing Test: All samples must pass to qualify for ENERGY STAR.
<b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"> <li>metal halide</li> <li>ceramic metal halide</li> <li>high pressure sodium</li> </ul>			IES LM-51-00	Provide: 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or 2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a> ; or 3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a> .  Sample Size: $\geq 3$ lamp/ballast combination samples must be tested [1]  Passing Test: All samples must pass to qualify for ENERGY STAR.
<b>Solid State: LED Light Engine</b>	$\geq 70$ LPW per LED light engine	Each LED light engine must provide a minimum of 850 lumens.  <u>Exception:</u> chandeliers featuring more than 5 heads must provide a minimum of 450 lumens per head.	IES LM-xx-1x  Note: EPA is working with industry to develop the above test procedure:  <i>IES Approved Method for the Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature</i>  Upon its publication, EPA intends to reference this new metric. This metric is based on the work of ASSIST ( <a href="http://www.lrc.rpi.edu/assist">www.lrc.rpi.edu/assist</a> ) See: ASSIST May 2008	Provide: 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]  Sample Size: <ul style="list-style-type: none"> <li>1 complete luminaire sample (LED light engine installed) [1]; and</li> <li>2 additional LED light engine samples external to luminaire; and</li> <li>Any components and/or materials required to install additional LED light engines in luminaire.</li> </ul> Passing Test: All LED light engine samples, tested in the luminaire, must pass to qualify for ENERGY STAR.

<p><b>Halogen Incandescent (outdoor only)</b></p>	<p>Qualification using halogen incandescent lamps is available for outdoor luminaires employing the following lampholders: E11, E26, G4, GX5.3, GY6.35.</p> <p>Improved product efficiency is achieved through minimized operating time. Qualifying luminaire must operate with an integral in-line motion sensor device that meets the following criteria:</p> <ul style="list-style-type: none"> <li>• ensures automatic shut-off of the lamp within 15 minutes of being manually activated by a switch or automatically activated by the sensor, and</li> <li>• has an indicator that visibly or audibly informs the device operator that the motion sensor is operating properly, or that it has failed or malfunctioned</li> <li>• meets Off-State Power Consumption Requirements in this specification</li> </ul> <p>Halogen luminaires may not feature any form of continuous operation. Luminaires may not offer any form of motion sensor override. Additionally, instructions provided with luminaire may not detail methods of defeat.</p>	<p>Lampholder: ANSI C81.62-2009</p>	<p>Provide:</p> <ol style="list-style-type: none"> <li>1. ANSI lampholder code</li> <li>2. Applicable sections of luminaire manual(s) that demonstrate control functionality and instructions for use for each luminaire being submitted.</li> </ol>
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**Note:** Recognizing that luminous efficacy requirements for ENERGY STAR qualification of luminaires have remained largely unchanged since the original program's inception in 1997, and consistent with increases in baseline performance of general service lamps mandated by the Energy Independence and Security Act of 2007, EPA proposes the increased efficacy values detailed in the table above with the understanding that products meeting these levels are both broadly accessible and cost effective. EPA welcomes stakeholder comments on the proposed values.

Consumers are unable to modify the light output of solid state luminaires, or fluorescent or HID luminaires featuring dedicated-wattage ballasts. For this reason EPA has proposed the above minimum light output requirements. The proposed requirements are intended to provide source output comparable to a 60 watt incandescent lamp, the most commonly used consumer lamp. An exception is allowed for chandeliers with more than 5 heads, where lower wattage lamps are often used.

Also, EPA is determining lab accreditation requirements across the suite of ENERGY STAR labeled products through the enhanced testing and verification efforts, and in a separate process will propose a set of laboratory accreditation requirements for luminaires in May 2010. **ENERGY STAR partners will automatically receive a copy of the draft laboratory requirements** by email when they are distributed in May. In the meantime, more information is available at [www.energystar.gov/testingandverification](http://www.energystar.gov/testingandverification)



**Luminous Efficacy Requirements: Directional Luminaires  
Residential: Fluorescent and Solid State Sources Only**

Luminaire Type	ENERGY STAR Requirements			Methods of Measurement and/or Reference Standards	Required Documentation
	Luminaire Efficacy	Minimum Light Output	Zonal Lumen Density Requirement		
<b>Cove Mount</b>	45 LPW	<p>Luminaire must deliver a minimum of 200 lumens (initial) per lineal foot.</p> <p>The minimum required light output (in lumens) is calculated by dividing the luminaire length in inches by 12, then multiplying the result by 200.</p> <p>Note: The equation applies to all luminaire configurations. For rectangular geometries the "measured luminaire length" is the longest dimension of the luminaire. For circular geometries the "measured luminaire length" is the diameter. For linear track luminaires the "measured luminaire length" is the track length.</p>	Luminaire must deliver a minimum of 35% of total lumens within the 120°-150° zone.	<p>Fluorescent: IES LM-41-98</p> <p>Solid State: IES LM-79-08</p>	<p>Provide (fluorescent):</p> <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or,</li> <li>2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a>; or</li> <li>3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a>.</li> </ol> <p>Provide (solid state):</p> <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]</li> </ol> <p>Sample Size: three complete luminaires [1], [7]</p> <p>Passing Test: All luminaires must pass to qualify for ENERGY STAR.</p>
<b>Downlights:</b> • recessed • surface • pendant	42 LPW	<p>≤ 4.5" Aperture: 345 lumens (initial)</p> <p>&gt; 4.5" Aperture: 575 lumens (initial)</p>	Luminaire must deliver a minimum of 75% of total lumens (initial) within the 0-60° zone (bilaterally symmetrical).		
<b>Surface Mount With Directional Head(s)</b>	35 LPW	Luminaire must deliver a minimum of 200 lumens (initial) per head.	Luminaire must deliver a minimum of 85% within the 0-90° zone (bilaterally symmetrical).		
<b>Under cabinet</b>	29 LPW	<p>Luminaire must deliver a minimum of 125 lumens (initial) per lineal foot.</p> <p>The minimum required light output (in lumens) is calculated by dividing the luminaire length in inches by 12, then multiplying the result by 125.</p> <p>Note: The equation applies to all luminaire configurations. For rectangular geometries the "measured luminaire length" is the longest dimension of the luminaire. For circular geometries the "measured luminaire length" is the diameter. For linear track luminaires the "measured luminaire length" is the track length.</p>	Luminaire must deliver a minimum of 60% of total lumens (initial) within the 0-60° zone and a minimum of 25% of total lumens (initial) within the 60-90° zone (bilaterally symmetrical).		

<b>Outdoor Post- or Arm-Mounted Decorative Luminaires</b>  (Note: for mounting below 10.5 feet above grade)	35 LPW	Luminaire must deliver a minimum of 300 lumens (initial).	Luminaire must deliver 95% of total lumens within the 0°- 85° zone (bilaterally symmetrical). Luminaire must not emit any light above 90°.	Fluorescent: IES LM-10-96  Solid State: IES LM-79-08	
<b>Inseparable Luminaires (solid state only)</b>	70 LPW	None	None		

**Note:** The proposed luminaire efficacy values above are in some instances the same values carried over from the SSL V1.1 specification, and in other instances represent increases which market research indicates are both broadly accessible and cost effective for consumers. The luminaire efficacy value proposed for inseparable luminaires (see Definitions section) is carried over from the proposed category B luminous efficacy value detailed in the SSL V1.1 specification. EPA seeks feedback on the proposed requirements.

EPA recognizes that the fluorescent test procedure referenced above, IES LM-41-98, is based on relative photometry rather than absolute photometry as detailed in IES LM-79-08, and is working with industry to develop a resolution to ensure that both procedures provide equivalent utility in the evaluation of directional luminaires.

EPA also requests stakeholder comment on the above zonal lumen density requirements, carried over from the SSL V1.1 specification (with the exception of Outdoor Post- or Arm-Mounted) along with the minimum light output requirements. EPA understands that zonal lumen density requirements may ensure performance comparable to those luminaires using incumbent light source technologies, but recognizes also that the requirements could limit the flexibility of manufacturers to design luminaires to address specific tasks, thus limiting the range of products available to consumers. Based on testing currently underway, in subsequent drafts EPA may propose further refinements to the zonal lumen density requirements for under cabinet and downlights.

Finally, in support of efforts to reduce light pollution, EPA proposes the above intensity distribution requirements for Outdoor Post- or Arm-Mounted Decorative Luminaires. Among outdoor decorative luminaire types, these luminaires are deemed most likely to be installed not under a structure but under the open sky, therefore, the proposed requirement is intended to prevent light emissions above 90 degrees.

## Luminous Efficacy Requirements: Directional Luminaires Commercial: Fluorescent and Solid State Sources Only

(Note: at this time the ENERGY STAR program is offering qualification of only the following commercial luminaire types. Other luminaire types will not be reviewed for qualification at this time. Long term, EPA is evaluating the potential for expansion of ENERGY STAR labeling of commercial luminaires.)

Luminaire Type	ENERGY STAR Requirements			Methods of Measurement and/or Reference Standards	Required Documentation
	Efficacy	Minimum Light Output	Zonal Lumen Density Requirement		
<b>Portable Desk Task</b>	29 LPW	Luminaire must deliver a minimum of 200 lumens (initial).	Luminaire must deliver a minimum of 85% of total lumens (initial) within the 0-60° zone (bilaterally symmetrical).	Fluorescent: IES LM-41-98  Solid State: IES LM-79-08	Provide (fluorescent): 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or, 2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a> ; or 3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a> .  Provide (solid state): a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]  Sample Size: three complete luminaires [1]. [7]  Passing Test: All luminaires must pass to qualify for ENERGY STAR.
<b>Downlights:</b> • recessed • surface • pendant	42 LPW	≤ 4.5" Aperture: 345 lumens (initial) > 4.5" Aperture: 575 lumens (initial)	Luminaire must deliver a minimum of 75% of total lumens (initial) within the 0-60° zone (bilaterally symmetrical).  Luminaires with asymmetrical distribution must have at least 12.5% of total luminaire lumens in the 60°-90° zone.		
<b>Under cabinet</b>	29 LPW	Luminaire must deliver a minimum of 125 lumens (initial) per lineal foot.  The minimum required light output (in lumens) is calculated by dividing the luminaire length in inches by 12, then multiplying the result by 125.  Note: The equation applies to all luminaire configurations. For rectangular geometries the "measured luminaire length" is the longest dimension of the luminaire. For circular geometries the "measured luminaire length" is the diameter. For linear track luminaires the "measured luminaire length" is the track length.	Luminaire must deliver a minimum of 60% of total lumens (initial) within the 0-60° zone and a minimum of 25% of total lumens (initial) within the 60-90° zone (bilaterally symmetrical).		

**Note:** The proposed luminaire efficacy values above are in some instances the same values carried over from the SSL V1.1 specification, and in other instances represent increases which EPA has concluded are both broadly accessible and cost effective for end users. EPA seeks feedback on the proposed requirements.

EPA recognizes that the fluorescent test procedure referenced above, IES LM-41-98, is based on relative photometry rather than absolute photometry as detailed in IES LM-79-08, and is working with industry to develop a resolution to ensure that both procedures provide equivalent utility in the evaluation of directional luminaires.

EPA also requests stakeholder comment on the above zonal lumen density requirements, carried over from the SSL V1.1 specification along with the minimum light output requirements. EPA understands that zonal lumen density requirements may ensure performance comparable to those luminaires using incumbent light source technologies, but recognizes also that these requirements could limit the creativity of manufacturers to design luminaires to address specific tasks, thus limiting the range of products available to consumers.

## Light Source Life Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"><li>• linear</li><li>• compact</li><li>• self ballasted compact (GU24)</li><li>• circline</li></ul>	For lamps shipped with luminaires, the average rated life of the source must be ≥ 10,000 hours.  If the lamp is not shipped with the luminaire, product packaging must meet the requirements set forth in the “Product Labeling & Packaging Requirements section of this spec.  <u>Exception:</u> Covered and dimmable versions of GU24 based integrated lamps are required to meet reduced life requirements as outlined in appendix A.	Linear & circline: IES LM-40-01  Compact & self ballasted compact: IES LM-65-01	Provide: 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or 2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a> ; or 3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a> .
<b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"><li>• metal halide</li><li>• ceramic metal halide</li><li>• high pressure sodium</li></ul>		IES LM-47-01	Sample Size: ≥ 10 lamps must be tested [3]  Passing Test: 50% of the sample set must be functioning at the lifetime requirement in order to qualify for ENERGY STAR.  Manufacturers may obtain ENERGY STAR conditional qualification for their luminaire if all of the following items are provided: 1. A letter on letterhead from a laboratory meeting ENERGY STAR laboratory accreditation requirements. 2. A laboratory report proving that testing has been completed for at least 40% of rated life. 3. The date for testing completion.
<b>Halogen Incandescent (outdoor only)</b>	Lamps shipped with luminaires must feature a rated life of ≥ 3,000 hours.	IES LM-49-01	Conditional approval will only be granted for a period of no longer than 325 days.
<b>Solid State</b>	On product packaging and all marketing materials related to a qualified luminaire, partners may claim luminaire life not exceeding: <ul style="list-style-type: none"><li>• 25,000 hours for residential grade indoor luminaires</li><li>• 35,000 hours for residential grade outdoor luminaires or commercial grade luminaires</li></ul> Refer to Lumen Maintenance Requirements in the next section.		

## Lumen Maintenance Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul>	For lamps indicated on the luminaire packaging or shipped with the luminaires, the lamp must have an average rated lumen maintenance of at least 80% of initial lamp lumens at 40% (4,000 hours minimum) rated lamp life.	Linear & circline: IES LM-40-01 IES LM-09-99  Compact & self ballasted compact: IES LM-65-01 IES LM-66-00	Provide: 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or 2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a> ; or 3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a> .  Sample Size: ≥ 10 lamps must be tested [3]  Passing Test: ≥ 80% of the samples must achieve the required lumen maintenance value in order to qualify for ENERGY STAR.
<b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"> <li>metal halide</li> <li>ceramic metal halide</li> <li>high pressure sodium</li> </ul>		IES LM-47-01 IES LM-51-00	
<b>Solid State Option 1: Component Performance</b>  (select either option 1 or option 2, below)	The manufacturer of the LED package(s) / LED module(s) / LED array(s) must have LM-80 test data available for the devices employed in the luminaire, with a sample size of 25 units for LED packages, or 10 units for LED modules or arrays.  Sample sizes are for each temperature measured.  For residential grade indoor luminaires:  <i>(language to be provided in a subsequent draft)</i>  For residential grade outdoor luminaires and all commercial luminaires:  <i>(language to be provided in a subsequent draft)</i>	Measurement: IES LM-80-08  Lumen maintenance projection: IES TM-21-11  <b>Note:</b> EPA is following industry efforts to develop the above test procedure:  <i>Projecting Long Term Lumen Maintenance of LED Packages</i> Upon its publication, EPA intends to reference this technical memorandum.	Provide each of the following: 1. an LM-80 test report for the LED package(s) / LED module(s) / LED array(s) employed in the luminaire; and, 2. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program ([2]), detailing the temperature measurement point (TMP <sub>LED</sub> ) for the hottest LED in the luminaire, including a diagram or picture of its location with an arrow indicating the thermocouple attachment point; and, 3. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program ([2]), detailing <i>in situ</i> TMP <sub>LED</sub> temperature measurements for the LED package(s) / LED module(s) / LED array(s) employed in the luminaire; and, 4. a written statement indicating the forward drive current in milliamps (mA) applied to each LED package(s) / LED module(s) / LED array(s) employed in the luminaire.  Sample Size: three complete luminaires [7]  Passing Test: all of the conditions below must be met. If any of the conditions are not met, the component performance option may not be used and the applicant must use Option 2, below, for compliance. 1. The LED package(s) / LED module(s) / LED array(s) manufacturer indicates a TMP <sub>LED</sub> on the LED package(s) / LED module(s) / LED array(s). 2. The TMP <sub>LED</sub> is accessible to allow temporary attachment of a thermocouple for measurement of <i>in situ</i> temperature. Access via a temporary hole in the luminaire housing, tightly resealed during testing with putty or other flexible sealant is allowable. 3. The TMP <sub>LED</sub> temperature, measured <i>in situ</i> , is less than or equal to the temperature(s) specified in the LM-80 test report for the corresponding drive current or higher, within the manufacturer's specified operating current range. 4. The drive current measured in the luminaire is less than or equal to the drive current specified in the LM-80 test report at the corresponding temperature or higher. 5. <i>(language to be inserted relating LM-80 data to TM-21-11 projection instructions)</i>

<p><b>Solid State Option 2: Luminaire or LED Light Engine Performance</b></p> <p>(select either option 2 or option 1, above)</p>	<p>Directional luminaires: the luminaire must deliver at 6,000 hours the fraction of initial lumens specified below:</p> <p>Non-directional luminaires: each LED light engine must deliver at 6,000 hours the fraction of initial lumens specified below:</p> <p>Indoor luminaires: ≥ 91.8%</p> <p>Outdoor luminaires: ≥ 94.1%</p> <p>All Commercial: ≥ 94.1%</p> <p>These percentages are based on exponential decay functions for 25,000 hours and 35,000 hours to determine the 6,000 hour lumen maintenance necessary to achieve those rated lumen maintenance life values.</p>	<p>Directional luminaires: IES LM-79-08</p> <p>Non-directional luminaires: IES LM-xx-1x</p> <p><b>NOTE:</b> EPA is working with industry to develop the above test procedure:</p> <p><i>IES Approved Method for the Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature</i></p> <p>Upon its publication, EPA intends to reference this new metric. This metric is based on the work of ASSIST (<a href="http://www.lrc.rpi.edu/assist">www.lrc.rpi.edu/assist</a>) See: ASSIST May 2008</p>	<p>Provide: A test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]:</p> <ul style="list-style-type: none"> <li>Directional luminaires: one IES LM-79-08 test report for the entire luminaire at the beginning of life, and one IES LM-79-08 data sheet for the entire luminaire at 6,000 hours.</li> <li>Non-directional luminaires: one IES LM-xx-1x test report for each LED light engine model at the beginning of life, and one IES LM-xx-1x data sheet for each engine model at 6,000 hours. Luminaire must be operated continuously in accordance with UL 1598-2008 or UL 153-2002 during the interim 6,000 hours; any deviations from this must be reported.</li> </ul> <p>Sample Size: three complete luminaires, or three LED light engines. Technical Notes: [7]</p> <p>Passing Test: All luminaires must pass to qualify for ENERGY STAR.</p>
<p><b>Halogen Incandescent (outdoor only)</b></p>	<p>Exempt</p>		

**Note:** For lumen maintenance projections for solid state luminaires, two approaches similar to options 1 and 2 from the SSL V1.1 specification have been inserted above for stakeholder comment.

