NLPIP Lighting Answers
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High-wattage Compact Fluorescent Lamps

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Introduction

High-wattage compact fluorescent lamps (HW-CFLs) have been developed using standard CFL architecture. HW-CFLs are sometimes called "high lumen CFLs." Manufacturers provide greater light output by elongating and reshaping fluorescent tubes. Typically, manufacturers bend or swirl a T5 tube into two basic configurations, as illustrated in Figure 1. HW-CFLs range from 55 to 200 watts (W) in power and 3400 to 12,000 lumens (lm) in light output.

The HW-CFL may have a screw base (medium or mogul) containing the ballast (self-ballasted), or may be pin-based and use a separate, remote ballast (remote-ballasted) [not shown in Figure 1]. HW-CFLs are offered by all of the larger lamp manufacturers as well as several smaller companies.

HW-CFL manufacturers claim long **lamp life**, high luminous **efficacy**, and good **color rendering** properties. In general, they are energy efficient and may be useful in retrofit applications. For some HW-CFL products, large size and thermal sensitivity of the ballast may limit their use. Typical retrofit applications are high-ceiling environments with diffuse pendant luminaires such as retail stores, warehouses, factories, gymnasia, houses of worship, and hotel lobbies.

NLPIP performed limited testing of thermal conditions typical for HW-CFLs installed in open and enclosed luminaires. NLPIP also measured **power**, light output, luminous efficacy, and color properties of several HW-CFL samples.

Figure 1. Samples of high-wattage CFLs together with a more common, low-wattage CFL (hand-held at bottom of photo)

Photo: Dennis Guyon

Note: All lamps were photographed together and are in scale.

What are the intended applications for HW-CFLs?

Self-ballasted high-wattage compact fluorescent lamps (HW-CFL) are intended primarily for retrofit in **high-intensity discharge (HID)** luminaires, after the HID ballast is disconnected, or for retrofit in high-wattage incandescent luminaires. Remote-ballasted HW-CFLs are intended for luminaires specifically designed for these lamps, including high- and low-bay luminaires or large recessed downlights. Both self-ballasted and remote-ballasted HW-CFLs are typically used in high-ceiling applications, where diffuse illumination is desired such as big-box retail stores, warehouses, factories, hotel lobbies, or houses of worship. It is difficult to have good optical control of the light emitted by luminaires employing HW-CFLs because of their many and large luminous tubes.

For good optical control where non-diffuse, directional lighting is required, the much smaller filaments of incandescent lamps and of HID arc tubes make them much better choices as light sources.

Manufacturers of HW-CFLs claim long **lamp life**, high luminous **efficacy**, instant **restrike**, and good **color rendering** properties. Compared to incandescent lamps, long lamp life would make HW-CFLs a better choice in applications with difficult-to-access, high ceilings. Fluorescent lamp life is shortened by frequent switching, however. So using occupancy sensors to control HW-CFLs may reduce actual lamp life significantly, compared to rated lamp life. For this reason, some manufacturers of HW-CFLs recommend that they not be used with occupancy sensors. Compared to HID lamps, HW-CFLs have fast starts and restrikes, so they would be a good choice in applications that require the lights to come on quickly. Compared to higher wattage incandescent lamps, HW-CFLs are more efficacious and can significantly reduce energy consumption for the same light output. It must be noted, however, that the specific operational characteristics of HW-CFLs can vary considerably for different manufacturers and for different designs. Therefore, to minimize disappointments, the specifier should query manufacturers about performance characteristics of specific interest.

How does light output of HW-CFLs compare to other light sources?

High-wattage compact fluorescent lamps (HW-CFL) have similar initial light output to high-wattage incandescent lamps, mid-wattage **metal halide (MH)** lamps, low- to mid-wattage **high-pressure sodium (HPS) lamps**, and electrodeless fluorescent lamps. Table 1 provides a comparison of initial light output of HW-CFLs with other lamp types.

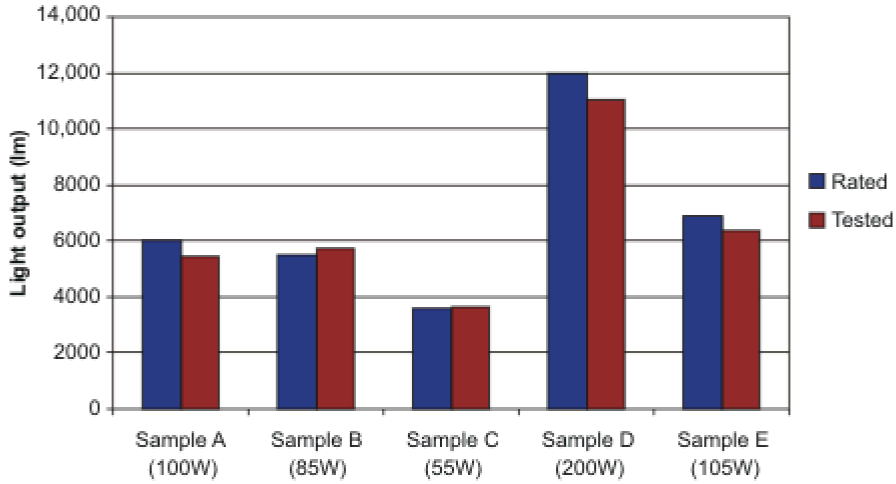
Table 1. Initial light output comparison of HW-CFL products with other lamp types

Lamp Type	Wattage	Initial Light Output (lumens)
Self-ballasted HW-CFL	55-200 W	3400 - 12,000
Remote-ballasted HW-CFL	55-140 W	4000 - 9000
Incandescent	200-500 W	3800 - 10,850
Ceramic MH	50-150 W	3600 - 12,500
Standard MH	70-175 W	3500 - 14,000
Pulse Start MH	70-175 W	4700 - 16,000
HPS	50-150 W	3700 - 16,000
Enhanced HPS	70-150 W	3800 - 12,000
Electrodeless Fluorescent	55-165 W	3500 - 12,000

As with any fluorescent source, temperature will affect light output of HW-CFLs (see Short-term thermal effects section in How is performance affected by ambient temperature?).

NLPIP tested one sample of five self-ballasted HW-CFLs ranging from 55 W - 200 W and compared these measurements to light output claims made by their manufacturers. After seasoning the lamps for 100 hours, NLPIP performed thermal testing (see Appendix A: Thermal testing of HW-CFLs), and then tested them in an integrating sphere to measure light output (see Appendix B: Power and light output of HW-CFLs). As shown in Figure 2, all of the samples were within 10 percent of the manufacturers' rated initial lumen (lm) values.

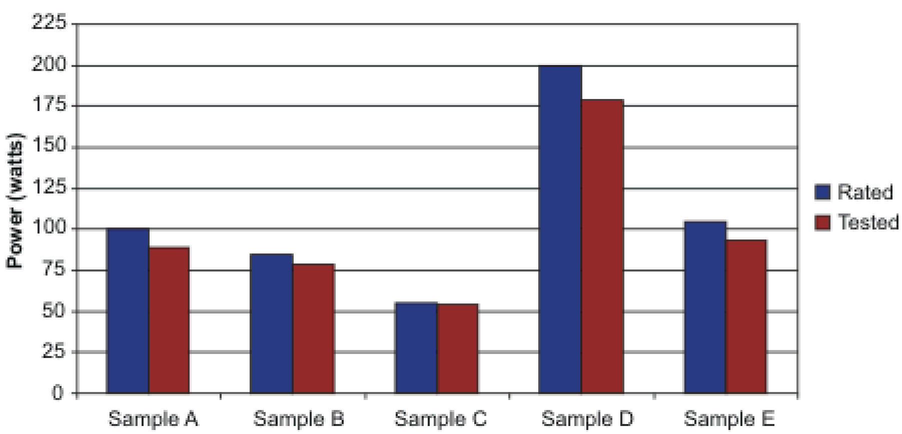
Figure 2. Rated vs. NLPIP-tested light output of five HW-CFL samples



How does lamp electric power of HW-CFLs compare to manufacturer claims?

Manufacturers of high-wattage compact fluorescent lamps (HW-CFL) provide **power** ratings for their products. NLPIP tested one sample of five self-ballasted HW-CFLs (55 – 200 W) and compared these measurements to their manufacturers' power ratings (see Appendix B: Power and light output of HW-CFLs). As shown in Figure 3, these ratings consistently overestimated actual wattage. Therefore, actual power was as much as 11 percent lower than rated.

