NATIONAL LIGHTING PRODUCT INFORMATION PROGRAM

Specifier Reports

Energy-Efficient Ceiling-Mounted Residential Luminaires

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Contents

Introduction

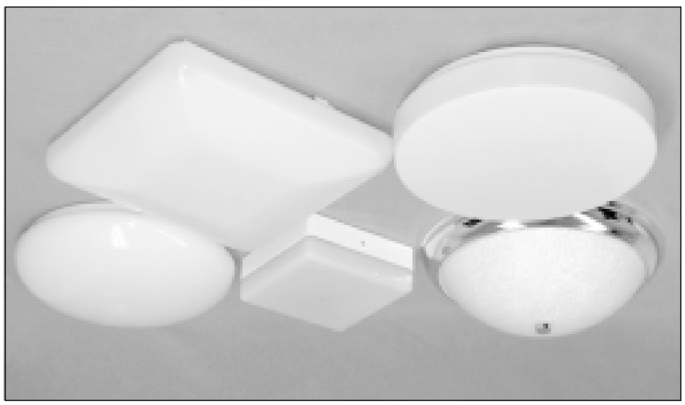
In recent years, manufacturers have introduced new styles of energy-efficient residential luminaires (usually designed for fluorescent lamps), yet the consumer sector has been slow to adopt these products. Less energy-efficient luminaires (usually using incandescent lamps) still prevail in the majority of U.S. households.

Some electric utility companies have begun to promote hardwired luminaires that have sockets dedicated to compact fluorescent lamps (CFLs) or linear fluorescent lamps, such as those shown in Figure 1. These efforts are complemented by the ENERGY STAR program for residential luminaires (see the sidebar on p. 2), which promotes energy-efficient residential luminaires with performance equal to or better than prevailing luminaires.

Even with utility and government programs promoting fluorescent-lamp luminaires that are energy efficient, there are still barriers to wider acceptance in the residential sector. Consumers may be aware of the energy savings associated with fluorescent lighting systems, but are reluctant to adopt them because of initial price and concern about aesthetics. Another barrier to consumer acceptance is the lack of information about luminaire performance.

This issue of *Specifier Reports* provides information about performance issues such as lamp efficacy, lamp life, ballast life, ballast factor, luminaire efficacy, luminaire efficiency, and light distribution. It also evaluates 42 hardwired ceiling-mounted residential luminaires that use CFL and linear fluorescent lamps and compares them to four base-case luminaires: two commercial-grade fluorescent-lamp luminaires and two residential-grade incandescent-lamp luminaires.

Figure 1. A Sampling of Ceiling-Mounted CFL Luminaires



Background

This report uses the term luminaire as defined in the *Lighting Handbook*, 8th Edition (Rea 1993): "A complete lighting unit consisting of a lamp or lamps and ballasting (when applicable) together with the parts designed to distribute the light, to position and protect the lamps and to connect the lamps to the power supply."

There are three grades of luminaires in the U.S. lighting market: specification, commodity commercial, and commodity residential. Commodity residential grade luminaires offer low price, have unsophisticated optical and thermal designs, and are made of inexpensive materials. Manufacturers provide very limited photometric testing and product services for these luminaires compared to the extensive photometric data and services that are usually available for the two other luminaire grades. Photometric data would enable consumers to obtain information about the active power of the lamp and ballast, the light distribution, and the efficiency of the luminaire. These data could help them make educated purchasing decisions.

In the price-driven residential market, reducing component and manufacturing costs is important for manufacturers. Because this market is also style-driven, most consumers look for luminaires that match their taste and home decor.

Some utility companies and other organizations offer incentive programs such as rebates for ENERGY STAR residential luminaires. For these programs to succeed, fluorescent-lamp luminaires must have prices and styles that consumers will accept. Promoters of energy-efficient residential luminaires also must address the lack of information available to consumers.

Most energy-efficient luminaires in the residential sector use CFLs or linear fluorescent lamps. Luminaires using fluorescent lamps require ballasts while luminaires using incandescent lamps do not. In this report, NLPIP explains lamp, ballast, and luminaire interaction, and how different components affect luminaire performance. The report presents data on commercially available products. None of the luminaires tested by NLPIP for this report were labeled as ENERGY STAR products as of June 1999.

ENERGY STAR

In 1997, the United States Environmental Protection Agency and the United States Department of Energy jointly initiated the ENERGY STAR Residential Light Fixtures Program. ENERGY STAR is a voluntary labeling program that promotes energy-efficient products.

Residential luminaires meeting the program's specifications for energy efficiency and quality can bear the ENERGY STAR label. ENERGY STAR specifications include criteria for energy efficiency, power, reliability, durability and safety. For example, Table 1 shows ENERGY STAR system efficacy specifications for indoor residential luminaires. For further details, see the ENERGY STAR web page (www.energystar.gov).

Table 1. ENERGY STAR System Efficacy Specifications for Indoor Energy-Efficient Residential Luminaires

System	System Efficacy (lumens per watt)
up to 20 watts input power	≥ 50
20–29 watts input power	≥ 55
≥ 30 watts input power and lamp length < 24 inches	≥ 60
≥ 30 watts input power and lamp length ≥ 24 inches	≥ 70

Luminaire Components and Their Interactions

Typical fluorescent-lamp luminaire components are lamps, ballasts, housings (with or without reflectors), and accessories.

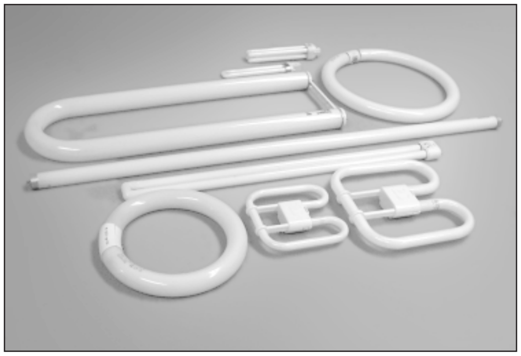
Lamps

Figure 2 shows some fluorescent lamps that are frequently used in residential luminaires. Table 2 lists types of lamps and their associated performance data: life, power, rated light output, correlated color temperature (CCT), color rendering index (CRI), and price. The lamps are sometimes included with the purchase of residential luminaires. Consumers must make sure that they purchase the appropriate lamp types that will fit the specific sockets. CFL socket configurations depend on the wattage, ballast, and dimming capabilities of a system. Table 3 (manufacturer-supplied data) includes the type of lamp used by each luminaire.

Lamp Efficacy

Lamp efficacy is the light output from the lamp (in lumens) divided by the rated lamp input power (in watts). The input power and light output shown on lamp packages or in catalogs are the manufacturers' rated values. These values are determined by standard testing methods with the lamp operated in a

Figure 2. Frequently Used Fluorescent Lamps



base-up position (for single-ended lamps) or a horizontal position (for double-ended lamps). The lamps are operated at 77±2º Fahrenheit (F) [25±1º Celsius (C)] ambient temperature, and measurements are obtained using a reference ballast (except for self-ballasted CFLs).

For example, a 100-watt (W) incandescent A-lamp with a rated light output of 1750 lumens (lm) has a lamp efficacy of 1750/100 = 17.5 lm per watt (LPW). A 26-W CFL with a rated light output of 1800 lm has a lamp efficacy of 1800/26 = 69 LPW, but because the ballast usually requires up to 5 W, the efficacy of a lamp-ballast system will be lower. When calculating efficacies for fluorescent systems, one should always use the active power (active power is the input power, in watts, for the lamp-ballast combination), not the rated input power.

Fluorescent lamp efficacy is affected by many factors, including ambient temperature, operating position, and lamp lumen depreciation (see "Factors Affecting Lamp Efficacy," p. 5). Lamp manufacturers suggest replacing an incandescent lamp with a CFL based on equivalency in rated light output under optimal test conditions. A consumer may choose a CFL for its rated light output but use it in a different position or at a different ambient temperature than it was tested. If so, the light output and therefore the efficacy might be less than expected.

To address this problem, some lamp manufacturers have replaced the liquid mercury inside the CFL with mercury amalgams to achieve relatively constant light output over a wide range of temperatures and in different operating positions. However, amalgam lamps can require a longer time to reach full light output after they are switched on and have unpredictable light output under dimmed conditions. These lamp behaviors may cause consumer complaints.

Table 2. Performance Data for Common Fluorescent Lamps

			Active Power (W)					
Lamp Type	Average Rated Life (hr)	Rated Power (W)	Lamp & Magnetic Ballast	Lamp & Electronic Ballast	Rated Light Output (lm)	CCT (K)	CRI	Typical Price (US $)[b]
48" T8 RE730	20,000	32	37	34	2800–2850[a]	3000	70+	1.70
48" T8 RE830	20,000	32	37	34	2950	3000	80+	2.60
T8 U-Shape Rare-Earth	20,000	32	36	37	2800–2850[a]	3000	80+	10.70
9-W Twin	10,000	9	11	NA	550–600[a]	2700	82	2.50
13-W Twin	10,000	13	15	NA	800–860[a]	2700	82	2.70
13-W Quad	10,000	13	15	NA	860–900[a]	2700	82	6.50
18-W Quad	10,000	18	22	NA	1160–1250[a]	2700	82	8.70
26-W Quad	10,000	26	30	NA	1700–1800[a]	2700	82	9.30
12" Circular Cool White	12,000–15,000[a]	32	42	NA	1800–1925[a]	4200	62	5.80
12" Circular Warm White	12,000–15,000[a]	32	42	NA	1950–2000[a]	3000	52	7.90
21-W Square	10,000	21	24	22	1350	3500	82	16.10
38-W Square	10,000	38	53	39	2850	3500	82	16.10

NA = not available

Note: Data sources include *The Lighting Pattern Book for Homes* (Leslie and Conway, 1996) and manufacturer catalogs.

[a] General Electric, OSRAM SYLVANIA, and Philips report different values.

[b] Average of prices from Albany, NY, distributors of General Electric, OSRAM SYLVANIA, and Philips lamps.

Lamp Life

The lamp is often the luminaire component that has the shortest life. Rated lamp life is the total operating time that elapses before half of a large group of lamps fail under standard test conditions. Rated life for fluorescent lamps is 5 to 20 times as long as that for incandescent lamps. The test standard for fluorescent lamps requires a switching cycle of three hours on and 20 minutes off at an ambient temperature of 77±18ºF (25±10ºC). Fluorescent lamp life decreases with switching cycles shorter than the standard test cycle and increases with switching cycles longer than the standard test cycle.

Incompatible ballasts can drastically shorten lamp life. Ballasts that fail to meet ANSI lamp starting voltage guidelines could reduce lamp life. To learn more about fluorescent lamp-ballast compatibility, please see NLPIP's *Guide to Fluorescent Lamp-Ballast Compatibility*, 1996; *Guide to Specifying High-Frequency Electronic Ballasts*, 1996; and *Guide to Selecting Frequently Switched T8 Fluorescent Lamp-Ballast Systems*, 1998.

Color

Two common parameters describe the color performance of a light source: correlated color temperature (CCT) and color rendering index (CRI).

CCT indicates the apparent warmth or coolness of light as measured on the Kelvin temperature scale. A low CCT indicates a warmer or more yellow light. A high CCT indicates a cooler or bluer light. For example, candlelight is usually below 2000 Kelvin (K) while north daylight is usually above 6000 K. CCTs for common incandescent lamps range from 2700 to 3000 K. For common fluorescent lamps, CCTs range from 2700 to 6500 K.

CRI is a measure of the similarity with which a light source renders certain reference colors in comparison to a reference light source of equal CCT. Incandescent lamps usually have the highest CRI, close to 100. Cool-white fluorescent lamps have a CRI of 62 and warm-white fluorescent lamps have a CRI of 52. Triphosphor fluorescent lamps (including T8 lamps and CFLs) have a CRI range from 70 to 85.

Lamp color information is usually provided on the lamp box or on the lamp itself. Lamps with a CRI of 70 or higher assure good color rendering. A CCT of 2700 to 3000 K is typical for indoor residential applications in the U.S.

Luminaire housing finish also affects the apparent color of the light emitted from a luminaire: light from a lamp in a gold-finish housing would look very different from light from the same lamp in a pewter-finish housing.

Ballasts

Ballasts provide the necessary circuit conditions (voltage, current, and wave form) for starting and operating fluorescent lamps. Currently, most ballasts used in residential luminaires are electromagnetic (magnetic) ballasts, but the number of electronic ballasts used is growing.

Magnetic ballasts are heavier than electronic ballasts and usually have greater power losses. Two characteristics commonly associated with magnetic ballasts are humming during operation and lamp flashing during starting.

