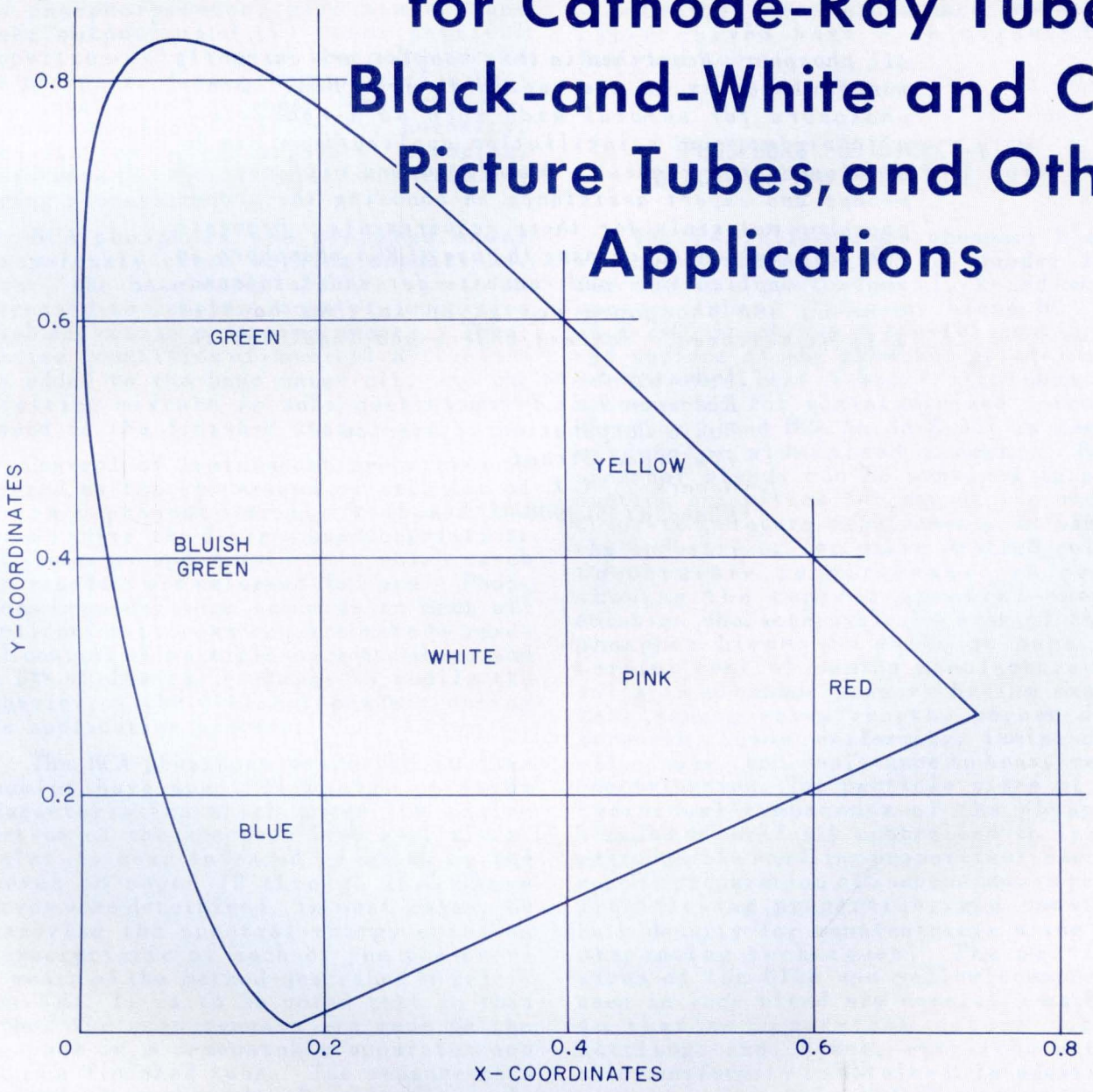
PRICE 75 CENTS*

RCA PHOSPHORS

for Cathode-Ray Tubes, Black-and-White and Color Picture Tubes, and Other Applications



RADIO CORPORATION of AMERICA
ELECTRON TUBE DIVISION
HARRISON, N. J.
Form No. TPM-1508A

* Optional List Price

All phosphors described in this booklet are currently manufactured by or are available from RCA. Other phosphors for special uses such as X-radiation, ultraviolet, and scintillation applications can be developed upon request. Manufacturers will receive prompt and expert assistance in choosing the proper phosphor materials for their requirements. Requests for information concerning the use of RCA phosphors in unusual applications and requests for added information on RCA phosphors not given in this booklet will be welcomed. Address orders and inquiries to:

Industry Sales
Electron Tube Products
Radio Corporation of America
744 Broad Street
Newark 2, N.J.
HUmboldt 5-3900

10-61
TPM-1508A

RCA PHOSPHORS

This booklet contains technical information on RCA's line of cathodoluminescent phosphors recommended for use in the manufacture of cathode-ray tubes, display-storage tubes, and image-converter tubes.

The properties of phosphors may be divided into two groups — (1) luminescent properties (such as color of fluorescence and phosphorescence, persistence, and light output), and (2) other physical properties relating to the behavior of the phosphors during the application process (such as wet-strength, dry-strength, slurry adherence, uniformity, porosity, free-flowing characteristics, clumping, resistance to contamination, and stability during processing).

RCA phosphors are prepared under scrupulously clean working conditions. First, the base materials are carefully processed to remove traces of impurities which may act as poisoning agents. Then, precise quantities of chemical activators are added to the base materials, and the resulting mixture is subsequently processed to the finished state.

Control of luminescent properties is assured by the comparison of each lot of finished phosphor with a standard lot known to give the desired characteristics. Only those phosphor materials which match the standard are released for use. Phosphors in powder form are made to meet all application-process requirements by careful control of particle size and shape and by use of chemical coatings to modify the behavior of the phosphor powders during the application process.

The RCA phosphors described in this booklet have spectral-energy emission characteristics which cover the entire portion of the spectrum from near ultraviolet to near infrared as shown by the curves on pages 12 through 18. These curves were determined, in most cases, by measuring the spectral-energy emission characteristic of each of the phosphors by means of the method described in reference (A). It is to be noted that in this method the measurements are made on the phosphor in a demountable apparatus and not in a finished tube. The measurements are made from the side of excitation. In the cases of phosphor-blend screens, cascaded screens, and structured screens (arrays), data for the component phosphors are plotted separately on the same graph.

Other physical and chemical data helpful to tube designers are summarized in the charts shown on pages 6 through 11. In addition, JEDEC curves showing persistence of the different phosphors in the RCA line are included. It is to be noted that these persistence characteristic curves have been measured on finished tubes.

PHOSPHORS FOR DIRECT-VIEW BLACK-AND-WHITE PICTURE TUBES

Two P4 sulfide-type phosphor blends are manufactured by RCA in powder form for use in direct-view black-and-white picture tubes. Phosphor blend RCA No. 33-Z-290, which has a special coating on the surface of the phosphor particles to insure excellent X-burn resistance, is recommended for non-aluminized screens. Phosphor blend RCA No. 33-Z-387 is recommended for aluminized screens. Both phosphor blends can be supplied in production quantities for any of the normal color-temperature requirements in use by the industry or for other desired color-temperature requirements. A curve showing the typical spectral-energy emission characteristic for each of these phosphor blends is shown on page 17. Careful control during manufacture results in phosphor powders having excellent screen wet-strength, screen dry-strength, color uniformity, luminescent efficiency, and resistance to heavy-metal contamination. The particle sizes of the individual components of the phosphor blends are carefully controlled to insure reproducible handling properties, such as ease in preparation of suspension; superior free-flowing properties; and constant bulk density for manufacturers using dry dispensing techniques. The particle sizes of the blue and yellow components used in each blend are carefully matched so that no separation occurs during settling: and, hence, excellent screen color uniformity is obtained. In addition, steps are taken in manufacturing techniques to insure very low levels of persistence.