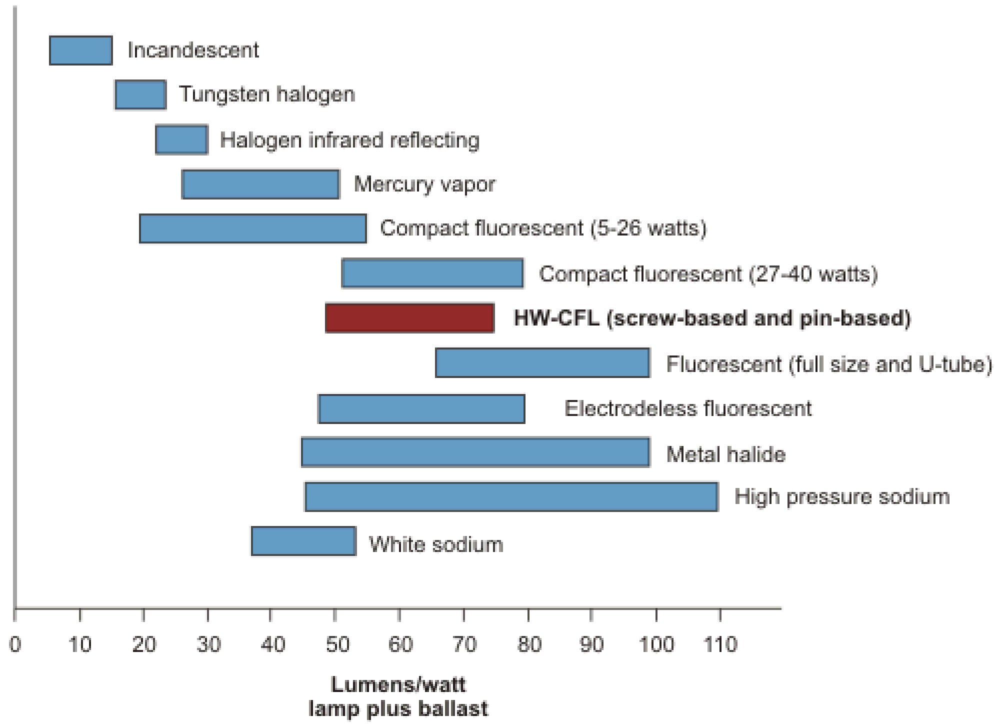
Figure 3. Rated vs. NLPIP-tested power of five HW-CFL samples



How does efficacy of HW-CFLs compare to other light sources?

High-wattage compact fluorescent lamps (HW-CFL) have similar luminous **efficacies** to other compact fluorescent lamps, electrodeless fluorescent lamps, and **metal halide (MH)** sources. Their efficacies far exceed high-wattage incandescent sources. Figure 4 shows comparisons to these and other light sources.

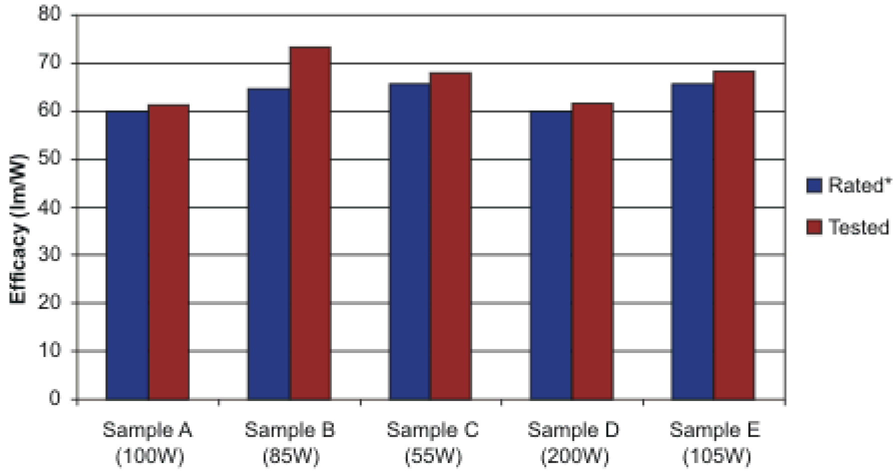
Figure 4. Efficacy of various light sources



Adapted from: Rea MS (ed.). 2000. *IESNA Handbook*, ninth edition. 26-3. New York: Illuminating Engineering Society of North America; and catalog information for electrodeless fluorescent and HW-CFL products

NLPIP tested five HW-CFL samples for luminous flux and **power**, which were used to calculate luminous efficacy as a spot check to manfuacturers' claimed luminous efficacy ratings (see Appendix B: Power and light output of HW-CFLs). Although some of the products had slightly lower light output than their manufacturers' ratings, all required less power than the manufacturers' wattage rating. As a result, NLPIP determined that all were near the expected efficacies based on the manufacturers' ratings (Figure 5). All samples were tested in a vertical base up position with ambient temperature of 77°F (25°C).

Figure 5. Rated vs. NLPIP-tested efficacy of five HW-CFL samples



*When manufacturers did not explicitly report efficacy, NLPIP calculated efficacy by dividing initial lumens by nominal wattage.

How does lamp life of HW-CFLs compare to other light sources?

Rated lamp life for self-ballasted high-wattage compact fluorescent lamps (HW-CFL) ranges from 8,000 to 10,000 hours (h). Remote-ballasted products range from 10,000 - 20,000 h. Rated lamp life for other lamp technologies varies, from 750 h for incandescent lamps to over 60,000 h for electrodeless fluorescent lamp systems (Table 2). The specifier should keep in mind that different lamp families use different standard test procedures for average rated life, that life ratings carry significant uncertainties, and that performance for some lamps is highly affected by temperature in the field. Therefore, direct comparisons of average rated life can be misleading.

Table 2. Rated lamp life comparison of HW-CFL products with other lamp technologies

Lamp Type (Lamps with comparable lumens)	Power (W)	Lamp life (h)
Self-ballasted HW-CFL	55-200	8000 - 10,000
Remote-ballasted HW-CFL	55-140	10,000 - 20,000
Incandescent	200-500	750 - 2500
Ceramic MH	50-150	10,000 - 20,000
Standard MH	70-175	10,000 - 15,000
Pulse Start MH	70-175	7500 - 15,000
HPS	50-150	24,000
Enhanced HPS	70-150	10,000 - 15,000
Electrodeless Fluorescent	55-165	60,000 - 100,000

Some manufacturers of HW-CFLs recommend avoiding frequent switching with their products in order to preclude shortened lamp life. Therefore, this lamp type may not be appropriate for use with occupancy sensors or in applications that involve frequent switching.

What are the color properties of HW-CFLs?

High-wattage compact fluorescent lamps (HW-CFL) provide white light in a variety of **correlated color temperatures (CCT)** ranging from 2700 to 6500 **kelvins (K)**. Most lamp manufacturers offer only one or two CCT options, rather than a wide range. Generally, the CCTs offered are high (cool color appearance) or low (warm color appearance).

HW-CFLs are commonly available with a **color rendering index (CRI)** of 80 or greater. CRI for these lamps is higher than for most **high-pressure sodium (HPS)**, standard **metal halide (MH)**, and **mercury vapor (MV)** lamps.

NLPIP measured the color properties of five HW-CFL samples. No single metric fully describes the color of light sources and how they render the color of other objects. Different metrics describe different aspects of color such as naturalness, discriminability, and saturation. Table 3 and Figures 6 and 7 show how the five samples compared in terms of efficacy and three color metrics: CRI, color **gamut area (GA)**, and **full spectrum color index (FSCI)**. In very general terms, a high CRI implies that colors will appear natural. A high FSCI implies that the light source will enable good color discrimination between small color variations. A large GA implies that color will be highly saturated. (For more information about these metrics, see NLPIP publication: *Lighting Answers: Light Sources and Color*.)

Figures 6 and 7 illustrate a method devised by NLPIP to represent values of CRI, FSCI, GA, and luminous efficacy for the five sample HW-CFLs tested. (For more information about this presentation technique, see NLPIP publication: *Lighting Answers: Light Sources and Color*.) For each group of similar CCT HW-CFLs, the three color rendering average metric values are shown as tri-color vectors, while the lamp efficacy value is shown as an achromatic (gray and black) vector. For comparison, the same diagram is provided for an incandescent, HPS, and MH lamp (Figure 8).

