Fluorescent Lamps 101

Kansas City Board of Public Utilities

Understanding the basics of fluorescent lamps guarantees that you'll select the most appropriate fluorescent lighting, maximize lamp life and dispose of spent lamps properly.

Screw-in compact fluorescent lamp

Pin-based compact fluorescent lamp

Compact Fluorescent Lamps

Screw-In CFLs

These were the first CFLs available, and they targeted the retrofit market. Screw-in CFLs can last up to five times longer than a 75-watt A19 incandescent. They are an efficient retrofit for lamps used in hospitality, multi-family and educational settings, and have an integrated ballast. When the lamp expires, both the lamp and ballast are disposed of.

Pin-Based CFLs

Commercial applications of CFLs typically use pin-based lamps. While purchasing fixtures for pin-based lamps might cost more initially, the lamps are less expensive and will perform better than a fixture originally designed for an incandescent and outfitted with a screw-in CFL. A pin-based CFL has a rated life of approximately 10,000 to 12,000 hours.

The popularity of fluorescent lighting isn't surprising. Fluorescent lighting can provide the same amount of illumination as incandescent lamps while using 25 to 35 percent less energy. The life of a fluorescent lamp is 10 times longer, too.

Fluorescent technology, over the past 10 to 15 years, has evolved dramatically in efficiency, longevity, color rendering, and even in issues of operations and waste disposal.

Fluorescent Lamp Types

T12 Lamps

The T12 (a 12/8- or 1.5-inch-diameter lamp) was the lamp of choice for many years—until a slimmer, more efficient lamp emerged. These lamps are rarely specified in new construction today.

The use of T12 lamps has declined due to their relative inefficiency. Technology advancements in the forms of improved (rare-earth) phosphors and electronic ballasts resulted in a T8 lamp-ballast system that provided better color rendering, longer life, and improved efficiency. These features made what was previously the workhorse of commercial lighting—the T12—a less desirable lamp. Despite the smaller diameter of the T8 (8/8 or 1 inch), switching from T12 to T8 lamps is relatively simple, because T8 lamps fit into the standard socket configuration of T12 luminaries, and lamp length is the same.

T8 Lamps

The T8 has rapidly become the most commonly used lamp. Building owners and facilities professionals like its efficiency and long life. T8 lamps can last anywhere from 20,000 to 30,000 hours and lighting designers appreciate the lamp's slim profile.

T8 lamps render colors better than most of their fluorescent predecessors, too. Unlike the majority of T12s that provide poor color rendering, the color rendering index (CRI) for most T8s is somewhere between 70 and 95 (the higher the number, the better; the maximum CRI is 100). A range of correlated color temperatures (CCTs), from 2,700 Kelvin (a yellow light) to 4,100 Kelvin (a more white or blue light), provides a broad spectrum of whites—ranging from warm to neutral to cool. Where color matching is especially important, 800 series T8 lamps are ideal. These triphosphor lamps provide above-average CRI.

High-performance T8 (HPT8) lamps—also known as super T8s—offer even greater energy efficiency than standard T8s. A high-lumen, long-life T8 lamp and low-watt electronic ballast generate the same total light output as a regular T8, but use less energy. The super T8 is about 20 percent more energy efficient than the regular T8. HPT8 lamps are extended-life lamps, typically rated to last 4,000 hours longer than standard T8 or T12 lamps. That could be up to 2 years in a normal office setting.

T5 Lamps

The newest member of the linear fluorescent family is the T5. This lamp's diameter (at 5/8-inch) isn't the only size differentiator between it and T12s or T8s. T5 lamps are not a full, exact 24, 36, or 48 inches long; they're actually somewhat smaller because they were made for metric fixtures. Retrofitting from T12s (or T8s) to T5s is often impractical because:

- They offer little to no efficacy over T8 lamps.
- Their metric lengths and lamp-holder design require significant changes to existing fixtures.
- The T5's substantially higher tube luminance is likely to cause glare problems in existing lighting equipment where the lamp can be viewed directly, even through a lens or diffuser.

It's best to use T5s in fixtures designed specifically for them. They are used in a wide range of interior and exterior fixtures including troffers, wall washers, decorative luminaries, ceiling cove applications, and suspended direct or indirect lighting.

T5 High Output (or T5 HO) lamps nearly double the light output of standard T5s. A T5 HO produces about 70 to 80 percent more light than the standard T5, yet, if you have them side by side on your desk, without reading the label, you wouldn't know the difference—they're identically-shaped lamps.

One advantage that T5 High Output has is that it's roughly the same lumen output as two T8s or two T12s, so once you go to a T5 HO, your lamp count can go down. A word of caution, though: Because T5 HO lamps are so bright, glare can be problematic. There's so much brightness in such a small-diameter lamp, and if it's not well diffused or somehow camouflaged, the brightness of the lamp can be almost painful. T5 HO lamps should be used in either suspended indirect fixtures or direct fixtures in high-bay applications, ideal for warehousing.