Screens may be applied to the faceplates of black-and-white picture tubes by various methods, the most common of which is the settling of the phosphor blend through a water suspension. The binding system generally used consists of potassium silicate together with a suitable electrolyte (such as barium acetate) to initiate and control the rate of silicate gelation. Typical screen wet-strength values obtained from the use of this settling system over a range of barium-acetate and potassium-silicate concentrations are shown for each phosphor blend type in the curves on page 17. Screen wet-strength is a measure of the ability of the screen to adhere to the tube face during pour-off of the settling medium and is measured by impinging a controlled jet of water onto the freshly settled screen and measuring the diameter of the eroded hole. Smaller eroded hole diameters indicate greater screen wet-strength. Because absolute values of the eroded hole diameters depend upon the jet diameter and the jet flow rate, the values shown on the curves are intended to show only relative screen wet-strengths at various solution concentrations.

In the case of the 33-Z-387 phosphor blend recommended for aluminized screens, an important property is the ability of the screen to withstand the forces exerted upon it during the rewetting step and the subsequent lacquer application step which occur at the filming stage of tube processing. This property is called the "rewet strength" and is given for a range of potassium-silicate concentrations for this phosphor blend in the curve shown on page 17. Barium-acetate concentrations are adjusted to give constant screen wet-strength which is indicated by an eroded hole diameter of 11 millimeters over the range of potassium-silicate concentrations used. As in the case of screen wet-strength, smaller eroded hole diameters indicate greater screen rewet strength. Depending on the processing conditions, it may be stated that a screen rewet strength represented by an eroded hole diameter of 25 millimeters is required for the spray filming process and a screen rewet strength represented by an eroded hole diameter of 60 millimeters is required for the flotation filming process.

Over the past several years it became apparent that there was a definite need in the industry for a phosphor that would resist contamination from heavy metal ions such as copper, nickel, and iron. Accordingly, RCA 33-Z-387 phosphor was developed to incorporate a superior contamination resistance level into the aluminizing type phosphor. Extensive laboratory testing, involving intentional contamination with various controlled quantities of the critical metals, has proven that efficiency change and emission-color change due to contamination is lower for RCA 33-Z-387 than it is on any other phosphor available in the industry. Factory use has corroborated the laboratory test results by exhibiting a dramatic reduction in the level of colored spot rejects in normal tube production.

PHOSPHORS FOR DIRECT-VIEW COLOR PICTURE TUBES

The screen of a direct-view color picture tube such as the RCA-21FBP22 consists of an orderly array of three phosphors each of which when excited with high-velocity electron beams emit light of one of the three additive primary colors—blue, green, or red. The three phosphors may be arrayed in triangular groups (trios) or in lines. In the direct-view color picture tube, this group of three phosphors is designated as JEDEC Group-Phosphor P22.

The most widely used method of producing these arrays is one in which the three phosphors are deposited directly on the curved faceplate by photographic technique. Although many different modifications of the basic photographic technique are employed, all utilize a photosensitized colloid as the photographic medium. The most popular colloid is an aqueous solution of polyvinyl alcohol sensitized with ammonium dichromate. Upon exposure to ultraviolet radiation, the dried film of dichromated polyvinyl alcohol becomes insoluble in water.

In the application of screens to color picture tubes, a continuous film of photosensitive material is exposed through a mask containing the desired dot or line pattern. Depending upon the particular method of application, the photosensitive film may or may not contain the phosphor powder at the time of exposure. The exposed print is developed with a water spray. The unexposed areas, being soluble in water, dissolve and wash away. The insolubilized areas remain on the faceplate.

The principal commercial process of applying the phosphor and photosensitive material to the faceplate is the slurry method.

Slurries of each of the phosphors are prepared by ball milling the powders in a dilute solution of aqueous polyvinyl alcohol. After milling, more of the colloid is added to obtain the required viscosity and phosphor concentration. Prior to use, each slurry is photosensitized by addition of ammonium dichromate. The first slurry is then flowed over the faceplate. The faceplate is subsequently spun to provide a uniform screen and to remove excess slurry. During spinning, the screen is dried. Next, the screen is exposed through a mask to ultraviolet radiation to make insoluble the desired dot or line pattern. Following irradiation, the screen is developed with a water spray. The phosphor powder and photosensitive material in the unexposed areas of the screen are washed away leaving on the faceplate the dot or line pattern of the first phosphor. The entire process is then repeated for the second phosphor. Before exposure, however, the ultraviolet source is moved so as to project the pattern of the mask in a position adjacent to the pattern of the phosphor deposited initially. The third phosphor is applied in the same manner with the ultraviolet source again being moved prior to exposure so as to project the pattern of the third phosphor in a position adjacent to the patterns of the other two.

CAUTION

All phosphor materials are toxic to some degree, those containing beryllium having very high toxicity. Extreme care should always be used to avoid ingestion of these materials, or inhalation of dusts which may be created in their storage, processing, or application.

REFERENCES

(A) A. E. Hardy, *"A Combination Phosphorometer and Spectroradiometer for Luminescent Materials"*, Transactions of the Electrochemical Society, April, 1947.

(B) H. W. Leverenz, *"An Introduction to the Luminescence of Solids"*, John Wiley & Sons, Inc., 1950.

(C) A. E. Hardy, *"Application of I.C.I. Color System to Development of All-Sulfide White Television Screen"*, RCA Review, Vol. VIII, No. 3, Sept., 1947.

(D) N. S. Freedman and K. M. McLaughlin, *"Phosphor-Screen Application in Color Kinescope"*, Proc. I.R.E., Vol. 39, No. 10, pp. 1230-1236, Oct., 1951.

(E) *"Optical Characteristics of Cathode-Ray Tube Screens"*, JEDEC Electron Tube Council, JEDEC Publication No. 16, June 1960.

(F) H. R. Seelen, H. C. Moodey, D. D. Van Ormer, and A. M. Morrell, *"Development of a 21-Inch Metal-Envelope Color Kinescope"*, RCA Review, Vol. XVI, No. 1, pp. 122-139, March 1955.

PHOSPHORS
FOR OSCILLOGRAPH, DISPLAY-STORAGE, AND IMAGE-CONVERTER TUBES

JEDEC Designation[a]	RCA Phosphor No.	Screen Composition[ab]	Layers on Screen[a]	Color of Fluorescence and Phosphorescence	Persistence (Time for Initial Brightness to Decay to 10% Point)
P1	33-W-2A[e] 33-W-2B[f]	Zinc orthosilicate (Zn_2SiO_4:Mn)	1	Yellowish-green	Medium[g] (24.5 millisec)
P2	33-Z-601	Zinc cadmium sulfide (ZnCdS:Cu)	1	Yellowish-green	Medium Short[h] (35 to 70 microsec)
P5	33-C-35	Calcium tungstate ($CaWO_4$)	1	Blue	Medium Short[g] (25 microsec)
P7	33-Z-20C	Zinc sulfide (ZnS:Ag) cascaded on Zinc cadmium sulfide (ZnCdS:Cu)	2	Purplish-blue	Medium Short (25 to 75 microsec)
	33-Z-21B			Yellowish-green	Long (400 millisec)
P10	33-P-32A	Potassium chloride (KCl)		A scotophor — white screen darkens	
P11	33-Z-16A	Zinc sulfide (ZnS:Ag)	1	Blue	Medium Short (34 microsec)
P12	33-Z-616	Zinc magnesium fluoride ($ZnMgF_2$:Mn)	1	Orange	Long[g] (210 millisec)
P14	33-Z-20C	Zinc sulfide (ZnS:Ag) cascaded on Zinc cadmium sulfide (ZnCdS:Cu)	2	Purplish-blue	Medium Short (27 microsec)
	33-Z-604B			Yellowish-orange	Medium (5 millisec)
P15	33-Z-613	Zinc oxide (ZnO:Zn)	1	Near Ultraviolet Green	Very Short[g] (0.05 microsec) Short[g] (2.8 microsec)
P16	33-C-298A	Calcium magnesium silicate ($2CaO \cdot MgO \cdot 2SiO_2$:Ce:Li)	1	Near Ultraviolet (Bluish-purple)	Very Short (0.12 microsec)
P20	33-Z-250[j] 33-Z-286A[k]	Zinc cadmium sulfide (ZnCdS:Ag)	1	Yellow-green	Medium to Medium Short (Approx. 60 microsec)
P24	33-Z-613A	Zinc oxide (ZnO:Zn)	1	Green	Short[g] (1.5 microsec)
P31	33-Z-245A	Zinc sulfide (ZnS:Cu)	1	Green	Medium Short[h] (Approx. 38 microsec)

