Lighting*Answers*

T5FT Lamps and Ballasts

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NATIONAL LIGHTING PRODUCT INFORMATION PROGRAM

Introduction

Introduced to the U.S. market in the early 1980s, T5FT fluorescent lamps (twin-tube lamps with 5/8 -in. diameter tubes; see the sidebar "T5FT nomenclature" on p. 2 and Figure 1 below) are designed to produce maximum light output at higher ambient temperatures than linear or U-bend fluorescent lamps. T5FT lamps are distinguished by their shape and high light output compared to compact fluorescent lamps (CFLs) and linear fluorescent lamps. Ballast compatibility and potential glare are the greatest concerns for specifiers considering the use of T5FT lamps.

The shortest T5FT lamps [10.5 in. (27 cm)] are suitable for use in exit signs, task lights, and wall sconces. The longest T5FT lamps [22.5 in. (57 cm)] are suitable for 2- by 2-ft (2′×2′) luminaires and signs. In these applications, T5FT lamps are an alternative to incandescent, other fluorescent, or metal halide lamps.

Controlling light distribution is easier with T5FT lamps than with linear and U-bend lamps because the T5FT lamp has a narrower diameter. The lamps themselves also block less of the light from exiting the luminaire. Therefore, the T5FT's diameter allows luminaire designers to improve *luminaire efficiency*,* so more light exits the luminaire.

The National Lighting Product Information Program (NLPIP) prepared this issue of *Lighting Answers* to help specifiers better understand the advantages and disadvantages of T5FT lamps and ballasts so that they can specify and use the lamps in suitable applications.

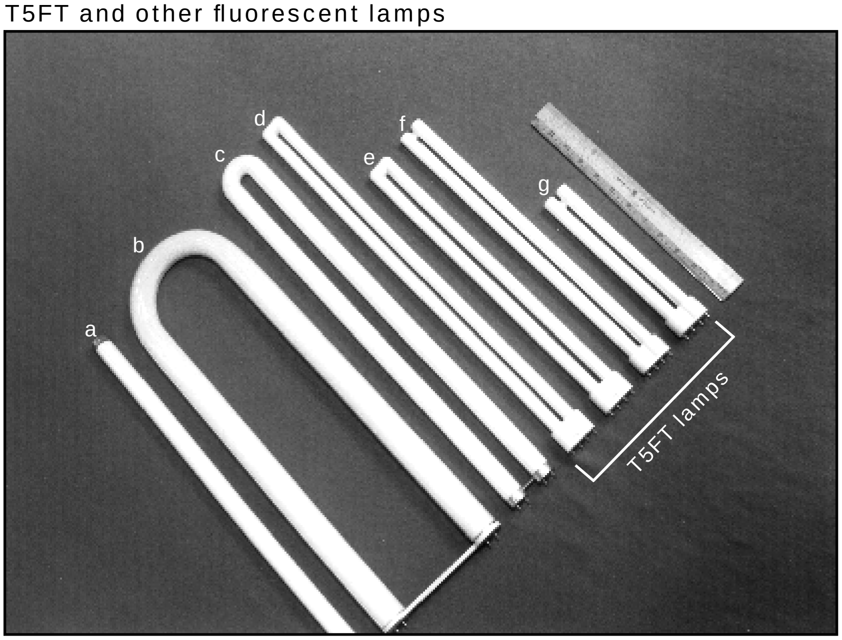
Abbreviations and units of measure used in this report

- C = Celsius
- cm = centimeter
- F = Fahrenheit
- ft = foot
- h = hour
- in. = inch
- Hz = hertz
- K = Kelvin
- kHz = kilohertz
- lm = *lumen*
- LPW = lumens per watt
- mA = milliampere
- ms = millisecond
- W = watt

* Terms in *italics* are defined in the glossary on p. 7.