The testing revealed that samples A, C, and E had a high color temperature (5000-5500 K) and have similar color features (Figure 6). Samples B and D had a low color temperature (2700 K) and also have similar color metric features (Figure 7). Figure 7 shows that samples B and D have higher CRI, GA, and FSCI values than samples A, C, and E. As a result, these samples should make colors appear more natural, more saturated, and will enable better discrimination between small color variations.

Table 3. Color characteristics of five HW-CFL samples

Sample	Rated CCT (K)	Tested CCT (K)	Tested Efficacy (lm/w)	CRI	GA scaled	FSCI
A	5500	5007	61.1	90.0	89.4	72.8
B	2700	2630	73.4	83.0	43.7	39.4
C	5000	4892	68.1	83.5	84.9	68.2
D	2700	2713	61.7	81.1	46.2	43.7
E	5000	4729	68.3	81.0	84.3	69.2

Figure 6. Color characteristics of Samples A, C, and E (High CCT)

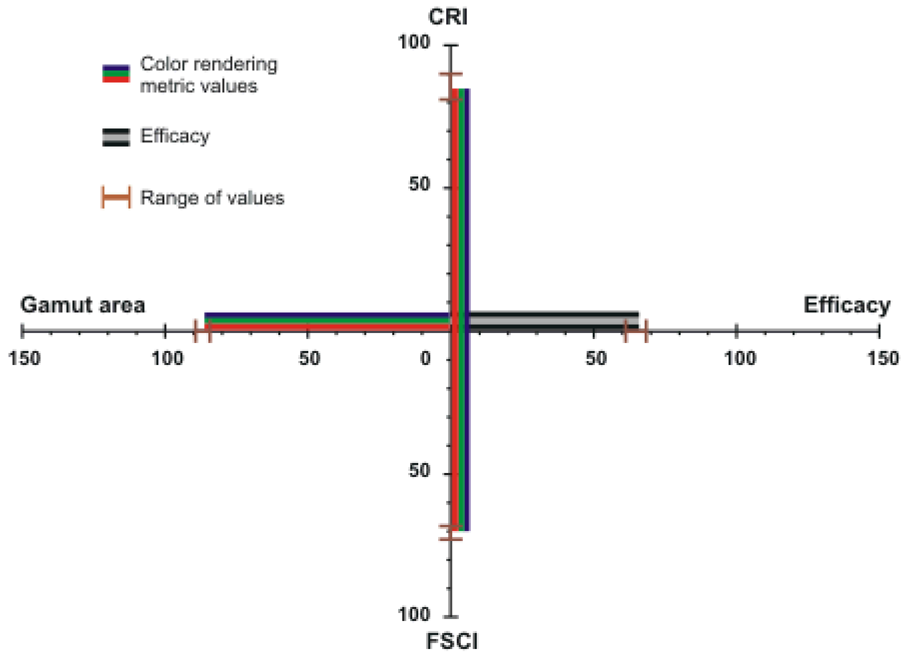


Figure 7. Color characteristics of Samples B and D (Low CCT)

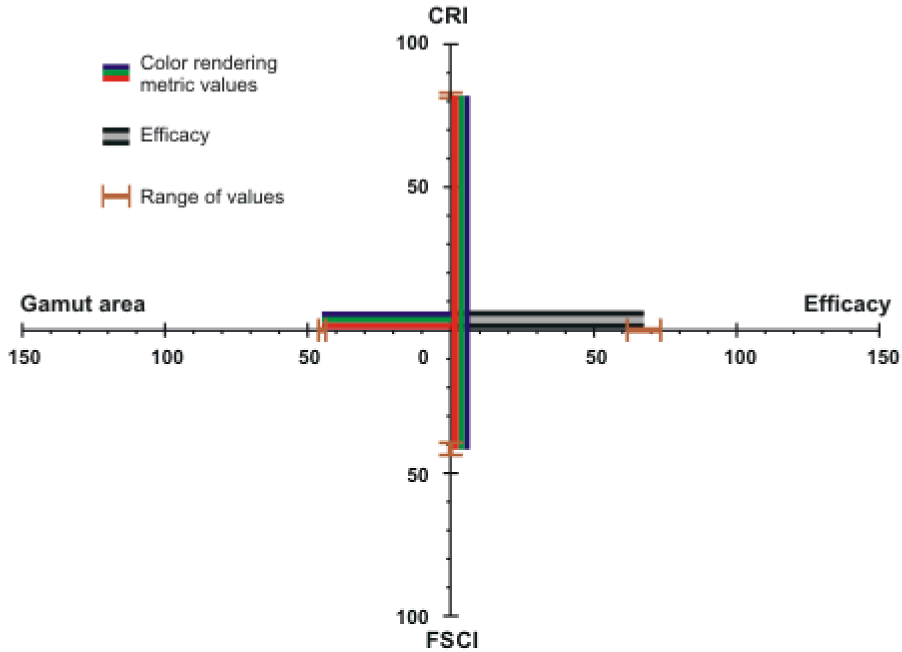
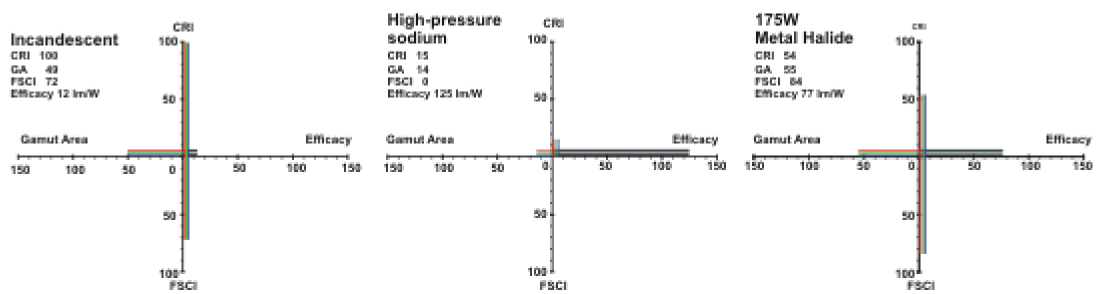


Figure 8. Color characteristics of three comparison light sources



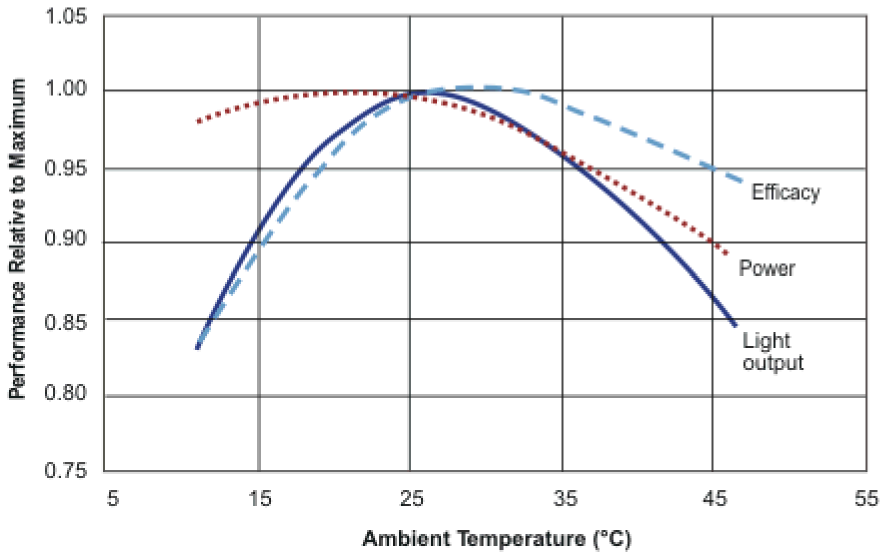
How is performance affected by ambient temperature?

Performance characteristics of high-wattage compact fluorescent lamps (HW-CFL) will be affected by lamp base position and by operation in cold or hot environments. Temperature impacts both short-term and long-term performance. In the short-term, temperature impacts HW-CFL light output, electric **power**, and luminous **efficacy**, with most lamps operating at their peak in an ambient temperature of about 77°F (25°C). Over long periods of time, elevated temperatures may shorten ballast life and consequently reduce lamp life in self-ballasted HW-CFLs.