While LED packages themselves may operate reliably for decades under the right conditions, driver components are generally regarded as the weak link in solid state luminaire designs. While option 1 may ensure that LED package(s) / LED module(s) / LED array(s) maintain greater than 70% of initial lumen output over 25khrs or 35 khrs, EPA is concerned that with this option, driver components are not tested over an extended period of time, and optical degradation is not accounted for. For this reason EPA proposes elimination of option 1 in favor of option 2 which provides for extended testing of luminaires (directional) or LED light engines (non-directional), inclusive of any degradation or failure of driver componentry and/or secondary optics. It is recognized that testing LED light engines per option 2 would not account for degradation of decorative optical components of luminaires. EPA seeks comment on this proposal to require option 2 for all qualified luminaires.

Regarding lumen maintenance projection methods, if option 1 is to remain, EPA understands that work on IES TM-21-11, a standardized method for projecting long term lumen maintenance performance based on 6,000 hours of collected data, will be completed in early 2011 in time for the effective date of this specification. Should delays occur, EPA proposes to employ the extrapolation methodology outlined in the SSL V1.1 specification, until TM-21-11 is completed.

Language referencing TM-21-11 will be further refined in a subsequent draft of this specification.

## Correlated Color Temperature (CCT) Requirements: Directional and Non-Directional Indoor Luminaires (Exemption: Outdoor Luminaires)

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>• linear</li> <li>• compact</li> <li>• self ballasted compact (GU24)</li> <li>• circline</li> </ul>	<p>Lamps shipped with luminaires must have one of the following nominal correlated color temperatures (CCT):</p> <ul style="list-style-type: none"> <li>• 2700K</li> <li>• 3000K</li> <li>• 3500K</li> <li>• 4100K</li> </ul> <p>If the lamp is not shipped with the luminaire, product packaging must meet the requirements set forth in Product Labeling &amp; Packaging Requirements.</p>	<p>Measurement (linear &amp; circline): IES LM-9-09</p> <p>Measurement (compact &amp; self ballasted compact): IES LM-66-00</p> <p>Calculation: CIE 15.2004</p>	<p>Provide:</p> <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a>; or</li> <li>3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a>; or</li> <li>4. a test report from an ISO 9000 registered facility.</li> </ol> <p>Sample Size: ≥ 10 lamps must be tested [3], [8]</p> <p>Passing Test: ≥ 90% of the lamps tested fall within a 7-step ANSI MacAdam ellipse for the designated CCT in order to qualify for ENERGY STAR [4]</p>
<b>Solid State</b>	<p>The luminaire (directional luminaires) or LED light engine (non-directional luminaires) must have one of the following nominal correlated color temperatures (CCTs):</p> <ul style="list-style-type: none"> <li>• 2700K</li> <li>• 3000K</li> <li>• 3500K</li> <li>• 4000K</li> </ul> <p>The luminaire or LED light engine must also fall within the corresponding 7-step chromaticity quadrangles as defined in ANSI C78.377-2008.</p>	<p>Chromaticity specifications: ANSI C78.377-2008</p> <p>Measurement (directional): IES LM-79-08</p> <p>Measurement (non-directional): IES LM-xx-1x</p> <p><b>NOTE:</b> EPA is working with industry to develop the above test procedure:</p> <p><i>IES Approved Method for the Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature</i></p> <p>Upon its publication, EPA intends to reference this new metric. This metric is based on the work of ASSIST (<a href="http://www.lrc.rpi.edu/assist">www.lrc.rpi.edu/assist</a>) See: ASSIST May 2008</p> <p>Calculation: CIE 15.2004</p>	<p>Provide:</p> <p>A test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]:</p> <ul style="list-style-type: none"> <li>• Directional luminaires: IES LM-79-08 test report for each luminaire.</li> <li>• Non-directional luminaires: IES LM-xx-1x test report for each LED light engine.</li> </ul> <p>Sample Size: three complete luminaires, or three LED light engines. Technical Notes: [7]</p> <p>Passing Test: All luminaires must pass to qualify for ENERGY STAR.</p>

**Note:** EPA proposes to eliminate target correlated color temperature values greater than 4100K due to historically low interest in qualification of high CCT luminaires. Fewer than 1% of all qualified luminaires in the RLF and SSL programs combined feature high CCT values. EPA seeks comment on this effort to simplify this specification.

**Color Rendering Requirements: Directional and Non-Directional Indoor Luminaires  
(Exemption: Outdoor Luminaires)**

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>• linear</li> <li>• compact</li> <li>• self ballasted compact (GU24)</li> <li>• circline</li> </ul>	<p>Lamps shipped with luminaires must meet the following requirement:</p> <p><math>R_a \geq 80</math>; and <math>R_9 &gt; 0</math></p> <p>If the lamp is not shipped with the luminaire, product packaging must meet the requirements set forth in the Product Labeling &amp; Packaging Requirements section of this specification.</p>	<p>Linear &amp; circline: IES LM-9-09</p> <p>For compact and self ballasted compact: IES LM-66-00</p> <p>Calculation: CIE 13.3-1995</p>	<p>Provide:</p> <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a>; or</li> <li>3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a>.</li> </ol> <p>Sample Size: <math>\geq 10</math> lamps must be tested [3], [8]</p> <p>Passing Test: <math>\geq 80\%</math> of the samples must achieve the required color rendering index value in order to qualify for ENERGY STAR.</p>
<b>Solid State</b>	<p>The luminaire (directional luminaires) or LED light engine (non-directional luminaires) must meet the following requirement:</p> <p><math>R_a \geq 80</math>; and <math>R_9 &gt; 0</math></p>	<p>Directional measurement: IES LM-79-08</p> <p>Non-Directional (LED light engine) measurement: IES LM-xx-1x</p> <p><b>NOTE:</b> EPA is working with industry to develop the above test procedure:</p> <p><i>IES Approved Method for the Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature</i></p> <p>Upon its publication, EPA intends to reference this new metric. This metric is based on the work of ASSIST (<a href="http://www.lrc.rpi.edu/assist">www.lrc.rpi.edu/assist</a>) See: ASSIST May 2008</p> <p>Calculation: CIE 13.3-1995</p>	<p>Provide:</p> <p>A test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]:</p> <ul style="list-style-type: none"> <li>• Directional luminaires: IES LM-79-08 test report for each luminaire; or,</li> <li>• Non-directional luminaires: IES LM-xx-1x test report for each LED light engine.</li> </ul> <p>Sample Size: three complete luminaires, or three LED light engines [7]</p>

**Note:** Seeking to improve the overall color performance of ENERGY STAR qualified luminaires, EPA proposes to extend to all qualified lighting products the positive  $R_9$  requirement established by DOE in the ENERGY STAR Integral LED Lamps specification. While the general color rendering index ("CRI",  $R_a$ ) provides a mean score of a source's color rendering performance across a range of eight pastel test color samples, these samples are known to provide a limited understanding of a source's color rendering performance with strong red objects; the  $R_9$  testing requirement is designed to address this shortcoming.

In consultation with the National Institute of Standards and Technology (NIST), EPA anticipates that most fluorescent lamps currently used to meet the Residential Light Fixture specification ( $R_a \geq 80$ ) have positive  $R_9$  values.



**Color Angular Uniformity: Directional Solid State Indoor Luminaires Only  
(Exemption: Outdoor Luminaires)**

ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
The variation of chromaticity in different directions (i.e., with a change in viewing angle) must be within 0.004 from the weighted average point on the CIE 1976 (u',v') diagram.	Measurement: IES LM-79-08 & IES LM-58-94  Calculations: CIE 15: 2004	Provide: an IES LM-79-08 test report for the luminaire from a laboratory meeting ENERGY STAR laboratory accreditation requirements. Vertical angular scanning resolution must be 1 degree on the 0 and 90 degree vertical planes, and $\Delta u', v'$ distance must be reported for each vertical angle measured [2]

**Note:** Variation in chromaticity by viewing angle is not found in fluorescent sources but can be a problem with LEDs and solid state luminaires. The above requirement is for directional luminaires only since the projection of color striations onto a work surface (from a downlight, under cabinet luminaire or desk task light) would be potentially noticeable and distracting. While this phenomenon is most pronounced and potentially problematic in the near field, standards only provide for far field measurements, therefore, this approach may only address luminaires with the most obvious deficiencies. EPA requests partner input on the utility of this approach.

**Color Maintenance: Solid State Indoor Luminaires Only  
(Exemption: Outdoor Luminaires)**

ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
The change of chromaticity over the rated lumen maintenance life of the luminaire must be within 0.007 on the CIE 1976 (u',v') diagram.	IES LM-80-08 IES LM-79-08	Provide: A test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]: 1. An IES LM-80-08 test report for the LED packages, LED array or modules [1]; or 2. An IES LM-79-08 test report for the entire luminaire at the beginning of life, and one IES LM-79-08 data sheet for the entire luminaire at 6,000 hours [1]  Passing Test: at 6,000 hours the distance of the average chromaticity coordinates from the initial chromaticity coordinates must not be greater than: <ul style="list-style-type: none"> <li>• 0.002 for residential indoor luminaires</li> <li>• 0.001 for residential outdoor and commercial luminaires</li> </ul>

**Note:** EPA proposes to evaluate chromaticity shift over the first 6,000 hours as a measure of a luminaire's progress toward a 0.007 threshold. LM-80 test reports for LED packages or LED arrays/modules include chromaticity shift reported over the measurement time. The passing values above are portions of the failure threshold (0.007) based on the first 6,000 hours, a portion of the rated lumen maintenance life (see Lumen Maintenance requirements). EPA seeks comment on this approach to improving long term color maintenance performance of qualified solid state luminaires.

## Lamp Shipment Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul> <b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"> <li>metal halide</li> <li>ceramic metal halide</li> <li>high pressure sodium</li> </ul> <b>Halogen Incandescent (outdoor only)</b>	<p>All luminaires must be shipped with a lamp for each lampholder.</p> <p><u>Exceptions:</u></p> <ol style="list-style-type: none"> <li>1. Linear fluorescent luminaires</li> <li>2. Solid state luminaires</li> <li>3. Outdoor luminaires employing ANSI E26 lampholders.</li> </ol> <p>Lamps must utilize an ANSI/IEC standardized lamp base configuration, as defined by ANSI C81.61 and IEC 60061-1.</p> <p>Fluorescent and high intensity discharge lamp bases must be labeled with the lamp manufacturer name, wattage, correlated color temperature, and color rendering index.</p> <p>In addition, lamps must either:</p> <ul style="list-style-type: none"> <li>• Meet the requirements of an ANSI/IEC standardized lamp specification sheet, as defined by ANSI C78.901-2001 and IEC 60901 (for compact fluorescent lamps) or ANSI C78.81-2001 and IEC 60081 (for linear lamps) if an applicable standard exists, or,</li> <li>• If no ANSI/IEC lamp standard exists (e.g., a spiral compact fluorescent lamp), a custom lamp specification sheet must be provided at the time of submittal. Specific lamp characteristics that should be included in the lamp specification sheet are detailed in the Required Documentation column.</li> </ul>	<p>Lamp base configuration: ANSI C81.61- 2005</p> <p>Lamps Compliant with an ANSI-IEC Standard (for lamp dimensions and electrical parameters): ANSI C78.901-2005; ANSI C78.81-2010; IEC 60901; IEC 60081</p> <p>Lamps Not Compliant with an ANSI-IEC Standard (for lamp dimensions and electrical parameters): ANSI C78.901-2005; ANSI C78.81-2010 (used as a reference for the format and type of information required on a custom lamp specification sheet)</p>	<p>Provide:</p> <ol style="list-style-type: none"> <li>1. A copy of the actual language that will be included on the base of the lamp.</li> <li>2. Lamps Compliant with an ANSI-IEC Standard (for lamp dimensions and electrical parameters): Provide manufacturer data indicating applicable ANSI-IEC lamp data sheet number.</li> <li>3. Lamps Not Compliant with an ANSI-IEC Standard (for lamp dimensions and electrical parameters): provide a manufacturer lamp specification sheet that describes the following (use the ANSI lamp data sheets found in ANSI C78.901 and C78.81 as a reference for the format and type of information requested): <ol style="list-style-type: none"> <li>1. Lamp Description, including: <ul style="list-style-type: none"> <li>• Lamp Model Number</li> <li>• Nominal Wattage</li> <li>• Bulb Designation / Lamp Size (i.e., T4, T5, T8, etc.)</li> <li>• Lamp Base Type as defined by ANSI C81.61 or IEC 60061-1(i.e., 2G13, GR10q, etc.)</li> <li>• Starting Circuit Application (i.e., rapid start, preheat, etc.)</li> </ul> </li> <li>2. Dimensional Characteristics, including diagram</li> <li>3. Lamp Operating Characteristics, including: <ul style="list-style-type: none"> <li>• Approximate wattage (W)</li> <li>• Voltage(V)</li> <li>• Current (A)</li> </ul> </li> </ol> </li> </ol>

**Note:** Lamp labeling requirements have been placed within the lamp shipment requirements.

## Electrical Performance Requirements

### Source Start Time: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul>	The time needed after switching on the lamp to start continuously and remain illuminated must be an average of one second or less.	ANSI C82.11-2002 Section-5.2	Provide: <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a>; or</li> <li>3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a>; or</li> <li>4. a test report from an OSHA NRTL laboratory.</li> </ol> Sample Size: $\geq 3$ lamp/ballast combination samples must be tested [1] Passing Test: All samples must pass in order to qualify for ENERGY STAR.
<b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"> <li>metal halide</li> <li>ceramic metal halide</li> <li>high pressure sodium</li> </ul>	Exempt		
<b>Solid State</b>			
<b>Halogen Incandescent (outdoor only)</b>	Not applicable		

### Source Run-up Time: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul>	The time needed after switching on the lamp to reach full rated lumen output must be an average of: <ul style="list-style-type: none"> <li><math>\leq 1</math> minute for non-amalgam lamps</li> <li><math>\leq 3</math> minutes for amalgam lamps</li> </ul>	ANSI C78.5, clauses 3.11 and 4.8.	Provide: <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a>; or</li> <li>3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a>; or</li> <li>4. a test report from an OSHA NRTL laboratory.</li> </ol> Sample Size: $\geq 3$ lamp/ballast combination samples must be tested. [1] Passing Test: All samples must pass in order to qualify for ENERGY STAR.
<b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"> <li>metal halide</li> <li>ceramic metal halide</li> <li>high pressure sodium</li> </ul>	Exempt		
<b>Solid State</b>			
<b>Halogen Incandescent (outdoor only)</b>	Not applicable		

**Note:** EPA recognizes run-up time as a performance criterion of importance to consumers and therefore proposes to, at minimum, implement the same performance requirement (above) found in the ENERGY STAR compact fluorescent lamp specification. EPA seeks comment on this approach, and the potential for further strengthening this requirement.