Figure 1

T5FT and other fluorescent lamps



Donna Abbott Vlahos

Lamps shown are:
- a F32T8
- b FB40T12
- c FB31T8
- d T5FT40W
- e T5FT36/39W
- f T5FT36/39W
- g T5FT18W

A 12-in. (30.5 cm) ruler is shown to indicate scale.

Who manufactures T5FT lamps?

The major North American manufacturers of T5FT lamps are GE Lighting (phone 216-266-2121) under the BIAX trade name; OSRAM SYLVANIA, INC. (508-777-1900) under the DULUX L trade name; and Philips Lighting (908-563-3000) under the PL Long Fluorescent trade name.

Where should specifiers consider using T5FT lamps?

The best applications for T5FT lamps are those that exploit the characteristics that make T5FTs different from other lamps: their size, shape, thermal performance, and relatively high light output. Specifiers should consider using T5FT lamps in indirect lighting applications such as coves and suspended luminaires, concealed behind the translucent panels of signs, in recessed ceiling luminaires with deep parabolic louvers, in spaces with high ceilings, or in task lights where they are obscured by lenses, reflectors, or shelves. Some general lighting and task lighting luminaires are designed specifically for T5FT lamps. Table 1 shows popular luminaire types for various sizes of T5FT lamps.

How can specifiers address potential glare from T5FT lamps?

T5FT lamps are a potential source of glare because they are brighter (higher *luminances*) than other fluorescent lamps, including T8 and T12 straight and U-bend lamps. NLPIP recommends that specifiers assess the potential for glare from T5FT lamps by viewing luminaires in a mock-up.

When a T5FT lamp is hidden from direct view, such as in a luminaire for indirect lighting or in a luminaire with a lens, its brightness is not a concern. However, T5FT lamps are sometimes used in recessed luminaires with parabolic louvers, where the lamp can be seen from below. Although the louvers are designed to block the view of the lamps from many viewing angles, surface brightness can still cause glare to someone beneath the luminaire.

How does ambient temperature affect the performance of a T5FT lamp?

Most linear and U-bend fluorescent lamps produce maximum light output at an ambient temperature of 77° F (25° C). However, lamps inside recessed ceiling luminaires or in small enclosed luminaires often operate in ambient temperatures higher than 77° F. T5FT lamps produce maximum light output in ambient temperatures close to 90° F (32° C) and so are better suited for use in these luminaires. In fact, as shown in Figure 2 on p. 3, T5FT lamps produce more than their rated light output in warmer ambient temperatures because rated light output is based on lamp operation at 77° F.

Figure 2 compares how ambient temperature affects relative light output for T5FT40W and T12/U lamps.

Table 1

Luminaires for T5FT lamps

NEMA Lamp Designation	Luminaires
T5FT18W	exit signs, 1´ × 1´ luminaires, task lights, wall sconces, surface-mounted luminaires for home use
T5FT24/27W	task lights, wall sconces, surface-mounted luminaires for home and institutional use
T5FT36/39W	2´ × 2´ and 1´× 2´ luminaires, under-shelf task lights, pendant uplights, wall sconces
T5FT40W T5FT50W T5FT55W	2´ × 2´ luminaires, under-shelf task lights, strip lights (for coves), signs, wall-wash systems, pendant uplights, wall-bracket uplights, torchieres

T5FT nomenclature

The National Electrical Manufacturers Association (NEMA) maintains a standard lamp nomenclature system. In this system T5FT lamps are classified as compact fluorescent lamps because their lamp tube diameter is $^5/_8$ in. In the T5FT designation, the first *T* stands for tubular, *5* means the lamp tube is $^5/_8$ in., or 0.63 in. (1.59 cm) in diameter, *F* is for fluorescent, and the last *T* stands for twin-tube. In most cases, the lamp wattage and, optionally, descriptors of the phosphor type (RE for *rare-earth phosphors*) and the lamp base type follow the lamp type designation. All T5FT lamps presently manufactured include rare-earth phosphors and a 2G11 base, so descriptors for these are not usually included. For example, a 40-W T5FT lamp is called *T5FT40W*.