Electronic ballasts weigh less than magnetic ballasts, operate more quietly, and have lower power losses. They operate fluorescent lamps at a higher frequency than magnetic ballasts [20,000 to 60,000 hertz (Hz) compared to 60 Hz], which eliminates flicker and increases system efficacy.

Possible problems with high-frequency electronic ballasts include electromagnetic interference, harmonic distortion, high inrush current, and incompatibility with some lamps. For an in-depth discussion of electronic ballasts, see NLPIP's *Specifier Reports: Electronic Ballasts*, 1994 and *Lighting Answers: Electromagnetic Interference Involving Fluorescent Lighting Systems*, 1995.

Most residential fluorescent-lamp luminaires should not be installed on a conventional dimming circuit because special dimming ballasts and circuit wiring are required to dim fluorescent lamps. Dimming electronic ballasts are now available for a variety of CFL and linear fluorescent lamps.

In hardwired luminaires, ballasts are wired as part of the luminaire housing. Many are concealed so consumers do not see them, even when installing or changing the lamps. Table 4 lists the ballasts used in the 42 NLPIP-evaluated luminaires and four base-case luminaires.

Factors Affecting Lamp Efficacy

Ambient Temperature
Ambient temperature has little effect on incandescent lamps. Ambient temperature has a significant effect on the light output, active power, and efficacy of fluorescent lamps.

In a linear fluorescent lamp or non-amalgam CFL, mercury vapor condenses at the coldest spot on the wall of the lamp. The temperature at the cold spot, which is directly affected by the lamp's ambient temperature, determines the mercury vapor pressure in the lamp and thus its light output. Figure A illustrates the effect of ambient temperature on the performance of a typical linear fluorescent lamp.

Operating Position
Figure B illustrates the locations of cold spots for a compact fluorescent lamp in base-up, base-down, and horizontal positions. For many CFLs, cold spots in the base-down position are directly above the hot lamp cathodes. When the mercury condenses on the cold spot, it drips down toward the cathodes and evaporates again, affecting the mercury vapor pressure and reducing light output.

Figure C illustrates the effect of lamp position at different temperatures for a typical non-amalgam CFL. For other fluorescent lamps such as circular or square lamps, operating position in ceiling-mounted luminaires has little effect on cold spots, light output, and efficacy because the lamp operating position is always horizontal. For more information about CFLs, please see NLPIP's *Specifier Reports: Screwbase Compact Fluorescent Lamp Products*, 1999.

Lamp Lumen Depreciation
Lamp light output decreases over the life of the lamp. As an incandescent lamp ages, its tungsten filament evaporates and some of the vapor molecules redeposit on the lamp wall, reducing the light output. As a fluorescent lamp ages, two factors cause lumen depreciation: the sputtering of the electrode coating and the evaporation of electrodes, causing end darkening, and the degradation of phosphor covering the lamp wall. Figure D illustrates the depreciation curves for incandescent, linear fluorescent, and compact fluorescent lamps.

Figure A. Effect of Ambient Temperature on a Linear Fluorescent Lamp

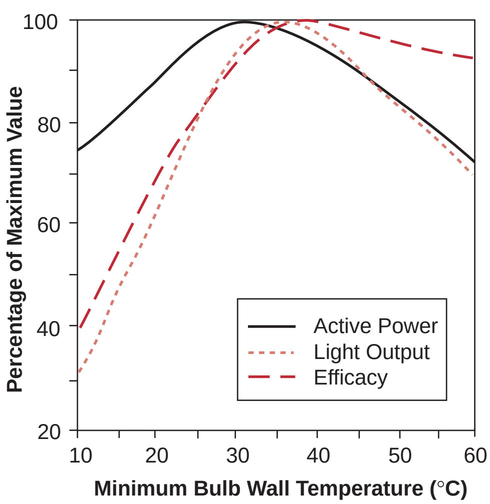


Figure B. Location of Cold Spot Varies with Operating Position

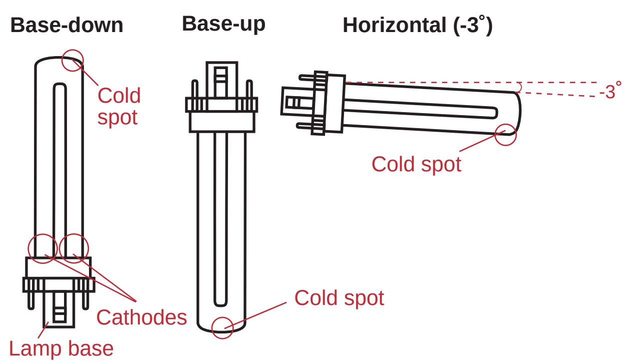
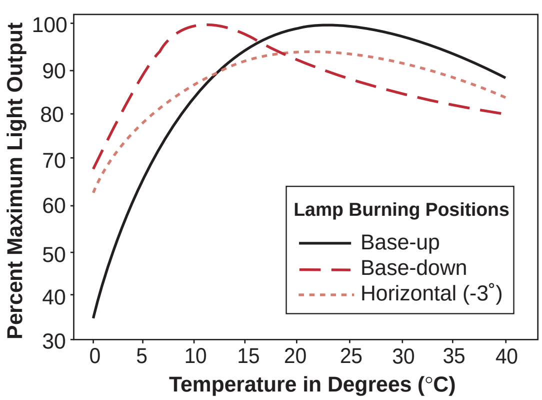
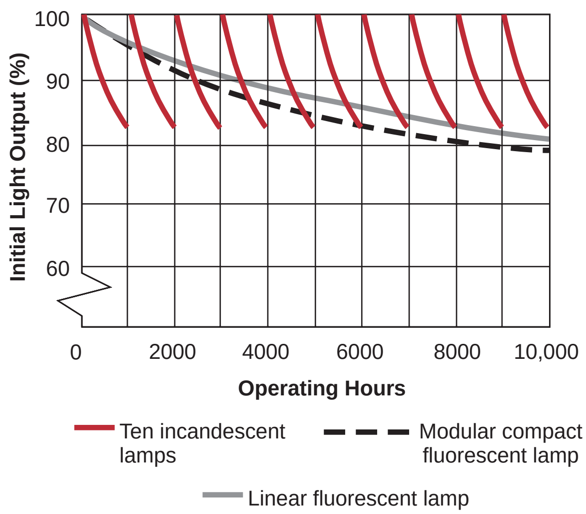


Figure C. Effect of Lamp Position on Light Output of a Non-Amalgam CFL



[IESNA Technical Memorandum (TM-6-96)]

Figure D. Lamp Lumen Depreciation



(Adapted from the *Lighting Handbook*, 8th edition)

Ballasts affect power quality, lamp life, and light output. Although power quality may not directly affect end users of residential luminaires, it is of concern to electric utilities and facilities engineers, who are responsible for efficient and reliable electrical system operation. The lighting industry uses two metrics for power quality: power factor and total harmonic distortion (THD). Every lamp and ballast combination has different power quality characteristics. The measured power factor and THD for each product tested are shown in Table 4. For more information on power quality, see NLPIP's *Lighting Answers: Power Quality*, 1995.

Very few luminaire manufacturers make their own ballasts. Component cost is a factor in price competitiveness, so luminaire manufacturers may use ballasts from more than one supplier. If a customer buys two luminaires (same manufacturer and same model number) six months apart, they may have different performance characteristics (such as lamp life, light output, and power quality) because the manufacturer used different lamps or ballasts. For the same reason, the luminaires' performance characteristics might not match those listed in Table 4.

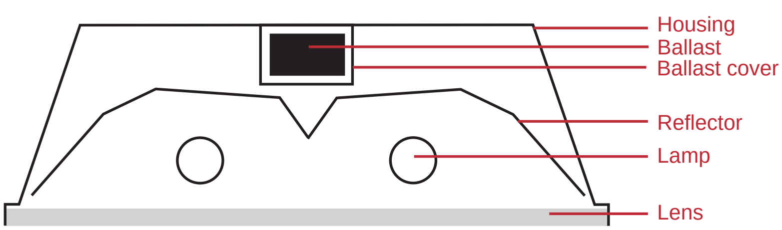
Ballast Life

Ballast life is usually several times longer than lamp life. Because a ballast is typically affixed to the luminaire, its failure can determine the life of the luminaire.

Ballast Factor

The light output of a fluorescent lamp varies, depending on the particular ballast used with it. Ballast factor is defined as the ratio of the light output of a fluorescent lamp operated by a particular ballast to the light output of the same lamp operated by a reference ballast. For example, when a 26-W CFL is operated on a reference ballast, its rated light output is 1800 lm. When this lamp is operated on commercial ballast "X," its light output might be 1674 lm. When it is operated on commercial ballast "Y," its light output might be 1584 lm. Thus, ballast "X" has a ballast factor of 0.93 (1674/1800 = 0.93) and ballast "Y" has a ballast factor of 0.88 (1584/1800 = 0.88). Table 4 contains ballast factors for the luminaires tested by NLPIP.

Figure 3. Schematic Cross-Section of a Luminaire



Housings

In this report, luminaire housing refers to the luminaire body structure, including lamp and ballast compartments. Figure 3 shows the most common components of residential luminaires. The housing provides a thermal environment for the lamp and ballast and optical control for the lamp to deliver light. It also adds style, shape, and color to the luminaire.

Thermal Control

Incandescent lamps are not very sensitive to their ambient temperature, so the housings serve mainly as optical control devices. The ambient temperature affects the light output of all fluorescent lamps, even amalgam CFLs. The amalgam makes the lamp less sensitive to temperature and lamp position.

All of the 42 NLPIP-evaluated products are indoor enclosed luminaires. Every luminaire has a plastic or glass diffuser and little or no ventilation. Internal ambient temperature can rise to over 122°F (50°C) for this type of luminaire. Although many specification and commercial grade luminaires include thermal design features such as vents or heat sinks to cool the lamps and ballasts, these features are not commonly found in commodity residential grade luminaires.

Optical Control

Incandescent lamps have compact filaments and those with clear bulbs are generally regarded as point sources that are easy to control optically. In the residential sector, however, many consumers prefer frosted lamps for non-glaring, softer light. With frosted incandescent lamps, the glass envelope becomes the source size. Their shapes still make them easier to control optically than fluorescent lamps, which have tubes of various sizes and shapes that emit light along their entire length.

The usual purpose of optical control is to deliver as much light as possible from the luminaire to the intended surface (task, floor, ceiling, or wall). For specification and commercial grade luminaires, the most common optical control device is a reflector specifically designed for the intended lamp(s) and coated with reflective materials. Commodity residential grade products include few, if any, sophisticated optical control devices in the luminaire housing. Often the interiors of the housings are painted white to provide large diffuse and reflective surfaces at relatively low costs.

Accessories

Luminaire accessories such as lenses, diffusers, and louvers provide optical control and glare reduction. The most common accessory is the diffuser. Most diffusers in commodity residential grade luminaires are made of plastic (usually acrylic or polycarbonate). Other materials include glass, alabaster, and perforated metal. Lenses control, or refract, the distribution of light and offer more precise lighting control than diffusers.

Plastic diffusers and lenses are inexpensive, lightweight, and easy to form. Fluorescent lamps give off ultraviolet (UV) radiation that gradually yellows some types of plastic diffusers and lenses. Incandescent lamps emit much less UV radiation. UV-degraded plastic diffusers and lenses affect luminaire appearance and reduce the amount of light that can be transmitted through them. UV degradation is not included in any prevailing lighting calculation methods, so NLPIP did not evaluate the effect of UV degradation. As a general rule, acrylic plastics are much more resistant to UV radiation than polycarbonate plastics.

Luminaire Performance Issues

Luminaire Warm-Up Time

When a luminaire is turned on, it takes time to reach thermal equilibrium. This warm-up period depends on the particular lamp-luminaire combination and the room temperature. The warm-up period for incandescent lamps is almost instantaneous because the lamps are relatively unaffected by ambient temperature. The warm-up period for fluorescent lamps can take several minutes or longer, and light output can be unstable until the luminaire has warmed up completely.

NLPIP did not conduct any warm-up tests in this study. All NLPIP data were obtained after the luminaires were fully stabilized.

Luminaire Efficacy

Luminaire efficacy is defined as the light output of the luminaire (in lumens) divided by the active power of the luminaire (the input power, in watts, for the lamp-ballast combination), measured in LPW. Luminaire efficacy is always lower than lamp efficacy because the luminaire material absorbs some light. For fluorescent lamps, actual luminaire efficacy is also affected by ambient temperature and lamp position (see the sidebar on p. 5). For the luminaire efficacy values in Table 4, NLPIP divided the measured light output of each luminaire by the luminaire’s measured active power.