Short-term thermal effects

Operating fluorescent lamps in cold or hot environments will lead to reduced light output, reduced power, and reduced efficacy, as shown in Figure 9. (Note: This graph is not specific to HW-CFLs.)

Figure 9. Impact of ambient temperature on power, light output, and efficacy of many fluorescent lamps



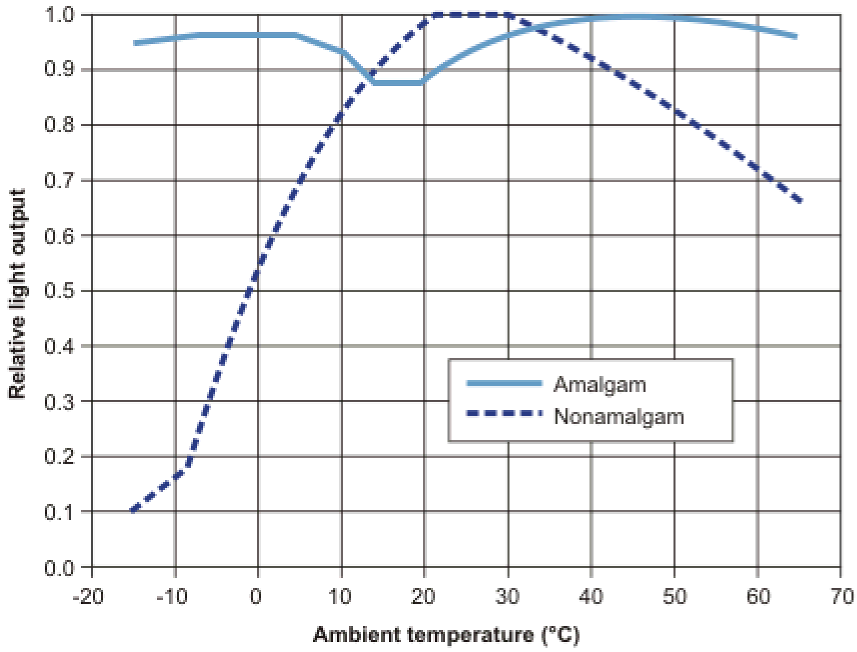
°F = (°C x 1.8) + 32

Adapted from: Bleeker and Veenstra, 1990

Some manufacturers of HW-CFLs report information about light output at a range of temperatures (see How does lamp orientation affect performance of HW-CFLs?). If this information is not available, users can generalize from other curves showing fluorescent output for **minimum bulb wall temperature** or ambient temperature, such as Figure 9.

As shown in Figure 10, reduction in light output can be minimized with the use of a mercury **amalgam**. (Note: This graph is not specific to HW-CFLs.) Use of mercury amalgam with HW-CFLs is often not reported in lamp catalog information. However, users can request this information from the lamp manufacturer. NLPIP obtained this information for products on the market (at the time of publication) and listed the results under “Mercury Type” in Table 7 and Table 8 (see What HW-CFL products are available?).

Figure 10. Impact of ambient temperature on light output of amalgam and nonamalgam fluorescent lamps



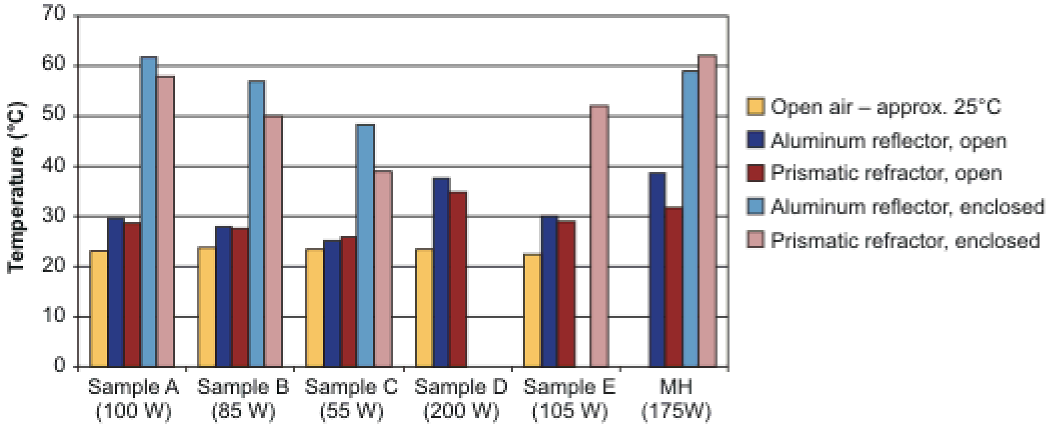
°F = (°C x 1.8) + 32

Rea MS (ed.). 2000. IESNA Handbook, ninth edition. 6-43. New York: Illuminating Engineering Society of North America.

The five high-wattage compact fluorescent lamps (HW-CFLs) tested by NLPIP were retrofitted in a luminaire designed for metal halide (MH) lamps. NLPIP then measured thermal conditions, electric power, and light output (see Appendix A: Thermal testing of HW-CFLs and Appendix B: Power and light output of HW-CFLs for details).

Figure 11 shows that when HW-CFL samples were operated in open air, lamp temperature was the lowest. When each HW-CFL was installed in either the aluminum reflector or prismatic refractor, lamp temperature increased. When each reflector was fully enclosed, the temperature increased further. Data from an example of a MH lamp is also included in Figure 11 for reference.

Figure 11. Temperature (at middle of lamp) of lamp samples in several enclosure conditions

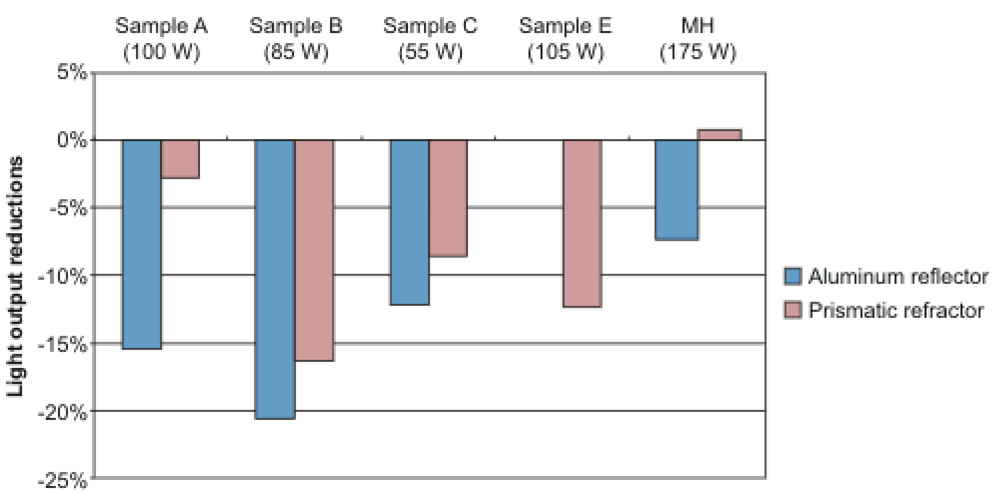


°F = (°C x 1.8) + 32
(Some data not available for samples D and E, due to lamp size; MH lamp not measured in open air.)

NLPIP demonstrated that all samples tested had reduced light output when the luminaire was fully enclosed. Figure 12 shows the light output reductions of the HW-CFL samples due to elevated temperatures when the two luminaire types were fully enclosed.

Enclosure had a greater relative impact on light output with the aluminum reflector than with the prismatic refractor. However, these data are reported in relative terms; readers should not assume that illuminances will be lower when retrofitting HW-CFLs into aluminum compared to prismatic luminaires.

