

ENERGY STAR®, DLC, and T24 Testing: Sorting through the Requirements

Introduction

The ENERGY STAR program, the DesignLights Consortium's Qualified Products Listings (DLC QPL), and the California Energy Commission's Title 24 high-efficacy lighting requirements all share an overall purpose: to promote energy efficiency – and thus reduce emissions of CO2 and other pollution – by ensuring quality, long-lived products for end-users. Because persistent energy savings is only assured where customers are happy with their LED luminaires and retrofit kits.

These programs push the lighting market to employ consistent metrics using standardized testing regimens. And by setting thresholds for minimum performance, they promote quality lighting and high-quality luminaires. Even as LED technologies continue to evolve, an ENERGY STAR Label or DLC listing ensures that customers can compare apples to apples on particular products.

The downside of that agreement is cost. A manufacturer may invest thousands of dollars in third-party testing for a single product, and then as newer, more efficient LEDs sources become available, retest to maintain that label, listing, or designation.

However, there are some possibilities to bypass the most burdensome testing regimens. First, be aware of your market and which luminaires might benefit from which listing. Generally, a listing on the DLC's QPL informs utilities and their commercial customers about commercial products. But the programs are designed not to overlap, so a rebate program might specify an ENERGY STAR downlight. The DLC requirements are less broad than ENERGY STAR, which is intended for the consumer market. Though many ENERGY STAR products are used in commercial applications, only a few specific luminaire types would carry both certifications.

Do consult your testing lab to see how your residential LED luminaire might qualify as a Title 24 high-efficacy fixture. And be aware that for all three programs, all the luminaires in a family need not be tested.

What is ENERGY STAR®?



Created by the EPA and Department of Energy, the ENERGY STAR program sets international standards for energy efficiency. ENERGY STAR certified LEDs use at least 75% less energy than incandescent, last longer, and produce less heat.

What is DLC®?



The DLC is a group of regional energy programs that promotes energy-efficient lighting through common standards, incentives, and education. Products on the DLC Qualified Product List achieve high standards for efficiency.

Third, ENERGY STAR itself offers a shortcut that still ensures a quality luminaire for the consumer and the luminaire manufacturer (OEM): the Certified Subcomponent Database (CSD) lists LED light engines that have already been tested and certified by ENERGY STAR. For luminaire manufacturers seeking an ENERGY STAR label, using a CSD light engine lowers the cost of third-party testing and speeds time to market – especially in the case of nondirectional luminaires.

Testing Regimens

To ensure the quality and performance of luminaires, all these product qualification programs require electrical and photometric testing in accordance with IES LM-79:

1. Total light output and light intensity distribution
2. Color characteristics, including chromaticity (CCT) and color rendering (CRI)
3. Electrical power consumption

For most programs, this is just the beginning. But these data and the resultant efficacy (in lumens per watt) are all that is required to be listed in the Department of Energy's Lighting Facts Database <http://www.lightingfacts.com/Products>; there are no minimum performance requirements.

DLC

Founded in 2008 to maximize the potential energy savings of LEDs, the DesignLights Consortium <https://www.designlights.org/> spun off from the Northeast Energy Efficiency Partnerships in 2017 and began operating as an independent nonprofit. The DLC is currently supported by its partner utilities and is referenced by 84 energy-efficiency rebate programs across the US and Canada. More than 250,000 products from more than 1700 manufacturers are listed as qualifying products.

For multiple categories of luminaires and retrofit kits, DLC requires minimum thresholds for electrical and photometric performance: light output, efficacy, CRI, and zonal lumen density (i.e., minimum lumens needed in the described light distribution angles of the lighting product). In addition, there is a minimum warranty specified and a maximum CCT specified, which is lower for indoor products vs outdoor products (high-bays are the exception). DLC also lists optional capabilities for products, such as dimming, and sets tolerances for power factor, and total harmonic distortion (THD).

Lumen maintenance is an important requirement for DLC, which requires $L70 \geq 50,000$ hrs for all luminaire types. They provide two alternatives for testing. The first avenue uses the luminaire's in-situ temperature test (ISTMT) results, along with the LM-80 data from the LED chip manufacturer. These data are imported into the TM-21 calculator, which extrapolates the lumen maintenance over time. In the second method, the luminaire as a whole is evaluated over 6000 hrs, and the lumen maintenance over time can be further extrapolated (LM-84/TM-28).

DLC requires that testing be performed by an approved or accredited lab. Groups or families of fixtures can be tested once, according to a "worst-case" model. Retrofit kits must be tested in a DLC-approved housing in order to qualify with no restrictions. DLC also has a "premium" listing category that describes higher efficacy and lumen maintenance requirements, along with ISTMT for the driver.

