Data Sheet

Product Data Sheet 7750
August 1, 1991

GE Components
Marketing & Sales Operation

A wide variety of discharge colors can be produced in fluorescent lamps through chemical formulation or by blending two or more phosphors.

Utilizing Lamp Phosphors To Their Full Potential

Fluorescent lamp phosphors are available from GE in a full range of colors and types to meet fluorescent lighting needs around the world.

Phosphors are luminescent chemicals that are in many ways unique. Selecting and applying them for fluorescent lamp manufacturing requires an in-depth understanding of their particular characteristics.

As one of the world's leading producers of lighting products, GE is deeply involved in efforts to increase the lumen output and coating efficiency of these high purity inorganic compounds. At our Chemical Products Plant in Cleveland, phosphors are created by formulating and blending various chemical ingredients. Using certain minerals and rare earth elements as activators, we can meet stringent customer specifications for color matching and brightness.

Smaller Particles

Calcium halophosphors, the most common type used in fluorescent lighting, are now being produced by GE in significantly smaller particle sizes. Test results demonstrate that reduced particle size phosphors (RPS) allow decreases in lamp coatings by as much as twenty percent by weight. Of major importance is the fact that this has been achieved without the loss of lamp brightness. As a result, lamp producers are now using less than 5 grams of phosphor per standard four-foot T-12 lamp, a significant cost savings for an already economical method of lighting.

Improved coating appearance, better phosphor adherence and durability have also been observed using the RPS phosphors.

Specifying Phosphor Color

There are a variety of discharge color variations that are possible in the fluorescence of general purpose calcium halophosphate phosphors. They can be achieved by varying the Ca/Mn and F/Cl ratios, or by blending two or more phosphors.

XY Coordinates

The International Commission on Illumination (CIE) bases its color specifications on the concept that any color can be created by mixing varying portions of primaries red, green and blue. This is schematically represented by the CIE diagram (Figure 1) in which the points and edges are saturated colors ranging from red to green to blue. Moving toward the center blends the color until it ultimately becomes white. A specific color in the triangle is located by specifying the X and Y coordinates. This is the most accurate method of color specification.

Correlated Color Temperature

Although less precise, color temperature can be a useful method to verify other indicators. As a theoretical black body is heated, it changes color from red to yellow to white to blue. The color at any point can be described in terms of the absolute temperature measured in degrees Kelvin (°K). This "black body locus" is plotted on the color diagram in Figure 1.

When specifying lamp colors by correlated color temperature (CCT), it is possible to have two lamps with the same CCT that are quite different. One plotted above the black body locus line on the diagram might appear more green than the one below. CCT, therefore, is not as precise as using the X/Y coordinates.

Unfortunately, there is no "one best" method of specifying color. Each of the accepted methods leaves something to be desired, but each can be useful in the selection process.

General Purpose Phosphors

Calcium halophosphors are the standard or general purpose phosphors used in fluorescent light manufacture. Shown in their spectral power distribution curves in Figure 3, they are designed to attain maximum brightness when activated by 254 nanometer ultraviolet.

Selection among these five halophosphors is determined by color compatibility for a specific region.

Figure 1 – CIE Chromaticity Diagram

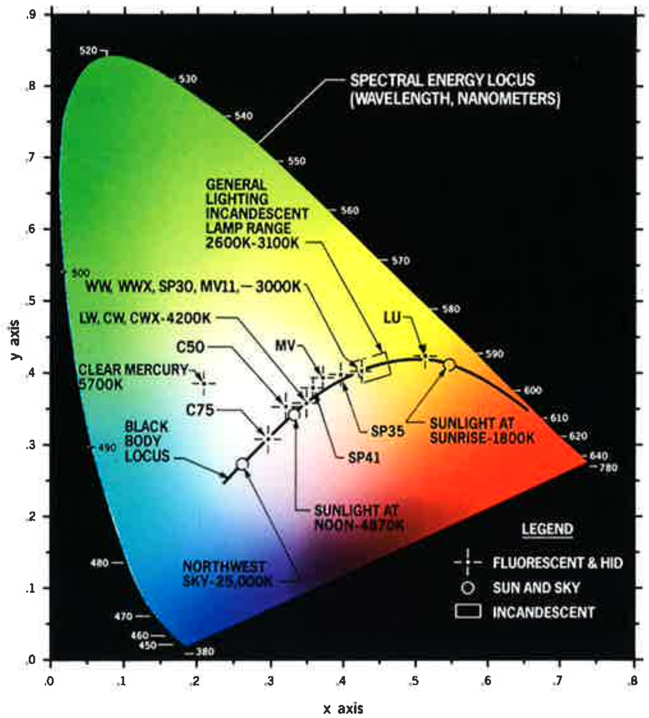
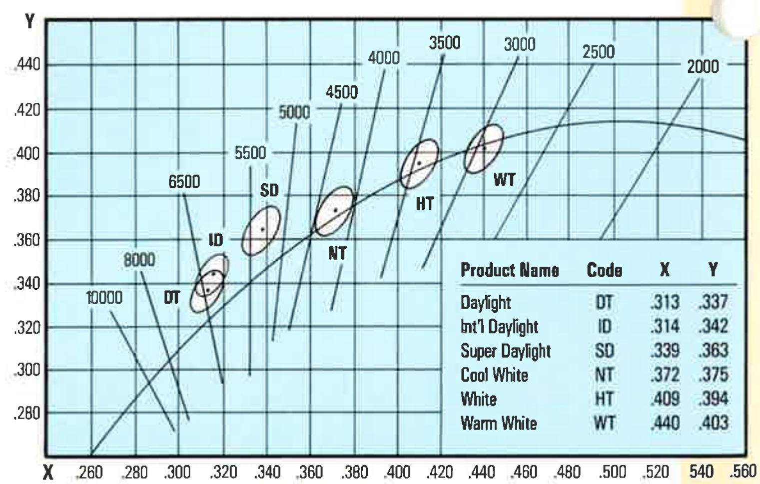