### Lampholder Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul> <b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"> <li>metal halide</li> <li>ceramic metal halide</li> <li>high pressure sodium</li> </ul> <b>Halogen Incandescent (outdoor only)</b>	<p>The lampholder must be designed to accept lamps with ANSI/IEC standardized lamp base configurations for all applicable wattages. For example, if the ballast can operate lamps with multiple wattages (e.g., an 18W, 26W, or 32W lamp) then the lampholder must be designed to accept lamps with ANSI/IEC standardized lamp base configurations for all three applicable wattages.</p> <p>Note: With the exception of halogen incandescent lamps used in outdoor models, luminaires employing screwbase lampholders (i.e. E26, E26d E12, E17, E39, E39d) are not eligible to earn the ENERGY STAR.</p>	Lampholder configuration: ANSI/IEC C82.62-2005	Provide: A test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program confirming the lampholder configuration.
<b>Solid State</b>	Exempt		

**Note:** EPA supports the development of electrical connectors allowing for user replacement of solid state lighting componentry at end of life. As standards for SSL electrical connections are not yet available, solid state luminaires are exempt from this requirement. EPA may implement requirements as standards become available.

### Dimming: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul> <b>Solid State</b>	To be determined		

**Note:** EPA intends to develop dimming performance requirements for luminaires offering dimming features, and is monitoring industry efforts to develop standards for dimming compatibility between controls and lighting products. Dimming requirements for this specification are to be determined, and will be available for stakeholder review and comment in a subsequent draft of this specification.

**Photosensor Controls: Directional and Non-Directional Outdoor Luminaires Only  
(Exemption: Indoor Luminaires)**

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>All Source Types (outdoor only)</b>	The luminaire must contain an integrated photosensor that automatically prevents operation during daylight hours. In addition, the control must automatically reactivate within 24 hours of a manual override or testing operation.	No Standard Available (Use manufacturer protocol)	Provide: Applicable sections of luminaire manual(s) that demonstrate a photosensor is integral to each luminaire being submitted. [5]

**Note:** EPA has received considerable feedback from manufacturing partners questioning the photosensor requirement for non-incandescent luminaires. Some partners have cited concerns including:

- availability of photosensors listed by UL for outdoor applications
- interactions between qualified luminaires due to installation problems (e.g. one luminaire is turned off due to the light output of another luminaire)
- lack of photosensor requirements in state building codes featuring more stringent lighting requirements (e.g. California, Oregon, Washington)
- inability to apply photosensor controls to certain popular luminaire designs due to geometrical constraints
- aesthetic concerns
- photosensor reliability concerns
- installations that would be better served by one central photosensor controlling outdoor circuits

To better understand the potential implications of removing this requirement, EPA evaluated 1,000 homes in 30 neighborhoods located in 10 cities across the United States. Of more than 2,800 luminaires reviewed, fewer than 10% were found to be operating during daylight hours (early afternoon). Based on historical market share data, a small percentage of the luminaires found to be off may be qualified models, and may have been found in the off state due to operation of photosensors.

EPA seeks stakeholder feedback on the potential for removing the Photosensor Control requirement, with the goal of increasing market penetration through reduced luminaire design constraints in order to expand the number of qualified luminaires available to consumers.

EPA does not propose to eliminate this requirement for halogen incandescent luminaires.

## Power Factor: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul>	≥ 0.5	ANSI C82.2 - 2002  ANSI C82.77-2002	Provide: <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or,</li> <li>2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a>; or</li> <li>3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a>; or</li> <li>4. a test report from the ballast manufacturer.</li> </ol> <p>Sample Size: ≥ 3 ballast samples must be tested [1]</p> <p>Passing Test: All samples must pass in order to qualify for ENERGY STAR.</p>
<b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"> <li>metal halide</li> <li>ceramic metal halide</li> <li>high pressure sodium</li> </ul>	≥ 0.90	ANSI C82.6-2005	Provide: <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or,</li> <li>2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a>; or</li> <li>3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a>; or</li> <li>4. a test report from the ballast manufacturer.</li> </ol> <p>Sample Size: ≥ 3 ballast samples must be tested [5]</p> <p>Passing Test: All samples must pass in order to qualify for ENERGY STAR.</p>
<b>Solid State</b>	Residential: ≥ 0.70 Commercial: ≥ 0.90	ANSI C82.77-2002	Provide: <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [1]</li> </ol>
<b>Halogen Incandescent (outdoor only)</b>	Exempt		

**Note:** EPA proposes the above power factor requirements after consultation with various industry stakeholders. The above values pose no significant tradeoffs for utilities, and represent what is both broadly accessible in the market and cost effective for consumers.

## Transient Protection: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>• linear</li> <li>• compact</li> <li>• self ballasted compact (GU24)</li> <li>• circline</li> </ul> <b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"> <li>• metal halide</li> <li>• ceramic metal halide</li> <li>• high pressure sodium</li> </ul> <b>Solid State</b>	Ballast or driver must comply with ANSI/IEEE C62.41, Class A operation. The line transient must consist of seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.	ANSI/IEEE C62.41.2 -2002	Provide: <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a>; or</li> <li>3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a>.</li> </ol> <p>Sample Size: ≥ 3 ballast or driver samples must be tested [1], [5]</p> <p>Passing Test: All samples must pass in order to qualify for ENERGY STAR.</p>
<b>Halogen Incandescent (outdoor only)</b>	Whole luminaire, including photosensor and motion sensor, must comply with ANSI/IEEE C62.41, Class A operation. The line transient must consist of seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.		Provide: <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a>; or</li> <li>3. EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a>.</li> </ol> <p>Sample Size: ≥ 3 luminaire samples must be tested [5]</p> <p>Passing Test: All samples must pass in order to qualify for ENERGY STAR.</p>

### Lamp Current Crest Factor: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul>	$\leq 1.7$	ANSI C82.11-2002 Sections 3.3.3 and 5.6  ANSI C82.1-2004 Section 5.6.1	Provide: <ol style="list-style-type: none"> <li>a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a>; or</li> <li>EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a>; or</li> <li>a test report from an OSHA NRTL laboratory.</li> </ol> Sample Size: $\geq 3$ ballast samples must be tested [5]  Passing Test: All samples must pass in order to qualify for ENERGY STAR.
<b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"> <li>metal halide</li> <li>ceramic metal halide</li> <li>high pressure sodium</li> </ul>	Exempt		
<b>Solid State</b>			
<b>Halogen Incandescent (outdoor only)</b>			

### Off-State Power Consumption Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>All Source Types</b>	<p>Luminaires must not draw power in the off state.</p> <p><u>Exception:</u> Luminaires with integral motion sensors, photosensors or individually addressable luminaires with external control and intelligence must consume no more than 0.5 watts in the off state.</p> <p><u>Exception:</u> Power supplies connected to multiple luminaires may draw up to 1.5 watts in the off state.</p> <p><u>Exception:</u> Luminaires employing an external power supply (EPS) must use either:</p> <ul style="list-style-type: none"> <li>an EPS that is ENERGY STAR qualified; or,</li> <li>an EPS that meets the applicable no-load mode limits, active mode efficiency levels, and power factor requirements provided in the latest version of the <a href="#">ENERGY STAR Program Requirements for Single Voltage External AC-AC and AC-DC Power Supplies</a>.</li> </ul>	No Standard Available (Use manufacturer protocol)	<p>No documentation required.</p> <p>Test report must be provided to EPA upon request.</p>



## Operating Frequency: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul>	20 to 33 kHz or $\geq 40$ kHz	ANSI C82.2	Provide: <ol style="list-style-type: none"> <li>a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>a Platform Approval Number from the <a href="#">EPA Approved Platform Database</a>; or</li> <li>EPA-approved documentation from an industry association, such as the <a href="#">NEMA/ALA matrices</a>; or</li> <li>a test report from the ballast manufacturer.</li> </ol> Sample Size: $\geq 3$ ballast samples must be tested [5]  Passing Test: All samples must pass in order to qualify for ENERGY STAR.
<b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"> <li>metal halide</li> <li>ceramic metal halide</li> <li>high pressure sodium</li> </ul>	Exempt		
<b>Solid State</b>	$\geq 120$ Hz  Note: This performance characteristic addresses problems with visible flicker due to low frequency operation and applies to steady-state as well as dimmed operation. Dimming operation must meet the requirement at all light output levels.	Oscilloscope or frequency counter	No supplemental documentation required.  Test report must be provided to EPA upon request.
<b>Halogen Incandescent (outdoor only)</b>	Exempt		

**Note:** EPA recognizes that frequency alone may not be sufficient to avoid flicker and/or stroboscopic effects with all end users, particularly with solid state luminaires. An [IEEE working group](#) is underway to provide recommended practices to aid in the design of LED products. Once more conclusive research is available with comprehensive recommendations for operating frequency, modulation depth and other related performance criteria, EPA will explore strengthening the above frequency requirement for solid state luminaires.

### Ballast/Driver Replaceability: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"><li>• linear</li><li>• compact</li><li>• self ballasted compact (GU24)</li><li>• circline</li></ul>	Ballasts or drivers in all luminaires must be accessible and removable by an electrician without the cutting of wires and without damage to the luminaire housing, trim, decorative elements or the carpentry (e.g., ceiling drywall) to which the luminaire is attached.	No Standard Available (Use manufacturer protocol)	Provide: A copy of the language that includes guidance on ballast or driver replacement and states that the ballast or driver is replaceable with the use of a “qualified electrician.”
<b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"><li>• metal halide</li><li>• ceramic metal halide</li><li>• high pressure sodium</li></ul>			
<b>Solid State</b>			
<b>Halogen Incandescent (outdoor only)</b>	Not applicable		

### Electromagnetic and Radio Frequency Interference: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>All Source Types</b>	Power supplies must meet FCC requirements: <ul style="list-style-type: none"> <li>Consumer Emission Limits for power supplies designated for residential use</li> <li>Non-consumer Emission Limits for power supplies designated for commercial use</li> </ul>	Code of Federal Regulations: FCC 47 CFR Part 15/18	No documentation required.  Test report must be provided to EPA upon request.

### Noise: Directional and Non-Directional Luminaires (Exemption: Outdoor Luminaires)

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul>	Class A sound rating for electronic ballasts & drivers within the luminaire, not to exceed a measured level of 24 dBA (audible) when the ballast or driver is installed in the luminaire.	Noise must be measured using a sound meter (similar in performance to B&K type 2209) where the microphone is located 12 inches from the luminaire in any direction.	No documentation required.  Test report must be provided to EPA upon request.
<b>Solid State</b>			

## Thermal Performance Requirements

### Maximum Measured Ballast or Driver Case Temperature during Normal Operation Inside Luminaire(s): Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul>	<p>Measured ballast case temperature measured at thermal equilibrium not to exceed the ballast manufacturer maximum recommended ballast case temperature during normal operation inside a luminaire.</p> <p>Note: This performance characteristic is separate and distinct from thermal requirements established by UL, which governs safety rather than longevity of the ballast. All qualified luminaires are expected to meet this requirement, including linear, suspended, close-to-ceiling, IC, ICAT and non-IC recessed canisters, etc. as well as those luminaires that may be exempt from UL1598.</p> <p><u>Exceptions:</u></p> <ul style="list-style-type: none"> <li>Indoor portable luminaires using GU24 lamps</li> <li>Outdoor luminaires</li> </ul>	<p>UL 1598-2008</p> <p>(Acceptable when the thermocouple is placed at the hot-spot location indicated by the ballast manufacturer.)</p>	<p>Provide a test report from:</p> <ol style="list-style-type: none"> <li>a laboratory meeting ENERGY STAR laboratory accreditation requirements [2]; or</li> <li>an OSHA NRTL laboratory; or</li> <li>any laboratory registered with UL to perform this test.</li> </ol> <p>Provide: A temperature test report containing all of the following information:</p> <ul style="list-style-type: none"> <li>Luminaire model(s) tested</li> <li>Lamp model(s) and ballast model(s) tested</li> <li>Measured maximum ballast case temperatures</li> <li>Ambient temperature</li> <li>Test procedure, including description of luminaire installation, thermocouple location(s), and time that elapsed before readings were taken.</li> <li>Ballast Manufacturer Maximum Recommended Case Temperature During Normal Operation Inside the Luminaire(s)</li> <li>Ballast Hot Spot Location Diagram from the ballast manufacturer</li> </ul> <p>Sample Size: 1 luminaire must be tested [1]</p> <p>Passing Test: Measured temperature at the appropriate ballast case test point must be less than the manufacturer recommended maximum.</p> <p>Laboratory test results must be produced using the luminaire with the highest operating temperature among all luminaires being qualified.</p>
<b>Solid State, Directional</b>	<p>Measured driver case temperature measured at thermal equilibrium not to exceed the LED driver manufacturer maximum recommended driver case temperature during <i>in situ</i> operation.</p> <p>Note: This performance characteristic is separate and distinct from safety requirements.</p>		<p>Provide each of the following:</p> <ol style="list-style-type: none"> <li>a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program detailing the temperature measurement point (TMP<sub>C</sub>) for the hottest location on the driver case [2]</li> <li>a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program detailing <i>in situ</i> TMP<sub>C</sub> temperature measurements for the LED package(s) / LED module(s) / LED array(s) employed in the luminaire [2]</li> </ol> <p>Sample Size: 1 luminaire must be tested [1]</p> <p>Passing Test: Measured temperature at the TMP<sub>C</sub> must be less than the manufacturer recommended maximum.</p> <p>Laboratory test results must be produced using the luminaire with the highest operating temperature among all luminaires being qualified.</p>

<b>Solid State, Non-Directional</b>	<p>Measured driver case temperature (TMP<sub>C</sub>) measured at thermal equilibrium not to exceed the LED driver manufacturer maximum recommended driver case temperature during <i>in situ</i> operation. Note: This performance characteristic is separate and distinct from safety requirements.</p>	<p>IES LM-xx-1x</p> <p><b>NOTE:</b> EPA is working with industry to develop the above test procedure:</p> <p><i>IES Approved Method for the Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature</i></p> <p>Upon its publication, EPA intends to reference this new metric. This metric is based on the work of ASSIST (<a href="http://www.lrc.rpi.edu/assist">www.lrc.rpi.edu/assist</a>)</p> <p>See: ASSIST May 2008</p>	<p>Provide a test report from:</p> <ol style="list-style-type: none"> <li>1. an ENERGY STAR approved laboratory; or</li> <li>2. an OSHA NRTL laboratory.</li> </ol> <p>Sample Size: One light engine sample must be tested [1]</p> <p>Passing Test: Measured temperature at the TMP<sub>C</sub> must be less than the manufacturer recommended maximum.</p>
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**Minimum Operating Temperature: Directional and Non-Directional Outdoor Luminaires  
(Exemption: Indoor Luminaires)**

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>All Source Types</b>	Luminaire must have a minimum operating temperature of -20°C or below.	No Standard Available (Use manufacturer protocol)	<p>No documentation required.</p> <p>Test report must be provided to EPA upon request.</p>

## Recessed Downlight Thermal Performance Requirements

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>• linear</li> <li>• compact</li> <li>• self ballasted compact (GU24)</li> <li>• circline</li> </ul> <b>Solid State</b>	<p>Recessed downlight luminaires that are either IC-Rated for direct contact with insulation or non IC-Rated may qualify as ENERGY STAR. For luminaires to be considered IC-Rated they must be approved for zero clearance insulation cover (IC) by an OSHA NRTL laboratory. Recessed downlight luminaires that are IC-Rated must also meet the requirements for air tight luminaires, listed below.</p> <p>Recessed downlight luminaires that are either air tight or not air tight may qualify as ENERGY STAR. For luminaires to be considered air tight, the housing or certified/listed accessory must have leakage less than 2.0 cubic feet per minute (CFM) at 75 Pascals (or 1.57 lbs/ft<sup>2</sup>) when tested in accordance with ASTM E283 and must be sealed with a gasket or caulk.</p> <p>For recessed downlight luminaires that are air tight, the following measures must be taken to ensure that luminaires can be properly installed and inspected:</p> <ol style="list-style-type: none"> <li>1. Product packaging must meet the requirements set forth in the Product Labeling &amp; Packaging Requirements</li> <li>2. The luminaire itself must include a label certifying "air tight", or similar designation, to show air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283. The label must be clearly visible to a building inspector.</li> <li>3. Installation instructions must be included listing all components of the assembly that will be necessary to ensure an airtight installation and how the components should be properly installed. For example, depending on the method used to achieve air-tight operation, the instructions should alternatively show how a gasket is to be attached, what type of caulk to use and how it should be applied, or which certified airtight trim kits are designed to be installed with the luminaire housing.</li> </ol>	ASTM E283-2004	<p>No documentation required.</p> <p>Test report must be provided to EPA upon request.</p>

## Safety Requirements

Note: qualified luminaires carrying a UL damp or wet label must meet all applicable outdoor requirements in this specification.