Surveillance testing

Like the DOE's Lighting Facts program <http://www.lightingfacts.com/About/Content/VTPolicy>, DLC instituted a Surveillance Testing program to keep tabs on manufacturers and ensure the validity of the test data submitted for product listings. Not completely random, DLC uses several criteria to designate products for verification: weighting factors include outliers in terms of performance and complaints from industry. For products selected, the manufacturer provides locations where luminaires can be purchased, and the manufacturer must reimburse DLC for the purchase and for re-testing. If a product fails, it is removed from the QPL or the product data can be updated, subject to appeal. The manufacturer always has the option to delist.

Title 24

The California Energy Commission's (CEC) pioneering Title 24 Energy Code <http://www.energy.ca.gov/title24/2016standards/> has a section describing high-efficacy lamps, LED light engines and hardwired luminaires. Effective 2017, these high-efficacy products are now required throughout residential construction in the state. Title 24 requires that manufacturers test luminaires at an accredited lab and then submit the results to the CEC. The CEC then confirms that the reported luminaire test results comply with requirements in Title 24's "Joint Appendix JA8 – Qualification Requirements for High Efficacy Light Sources." The product is then listed on the CEC Appliance Database <https://cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx> and labeled. Only those high-efficacy luminaires listed on the database are accepted by California residential building inspectors.

The Title 24 testing for high-efficacy residential luminaires includes photometric, electrical, and lumen maintenance testing. CEC sets limits on CCT and CRI (including an $R9 \geq 50$), efficacy, power factor, several lifetime and lumen maintenance metrics, and minimum dimming (where required). CEC then adds requirements for start time, audible noise, and flicker at different dimming levels.

Where an LED light engine can be detached from the luminaire the lumen maintenance of the light engine must be tested separate from the luminaire. Note that there is an Elevated Temperature Life Test protocol that certifies that a detachable LED light engine can be used in an enclosed fixture or downlight: the JA-8-E label.

In a hardwired LED luminaire, manufacturers can use the LM-80/TM-21 data from the chip or array provider. ISTMT must include three sample products. Where a family of luminaires uses the same light engine or array and provides the same optical, thermal, and other operating conditions only one “basic model” would need to be tested. Recessed downlights are required to be AT- and IC-rated.

CEC has no verification protocol, other than an affirmation by the manufacturer and the requirement to keep testing reports on file. CEC does not specify a warranty, but the product must have a rated life $\geq 15,000$ hrs.

ENERGY STAR

We have worked our way up to 10 or 12 tests (depending on how you slice it), plus the chance of having to repeat testing if selected for verification (Surveillance Testing) by DLC. And yes, this is in addition to UL/ETL safety testing required by all authorities having jurisdiction.

But all this testing does offer assurances of quality and performance:

- Light output minimums ensure that you get enough light.
- Light distribution requirements ensure the light goes where advertised.
- Long-term testing and minimum warranties back up lifetime claims.
- Evolving technologies are held to the same rubric as existing products.
- Consistent, consensus-based testing regimens help customers compare performance among products and replace failed luminaires and sources with equivalent products.

ENERGY STAR – covering a wide variety of consumer and commercial products – is a joint partnership of the U.S. Environmental Protection Agency and the U.S. Department of Energy. In mid-2017 ENERGY STAR listed close to 15,000 indoor and outdoor light fixtures in 13 categories. About half are recessed luminaires, including downlights.

The program has even more onerous testing and “off-the-shelf” verification requirements. ENERGY STAR continues to raise its standards for efficiency and quality. EPA released the V2.0 Luminaire Specification in 2016, updating guidance on LM-80 test data in 2017. Testing labs must be accredited. In addition, a Certification Body (CB) is required to follow up and verify that the test results are from an EPA-recognized laboratory and that they meet the criteria for product labeling. CBs also administer verification testing.

Multiple requirements for light color include tolerances for CRI and CCT shift over life and color angular uniformity for indoor fixtures only. Driver case temperature, transient protection, and off-state power consumption may also require testing; with minimums, maximums, or tolerances for some or all luminaire types. Note that where LED arrays are not field-replaceable, higher efficacies, and lumen maintenance may be required. ENERGY STAR sets minimums on total lumen output for the different luminaire types.

Manufacturers must test the highest-temperature, highest-wattage, highest-CRI, and lowest-CCT model. Retrofit kits are tested in the worst-case thermal environment that the product is rated for; e.g., downlights and enclosures. ENERGY STAR provides detailed advice on product families, allowing manufacturers to test representative configurations. Finishes, reflectors, and trims can be varied, provided light output and air flow are unaffected. Variations in thermal management are not allowed.

As with DLC listings, only a single sample luminaire needs to be tested.