Luminaire Efficiency

Luminaire efficiency is obtained from standard photometry testing, which specifies the use of a goniophotometer in a black room with a 77±2°F (25±1°C) ambient temperature. To measure luminaire efficiency, the luminaire is first installed in the goniophotometer in the same position that it would occupy in practice. (For example, a ceiling-mounted luminaire is installed horizontally, and a wall sconce is installed vertically.) The luminaire’s light distribution and total light output are measured. Next, the lamp or lamps are taken out of the luminaire and installed in the goniophotometer in the same position as inside the luminaire, using the same ballast. The light distribution and total light output of the bare lamps are measured. Luminaire efficiency is then calculated as the ratio of the total light output from the luminaire to the total light output from the bare lamp(s), expressed as a percentage.

Luminaire efficiency is a good predictor of light output for luminaires using incandescent lamps, but for luminaires using fluorescent lamps, luminaire efficiency is not enough to allow a specifier to predict the actual light output. Lamp position, ambient temperature, and ballast factor also affect the light output. See the sidebar "The Limitations of Luminaire Efficiency."

The National Electrical Manufacturers Association (NEMA) developed a related metric for "energy efficiency" of luminaires that use linear fluorescent lamps (NEMA 1995). NLPIP's data suggest that LER is an appropriate metric only when used with linear fluorescent lamps. Therefore, NLPIP did not include LER in the data tables. See the sidebar "Luminaire Efficacy Rating (LER)" on p. 10 for more details.

Light Distribution

Figure 4 contains a portion of a photometric report, which shows the distribution of the light at various angles from the source. The shape of the light distribution plot indicates the directions (via the angles) the light travels, and the intensity of light going in a particular direction [measured in candelas (cd)]. Figure 5 illustrates the light distribution of a luminaire with a dome-shaped diffuser. Figure 6 illustrates the light distribution of a luminaire with a wrap-around diffuser. Photometric data and light distribution information are rarely available for commodity residential grade luminaires. For this report, NLPIP obtained standard photometric reports from independent testing laboratories for all 42 residential luminaires evaluated. Selected data from these reports, such as luminaire efficiency, appear in Table 4.

The Limitations of Luminaire Efficiency

Lamp Position and Ballast Factor

1. Assume Downlight A uses two horizontally mounted 13-W CFLs with 1800 total rated lamp lumens. When the downlight is installed in the goniophotometer, its total light output is 65% of the total light output produced when only the two lamps are installed in the goniophotometer. Therefore, Downlight A's luminaire efficiency is 65%.

2. Assume Downlight B uses a 100-W incandescent A-lamp with 1750 rated lamp lumens. When the downlight is installed in the goniophotometer, its total light output is also 65% of the total light output produced when only the lamp is installed in the goniophotometer. Therefore Downlight B also has a luminaire efficiency of 65%.

According to the definition of luminaire efficiency, the downlights in this example should have comparable light output. Downlight A should deliver 1800 × 65% = 1170 lumens, and Downlight B should deliver 1750 × 65% = 1138 lumens. In reality, however, actual light output from the luminaires may be very different. The rated light output for the 13-W CFLs was measured by the lamp manufacturer in a base-up lamp position using a reference ballast. However, the luminaire uses horizontally mounted lamps and a commercial ballast. Given a horizontal lamp position factor of 0.95 and a commercial ballast factor of 0.88, Downlight A will in fact deliver 1800 × 0.95 × 0.88 × 65% = 978 lm, while Downlight B will still deliver 1750 × 65% = 1138 lm.

Position factor is rarely published for fluorescent lamps. Amalgam CFLs minimize the effect of operating position on light output. For linear, square, and circular fluorescent lamps, operating position in ceiling-mounted luminaires has a negligible effect on light output. See "Factors Affecting Lamp Efficacy" on p. 5 for more details.

Ballast factor is available from ballast manufacturers. The product of luminaire efficiency and ballast factor provides a more accurate measure of luminaire performance than luminaire efficiency alone.

Ambient Temperature

Luminaire efficiency is measured at a 77±2°F (25±1°C) ambient temperature. When a luminaire is installed in a hotter or colder environment, the temperature inside the luminaire will rise or drop accordingly, thus affecting the light output of the fluorescent lamp. Although luminaire efficiency captures the effect of the luminaire's thermal control (in addition to the luminaire's optical control) at a 77±2°F (25±1°C) ambient temperature, it does not reflect the effect of other ambient temperatures. Amalgam CFLs minimize the effect of ambient temperature on light output, as explained in "Factors Affecting Lamp Efficacy" on p. 5.

Performance Evaluations

Selection Criteria

Numerous manufacturers produce many kinds of residential luminaires. Based on previous studies, such as the *Lighting Market Sourcebook for the U.S.* (Vorsatz et al. 1997), and NLPIP's discussions with utilities, ceiling-mounted indoor luminaires for general lighting account for more electricity consumption than any other indoor residential luminaires. NLPIP focused on ceiling-mounted luminaires designed for high-use areas such as kitchens and staircases.

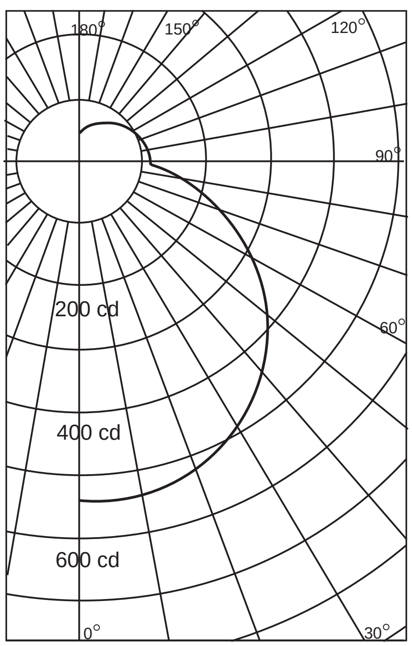
NLPIP identified major residential luminaire manufacturers and asked them to submit product literature and photometric reports for up to four hardwired, ceiling-mounted luminaires for each of the following areas: a small kitchen, a medium kitchen, and a staircase. Figures 7 through 9 on p. 11, adapted from the Lighting Research Center's *Lighting Pattern Book for Homes* (Leslie and Conway 1996), show the illustrations that were provided to the manufacturers for these areas. NLPIP also requested that the luminaires meet minimum system efficacy criteria of 40 LPW for the small kitchen and staircase and 50 LPW for the medium kitchen.

Fifteen manufacturers responded. All of them provided product literature, but only four provided photometric data. Table 3 lists the manufacturer-supplied luminaire information. NLPIP selected samples of luminaires from the product literature and asked manufacturers to submit those products for evaluation. A total of 42 different products were received in their original packaging from the manufacturers.

Figure 4. Standard Photometric Report

Intensity or Candlepower (CP) Distribution

Angle	Mean CP	Lumens	Angle	Mean CP	Lumens
0	541		90	110	
5	539	52	95	110	119
10	535		100	108	
15	529	149	105	106	112
20	520		110	103	
25	507	234	115	100	99
30	490		120	96	
35	469	293	125	93	83
40	445		130	88	
45	416	321	135	83	65
50	385		140	78	
55	350	313	145	72	46
60	313		150	66	
65	273	270	155	61	28
70	233		160	55	
75	191	202	165	51	15
80	152		170	48	
85	121	136	175	46	5
90	110		180	46	



Zonal Lumens and Percentages

	Lumens	% Lamp	% Luminaire
0–30	434	9.48	17.12
0–40	728	15.88	28.66
0–60	1361	29.70	53.61
0–90	1969	42.96	77.55
40–90	1241	27.08	48.89
60–90	608	13.26	23.94
90–180	570	12.44	22.45
0–180	2540	55.40	100.00

Luminaire Efficiency = 55.40%

Figure 5. Light Distribution of a Luminaire with a Dome-Shaped Diffuser

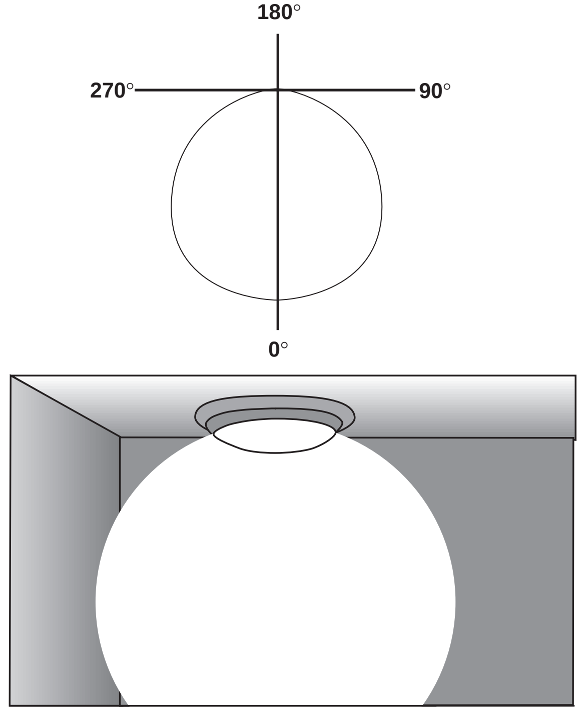
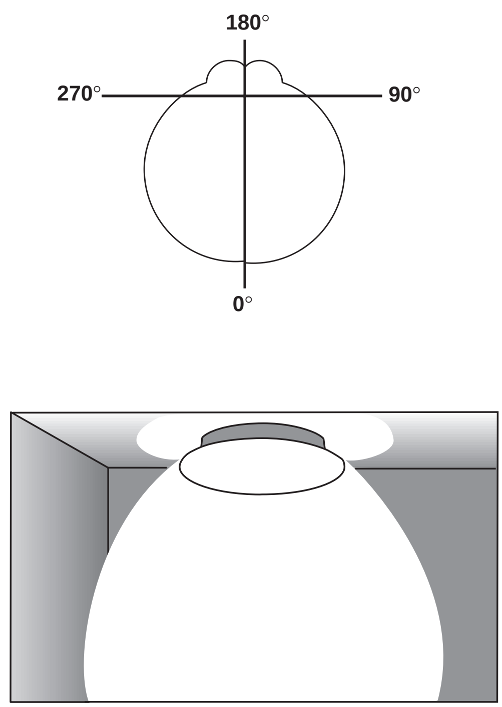


Figure 6. Light Distribution of a Luminaire with a Wraparound Diffuser



Photometric and Power Quality Testing

NLPIP obtained photometric testing measurements for all 42 luminaires. The light values in standard photometric reports are relative measures based on rated lamp light output. Absolute luminaire photometry measures the actual luminaire light output.

Under NLPIP's direction, Independent Testing Laboratories, Inc. (ITL) in Boulder, Colorado, conducted absolute photometric tests for the 10 products from the manufacturers who provided standard photometric reports. Lighting Sciences, Inc. (LSI), in Scottsdale, Arizona, performed standard photometric tests for the remaining 32 products. NLPIP supplemented the 32 standard photometric reports with measurements to determine the absolute light output at the Lighting Research Center's laboratory in Watervliet, New York. As described in the sidebar "Luminaire Efficacy Rating (LER)," NLPIP measured the active power, power factor, and current THD for all luminaires.

Table 4 lists the results for all 42 luminaires tested by NLPIP. Data for the four base-case luminaires were taken from manufacturers' photometric reports.

Luminaire Efficacy Rating (LER)

LER is the product of luminaire efficiency, total rated lamp lumens, and ballast factor, divided by luminaire input power. It was developed by NEMA in 1993 as a practical means of determining efficacy ratings for five categories of linear fluorescent lamp luminaires, which "represent better than 80% of the fluorescent luminaire market in the U.S" (NEMA 1995). To determine whether the LER calculation procedure was accurate, NLPIP measured light output and electrical power for every luminaire in Table 4.

NLPIP mounted each luminaire on a scaffold to simulate a residential ceiling, and used a photometer (LMT model P30SC0) with a photocell directly beneath the luminaire to measure the illuminance at nadir. At the same time, NLPIP measured the active power, input voltage, input current, and current THD. NLPIP also measured the distance from the bottom of the luminaire to the photocell. The luminaires were powered by a regulated alternating current (ac) power supply at 120.0±0.5 volts ac. All testing was performed at an ambient temperature of 77±2°F (25±1°C).