For footnotes, see pages 10 and 11.

CLASSIFICATION CHARTS

Wavelength of Peak Radiant Energy angstroms	C.I.E. Coordinates[c]		Relative Radiant Energy[d]			Luminous Efficiency lumens/ watt	JEDEC Designation[a]
	x	y	Peak	Total	Visual		
5250	0.218 0.218	0.712 0.728	100 95	100 95	100 95	31.1 29.6	P1
5350	0.279	0.534	56	118	104	32.4	P2
4150	0.169	0.132	12	25	11	3.4	P5
4350 5550	0.151 0.357	0.032 0.537	206 58	272 131	16 121	5.0 37.7	P7
under cathode-ray excitation (dark-trace screen) — persistence very long.							P10
4600	0.139	0.148	204	351	87	27.0	P11
5900	0.605	0.394	50	69	71	21.8	P12
4350 6000	0.151 0.520	0.032 0.463	206 69	272 164	16 123	5.0 38.4	P14
3910 5100	- 0.246	- 0.439	- 33	- 85	- 59	- 18.2	P15
3830	0.175	0.003	60	82	0.3	0.09	P16
5600	0.426	0.546	107	267	200	62.2	P20
5100	0.245	0.441	17	44	31	9.7	P24
5220	0.245	0.523	164	366	160	49.8	P31

For footnotes, see pages 10 and 11.

PHOSPHORS FOR DIRECT-VIEW BLACK-AND-WHITE PICTURE TUBES

JEDEC Designation[a]	RCA Phosphor No.	Screen Composition[ab]	Layers on Screen[a]	Color of Fluorescence and Phosphorescence	Persistence (Time for Initial Brightness to Decay to 10% Point)
P4 Sulfide[m]	33-Z-387	Blend of Zinc sulfide (ZnS:Ag) and Zinc cadmium sulfide (ZnCdS:Ag) Characteristics of Blend	1	Purplish-blue	Medium Short (22 microsec)
				Greenish-yellow	Medium Short (60 microsec)
				White	Medium Short (60 microsec)
P4 Sulfide[n]	33-Z-290	Blend of Zinc sulfide (ZnS:Ag) and Zinc cadmium sulfide (ZnCdS:Ag) Characteristics of Blend	1	Blue	Medium Short (22 microsec)
				Greenish-yellow	Medium Short (60 microsec)
				White	Medium Short (60 microsec)

PHOSPHORS FOR PROJECTION BLACK-AND-WHITE KINESCOPES

P4 Silicate[p]	33-C-628	Blend of Calcium magnesium silicate ($CaO \cdot MgO \cdot SiO_2$:Ti) and Zinc beryllium silicate ($ZnO \cdot BeO \cdot SiO_2$:Mn) Characteristics of Blend	1	Purplish-blue	Medium Short[g] (40 microsec)
	33-Z-5C			Greenish-yellow	Medium[g] (12.5 millisec)
				White	Medium[g] (12.5 millisec)
P4 Silicate-Sulfide[q]	33-C-628	Blend of Calcium magnesium silicate ($CaO \cdot MgO \cdot SiO_2$:Ti) and Zinc beryllium silicate ($ZnO \cdot BeO \cdot SiO_2$:Mn) cascaded on Zinc sulfide (ZnS:Ag) Characteristics of Blend	2	Purplish-blue	Medium Short[g] (40 microsec)
	33-Z-5C			Greenish-yellow	Medium[g] (12.5 millisec)
	33-Z-16A			Blue	Medium Short (34 microsec)
				White	Medium (12.5 millisec)

PHOSPHORS FOR DIRECT-VIEW COLOR PICTURE TUBES

Group P22—Sulfide-Silicate-Phosphate Type	33-Z-265	Array of Zinc sulfide (ZnS:Ag) Zinc orthosilicate (Zn_2SiO_4:Mn) and Zinc phosphate ($Zn_3[PO_4]_2$:Mn)	1	Purplish-blue	Medium Short (22 microsec)
	33-W-2A			Yellowish-green	Medium[g] (25 millisec)
	33-Z-639D			Reddish-orange	Medium[g] (28 millisec)
Group P22—All-Sulfide Type	33-Z-265	Array of Zinc sulfide (ZnS:Ag) Zinc cadmium sulfide (ZnCdS:Ag) and Zinc cadmium sulfide (ZnCdS:Ag)	1	Purplish-blue	Medium Short (22 microsec)
	33-Z-236A			Green	Medium Short (60 microsec)
	33-Z-237A			Reddish-orange	Medium Short (60 microsec)

For footnotes, see pages 10 and 11.

CLASSIFICATION CHARTS

Wavelength of Peak Radiant Energy angstroms	C.I.E. Coordinates[c]		Relative Radiant Energy[d]			Luminous Efficiency lumens/ watt	JEDEC Designation[a]
	x	y	Peak	Total	Visual		
4550	0.152	0.108	162	320	50	15.5	
5650	0.453	0.521	107	267	200	62.2	P4 Sulfide[m]
-	0.270	0.300	-	-	-	-	
4570	0.148	0.117	145	281	47	14.6	
5650	0.448	0.512	88	223	163	46.1	P4 Sulfide[n]
-	0.270	0.300	-	-	-	-	
4250	0.169	0.134	39	86	19	5.9	
5500	0.476	0.514	36	86.5	85	26.4	P4 Silicate[p]
-	0.333	0.347	-	-	-	-	
4250	0.169	0.134	39	86	19	5.9	
5500	0.476	0.514	36	86.5	85	26.4	P4 Silicate-Sulfide[q]
4600	0.139	0.148	204	351	87	27.0	
-	0.317	0.331	-	-	-	-	
4500	0.146	0.052	180[r]	242	26	8.1	Group P22— Sulfide-Silicate-Phosphate Type
5250	0.218	0.712	100	100	100	31.1	
6380	0.674	0.326	44	73	22.5	7.0	
4500	0.146	0.052	180[r]	242	26	8.1	
5150	0.242	0.529	140	302	190	56	Group P22— All-Sulfide Type
6800	0.663	0.337	116	223	44	12.6	

For footnotes, see pages 10 and 11.