Figure 12. Light output reductions due to elevated temperatures with enclosure plate installed

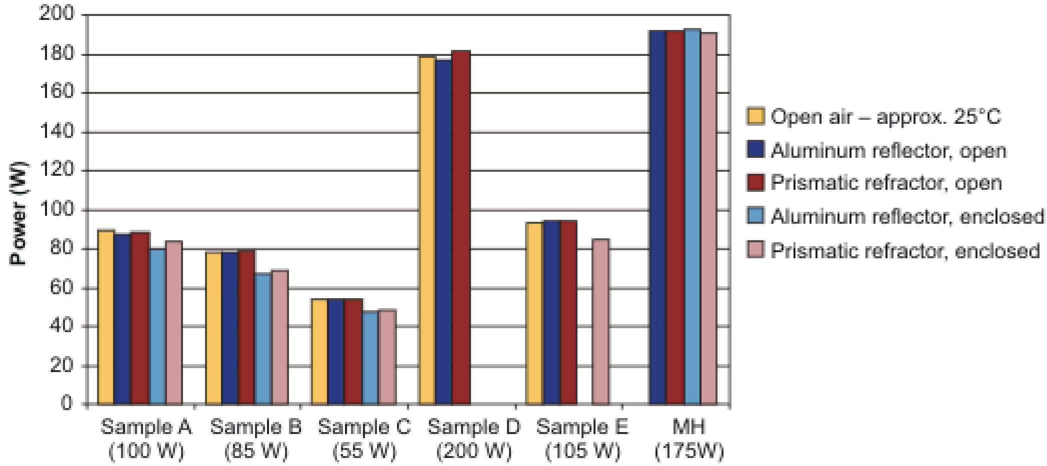


(Some data not available for samples D and E, due to lamp size)

Electric power is also affected by thermal conditions. As shown in Figure 9, operating power varies as temperature varies. As temperature increases beyond the optimal temperature, power, and subsequently efficacy, can be expected to decrease.

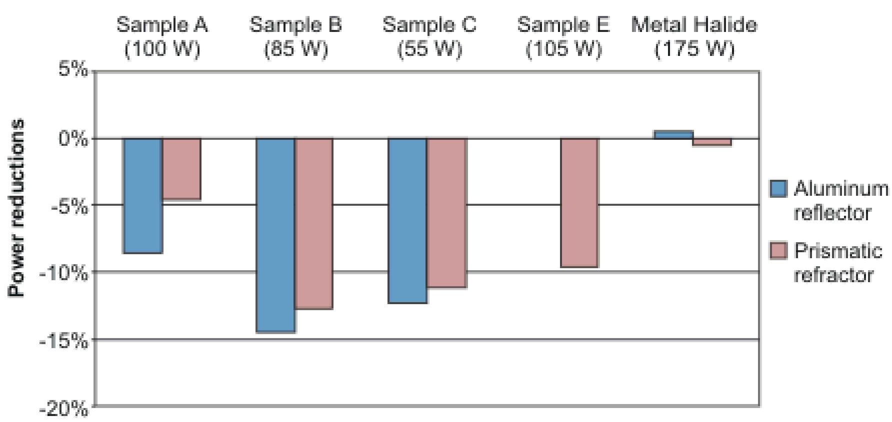
Figure 13 shows electric power of five HW-CFLs in luminaires (see Appendix A: Thermal testing of HW-CFLs for testing methodology). The HW-CFL power was reduced by 4.5% to 14.5% as temperature increased due to operation inside an enclosed luminaire (Figure 14).

Figure 13. Measured electric power in several enclosure conditions



(Some data not available for samples D and E, due to lamp size; MH lamp not measured in open air.)

Figure 14. Power reductions due to elevated temperatures with enclosure plate installed



(Some data not available for samples D and E, due to lamp size)

Although light output of a HW-CFL decreases when operated at elevated temperatures, power also decreases, thus efficacy may not necessarily decrease. NLPIP estimates that efficacy of these samples changed during thermal testing by -7.6% to +2.9%

Long-term thermal effects

Ballast life can also be affected by elevated **ambient temperatures**. Electronic components in ballasts tend to suffer under elevated temperatures. The life of electrolytic **capacitors**, for example, is reduced dramatically with elevated temperatures (Stevens, Shaffer, Vandenham 2002). An industry rule-of-thumb states that for every 10-degree increase in temperature, capacitor life is reduced by half.

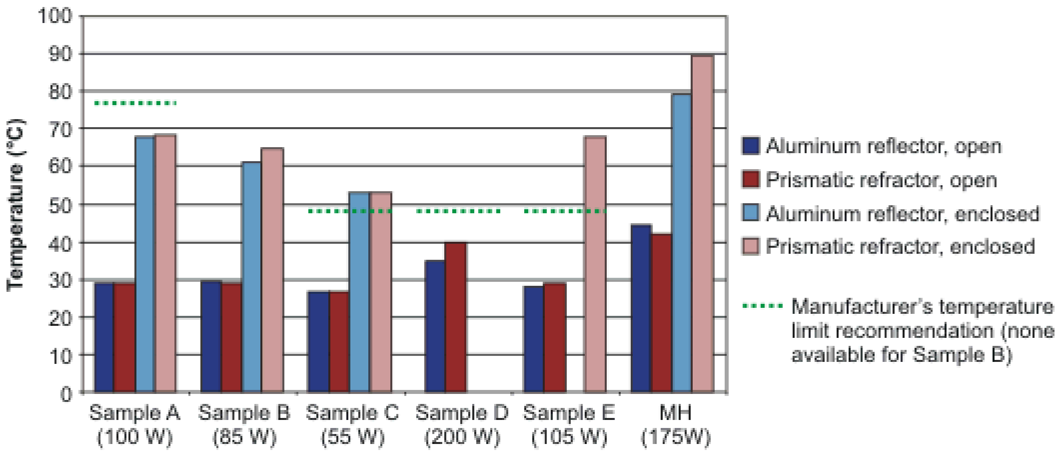
Elevated temperature at the ballast of self-ballasted high-wattage compact fluorescent lamps (HW-CFLs) is caused primarily by higher lamp wattage, base-up orientation, and luminaire enclosure that limits the convective cooling of the ambient environment.

Self-ballasted HW-CFLs typically replace traditional MH or incandescent sources, which are often mounted in a base-up orientation. Heat generated by the HW-CFL will elevate the ballast temperature. Also, some luminaires in typical retrofit applications are totally enclosed, both above and below the lamp socket. As a result of base orientation and luminaire enclosure, components in the ballast of a self-ballasted HW-CFL may be exposed to elevated temperatures.

Manufacturers of self-ballasted HW-CFLs have acknowledged the risk of high ambient temperatures. One product has a warning label recommending avoidance of base-up orientation. Another product combats the overheating problem by integrating a small fan in the ballast, presumably to cool electronic ballast components. Most manufacturers recommend using these products only in open luminaires that allow some ventilation of the ballast, and many have established maximum temperature limits for their products.

NLPIP performed limited product testing to survey typical thermal conditions in open and enclosed high-bay or low-bay luminaires (see Appendix A: Thermal testing of HW-CFLs for testing methodology). Without the enclosure plate, temperatures ranged from 81-104°F (27-40°C); this is below temperature limits imposed by the manufacturers of HW-CFLs. However, temperatures in enclosed conditions approached and in some cases exceeded temperature limits, ranging from 127-154°F (53-68°C). In general, the higher the wattage of the HW-CFL, the higher the temperatures in the luminaire (Figure 15).

Figure 15. Temperature (at top of lamp, near the ballast) of lamp samples in several enclosure conditions



°F = (°C x 1.8) + 32
(Some data not available for samples D and E, due to lamp size)

Two of the lamps (samples D and E) were too large to fit in the test luminaire in one or both of the enclosed conditions. For several reasons, NLPIP assumes that they would have exceeded temperature limits in both enclosed conditions if they had fit. Sample E was shorter and lower in wattage than Sample D, but both had similar product designs.

Without the enclosure plate, Sample D produced higher temperatures than sample E (due to higher wattage). Because Sample E exceeded thermal limits when enclosed, NLPIP infers that Sample D would have exceeded its temperature limit as well.