NLPIP used the illuminance at nadir and the distance to calculate the absolute light intensity at nadir. The ratio of the absolute light intensity to the light intensity reported in the photometric reports obtained by NLPIP (see "Photometric and Power Quality Testing"), multiplied by the total light output reported in the photometric reports, yields the absolute light output of the luminaire. For each luminaire, NLPIP divided this absolute light output by the measured active power to determine absolute luminaire efficacy.

NLPIP compared the measured absolute luminaire efficacy to calculated LER for every luminaire and grouped the results according to the following three lamp types: CFLs, U-bend fluorescent lamps, and linear fluorescent lamps. For the CFL luminaires, the measured luminaire efficacy differs from the calculated LER by –23 to +86% of the luminaire efficacy value with a median difference of +19%. For U-bend fluorescent lamp luminaires, the difference ranges from +13% to +26% with a median of +20%. For linear fluorescent lamp luminaires, the difference ranges from –0.8 to +11% with a median of +4%.

NLPIP results revealed that LER is probably an appropriate metric for luminaire efficacy when used with linear fluorescent lamps. However, the accuracy is much less for luminaires using other lamp types.

This is probably true for several reasons. First, the lighting industry has more experience with linear fluorescent lamps, and their operational characteristics are better known and accounted for in the measurement practices for ballast factor and lumen output. Industry standards, such as those created by the Certified Ballast Manufacturers Association, may help predict the performance of certain linear products better than for CFL products. Second, operating conditions are more consistent for linear systems than for other types. Operating position is not a significant variable for linear lamps in ceiling-mounted luminaires because these lamps are always operated in a horizontal orientation. Also, the thermal design features and larger sizes of linear lamp luminaires can dissipate heat more effectively to keep the lamp operating temperature near optimum.

Application Analyses

To simulate the 42 luminaires and four base-cases in the three applications, NLPIP used version 6.04 of Lumen-Micro, a lighting software package from Lighting Technologies, Inc. For the three simulations (small kitchen, medium kitchen, and staircase), NLPIP used spaces with 8-foot (ft) [2.44-meter (m)] ceilings. Ceiling, wall, and floor reflectances were 80%, 50%, and 20%, respectively. For each product simulation, NLPIP calculated horizontal and vertical illuminances.

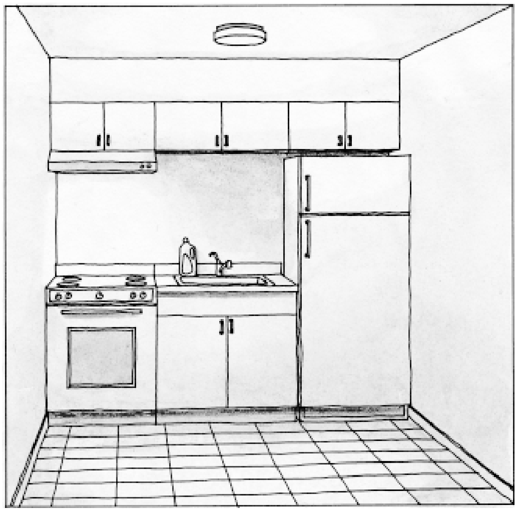
Small Kitchen

For the 8- by 6-ft (2.4- by 1.8-m) small kitchen simulation, NLPIP used four base-cases:

1. A 10-inch (in.)-diameter residential grade luminaire with a dome-shaped diffuser and two 60-W incandescent A-lamps
2. A 22-in.-diameter residential grade luminaire with a dome-shaped diffuser and four 60-W incandescent A-lamps
3. A 2- by 2-ft commercial grade luminaire with a prismatic lens and two 40-W U-shaped T12 fluorescent lamps
4. A 4- by 1-ft commercial grade luminaire with a prismatic lens and two 40-W 4-ft T12 fluorescent lamps

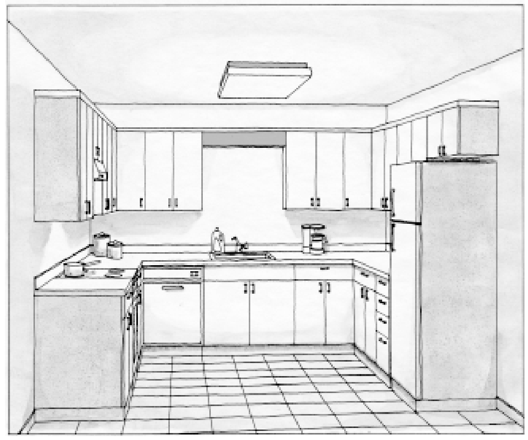
Of the 42 luminaires, NLPIP used only the 29 luminaires with rated lamp power greater than 30 W for the small kitchen. Although some manufacturers also recommended luminaires with lower lamp wattages, NLPIP contends that those products would provide insufficient light for the application. Horizontal illuminances (countertop and floor) and vertical illuminances (upper cabinet, lower cabinet, and refrigerator) were calculated. These areas can be seen in Figure 7. For every small kitchen

Figure 7. Typical Small Kitchen



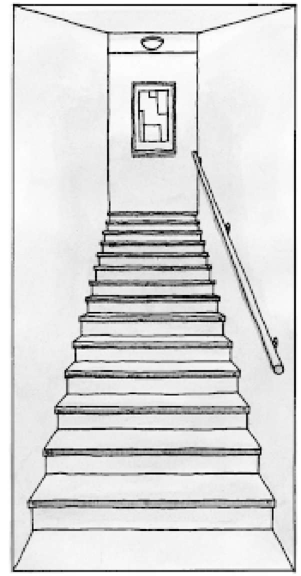
(*The Lighting Pattern Book for Homes*, 1996)

Figure 8. Typical Medium Kitchen



(*The Lighting Pattern Book for Homes*, 1996)

Figure 9. Typical Closed Staircase



(*The Lighting Pattern Book for Homes*, 1996)

product tested by NLPIP, horizontal and vertical illuminances for these areas are reported in Table 5.

Medium Kitchen

For the 12- by 10.75-ft (3.6- by 3.3-m) medium kitchen simulation, NLPIP used three base-cases:

1. A 22-in.-diameter residential grade luminaire with a dome-shaped diffuser and four 60-W incandescent A-lamps
2. A 2- by 2-ft commercial grade luminaire with a prismatic lens and two 40-W U-shaped T12 fluorescent lamps
3. A 4- by 1-ft commercial grade luminaire with a prismatic lens and two 40-W 4-ft T12 fluorescent lamps

Of the 42 luminaires, NLPIP used only the 18 luminaires with rated lamp power greater than 48 W for the medium kitchen. Although some manufacturers also recommended luminaires with lower lamp wattages, NLPIP contends that those products would provide insufficient light for the application. Horizontal illuminances (countertop and floor) and vertical illuminances (upper cabinet, lower cabinet, and refrigerator) were calculated. These areas can be seen in Figure 8. For every medium kitchen luminaire tested by NLPIP, the average horizontal and vertical illuminances for these areas are reported in Table 6.

Staircase

Two identical luminaires, one upstairs and the other downstairs (not illustrated in Figure 9), illuminate the staircase. For the 3.75- by 20-ft (1.1- by 6.1-m) staircase simulation, NLPIP used one base-case: two 10-in.-diameter residential grade luminaires, each with a dome-shaped diffuser and two 60-W incandescent A-lamps.

Of the 42 luminaires, NLPIP used only the 19 luminaires with rated lamp power lower than 30 W for the staircase to prevent potential over-lighting. The areas measured for horizontal illuminance were the upstairs floor and the middle stair (which is the farthest away from both luminaires). Vertical illuminances were calculated at the point on the wall at the top of the stairs where a painting hangs and the sidewall next to the middle stair. These horizontal and vertical areas can be seen in Figure 9. For every staircase luminaire tested by NLPIP, the average horizontal and vertical illuminances for these areas are reported in Table 7.

Results

All the manufacturer-supplied products met the minimum lamp efficacy criterion set by NLPIP for participation in this testing. Although CFLs are 4.2 to 5.5 times as efficacious as the incandescent base-case lamps, the energy advantages of CFL luminaires over incandescent-lamp luminaires can be significantly less due to the factors that affect lamp performance when enclosed in a luminaire (see “Factors Affecting Lamp Efficacy” on p. 5). As a result, the CFL luminaires were only 1.2 to 5.3 times as efficacious as the incandescent base-case luminaires.

The average luminaire efficacy for the luminaires using linear or U-bend fluorescent lamps was 30% higher than the average luminaire efficacy for luminaires using CFLs and circular lamps. The linear and U-bend luminaires also averaged 2.5 times the light output of luminaires using CFLs and circular lamps. NLPIP recommends considering linear fluorescent-lamp luminaires for applications requiring high light output.

NLPIP testing showed that the efficacy of luminaires with CFLs varied from 11 to 48 LPW, and the efficacy of luminaires with linear and U-bend fluorescent lamps varied from 27 to 67 LPW. In comparison, the efficacies of the two base-case incandescent-lamp luminaires were 8 and 9 LPW.

Further Information

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Data Table Terms and Definitions

The following data tables present information obtained by NLPIP from manufacturers or during product testing. Most of the performance characteristics listed in these tables are discussed in this report or are self-explanatory, but the column headings are defined in this section.

Active power. The input power measured (in watts) for a lamp-ballast combination.

Application. The application (small kitchen, medium kitchen, staircase) for which the manufacturer submitted the luminaire, as described on p. 8.

Ballast factor. The ratio of the light output of a fluorescent lamp operated by a particular ballast to the light output of the same lamp operated by a reference ballast under standard testing conditions.

Diffuser material. Diffusers scatter the light from a luminaire in all directions. Most diffusers in commodity residential grade luminaires are made of plastic (usually acrylic or polycarbonate). Other materials include glass and alabaster.

Horizontal illuminance. The average density of luminous flux incident on a horizontal surface. Illuminance is measured in footcandles (fc) or lux (lx). One fc equals 10.76 lx. All horizontal illuminance values were calculated by Lumen-Micro software, using a 6- by 6-in. (15- by 15-cm) grid on the specified surface (countertop or floor).

Lamp quantity and type. The number of lamps (in parentheses) used by the luminaire, followed by a generic designation indicating the type:

Generic Lamp Designation	Description
60A19	60-W A19 incandescent lamp
CFQ9T4	9-W quad tube CFL
CFQ13T4	13-W quad tube CFL
CFQ26T4	26-W quad tube CFL
CFS21	21-W square CFL
CFS28	28-W square CFL
CFS38	38-W square CFL
CFT9T4	9-W twin tube CFL
CFT13T4	13-W twin tube CFL
CFT18T4	18-W twin tube CFL
CFT24/27T5	24- or 27-W twin tube CFL (NLPIP used a 24-W lamp in testing)
F32T8	32-W linear fluorescent lamp
F34T12	34-W linear fluorescent lamp
F40T12	40-W linear fluorescent lamp
FB32T8	32-W U-bend fluorescent lamp
FB40T12	40-W U-bend fluorescent lamp
FB40T12/ES	34- or 35-W U-bend fluorescent lamp (NLPIP used a 35-W lamp in testing)
FC6T9	20-W circular fluorescent lamp
FC8T9	22-W circular fluorescent lamp
FC9T9	30- or 36-W circular fluorescent lamp
FC12T9	32-W circular fluorescent lamp
FC16T9	40-W circular fluorescent lamp

Light output from luminaire. The total measured light emitted by a luminaire.

Luminaire efficacy. The ratio of the measured light output of a luminaire to its active power, expressed in lumens per watt (LPW).

Luminaire efficiency. The ratio of the light output of a luminaire to the light output of the bare lamp-ballast system measured under standard conditions, expressed as a percentage.

Power factor. The ratio of active power in watts to apparent power in root-mean-square volt-amperes; it ranges from zero to one.

Rated light output from lamp(s). The sum of the initial rated lamp lumens of the lamp(s) that were supplied with the luminaire.

THD (Total harmonic distortion). A measure of the degree to which the current waveform is distorted from sinusoidal, expressed as a percentage.

Trim option. A decorative luminaire accessory.

Vertical illuminance. The average density of luminous flux incident on a vertical surface, measured in fc or lx. One fc equals 10.76 lx. All vertical illuminance values were calculated by Lumen-Micro software, using a 6- by 6-in. (15- by 15-cm) grid on the specified surface (upper cabinet, lower cabinet, refrigerator, or wall).

