

Commercial & Industrial Lighting LED Retrofits for Troffers



LED retrofit kits and linear replacement lamps are now available to convert recessed fluorescent light fixtures (or 'troffers') in commercial buildings such as offices and retail. These retrofits re-use the top portion of the existing troffer, so the space above the dropped ceiling is not disturbed. Compared to complete troffer replacement, LED retrofits can usually be installed more quickly, with less dust and disturbance of the occupants.

Two types of retrofits are available. LED linear replacement lamps are shaped like fluorescent lamps. They reuse the existing lens, and often the existing lamp holders. Integrated-style LED retrofit kits are not shaped like fluorescent lamps. Some reuse the existing lens, while others provide a new customized lens, to enhance appearance and light distribution. Note that besides LED kits, energy efficient kits with new customized lenses are also available with new fluorescent HPT8's.

A recently published report [1] found that, among 21 LED troffer products purchased in summer 2012, most dedicated LED troffers performed better than most LED retrofits. However, as new LED retrofit kits continue to enter the market, early adopters may find products suitable for various applications.

Brightness

LED retrofits for troffers rarely provide the same light output of the existing fluorescent lamps. Some are considerably brighter than others. High light levels are appropriate for applications such as retail and precision manufacturing, while lower light levels are often appropriate for modern offices devoted to computer work. If precise control over light output is desired, then a compatible lighting control system should be included in the project.

While fluorescent high performance T8 lamps (HPT8's) only lose 6% of light output over their rated lifetime, most LED lights are expected to lose 30% of their initial brightness by the end of their rated lifetime (L70). Some LED products include automatic adjustments over time, to provide constant brightness throughout life; others are rated at L90, to only lose 10% of initial brightness at the end of rated life.



Cree LED CR24 Upkit



OSRAM LED 2x2 Retrofit Kit



Lithonia VTLR LED

Light Distribution

Most LED lights on the market today are highly directional: each LED points in one direction. Existing troffer lenses are designed for fluorescent tubes that distribute light in all directions. A new lens designed specifically for LED's can deliver more uniform lighting, compared to an old lens not designed for LED sources.

If the LED retrofit does not include a new lens and an old acrylic diffusing lens is reused, the light distribution may be less uniform than before the retrofit. A bright stripe of white light under each LED light bar can be expected, with stripes of gray between the LED light bars. When a multi-lamp troffer has been delampaged, the gray stripes are especially prominent. When the LED lights all aim directly down, this lights the area under each troffer well, but may result in lower lighting levels in areas between troffers.

If an old parabolic louver is reused with bare LED light bars or lamps, multiple light stripes and shadows are likely to appear throughout the room.

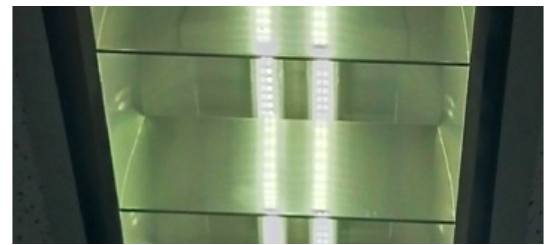
Products

This is a partial list of integrated style LED retrofit kits that include a dedicated new lens (as of Spring 2013) Most utility incentives for commercial LED light fixtures refer to the DesignLights Consortium Qualified Product List (DLC QPL). In March 2013, the DLC QPL listed the following integrated-style LED retrofit kits, and too many LED linear replacement lamps to show here. Product selection is changing rapidly, so please refer to the updated DLC QPL for a current product list.

Product	Company Website
Acuity Lithonia RTL & VTL	lithonia.com
Cree CR24 Upkit	cree.com
LED Living Technology Claris	ledlivingtechnology.com
OSRAM Sylvania LED 2x2 Retrofit	sylvania.com
PristineLED Star Bright SB4-40N	pristineled.com



These 2'x4' troffers with acrylic lenses (above) originally had 3 fluorescent T12 lamps, and now have 2 T8 LED linear replacement lamps that create white and gray stripes on each troffer lens. With a new lens designed for LED's, each troffer would have a more uniform appearance.



This 1'x4' parabolic louvered troffer has been retrofitted with two new T8 LED linear replacement lamps (above).

This retrofit created patterns of white lines such as the horizontal white lines shown on this cabinet (below). A new lens designed for LEDs would light the room more uniformly.



Safety

Safety of Both Types of LED Retrofits

Electrical safety is an important issue in product selection, installation and maintenance. A March 2013 CALiPER report [1] found that more than half of the 9 LED retrofit kits tested

“would not have passed an electrical safety inspection because of labeling issues, poor installation instructions, poor mounting or construction, and other complications. This does not necessarily mean that the luminaires were unsafe, but it could trigger the inspector to require a site inspection.”

Significant installation and safety challenges for some LED retrofits are documented on pp.23-27[1]. For electrical safety, certifications from National Recognized Testing Laboratories (NRTL) such as UL, CSA and ETL should be maintained. The visible means of ensuring that safety certifications are maintained is through the use of labels. The manufacturer of the LED retrofit product should provide a label that includes information about the installed product and the NRTL approval mark. The label is important for the safe future maintenance of the product, and to transfer responsibility of the retrofitted product from the original troffer manufacturer to the LED product manufacturer.