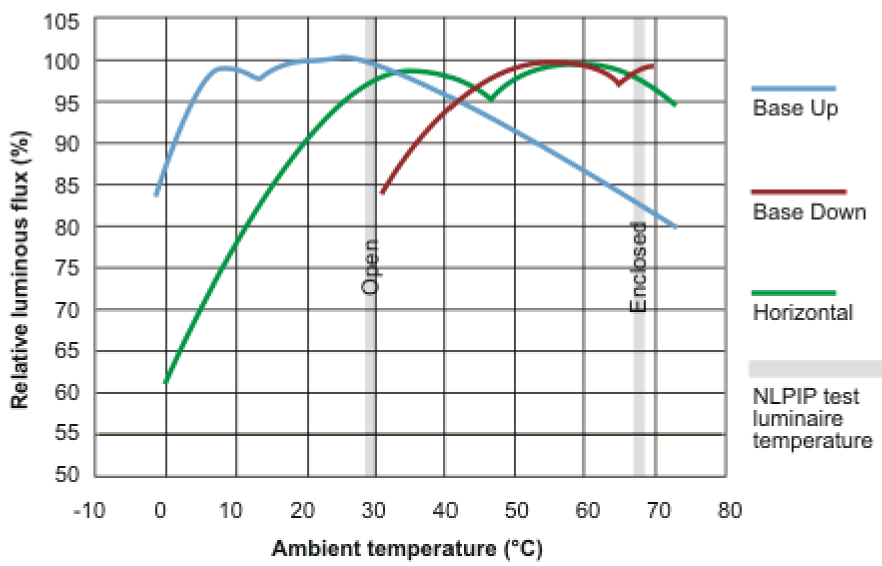
Sample E did fit within an enclosed prismatic refractor. In this condition, Sample E exceeded its temperature limit. For the other lamp samples, enclosure with the specular aluminum reflector generated similar temperatures compared to enclosure with the prismatic refractor. NLPIP assumes that this Sample E would therefore have exceeded temperature limits in the specular reflector as well.

Before retrofitting with HW-CFLs, readers are encouraged to check lamp manufacturers' recommended thermal conditions.

How does lamp orientation affect performance of HW-CFLs?

Lumen output for some products varies with not only **ambient temperature** but also with lamp orientation. Most manufacturers of high-wattage compact fluorescent lamps (HW-CFL) do not limit operation position of their products, but some do show the effect of lamp orientation on light output. Figure 16 illustrates the thermal sensitivity of two **amalgam**-type HW-CFL products, based on three **operating positions**. For these lamps, the vertical base up operating position shows optimal output at lower temperatures, compared to horizontal or vertical base down operating positions. For comparison, shaded bands in Figure 16 indicate the interior temperature of NLPIP-tested luminaires operating an amalgam HW-CFL. Actual temperatures inside other luminaires will vary, depending on lamp wattage, ambient air temperature, and luminaire materials and size.

Figure 16. Impact of operating position and temperature on light output of some amalgam HW-CFLs

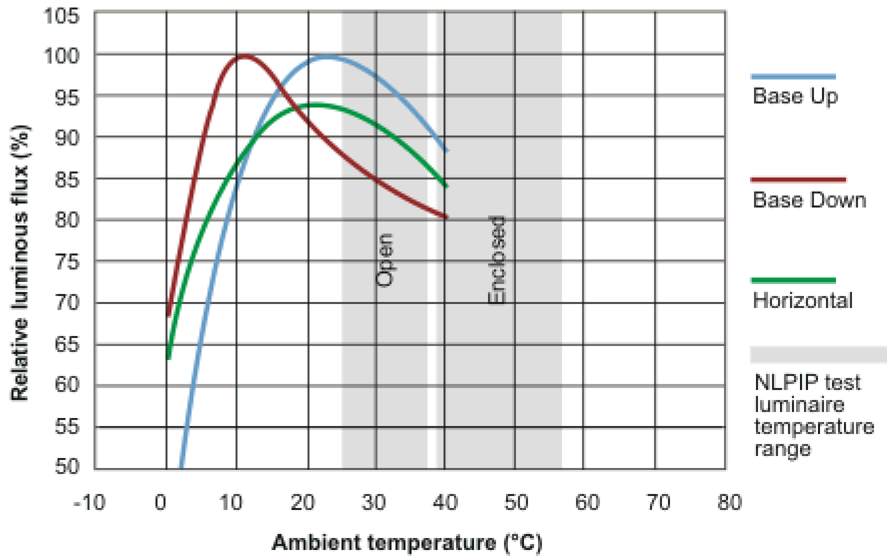


°F = (°C x 1.8) + 32

Adapted from: catalog information from GE Lighting and Philips Lighting Company

The impact of orientation and temperature on light output differs with nonamalgam CFLs. Figure 17 illustrates that with nonamalgam lamps, the vertical base up operating position has peak light output at approximately the same temperature as amalgam lamps, but light output peaks at lower temperatures in the vertical base down position. (NLPIP measurements of in-luminaire temperatures with nonamalgam HW-CFLs are shown in shaded bands.) Regardless of lamp orientation, light output of nonamalgam lamps may be less than optimal when operated in enclosed conditions.

Figure 17. Impact of operating position and temperature on light output of a nonamalgam CFL (not specific to HW-CFLs)



°F = (°C x 1.8) + 32

Adapted from: IESNA. 1996. Technical Memorandum: Understanding and Controlling the Effects of Temperature on Fluorescent Lamp Systems. TM-6-96. New York: Illuminating Engineering Society of North America.

What are the starting profiles of HW-CFLs?

In terms of starting characteristics, high-wattage compact fluorescent lamps (HW-CFL) perform similarly to lower-wattage CFLs. The five HW-CFLS tested by NLPIP all started in less than one second and reached at least 80 percent of full light output in less than three minutes. This is much faster than **high intensity discharge (HID)** sources such as **metal halide (MH)**, which require three to seven minutes to reach full brightness (commonly known as "ramp-up" or "warm-up" time).

Many HW-CFLs use a mercury **amalgam**. As a result, they require more time to come to full light output than nonamalgam sources. Long ramp-up times can be annoying to users in frequently switched spaces. However, HW-CFLs are usually intended for use in large facilities where they are turned on once a day, often from a remote location. As a result, long ramp-up times may be acceptable.

Use of mercury amalgam is not readily reported in lamp catalog information; however, users can request this information from the lamp manufacturer. NLPIP has obtained this information for HW-CFLs (listed in What HW-CFL products are available?).

One benefit of HW-CFLs is that they restrike instantly after a power interruption, unlike HID sources, which require several minutes to cool down before they can be turned on again. This delay can present a problem in public spaces such as retail stores, where shoppers may be unlikely to wait several minutes for restrike of HID sources so they can continue their shopping.

What should I consider when retrofitting a HW-CFL into a high-intensity discharge luminaire?

Many high-wattage compact fluorescent lamps (HW-CFL) screw into either medium-based or mogul-based sockets. If retrofitting a HW-CFL into a **high-intensity discharge (HID)** luminaire, the HID ballast must be removed from the circuit before installation of the new HW-CFL can proceed.

Some HW-CFLs may be too large to fit within a luminaire designed for an HID lamp. NLPIP had difficulty fitting two of the five HW-CFLs into test luminaires (see Appendix A: Thermal testing of HW-CFLs). The large size of some HW-CFLs may prevent attachment of luminaire housing pieces. Alternatively, the lamp may protrude out of an open luminaire, creating an unattractive appearance or **glare**.

The optical characteristics of HW-CFLs differ from those of HID lamps. A HW-CFL is a large, diffuse light source. As a result, a reflector designed for a small HID point source will not distribute light from a HW-CFL in the same manner. Light may be emitted at higher angles, possibly becoming a source of glare. Therefore, a luminaire designed to deliver diffuse illumination is more suitable to the optical characteristics of an HW-CFL, rather than a luminaire intended to focus light in a specific direction.

Retrofits with HW-CFLs may also result in lower **illuminances**, despite equivalent lumen output. The large size of the HW-CFL itself will increase the self-absorption and scattering of light within the luminaire, reducing luminaire optical efficiency. As an example, NLPIP calculated the optical efficiency of a luminaire with a 200W HW-CFL and with the 175W MH lamp recommended by the luminaire manufacturer. The calculation was performed using the same luminaire and aluminum reflector (as described in Appendix A: Thermal testing of HW-CFLs) both with (enclosed) and without (open) an enclosure plate. The result of this calculation showed that luminaire optical efficiency was 10% lower with the HW-CFL than with the MH lamp in the enclosed luminaire and 7% lower in the open luminaire.

What maintenance issues should I consider when using a HW-CFL?

Dirt depreciation may be a concern with high-wattage compact fluorescent lamps (HW-CFL). This lamp type tends to have a larger surface area and multiple glass bends, compared to **high intensity discharge (HID)** and incandescent lamps. These convoluted lamp bends may be difficult to clean, and will provide surfaces on which dust and other debris may deposit. This may cause a loss in light output due to a build up of dirt on the lamp.