Table 3. Manufacturer-Supplied Data: Residential Luminaires

Manufacturer	Catalog Number[a]	Application[b]	Lamp Quantity and Type	Dimensions[c] (in.)	Shape	Diffuser Material	Trim Option	Photometric Report	Suggested Retail Price (US $)
Brownlee Lighting	2025-13	3	(1) CFT13T4	10 3/8	dome	clear ribbed glass	polished brass	N	NS
	2030-13	3	(1) CFT13T4	10 7/8	drum	clear crystal glass	polished brass	N	NS
	2045-11-13	3	(1) CFT13T4	11 1/2	dome	white acrylic wraparound	NA	N	NS
	2155-13	3	(1) CFT13T4	12 1/2	dome	frosted glass	polished brass	N	NS
	2025-2X13	1	(2) CFT13T4	10 3/8	dome	clear ribbed glass	polished brass	N	NS
	2215-2X13	1	(2) CFT13T4	11 1/2	dome	clear acrylic simulating cut crystal	polished brass	N	NS
	2045-11-2X13	1	(2) CFT13T4	11 1/2	dome	white acrylic wraparound	NA	N	NS
	2035-12-2X13	1	(2) CFT13T4	12 × 12	square	white acrylic wraparound	NA	N	NS
	2045-14-3X13	2	(3) CFT13T4	14	dome	white acrylic wraparound	NA	N	NS
	2035-14-3X13	2	(3) CFT13T4	14 × 14	square	white acrylic wraparound	NA	N	NS
	2130-3X13	2	(3) CFT13T4	15	dome	fluted opal glass	polished brass	N	NS
	2130-3X13-CRG	2	(3) CFT13T4	15	dome	fluted opal glass	polished brass	N	NS
Cooper Lighting	7313	3	(1) FC8T9	11	drum	opal white acrylic wraparound	NA	N	38.70
	7323	3	(1) FC12T9	14	drum	opal white acrylic wraparound	NA	N	38.70
	7433	1, 2	(1) FC8T9 and (1) FC12T9	14	dome	opal white acrylic wraparound	NA	N	47.95
	4111	1, 2	(2) F40T12	12 × 48	flat	opal white acrylic	solid oak frame	N	182.35
	5211	1, 2	(2) F40T12	12 × 48	flat	opal white acrylic	solid oak frame	N	109.30
	4211	1, 2	(2) FB40T12	24 × 24	flat	opal white acrylic	solid oak frame	N	175.95
	4261	1, 2	(2) FB40T12	24 × 24	flat	opal white acrylic	solid oak frame	N	175.80
	5511	1, 2	(2) FB40T12	24 × 24	square	opal white acrylic	solid oak frame	N	143.50
	5411	1, 2	(4) F40T12	18 × 48	flat	opal white acrylic	solid oak frame	N	137.35
	4311	1, 2	(4) F40T12	24 × 48	flat	opal white acrylic	solid oak frame	N	269.25
	5445	1, 2	(4) F40T12	24 × 48	flat	opal white acrylic	NA	N	140.30

NA = not applicable
NS = not supplied
1 in. = 2.54 cm

Y = Yes, the manufacturer provided a photometric report.
N = No, the manufacturer did not provide a photometric report.

[a] Catalog numbers in red indicate products tested by NLPIP. See Table 4 for performance results for these NLPIP-evaluated products. See Tables 5, 6, and 7 for the illuminances of NLPIP-tested products for small kitchen, medium kitchen, and staircase, respectively.

[b] Application: 1 = Small Kitchen; 2 = Medium Kitchen; 3 = Staircase.

[c] A single entry indicates the diameter.

Table 3 (continued). Manufacturer-Supplied Data: Residential Luminaires

Manufacturer	Catalog Number[a]	Application[b]	Lamp Quantity and Type	Dimensions[c] (in.)	Shape	Diffuser Material	Trim Option	Photometric Report	Suggested Retail Price (US $)
Illuminating Experiences	Rigadin 858-PL Rigadin 859-PL Rigadin 860-PL	NS	(1) CFQ13T4 (2) CFT13T4 (2) CFT13T4	10 12 14	dome	glass wraparound	NA	N	79.00 99.00 119.00
	Jesolo 450PL Jesolo 452PL Jesolo 454PL	NS	(1) CFQ13T4 (1) CFQ13T4 (3) CFQ26T4	8 1/2 12 18 1/2	dome	opal glass wraparound	NA	N	59.00 89.00 299.00
	Arianna ARI28 Arianna ARI26 Arianna ARI40	NS	(1) FC12T9 or (2) CFT13T4	11 14 16	dome	opaline glass shield	decorative metal rings	N	275.00 299.00 350.00
	Fortuna 423F-PL Fortuna 424F-PL Fortune 425F-PL	NS	(2) CFQ9T4	11 13 15	dome	glass	NA	N	225.00 250.00 350.00
	Disco 28FL Disco 35FL Disco 40FL	NS	(2) CFT13T4 (2) CFT18T4 (2) CFT18T4	11 13 3/4 15 3/4	drum	matte finish glass	perforated polycarbonate bands within satin-nickel-plated steel frame	N	425.00 475.00 500.00
	Alabaster 179PL Alabaster 180PL Alabaster 171PL	NS	(2) CFT13T4 (2) CFT13T4 (4) CFT13T4	13 15 20	dome	alabaster	solid brass spacers	N	450.00 600.00 750.00
Kichler Lighting	K-10832	3	(1) FC8T9 and (1) FC12T9	14	drum	white acrylic wraparound	NA	N	116.60
	K-10873	3	(1) FC8T9 and (1) FC12T9	14	dome	white acrylic wraparound	NA	N	118.80
	K-10846	3	(1) FC8T9 and (1) FC12T9	15 1/2 × 15 1/2	square	white acrylic wraparound	NA	N	143.00
	K-10862	2, 3	(1) FC8T9 and (1) FC12T9	16 1/2	dome	white and clear acrylic	NA	N	202.40
	K-10866	1	(1) FC8T9 and (1) FC12T9	19 1/4	drum	white acrylic	finished ring	N	204.60
	K-10848	1	(1) FC12T9 and (1) FC16T9	20 1/2 × 20 1/2	square	white acrylic wraparound	NA	N	182.60
	K-10868	2	(1) FC12T9 and (1) FC16T9	23 3/4	dome	white acrylic	finished ring	N	250.80
	K-10852	2	(2) CFT13T4	15	dome	textured white glass	polished brass	N	103.40
	K-10855	2	(2) CFT13T4	17	dome	white opal glass	polished brass	N	172.70
	K-10022	1	(2) FB40T12	27 1/4 × 26 1/4	square	white acrylic	decorative molding	N	107.70
	K-10024	1	(2) F40T12	27 × 50	rectangle	white acrylic	decorative molding	N	169.30
Leadco Lighting	CF2983TW	1, 3	(2) CFT13T4	13	dome	Etruscan melon glass	textured white	N	NS
	CF2988BR	1, 3	(2) CFT13T4	13	dome	pearlescent glass	polished brass	N	NS
	CF2991BR	1, 3	(2) CFT13T4	13	dome	iced ribbed glass	polished brass	N	NS

NA = not applicable
NS = not supplied
1 in. = 2.54 cm

Y = Yes, the manufacturer provided a photometric report.
N = No, the manufacturer did not provide a photometric report.

[a] Catalog numbers in red indicate products tested by NLPIP. See Table 4 for performance results for these NLPIP-evaluated products. See Tables 5, 6, and 7 for the illuminances of NLPIP-tested products for small kitchen, medium kitchen, and staircase, respectively.
[b] Application: 1 = Small Kitchen; 2 = Medium Kitchen; 3 = Staircase.
[c] A single entry indicates the diameter.

Table 3 (continued). Manufacturer-Supplied Data: Residential Luminaires

Manufacturer	Catalog Number[a]	Application[b]	Lamp Quantity and Type	Dimensions[c] (in.)	Shape	Diffuser Material	Trim Option	Photometric Report	Suggested Retail Price (US $)
Leadco Lighting	CF2991TW	1, 3	(2) CFT13T4	13	dome	iced ribbed glass	textured white	N	NS
	CF2950BR	2	(3) CFT13T4	15	dome	frosted swirl ribbed glass	polished brass	N	NS
	CF2950TW	2	(3) CFT13T4	15	dome	frosted swirl ribbed glass	textured white	N	NS
Lighting Depot	Domelite LTD 1122 Domelite LTD 1422 Domelite LTD 1130 Domelite LTD 1430	NS	(1) FC8T9 (1) FC8T9 (1) FC9T9 (1) FC9T9	12 1/2 15 12 1/2 15	dome	white acrylic wraparound	NA	N	33.95
	Flutelites LTD 2203 Flutelites LTD 2204 Flutelites LTD 3303 Flutelites LTD 3004 Flutelites LTD 3605 Flutelites LTD 3606 Flutelites LTD 3607	NS	(1) FC8T9 (1) FC8T9 (1) FC9T9 (1) FC9T9 (1) FC9T9 (1) FC9T9 (1) FC9T9	13 3/4	dome	white acrylic	brass	N	39.95–40.95 approx.
	Trimlite LTD 2201 Trimlite LTD 2202 Trimlite LTD 3001 Trimlite LTD 3002 Trimlite LTD 3601 Trimlite LTD 3602 Trimlite LTD 3603 Trimlite LTD 3604	NS	(1) FC8T9 (1) FC8T9 (1) FC9T9 (1) FC9T9 (1) FC9T9 (1) FC9T9 (1) FC9T9 (1) FC9T9	13 3/4	dome	white acrylic	brass decorative, white decorative	N	39.95–40.95 approx.
Lightolier	Triplex 5001 Triplex 5003 Triplex 5005	1	(1) CFQ13T4 (2) CFT13T4 (3) CFT13T4	11 12 7/8 15 3/8	dome	white opal glass	white	N	168.00 228.00 408.00
	Discus 6700	NS	(1) CFS28 or (1) CFS38	13	shallow dome	white acrylic	matte silver, matte black, matte white	Y	85.00
	Discus 6701	NS	(1) CFS28 or (1) CFS38	17	shallow dome w/shade	white acrylic	matte silver, matte black, matte white	Y	120.00
	Lumidisc 6752	1	(1) FC8T9 and (1) FC12T9	14	drum	white acrylic	white	N	156.00
	Lumidisc 5240WH	2	(1) FC12T9 and (1) FC16T9	19	drum	white Lexan	white	Y	235.50
	Lumidome 5241WH	2	(1) FC12T9	19	dome	acrylic hemisphere wraparound	white	Y	235.50
	Lumidome 5242PB	2	(1) FC16T9	19	dome	acrylic hemisphere wraparound	brass	Y	319.80
	Opaline 6619	1	(2) CFT13T4	11	dome	white Lexan	white	Y	142.80
	Opaline 6623	1	(2) CFT13T4	11	dome	white Lexan	brass	Y	175.20
	Gridworks 13814 series Gridworks 13822 series Gridworks 13824 series	2	(2) F40T12 (2) FB40T12 (4) F40T12	12 × 48 24 × 24 24 × 48	rectangle square rectangle	white acrylic on wood grid	natural oak frame, white frame	N	340.50 340.50 492.00
	Lumiplex 13550 series Lumiplex 13554 series Lumiplex 13558 series	2	(2) F40T12 (2) FB40T12 (4) F40T12	12 × 48 24 × 24 24 × 48	rectangle square rectangle	acrylic wraparound	white, black	Y	491.10 255.90 255.90

NA = not applicable
NS = not supplied
1 in. = 2.54 cm
Y = Yes, the manufacturer provided a photometric report.
N = No, the manufacturer did not provide a photometric report.

[a] Catalog numbers in red indicate products tested by NLPIP. See Table 4 for performance results for these NLPIP-evaluated products. See Tables 5, 6, and 7 for the illuminances of NLPIP-tested products for small kitchen, medium kitchen, and staircase, respectively.
[b] Application: 1 = Small Kitchen; 2 = Medium Kitchen; 3 = Staircase.
[c] A single entry indicates the diameter.

