

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



OFFICE OF
AIR AND RADIATION

September 22, 2008

Dear ENERGY STAR Residential Light Fixture (RLF) Partner, Stakeholder or Other Interested Party:

On June 2, 2008, the Environmental Protection Agency (EPA) issued a technical amendment to the ENERGY STAR Residential Light Fixture (RLF) specification. This amendment extended the existing efficiency requirements to fixtures employing light emitting diodes (LEDs) by detailing the procedures to be used to evaluate key performance levels.

Previously the specification did not include test procedures appropriate for LEDs, placing fixtures which potentially could meet the ENERGY STAR specification at a competitive disadvantage in the market. Consistent with the program's commitment to technology neutrality, the amended specification (V4.2) seeks to create a level playing field across residential lighting technologies, and was extended to fixtures employing LED light engines based on industry requests to allow these fixtures to qualify once an applicable testing procedure had been finalized. The intent was that with the addition of these new test procedures, consumers can be confident in the energy savings and quality of an ENERGY STAR qualified fixture regardless of the lighting technology employed, and can make meaningful comparisons of qualified fixtures employing different technologies.

EPA recently sought comment on the technical amendment; comments received are available for review on the ENERGY STAR website. With this letter, EPA intends to summarize comments received, clarify outstanding questions, propose next steps for Partner and stakeholder review and comment, highlight recent test results, and provide an update on other program activities.

Summary of Comments Received

While not an exhaustive list, the following summarizes the vast majority of comments received during the comment period which closed August 25, 2008. All correspondence received is available for review on the ENERGY STAR website.

Correlated Color Temperature (CCT) Requirements

The technical amendment continued program precedent of allowing manufacturing Partners to select correlated color temperature values which they feel are appropriate and appealing to consumers. Partners historically have demonstrated their understanding of consumer color preferences for energy efficient lighting through the products they qualify; more than 98% of

presently qualified indoor fixtures supplied with a lamp employ warm CCT values of 3500K or lower.

EPA received numerous comments expressing concern about the potential for qualification of fixtures employing high CCT LED light engines (i.e. > 3500 Kelvin), along with requests to limit those CCT values which would be allowable for qualification. Concern was also expressed about EPA monitoring of products seeking qualification to ensure appropriate CCT values.

To clarify a misconception, EPA's intent was to conduct such monitoring during the qualification process, rather than after products are shipped to market.

See Proposed Next Steps, below.

Light Output

As with CCT requirements, there is no precedent within the RLF program for placing restrictions on light output values acceptable for qualification. EPA received many requests to restrict Partners to specific minimum light output values by fixture application. No proposed values were received.

This element of the program's design was intended to allow consumers a pathway towards energy efficiency whether shopping for a bright torchiere to illuminate a whole room, or a decorative accent table lamp for the corner of an office. Program Partners are allowed the freedom to design and qualify fixtures based on market demand. See Proposed Next Steps, below.

Testing Approach / Test Procedure Standards

Comments were received in support of a source-based testing approach for LED light engines, keeping with RLF program precedent of providing 75% energy savings over incandescent through the evaluation of fixture source performance without restrictions on fixture construction, optics or aesthetics. Supporting comments underscored the opportunity this approach presents to fixture manufacturers to economically qualify numerous fixtures employing the same light engine, thus boosting the number of qualified fixtures and corresponding energy savings potential available to consumers. Other comments supported a luminaire efficacy testing approach as found in the SSL V1.0 specification.

Concerns were expressed about the use of non-standard test procedures developed by the Alliance for Solid State Illumination Systems and Technologies (ASSIST). These concerns were accompanied by requests to employ photometric testing procedures standardized by the Illuminating Engineering Society of North America.