The large size and elaborate glass bends may also make these lamps fragile for shipping and installation. For example, some HW-CFLs must be handled by only the base rather than the glass end, which can make installing HW-CFLs awkward. All of the samples received by NLPIP for testing arrived intact, as they had all been carefully shipped with nested boxes or multiple layers of packing material. Also, the large size of HW-CFLs requires increased storage space compared to other lamp types.

Overall, what are the benefits and drawbacks of HW-CFLs?

High-wattage compact fluorescent lamps (HW-CFL) offer a number of benefits, but present some drawbacks as well.

Among the benefits:

- HW-CFLs offer a high **color rendering index (CRI)**.
- Many color temperatures are available, but not always as wide a range as low-wattage CFLs.
- HW-CFLs are capable of instant **restrike**.
- Medium and mogul screw-base provides retrofit convenience in some applications.
- HW-CFLs are competitive on life and light output with incandescent, **metal halide (MH)**, and enhanced **high-pressure sodium (HPS)**.

Drawbacks and concerns:

- HW-CFLs are more suited optically for diffuse illumination rather than for directional lighting.
- Enclosed luminaires may overheat the ballast electronics of self-ballasted products.
- Many manufacturers recommend avoiding frequent switching; therefore, HW-CFLs may not be appropriate for use with occupancy sensors in some applications.
- HW-CFLs are large in size and may not fit within some luminaires.
- Due to complex shapes and difficult-to-clean surfaces, dirt depreciation may be greater with HW-CFLs than with other light sources.
- Relamping may be awkward; many lamps are too fragile to be held by the glass end and must be handled by only the base.
- Large size increases storage space requirements.

What HW-CFL products are available?

Table 4 lists names and contact information for several manufacturers of high-wattage compact fluorescent lamp (HW-CFL) products offered for sale on the North American market. Tables 5 and 6 show available wattages of these products. Tables 7 and 8 show manufacturer-supplied product information such as voltage, base type, lumen output, **lamp life** (in hours [h]), **CCT**, **CRI**, and whether the product mercury is **amalgam** or nonamalgam.

Table 4. Manufacturers of HW-CFL products (in North America)

Manufacturer	Web Site	Phone
CE Lighting of North America	www.landlite.com	905-737-1898
EiKO Ltd.	www.eiko-ltd.com	800-852-2217
Elong International / Longstar	www.elonginternational.com	972-247-7995
Fulham	www.fulham.com	800-238-5426
GE Lighting	www.gelighting.com	800-435-4448
Harmony Lighting	www.harmonylight.com	781-740-4006
Litetronics	www.litetronics.com	708-389-8000
Luxlite-Primex Industries Ltd.	www.luxlite.com	905-568-3735
MaxLite	www.maxlite.com	973-244-7300
OSRAM SYLVANIA	www.sylvania.com	978-777-2000
Philips Lighting	www.nam.lighting.philips.com	800-555-0050
Sunshine Lighting / Sunlite	www.sunshinelighting.com	800-605-2852

Table 5. Available wattages, self-ballasted HW-CFL products

Manufacturers - Self-ballasted HW-CFLs	55-65 W	85 W	100-105 W	125 W	150 W	200 W
EiKO Ltd.		•	•			
Elong International / Longstar	•	•	•			
Harmony Lighting	•		•			
Litetronics	•	•				
Luxlite-Primex Industries Ltd.	•	•	•	•	•	•
MaxLite	•	•	•		•	•
Sunshine Lighting / Sunlite	•	•				

Table 6. Available wattages, remote-ballasted HW-CFL products

Manufacturers - Remote-ballasted HW-CFLs	55-65 W	70 W	85 W	105 W	120-140 W
CE Lighting of North America	•		•	•	•
Fulham	•	•			
GE Lighting	•	•			
OSRAM SYLVANIA	•	•			
Philips Lighting	•		•		•

Table 7. Manufacturer-supplied Information, self-ballasted HW-CFL products

Manufacturer	Power (W)	Voltage (V)	Light output (lms)	Lamp life (h)	CCT (K)	CRI	Mercury type	Base
EiKO Ltd.	85	120	5100	8000	4100 5000	81	nonamalgam	medium
	105	120	6100	8000	4100	81	nonamalgam	medium, mogul
	105	120	5900	8000	5000	81	nonamalgam	medium
Elong International / Longstar	55	120	3600	8000	2700 5000	>80	nonamalgam	medium
	85	120	5000	8000	5000	>80	nonamalgam	medium
	105	120	6000	8000	5000	>80	nonamalgam	medium
Harmony Lighting	55	120 277	3500	10,000	2700 3000	82	amalgam	medium, mogul
	65	120 277	4100	10,000	2700 3000	82	amalgam	medium, mogul
	100	120 277	6000	10,000	2700 3000	82	amalgam	medium, mogul
Litetronics	65	120	4200	10,000	2700	85	nonamalgam	medium
	85	120	5500	10,000	2700	85	nonamalgam	mogul
Luxlite-Primex Industries Ltd.	65	120 277 347	3900	10,000	2700 4100 5000 6400	84	amalgam	medium, mogul
	85	120 277 347	5100	10,000	2700 4100 5000 6400	84	amalgam	mogul
	100	120 277 347	6000	10,000	2700 4100 5000 6400	84	amalgam	mogul
	125	120 277 347	7500	10,000	2700 4100 5000 6400	84	amalgam	mogul
	150	120 277 347	9000	10,000	2700 4100 5000 6400	84	amalgam	mogul
	200	120 277 347	12000	10,000	2700 4100 5000 6400	84	amalgam	mogul
MaxLite	55	120 277	3500	10,000	2700 5000	84	nonamalgam	medium
	65	120 277	4200	10,000	2700 5000	84	nonamalgam	medium

	85	120 277	5500	10,000	2700 5000	84	nonamalgam	medium
	105	120 277	6900	10,000	2700 5000	84	nonamalgam	mogul
	150	120 277	9200	10,000	5000	84	nonamalgam	mogul
	200	120 277	12,000	10,000	2700	84	nonamalgam	mogul
Sunshine Lighting / Sunlite	65	120	3400	8000	3000 6500	82	nonamalgam	medium, mogul
	85	120	4200	8000	3000 6500	82	nonamalgam	medium

Table 8. Manufacturer-supplied Information, remote-ballasted HW-CFL products

Manufacturer	Power (W)	Light output (lms)	Lamp life (h)	CCT (K)	CRI	Mercury type	Base
CE Lighting of North America	55	3850	10,000	5000 6500	85	nonamalgam	medium, mogul
	65	4500	10,000	5000 6500	85	nonamalgam	medium, mogul
	85	6500	10,000	5000 6500	85	nonamalgam	medium, mogul
	105	7500	10,000	5000 6500	85	nonamalgam	mogul
	120	8500	10,000	5000 6500	85	nonamalgam	mogul
	140	8700	10,000	5000 6500	85	nonamalgam	mogul
Fulham	57	4300	10,000	2700 3000 3500 4100 5000	>80	nonamalgam	pin
	70	5200	10,000	2700 3000 3500 4100 5001	>80	nonamalgam	pin
GE Lighting	57	4300	12,000	2700 3000 3500 4100 5000	82	amalgam	pin
	70	5200	12,000	2700 3000 3500 4100 5000	82	amalgam	pin
OSRAM SYLVANIA	57	4300	12,000	2700 3000 3500 4100	82	amalgam	pin
	70	5200	12,000	2700 3000 3500 4100	82	amalgam	pin
Philips Lighting	60	4000	20,000	3000 4000	82	amalgam	pin
	85	6000	20,000	3000 4000	82	amalgam	pin
	120	9000	20,000	3000 4000	82	amalgam	pin

Appendix A: Thermal testing of HW-CFLs

NLPIP tested five self-ballasted high-wattage compact fluorescent lamps (HW-CFL) ranging from 55 W to 200 W in four in-luminaire thermal testing conditions. NLPIP used a typical mid-wattage **metal halide (MH)** highbay luminaire (Ruud A2417-1E, 175 W), with either a specular aluminum reflector (Ruud R-A) or an acrylic prismatic refractor (Ruud R-AP), as shown in Figure App-1. Neither the reflector nor the refractor had ventilation holes above the lamp. The fully "enclosed" condition was created by attaching a clear glass plate to the bottom of the aluminum reflector, or a clear acrylic plate to the bottom of the prismatic refractor. The enclosed condition also employed a rubber gasket at the top of the reflector and refractor. Each HW-CFL was installed after the metal halide ballast was removed from the circuit. Lamps were tested in a base-up orientation, with an ambient temperature of 72–75°F (22–24°C).