Table 3 (continued). Manufacturer-Supplied Data: Residential Luminaires

Manufacturer	Catalog Number[a]	Application[b]	Lamp Quantity and Type	Dimensions[c] (in.)	Shape	Diffuser Material	Trim Option	Photometric Report	Suggested Retail Price (US $)
Lightolier	Copper Foil 5549	2	(2) CFT24/27T5	16 3/4 × 4 3/8	shallow pyramid	white glass panels	hand-soldered copper foil	Y	318.00
	Wafer 10351 Wafer 10353 Wafer 10355	2	(2) CFT24/27T5 (2) F32T8 (4) F32T8	16 9/16 × 16 9/16 49 1/2 × 9 7/8 49 1/2 × 15 7/8	square rectangle rectangle	white acrylic	black, white	Y	258.00 324.00 444.00
	Spill Ring 5543WH	2	(2) CFT24/27T5	22	dome	white acrylic	double-flanged white ring	Y	318.00
	Spill Ring 5543PB	2	(2) CFT24/27T5	22	dome	white acrylic	double-flanged polished brass ring		348.00
Lights of America	4021	1	(1) FC6T9	11	dome	polycarbonate lens	white gloss w/stepped base	Y	39.90
	4000	NS	(1) FC9T9	10	drum	polycarbonate lens	Lexan backplate	Y	29.90
	4010	1, 2, 3	(1) FC9T9	14	dome	polycarbonate lens	white gloss w/flat base	Y	39.90
	4035	1, 2, 3	(1) FC9T9	14	dome	frosted polycarbonate	polished brass w/stepped base	Y	39.90
	4026	2, 3	(1) FC9T9	14	dome	polycarbonate lens	white gloss w/stepped base	Y	39.90
	4027	2, 3	(1) FC9T9	14	dome	polycarbonate lens	polished brass w/stepped base	Y	39.90
	4040	1, 2, 3	(1) FC9T9	14	dome	fluted and prismatic polycarbonate	polished brass w/flat base	Y	39.90
Lithonia Lighting	10970	3	(1) FC8T9	11	drum	matte white molded acrylic wraparound	NA	Y	48.80
	10972	3	(1) FC8T9 and (1) FC12T9	14	drum	matte white molded acrylic wraparound	NA	Y	65.95
	11493	1	(1) FC8T9 and (1) FC12T9	16	dome (octagonal)	pure white acrylic dropped dish	hi-gloss white wood	N	101.60
	10821	3	(2) CFT9T4	11 1/2	dome	acrylic wraparound	NA	N	41.50
	11602	1	(2) F32T8	48 5/8 × 10	rectangle	matte white acrylic wraparound	NA	Y	137.00
	11402ES	1	(2) F40T12	48 3/8 × 12	rectangle	curved opal-white acrylic	wooden frame	Y	163.20
	11496ES	2	(2) F40T12	18 × 48	rectangle	pure white acrylic dropped dish	hi-gloss white wood	N	182.35
	10823	1	(3) CFT9T4	14	dome	acrylic wraparound	NA	N	54.80
	10832	3	(3) CFT13T4	15	dome	clear cut acrylic	brass-plated pan	N	58.80

NA = not applicable Y = Yes, the manufacturer provided a photometric report.
NS = not supplied N = No, the manufacturer did not provide a photometric report.
1 in. = 2.54 cm

[a] Catalog numbers in red indicate products tested by NLPIP. See Table 4 for performance results for these NLPIP-evaluated products. See Tables 5, 6, and 7 for the illuminances of NLPIP-tested products for small kitchen, medium kitchen, and staircase, respectively.

[b] Application: 1 = Small Kitchen; 2 = Medium Kitchen; 3 = Staircase.

[c] A single entry indicates the diameter.

Table 3 (continued). Manufacturer-Supplied Data: Residential Luminaires

Manufacturer	Catalog Number[a]	Application[b]	Lamp Quantity and Type	Dimensions[c] (in.)	Shape	Diffuser Material	Trim Option	Photometric Report	Suggested Retail Price (US $)
Lithonia Lighting	11604	2	(4) F32T8	48 5/8 × 10	rectangle	matte white acrylic wraparound	NA	Y	160.65
	11497ES	2	(4) F40T12	24 × 48	rectangle	pure white acrylic dropped dish	hi-gloss white wood	N	228.00
	11403ES	2	(4) F40T12	48 3/8 × 18 1/4	rectangle	curved opal-white acrylic	wooden frame	Y	187.20
Progress Lighting	7372-30	1	(1) FC8T9 and (1) FC12T9	13 3/4	drum	white acrylic wraparound	white	Y	133.50
	7373-30	2	(1) FC12T9 and (1) FC16T9	19	drum	white acrylic wraparound	white	Y	192.60
	7376-30	1	(2) CFT13T4	11	drum	white acrylic wraparound	white	Y	74.40
	7376-31	1	(2) CFT13T4	11	drum	white acrylic wraparound	black	Y	74.40
	3564-10EB	3	(3) CFQ13T4	19 3/8	dome	sprayed white glass	polished brass	Y	372.00
	3564-10	3	(3) CFT13T4	19 3/8	dome	sprayed white glass	polished brass	Y	189.00
	3564-13	3	(3) CFT13T4	19 3/8	dome	sprayed white glass	brushed steel	Y	195.00
	7280-60ES	2	(4) F40T12 or (4) F34T12	18 × 52	rectangle	white acrylic cloud	NA	Y	317.10
Ruud Lighting	SS0221	3	(1) CFS21	8 × 8	square	polycarbonate translucent lens	die-cast aluminum housing	Y	90.00
	SS0238	3	(1) CFS38	10 × 10	square	polycarbonate translucent lens	die-cast aluminum housing	Y	105.00
Sea Gull Lighting	5995-15	NS	(1) FC12T9 and (1) FC16T9	24 1/4	dome	acrylic	white finish stepped trim	N	220.00
	7979-02	NS	(2) CFT13T4	12 1/2	dome	NS	polished brass base	N	79.20
	5931-15 5932-15	NS	(2) CFT13T4 (3) CFT13T4	14	drum	white acrylic wraparound	white base	N	61.60 85.80
	5977-15	NS	(2) FB32T8	27 3/8 × 26 3/8	square	flat white acrylic	white finish cornice	N	154.00
	5913-68-9513-15S	NS	(4) F32T8	51 1/2 × 27	rectangle	NS	white trim and chassis	N	336.60
Simkar Lighting	SY130-14 E1	3	(1) F34T12	5 5/8 × 48	rectangle	clear acrylic prismatic wraparound	NA	Y	118.50
	SY66-232-B11-M-RH	NS	(2) F32T8	48 × 5 3/4	rectangle	prismatic plastic acrylic flat	NA	Y	173.00

NA = not applicable
NS = not supplied
1 in. = 2.54 cm

Y = Yes, the manufacturer provided a photometric report.
N = No, the manufacturer did not provide a photometric report.

[a] Catalog numbers in red indicate products tested by NLPIP. See Table 4 for performance results for these NLPIP-evaluated products. See Tables 5, 6, and 7 for the illuminances of NLPIP-tested products for small kitchen, medium kitchen, and staircase, respectively.
[b] Application: 1 = Small Kitchen; 2 = Medium Kitchen; 3 = Staircase.
[c] A single entry indicates the diameter.

Table 3 (continued). Manufacturer-Supplied Data: Residential Luminaires

Manufacturer	Catalog Number[a]	Application[b]	Lamp Quantity and Type	Dimensions[c] (in.)	Shape	Diffuser Material	Trim Option	Photometric Report	Suggested Retail Price (US $)
Simkar Lighting	SY920-232-B11-A-RH SY920-240 E1	1, 2	(2) F32T8 (2) F34T12	48 × 9	rectangle	clear acrylic prismatic wraparound	oak, bleached oak, walnut, unfinished ends	Y	65.03 46.28
	SY950-232-B11-M-RH SY950-240 E1	1, 2	(2) F32T8 (2) F34T12	48 × 8³/₄ 48 × 9	rectangle	clear acrylic prismatic wraparound	NA	Y	58.00 46.28
	SMCW232-B11-MRH	3	(2) F32T8	51 × 4³/₄	rectangle	UV acrylic milk white	NA	Y	97.00
	SY920-432-B11-A-1/4 SY920-440 E1	1, 2	(4) F32T8 (4) F34T12	48 × 14¹/₂	rectangle	clear acrylic prismatic wraparound	oak, bleached oak, walnut, unfinished ends	Y	96.15 77.40
Teron Lighting	Fairway - FY26 Fairway - FY26Q	3	(2) CFT13T4 (1) CFQ26T4	10	dome	clear "crystal cut" acrylic	white steel	N	43.69 57.34
	Eagle - EE26	1	(2) CFT13T4	11	drum	white acrylic wraparound	NA	N	38.06
	Irwin - IN26	3	(2) CFT13T4	11	dome	clear ribbed glass	bright polished brass	N	45.04
	Golden Bear Small - GRS26 Golden Bear Small - GRS26Q	3	(2) CFT13T4 (1) CFQ26T4	12¹/₂	dome	clear "crystal cut" acrylic	multi-tiered polished brass	N	47.99 61.69
	Medina - MA26 Medina - MA26Q	1	(2) CFT13T4 (1) CFQ26T4	12¹/₂ × 12¹/₂	square	white acrylic wraparound	NA	N	55.88 66.55
	Faultless - FS26	1	(2) CFT13T4	14	dome	white acrylic wraparound	NA	N	43.83
	Golden Bear - GR26 Golden Bear - GR26Q	1	(2) CFT13T4 or (1) CFQ26T4	15	dome	clear "crystal cut" acrylic	multi-tiered polished brass	N	52.21 62.10
	Eagle - EE39 Eagle - EE52	2	(3) CFT13T4 (2) CFQ26T4	11	drum	white acrylic wraparound	NA	N	51.56 82.55
	Medina - MA39	2	(3) CFT13T4	12¹/₂ × 12¹/₂	square	white acrylic wraparound	NA	N	68.66
	Faultless - FS39 Faultless - FS52	2	(3) CFT13T4 (2) CFQ26T4	14	dome	white acrylic wraparound	NA	N	58.50 85.86
	Golden Bear - GR39	2	(3) CFT13T4	15	dome	clear "crystal cut" acrylic	multi-tiered polished brass	N	60.94
Troy Lighting	1938-C	NS	(1) FC8T9 and (1) FC12T9	18	dome	acrylic wraparound	NA	N	89.00
	1939-C	NS	(1) FC12T9 and (1) FC16T9	20	dome	acrylic wraparound	NA	N	99.00

NA = not applicable
NS = not supplied
1 in. = 2.54 cm
Y = Yes, the manufacturer provided a photometric report.
N = No, the manufacturer did not provide a photometric report.

[a] Catalog numbers in red indicate products tested by NLPIP. See Table 4 for performance results for these NLPIP-evaluated products. See Tables 5, 6, and 7 for the illuminances of NLPIP-tested products for small kitchen, medium kitchen, and staircase, respectively.

[b] Application: 1 = Small Kitchen; 2 = Medium Kitchen; 3 = Staircase.

[c] A single entry indicates the diameter.