For some T5FT lamps, lamp wattage varies depending on the starting method used by the ballast. Compared to preheat ballasts, rapid-start ballasts require an extra 3 W for lamp-electrode heating during operation. The designations for these lamps may include both the lower and higher lamp wattages; for example, T5FT24/27W or T5FT36/39W.

Within the lighting industry, T5FT lamps are also referred to as long compact fluorescent lamps, long twin-tube fluorescent lamps, high-lumen compact fluorescent lamps, or high-lumen twin-tube fluorescent lamps.

One study (Hammer 1988) compared the in-luminaire performance of T5FT40W lamps with two U-bend lamp types: FB31T8 and FB40T12 lamps. All three lamp types were tested in both two-lamp and three-lamp 2´×2´ luminaires with parabolic louvers and prismatic lenses. With all three lamp types using electronic ballasts, the T5FT luminaires had an average of 13% greater system *efficacy* (in LPW) than the T8 luminaires and 30% greater LPW than the T12 luminaires.

Figure 2

Relative light output vs. ambient temperature for T5FT and T12 U-bend fluorescent lamps

Adapted from GE Lighting 1990

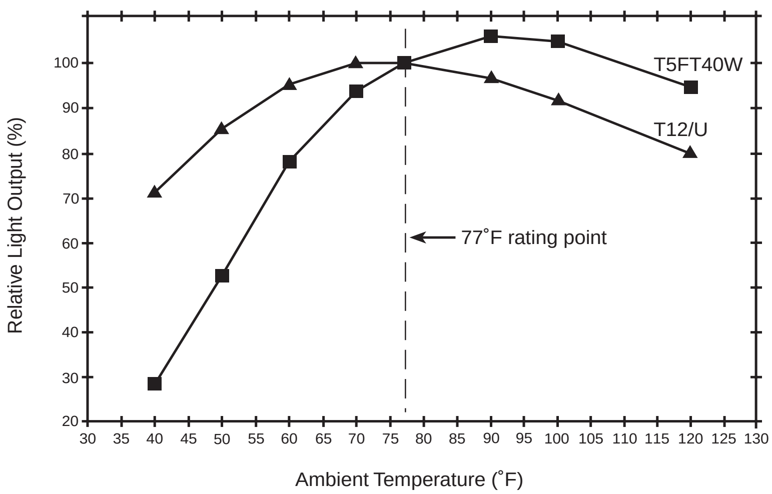


Table 2

Ballast availability for T5FT lamps

	Magnetic Ballasts		Electronic Ballasts		
NEMA Lamp Designation	Preheat	Rapid-Start	Rapid-Start	Instant-Start	Dimming
T5FT18W	●	●	●	●	
T5FT24/27W	●	●	●	●	
T5FT36/39W	●	●	●	●	●
T5FT40W		●	●	●	●
T5FT50W		●	●	●	●
T5FT55W				●	

●=available

Compiled in December 1995 from catalogs from the following ballast manufacturers: Advance Transformer Co. (phone 708-390-5000); ETTA Industries, Inc. (303-444-2244); MagneTek (800-225-5278); Motorola Lighting, Inc. (800-654-0089); OSRAM SYLVANIA, INC. (508-777-1900); Robertson Transformer Co. (800-323-5633); Valmont Electric (800-533-7290).

What types of ballasts are available for T5FT lamps?

Advance Transformer Co., MagneTek, Robertson Transformer Co., and Valmont Electric are the major North American manufacturers of magnetic ballasts for T5FT lamps. Most magnetic ballasts for T5FT lamps are designed specifically for use with these lamps.

The same four companies and ETTA Industries, Motorola Lighting, Inc., and OSRAM SYLVANIA, INC. offer electronic ballasts for T5FT lamps. Some manufacturers offer ballasts designed specifically for T5FT lamps, but most manufacturers suggest using ballasts that will also operate T12 or T8 lamps.

