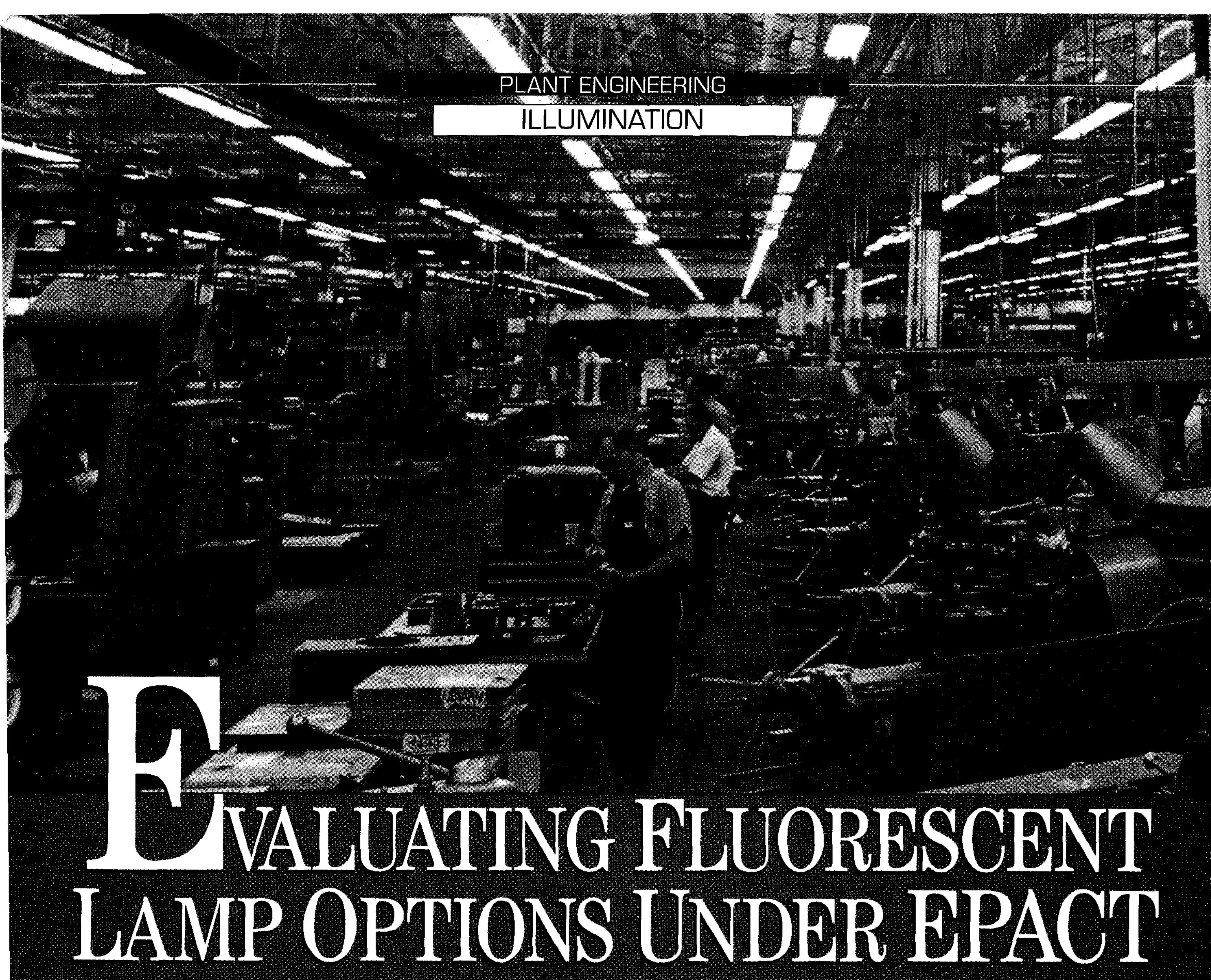

EVALUATING FLUORESCENT LAMP OPTIONS UNDER EPACT

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The 1992 Energy Policy Act will eliminate many types of fluorescent lamps now in common use, but there are some excellent choices still left

The National Energy Policy Act (EPACT) became law in October 1992. This far-reaching legislation sweeps the full spectrum of energy use in all forms, prescribing minimum efficiency standards for energy-consuming products. Notable among the products covered under EPACT are general-purpose fluorescent lamps commonly used to illuminate manufacturing, storage, laboratory, and office areas of industrial plants.