PHOSPHORS FOR PROJECTION COLOR PICTURE TUBES

JEDEC Designation[a]	RCA Phosphor No.	Screen Composition[ab]	Layers on Screen[a]	Color of Fluorescence and Phosphorescence	Persistence (Time for Initial Brightness to Decay to 10% Point)
-	33-Z-375	"Blue" Tube: Zinc sulfide ($ZnS:Ag:Al$)	1	Purplish-blue	Medium Short (22 microsec)
-	33-W-2B	"Green" Tube: Zinc orthosilicate ($Zn_2SiO_4:Mn$)	1	Yellowish-green	Medium[g] (24.5 millisec)
-	33-Z-275	"Red" Tube: Zinc magnesium cadmium silicate ($ZnMgCdSiO_3:Mn$)	1	Reddish-orange	Medium[g] (35 millisec)

[a] Information shown in this column applies to finished tube.
[b] Chemical elements following colons at end of composition formulae represent activators.
[c] Different lots of phosphor may result in minor variations of these coordinates.
[d] Relative to JEDEC Phosphor P1 (RCA Phosphor No.33-W-2A).
[e] Unmilled.
[f] Milled to 1 approx. micron.
[g] Value is essentially independent of current density.
[h] Phosphorescence may have a useful brightness for over a minute under conditions of adequate excitation and low-ambient illumination.

CROSS REFERENCE CHART

Phosphor Powders	
RCA Number	For Use in JEDEC Phosphor
33-C-35	P5
33-C-298A	P16
33-C-628	P4—Silicate (Purplish-blue) P4—Silicate-Sulfide (Purplish-blue)
33-P-32A	P10 (Scotophor)
33-W-2A	P1—Unmilled Group P22—Sulfide Silicate Phosphate (Green)
33-W-2B	P1—Milled to approx. 1 micron. Color projection picture tube (Yellowish-green)
33-Z-5C	P4—Silicate (Greenish-yellow) P4—Silicate-Sulfide (Greenish-yellow)
33-Z-16A	P11 P4—Silicate-Sulfide (Blue)
33-Z-20C	P7 (Purplish-blue) P14 (Purplish-blue)
33-Z-21B	P7 (Yellowish-green)
33-Z-236A	Group P22—All Sulfide (Green)
33-Z-237A	Group P22—All Sulfide (Red)
33-Z-245A	P31
33-Z-250	P20 (Fine particles for image-converter tubes)

CLASSIFICATION CHARTS

Wavelength of Peak Radiant Energy angstroms	C.I.E. Coordinates[c]		Relative Radiant Energy[d]			Luminous Efficiency lumens/ watt	JEDEC Desig-nation[a]
	x	y	Peak	Total	Visual		
4360	0.155	0.048	190	266	24	7.5	-
5250	0.218	0.728	95	95	95	29.6	-
6550	0.682	0.318	22	37	8	2.5	-

j Fine particles, for image-converter tubes.
k For display-storage tubes.
m For aluminized screens.
n For non-aluminized screens.
p For projection types such as 5TP4.
q For projection types such as 7WP4.
r Subject to color-balance requirements.

CROSS REFERENCE CHARTS

Phosphor Powders	
RCA Number	**For Use in JEDEC Phosphor**
33-Z-265	Group P22—Sulfide Silicate Phosphate and All Sulfide (Blue)
33-Z-275	Color projection picture tube (Reddish-orange)
33-Z-286A	P20 (For display-storage tubes)
33-Z-375	Color projection picture tube (Purplish-blue)
33-Z-601	P2
33-Z-604B	P14 (Yellowish-orange)
33-Z-613	P15
33-Z-613A	P24
33-Z-616	P12
33-Z-639D	Group P22—Sulfide Silicate Phosphate (Red)

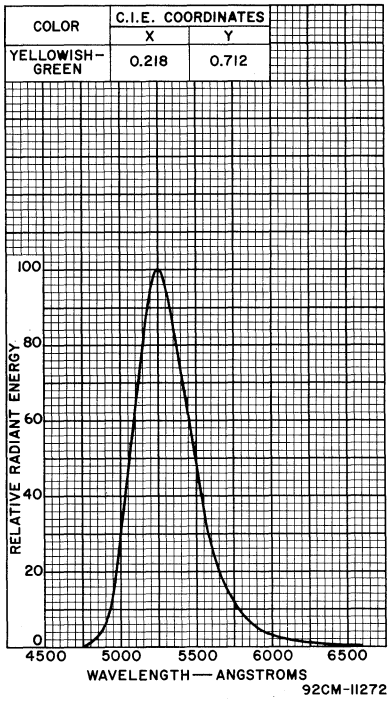
Phosphor Blends	
RCA Number	**For Use in JEDEC Phosphor**
33-Z-290	P4—Sulfide (For non-aluminized screens)
33-Z-387	P4—Sulfide (For aluminized screens)

SPECTRAL-ENERGY EMISSION CHARACTERISTICS

Measured under following conditions: Excitation = 8 KV; Current Density = 1.5 to 2.0 μa/cm²; Defocused Spot.
For apparatus and method of measurement, see page 3.

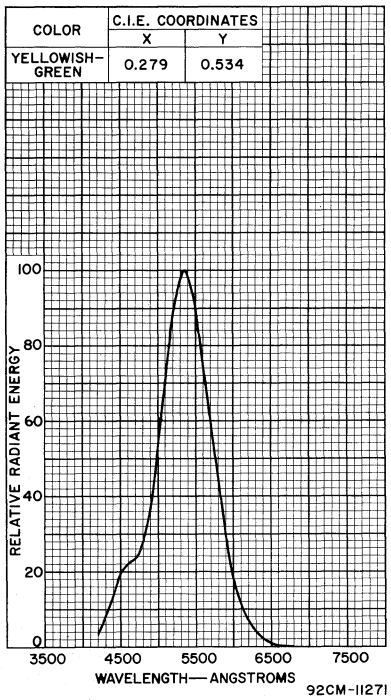
RCA PHOSPHOR Nos. 33-W-2A AND 33-W-2B JEDEC PHOSPHOR P1

COLOR	C.I.E. COORDINATES	
	X	Y
YELLOWISH-GREEN	0.218	0.712



RCA PHOSPHOR No. 33-Z-601 JEDEC PHOSPHOR P2

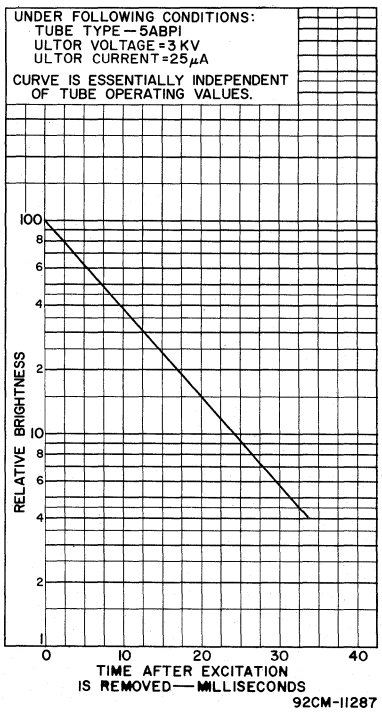
COLOR	C.I.E. COORDINATES	
	X	Y
YELLOWISH-GREEN	0.279	0.534



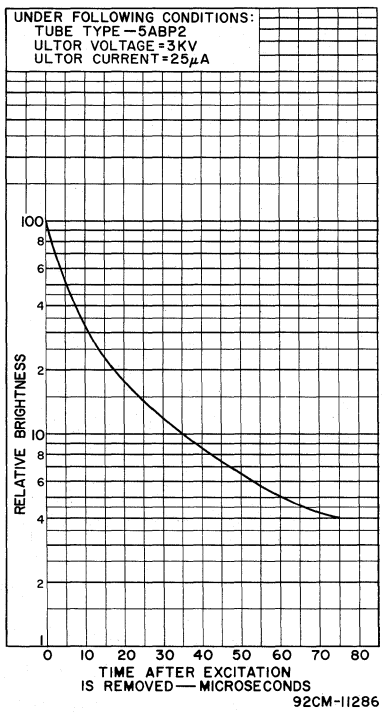
PERSISTENCE CHARACTERISTICS

Persistence is dependant upon tube operating conditions unless otherwise specified.