**Note:** EPA understands that end of life (EOL) requirements for T4 and T5 sized fluorescent lamps are now present in the UL safety standards detailed below. Therefore, there is no EOL requirements section in this specification.

### Indoor Luminaire Safety - Portable Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"><li>• linear</li><li>• compact</li><li>• self ballasted compact (GU24)</li><li>• circline</li></ul> <b>Solid State</b>	Demonstrate compliance with ANSI/UL 153-2002.	ANSI/UL 153-2002	Provide: The cover page of a safety test report or a general coverage statement from an OSHA NRTL laboratory.

### Indoor Luminaire Safety - Hardwired Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"><li>• linear</li><li>• compact</li><li>• self ballasted compact (GU24)</li><li>• circline</li></ul> <b>Solid State</b>	Demonstrate compliance with UL 1598-2008.	UL 1598-2008	Provide: The cover page of a safety test report or a general coverage statement from an OSHA NRTL laboratory.

### Outdoor Luminaire Safety

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>All Source Types</b>	Demonstrate compliance with NFPA 70, the National Electrical Code (NEC), including requirements for wet or damp locations (Articles 410-4a and Article 100).	NFPA 70 (2008 Edition), the National Electrical Code (NEC), including requirements for wet locations when applicable (Articles 410-4a and Article 100)	Provide: The cover page of a safety test report or a general coverage statement from an OSHA NRTL laboratory. Include evidence of a Rain Test for Wet Locations, when applicable.  For wet listed luminaires: Provide a copy of the wet location safety test report [1]

### Electronic Ballast Requirements - Safety - Ballasts and “Non-Edison base Fluorescent Adapters”

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"><li>• linear</li><li>• compact</li><li>• self ballasted compact (GU24)</li><li>• circline</li></ul>	Demonstrate compliance with ANSI/UL 935-2001 or UL 1993-2009, as appropriate.	ANSI/UL 935-2001 or UL 1993-2009	Provide: A cover page of a safety test report or a general coverage statement from an OSHA NRTL laboratory.

## Product Labeling & Packaging Requirements

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>Fluorescent</b> <ul style="list-style-type: none"> <li>linear</li> <li>compact</li> <li>self ballasted compact (GU24)</li> <li>circline</li> </ul> <b>High Intensity Discharge (outdoor only)</b> <ul style="list-style-type: none"> <li>metal halide</li> <li>ceramic metal halide</li> <li>high pressure sodium</li> </ul> <b>Halogen Incandescent (outdoor only)</b>	<p><b>For luminaires shipped with lamps:</b></p> <ul style="list-style-type: none"> <li>Packaging must clearly describe the nominal color designation of the lamp in units of Kelvin (i.e., 2700K, 3000K, 3500K, 4100K).</li> </ul> <p><b>Note: for luminaires shipped with GU24 based integrated lamps:</b></p> <ul style="list-style-type: none"> <li>Language for mercury content on both luminaire and luminaire packaging must include the following: <a href="http://www.epa.gov/bulbrecycling">www.epa.gov/bulbrecycling</a> or <a href="http://www.lamprecycle.org">www.lamprecycle.org</a></li> </ul> <p><b>For luminaires not shipped with lamps:</b></p> <ul style="list-style-type: none"> <li>Packaging must include a list of lamp types that would ensure ENERGY STAR quality and performance when paired with the qualifying luminaire. This list must be clearly visible to the consumer on the luminaire packaging. These can be generic NEMA or ANSI lamp descriptions, including a color designation (e.g., F32T8/830 or CFQ26W/G24q/827)</li> <li>Packaging must suggest that consumers select a lamp with a rated life of 10,000 hours or more.</li> </ul> <p><b>For recessed downlight luminaires that are Insulation-Contact (IC) rated:</b></p> <ul style="list-style-type: none"> <li>Product packaging must clearly state this rating. Sample language: "IC-rated for direct contact with insulation".</li> </ul> <p><b>For recessed downlight luminaires that are Air-Tight (AT) certified:</b></p> <ul style="list-style-type: none"> <li>Packaging must clearly show that the luminaire produces less air leakage than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283. Sample language: "Certified Air Tight per ASTM E283."</li> </ul> <p><b>For outdoor luminaires:</b> Packaging must indicate the minimum (lowest) starting temperature for the lamp and ballast platform of the luminaire.</p> <p><b>Dimming capability and compatibility:</b> External packaging must state any known incompatibilities with dimmers, occupancy or vacancy sensors, timing devices or any other external lighting controls.</p>	No Standard Available (Use manufacturer protocol)	<p>Provide:</p> <ol style="list-style-type: none"> <li>Language or a graphic of the language that will be displayed on product packaging and within the packaging, as required (e.g., installation instructions for air-tight rated luminaires).</li> <li>If product is marketed as dimmable, a copy of the language that includes dimming range and known lighting control incompatibilities.</li> <li>Included documentation must clearly state any known incompatibility with photo-controls, dimmers or timing devices.</li> </ol>
<b>Solid State</b>	<p>Packaging must clearly describe the nominal color designation in units of Kelvin (i.e., 2700K, 3000K, 3500K, 4000K).</p> <p><b>For recessed downlight luminaires that are Insulation-Contact (IC) rated:</b></p> <ul style="list-style-type: none"> <li>Product packaging must clearly state this rating. Sample language: "IC-rated for direct contact with insulation".</li> </ul> <p><b>For recessed downlight luminaires that are Air-Tight (AT) certified:</b> Packaging must clearly show that the luminaire produces less air leakage than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283. Sample language: "Certified Air Tight per ASTM E283."</p> <p><b>For outdoor luminaires:</b> Product packaging must indicate the minimum (lowest) starting temperature of the luminaire.</p> <p><b>Dimming capability and compatibility:</b> External packaging must state any known incompatibilities with dimmers, occupancy or vacancy sensors, timing devices or any other external lighting controls.</p>		

## Lighting Toxics Reduction Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>All Source Types</b>	Luminaires must not exceed hazardous substance concentration limits set forth in the European Union's (EU) Restriction of the Use of Certain Hazardous Substances (RoHS) directive.  Fluorescent lamps (all types) must not contain more than 5 milligrams of mercury.	<u>EU Directive 2002/95/EC</u>	To be determined.

**Note:** Consistent with its mission to protect human health and the environment, EPA is proposing to apply the above requirement to all ENERGY STAR qualified luminaires.

EPA is proposing a 5 milligram mercury content limit for all fluorescent lamp types including linear, circline, and compact fluorescent lamps, both self ballasted and otherwise.

Documentation requirements are under development; in a subsequent draft EPA will detail requirements for stakeholder review and comment.

## ENERGY STAR Labeling of Luminaire

While not a requirement for qualification, EPA strongly recommends manufacturers provide a conspicuous ENERGY STAR certification mark (e.g. sticker, hangtag) on qualified luminaires themselves:

- to facilitate building inspectors confirming qualification status of installed luminaires
- to provide out-of-the-box marketing of the luminaire's ENERGY STAR qualification
- to demonstrate to consumers a partner's commitment to advancing energy efficiency in lighting



## Warranty Requirements: Directional and Non-Directional Luminaires

Source Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>All Source Types</b>	<p>A written unconditional warranty must be included with luminaire packaging at the time of shipment, which covers repair or replacement of defective parts of the luminaire housing, optics, trim and electronics for a minimum of three years from the date of purchase.</p> <p>Lamps which are not self-ballasted are not included in this requirement.</p> <p>Manufacturer is solely responsible for honoring warranty; intermediate parties (e.g. showrooms, electrical distributors, retailers) are not responsible for meeting manufacturer's warranty requirements.</p> <p><u>Exceptions:</u> for the following, the above requirements are limited to two years:</p> <ul style="list-style-type: none"> <li>• Luminaires employing GU24 based integrated lamps</li> <li>• Luminaires employing LED light engines which can be replaced manually or with a screwdriver</li> </ul>	No Standard Available (Use manufacturer protocol)	<p>Provide:</p> <p>A copy of the actual luminaire manufacturer written warranty that is included with product packaging.</p>

**Note:** Seeking parity for warranty requirements, EPA proposes to apply to all qualified luminaires the strongest ENERGY STAR warranty requirement to date: three years, per the SSL V1.1 specification. Recognizing that replacement of the light source may resolve many warranty issues, EPA proposes shorter required warranty terms - two years - for luminaires with the simplest means of source replacement: GU24 based integrated lamps, and luminaires with replaceable LED light engines. EPA requests comment on this approach.

## Appendix A:

### GU24 Integrated Lamp Requirements For ENERGY STAR Qualification

Note: At this time these requirements apply to self-ballasted compact fluorescent lamps only; expansion of requirements for GU24 based lamps to other technologies will take place with the development of the ENERGY STAR Lamps specification.

**Note:** EPA intends to move performance requirements for GU24 based integrated lamps to the forthcoming ENERGY STAR Lamps specification, development of which is slated to begin in the fall of 2010. In the interim, requirements for GU24 based integrated lamps will be located in this appendix. Partners may continue to use qualified GU24 lamps in their luminaire designs toward fulfillment of numerous performance requirements of ENERGY STAR.

At this time, these requirements apply to self-ballasted compact fluorescent lamps only; expansion of requirements for GU24 based lamps to other technologies will take place with the development of the ENERGY STAR Lamps specification.

Metric	ENERGY STAR Requirements	Methods of Measurement and/or Reference Standards	Required Documentation
<b>System Efficacy</b>  <b>Per Integrated Lamp in Lumens Per Watt (LPW)</b>	Bare Lamps: ≥ 70 LPW  Covered, Reflector, and Dimmable Lamps: ≥ 50 LPW for all lamp types and wattages	LM-66-00  ANSI C78.5 - 2003	Provide: 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or 2. EPA-approved documentation from an industry association.  Sample Size: ≥ 10 samples must be tested for each testing orientation selected for the submittal.  Passing Test: ≥ 80% of the samples must achieve the required System Efficacy value.
<b>Average Rated Lamp Life</b>	Bare Lamps: The average rated life of the lamp must be ≥ 10,000 hours.  Covered, Reflector, and Dimmable Lamps: The average rated life of the lamp must be ≥ 8,000 hours.	IES LM-65-01  ANSI C78.5 - 2003	Provide: 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or 2. EPA-approved documentation from an industry association.  Sample Size: ≥ 10 samples must be tested for each testing orientation selected for the submittal.  Passing Test: ≥ 50% of the samples must be functioning at the lifetime requirement [6]
<b>1,000-Hour Lumen Maintenance</b>	Must be greater than 90.0% of initial (100-hour) lumen output at 1,000 hours of rated life.	IES LM-65-01 IES LM-66-00  ANSI C78.5 - 2003 Section 4.10	Provide: 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or 2. EPA-approved documentation from an industry association.  Sample Size: ≥ 10 samples must be tested for each Testing Orientation selected for the submittal.  Passing Test: ≥ 80% of the samples must achieve the required lumen maintenance value [6]
<b>Lumen Maintenance at 40% of Rated Life</b>	Must be greater than 80.0% of initial (100-hour) lumen output at 40% of rated life.	IES LM-65-01 IES LM-66-00  ANSI C78.5 - 2003 Section 4.10	Provide: 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or 2. EPA-approved documentation from an industry association.  Sample Size: ≥ 10 samples must be tested for each Testing Orientation selected for the submittal.  Passing Test: ≥ 80% of the samples must achieve the required lumen maintenance value[6]
<b>Accelerated Cycling, Thermal, and Voltage (ACTV) Stress Test</b>	Lamp must remain operational for 2,880 cycles @ 60°C or 720 cycles at 80°C	<u>Lighting Research Center (LRC) Test Method</u>	Provide: 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program. [2]  Sample Size: 5 or 10 samples must be tested for each testing orientation selected for the submittal.  Passing Test: If a sample size of 5 is chosen, then ALL 5 samples must remain functional for the duration of the test. If a sample size of 10 is used then 1 sample failure is permitted.
<b>Color Rendering Index</b>	$R_a \geq 80$ ; and $R_9 > 0$	IES LM-58-94  IES LM-16-93	Provide: 1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or 2. EPA-approved documentation from an industry association.

		CIE 13.3-1995	<p>Sample Size: ≥ 10 samples must be tested for each testing orientation selected for the submittal.</p> <p>Passing Test: ≥ 80% of the samples must achieve the required color rendering index value.</p>
<b>Correlated Color Temperature</b>	Lamps must have one of the following designated correlated color temperatures (CCT): 2700K, 3000K, 3500K, or 4100K	<p>IES LM-58-94</p> <p>LM-16-93</p> <p>CIE 15:2004</p>	<p>Provide:</p> <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. EPA-approved documentation from an industry association.</li> </ol> <p>Sample Size: ≥ 10 samples must be tested for each testing orientation selected for the submittal.</p> <p>Passing Test: ≥ 90% of the samples tested fall within a 7-step ANSI MacAdam ellipse for the designated CCT [4]</p>
<b>Lamp Base</b>	Lamp base configuration must utilize the GU24 base.	ANSI C81.61-2005	No supplemental documentation is required.
<b>Lighting Toxics Reduction Requirements</b>	<p>Luminaires must not exceed hazardous substance concentration limits set forth in the European Union's (EU) Restriction of the Use of Certain Hazardous Substances (RoHS) directive.</p> <p>Fluorescent lamps (all types) must not contain more than 5 milligrams of mercury.</p>	<u>EU Directive 2002/95/EC</u>	To be determined (see page 36).
<b>Labeling for Replacement GU24 Lamps</b>  <b>(language printed on integrated lamp base)</b>	<p>Required lamp labeling language for consumer replacement must include a manufacturer designation that encompasses the following:</p> <ul style="list-style-type: none"> <li>• lamp manufacturer name</li> <li>• lamp wattage</li> <li>• correlated color temperature</li> <li>• color rendering index</li> </ul> <p>Additional packaging requirements for mercury content are included in the Product Packaging and Lamp Labeling for Consumer Awareness Requirements, below.</p>	No Standard Available (Use manufacturer protocol – optionally, manufacturer may use the NEMA or ANSI generic lamp description).	<p>Provide:</p> <p>A copy of the actual language that is included on the base of the GU24 product.</p>
<b>General Ballast Requirement</b>	Integrated lamps are required to meet the general requirement of ANSI C78.5, in addition to the specific requirements listed below.	ANSI C78.5 -2003	No supplemental documentation is required.
<b>Lamp Start Time</b>	The time needed after switching on the lamp to start continuously and remain illuminated must be one second or less.	ANSI C78.5 -2003 Section 4.7, for test conditions and methodology	<p>Provide:</p> <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. EPA-approved documentation from an industry association; or</li> <li>3. a test report from an OSHA NRTL laboratory.</li> </ol> <p>Sample Size: ≥ 10 samples must be tested for each testing orientation selected for the submittal.</p> <p>Passing Test: ≥ 80% of the samples tested must meet the required lamp start time.</p>
<b>Run-up Time</b>	<p>Non-amalgam: Average of 10 samples tested must be less than 1.0 minute per ANSI C78.5, Section 3.11 and 4.8.</p> <p>Amalgam: Average of 10 samples tested must be less than 3.0 minutes per ANSI C78.5, clause 3.11 and 4.8.</p>	ANSI C78.5 -2003 Section 3.11 and 4.8	<p>Provide:</p> <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. EPA-approved documentation from an industry association.</li> </ol> <p>Sample Size: ≥ 10 samples must be tested for each testing orientation selected for the submittal.</p> <p>Passing Test: ≥ 80% of the samples tested must achieve the required run-up time.</p> <p>Partners must specify if their product contains amalgam mercury during the qualification submission process to meet this requirement.</p>
<b>Power Factor</b>	≥ 0.5	ANSI C82.11-2002 Section-3.3.1	<p>Provide:</p> <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. EPA-approved documentation from an industry association; or</li> <li>3. a test report from the manufacturer.</li> </ol>