Figure 2 – Phosphor Color Specifications



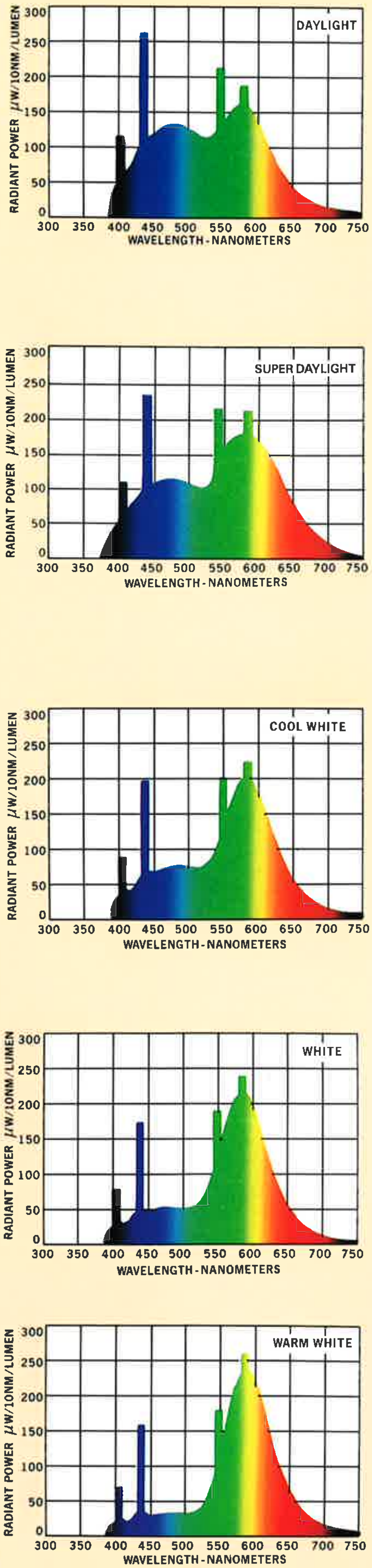
Product Name	Code	X	Y
Daylight	DT	.313	.337
Int'l Daylight	ID	.314	.342
Super Daylight	SD	.339	.363
Cool White	NT	.372	.375
White	HT	.409	.394
Warm White	WT	.440	.403

This schematic diagram provides a visual profile of the color characteristics of several GE phosphors. They show the radiant power emitted by the source at each wavelength or band of wavelengths over the visible region (360 to 720nm).

Daylight has color temperatures typical of daytime sunlight in tropical regions while **Cool White** matches daytime sunlight in the temperate regions. **Super Daylight** color is between daytime sunlight in tropical and temperate regions. **White** matches afternoon sunlight and **Warm White** simulates the color of evening sunlight.

Individual data sheets are available on all these phosphors.

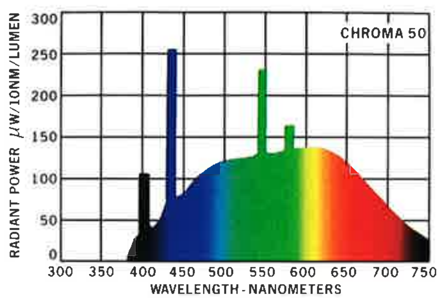
Figure 3



Strontium Halophosphors

Deluxe phosphors, an example of which is shown below, emit a broad spectrum of radiated light and have excellent color quality. But the brightness of these strontium phosphors is 30% less than standard calcium halophosphors.