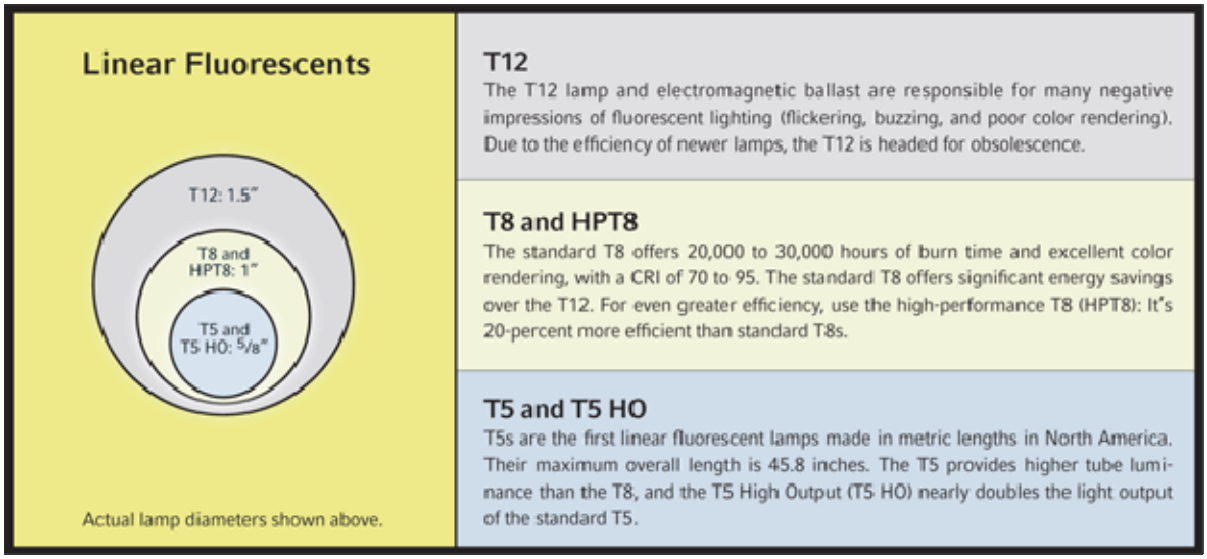
Compact Fluorescent Lamps

Wall sconces, pendants, down lights, and table and floor lamps are ideal applications for compact fluorescent lamps (CFLs). CFLs can replace incandescents that are roughly 3 to 4 times their wattage, saving up to 75 percent of the initial lighting energy. Both the energy savings that result and their long lives offset the significantly higher cost of CFLs. While you can expect to pay 3 to 10 times less for comparable incandescent lamps, CFLs last 6 to 15

times as long. A standard light bulb might be anywhere from 1,000 to 2,000 hours. Compact fluorescents are going to be 10,000 or 12,000 hours.

Integral lamp-ballast combinations with screw-in Edison bases provide convenient and inexpensive alternatives for lamps used in hotels, apartment complexes, schools, and other long burning-hour applications. Because these are self-ballasted, the ballast is disposed of with the lamp when it's spent. While the energy savings and long life are definite advantages, these self-ballasted, screw-in CFLs are not as efficient as pin-based CFLs. Despite this, screw-based CFLs remain the best choice when trying to maximize energy efficiency in historic fixtures.

In commercial applications, pin-based CFLs are the clear choice over their screw-in counterparts. If you buy a regular incandescent down light and screw a compact fluorescent in, it will work much worse than if you bought a compact fluorescent down light with a pin-based lamp. These lamps have a rated life of between 10,000 to 12,000 hours and offer significant energy savings over incandescent and halogen sources.



Maintenance Considerations

Maximize Lamp Life

Selecting the best lamp and ballast combination for your application can dramatically reduce the maintenance required. For example, by installing lamps with a long life, fewer replacements are necessary, saving on time and labor.

Long lamp life and infrequent relamping are especially important when lighting areas that require special lift equipment to access fixtures (e.g., an atrium).

Lamp life may also be affected by lamp and fixture capability. The misuse of CFLs is a prime example. Incandescents really aren't susceptible to heat problems, whereas a compact fluorescent might overheat inside a recessed can and shorten its life.

Selecting the right ballast is equally important in reducing maintenance and maximizing lamp life. While lighting controls reduce wasteful operation by turning lights off in unoccupied areas, selecting the most appropriate ballast in these applications is necessary to prevent premature lamp failure. Use rapid-start ballasts when the average "on" time for lamps is less than 3 hours per start. There are a few drawbacks, though: Rapid-start ballasts are 5 to 10 percent more expensive than instant-start ballasts, and are not as efficient, either. The vast majority of ballasts out there are going to be instant-start ballasts. They cost less and they also use a little less power. But, with instant-start, if they're turned on and off a lot during the day, then it's hard on the lamps and they fail sooner. Rapid-start ballasts (especially *programmed-start* rapid-start ballasts) are ideal because they minimize cathode deterioration. The way they turn the lamp on is much gentler on the lamp.