Across its more than 50 product categories, the ENERGY STAR Program has a longstanding history of leveraging industry accepted, technically sound test procedures that have not been through a formal standards process. EPA is confident in the credibility of the ASSIST test procedure cited in RLF V4.2 for purposes of testing LED light engines. EPA has learned that the Illuminating Engineering Society of North America (IESNA) is moving beyond defining LED light engines to developing a standard for their evaluation, similar to LM-79 or LM-80, which will be based on the work of the ASSIST group, specifically ASSIST Recommends:

Recommendations for Testing and Evaluating White LED Light Engines and Integrated LED Lamps Used in Decorative Lighting Luminaires. EPA will be an active participant in this development process and will include the outcome of this process in updates to the RLF program as appropriate.

Conflicting Specifications / Market Confusion

Concerns were expressed about potentially overlapping program scope between the ENERGY STAR RLF and SSL programs, and the potential for market confusion.

EPA initiated efforts to coordinate with the Department of Energy (DOE) prior to the announcement of the proposed SSL V1.0 “Category A” additions. Efforts are ongoing to improve coordination.

Withdrawal of RLF V4.2

Requests were made for EPA to withdraw Version 4.2 of the RLF specification. The majority of these requests were based on aforementioned comments and concerns.

EPA is working to address the concerns associated with these requests. See Proposed Next Steps, below.

Program Scope

Some comments acknowledge the history and success of the RLF program (est. 1997) and the limitation of the program’s scope to only the residential segment of the broader lighting industry.

EPA has refrained from labeling commercial lighting products for important reasons such as the significant contribution of lighting design in achieving the savings potential in commercial applications.

RLF Program Precedent

Support was received from manufacturing Partners wishing to continue working with the same ENERGY STAR program, contacts, practices and procedures with which they’re accustomed and with which they have achieved success marketing energy efficient lighting products. Many manufacturers who provided these comments have been Partners with EPA since the Green Lights program (1992), predecessor to the ENERGY STAR RLF program.

Technology Neutrality

Support was expressed for a technology neutral approach to product specifications, a hallmark of the ENERGY STAR program, to ensure that consumers receive equivalent performance and energy savings from an ENERGY STAR qualified light fixture regardless of the technology employed.

Efficacy, Power Factor and CRI Requirements

EPA received comments that the efficacy, power factor and color rendering index requirements are too stringent, and that these requirements should be relaxed specifically for fixtures employing LED light engines.

EPA believes that the best way to evaluate solid state lighting technology, in terms of its ability to offer the same or better performance over other available technologies, is to compare it against the pre-existing required performance thresholds, unchanged in V4.2. EPA does not feel it is appropriate to relax performance requirements to accommodate a new technology. In regards to power factor, stakeholder input had previously been solicited on the level specified in RLF V4.2 as part of the SSL V1.0 specification development process.

EPAct 2005

Concern was expressed that a comment period was not held prior to the release of the technical amendment, and that the amendment was made effective immediately. The assertion was also made that EPAct 2005 gives DOE sole authority over the promotion of solid state lighting.

Section 131 of EPAct 2005 requires solicitation of comments when specification revisions are made; EPA acted with the understanding that no revision was being made to existing specification requirements. The technical amendment issued June 2, 2008 added language for test procedures while leaving existing requirements and language unchanged.

Section 912 of EPAct granted DOE authority for conducting research and other activities for solid state lighting. Such authority clearly does not limit or preclude other parts of the federal government from advancing the market for SSL, particularly in the context of existing programs for which the lead is clearly established.

Light Pollution / Light Trespass

Requests were made for the RLF program to include light pollution requirements for outdoor fixtures (i.e. full cutoff) to minimize sky glow and improve the visibility of stars. Other comments proposed limiting outdoor fixture adjustability to thwart light trespass.

EPA intends to address these issues as part of the next major specification revision (i.e. Version 5.0).

ASSIST Test Procedure

Questions were posed about how to conduct, and the applicability of some sections of the aforementioned ASSIST Recommends test procedure.

An LED light engine includes a 'board' or other surface to which LEDs are mounted. In short, the procedure collects photometric, electrical and thermal performance data for an LED light engine at three elevated board temperatures, the highest of which approaches the known failure point of the LEDs employed. A thermal chamber manipulates the board temperature. The data from these tests is plotted: performance criterion vs. board temperature. The final test measures the same board temperature in-situ (i.e. in-fixture); the thermally stabilized measurement is

compared to the previously plotted data to predict light engine performance when the fixture is operated in a residential environment. Performance is then compared against ENERGY STAR RLF performance requirements, applicable to any technology, to determine qualification eligibility.