			<p>Sample Size: <math>\geq 10</math> samples must be tested.</p> <p>Passing Test: <math>\geq 80\%</math> of the samples tested must achieve the required power factor.</p>
<b>Electro-magnetic and Radio Frequency Interference</b>	Integrated Lamp must meet FCC requirements for consumer use, FCC 47 CFR Part 2 (Equipment Authorization) and Part 18 (Consumer Emission Limits)	FCC 47 CFR Part 2 and Part 18	<p>Provide:</p> <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. EPA-approved documentation from an industry association; or</li> <li>3. a test report from the manufacturer.</li> </ol> <p>Sample Size: 1 sample must be tested.</p> <p>Passing Test: The sample tested must meet the requirement.</p>
<b>Ballast Frequency</b>	20 to 33 kHz or $\geq 40$ kHz	Oscilloscope or frequency counter	<p>Provide:</p> <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. EPA-approved documentation from an industry association; or</li> <li>3. a test report from the manufacturer.</li> </ol> <p>Sample Size: <math>\geq 10</math> samples must be tested.</p> <p>Passing Test: <math>\geq 80\%</math> of the samples tested must achieve the required ballast frequency.</p>
<b>Transient Protection</b>	Per ANSI C82.11b, paragraph 5.10.1 (100kHz Ring Wave, 2.5kV, both common mode and differential mode, 7 strikes)	ANSI C82.11, Section 5.11	<p>Provide:</p> <ol style="list-style-type: none"> <li>1. a test report from a laboratory recognized by EPA to conduct testing for the ENERGY STAR program [2]; or</li> <li>2. EPA-approved documentation from an industry association; or</li> <li>3. a test report from the manufacturer.</li> </ol> <p>Sample Size: <math>\geq 5</math> samples must be tested.</p> <p>Passing Test: <math>\geq 90\%</math> of the samples tested must meet the 7 strike test requirement.</p>
<b>Safety</b>	Demonstrate compliance with UL1993-2009.	UL 1993-2009	<p>Provide:</p> <p>File number for the respective product as listed by the appropriate OSHA NRTL laboratory and one of the following:</p> <ol style="list-style-type: none"> <li>1. Letter or statement from an OSHA NRTL facility indicating that the product meets the requirements of UL1993-2009.</li> <li>2. Internet hyperlink to the manufacturer's listed product at the OSHA NRTL laboratory that carried out the safety tests.</li> <li>3. Print out of the OSHA NRTL webpage showing the listed product.</li> </ol>
<b>Testing Orientation</b>	<p>GU24 manufacturers must declare the orientation used for each of the following requirements:</p> <ol style="list-style-type: none"> <li>1. System Efficacy</li> <li>2. Average Rated Lamp Life</li> <li>3. 1,000-hour Lumen Maintenance</li> <li>4. Lumen Maintenance at 40% of Rated Life</li> <li>5. ACTV Test</li> <li>6. Color Rendering Index</li> <li>7. Correlated Color Temperature</li> <li>8. Lamp Start Time</li> <li>9. Run-up Time</li> </ol> <p>The following options will be presented in the Approved Platform Database</p> <ol style="list-style-type: none"> <li>1. Base Up</li> <li>2. Base Down</li> <li>3. 50% Base Up, 50% Base Down</li> <li>4. Horizontal Operation</li> </ol>	No Standard Available (Use manufacturer protocol)	<p>Provide:</p> <p>No supplemental documentation required, but a response is mandatory when submitting a product.</p>
<b>Lamp Warranty</b>	Warranty or limited warranty statement must cover at least a minimum of 24 months, or 2 years, from date of purchase based on no less than 3 hour per day of use.	No Standard Available (Use manufacturer protocol)	<p>Provide:</p> <p>A copy of the actual two-year manufacturer written warranty.</p> <p>Product packaging must state "Warranty" or "Limited Warranty" and have one of the following for consumer complaint resolution (as applicable):</p> <ul style="list-style-type: none"> <li>• a company phone number; or</li> <li>• mailing address; or</li> <li>• webwite address.</li> </ul>

<b>Product Packaging and Lamp Labeling for Consumer Awareness Requirements</b>	<p><b>Note:</b> Please review all of the following to determine applicability of various requirements below.</p> <p><b>Lamp labeling:</b> Language for mercury content on the lamp itself must include one (1) of the following :</p> <ul style="list-style-type: none"> <li>• the symbol “Hg” within a circle</li> <li>• “Contains Mercury”</li> </ul> <p>Additional information may also be printed as required by applicable state laws.</p> <p><b>Lamp product packaging:</b> Language for mercury must include the following:</p> <ul style="list-style-type: none"> <li>• the symbol “Hg” within a circle;</li> <li>• “Contains Mercury”; and</li> <li>• <a href="http://www.epa.gov/bulbrecycling">www.epa.gov/bulbrecycling</a> or <a href="http://www.lamprecycle.org">www.lamprecycle.org</a></li> </ul> <p><b>Required lamp product packaging language for FTC labeling requirements when lamp is not included with a light luminaire:</b> ENERGY STAR qualified compact fluorescent lamps and lamp systems must comply with the labeling requirements of the U.S. Federal Trade Commission Packaging Laws - FTC 16CFR Part 305.1-.19.</p> <p><b>Required lamp product packaging language for starting temperature when lamp is not included with a light luminaire:</b> Packaging must state the minimum starting temperatures or geographic zone of use and any other conditions for reliable starting to meet the starting time requirements of ANSI C78.5, clause 4.8.</p> <p><b>Control incompatibilities:</b> Lamp package must clearly state any known incompatibility with photo controls, dimmers or timing devices. In addition, packaging should state specific application exceptions.</p> <p><b>Required languages:</b> Lamp packaging and lamp labeling language must be in English; translations to other languages may also be printed. For products that will be sold in Canada, packaging must include both English &amp; French language.</p>	<p>No Standard Available (Use manufacturer protocol)</p> <p>FTC 16CFR Part 305.1-.19</p> <p>ANSI C78.5 -2003 clause 4.8</p>	<p><b>Provide:</b> A written copy or a PDF graphic of the language that will be displayed on lamps and product packaging.</p>
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**Note:** In addition to the above requirements, EPA is exploring defining dimensional limitations and tolerances for qualified GU24 based integrated lamps, in the interest of ensuring that qualified replacement lamps will be broadly compatible with qualified luminaires. Further details will be provided in subsequent drafts, and EPA seeks partner input towards this effort.



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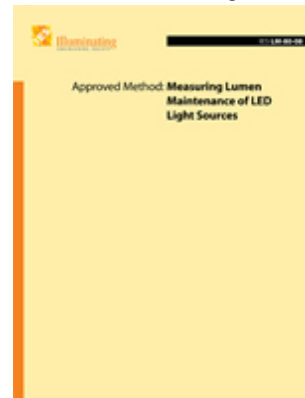


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Approved Method: Measuring Lumen Maintenance of LED Light Sources\*



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Product ID: LM - 80 - 08  
Price: \$25.00  
Member Price: \$17.50

\*LIGHTFAIR 2009 Judges Citation Award recipient

2008 - 7 Pages  
8 1/2 x 11 Softcover  
ISBN: 978 - 0 - 87995 - 227 - 3  
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Product Detailed Description

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The purpose of LM - 80 - 08 is to allow a reliable comparison of test results among laboratories by establishing uniform test methods. It addresses the measurement of lumen maintenance testing for LED light sources including LED packages, arrays and modules only. It does not provide guidance or recommendations regarding prediction estimations or extrapolations for lumen maintenance beyond the limits of the lumen maintenances determined from actual measurements.

Contents: Definitions/Ambient Physical Conditions/Electrical and Thermal Conditions/ Test and Measurement Procedures/Lumen Maintenance Testing Method for LED Sight Sources/Test Report

Also of interest: LM - 79 - 08 Approved Method: Photometric Measurements of Solid State Lighting Products

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# ENERGY STAR® Manufacturer's Guide for Qualifying Solid State Lighting Luminaires – Version 2.1

April 2010

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## Manufacturer Submission Checklist

### Prequalification Activities

1. Sign up as a Partner.
  - Read and understand the Program Requirements.
  - Read and understand the ENERGY STAR criteria for SSL Luminaires.
  - Fill out Partnership Agreement and send to [ssl@drintl.com](mailto:ssl@drintl.com).
  - Read and understand the SSL Manufacturer's Guide.
2. Find approved laboratories to test your products.
  - Photometric Testing, LM-79 Testing – *Laboratory must hold NVLAP accreditation for the LM-79-08 test procedure or must be qualified, verified, and recognized through the U.S. Department of Energy (DOE)'s CALiPER program.*
  - In-Situ Temperature Measurement Test (ISTMT) – *Laboratory must be approved by OSHA as a Nationally Recognized Testing Lab (NRTL), must be qualified, verified, and recognized through DOE's CALiPER program, or must be recognized through UL's Data Acceptance Program.*
    - For hardwired products, ISTMT must be conducted with the luminaire installed in the appropriate application as defined by ANSI/UL 1598.
    - For corded products, use ANSI/UL 153.
  - Lumen Maintenance Testing, LM-80 Testing – *Provided by LED package, array, or module manufacturer.*
3. Create a "Product Group"
  - If you are submitting more than one version of a product, choose one model for testing that represents a group of products. It must represent other group members within allowable variations identified in **Table 1** and be consistent with additional product group guidance in **Attachment A**.
4. Submit 1 sample of the representative model for testing to each of the following:
  - DOE CALiPER qualified labs – test for luminaire efficacy, light output, zonal lumen density, color rendering index, correlated color temperature, color spatial uniformity (if available), and optionally, lumen maintenance and color maintenance. (See lumen maintenance test options in **Table 2**.)
  - OSHA approved NRTLs or Laboratory qualified, verified, and recognized through DOE's CALiPER program or Laboratory recognized through UL's Data Acceptance Program – conduct In Situ Temperature Measurement Testing.
  - Independent or manufacturer-based testing laboratory – test for output operating frequency, noise, electromagnetic and radio frequency interference, transient protection, and for outdoor products, minimum operation temperature.

### Submission Process

1. Sign in to your My ENERGY STAR Account (MESA).
  - To obtain a username and password, you must sign up as a partner.
2. Launch the on-line product submission tool at <http://www.energystar.gov/sslpartners>.

3. Enter product information.

- Required Documentation to upload into on-line tool:
  - A. IESNA LM-79-08 Photometric (Goniophotometry) Test Report (Formatted to LM-63-03)
  - B. IESNA LM-79-08 Integrating Sphere Output Report
  - C. For Lumen Maintenance, use either:
    - Option 1 – Component Performance***
      - LED Package Manufacturer LM-80 Test Report with results showing relative light output over time
      - In situ temperature measurement test (ISTMT) showing measured  $TMP_{LED}$
      - Diagram or photograph of the Temperature Measurement Points for the package, array or module
    - Option 2 – Luminaire Performance***
      - IESNA LM-79-08 Test Report at time = 0 and 6,000 hours respectively.
  - D. For Power Supply (the ISTMT typically includes these results)
    - ☐ In situ temperature measurement test showing measured  $TMP_{PS}$
    - ☐ Diagram or photograph of the Temperature Measurement Point for the power source
  - E. Warranty
- Documentation for self-certification
  - A. A written statement showing the manufacturer self-certifies the product/grouping for Color Spatial Uniformity, Color Maintenance, Output Operating Frequency, Noise, Electromagnetic and Radio Frequency Interference, Transient Protection, and for Outdoor Products, Minimum Operating Temperature.
  - B. A written statement indicating the forward drive current (in milliamps, mA) applied to the LEDs in the luminaire.

## **Technical Interpretations by U.S. Department of Energy (DOE)**

The following technical interpretations provide additional clarification, information, and/or examples pertaining to requirements stated in the ENERGY STAR for SSL Luminaires criteria or in the ENERGY STAR Manufacturers Guide for Qualifying SSL Luminaires.

### **I. Recessed, surface, and pendant-mounted downlights - Aperture**

A .25" tolerance is allowed for the aperture size. "Aperture" is defined as the maximum distance between the points inside the luminaire where light escapes the luminaire.

### **II. Product Groupings -- CCT**

If a manufacturer offers the same luminaire with different correlated color temperatures (CCTs), ENERGY STAR will allow those products to be grouped together, so long as the LED package(s)/module(s)/array(s), drive current, electronics, and thermal management are otherwise identical. At a minimum, manufacturer must submit one set of LM-80, In-situ Temperature Measurement Test (ISTMT), and LM-79 test results applicable to the product version with the lowest CCT.

### **III. Lumen Maintenance -- Luminaires employing remote phosphors**

The LED package, array, or module must contain all optics and electronics which significantly change the color and/or intensity of the light emitted from the luminaire. Luminaires incorporating remote phosphors, secondary phosphors, optics, and/or color or intensity correction electronics that are not contained within the LED package, array, or module must be tested under OPTION 2.

### **IV. Lumen Maintenance -- Successor LED packages/modules/arrays**

LED package manufacturers continue to improve their products, incorporating various upgrades into revised and next-generation packages. Typically these are incremental improvements, rather than entirely new products. To avoid significant delays in qualifying luminaires using LED packages that are successors to those previously approved for lumen maintenance in DOE's ENERGY STAR SSL program, DOE allows for provisional ENERGY STAR approval based on the following conditions:

1) The luminaire manufacturer must submit at least 3000 hours of lumen maintenance (based on LM-80) data for the successor LED package(s) used, at the appropriate temperature and drive current for the luminaire, and assuming all other required provisions for ENERGY STAR qualification are met by the luminaire.

2) At least 6000 hours of lumen maintenance data for the successor LED package(s) must be provided to the DOE ENERGY STAR SSL program as soon as available.

3) If complete lumen maintenance data is not provided within 6 months of the provisional approval date, all qualified luminaires using the successor packages will face de-listing.

### **V. Lumen Maintenance -- Required sample size for LED modules and arrays**

For LM-80 lumen maintenance testing of LED modules and arrays, a sample size of less than 25 units per temperature is allowed, subject to the following conditions:

- 1) No fewer than 10 complete modules or arrays must be tested according to LM-80.
- 2) Testing may be conducted by the LED module or array manufacturer and/or by a qualified testing laboratory recognized by DOE's CALiPER program or holding NVLAP accreditation for the LM-80-08 test procedure.

## **VI. Lumen Maintenance -- Acceptance of historical lumen maintenance data**

The final version of LM-80 was published in September 2008 with several significant changes relative to prior drafts, including how the case temperature is maintained (via ambient temperature versus current modulation) and in the three LED case temperatures at which the packages are maintained (55°C, 85°C, and one other temperature selected by the manufacturer, compared to the earlier drafts that required 45°C, 65°C and 85°C).

DOE recognizes that all LED manufacturers may not have 6,000 hours worth of data for all three case temperatures prescribed in LM-80. DOE therefore will allow prior data collected to be used for compliance purposes until March 31, 2010, after which date new product submissions will be required to include test lumen maintenance data collected in compliance with LM-80.

## **VII. Off-state Power**

For products designed for use in a system configuration, i.e., multiple luminaires operating on a single power supply, off-state power requirements will be expanded from 0.5 watts to 1.5 watts. The rationale is that for such “systems”, DOE anticipates that at least three luminaires would be connected to a single power supply.

## **VIII. Under-cabinet shelf-mounted task lighting – Asymmetrical distribution**

Zonal Lumen Density Requirement -- luminaires with asymmetrical distribution must have at least 12.5% of total luminaire lumens in the 60°-90° zone (see **Figure 1**). There is a 3% tolerance in the backward zone.