Dimming electronic ballasts are also available for the 36/39-, 40- and 50-W versions of T5FT lamps. Again, some manufacturers offer dimming electronic ballasts designed specifically for T5FT lamps, while others recommend using ballasts that will also operate T12 or T8 lamps. Table 2 shows the availability of ballasts for T5FT lamps.

What should specifiers consider when choosing ballasts for T5FT lamps?

The specifier must choose either a magnetic or electronic ballast. Electronic ballasts offer greater lamp efficacy than magnetic ballasts, but are more expensive. As with other fluorescent lamps, the high-frequency (20 kHz or greater) operation of most electronic ballasts increases T5FT lamp efficacy by approximately 10% relative to the 60 Hz operation of magnetic ballasts. High-frequency electronic ballasts also produce less noise, heat, and flicker than magnetic ballasts. See *Specifier Reports: Electronic Ballasts* for more information on electronic ballasts.

Depending on lamp wattage, specifiers can choose T5FT lamps in preheat, rapid-start, and instant-start versions. Specifiers must also choose a ballast with an appropriate starting circuit (preheat, rapid-start, or instant-start) for the lamp type. For best performance the ballast starting circuit should match the lamp type; for example, a rapid-start ballast should be used with a rapid-start lamp.

Preheat. Although preheat ballasts are becoming outdated, they are relatively inexpensive. Some kinds of luminaires, particularly task lights, have preheat ballasts built into them. Preheat starting is usually characterized by the lamp flashing on and off a few times before operating.

Rapid-start. Rapid-start ballasts heat the lamp's electrodes before starting the lamp, and usually continue to heat the electrodes while the lamp is operating. As a result, rapid-start ballasts require 3 W of additional power per lamp during operation, relative to preheat or instant-start ballasts. Lamp life may be longer than with an instant-start ballast.

Instant-start. Many electronic ballasts use the instant-start method. With this method, the lamp's electrodes are not heated prior to starting so a higher initial voltage is required to start the lamp. Although some rapid-start T5FT lamps will operate with instant-start ballasts, the ballasts may reduce lamp life, especially if the lamps are switched frequently. Also, not all instant-start electronic ballasts have a shut-off circuit that prevents repeated start attempts once the lamp has failed (see the sidebar "Shut-off circuits"). NLPIP recommends using only instant-start electronic ballasts with shut-off circuits with T5FT lamps. Specifiers should check with the manufacturer to determine if the ballast has a shut-off circuit.

Lamp manufacturers claim that many T5FT lamps will also operate on alternative ballast types. For example, most preheat T5FT lamps will operate on rapid-start ballasts, and many rapid-start T5FT lamps will operate on instant-start ballasts. However, ballast type can affect lamp power, light output, efficacy and lamp life.

The lamp-ballast system must also meet the application's requirements for:

- *active power*
- *ballast factor (BF)*
- light output
- system efficacy
- minimum starting temperature
- *power factor (PF)*

Shut-off circuits

For small-diameter fluorescent lamps such as T5FT lamps, very high temperatures can develop on the lamp tube around the electrodes toward the end of the lamp's useful life. When the lamp fails, the ballast may still deliver voltage and current in an attempt to start and operate the lamp. This high voltage and current increases the temperature near the electrode, particularly when delivered by an instant-start ballast. Temperatures can reach as high as 660° F (350° C) at the lamp tube, cracking or melting the lamp tube and damaging the lamp base, socket, or other luminaire components. A circuit that shuts off the starting voltage when the lamp has failed prevents this problem. Some lamp manufacturers suggest that ballast manufacturers include a shut-off circuit in all electronic ballasts. Members of NEMA are discussing the issue, but have yet to reach a resolution.

Table 3 compares the performance of T5FT lamps with different types of ballasts. Note that ballast factor (BF) ranges widely from 0.69 to 0.97, and that system efficacy is consistently higher with electronic ballasts than with magnetic ballasts.