This approach allows LED light engine performance to be characterized based on temperature; subsequently fixture manufacturers can use a single light engine in many fixtures and determine their performance in each simply by measuring in-situ board temperature.

ASSIST's "worst case scenario" procedure is intended to improve a fixture manufacturer's understanding of a given LED light engine's performance; this test is not required for qualification. EPA will work with manufacturing Partners to clarify other outstanding questions about the procedure.

Federal Agency Coordination

Commenters requested improved coordination between EPA and DOE.

EPA initiated efforts to coordinate with the Department of Energy prior to the announcement of the proposed SSL V1.0 "Category A" additions. Efforts are ongoing to improve coordination.

Proposed Next Steps

EPA has carefully considered the comments and concerns expressed, and proposes the following next steps for Partner and stakeholder review and comment.

The ENERGY STAR Residential Light Fixture program has not been prescriptive about correlated color temperature or light output for residential light fixture applications, relying instead on manufacturing Partners' understanding of the market for their products. Program Partners continue to demonstrate creativity and skill in matching energy efficient light sources with fixture housings and optics to provide efficient yet aesthetically pleasing, consumer-friendly designs. However, concerns exist about these performance criteria as they relate to solid state residential lighting, due to the present tradeoff between the CCT and cost of LED packages. Concerns have centered on the potential qualification of high CCT, low light output fixtures, and the prevention of repeating mistakes made with early compact fluorescent technology. To allay these concerns, **EPA proposes to limit qualifiable LED light engine CCT values to 2700, 3000 and 3500 Kelvin for indoor fixtures. EPA seeks feedback on this approach.** Also, an increasingly common design practice employs higher CCT LEDs (e.g. 4100 Kelvin) in conjunction with fixture optics and materials which shift fixture light output to warmer tones rivaling the appearance of incandescent lamps. EPA seeks input on the appropriateness of allowing qualification of products employing this design approach to achieve aesthetically pleasing fixture designs at consumer-friendly prices.

In addition, **EPA proposes to set minimum light output requirements for fixtures qualified using LED light engines.** All typical residential light fixture applications, encompassing lumen packages large and small, are addressed by the RLF specification. A minimum light output requirement must establish realistic goals without undue complexity, to allow manufacturing Partners the creative freedom required to compete in this aesthetically-driven segment of the

lighting industry. The following table is offered as a starting point for discussion; EPA requests input on the proposed segmentation and corresponding minimums, and welcomes other proposals for minimum light output requirements.

Fixture Type	Examples	LED Light Engine Min. Light Output	Basis
Single source	Ceiling mount, close-to-ceiling mount, pendant, wall sconce, ceiling fan light kit (single diffuser)	475 lumens (initial)	Approximate output of 40W incandescent. The 60W incandescent is the most commonly used residential lamp, but for some applications this lumen package is excessive.
Multiple source	Multi-light chandelier, bathroom vanity, ceiling fan light kit (multiple head)	475 lumens per source (initial)	
Outdoor single source	Wall mount, ceiling mount, suspended, porch light, post top	475 lumens (initial)	Approximate output of 40W incandescent lamps.
Outdoor multiple source		475 lumens per sources (initial)	

Table 1: Proposed minimum light output requirements for LED light engines, as a starting point for Partner and stakeholder discussion.

EPA seeks comment on the above proposed next steps, and will be accepting written comments submitted to RLF@icfi.com until October 20, 2008. After this period, EPA will compile and carefully consider comments received, and release a formal spec revision for final comment as appropriate.

EPA also seeks input on ways to visually communicate information about color temperatures employed in qualified fixtures. While the wide variety of color choices available in fixtures employing LEDs is a potentially positive development, experience to date with other phosphor converted sources such as compact fluorescent lamps has shown that consumer confusion on this topic persists. EPA welcomes suggestions on coordination with industry and the efficiency community to advance the development of color metrics and descriptors that will educate consumers about the color choices available to them.