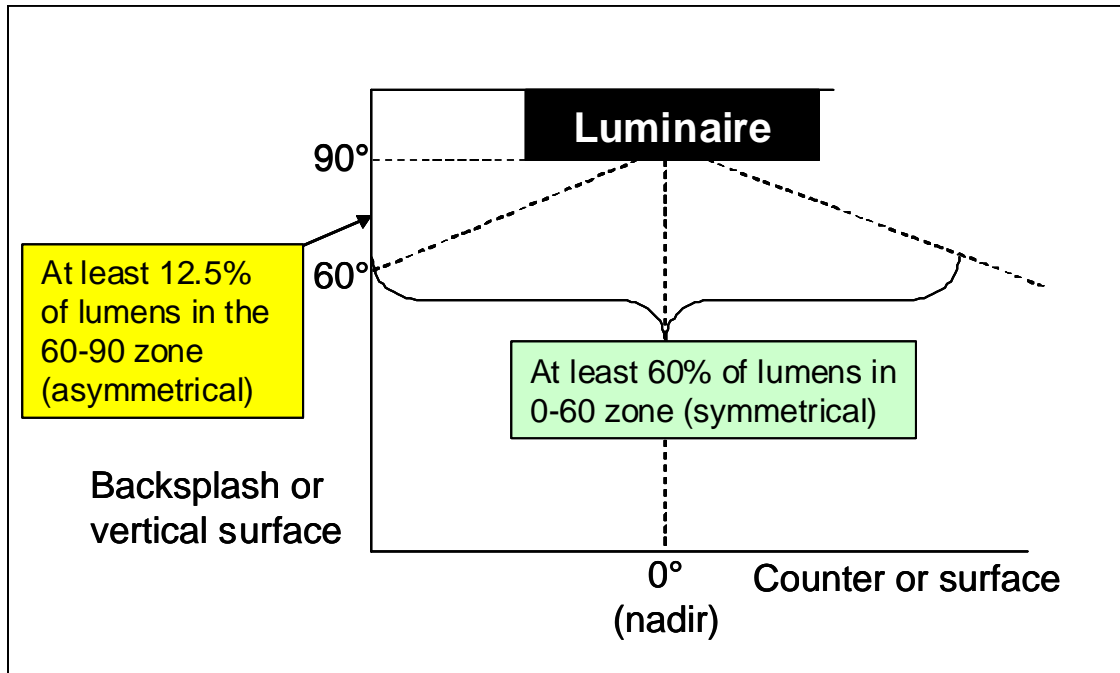


Figure 1 - Zonal lumen diagram for asymmetric under-cabinet products

## IX. NVLAP Accreditation Requirement

As originally stated in ENERGY STAR for SSL Luminaires version 1.0 and updated in version 1.1, DOE intends to require LM-79 and LM-80 test results from laboratories accredited for these procedures by the National Voluntary Laboratory Accreditation Program (NVLAP). DOE suspended this requirement for the first year of the ENERGY STAR SSL program through September 30, 2009. DOE hereby extends this requirement to Sept 30, 2010. Below is a brief characterization of the status of the test procedures, NVLAP accreditation process, and laboratory progress, which inform the decision to extend these deadlines.

A. LM-80-08 was published by IESNA in September 2008. Several factors limit the availability of LM-80 testing services and the timeline for NVLAP accreditation. First, due to the long-term nature of lumen maintenance testing, it is almost exclusively conducted in-house by LED manufacturers. Second, significant changes were made to the final LM-80 test procedure compared to earlier drafts, effectively eliminating any “first mover advantage” towards accreditation. Third, strict temperature control methods required by LM-80 necessitate specialized thermal chambers and auxiliary equipment. Cost and space requirements for this equipment, along with the minimum 6,000 hour test period make LM-80 testing by independent test labs impractical at this time.

B. LM-79 and LM-80 were added to the NVLAP Energy Efficient Lighting Products program and NIST began accepting applications for accreditation to these procedures in March 2009. The time required for the accreditation process varies depending on lab capabilities, existing accreditations, and other factors. NIST estimates that the first LM-79 and LM-80 accredited laboratories will complete the process by the end of 2009. Both independent and manufacturer-owned laboratories are eligible to earn LM-79 and LM-80 accreditation.

## **X. In situ Temperature Measurement Test**

DOE will accept ISTMT results from laboratories approved by OSHA as Nationally Recognized Testing Laboratories (NRTLs). Alternatively, DOE will accept ISTMT results from independent laboratories qualified under the DOE CALiPER testing program as listed at [http://www1.eere.energy.gov/buildings/ssl/test\\_labs.html](http://www1.eere.energy.gov/buildings/ssl/test_labs.html) under the heading “CALiPER Testing Laboratories, Laboratories Qualified, Verified, and Contracted for 2009 CALiPER LM-79 Testing and LM-79 Testing for ENERGY STAR for SSL”. Alternatively, ISTMT may be carried out by laboratories recognized through UL’s Data Acceptance Program.

## **XI. Lumen Maintenance – LM-80 thresholds**

DOE established a pass/fail threshold for lumen maintenance compliance, based on the available 6,000 hour data provided by the LM-80 test report. The requirements differ for applications requiring 25,000 hours of useful life and those requiring 35,000 hours, as follows:

<b>Application required minimum useful life (<math>L_{70}</math>)</b>	<b>Required lumen maintenance at 6,000 hours</b>
25,000 hours	91.8%
35,000 hours	94.1%

These percentages result from solving an exponential decay function for 25,000 and 35,000 hours, respectively, to determine the minimum lumen maintenance necessary to achieve those thresholds.

In some cases, manufacturers continue to collect LM-80 data beyond 6000 hours (LM-80 establishes 6000 hours as a minimum test period, but recommends 10,000 hours). If additional data is available, it may be used to meet the lumen maintenance requirements, with the following thresholds:

<b>Required lumen maintenance at test periods exceeding 6000 hours</b>		
<b>Cumulative hours of testing</b>	<b>For 25000 hour projected <math>L_{70}</math> life</b>	<b>For 35000 hour projected <math>L_{70}</math> life</b>
7000	90.5%	93.1%
8000	89.2%	92.2%
9000	88.0%	91.2%
10000	86.7%	90.3%
11000	85.5%	89.4%
12000	84.3%	88.5%
13000	83.1%	87.6%
14000	81.9%	86.7%
15000	80.7%	85.8%

## Scope

This document is an accompaniment to DOE's ENERGY STAR® for SSL Luminaires Criteria and provides manufacturers with information about product submission, testing laboratories and requirements, and using "product groups" to reduce testing costs.

## Pre-qualification Activities

A manufacturer should take several steps before submitting products for ENERGY STAR qualification.

### A. Become an ENERGY STAR Partner

All manufacturers who wish to earn the ENERGY STAR label for their products must first become an ENERGY STAR SSL Partner. ENERGY STAR Partnership Agreements are available for download at [www.energystar.gov/sslpartners](http://www.energystar.gov/sslpartners) or by submitting an e-mail request to [ssl@energystar.gov](mailto:ssl@energystar.gov). If your company is already an ENERGY STAR partner under a different product category, you still need to fill out a new form.

### B. Find a DOE-Approved or NVLAP Accredited Laboratory

ENERGY STAR requires independent product testing to verify performance against the key requirements laid out in the criteria. DOE maintains a list of approved independent testing laboratories to perform the required testing, as outlined below and in **Table 2**. Laboratories can now begin the process for NVLAP accreditation for both IESNA LM-79-2008 and IESNA LM-80-2008. NVLAP accreditation involves a rigorous process demonstrating technical competence, quality control, proficiency testing, and laboratory impartiality and objectivity. As of September 30, 2010, DOE will only accept LM-79 and LM-80 test results from NVLAP-accredited labs.

## Photometric Testing

Independent testing laboratories qualified, verified, and recognized through DOE's CALiPER program shall be used for photometric testing under the ENERGY STAR program. Labs must satisfactorily complete round-robin testing verification adhering to IESNA LM-79-08 test procedures for integrating sphere and/or goniophotometric testing of SSL luminaires and lamps. Alternatively, labs must successfully acquire NVLAP accreditation for LM-79 testing or be currently accredited under the NVLAP Program for Energy Efficient Lighting (EEL) Products while in the process of attaining NVLAP LM-79 accreditation. A list of currently qualified test labs is below. Manufacturers are encouraged to check for updates to this list available at: [http://www1.eere.energy.gov/buildings/ssl/test\\_labs.html](http://www1.eere.energy.gov/buildings/ssl/test_labs.html)

Integrating Sphere (LM-79 Section 9.1 and 9.2)

- Independent Testing Laboratories, Inc. – Boulder, CO
- Intertek - Cortland, NY
- Luminaire Testing Laboratory, Inc. – Allentown, PA
- Lighting Sciences, Inc. – Scottsdale, AZ
- OnSpeX/CSA International – Atlanta, GA



- Aurora International Testing Laboratory – Aurora, OH
- GE Consumer & Industrial – Lighting Product Testing Laboratory – Cleveland, OH

#### Goniophotometry (LM-79 Section 9.3)

- Independent Testing Laboratories, Inc. – Boulder, CO
- Intertek - Cortland, NY
- Luminaire Testing Laboratory, Inc. – Allentown, PA
- Lighting Sciences, Inc. – Scottsdale, AZ
- OnSpeX/CSA International – Atlanta, GA
- GE Consumer & Industrial – Lighting Product Testing Laboratory – Cleveland, OH

#### **In situ Temperature Measurement Test (ANSI/UL 1598-04 or ANSI/UL 153-05)**

ISTMT must be conducted with the luminaire installed in its appropriate application, as defined in UL 1598 (for hard-wired luminaires) or UL 153 (for corded products). ISTMT may be carried out concurrently with UL safety testing.

Product safety testing of electrical equipment is required under OSHA Safety Standards (29 CFR Part 1910). In particular, SSL luminaires submitted for ENERGY STAR qualification must be tested and certified to ANSI/UL 1598-04 or ANSI/UL 153-05 standards. OSHA has approved a number of organizations as Nationally Recognized Testing Laboratories (NRTLs), and can accept products that have been properly certified by these laboratories.

DOE will accept ISTMT results from the following NRTLs, recognized as qualified by OSHA:

- Canadian Standards Association (CSA) (also known as CSA International)
- Communication Certification Laboratory, Inc. (CCL)
- Curtis-Straus LLC (CSL)
- FM Approvals LLC (FM)(formerly Factory Mutual Research Corporation)
- Intertek Testing Services NA, Inc. (ITSNA) (formerly ETL)
- MET Laboratories, Inc. (MET)
- NSF International (NSF)
- National Technical Systems, Inc. (NTS)
- SGS U.S. Testing Company, Inc. (SGSUS) (formerly UST-CA)
- Southwest Research Institute (SWRI)
- TUV America, Inc. (TUVAM)
- TUV Product Services GmbH (TUVPSG)
- TUV Rheinland of North America, Inc. (TUV)
- Underwriters Laboratories Inc. (UL)
- Wyle Laboratories, Inc. (WL)

A current listing of NRTLs and detailed qualifications and contact information is provided on OSHA's NRTL Program webpage (<http://www.osha.gov/dts/otpca/nrtl/>).

Alternatively, ISTMT may be carried out concurrently with photometric (LM-79) testing. DOE will accept ISTMT results from independent laboratories qualified under the DOE CALiPER testing program as listed at [http://www1.eere.energy.gov/buildings/ssl/test\\_labs.html](http://www1.eere.energy.gov/buildings/ssl/test_labs.html) under the heading “CALiPER Testing Laboratories, Laboratories Qualified, Verified, and Contracted for 2009 CALiPER LM-79 Testing and LM-79 Testing for ENERGY STAR for SSL”.

Alternatively, ISTMT may be carried out by laboratories recognized through UL’s Data Acceptance Program.

### C. Submit Products to Labs for Testing

Manufacturers are responsible for product testing costs. Each product must adhere to the appropriate standards and test procedures. To help ease the burden of testing, DOE will allow manufacturers to qualify one product as a representative sample of similar models.

### D. Creating Product Groups

DOE will allow manufacturers to qualify multiple products of a similar nature using one model. For example, the same basic fixture may be available with various shade, reflector, finish, or trim options. Manufacturers will define the product group and identify the specific model used for testing to represent the entire group. When choosing this test sample, DOE advises applicants to choose the variation which will have the most difficulty meeting the ENERGY STAR criteria. This will ensure that other group members will perform at least as well as the tested product.

**Table 1** summarizes allowable variations under the product grouping allowance.

**Table 1 - Variations within Product Groupings**

Housing/Chassis	allowed, with conditions <sup>†</sup>
Heat Sink/Heat Management	not allowed
Finish	allowed
Reflector/Trim	allowed
Shade/Diffuser	allowed
Mounting	allowed
Light Source	allowed, w/ conditions
Power Supply	allowed, w/ conditions
<sup>†</sup> The light source, heat sink, and power supply are integrated into housing/chassis variations in such a way that the thermal performance of the luminaire is not significantly degraded by the housing/chassis.	

As seen in the table, housing/chassis variations and heat sink/heat management component variations within a group are not allowed because they may materially impact LED performance (a possible exception for chassis/housing variations is allowed as noted). Finish, reflector/trim, shade/diffuser, and mounting variations are allowed.

Light source and power supply variations are allowed with certain conditions:

### Substitute LED packages that produce the identical quality and quantity of light

Products qualified under a single application may include LED package(s)/module(s)/array(s) and power supplies from more than one manufacturer, but the LED package(s)/module(s)/array(s) and power supplies must be substitutable components used to manufacture essentially identical luminaires and must be intended to produce the same quantity and quality of light. All LED package(s)/module(s)/array(s) substitution components must separately comply with the Option 1 (Component Performance) requirements in the Lumen Maintenance section.

#### **Same luminaire available in different CCTs**

If a manufacturer offers the same luminaire with different correlated color temperatures (CCTs), ENERGY STAR will allow those products to be grouped together, so long as the LED package(s)/module(s)/array(s), drive current, electronics, and thermal management are otherwise identical. At a minimum, manufacturer must submit one set of LM-80, In-situ Temperature Measurement Test (ISTMT), and LM-79 test results applicable to the product version with the lowest CCT.

Manufacturers are allowed to retroactively add new products to a grouping.

More information on Product Grouping can be found in **Attachment A**.

## **Submittal Process**

### **On-line Product Submission Tool**

To submit your test results for ENERGY STAR approval, DOE has created an on-line product submission tool for partners. Partners must submit their information via the on-line tool posted at [www.energystar.gov/sslpartners](http://www.energystar.gov/sslpartners). The process is as follows:

#### **Step 1. Set up your “My ENERGY STAR® Account” (MESA).**

Once you register as an ENERGY STAR SSL Partner, you will receive an e-mail that contains your MESA set-up information. This information will include a user name and password required for accessing the on-line product submittal tool.

#### **Step 2. Launch the On-line Product Submittal Tool.**

A link to the On-line Product Data Submittal Tool will be added to your ENERGY STAR SSL Partner landing page. Launching the tool will begin the data submittal process, and take you to the tool’s main screen which displays the manufacturer’s information (i.e., name, address, contacts, etc.).

#### **Step 3. Enter Product Information.**

The On-line Product Submittal Tool provides entry fields for all information needed for ENERGY STAR qualification. Next to each data entry field is guidance on its required minimum level of detail. You can upload LM-79 test reports directly to the tool and receive instant feedback on how the photometric results compare with specific ENERGY STAR product category requirements. The tool also allows you to upload other test reports and packaging proofs for review by ENERGY STAR.

At any time during the submittal process, you can save your work for completion at a later date. A progress meter indicates your stage of completion in the data submittal/qualification process.

**Step 4. Submit Application**

Once you have completed the appropriate data entry fields, click “Submit.”

Once a product has been submitted by a manufacturer, ENERGY STAR will review the results and notify the applicant within one calendar week of acceptance, rejection, or the need for additional information. If you experience problems with the On-line Product Submission Tool, please contact [ssl@drintl.com](mailto:ssl@drintl.com).

## Testing

### Temperature Measurement Point (TMP)

LED package, array, or module manufacturers and power supply/driver manufacturers designate specific locations on their products which act as surrogate points for measuring junction temperature ( $t_j$ ) or, in the case of power supplies, the point to which the warranted temperature is measured. DOE generically designates these locations as the temperature measurement points (TMPs) for the purposes of measurement in testing.