Both fluorescent lamps and ballasts have rated minimum starting temperatures. Specifiers should expect the combined lamp-ballast system to perform only at the higher of these two temperatures. For example, a system consisting of a lamp rated for starting at 50° F (10° C) and a ballast rated for starting at 32° F (0° C) will start reliably only at temperatures above 50° F. Specifiers should check with lamp and ballast manufacturers to see that the products meet the temperature requirements of the installation, especially for outdoor applications.

Finally, the specifier should consider American National Standards Institute (ANSI) standards for *glow current*, *preheat time*, lamp current, lamp *current crest factor* (CCF), and current *total harmonic distortion* (THD) (ANSI 1993). Table 4 on p. 6 gives the values from ANSI to reach rated lamp life. Lamp manufacturers will not honor a lamp's warranties if the ballast does not meet ANSI standards. All ballasts certified by the Certified Ballast Manufacturers (CBM) comply with ANSI standards.

Some ballasts that are claimed to operate both linear and T5FT fluorescent lamps are CBM-certified for linear fluorescent lamp types, but may not meet ANSI standards for T5FT lamps. If a ballast is not certified for T5FT lamps, specifiers should consult with the manufacturer to determine whether the ballast meets ANSI standards in a T5FT lamp-ballast system.

In addition, many electric utilities' incentive programs require the use of ballasts with current THD less than 20% and power factor of 0.9 or greater.

Table 3

System performance of fluorescent lamps and ballasts

NEMA Lamp Designation	Ballast Type[a]	Active Power (W)	Ballast Factor	Light Output (lm)	System Efficacy (LPW)
T5FT18W/PH	Magnetic PH	22	0.90	1125	51
T5FT18W/RS	Magnetic RS	23	0.90	1125	49
	Electronic IS	17	0.95	1199	70
T5FT24W	Magnetic RS	32	0.925	1665	52
	Electronic IS	21	0.81	1458	69
T5FT39W	Magnetic RS	51	0.925	2682	53
	Electronic IS	26	0.69	2001	77
T5FT40W	Magnetic RS	43	0.93	2930	68
	Electronic RS	36	0.83	2615	73
T5FT50W	Electronic IS	54	0.97	3880	72
T5FT55W	Electronic IS	62	0.97	4656	75
F32T8 (2 lamps)	Magnetic RS	70	0.94	5452	78
	Electronic IS	63	0.95	5510	87
F40T12 (2 lamps)	Magnetic RS	88	0.94	6016	68
	Electronic RS	72	0.88	5632	78
CFT13W	Electronic IS	17	1.00	900	53
CFQ18W	Electronic IS	25	1.00	1250	50
CFQ26W	Electronic IS	37	1.00	1800	49

[a]PH=Preheat, RS=Rapid-start, IS=Instant-start

The data for linear T8 and T12 lamps and compact fluorescent twin-tube (CFT) and compact fluorescent quad-tube (CFQ) lamps are included for comparison. The T8 and T12 lamps are RE70 rare-earth phosphor lamps. The data for T5FT, CFT, and CFQ lamps are based on one ballast operating each lamp type; the data for T8 and T12 lamps are based on one ballast operating two lamps. All data are based on bare-lamp operation in open air at 77° F (25° C), as per ANSI C82.2. This temperature is below the optimum temperature for T5FT lamps; light output and efficacy for T5FT lamps should increase at higher temperatures up to 90° F (32° C). The data for T5FT, T12, and T8 lamps are from independent evaluations. The data for CFT and CFQ lamps are based on manufacturer's ratings.

(Adapted from California Energy Commission 1993.)

How do T5FT lamps rate on life, color characteristics, and lumen depreciation?