Table 4. NLPIP Evaluations: Performance Data for All Luminaires

Manufacturer	Catalog Number	Lamp Quantity and Type	Rated Lamp Power[a] (W)	Ballast	Ballast Type
Base Cases[b]					
Columbia	SM22-240-FSA12	(2) FB40T12	80	Advance R-2S40-TP	M
Lightolier	ANB240	(2) F40T12	80	Advance R-2S40-TP	M
Progress Lighting	3561	(2) 60A19	120	NA	NA
	3565	(4) 60A19	240	NA	NA
NLPIP-Evaluated Products					
Brownlee Lighting	2045-11-13	(1) CFT13T4	13	Advance LCL-13-TP	M
Lithonia Lighting	10821	(2) CFT9T4	18	Advance LPL-5-9-TP	M
Lights of America	4021	(1) FC6T9	20	Lights of America	E
Ruud Lighting	SS0221	(1) CFS21	21	Hatch HR-2100	E
Cooper Lighting	7313	(1) FC8T9	22	Advance RLQS-122-TP	M
Lighting Depot	Domelite LTD 1122	(1) FC8T9	22	Lighting Depot EC-22-8	E
	Domelite LTD 1422	(1) FC8T9	22	Lighting Depot EC-22-8	E
Kichler Lighting	K-10852	(2) CFT13T4	26	Robertson SP2P	M
Leadco Lighting	CF2983TW	(2) CFT13T4	26	Robertson HPS1P	M
Lightolier	Opaline 6619	(2) CFT13T4	26	Robertson SP2P	M
Progress Lighting	7376-30	(2) CFT13T4	26	Robertson SP2P	M
Sea Gull Lighting	5931-15	(2) CFT13T4	26	Advance LC-13-TP	M
Teron Lighting	Eagle - EE26	(2) CFT13T4	26	Valmont 8G1013G04	M
Lighting Depot	Trimlite LTD 3001	(1) FC9T9	30	Lighting Depot EC-30-8	E
	Trimlite LTD 3601	(1) FC9T9	30	Lighting Depot EC-36-10	E
Lights of America	4000	(1) FC9T9	30	Lights of America	E
	4026	(1) FC9T9	30	Lights of America	E
	4035	(1) FC9T9	30	Lights of America	E
	4040	(1) FC9T9	30	Lights of America	E
Ruud Lighting	SS0238	(1) CFS38	38	Hatch HR-3800	E
Brownlee Lighting	2035-14-3X13	(3) CFT13T4	39	Advance LCL-13-TP	M
Leadco Lighting	CF2950TW	(3) CFT13T4	39	Robertson HPS1P	M
Sea Gull Lighting	5932-15	(3) CFT13T4	39	Advance LC-13-TP	M
Teron Lighting	Faultless - FS39	(3) CFT13T4	39	MagneTek 4111H2P	M
Lightolier	Wafer 10351	(2) CFT24T5	48	Valmont 8G3383W	M
Teron Lighting	Faultless - FS52	(2) CFQ26T4	52	Fulham FEP100120227TB	E
Cooper Lighting	7433	(1) FC8T9 & (1) FC12T9	54	Advance RMS-22-32-TP	M
Kichler Lighting	K-10832	(1) FC8T9 & (1) FC12T9	54	MagneTek 726-L-VLH-WS-TC-P	M
	K-10846	(1) FC8T9 & (1) FC12T9	54	MagneTek 726-L-VLH-WS-TC-P	M
Lithonia Lighting	11493	(1) FC8T9 & (1) FC12T9	54	Robertson R2232P-A W/S	M
Progress Lighting	7372-30	(1) FC8T9 & (1) FC12T9	54	Robertson R2232P-A W/S	M
Troy Lighting	1938-C	(1) FC8T9 & (1) FC12T9	54	Advance RS-22-32-TP	M
Lightolier	Wafer 10353	(2) F32T8	64	MagneTek 749-L-SLH-TC-P[c]	M
Sea Gull Lighting	5977-15	(2) FB32T8	64	Advance REL-2P32-RH-TP	E
Simkar Lighting	SY66-232-B11-M-RH	(2) F32T8	64	MagneTek B232I120RH	E
	SY950-232-B11-M-RH	(2) F32T8	64	MagneTek B232I120RH	E
	SY920-232-B11-A-RH	(2) F32T8	64	Advance REL-2P32-RH-TP	E
Cooper Lighting	4261	(2) FB40T12/ES	70	Advance R-2S40-TP	M
Kichler Lighting	K-10868	(1) FC12T9 & (1) FC16T9	72	MagneTek 726-L-VLH-WS-TC-P	M
Lightolier	Lumidisc 5240WH	(1) FC12T9 & (1) FC16T9	72	MagneTek 474-L-WS-TC-P[c]	M
Progress Lighting	7373-30	(1) FC12T9 & (1) FC16T9	72	MagneTek 474-L-WS-TC-P[c]	M
Sea Gull Lighting	5995-15	(1) FC12T9 & (1) FC16T9	72	Robertson RS2232P W/S	M

NA = not applicable NS = lamp was not supplied with luminaire M = magnetic E = electronic

[a] Values provided by manufacturers or manufacturer catalogs.

[b] Data taken from manufacturers' photometric reports.

[c] Ballast is no longer available. Consult the ballast manufacturer for current equivalent.

Electrical Characteristics			Photometric Characteristics				
Active Power (W)	Power Factor	THD (%)	Rated Light Output from Lamp(s)[a] (lm)	Ballast Factor[a]	Light Output from Luminaire (lm)	Luminaire Efficiency (%)	Luminaire Efficacy (LPW)
85.0	0.97	13	6000	0.95	4304	71.7	51
83.2	0.97	13	6300	0.95	4492	71.3	54
120.0	NA	NA	1730	NA	1091	63.0	9
240.0	NA	NA	3240	NA	1864	57.5	8
14.9	0.46	7	825	0.82	361	58.2	24
18.9	0.55	8	1200	0.89	295	49.3	16
16.2	0.91	39	1400	1.00	474	41.9	29
19.1	0.92	10	1350	0.90–1.00	751	69.6	39
21.2	0.35	4	NS	0.75	332	45.5	16
19.1	0.97	24	1400	>0.95	717	57.2	38
19.3	0.97	25	1400	>0.95	726	63.4	38
30.8	0.45	7	NS	0.94	658	49.8	21
33.3	0.85	52	1720	0.94	389	30.9	12
30.6	0.45	7	NS	0.94	547	42.6	18
30.7	0.47	9	1650	0.94	586	41.0	19
30.2	0.45	7	1650	0.93	705	54.8	23
28.8	0.44	6	1600	1.00	498	39.9	17
26.4	0.97	22	2000	>0.95	977	65.4	37
30.7	0.98	21	2000	>0.95	1254	59.6	41
23.4	0.50	166	2400	1.00	1023	62.6	44
23.3	0.50	167	2400	1.00	734	46.0	31
24.3	0.50	165	2400	1.00	871	53.2	36
23.1	0.46	165	2400	1.00	890	54.5	39
31.3	0.96	10	2850	0.90–1.00	1512	73.1	48
42.9	0.43	6	2475	0.82	724	42.9	17
48.4	0.83	63	2520	0.94	668	41.4	14
45.8	0.42	5	2475	0.93	520	35.1	11
51.8	0.44	54	2400	1.00	643	34.8	12
55.2	0.98	19	3240	0.93	1469	43.3	27
40.8	0.95	22	3400	0.85	1109	42.3	27
49.5	0.47	9	2975	0.61	903	35.2	18
41.5	0.97	22	NS	0.68	1241	52.7	30
43.6	0.97	21	NS	0.68	1561	66.3	36
47.0	0.48	6	2850	0.70	1012	42.5	22
44.7	0.53	7	2975	0.70	932	45.3	21
47.7	0.50	9	NS	0.80	1310	52.1	27
64.7	0.98	19	5900	0.95	2241	46.1	35
55.6	0.98	18	5400	0.88	1765	47.7	32
54.6	0.98	16	5900	0.88	2461	52.5	45
55.7	0.98	16	5900	0.88	3626	78.0	65
55.0	0.98	18	5900	0.88	3478	76.9	63
75.5	0.97	13	4800	0.88	2002	53.7	27
53.9	0.93	38	NS	0.68	1275	44.4	24
53.4	0.96	28	NS	0.65	1746	55.4	33
54.7	0.94	35	4425	0.65	1186	36.8	22
60.4	0.93	24	4800	0.74	1509	40.7	25

Table 5. NLPIP Evaluations: Photometric Data for Luminaires in the Small Kitchen

Manufacturer	Catalog Number	Lamp Quantity and Type	Rated Lamp Power[a] (W)	Active Power (W)	Light Output from Luminaire (lm)
Base Cases					
Columbia	SM22-240-FSA12	(2) FB40T12	80	85.0	4304
Lightolier	ANB240	(2) F40T12	80	83.2	4492
Progress Lighting	3561	(2) 60A19	120	120.0	1091
Progress Lighting	3565	(4) 60A19	240	240.0	1864
NLPIP-Evaluated Products					
Lighting Depot	Trimlite LTD 3001	(1) FC9T9	30	26.4	977
	Trimlite LTD 3601	(1) FC9T9	30	30.7	1254
Lights of America	4000	(1) FC9T9	30	23.4	1023
	4026	(1) FC9T9	30	23.3	734
	4035	(1) FC9T9	30	24.3	871
	4040	(1) FC9T9	30	23.1	890
Ruud Lighting	SS0238	(1) CFS38	38	31.3	1512
Brownlee Lighting	2035-14-3X13	(3) CFT13T4	39	42.9	724
Leadco Lighting	CF2950TW	(3) CFT13T4	39	48.4	668
Sea Gull Lighting	5932-15	(3) CFT13T4	39	45.8	520
Teron Lighting	Faultless - FS39	(3) CFT13T4	39	51.8	643
Lightolier	Wafer 10351	(2) CFT24T5	48	55.2	1469
Teron Lighting	Faultless - FS52	(2) CFQ26T4	52	40.8	1109
Cooper Lighting	7433	(1) FC8T9 & (1) FC12T9	54	49.5	903
Kichler Lighting	K-10832	(1) FC8T9 & (1) FC12T9	54	41.5	1241
	K-10846	(1) FC8T9 & (1) FC12T9	54	43.6	1561
Lithonia Lighting	11493	(1) FC8T9 & (1) FC12T9	54	47.0	1012
Progress Lighting	7372-30	(1) FC8T9 & (1) FC12T9	54	44.7	932
Troy Lighting	1938-C	(1) FC8T9 & (1) FC12T9	54	47.7	1310
Lightolier	Wafer 10353	(2) F32T8	64	64.7	2241
Sea Gull Lighting	5977-15	(2) FB32T8	64	55.6	1765
Simkar Lighting	SY66-232-B11-M-RH	(2) F32T8	64	54.6	2461
	SY950-232-B11-M-RH	(2) F32T8	64	55.7	3626
	SY920-232-B11-A-RH	(2) F32T8	64	55.0	3478
Cooper Lighting	4261	(2) FB40T12/ES	70	75.5	2002
Kichler Lighting	K-10868	(1) FC12T9 & (1) FC16T9	72	53.9	1275
Lightolier	Lumidisc 5240WH	(1) FC12T9 & (1) FC16T9	72	53.4	1746
Progress Lighting	7373-30	(1) FC12T9 & (1) FC16T9	72	54.7	1186
Sea Gull Lighting	5995-15	(1) FC12T9 & (1) FC16T9	72	60.4	1509

1 lx = 0.0929 fc

[a] Data provided by manufacturers or manufacturer catalogs.

Horizontal Illuminance (lx)		Vertical Illuminance (lx)		
Countertop	Floor	Upper Cabinet	Lower Cabinet	Refrigerator
413	372	501	225	210
434	377	761	222	175
101	90	183	58	60
195	173	345	110	109
80	70	141	45	46
111	97	197	63	64
80	69	153	45	48
60	53	110	35	36
70	62	133	40	42
72	65	139	42	43
110	93	199	60	64
50	44	87	28	29
54	49	93	31	32
41	35	72	23	24
54	47	95	31	31
120	105	207	66	66
86	76	154	49	50
53	47	95	30	31
67	58	120	37	39
82	71	147	46	47
58	51	104	33	34
49	42	91	27	29
72	63	126	41	41
199	172	404	105	88
152	134	247	83	80
234	207	409	120	83
321	285	548	168	132
308	271	526	161	126
171	150	287	94	89
74	66	125	42	41
92	80	169	51	52
67	58	124	37	38
100	89	168	56	56

Table 6. NLPIP Evaluations: Photometric Data for Luminaires in the Medium Kitchen

Manufacturer	Catalog Number	Lamp Quantity and Type	Rated Lamp Power[a] (W)	Active Power (W)	Light Output from Luminaire (lm)
Base Cases					
Columbia	SM22-240-FSA12	(2) FB40T12	80	85.0	4304
Lightolier	ANB240	(2) F40T12	80	83.2	4492
Progress Lighting	3565	(4) 60A19	240	240.0	1864
NLPIP-Evaluated Products					
Lightolier	Wafer 10351	(2) CFT24T5	48	55.2	1469
Teron Lighting	Faultless - FS52	(2) CFQ26T4	52	40.8	1109
Cooper Lighting	7433	(1) FC8T9 & (1) FC12T9	54	49.5	903
Kichler Lighting	K-10832	(1) FC8T9 & (1) FC12T9	54	41.5	1241
	K-10846	(1) FC8T9 & (1) FC12T9	54	43.6	1561
Lithonia Lighting	11493	(1) FC8T9 & (1) FC12T9	54	47.0	1012
Progress Lighting	7372-30	(1) FC8T9 & (1) FC12T9	54	44.7	932
Troy Lighting	1938-C	(1) FC8T9 & (1) FC12T9	54	47.7	1310
Lightolier	Wafer 10353	(2) F32T8	64	64.7	2241
Sea Gull Lighting	5977-15	(2) FB32T8	64	55.6	1765
Simkar Lighting	SY66-232-B11-M-RH	(2) F32T8	64	54.6	2461
	SY950-232-B11-M-RH	(2) F32T8	64	55.7	3626
	SY920-232-B11-A-RH	(2) F32T8	64	55.0	3478
Cooper Lighting	4261	(2) FB40T12/ES	70	75.5	2002
Kichler Lighting	K-10868	(1) FC12T9 & (1) FC16T9	72	53.9	1275
Lightolier	Lumidisc 5240WH	(1) FC12T9 & (1) FC16T9	72	53.4	1746
Progress Lighting	7373-30	(1) FC12T9 & (1) FC16T9	72	54.7	1186
Sea Gull Lighting	5995-15	(1) FC12T9 & (1) FC16T9	72	60.4	1509

1 lx = 0.0929 fc
[a] Data provided by manufacturers or manufacturer catalogs.