The US Department of Energy recommends[1], when considering an LED retrofit, to ask the product manufacturer:

1. Is the lamp or kit NRTL approved? If this is an LED lamp, it must comply with UL1598C and the UL1993 standard. LED lamps that use a separate driver (i.e., the driver is not built into the lamp itself) must comply with UL1598C only.
2. Is there any limitation on which manufacturers' troffers it can be used with?

Additional Safety Concerns for LED Retrofit Kits

Many LED linear replacement lamps require new wire connections inside the troffer to supply AC line voltage directly to lamp holders not originally designed for this use. For safe installation, care must be taken to ensure that appropriate single-ended vs. double-ended LED lamps are matched with appropriate non-shunted vs. shunted lamp holders. Everyone replacing lamps in the future should be mindful of the AC line voltage at the lamp holders, and of the need for the appropriate single-ended or double-ended lamps. Some LED linear replacement lamps, especially those with integrated drivers, may exceed the weight capacity of lamp holders designed for light-weight fluorescent lamps.

The following table shows that, among the various configurations of LED retrofits for troffers, the BPA Energy Efficiency Program prefers integrated-style retrofit kits. Among LED linear replacement lamps, BPA prefers products with a driver physically separated from the lamp itself.

Configurations of LED Retrofits for Troffers

BPA's Position	Physical Configuration	Energy savings positive & persistent	Maintenance: low danger of line voltage between 2 hands	Low power & low weight at all lamp holders
Best	Integrated-style kits	*	*	Not applicable
Better	Lamp with separate driver	*	*	*
Good	Lamp with integrated driver, single-ended	*	*	
Less Good	Lamp with integrated driver, double-ended	*		
No Incentive	Lamp, reuse existing ballast		*	*

Considerations for Purchase

Before purchasing, understand what the warranty covers and how it is exercised. Coverage may not include all components, shipping, and labor. How many individual LEDs must fail before a product is replaced under warranty? Must the whole unit be shipped back to the manufacturer, or can field repairs be made? Warranty terms from 5 years to 10 years are available from various manufacturers. Install a sample of the product you are considering, and use it awhile.

Engage a professional who will ensure that the project complies with energy code power allowances and control requirements plus utility incentive requirements, while providing light that meets your needs. Note that to receive most utility incentives, LED lights should be on a qualified list:

For light bulbs, ENERGY STAR
http://www.energystar.gov/index.cfm?c=manuf_res.pt_lighting

For commercial light fixtures, Design Lights Consortium or Lighting Design Lab
http://www.designlights.org/solidstate.about.QualifiedProductsList_Publicv2.php
<http://www.lightingdesignlab.com/led-list>

Additional questions to ask are available at this US Department of Energy Website:
<http://www1.eere.energy.gov/buildings/ssl/what-to-ask.html>

References

1) "CALiPER Exploratory Study: Recessed Troffer Lighting", NJ Miller, MP Royer, ME Poplawski, March 2013, PNNL-22348

www.ssl.energy.gov/exploratory.html

This 60-page report compared products delivered in July 2012: four 2'x2' integrated-style LED retrofit kits, five 2'x4' LED linear replacement lamps, twelve dedicated LED troffers and three fluorescent troffers.

Significant installation and safety challenges for some lamps and kits are documented on pp.23-27. For LED linear replacement lamps, color quality ranged from very poor (low 60's CRI) to very good (high 80's CRI). Integrated-style kits matched the performance of 25W and 28W HPT8's in most categories, although each product had one or more drawbacks such as color matching, glare or appearance. Of the four integrated-style kits tested, only two, the Acuity RTLED and LED Living Technology Claris (products 'E' and 'H'), were listed on the DLC QPL as of March 2013.

Almost all of the dedicated LED troffers demonstrated superior performance compared to the LED retrofits and to the HPT8 fluorescents, except that 4 of the 12 LED troffers flickered when dimmed, and one product performed poorly in multiple categories.

2) "LED APPLICATION SERIES: LINEAR FLUORESCENT REPLACEMENT LAMPS", May 2011

<http://cool.conservation-us.org/byorg/us-doe/led-t8-fluorescent-replacement.pdf>

This is a 4-page overview of CALiPER tests in 2008, 2009 and 2010, evaluating performance such as light output levels, efficacy in lumens/watt, and Color Rendering Index (CRI). In these studies, all of these measurements were low for LED's compared to fluorescents. The best LED products have improved since 2010, but inferior products remain on the market. There is a clear description of the challenge of replacing omni-directional fluorescent lamps with highly-directional LED lamps.

3) "Laboratory Evaluation of LED T8 Replacement Lamp Products", EE Richman, BR Kinzey, NJ Miller, May 2011, PNNL-20404

http://www.pnl.gov/main/publications/external/technical_reports/PNNL-20404.pdf

In September 2010, three 'best in class' LED T8 linear replacement lamps were purchased, ranging in price from \$63 to \$120. They were installed in 3 types of troffer in a lab. In most cases, light levels were sufficient for a modern office, but too dim for a retail space. Uniformity was relatively poor for LED lamps in conventional troffers except for basket direct/indirect troffers, which provided good uniformity but insufficient brightness. Comparable light levels and energy savings were achievable with 25W fluorescent High Performance T8's, at a significantly lower lifetime cost. Note that integrated-style retrofit kits with new optics are available for HPT8's, as well as LED's.