JEDEC PHOSPHOR P1



JEDEC PHOSPHOR P2

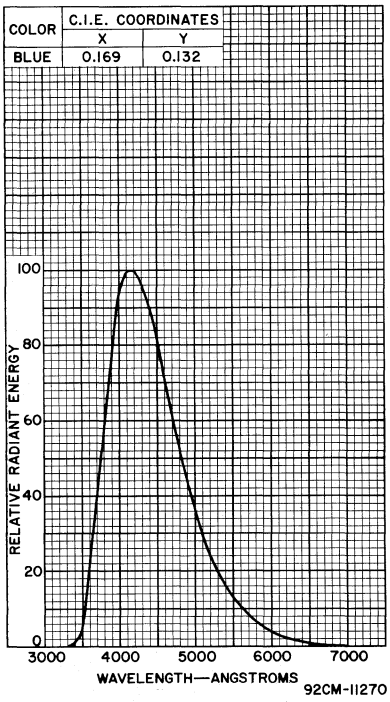


SPECTRAL-ENERGY EMISSION CHARACTERISTICS

Measured under following conditions: Excitation = 8 KV; Current Density = 1.5 to 2.0 μa/cm²; Defocused Spot.
For apparatus and method of measurement, see page 3.

RCA PHOSPHOR No. 33-C-35
JEDEC PHOSPHOR P5

COLOR	C.I.E. COORDINATES	
	X	Y
BLUE	0.169	0.132

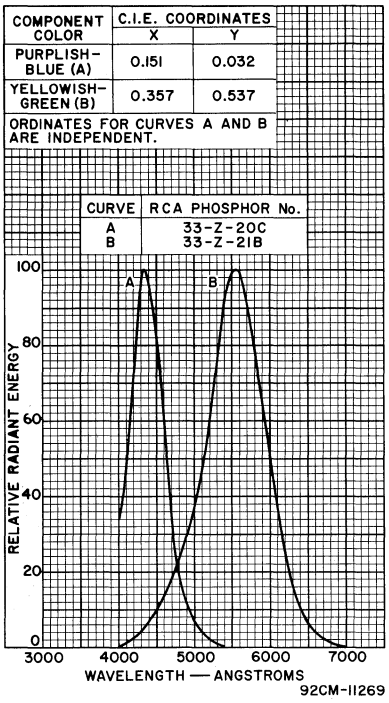


RCA PHOSPHOR Nos. 33-Z-20C AND 33-Z-21B
JEDEC PHOSPHOR P7

COMPONENT COLOR	C.I.E. COORDINATES	
	X	Y
PURPLISH-BLUE (A)	0.151	0.032
YELLOWISH-GREEN (B)	0.357	0.537

ORDINATES FOR CURVES A AND B ARE INDEPENDENT.

CURVE	RCA PHOSPHOR No.
A	33-Z-20C
B	33-Z-21B

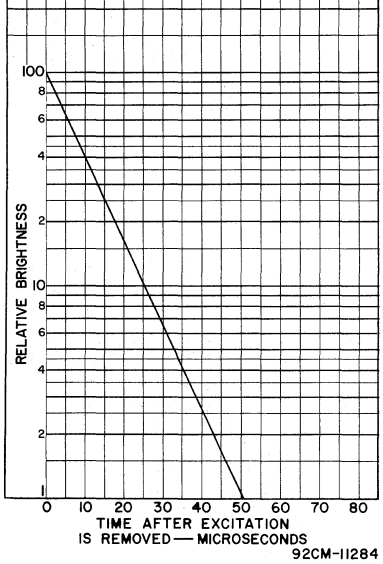


PERSISTENCE CHARACTERISTICS

Persistence is dependent upon tube operating conditions unless otherwise specified.

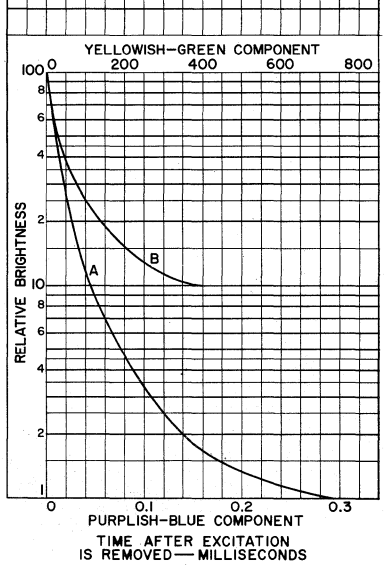
JEDEC PHOSPHOR P5

UNDER FOLLOWING CONDITIONS:
TUBE TYPE — 5ABP5
ULTOR VOLTAGE = 3.5 KV
ULTOR CURRENT = 0.5 μA
CURVE IS ESSENTIALLY INDEPENDENT OF TUBE OPERATING VALUES.



JEDEC PHOSPHOR P7

UNDER FOLLOWING CONDITIONS:
TUBE TYPE — 5ABP7
PURPLISH-BLUE COMPONENT (A)
ULTOR VOLTAGE = 3 KV
ULTOR CURRENT = 17 μA
YELLOWISH-GREEN COMPONENT (B)
ULTOR VOLTAGE = 3 KV
ULTOR CURRENT = 1.5 μA

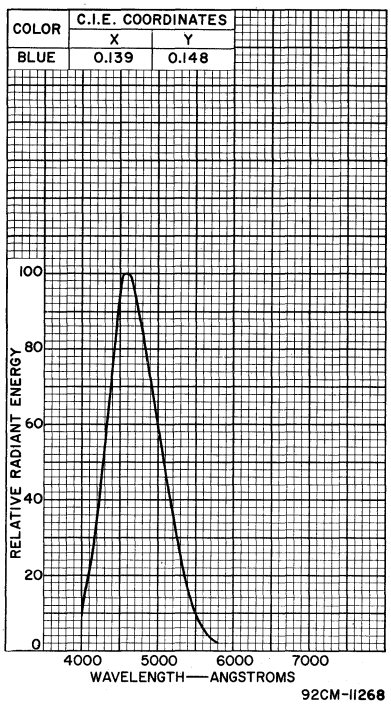


SPECTRAL-ENERGY EMISSION CHARACTERISTICS

Measured under following conditions: Excitation = 8 KV; Current Density = 1.5 to 2.0 μa/cm²; Defocused Spot. For apparatus and method of measurement, see page 3.

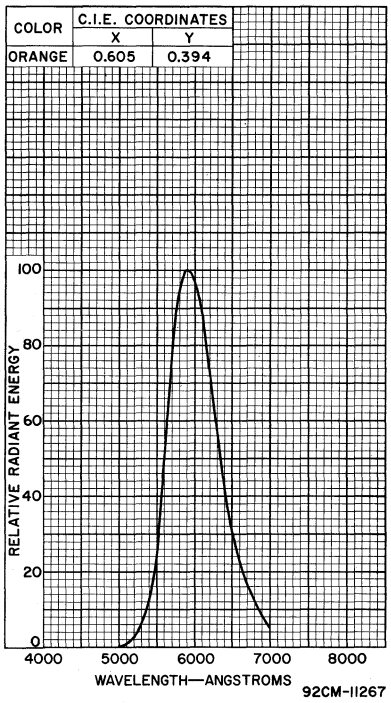
RCA PHOSPHOR No. 33-Z-16A
JEDEC PHOSPHOR P11