Some specialty fluorescent lamp categories are exempt from the provisions of EPACT. Included in this specialty group are plant-growth, reflectorized or aperture, colored, reprographic, cold-temperature, and impact-resistant lamps.

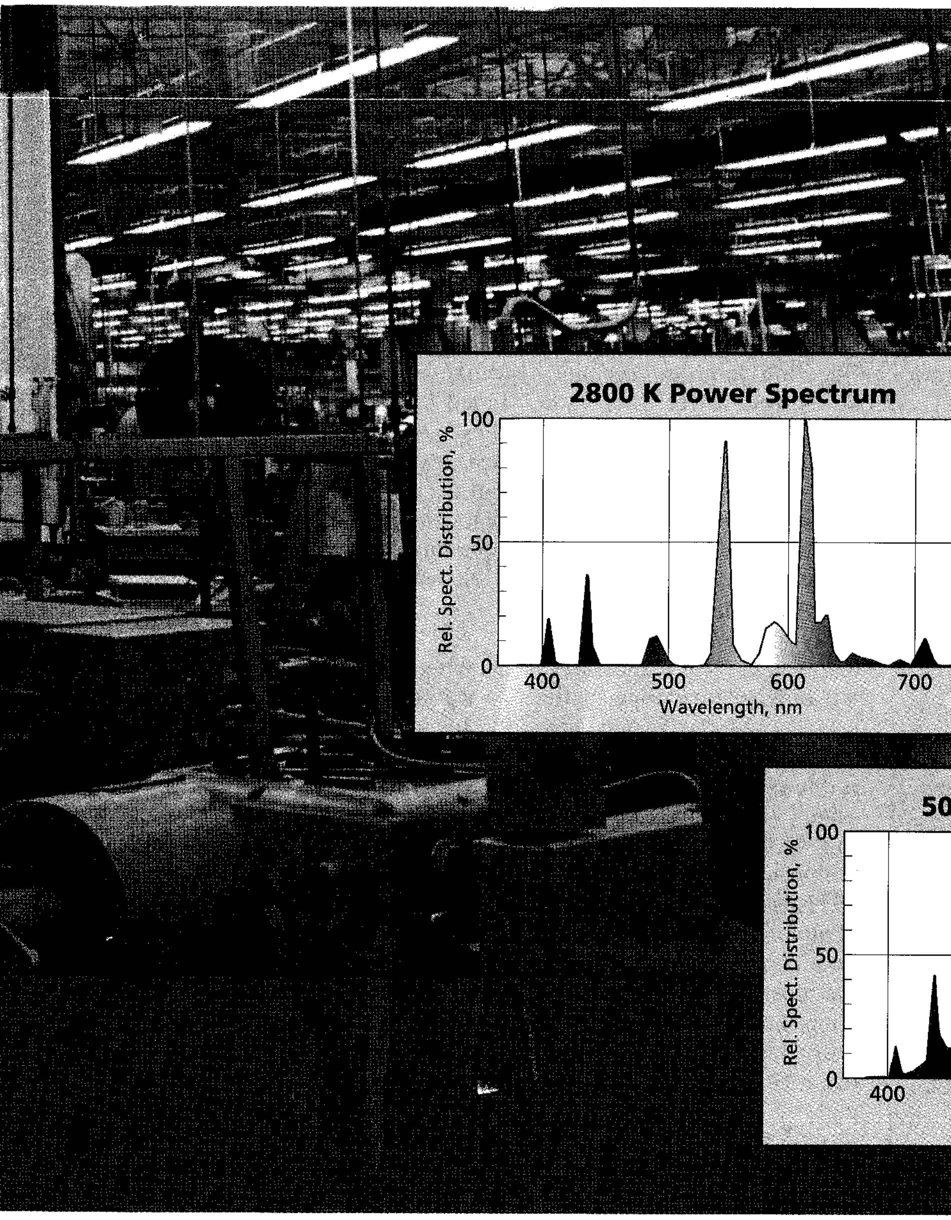
EPACT decrees moratorium dates on the manufacture of many types of lamps in common use in plants today. Lamps proscribed by EPACT, and their effective manufacturing cutoff dates, are given in the accompanying section, "Fluorescent Lamps Outlawed Under EPACT." Noncomplying lamps, however, are permitted to remain in service, and can continue to be sold until stock is depleted.