#### **TMP for the LED (TMP<sub>LED</sub>)**

Knowledge of the thermal pathway between the LED die junction and a designated external measurement point on the package, array, or module allows manufacturers to accurately estimate junction temperature. The surrogate temperatures and their measurement locations vary from manufacturer to manufacturer. Some manufacturers use temperatures measured at the solder joint ( $t_s$ ) at the board attachment site; some use the package case temperature ( $t_c$ ); and others use the board temperature ( $t_b$ ) on the module. Collectively, these locations serve the same function, i.e., to correlate an external temperature to the junction temperature, which is critical for determining LED lumen maintenance. For purposes of this document, the measurement locations for  $t_s$ ,  $t_c$ , and  $t_b$  are Temperature Measurement Points for LEDs (TMP<sub>LED</sub>).

#### **TMP for the Power Supply (TMP<sub>PS</sub>)**

The longevity of power supplies is highly dependent upon operating temperature and thermal environment. It is standard practice in the lighting industry to tie the product warranty to maintained operating temperature—referred to as the case temperature ( $t_c$ )—for which most manufacturers designate a measurement location on the power supply case. For purposes of this document, the measurement locations for  $t_c$  (or other manufacturer designated location) are Temperature Measurement Points for power supplies (TMP<sub>PS</sub>).

### Required Test Reporting and Tolerance

Manufacturers are required to test their products at approved testing laboratories, and provide the results to DOE as part of the submittal process. Table 2 defines the required testing and reporting, sample size, and applicable tolerance for the ENERGY STAR criteria. Table 3 presents the zonal lumen tolerances for the individual Category A applications.

**Table 2 - Required Test Reporting and Tolerance<sup>1</sup>**

Performance Characteristic	Methods of Measurement/ Reference	Approved Test Facility	Required Documentation	Sample Size	Tolerance
<b>Luminaire Efficacy</b>	IESNA LM-79-08 Section 9.1, 9.2 or 9.3  ANSI C82.2	DOE CALiPER Recognized or NVLAP Accredited	IESNA LM-63-03 Formatted Photometric Report (required for electronic submission) <b>and/or</b> Goniophotometer Test Report <b>and/or</b> Integrating Sphere Output Report	One	-3%
<b>Minimum Light Output</b>	IESNA LM-79-08 Section 9.1, 9.2 or 9.3	DOE CALiPER Recognized or NVLAP Accredited	IESNA LM-63-03 Formatted Photometric Report (required for electronic submission) <b>and/or</b> Goniophotometer Test Report <b>and/or</b> Integrating Sphere Output Report	One	- 10%
<b>Zonal Lumen Density</b>	IESNA LM-79-08 Section 9.3	DOE CALiPER Recognized or NVLAP Accredited	IESNA LM-63-03 Formatted Photometric Report (required for electronic submission) <b>and/or</b> Goniophotometer Test Report	One	See Table 3
<b>Lumen Maintenance (L<sub>70</sub>)</b>	<b>OPTION 1: Component Performance</b>				
	IESNA LM-80-08	NVLAP Accredited or LED Package, Module, or Array Manufacturer (must begin process of NVLAP accreditation)	LED package, module, or array manufacturer test report (data table and chart) showing relative light output over time.  For L <sub>70</sub> of 25,000 hours, average of sample at 6,000 hours shall have lumen maintenance of ≥ 91.8%.  For L <sub>70</sub> of 35,000 hours, average of sample at 6,000 hours shall have lumen maintenance of ≥ 94.1%.  <i>(continued on next page)</i>	For LED packages, the average of at least 25 samples for each temperature measured  For LED modules and arrays, the average of at least 10 samples for each temperature	0%

<sup>1</sup> After September 30, 2010, DOE will only accept LM-79 and LM-80 test results from NVLAP-accredited laboratories.

	In Situ Temperature Measurement Test (ISTMT)  ANSI/UL 1598-04, ANSI/UL 153-05	OSHA approved NRTLs or DOE CALiPER Recognized or UL Data Acceptance Program labs	1. Test report indicating the Temperature Measurement Point for the hottest LED (TMP <sub>LED</sub> ) in the luminaire. 2. Diagram/picture of the TMP <sub>LED</sub> location with an arrow indicating the thermocouple attachment point.	One	N/A
	<b>OPTION 2: Luminaire Performance</b>				
	IESNA LM-79-08 Section 9.1, 9.2 or 9.3	DOE CALiPER Recognized or NVLAP Accredited	IESNA LM-63-03 Formatted Photometric Report <b>and/or</b> Goniophotometer Test Report <b>and/or</b> Integrating Sphere Output Report  1. Report @ T = 0 hours 2. Report @ T = 6000 hours	One	N/A
<b>Color Rendering Index</b>	IESNA LM-79-08 Section 9.1 CIE 13.3-1995 IESNA LM-58	DOE CALiPER Recognized or NVLAP Accredited	Integrating Sphere Output Report	One	- 2 points of required CRI
<b>Correlated Color Temperature</b>	IESNA LM-79-08 Section 9.1 ANSI C78.377-08	DOE CALiPER Recognized or NVLAP Accredited	Integrating Sphere Output Report	One	ANSI C78.377 Defined
<b>Color Spatial Uniformity</b>	IESNA LM-79-08 CIE 15: 2004 IESNA LM-58 IESNA LM-16	DOE CALiPER Recognized or NVLAP Accredited	Self Certification  <b>Note:</b> A laboratory test report must be submitted upon DOE request.	One	N/A
<b>Color Maintenance</b>	IESNA LM-80-08 CIE 15: 2004 IESNA LM-58 IESNA LM-16	NVLAP Accredited or LED Package, Module, or Array Manufacturer	Self Certification  <b>Note:</b> A laboratory test report must be submitted upon DOE request.	One	N/A
<b>Power Factor</b>	ANSI C82.77	OSHA approved NRTLs or DOE CALiPER Recognized or UL Data Acceptance Program labs	Laboratory test report	One	- 3%

<b>Power Supply TMP<sub>PS</sub></b>	ISTMT ANSI/UL 1598-04, ANSI/UL 153-05	NRTLs or DOE CALiPER Recognized or UL Data Acceptance Program labs	<ol style="list-style-type: none"> <li>1. Test report indicating the Temperature Measurement Point for the power supply (TMP<sub>PS</sub>) in the luminaire.</li> <li>2. Diagram/picture of in the TMP<sub>PS</sub> location with an arrow indicating the thermocouple attachment point.</li> </ol>	One	N/A
<b>Output Operating Frequency</b>	Oscilloscope Manual	Any	Self Certification. Output operating frequency is measured by attaching an oscilloscope between the driver and the LED package. It is conducted simultaneously with the measurement of the output drive.	One	N/A
<b>Noise</b>	Not to exceed 24 dB when measured 12" in any direction. Class A sound rating for power supplies installed within the fixture are not to exceed a measured level of 24 dBA (audible).	Any	<p>Self Certification. Sound is measured using a sound meter (similar in performance to B&amp;K type 2209) where the microphone is located 12 inches from the fixture in any direction.</p> <p><b>Note:</b> A laboratory test report must be submitted upon DOE request.</p>	One	N/A
<b>Electromagnetic and Radio Frequency Interference</b>	Residential applications must meet FCC 47 CFR Part 15 (remote) or 18 (integral) Consumer Emission Limits. Commercial ones must meet FCC 47 CFR Part 15 (remote) or 18 (integral) Non-consumer Emission Limits.	Any	<p>Self-Certification</p> <p><b>Note:</b> A laboratory test report must be submitted upon DOE request.</p>	One	N/A
<b>Transient Protection</b>	Comply with IEEE C.62.41-1991, Class A operation. Seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common and differential mode.	Any	<p>Self-Certification</p> <p><b>Note:</b> A laboratory test report must be submitted upon DOE request.</p>	One	N/A



<b>Minimum Operation Temperature (Outdoor)</b>	≥-20℃	Any	Self-Certification  <b>Note:</b> A laboratory test report must be submitted upon DOE request.	One	N/A
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**Table 3 - Zonal Lumen Tolerances**

Category A Application	Zonal Lumen Density Requirement			Tolerance (Values below are subtracted from minimum % values on the left)	Method of Measurement
	Zone (bilaterally symmetrical)	Minimum Percentage of Total Lumens	Maximum Percentage of Total Lumens		
Under-cabinet kitchen lighting	0-60°	60%	--	- 5%	IESNA LM-79-08 Section 9.1
	60-90°	25%	--	- 10%	
Under-cabinet shelf-mounted task lighting	0-60°	60%	--	- 5%	
	60-90°	25%	--	- 10%	
Under-cabinet shelf-mounted task lighting (asymmetrical distribution)	60-90°	12.5%		- 3%	
Portable desk task lights	0-60°	85%	--	- 15%	
Recessed, surface, and pendant-mounted downlights	0-60°	75%	--	- 10%	
Cove lighting (asymmetrical distribution)	120 - 150°	35%	--	- 3%	
Surface-mounted luminaires with directional heads	0 - 90°	85%	--	- 3%	
Wall wash luminaires (asymmetrical distribution)	20 - 40°	50%	--	- 3%	
Outdoor wall-mounted porch lights	0-90°	85%	--	- 5%	
Outdoor step lights	0-90°	85%	--	- 10%	
Outdoor pathway lights	0-90°	85%	--	- 10%	
Outdoor pole/arm-mounted decorative luminaires	0-90°	85%	--	- 3%	
	110° and above	--	0%	+ 3%	
Bollards	90 – 110°	--	0 – 15%	+ 3%	
	110° and above	--	0%	+ 3%	

## Lumen Maintenance Testing

The ENERGY STAR program offers two compliance methods for lumen maintenance testing: 1) Component Performance and 2) Luminaire Performance. Given the potential delays in market introduction required for full luminaire testing, DOE anticipates the majority of products submitted will be qualified via component performance testing.

### OPTION 1: Component Performance

The Component Performance option allows the applicant to demonstrate compliance with the lumen maintenance requirement by demonstrating the highest temperature LED package(s), array(s), or module(s) used in the luminaire operates at or below temperatures yielding an  $L_{70}$  of 25,000 or 35,000 hours, respectively.

#### *IESNA LM-80-2008*

The *IESNA LM-80-2008 Approved Method for Measuring Lumen Maintenance of LED Light Sources* prescribes the measurement of lumen maintenance for LED-based packages, arrays, and modules only and does not entail testing of the entire luminaire. LED packages, arrays or modules are tested for at least 6,000 hours at a minimum of three discrete case temperatures: 55°C, 85°C and a third temperature at the discretion of the manufacturer  $\pm 2^\circ\text{C}$ . At a minimum, light output is measured every 1,000 hours and recorded for a minimum of 6,000 hours.

#### *In Situ Temperature Measurement Test (ISTMT)*

IESNA LM-80 defines lumen maintenance testing for LED packages, arrays, and modules. Because LEDs are incorporated into luminaires with heat sinks, optical elements, power supplies, etc. and then operated in a variety of ambient environments, LM-80 by itself is not a predictor of luminaire lumen maintenance. To relate the results of the LM-80 test to the luminaire, DOE requires verification of LED and power supply temperatures in environments that simulate real-world applications (in situ) with tests that measure the temperature of both the highest temperature LED in the luminaire and the power supply at steady-state thermal equilibrium. The procedure is called the *In-situ Temperature Measurement Test (ISTMT)* which follows *ANSI/UL 1598-2004 Luminaires* or *ANSI/UL 153-2005 Portable Luminaires*. It includes the addition of two (or more) thermocouples, one for the LED package, array, or module and one for the power supply.

According to UL, hard-wired luminaires are separated into two broad categories: 1) Surface—products that are surface-mounted, suspended or freestanding where the fixture housing is exposed to free air and 2) Recessed—products recessed into ceilings or walls and often placed in direct contact with insulation. ANSI/UL1598 prescribes enclosures for luminaires for the purposes of simulating in situ operation and conducting temperature measurements for electrical safety (see Figure 2). In efforts to facilitate testing and minimize costs, DOE has reduced the number of environments to the fewest possible without significantly affecting the resulting steady-state temperatures. **Table 4** lists the appropriate section references in ANSI/UL 1598.

Portable luminaires shall follow the procedures contained within ANSI/UL 153.

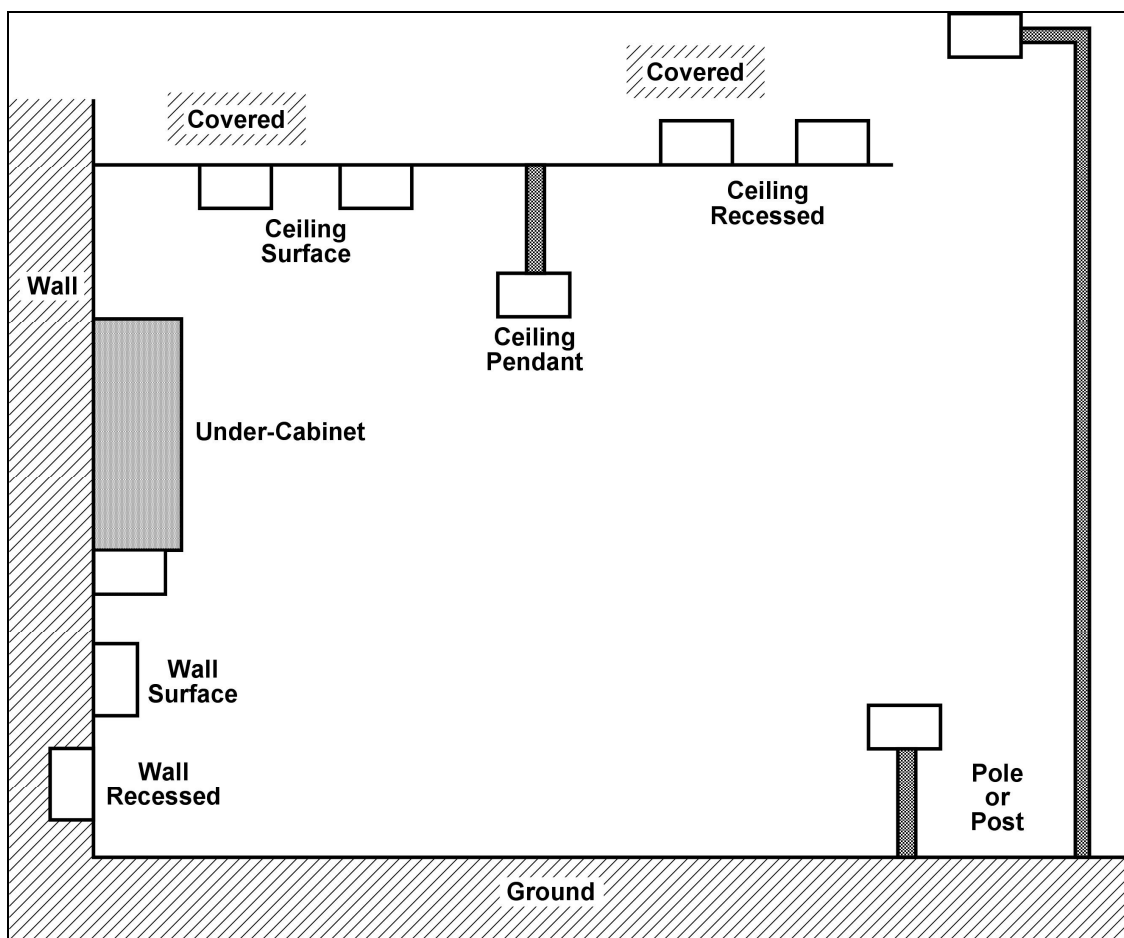


Figure 2 - ANSI/UL 1598 Test Environments

Table 4 – In Situ Test Environments

Luminaire Types	Mounting Orientation	
	Horizontal	Vertical
<b>Surface</b>		
Surface	Section 19.10	Section 19.11
Surface-mounted under-cabinet	Section 19.12	
Suspended	No apparatus required except if in situ mounting is $\leq 4$ " from the surface. In this case mount to apparatus defined in Section 19.10	
Freestanding	No apparatus required	
<b>Recessed</b>		
Non-IC	Section 19.13	Section 19.13 except without insulation
IC	Section 19.15	Section 19.15

*Conditions for Use*

To be eligible for the component performance option, **ALL** conditions below must be met. If

**ANY** of the conditions are not met, the component performance option may not be used and the applicant must use the luminaire performance option for compliance.