For purposes of comparison, NLPIP also tested a clear MH lamp (Venture 175W/U) under these same conditions. For all lamp samples, NLPIP collected lamp power data under these thermal conditions.

Figure App-1. Luminaire and reflectors used for thermal testing - Specular aluminum reflector (left) and acrylic prismatic refractor (right)

NLPIP measured relative light output with each HW-CFL sample operating within a luminaire. NLPIP positioned an illuminance meter under the luminaire, and measured with and without enclosure. Figure 12 (in How is performance affected by ambient temperature?) shows the amount of light output reduction due to enclosure.

Appendix B: Power and light output of HW-CFLs

NLPIP tested five self-ballasted high-wattage compact fluorescent lamps (HW-CFL) ranging from 55 W - 200 W with no luminaire enclosure. Total light output of each sample was measured in an integrating sphere. Each HW-CFL was measured base-up at approximately 77°F (25°C). While performing sphere testing, NLPIP collected data about power and color characteristics (see What are the color properties of HW-CFLs?). NLPIP also collected data about relative light output (see Short-term thermal effects section in How is performance affected by ambient temperature?).

Resources

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Credits

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Glossary

Sources of term definitions: National Lighting Product Information Program (NLPIP), Lighting Research Center's Lighting Education Online, the IEEE Standard Dictionary of Electrical and Electronics Terms (IEEE Std 100-1996).

Amalgam	An alloy of mercury with other metals. Some CFLs use a mercury amalgam rather than standard mercury. An amalgam keeps mercury pressure in the discharge near its optimal value as lamp temperature changes. Amalgam lamps can produce more than 90 percent of maximum light output over a wide temperature range, but they can take longer to reach their full light output when started.
Ambient temperature	The temperature of the surrounding air that comes into contact with the lamp and ballast. Ambient temperature affects the light output and active power of fluorescent lamp/ballast systems. Each fluorescent lamp-ballast system has an optimum ambient temperature at which it produces maximum light output. Higher or lower temperatures reduce light output. For purposes of lamp/ballast tests, ambient temperature is measured at a point no more than 1 meter (3.3 feet) from the lamp and at the same height as the lamp.
Capacitor	A device used in electric circuitry to temporarily store electrical charge in the form of an electrostatic field. In lighting, a capacitor is used to smooth out alternating current from the power supply.
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.
Color rendering index (CRI)	A measure of the degree of color shift that objects undergo when illuminated by a lamp, compared with those same objects when illuminated by a reference source of comparable correlated color temperature (CCT). A CRI of 100 represents the maximum value. A lower CRI value indicates that some colors may appear unnatural when illuminated by the lamp. Incandescent lamps have a CRI above 95. The cool white fluorescent lamp has a CRI of 62; fluorescent lamps containing rare-earth phosphors are available with CRI values of 80 and above.
Correlated color temperature (CCT)	A specification of the apparent color of a light source relative to the color appearance of an ideal incandescent source held at a particular temperature and measured on the Kelvin (K) scale. The CCT rating for a lamp is a general indication of the warmth or coolness of its appearance. As CCT increases, the appearance of the source shifts from reddish white toward bluish white; therefore, the higher the color temperature, the cooler the color appearance. Lamps with a CCT rating below 3200 K are usually considered warm sources, whereas those with a CCT above 4000 K usually considered cool in appearance.
Efficacy	The ratio of the light output of a lamp (lumens) to its active power (watts), expressed as lumens per watt.
Full-spectrum color index (FSCI)	A mathematical transformation of full-spectrum index into a zero to 100 scale, where the resulting values are directly comparable to color rendering index. An equal energy spectrum is defined as having an FSCI value of 100, a "standard warm white" fluorescent lamp has an FSCI value of 50, and a monochromatic light source (e.g., low pressure sodium) has an

FSCI value of 0.

Gamut area	A measure of color rendering based upon volume in color space. It is the range of colors achievable on a given color reproduction medium (or present in an image on that medium) under a given set of viewing conditions.
Glare	The sensation produced by luminances within the visual field that are sufficiently greater than the luminance to which the eyes are adapted, which causes annoyance, discomfort, or loss in visual performance and visibility.
High-intensity discharge (HID)	An electric lamp that produces light directly from an arc discharge under high pressure. Metal halide, high-pressure sodium, and mercury vapor are types of HID lamps.
High-pressure sodium (HPS)	A high-intensity discharge lamp type that uses sodium under high pressure as the primary light-producing element. HPS lamps produce light with a correlated color temperature (CCT) of approximately 2000 kelvins, although CCTs for lamps having higher CRI values range from 2200 to 2700 kelvins. Standard lamps have a CRI value of 22; others have CRI values from 60 to 80. HPS lamps are among the most efficacious light sources, with efficacies as high as 150 lumens per watt, although those with higher CRI values have efficacies as low as 25 lumens per watt.
High-wattage compact fluorescent lamp	Abbreviated as HW-CFL, sometimes called "high lumen CFLs", these lamps are a larger cousin to regular CFLs, usually much larger in size and with higher wattages and light output.
Illuminance	The amount of light (luminous flux) incident on a surface area. Illuminance is measured in footcandles (lumens/square foot) or lux (lumens/square meter). One footcandle equals 10.76 lux, although for convenience 10 lux commonly is used as the equivalent.
Kelvin	Color temperature is measured in degrees Kelvin, which indicathe hue of a specific type of light source. Higher temperatures indicate whiter, "cooler" colors, while lower temperatures indicate yellower, "warmer" colors.
Lamp life	The median life span of a very large number of lamps (also known as the average rated life). Half of the lamps in a sample are likely to fail before the rated lamp life, and half are likely to survive beyond the rated lamp life. For discharge light sources, such as fluorescent and HID lamps, lamp life depends on the number of starts and the duration of the operating cycle each time the lamp is started.
Mercury vapor (MV) lamp	A high-intensity discharge lamp type that uses mercury as the primary light-producing element. Mercury vapor lamps produce light with a CCT from 3000 to 7000 K. Mercury vapor lamps with clear outer bulbs have CRI values from 15 to 25, whereas phosphor-coated lamps have CRI values from 40 to 55. Mercury vapor lamps are less efficacious than other HID lamp types, typically producing only 30 to 65 LPW, but they have longer lamp lives and lower initial costs than other HID lamp types.
Metal halide (MH) lamp	A high-intensity discharge lamp type that uses mercury and several halide additives as light-producing elements. Metal halide lamps have better color properties than other HID lamp types because the different additives produce more visible wavelengths, resulting in a more complete spectrum. Metal halide lamps are available with CCTs from 2300 to 5400 K and with CRI values from 60 to 93. Efficacies of metal halide lamps

	typically range from 75 to 125 LPW.
Minimum bulb wall temperature (MBWT)	The temperature of the coldest spot on a lamp's bulb wall. MBWT is determined by the ambient temperature, the heat generated within the luminaire, and the luminaire's heat dissipation effectiveness. The coldest spot on a lamp wall is where the mercury vapor tends to condense because pressure is lowest there.
Operating position	The manufacturer-recommended operating position for a lamp.
Power	The power (in watts) used by a device to produce useful work (also called input power or active power). In lighting, it is the system input power (in watts) for a lamp and ballast combination. When referred to as benchtop active power, the measurement procedure follows ANSI standards, which include horizontally mounted bare lamp(s) at an ambient temperature of 25°C, ±1°C, and air movement less than 5 feet per minute. The lamps are seasoned 100 hours before testing, and the measurements are conducted after lamp light output stabilizes.
Rated lamp life	The number of hours at which half of a group of product samples fail. The rated life is a median value of life expectancy; any lamp or group of lamps may vary from the published rated life. Rated life is based on standard test conditions.
Restrike time	The time required for a lamp to restrike, or start, and to return to 90% of its initial light output after the lamp is extinguished. Normally, HID lamps need to cool before they can be restarted.

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