Figure 4

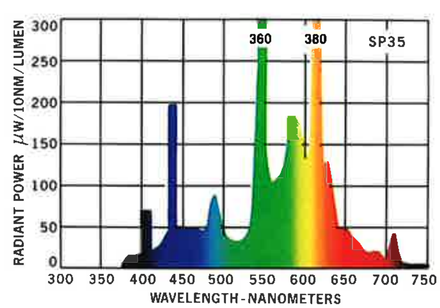


In addition to Chroma 50, shown above, others in this group include Chroma 75, Deluxe Cool White, Deluxe White, and Deluxe Warm White.

Rare Earth Phosphors

Super Deluxe SP 35, shown below, is one of several rare earth phosphors that are very useful in situations where color quality and luminosity of the lighting are the overriding considerations.

Figure 5



Super Deluxe phosphors have high lumen output and excellent color rendering. They emit the most perceived light, with strong reds, greens and blues matched to the eye's sensitivity. In addition to SP 35, this group includes SP27, SP30, SP41, SP30, SP50 and SP65.

Mixing & Milling

The purpose of mixing is to disperse the powder in a suspension in order to produce a lamp coating with a smooth surface and a good appearance.

Phosphor suspensions can be either organic or water based.

Organics provide good coating consistency and they dry in air, but the materials are volatile and flammable. Using water is less costly over all, but it does require forced hot air drying.

Preparation

The easiest method of preparing a suspension is by blending the correct proportions of solvent (water or organic), phosphor and binder in a ball mill.

Milling serves the dual purpose of dispersing the phosphor in the binder and creating particles that are fine enough for effective coating.

For milling, the input materials and the stones should be loaded to a level just above mid-point of the mill.

Calcium Halophosphors

Milling tends to reduce lumen efficiency, but that is not a problem for GE calcium halophosphors. Their particle size is small enough so that milling is not required. Since only a mixing action is desired, the ball mill should only be loaded to the 90% level.

The ball mill is operated for as long as it takes to complete the dispersion, the time depending on mill speed, phosphor type, size of stones, and viscosity of the mixture. Coating appearance is the best determinant of sufficient dispersion.

Quality Control

Sample testing is done before removing the material from the ball mill so that necessary adjustments can be made. Appearance and color specifications, determined in a lamp test for the specific product, are used as quality criteria.

After the suspension is emptied from the ball mill, it is passed through a screen to separate non-dispersed material.

Deluxe Phosphors

These phosphors are prepared by the method described above except that complete milling is required to achieve optimum coating appearance at a low lamp coating weight.

Triphosphor Suspensions

Rare earth phosphors of red, green and blue are used in a triphosphor suspension in applications where color rendition and high luminosity are the key factors.

Mixing of triphosphor suspensions is very similar to the procedure described above, with two major exceptions. Three different phosphors are used and the relative amounts of these phosphors will determine the lamp color. These phosphors have small particle sizes and do not require milling during the dispersion.

Even when adhering closely to a given phosphor formula, the lamp color can vary because of design factors such as lamp size, wattage, and coating weight. After color measurement, the phosphor mixture should be adjusted to achieve the desired lamp color by adding appropriate phosphors to the batch.

Typical formulations:

Color Temperature	Type	Red	Green	Blue
2700	SP 27	73%	27%	0%
3000	SP 30	67%	28%	5%
3500	SP 35	63%	29%	8%
4100	SP 41	50%	37%	13%
5000	SP 50	43%	37%	20%
6500	SP 65	36%	37%	27%

Storage

Dry phosphors do not require special storage accommodations. Phosphor suspensions, however, have a shelf life of only two to three months. They should be stored at moderate temperatures (10-30°C) because temperature extremes hasten binder deterioration. If the binder deteriorates, the phosphor can be salvaged by removing the binder and solvent and redispersing the phosphor.

This tunnel furnace provides the controlled firing conditions required for maximum brightness and particle size control of lamp phosphors.

Manufacturing

At GE, phosphors are produced in a modern and efficient chemical facility using state-of-the-art equipment and stringent quality control procedures.

In our 250,000 square foot facility in Cleveland, Ohio, raw chemicals are blended, crushed, screened, mixed and milled . . .again and again . . .to achieve specific particle sizes. They are then fired in furnaces to form and thermally polish the phosphor crystals for maximum particle translucence.

Frequent sampling and continuing study with the latest scientific instruments assure that purity specifications are met throughout the process. Purity levels of the final products are usually 99.95%, and sometimes up to 99.99% for high performance materials.

We also control particle size, particle size distribution and surface chemistry within very close tolerances. Specializing in chemicals that are made in relatively small, tightly monitored batches enables us to meet our customers particular quality requirements.

Detailed information about these phosphors is available from the GE Chemical Products Plant, 1099 Ivanhoe Road, Cleveland, Ohio 44110, (216) 266-4611, or:

GE Components
Marketing & Sales Operation
21800 Tungsten Road
Cleveland, Ohio 44117
(216) 266-2451

GE Components
Marketing & Sales Operation

Printed in U.S.A.

2M/8/91