1. The LED package, array, or module used in the fixture has been tested according to LM-80.
2. The LED package, array, or module manufacturer prescribes/indicates a TMP on the package, array, or module.
3. The LED package, array, or module TMP is accessible to allow temporary attachment of a thermocouple for measurement of in situ operating temperature. Access via a temporary hole in the housing (no larger than 0.375" diameter), tightly resealed during testing with putty or other flexible sealant, is allowable. The size and location of the access port shall be documented in the submittal for the purposes of repeatability.
4. The LED package, array, or module must contain all optics and electronics which significantly change the color and/or intensity of the light emitted from the luminaire. Luminaires incorporating remote phosphors, secondary phosphors, optics, and/or color or intensity correction electronics that are not contained within the LED package, array, or module must be tested under OPTION 2.

#### *Test Procedure*

The ISTMT follows all requirements of ANSI/UL 1598/153 with the following additions:

1. One or more additional thermocouples are attached to the highest temperature LED package or module in the luminaire (i.e., TMP<sub>LED</sub>).
2. One or more additional thermocouples are attached to the power supply/driver at the TMP<sub>PS</sub>. For off-the-shelf remote power supplies manufacturers typically provide a measurement location (case temperature designated by a “dot” adjacent to a (t<sub>c</sub>) symbol) for warranty purposes. In situations where the TMP<sub>PS</sub> is not designated by the manufacturer, or where power supplies are integrated with the LED package(s), array or module(s), fixture manufacturers should identify the TMP<sub>PS</sub> to be used for warranty purposes.

#### *Guidance for Thermocouple Attachment*

- Manufacturers shall select and designate the highest temperature LED package, array, or module in the luminaire. In most cases the individual LED in the middle of symmetric arrays should be hottest. A well designed thermal management solution will minimize the temperature gradient across packages.
  - For square/rectangular/circular arrays the individual LED closest to the center
  - For other configurations it is recommended manufacturers sample several LEDs to find the highest temperature device within the luminaire.
- Temperature probes shall be in contact with the TMP and permanently adhered. Permanent adhesion consists of high temperature solder, conductive adhesives (e.g. accelerator/UV activated or epoxy), or melting the tip into plastic or other approved product recommended by the temperature probe manufacturer. Tape alone is not acceptable for providing good thermal contact at the thermocouple/TMP interface.
- The thermocouple tolerance shall conform to ASTM E230 **Table 1** “Special Limits” ( $\leq 1.1^{\circ}\text{C}$  or 0.4%, whichever is greater).

### ***TMP Evaluation***

DOE has established a pass/fail threshold for lumen maintenance compliance, based on the available 6,000 hour data provided by the LM-80 test report. The requirements differ for applications requiring 25,000 hours of useful life and those requiring 35,000 hours, as follows:

**Table 5. Required lumen maintenance at 6000 hours**

<b>Application required minimum useful life (L<sub>70</sub>)</b>	<b>Required lumen maintenance at 6,000 hours</b>
25,000 hours	91.8%
35,000 hours	94.1%

These percentages result from solving an exponential decay function for 25,000 and 35,000 hours, respectively, to determine the minimum lumen maintenance necessary to achieve those thresholds.

In some cases, manufacturers continue to collect LM-80 data beyond 6000 hours (LM-80 establishes 6000 hours as a minimum test period, but recommends 10,000 hours). If additional data is available, it may be used to meet the lumen maintenance requirements, with the following thresholds:

**Table 6. Required lumen maintenance at test periods exceeding 6000 hours**

<b>Cumulative hours of testing</b>	<b>For 25000 hour projected L<sub>70</sub> life</b>	<b>For 35000 hour projected L<sub>70</sub> life</b>
7000	90.5%	93.1%
8000	89.2%	92.2%
9000	88.0%	91.2%
10000	86.7%	90.3%
11000	85.5%	89.4%
12000	84.3%	88.5%
13000	83.1%	87.6%
14000	81.9%	86.7%
15000	80.7%	85.8%

**Note:** The final version of LM-80 was published September 2008 with several significant changes relative to prior drafts, including how the case temperature is maintained (via ambient temperature versus current modulation) and in the three LED case temperatures at which the packages are maintained 55°C, 85°C, and one other temperature selected by the manufacturer (compared to the earlier drafts that required 45°C, 65°C and 85°C).

DOE recognizes that all LED manufacturers may not have 6,000 hours worth of data for all three case temperatures prescribed in LM-80. DOE therefore will allow prior data collected to be used for compliance purposes until March 31, 2010, after which date new product submissions will be required to include full LM-80 test results.

This next section describes how DOE will evaluate LM-80 data. There are three possible scenarios for determining the lumen maintenance for the product submitted to ENERGY STAR:

#### SCENARIO 1

The in situ measured  $TMP_{LED}$  is greater than the highest case temperature collected according to LM-80 procedures. In this case the product cannot qualify under Option 1 as there is no test data to substantiate manufacturer claims. Products that fall under this scenario must be successfully tested according to Option 2 in order to qualify.

#### SCENARIO 2

The in situ measured  $TMP_{LED}$  is less than the lowest case temperature ( $T_c$ ) or solder-joint ( $T_s$ ) temperature at which LM-80 data was collected. In this case the product must use the data from the lowest case temperature measured according to LM-80 procedures.

#### SCENARIO 3

The in situ measured  $TMP_{LED}$  is bounded above and below by case temperature data collected according to LM-80 procedures. In this case linear interpolation shall be used to determine the lumen maintenance for the proposed product, as follows:

$$L_{TMP} = L_{below} + \left( \frac{L_{above} - L_{below}}{T_{s, above} - T_{s, below}} \right) (TMP_{LED} - T_{s, below})$$

Where:

$L_{below}$  = Lumen maintenance (%) below the  $TMP_{LED}$  @ 6000 hours

$L_{above}$  = Lumen maintenance (%) above the  $TMP_{LED}$  @ 6000 hours

$T_{s, below}$  = LM-80 case temperature (°C) below the  $TMP_{LED}$

$T_{s, above}$  = LM-80 case temperature (°C) above the  $TMP_{LED}$

$TMP_{LED}$  = In situ measured TMP of the hottest LED within the luminaire

$L_{TMP}$  = Calculated lumen maintenance of the hottest in situ LED within the luminaire

#### EXAMPLE:

In situ measured TMP ( $TMP_{LED}$ ) = 67°C

LED Manufacturer LM-80 test data for XYZ Package

	Case Temperature		
Time (hours)	25°C	55°C	85°C
0	100%	100%	100%
⋮	⋮	⋮	⋮
6000	99%	95%	90%

Applying the equation above:

$$L_{TMP} = 95 + \left( \frac{90 - 95}{85 - 55} \right) (67 - 55)$$

$$\therefore L_{TMP} = 93.0\%$$

#### ***Component Performance “Passing” Threshold***

The luminaire **PASSES** the Component Performance Lumen Maintenance requirements if the following three conditions are met:

1. The LM-80 test report for the package, array, or module demonstrates lumen maintenance of  $\geq 91.8\%$  for a projected  $L_{70}$  of 25,000 hours (indoor residential) or  $\geq 94.1\%$  for a projected  $L_{70}$  of 35,000 hours (outdoor residential and all commercial)<sup>2</sup>.
2. The ISTMT temperature at the TMP is less than the lowest temperature that correlates to a lumen maintenance  $\geq 91.8\%$  (residential) or  $\geq 94.1\%$  (commercial) in the LM-80 test. Or the in-situ temperature at the TMP, when input into the linear interpolation equation, results in a lumen maintenance  $\geq 91.8\%$  for residential products or  $\geq 94.1\%$  for outdoor residential and commercial products.
3. The drive current measured in the fixture is less than or equal to the drive current specified in the LM-80 test report.

#### ***Submittal requirement***

Applicant submits the following information to ENERGY STAR:

1. LM-80 test report (data table and chart) showing relative light output over time at various case ( $T_c$ ), board ( $T_b$ ), or solder-joint ( $T_s$ ) temperatures and at a drive current greater than or equal to the measured current of the LED package, array, or module used in the luminaire. A template will be released shortly and will be available at [www.energystar.gov/sslpartners](http://www.energystar.gov/sslpartners).
2. In situ temperature measurement test report with the measured temperature of the hottest LED ( $TMP_{LED}$ ).
3. Diagram/picture of the  $TMP_{LED}$  location with an arrow indicating the thermocouple attachment point.

NOTE: If more than one type of LED is used in a luminaire, an LM-80 test report and the above described ISTMT and interpolation procedures must be applied to each type of LED used in the luminaire. If LM-80 test reports do not exist for the different packages used in the luminaire, the product must undergo Option 2 to verify lumen maintenance.

**Successor or next generation LED packages.** LED package manufacturers continue to improve their products, incorporating various upgrades into revised and next-generation packages. Typically these are incremental improvements, rather than entirely new products. To avoid

<sup>2</sup> Note that 91.8% and 94.1% are the passing thresholds for 6000 hour LM-80 data. For longer test periods, please see thresholds listed in Table 6 above.

significant delays in qualifying luminaires using LED packages that are successors of LED packages previously approved for lumen maintenance in DOE's ENERGY STAR SSL program, DOE allows for provisional ENERGY STAR approval based on the following conditions:

1) Luminaire manufacturer must submit at least 3000 hours of lumen maintenance (based on LM-80) data for the successor LED package(s) used, at the appropriate temperature and drive current for the luminaire, and assuming all other required provisions for ENERGY STAR qualification are met by the luminaire.

2) At least 6000 hours of lumen maintenance data for the successor LED package(s) must be provided to the DOE ENERGY STAR SSL program as soon as available.

3) If complete lumen maintenance data is not provided within 6 months of the provisional approval date, all qualified luminaires using the successor packages will face de-listing.

## **OPTION 2: Luminaire Performance**

The Luminaire Performance option allows the applicant to show compliance with the lumen maintenance requirement by demonstrating that the light output from the luminaire at 6,000 yields  $\geq 91.8\%$  lumen maintenance for a projected  $L_{70}$  of 25,000 hours (indoor residential) or  $\geq 94.1\%$  lumen maintenance for a projected  $L_{70}$  of 35,000 hours (outdoor residential and all commercial).

### ***Luminaire Performance “Passing” Threshold***

The luminaire **PASSES** the Lumen Maintenance requirements if:

1. Based on the LM-79 test report, light output determined at 6000 hours divided by the light output at 0 hours multiplied by 100 yields  $\geq 91.8\%$  lumen maintenance for a projected  $L_{70}$  of 25,000 hours (indoor residential) or  $\geq 94.1\%$  lumen maintenance for a projected  $L_{70}$  of 35,000 hours (outdoor residential and all commercial).
2. The luminaire must be operated continuously in the appropriate UL 1598/153 environment except when it is removed to perform the LM-79 light output tests.

### ***Submittal requirement***

Applicant submits the following information to ENERGY STAR:

1. LM-79 test report at 0 hours
2. LM-79 test report at 6000 hours after continuous operation in the appropriate UL1598/153 environment

## **Power Supply Qualification**

Power supplies integrated with the LED package(s), array(s) or module(s), or enclosed within the fixture shall be tested in situ under steady-state operating conditions, with power supply case temperature measured at the designated  $TMP_{PS}$ . The luminaire passes power supply requirements if the measured temperature at the  $TMP_{PS}$  is less than or equal to the warranted temperature specified by the power supply manufacturer.

### **Power Supply “Passing” Threshold**

The power supply **PASSES** if:

1. The power supply measured in situ at the  $TMP_{PS}$  is less than the power supply



manufacturer's three year minimum warranted temperature.

**Submittal requirement**

Applicant submits the following information to ENERGY STAR:

1. ANSI/UL1598/153 Test Report with the measured temperature from the TMP<sub>PS</sub>.
2. Diagram/picture of the TMP<sub>PS</sub> location (if not permanently marked on the circuit board or power supply case) with an arrow indicating the thermocouple attachment point.
3. Warranty from the driver manufacturer indicating the maximum power supply case temperature for which a minimum three year warranty is offered.

## Attachment A

### Product Groups

Luminaires are often available in multiple variations and options. For example, the same basic fixture may be available with different shades, diffusers, trim, reflectors, mountings, and/or sizes. To avoid the need to test all product variations in the ENERGY STAR SSL program, DOE allows for qualification of product groups. Allowable variations within a qualified group may be a function of:

- Component substitution: where components of a single version of a luminaire may be substituted in the manufacturing process based on component availability, cost, etc., while not substantively affecting product performance.
- Product variations: where multiple versions of a luminaire are based on the same LED platform (i.e., LED module(s)/array(s) and driver), deliver similar function and performance, but vary in physical appearance.

ENERGY STAR partners may self-define product groups consisting of a collection of products sharing similar features, and submit a single luminaire from the group for testing. DOE will verify the applicant's grouping rationale and—if the submitted product passes testing—will extend the ENERGY STAR qualification to the entire product group. Continued group qualification will be contingent on successful follow-up testing under DOE's Quality Assurance (QA) program, as described in the ENERGY STAR Program Requirements for SSL Luminaires (ver. 1.1).

### LED Platform

All luminaires in a product group must share the same type of LED platform. The LED platform consists of an LED package, array, or module with integrated thermal management (e.g., heat sinking), and a power supply (driver), assembled and operated to produce a specified quantity and quality of light. Substitution of platform components is allowed, provided that it does not significantly alter light output or color properties.

Substitute power supplies must provide the same input power as that used in the tested product, and may not exceed the drive current specified in LM-80 testing for the associated LED package(s)/module(s)/array(s). Substitution of LED package, array or modules is allowed, subject to the light quantity and quality restrictions described above. Further, the package, array, or module must be tested according to LM-80 and demonstrate the required lumen maintenance ( $L_{70}$ ) characteristics.

Consistent LED platform performance is critical to group qualification, as any luminaire in the group is subject to follow-up QA testing and must demonstrate compliance with the current ENERGY STAR criteria in effect at the time of testing.

## Component Substitution

Multiple luminaires qualified under a single application may incorporate LED packages, arrays, or modules and power supplies from more than one manufacturer, but the substituted components and resulting LED platform must produce the same quantity and quality of light as the LED platform used in the qualifying luminaire. Further, all LED package, array, or module substitution components must comply separately with ENERGY STAR lumen maintenance qualification requirements.

## Additional Requirements

For manufacturers seeking to qualify product groups on the basis of tests on a single product, DOE requires partners to submit for qualification the luminaire likely to be the lowest-performing (relative to ENERGY STAR requirements) luminaire within a group. Selecting the lowest performing luminaire within a group is the responsibility of the manufacturer. Successful qualification of the lowest-performing version will help ensure that other luminaires in the group will meet or exceed ENERGY STAR requirements, pass any subsequent QA testing, and maintain qualification status for the product grouping. Manufacturers are allowed to retroactively add models to a product group; to start the process they must inform their D&R account manager. Product groups may not span more than one of the lighting applications contained in Category A, e.g., individual porch lights and walkway lights may not be combined into a single product group.

Applicants are reminded that thermal management is a key element of LED luminaire performance and that heat must be removed from the package, array, or module —by conduction or convection—to maintain required light output, efficacy, and color quality. For this reason, DOE will not allow significant variations in luminaire housings and chassis within product groupings that are likely to affect thermal performance because material and design changes can alter the LED thermal pathway and diminish lighting performance.

However, product variations including those to housing and chassis that do not significantly degrade thermal performance are allowed. For example, outdoor wall-mounted porch lights within a product group could include a coach lantern with metal mullions or an opaque glass cylinder with a top shade while sharing the same LED platform and internal mounting hardware. Similarly, outdoor pathway lights with the same LED platform and similar basic structure may be offered in a range of ornamental shapes and embellishments.

Limited variations of luminaire housings within product groups are allowed for ENERGY STAR qualification. Applicants self-define their product groups, and should explain their rationale for each product group proposed, including selection of the version submitted for testing. DOE will evaluate grouping rationales on a case-by-case basis and, where appropriate, advise the applicant of any recommended modifications to the product group. Note that applicants ultimately bear the risk of inappropriate product grouping, which could result in failed follow-up QA testing, non-compliance, and revocation of product grouping eligibility.

As the ENERGY STAR eligibility criteria document details, applicants may also include

variations in luminaire finish, reflectors/trim, shades/diffusers, and mountings within product groups. In all cases, however, DOE encourages applicants to be conservative in their selection of grouped luminaires, and adhere to the following basic requirements and guidelines:

- 1) It is mandatory to use the same type of LED platform for all luminaires in a product grouping;
- 2) To help ensure product group qualification, submit the lowest-performing compliant luminaire in the group for testing;
- 3) Limit product variations in a group to ensure all members meet the ENERGY STAR requirements.