COLOR	C.I.E. COORDINATES	
	X	Y
BLUE	0.139	0.148



RCA PHOSPHOR No. 33-Z-616
JEDEC PHOSPHOR P12

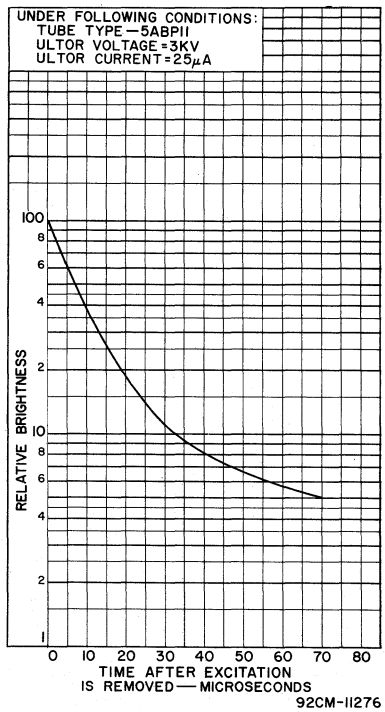
COLOR	C.I.E. COORDINATES	
	X	Y
ORANGE	0.605	0.394



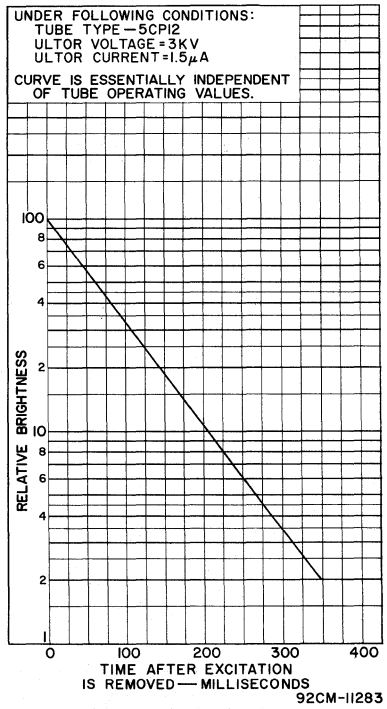
PERSISTENCE CHARACTERISTICS

Persistence is dependent upon tube operating conditions unless otherwise specified.

JEDEC PHOSPHOR P11



JEDEC PHOSPHOR P12



SPECTRAL-ENERGY EMISSION CHARACTERISTICS

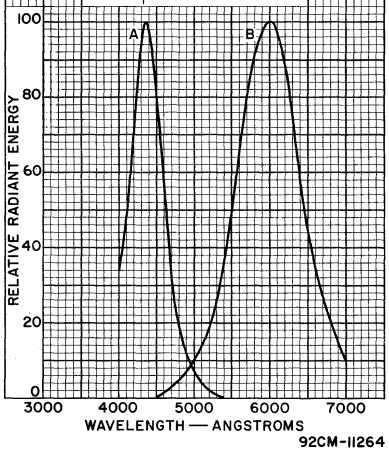
Measured under following conditions: Excitation = 8 KV; Current Density = 1.5 to 2.0 μa/cm²; Defocused Spot. For apparatus and method of measurement, see page 3.

RCA PHOSPHOR Nos. 33-Z-20C AND 33-Z-604B JEDEC PHOSPHOR P14

COMPONENT COLOR	C.I.E COORDINATES X	Y
PURPLISH-BLUE (A)	0.151	0.032
YELLOWISH-ORANGE (B)	0.520	0.463

ORDINATES FOR CURVES A AND B ARE INDEPENDENT.

CURVE	RCA PHOSPHOR No.
A	33-Z-20C
B	33-Z-604B



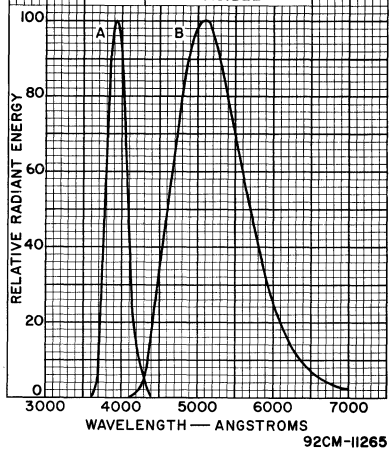
92CM-11264

RCA PHOSPHOR No. 33-Z-613 JEDEC PHOSPHOR P15

COMPONENT	COLOR	C.I.E. COORDINATES X	Y
VISIBLE	GREEN	0.246	0.439
NEAR ULTRA-VIOLET	—	—	—

ULTRAVIOLET COMPONENT APPEARS AT HIGH VALUES OF CURRENT DENSITY.

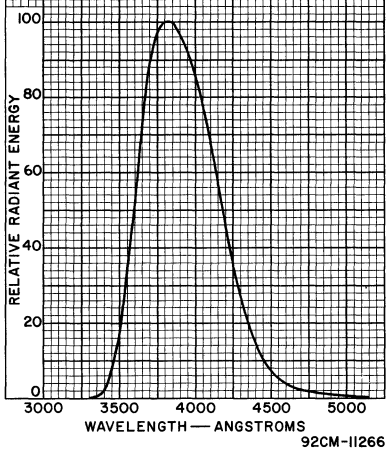
CURVE	COMPONENT
A	NEAR ULTRAVIOLET
B	VISIBLE



92CM-11265

RCA PHOSPHOR No. 33-C-298A JEDEC PHOSPHOR P16

COMPONENT	COLOR	C.I.E. COORDINATES X	Y
VISIBLE	BLUISH-PURPLE	0.175	0.003
NEAR ULTRA-VIOLET	—	—	—



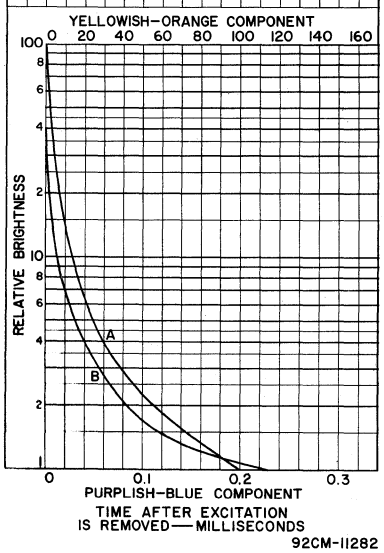
92CM-11266

PERSISTENCE CHARACTERISTICS

Persistence is dependent upon tube operating conditions unless otherwise specified.

JEDEC PHOSPHOR P14

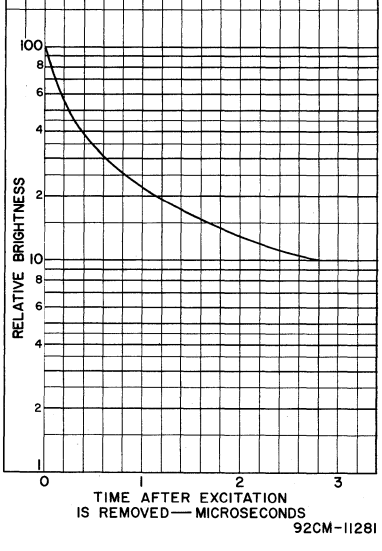
UNDER FOLLOWING CONDITIONS:
TUBE TYPE - EXPERIMENTAL
PURPLISH-BLUE COMPONENT (A)
ULTOR VOLTAGE = 7 KV
ULTOR CURRENT = 10 μA
YELLOWISH-ORANGE COMPONENT (B)
ULTOR VOLTAGE = 7KV
ULTOR CURRENT = 1 μA



92CM-11282

JEDEC PHOSPHOR P15

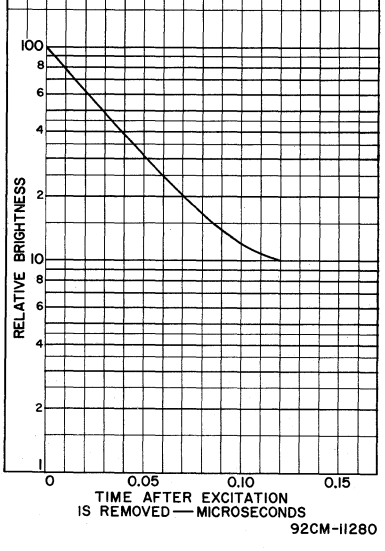
UNDER FOLLOWING CONDITIONS:
TUBE TYPE - 5WP15
ULTOR VOLTAGE = 27 KV
ULTOR CURRENT = 150 μA
ULTRAVIOLET COMPONENT DECAYS TO 10% IN NOT MORE THAN 0.05 MICROSECOND.
CURVE IS ESSENTIALLY INDEPENDENT OF TUBE OPERATING VALUES.