Once you've purchased the most appropriate lamp and ballast, make sure they are both installed properly. If the lamp isn't clicked into the sockets right, it can burn for awhile, but it tends to short arc and will shorten lamp life.

Control Light

Fluorescent lamps are ideal for applications that control light via timers, occupancy sensors and daylight photo sensors. As a result, lamps are operated less, energy is saved, and the frequency of relamping decreases. Depending on the application, occupancy sensors can be a good way to lengthen maintenance cycles.

Dual switching is another lighting-control strategy (although it's less sophisticated). The basic principle is that one luminaire housing multiple lamps and ballasts has two manual switches. For example, one switch will control two of the three lamps, and the other switch will power the remaining lamp. With both switches on, the space is illuminated by all three lamps. If you have a lot of daylight coming in during the day, you may only need one lamp on. Then, as the sun goes down, you may need two lamps; at night, you may need three, depending on your task.

Of course, the simplest way to curb wasteful lighting is with the flick of a switch. Simply turn lights off that don't need to be on. Encourage building occupants to help you in this quest.

Group Relamp

Spot relamping, the practice of replacing lamps one at a time as they expire, can become a tiresome task for maintenance professionals. This method for lamp replacement wastes valuable labor. Since the expense of labor far exceeds the price of fluorescent lamps, group relamping may be a more cost-effective strategy. With the use of group-relamping procedures, all of the lamps in an area are installed at once and then, at a predetermined interval, all of the lamps are replaced before they start burning out on a regular basis. Group relamping enables maintenance staff to schedule a time that's least disruptive to building occupants and work-efficiently with equipment and supplies in tow. Another benefit of group relamping is the reduced cost of lamps, because they can be bought with bulk-purchase discounts and less storage space is needed for the replacement lamps. Evaluate staff resources to see if group relamping makes sense. If you've got a huge building, then group relamping is *usually* more economical.

To determine when to perform group relamping, find the rated life of the lamp and calculate the typical hours of operation. At 100 percent of the rated life of the lamps, which is typically 20,000 hours or more, 50 percent of the lamps will fail. The most economical point to group relamp is around 70 percent of the rated life of the lamps.

Replace Lamps with the Same Bulb

Using the wrong lamp in a fixture can result in shortened lamp life and generate complaints from occupants about glare and insufficient light levels. To avoid these problems, pay close attention to the diversity of lamp types being specified during the design or retrofit of a lighting system. Spaces with too much variety, such as an office that uses T8, HPT8 *and* T5 lamps, can cause confusion among maintenance employees, who may inadvertently install the wrong equipment during relamping. Fewer types of lamps can also alleviate other headaches, too. If lighting professionals have provided a manual explaining what equipment is used and where, refer back to it when any component of the lighting system needs to be replaced. Opting for cheaper lamps may save a few dollars initially, but can compromise energy efficiency and the quality of light. As an example, a less expensive, easier-to-find CFL may cast an undesirable bluish light, contrasting with the CCT of surrounding lamps. It can also be tempting to replace screw-based CFLs with incandescents because it's easier, quicker, and dramatically cheaper - a practice called "snap back." The bottom line: The manual is provided so that replacement lamps can be selected to meet the original specification, so use it.

Lamp Disposal

Recycle or Dispose of as Hazardous Waste?

Despite all the things facilities and lighting professionals love about fluorescent lamps, there is one undesirable characteristic: the mercury they contain. The light produced by a fluorescent tube is caused by an electric current conducted through mercury and inert gases. Mercury is a neurotoxin known to cause kidney

and brain damage. Efforts made by the lighting industry to address concerns about disposal and the risk of mercury from lamps leaching into soil and water are commendable. According to the National Electrical Manufacturers Association (NEMA), manufacturers have reduced the amount of mercury in their fluorescent lamps by more than 90 percent.

In 1995, the EPA issued the universal waste rule to address many hazardous wastes that were previously discarded in the trash (e.g., fluorescent lamps). According to the organization, the rule is designed to reduce hazardous waste in the municipal solid waste (MSW) stream by making it easier for universal waste handlers to collect these items and send them for recycling or proper disposal.

Options for disposal include recycling or taking spent lamps to a designated drop-off point.

Lamp recycling is increasing rapidly. In September 2007, NEMA reported that lamp recycling had increased from 70 million lamps in 1997 to 156 million lamps in 2005. Lamp manufacturers are all very aware of the environmental impacts of their products and have a long history of being environmentally conscious and responsible; everybody advocates recycling fluorescent lamps, not just to sequester the mercury, but also to reclaim the metals and even the glass from the lamp. Recycling isn't costly, either. The cost of recycling, according to NEMA, represents only 1 percent of the total costs of owning a fluorescent lamp.