CSD provides an easier path to ENERGY STAR

The ENERGY STAR Certified Lighting Subcomponent Database https://www.energystar.gov/products/lighting_fans/certified_lighting_subcomponent_database_csd can streamline the certification process for luminaire OEMs. (But use of these components is not required.) Intended to replace the old NEMA/ALA Lamps and Ballast Platform Matrix, several different types of components, primarily light engines, are listed. The CSD components carry EPA-approved, third-party certified performance data:

- Luminous Efficacy
- Lumen Output
- Lumen Maintenance
- CCT (Indoor and Indoor/Outdoor only)
- CRI (Indoor and Indoor/Outdoor only)
- Color Maintenance (Indoor and Indoor/Outdoor only)

- Maximum In-Situ Operating Temperature at Tb to meet ENERGY STAR specifications based on LM-82-12 results
- Source Start Time (Indoor and Indoor/Outdoor only)
- Source Run-Up Time (Indoor and Indoor/Outdoor only)
- Dimming (as applicable)
- Power Factor
- Transient Protection
- Operating Frequency
- Maximum Measured Driver Case Temperature
- Minimum Starting Temperature (Outdoor and Indoor/Outdoor only)
- Driver Safety (UL)

But note that a CSD light engine – comprising an LED source and driver – is not an ENERGY STAR–qualified product and, thus, does not bear the ENERGY STAR label.

From ENERGY STAR:

In most instances, this approach to luminaire certification significantly reduces the luminaire partner’s testing burden, such that only limited additional testing is needed at the luminaire level (e.g., in situ temperature measurements and electrical safety testing).

Component testing sets the same high bar as for luminaires, but an OEM can leverage the efforts and relationships of their supplier-partner; thus, reducing testing costs and time to market. Of course, an OEM should review the component data to make sure it meets the ENERGY STAR requirements for a specific luminaire type.

Thermal testing is still required in the fixture to make sure temperatures do not exceed the operational limits. But for nondirectional luminaires, electrical safety testing and the ISTMT could be the only requirements for an ENERGY STAR fixture using a CSD light engine – saving perhaps thousands of dollars and cutting the testing and qualification time down to weeks instead of months.

Directional luminaires require additional photometric and color testing (LM-79) for ENERGY STAR, to ensure that the lumens from the light engine are being delivered effectively. But all the non-photometric datapoints collected during testing of the CSD light engine are accepted for ENERGY STAR luminaire labeling. (Integrated controls being the exception.)

For listing on the DLC's QPL, a luminaire OEM may certainly use a light engine listed on ENERGY STAR's CSD. But again, DLC is focusing on delivered lumens, so LM-79 testing must be performed along with ISTMT for all fixtures. For a multi-voltage driver, additional power factor and THD testing might also be required.

For Title 24, JA-8 seems to have focused more on LED replacement lamps than light engines and luminaires. For inseparable luminaires using a CSD light engine, LM-79 testing must be performed along with ISTMT. Non-photometric testing requirements are nearly identical to the ENERGY STAR CSD requirements, which can be helpful. But for separable luminaires, where the light engine is field-replaceable, JA-8 requires the full gamut of 6000 hrs of lumen and color maintenance testing for the light engine assembly, in addition to photometrics.



Sample ENERGY STAR CSD Component: Fulham Vizion DC LED Engines & Retrofit Kits

- Six wattages, 11W to 39W, with built-in drivers
- Round, half-round and rectangular configurations
- Listed on the ENERGY STAR Certified Subcomponent Database
- UL listed both US and Canada
- Thermal and optical optimization with simple install
- 2700K, 3000K, 3500K, 4000K, and 5000K CCTs
- Round, half-round, and rectangular light engines for ceiling-mounted fixtures, pendants and sconces
- Dimming or non-dimming
- Compatible with Fulham HotSpot2 emergency lighting system
- 5 year warranty

Summarizing the strategies

Despite the high cost to luminaire manufacturers, the various testing and quality-assurance program have proved a boon to both consumers and manufacturers. Customers and utility rebate programs have come to rely on ENERGY STAR and the DesignLights Consortium, for efficient, effective products backed by a warranty. Manufacturers have also benefitted from the push for standardization in testing protocols, which enables one-stop testing for dual certifications of multiple models – even as LED and lighting controls technologies continue to evolve. Comparing products apples-to-apples makes it easier for customers to make more-confident, better-informed decisions, and gives the market a measure of protection against outrageous claims, disappointing performance, and dangerous installations.

Manufacturers aware of their market position will choose carefully which certifications and listings they seek for particular products. Commercial luminaire OEMs primarily focus their certification efforts and dollars on the DLC's Qualified Products List, seeking the ENERGY STAR label where a product falls into that

domain. Consult your testing lab in advance to see how your residential luminaire might qualify for both ENERGY STAR and Title 24 labels, and whether it's better to house a field-replaceable light engine vs hardwired.

LED light engines from the ENERGY STAR Certified Subcomponents Database can provide a shortcut through testing to labeling. ENERGY STAR CSD light engines have already undergone testing and meet requirements for more than 15 different parameters of operation and output. So a luminaire OEM may bypass many of the testing requirements for the ENERGY STAR label.

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