92CM-11281

JEDEC PHOSPHOR P16

UNDER FOLLOWING CONDITIONS:
TUBE TYPE - 5ZP16
ULTOR VOLTAGE = 27KV
ULTOR CURRENT = 25 μA



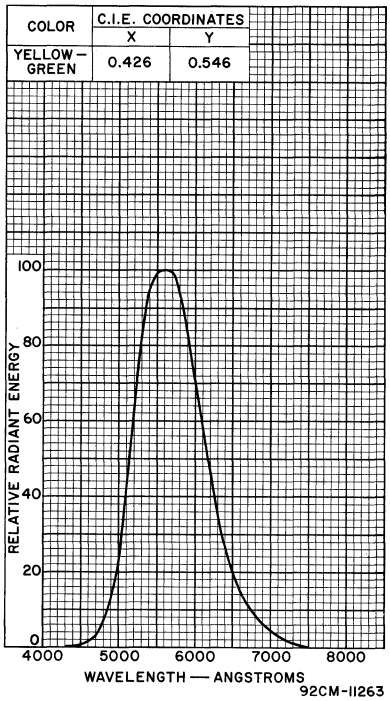
92CM-11280

SPECTRAL-ENERGY EMISSION CHARACTERISTICS

Measured under following conditions: Excitation = 8 KV; Current Density = 1.5 to 2.0 μa/cm²; Defocused Spot. For apparatus and method of measurement, see page 3.

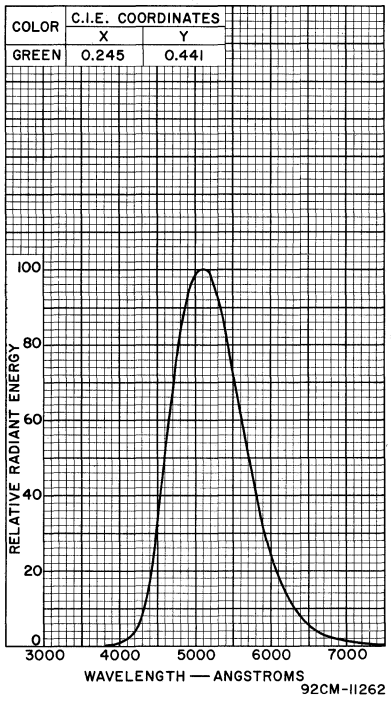
RCA PHOSPHOR Nos. 33-Z-250 AND 33-Z-286A JEDEC PHOSPHOR P20

COLOR	C.I.E. COORDINATES	
	X	Y
YELLOW-GREEN	0.426	0.546



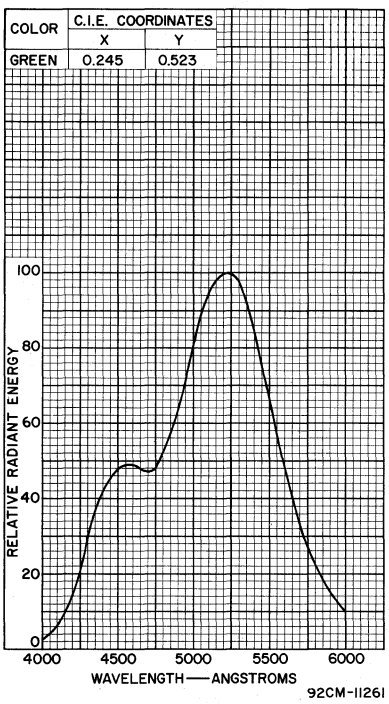
RCA PHOSPHOR No. 33-Z-613A JEDEC PHOSPHOR P24

COLOR	C.I.E. COORDINATES	
	X	Y
GREEN	0.245	0.441



RCA PHOSPHOR No. 33-Z-245A JEDEC PHOSPHOR P31

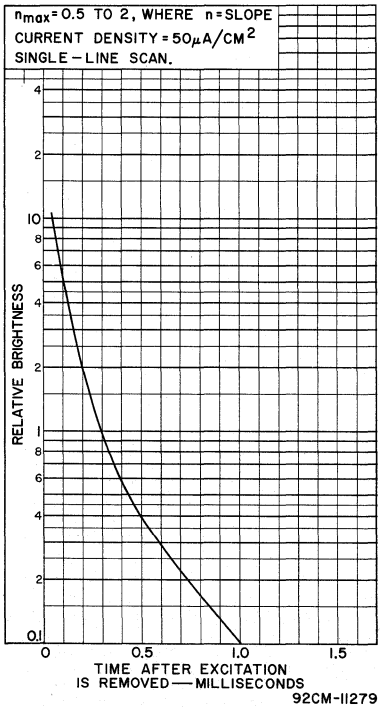
COLOR	C.I.E. COORDINATES	
	X	Y
GREEN	0.245	0.523



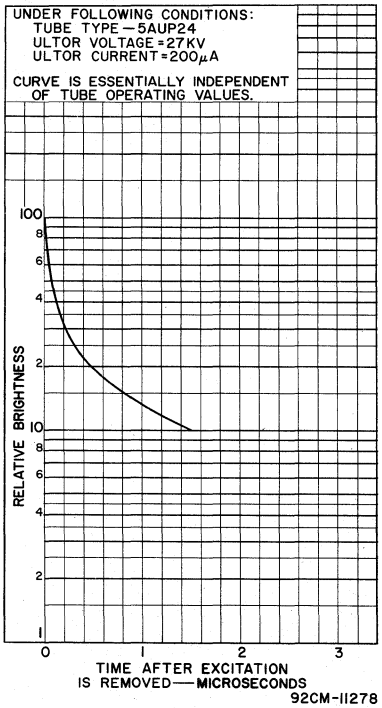
PERSISTENCE CHARACTERISTICS

Persistence is dependent upon tube operating conditions unless otherwise specified.