Recent Test Results

Since the issuance of the technical amendment, with support from EPA, the Lighting Research Center (LRC) at RPI has tested numerous LED light engines and corresponding fixtures to better understand manufacturers' abilities to meet RLF performance criteria using this relatively new technology. To date, no fixture employing an LED light engine has been found which can achieve the RLF V4.2 performance requirements applied to all technologies and currently met by linear and compact fluorescent sources. Table 2 compares several measured performance values for three examples against RLF V4.2 performance requirements.

Fixture Type	Efficacy (lumens per watt)	CCT (Kelvin)	CRI	Power Factor	T _s (°C)
Fixed Track	37	2770 (a)	95	0.96	67.5
Porch Light 1	48	2760 (a)	85	0.96	60.5
Porch Light 2	29	3540 (b)	75	0.49	53.0
RLF V4.2 Requirement	50	(a) 2725 ± 145 (b) 3465 ± 245	≥ 75	≥ 0.7	n/a

Table 2: Examples of tested fixtures failing to meet RLF V4.2 performance requirements. Two products are in development, therefore make and model information is not provided.

Samples tested by the LRC have consistently demonstrated several commonalities: use of LED packages from industry leading manufacturers, and a failure to meet longstanding RLF luminous efficacy requirements. Proper thermal design has been evident among samples tested, with LED junction temperatures well within manufacturer design recommendations. Measured *in situ* LED junction operating temperatures compared to manufacturer datasheets demonstrated anticipated lifetimes exceeding V4.2 requirements.

Other Program Updates

While other product categories within ENERGY STAR often experience double-digit market share, the challenge of swaying consumers toward energy efficient fixtures combined with the sheer number of residential fixture models sold has historically kept market share fairly low. EPA is pleased to announce that despite the housing industry downturn and the corresponding slump in the residential segment of the lighting industry, market share of ENERGY STAR qualified residential light fixtures jumped 2.4 percentage points in 2007 to a total of 7.2% market share. EPA congratulates our Partners and commends their efforts in the last eleven years to advance the installation of energy efficient residential lighting. To date more than 15,500 fixtures have been qualified, a number continuing to grow substantially as Partners expand their qualified offerings and convert many of their incandescent designs to employ GU24 based integrated lamps and LED light engines.

All GU24 based integrated lamps which previously received platform approval letters have undergone and passed accelerated cycling, thermal and voltage (ACTV) stress testing required for full qualification to carry the ENERGY STAR. Nearly 100 qualified GU24 lamps, including dimmable models, are now available for manufacturing Partners to incorporate into fixtures, enabling simple conversion of incandescent designs to this non-regressive line voltage socket. ANSI standardization of the GU24 socket design should be complete by year's end, and availability of qualified replacement lamps has expanded to include stocking at national retailers.

Later this month, EPA will roll out a completely revamped RLF submittal system, incorporating into one form all aspects of the current QPI, SIR and NEMA supplemental forms. This next generation "smart form" will guide users through the qualification process, responding to user input and providing direction. With these changes EPA hopes to greatly simplify the paperwork burden on Partners seeking qualification of fixtures, and reduce the time required to complete submittals.

The market for LED light engines is rapidly developing, with some full service providers making high efficiency, high quality out-of-the-box solutions available to fixture manufacturers, along with design support. Some of these light engines will meet RLF V4.2 requirements if properly incorporated into fixtures, many will not. RLF program Partners pioneered ENERGY STAR efforts with phosphor converted energy efficient lighting, and EPA is excited to continue working with our valued Partners on these new directions in residential lighting. As always, please contact me with questions at (202) 343-9272 or baker.alex@epa.gov, and thank you for your continued support of ENERGY STAR.

Sincerely,

A handwritten signature in black ink, appearing to read 'Alex Baker', with a long horizontal flourish extending to the right.

Alex Baker
ENERGY STAR Lighting Program Manager
US EPA