Terminology

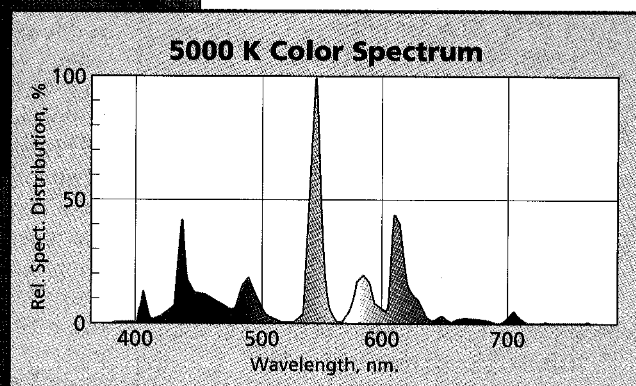
In conventional illuminating engineering parlance, lamp energy-to-light conversion efficiency is actually referred to as *efficacy*, with the term *efficiency* reserved for the percentage of light that leaves the luminaire. Lamp efficacy is defined as lumens of light output per watt of energy input (lumens per watt, or LPW).

Raw lumens emitted by the lamp, however, fall quite short of defining how a typical human eye responds to light. The term *vision* describes a function unique to a given set of eyes. The term *seeability* is used to describe the factors external to the eye that affect vision.

Illumination level — as measured



Color cannot be perceived in the viewing task unless the color itself is present in the spectral distribution of the light source. Source spectrum at left yields a CRI of 84; gaps in the blue/green portion of the spectrum affect shades of these colors. Improved spectrum below yields a CRI of 88. (Courtesy Panasonic Lighting Products)



National Energy Policy Act of 1992 puts an end to manufacture of many types of fluorescent lamps in common use in manufacturing plants today. (Courtesy Philips Lighting Co.)

in raw footcandles by a light meter — is only one of several criteria that affect seeability. Light source color balance is also an important constituent among the numerous seeability factors, with different colors stimulating the eye's receptors to differing degrees. The measure applied to a lamp's ability to render the seeing task in its true colors is its *color rendering index*, or CRI.

Color and the Law

A long-standing illuminating engineering rule-of-thumb generalizes that the better the light source color, the lower its LPW efficacy. This precept has diminished in validity because of recent developments in fluorescent lamp technology. EPACT also requires that a lamp's LPW efficacy be correlated with its CRI (see section "EPACT Criteria for Permissible Lamps").

Rationale for the EPACT CRI requirement is that in well-color-balanced light, objects are better perceived at lower light levels, and this factor is applied to reduce energy consumption. But while EPACT is ostensibly concerned only with energy efficiency, plant engineers can enhance *economic* efficiency of their lighting systems by selecting lamps that enhance seeability via improved CRI (see section "Lamp Price vs Value").

Efficacy and Color Comparison

Although quite different from "natural" daylight, incandescent sets the color-rendition standard to which all artificial light sources are compared. Incandescent lighting is assigned a "perfect" CRI of 100. On the other side of the coin, incandescent has the lowest efficacy of any electric light source. Incandescent lamp efficacy ranges from less than 10 LPW for 15-W lamps to about 23 LPW in the 1000-W size.

In comparison, standard, clear, high-pressure sodium lamps have a CRI of about 22 and efficacies ranging from 60 LPW through 140 LPW spanning the size range from 35 through 1000 W.