Life. The life of a T5FT lamp ranges from 10,000 to 20,000 h, depending on the type of lamp and the type of starting circuit. Typical CFL life is 10,000 to 12,000 h and U-shaped fluorescent lamp life is 15,000 to 20,000 h. Fluorescent lamp life is determined by the number of operating hours until 50% of a large sample of lamps fails, when operated on a 3-hours-on-20-minutes-off cycle.

Color. T5FT lamps have high *color rendering index* (CRI) values because, like T8 and some T12 lamps, they use rare-earth phosphors. According to manufacturer's data, T5FT lamps are available with CRI values ranging from 82 to 85 and *correlated color temperatures* (CCTs) of 2700, 3000, 3500, 4100, and 5000 K.

Lamp lumen depreciation. As lamps age, their light output gradually declines in a process called lamp lumen depreciation. Rare-earth phosphors depreciate more slowly than the halophosphors that were formerly used in some fluorescent lamp types.

How do the prices of T5FT lamps compare with other fluorescent lamps?

T5FT lamp prices compare favorably with those for U-bend lamps, though they are more expensive than linear fluorescent lamps. NLPIP obtained typical lamp prices (see Table 5). Prices vary, so specifiers should consult lamp suppliers for accurate price estimates.

Table 4

Some ANSI standards for lamp-ballast systems

Ballast Characteristic	ANSI C82.11 Standard for High-Frequency Fluorescent Lamp Ballasts
Glow current (for rapid-start)	25 mA maximum (average value of root-mean-square [rms] glow current)
Preheat time (for rapid-start)	500 ms minimum, or equal to or greater than 90% of the preheat time of a comparable rapid-start magnetic ballast
Lamp current	Maximum 107.5% of lamp manufacturer's rating
Current crest factor	Maximum 1.7 (for electronic ballasts made in the United States after January 1, 1995)
Current total harmonic distortion	Maximum 32% for electronic ballasts

Table 5

Typical fluorescent lamp prices

Lamp Type	NEMA Lamp Designation	Cost
T5FT	T5FT18W	$13.00
	T5FT24/27W	$13.50
	T5FT36/39W	$14.50
	T5FT40W	$14.50
U-bend	FB31T8/RE	$18.50
	FB40T12/RE	$16.50
	FB40T12/CW	$10.50
Linear	F32T8/RE	$2.40
	F40T12/RE	$2.75

Information is based on quotes from distributors in Albany, New York, in September 1995.

Linear T5 lamps

Manufacturers introduced linear T5 lamps at lighting trade shows in 1995. They are metric lamps, which are slightly shorter than U.S.–standard linear fluorescent lamps, although they are listed with 2-, 3-, 4-, and 5-ft lengths in manufacturers' catalogs. Presently only a few ballasts and luminaires are available for linear T5 lamps, but they are becoming increasingly popular because of their high efficacies and small diameters.

Glossary

active power The system input power in watts for a lamp and ballast combination.

ballast factor (BF) The ratio of the light output of a fluorescent lamp(s) operated on a ballast to the light output of the lamp(s) operated on a standard (reference) ballast. BF is dependent upon both the ballast and the lamp type; a single ballast can have several BFs, depending on the type and number of lamps that it is operating. Accordingly, the BFs for different ballasts should only be compared if the ballasts are operating the same type and number of lamps.

color rendering index (CRI) A measure of the consistency with which a light source of a particular CCT renders different colors compared with a reference light source of the same CCT. The highest CRI attainable is 100.

correlated color temperature (CCT) A specification of the apparent color of a light source relative to the color appearance of a reference source, measured in degrees Kelvin (K). The CCT rating for a lamp is a general indication of the "warmth" or "coolness" of its appearance. Lamps with a CCT rating below 3200 K are usually considered "warm" sources, whereas those with a CCT above 4000 K are usually considered "cool" in appearance.

current crest factor (CCF) The peak current divided by the root-mean-square (rms) current. CCF may range from one to infinity. The CCF of a sine wave is 1.41. A high lamp CCF indicates that the current wave shape has high peaks that can reduce lamp life, whereas a lower lamp CCF indicates a smoother current wave shape.