Horizontal Illuminance (lx)			Vertical Illuminance (lx)		
Countertop	Floor		Upper Cabinet	Lower Cabinet	Refrigerator
150	265		103	186	206
173	253		114	178	207
80	117		83	87	94
50	72		48	54	58
36	52		38	39	43
22	32		24	24	26
28	40		29	30	33
35	49		37	36	40
24	35		25	26	29
21	29		22	22	24
30	43		31	34	36
85	113		73	82	93
62	93		53	69	74
90	144		49	100	100
123	191		88	132	142
120	182		89	129	136
70	102		64	76	82
30	45		30	34	36
39	54		41	41	45
29	39		30	30	33
37	55		33	39	41

Table 7. NLPIP Evaluations: Photometric Data for Luminaires in the Staircase

Manufacturer	Catalog Number	Lamp Quantity and Type	Rated Lamp Power[a] (W)	Active Power (W)	Light Output from Luminaire (lm)
Base Case					
Progress Lighting	3561	(2) 60A19	120	120.0	1092
NLPIP-Evaluated Products					
Brownlee Lighting	2045-11-13	(1) CFT13T4	13	14.9	361
Lithonia Lighting	10821	(2) CFT9T4	18	18.9	295
Lights of America	4021	(1) FC6T9	20	16.2	474
Ruud Lighting	SS0221	(1) CFS21	21	19.1	751
Cooper Lighting	7313	(1) FC8T9	22	21.2	332
Lighting Depot	Domelite LTD 1122	(1) FC8T9	22	19.1	717
	Domelite LTD 1422	(1) FC8T9	22	19.3	726
Kichler Lighting	K-10852	(2) CFT13T4	26	30.8	658
Leadco Lighting	CF2983TW	(2) CFT13T4	26	33.3	389
Lightolier	Opaline 6619	(2) CFT13T4	26	30.6	547
Progress Lighting	7376-30	(2) CFT13T4	26	30.7	586
Sea Gull Lighting	5931-15	(2) CFT13T4	26	30.2	705
Teron Lighting	Eagle - EE26	(2) CFT13T4	26	28.8	498
Lighting Depot	Trimlite LTD 3001	(1) FC9T9	30	26.4	977
	Trimlite LTD 3601	(1) FC9T9	30	30.7	1254
Lights of America	4000	(1) FC9T9	30	23.4	1023
	4026	(1) FC9T9	30	23.3	734
	4035	(1) FC9T9	30	24.3	871
	4040	(1) FC9T9	30	23.1	890

1 lx = 0.0929 fc
[a] Data provided by manufacturers or manufacturer catalogs.
[b] “Floor” refers to the upper-level floor adjacent to the stairs.
[c] “Mid-Stair” refers to the stair halfway up the staircase.
[d] “Painting” refers to the painting at the top of the staircase in Figure 9.
[e] “Mid-Sidewall” refers to the sidewall right next to the mid-stair.

Horizontal Illuminance (lx)		Vertical Illuminance (lx)	
Floor[b]	Mid-Stair[c]	Painting[d]	Mid-Sidewall[e]
58	20	150	13
15	5	38	3
13	4	33	3
23	8	58	5
32	10	84	7
13	4	34	3
43	14	109	9
44	14	109	9
30	10	76	7
17	6	43	4
23	8	58	5
25	8	64	5
31	10	79	7
24	8	62	5
46	15	114	10
64	21	159	13
45	16	115	10
34	12	87	8
39	14	101	9
41	15	102	9

Table 8. Contact Information

Manufacturer	Phone	Fax	Web Site
Brownlee Lighting	800-318-6768	407-297-3705	www.brownlee.com
Catalina Industries	305-558-4777	305-558-3024	www.catalinaltg.com
Cooper Lighting	912-924-8000	912-924-5507	www.cooperlighting.com
Kichler Lighting	800-659-9000	216-573-1070	NA
Leadco Lighting	216-573-5888	216-573-1053	NA
The Lighting Depot Ltd.	610-832-7960	610-832-1494	NA
Illuminating Experiences	732-745-5858	732-745-9710	NA
Lightolier, Genlyte	508-679-8131	508-674-4710	www.lightolier.com
Lights of America	800-321-8100	909-594-6758	www.lightsofamerica.com
Lithonia Lighting	770-922-9000	770-760-0977	www.lithonia.com
Progress Lighting	864-599-6000	864-599-6151	www.progresslighting.com
Ruud Lighting	414-886-1900	414-884-3309	www.ruudlighting.com
Sea Gull Lighting	800-347-5483	800-877-4855	www.seagulllighting.com
Simkar Lighting	215-831-7700	215-831-7703	www.simkar.com
Teron Lighting	513-858-6004	513-858-6038	www.teronlight.com
Troy Lighting	626-336-4511	626-330-4266	NA

U.S. EPA/U.S. DOE	Phone	Fax	Web Site
Energy Star Programs	888-STAR-YES	202-565-2134	www.energystar.gov

NA = not available

NATIONAL LIGHTING PRODUCT INFORMATION PROGRAM

Specifier Reports

Energy-Efficient Ceiling-Mounted Residential Luminaires

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The National Lighting Product Information Program

The National Lighting Product Information Program (NLPIP) was established in 1990 and is administered by the Lighting Research Center at Rensselaer Polytechnic Institute. The Lighting Research Center is a nonprofit educational and research organization dedicated to the advancement of lighting knowledge.

NLPIP's mission is to rapidly provide the best information available on energy-efficient lighting products. NLPIP strives to provide complete, current, and valuable manufacturer-specific performance data in useful formats to guide lighting decisions. Priority is given to information not available now or not easily accessible from other sources.

The National Lighting Product Information Program tests lighting products according to accepted industry procedures. If procedures are not available or applicable, NLPIP develops interim tests, focusing on those performance issues that are important to the lighting specifier and end user. The program does not accept funding from manufacturers.

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Specifier Reports

Power Reducers, 1992; *Specular Reflectors*, 1992; *Parking Lot Luminaires*, 1993; *Cathode-Disconnect Ballasts*, 1993; *Exit Signs*, 1994; *Electronic Ballasts*, 1994; *Reflector Lamps*, 1994; *CFL Downlights*, 1995; *Dimming Electronic Ballasts*, 1995; *HID Accent Lighting Systems*, 1996; *Occupancy Sensors*, 1997; *Photosensors*, 1998; *Lighting Circuit Power Reducers*, 1998; *Screwbase Compact Fluorescent Lamp Products*, 1999

Specifier Reports Supplements

Exit Signs, 1995; *Electronic Ballasts*, 1995, 1996, 1997

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T8 Fluorescent Lamps, 1993; *Multilayer Polarizer Panels*, 1993; *Task Lighting for Offices*, 1994; *Dimming Systems for High-Intensity Discharge Lamps*, 1994; *Electromagnetic Interference Involving Fluorescent Lighting Systems*, 1995; *Power Quality*, 1995; *Thermal Effects in 2'×4' Fluorescent Lighting Systems*, 1995; *T10 and T9 Fluorescent Lamps*, 1995; *T5FT Lamps and Ballasts*, 1996; *Controlling Lighting with Building Automation Systems*, 1997

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Specifier Reports *Supplements*

Online Supplement

Specifier Reports: Energy-Efficient Ceiling-Mounted Residential Luminaires

Sampling and Testing Procedure

This online supplement to *Specifier Reports: Energy-Efficient Ceiling-Mounted Residential Luminaires* contains current information about hardwired ceiling-mounted luminaires that use compact fluorescent lamps (CFLs) or circular fluorescent lamps. A total of 12 products from three manufacturers were tested for this supplement. Manufacturer-supplied data and NLPIP test data are provided here in Adobe Acrobat "pdf" format. NLPIP directed the testing of product samples during March and April 2000.

Sampling and testing procedures for this online supplement differ slightly from *Specifier Reports: Energy-Efficient Ceiling-Mounted Residential Luminaires*. For this supplement, NLPIP

- tested only ENERGY STAR labeled products;
- purchased three samples of each product from online retail sources and retail stores in eastern New York State, choosing stores that had the products available and were scattered over a wide geographical area;
- had all absolute photometric and electrical testing performed at Luminaire Testing Laboratory, Inc. (LTL), an independent testing laboratory in Allentown, Pennsylvania.

The simulated application analyses included in the original *Specifier Reports: Energy-Efficient Ceiling-Mounted Residential Luminaires* were not performed for this product grouping. Products tested for this online supplement were added to the NLPIP website in June 2000.

Table 1. Manufacturer-Supplied Data: Residential Luminaires

Manufacturer	Catalog Number	Lamp Quantity and Type	Dimensions (in.)	Shape	Diffuser Material	Trim Option	Photometric Report	Suggested Retail Price (US $)
Brownlee Lighting	Whitney 2025	CFQ13T4	10.4	dome	clear ribbed glass	polished brass	N	NS
	Andrew 2140	CFQ13T4	13	dome	clear ribbed glass	polished brass or painted finishes	N	NS
Good Earth Lighting	Sparta G4902-PB-1	FC9T9	15	dome	frosted glass	polished brass	N	NS
	DuBois G4922-WH-1	FC9T9	15	dome	frosted swirl ribbed glass	gloss white	N	NS
	La Scala G4932-NK-1	FC9T9	14.5	dome	frosted swirl ribbed glass	polished nickel	N	NS
	Terrazzo G4942-WH-1	FC9T9	14.5	dome	textured white glass	gloss white	N	NS
Lights of America	Simplicity 4010	FC9T9	14	dome	white polycarbonate wraparound	white	N	NS
	Elegance 4022	FC6T9	11	dome	white polycarbonate wraparound	polished brass	N	NS
	Elegance 4026	FC9T9	14	dome	white polycarbonate wraparound	white	N	NS
	Elegance 4027	FC9T9	14	dome	white polycarbonate wraparound	polished brass	N	NS
	Sophistication 4035	FC9T9	14	dome	white ribbed polycarbonate	polished brass	N	NS
	Grandeur 4040	FC9T9	14	dome	fluted and prismatic polycarbonate	polished brass	N	NS

Table 2. NLPIP Evaluations: Performance Data for All Luminaires

Manufacturer	Catalog Number	Lamp Quantity and Type	Rated Lamp Power (W)	Ballast	Ballast Type	Active Power (W)	Power Factor	THD (%)	Measured Light Output from Lamps (lm)	Ballast Factor	Light Output from Luminaire (lm)	Luminaire Efficiency (%)	Luminaire Efficacy (LPW)
Brownlee Lighting	Whitney 2025	CFQ13T4	26	Brownlee IG 13CP	electronic	28.3	0.75	83	1160	NS	581	50.1	21
	Andrew 2140	CFQ13T4	26	Brownlee IG 13CP	electronic	29.4	0.45	13	1224	NS	664	54.2	23
Good Earth Lighting	Sparta G4902-PB-1	FC9T9	30	Good Earth Lighting EB-1C30-1-TP-EOL-GEL	electronic	27.2	>0.95	25	1476	NS	626	42.4	23
	DuBois G4922-WH-1	FC9T9	30	Good Earth Lighting EB-1C30-1-TP-EOL-GEL	electronic	27.9	>0.95	24	1529	NS	533	34.9	19
	La Scala G4932-NK-1	FC9T9	30	Good Earth Lighting EB-1C30-1-TP-EOL-GEL	electronic	27.3	>0.95	23	1531	NS	575	37.6	21
	Terrazzo G4942-WH-1	FC9T9	30	Good Earth Lighting EB-1C30-1T-EOL-GEL	electronic	26.1	>0.95	23	1578	NS	640	40.6	25
Lights of America	Simplicity 4010	FC9T9	30	Lights of America 2995	electronic	23.9	0.49	169	1692	NS	1038	61.3	43
	Elegance 4022	FC6T9	20	Lights of America 2995	electronic	17.8	0.44	196	1232	NS	677	55.0	38
	Elegance 4026	FC9T9	30	Lights of America 2995	electronic	24.2	0.51	158	1774	NS	1132	63.8	47
	Elegance 4027	FC9T9	30	Lights of America 2995	electronic	22.6	0.44	189	1653	NS	1023	61.9	45
	Sophistication 4035	FC9T9	30	Lights of America 2995	electronic	21.8	>0.95	171	1432	NS	818	57.1	38
	Grandeur 4040	FC9T9	30	Lights of America 2995	electronic	22.9	0.49	168	1626	NS	940	57.8	41

Table 3. Contact Information

Manufacturer	Phone	Fax	Web Site
Brownlee Lighting	800-318-6768	800-662-6768	www.brownlee.com
Good Earth Lighting	847-808-1133	847-808-0838	NA
Lights of America	800-321-8100	909-594-6758	www.lightsofamerica.com