The most energy-efficient artificial light source available is low-pressure sodium (LPS), with an efficacy of more than 180 LPW in the 180-W size. LPS, however, emits all of its light in a very narrow yellow segment of the light spectrum. The manner in which CRI is calculated actually yields a negative CRI for LPS. Persons familiar with low-pressure sodium lighting recognize that seeability under a given light level produced by the phosphors that fluoresce in the presence of the electric arc, and their proximity to the arc stream that excites them to fluorescence. The result is optimum efficacy. The most seeability per lighting system operating dollar is realized with high-CRI, trichromatic phosphor, T8 lamps.

T8 lamps, however, cannot simply be substituted for T12 lamps in existing systems; T8 lamps do not operate in luminaires ballasted for T12. To switch from T12 to T8 lamps in existing systems, a ballast changeout is required. Such a retrofit, however, provides the opportunity to further enhance value received per dollar of lighting system operating cost.

Optimum economic life of a fluorescent lighting system is 15 to 20 yr. At this point, ballast failures proliferate. Depending on operating conditions, the system might be experiencing its second or third round of ballast replacements. And dirt accumulation on reflectors and lenses has often taken a considerable toll on luminaire efficiency. A retrofit to T8 provides an opportunity to combine ballast replacement and luminaire cleaning with only moderately more labor cost than if either function were undertaken separately.

Ideal candidates for retrofitting to T8 are systems still operating with the standard-efficiency ballasts of yesteryear. All ballasts manufactured today for 4-ft F40T12 and 8-ft slimline and high output lamps must meet minimum efficiency standards mandated by an amendment to the Energy Policy and Conservation Act of 1987.

Both electromagnetic and electronic ballasts manufactured today must satisfy the efficiency minimums dictated by the 1987 Energy Policy and Conservation Act. Any replacement of standard-efficiency ballasts must, therefore, result in reduced ballast losses.

Although the electromagnetic types manufactured today meet the minimum efficiency requirements, maximum efficiency is attained with the electronic types. And life expectancy of electronic ballasts is higher than for their high-efficiency electromagnetic counterparts. The ultimate fluorescent system upgrade is, therefore, a retrofit that combines electronic ballasting with high-CRI T8 lamps.

The help of Joe Booker, Product Manager, Lamps and Ballasts, W.W. Grainger, Inc., in preparing this article is greatly appreciated. ❑

Fluorescent Lamp Sourcing Guide

PLANT ENGINEERING acknowledges with appreciation these manufacturers who provided information for this article. *For more information on the fluorescent lamps they offer, circle the indicated numbers on the reader service card in this issue.*

Circle	Manufacturer
51	Duro-Test Lighting Corp., 9 Law Drive, Fairfield, NJ 07004
52	GE Lighting, Nela Park, Cleveland, OH 44112
53	Interlectric Corp., 1401 Lexington Ave., Warren, PA 16365
54	Osram Sylvania Inc., 100 Endicott St., Danvers, MA 01923
55	Panasonic Lighting Products, One Panasonic Way, Secaucus, NJ 07094
56	Philips Lighting Co., P.O. Box 6800, Somerset, NJ 08875-6800

Lamp Price vs Value

"But that lamp costs a lot more" is an argument often applied in defense of a "cheaper" lamp that might have lower efficacy, lower CRI, or both.

However, the purpose of a lighting system is not to simply keep a given number of lamps burning, nor is its role that of just delivering a specified footcandle level to the workplane. Purely and simply, the purpose of a lighting system is to enable people to see. And a lamp that enables people to see better often delivers the most value — even if its price is considerably higher. Indeed, raw price of the lamp is a virtually insignificant ingredient in the total cost of light.

A typical, 4-ft, 40-W fluorescent lamp has an average life of 20,000 burning hours. Life expectancy is based on three burning hours per start; life is extended with longer "on" intervals. In a five-day, one-shift operation with a 4-hr daily cleanup period, it takes somewhat more than 6½ yr to "use up" the lamp. At a typical energy rate of $0.08/kWh, the lamp devours more than $64 in energy during that time.

Energy generally accounts for about 86% of the life-cycle owning-and-operating cost of a lighting system, and lamp cost about 3%. If a lamp with better color rendition permits people to see equally well at a lower light level, fewer luminaires need be installed, fewer lamps incur labor and material costs for replacement, and less energy need be consumed over the life of the system. These facts can readily justify a far higher price for a better lamp.

For more information . . .
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