efficacy The ratio of light output (in lumens) to active power (in watts), expressed in lumens per watt (LPW).

glow current The flow of electrons away from a rapid-start lamp's electrodes during preheating. The higher the glow current, the faster the electrodes' emissive coating degrades, increasing lamp-end darkening and reducing lamp life.

lumen (lm) A unit measurement of the rate at which a lamp produces light. A lamp's light output rating expresses the total amount of light emitted in all directions per unit time. Ratings of initial light output provided by manufacturers express the total light output after 100 h of operation.

luminance The photometric quantity most closely associated with the perception of brightness, measured in units of luminous intensity (candelas) per unit area (ft^2 or m^2).

luminaire efficiency The ratio of the light output of a luminaire to the light output of the same lamp-ballast combination without the luminaire. Luminaire efficiency accounts for the optical and thermal effects that occur within the luminaire under standard test conditions.

power factor (PF) A measure of how effectively an electric load converts power into useful work. Power factor is the ratio of active power to the product of rms voltage and rms current.

preheat time For rapid-start lamps, the time from the onset of lamp current to the lamp arc's striking, during which the lamp electrodes are heated to ease starting.

rare-earth phosphors A group of phosphors containing rare-earth elements, used in fluorescent lamps to achieve high efficacy, good color rendering, and low lamp lumen depreciation.

total harmonic distortion (THD) For a current or voltage wave, the ratio of the wave's harmonic content to its fundamental component, expressed as a percentage. Also called "harmonic factor," it is a measure of the extent to which a waveform is distorted by harmonics, which are multiples of the fundamental frequency. High current THD can create distortion in the line voltage, which could interfere with the operation of other electrical equipment.

Resources

American National Standards Institute. 1993. *High-Frequency Fluorescent Lamp Ballasts*, ANSI C82.11-1993. New York, NY: American National Standards Institute.

American National Standards Institute. 1984. *American National Standard for Fluorescent Lamp Ballasts: Methods of Measurement*, ANSI C82.2-1984. New York, NY: American National Standards Institute.

California Energy Commission. 1993. *Advanced Lighting Guidelines.* Sacramento, CA: California Energy Commission.

GE Lighting. 1990. *Biaxial Fluorescent Lamps.* Nela Park, OH: GE Lighting.

Hammer, E. E. 1988. Comparison of Bent Tube Fluorescent Lamps in a 2×2 ft Luminaire. *Journal of the Illuminating Engineering Society.* 20(1):56-63.

Illuminating Engineering Society of North America. 1993. *Lighting Handbook: Reference and Application.* M. Rea, ed. New York, NY: Illuminating Engineering Society of North America.

Ji, Y., and R. G. Davis. 1994. *Fluorescent Lamp/Ballast Compatibility.* Troy, NY: Lighting Research Center, Rensselaer Polytechnic Institute.

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Principle Investigator: Yunfen Ji
Technical Writers: Michael Klein, Robert Wolsey
Program Director: Robert Davis
Editor: Claudia Hunter
Production Manager: James Gross

Other Lighting Research Center members who contributed include Joseph Ceterski, Kathryn Conway, Amy Fowler, Kevin Heslin, Russell Leslie, Dorene Maniccia, Wendy McCandless, Naomi Miller, Mark Rea, and Pamela Schemenaur.

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For publications ordering information, contact:
Lighting Research Center
Rensselaer Polytechnic Institute
Troy, NY 12180-3590
Telephone: (518) 276-8716
Fax: (518) 276-2999
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Lighting Answers complements the National Lighting Product Information Program's (NLPIP) other serial, *Specifier Reports*. Each issue of *Lighting Answers* presents educational information about a specific topic or a particular technology. For some issues, NLPIP may perform limited testing. For this issue of *Lighting Answers*, NLPIP has summarized information about T5FT fluorescent lamps and compatible ballasts.

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