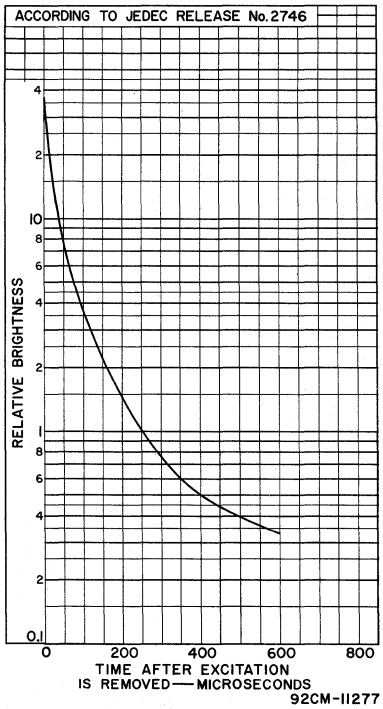
JEDEC PHOSPHOR P20



JEDEC PHOSPHOR P24

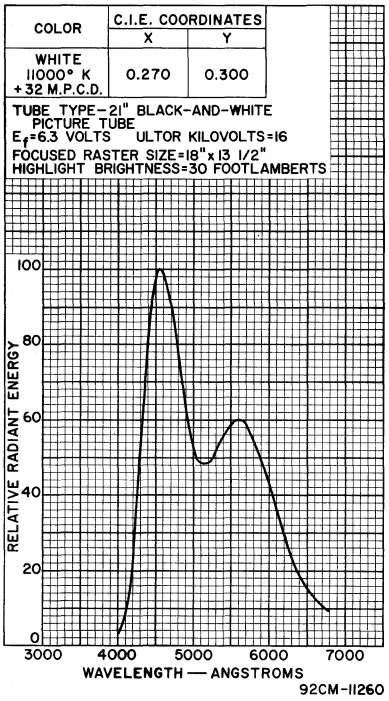


JEDEC PHOSPHOR P31



SPECTRAL-ENERGY EMISSION CHARACTERISTICS

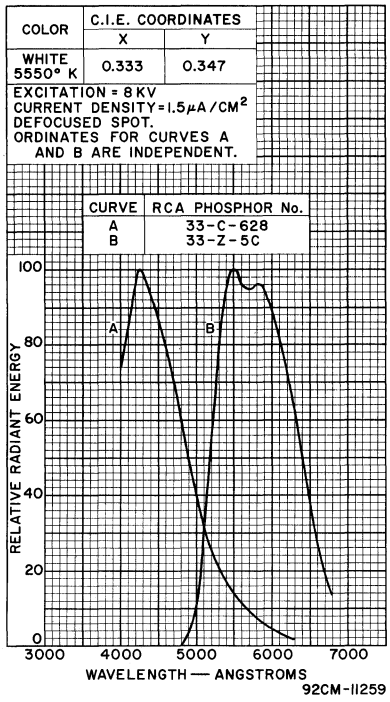
RCA PHOSPHOR BLENDS No. 33-Z-387 or 33-Z-290 JEDEC PHOSPHOR P4-SULFIDE



Persistence of P4-Sulfide Phosphor

Initial brightness will decay to 10% point in 60 microseconds after excitation is removed.

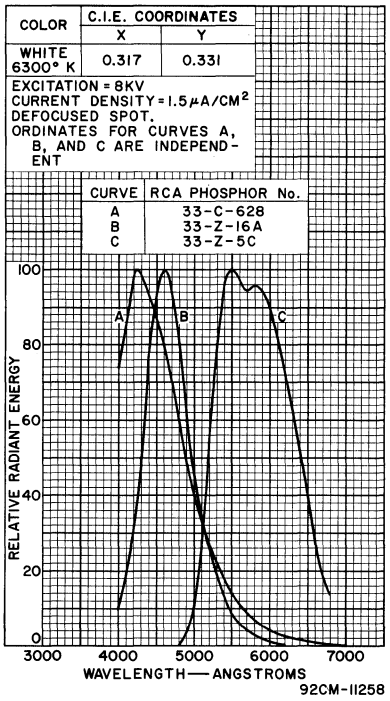
BLEND OF RCA PHOSPHORS No. 33-C-628 AND 33-Z-5C JEDEC PHOSPHOR P4-SILICATE



Persistence of P4-Silicate Phosphor

Initial brightness will decay to 10% point in 12.5 milliseconds after excitation is removed.

BLEND OF RCA PHOSPHORS No. 33-C-628, 33-Z-5C, AND 33-Z-16A JEDEC PHOSPHOR P4-SILICATE SULFIDE

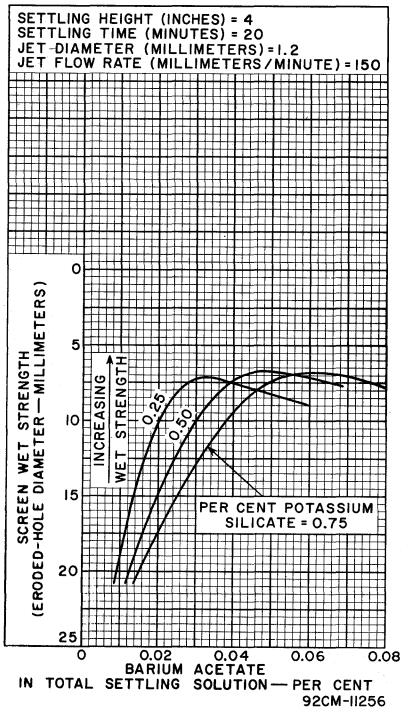


Persistence of P4-Silicate Sulfide Phosphor

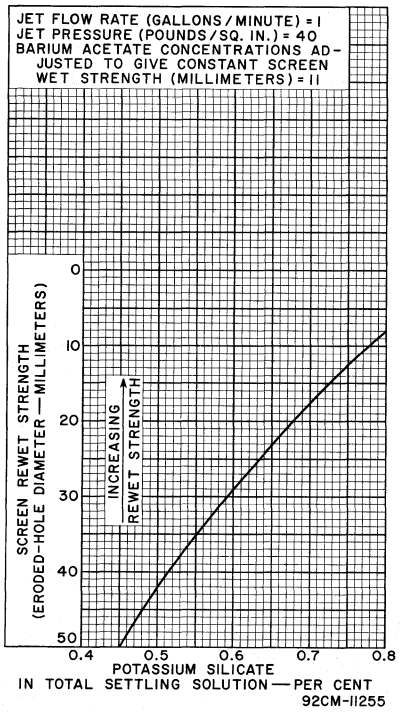
Initial brightness will decay to 10% point in 12.5 milliseconds after excitation is removed.

SCREEN-STRENGTH CHARACTERISTICS

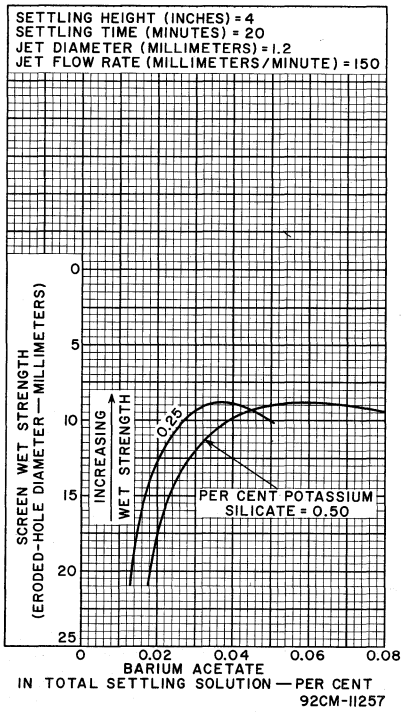
SCREEN WET STRENGTH P4-SULFIDE PHOSPHOR BLEND RCA No. 33-Z-387



SCREEN REWET STRENGTH P4-SULFIDE PHOSPHOR BLEND RCA No. 33-Z-387



SCREEN WET STRENGTH P4-SULFIDE PHOSPHOR BLEND RCA No. 33-Z-290



SPECTRAL-ENERGY EMISSION CHARACTERISTICS

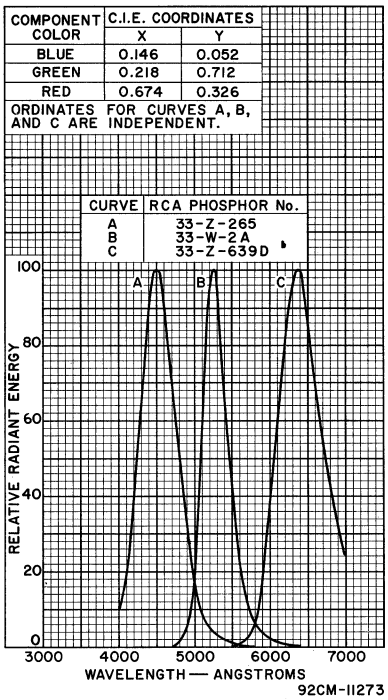
Measured under following conditions: Excitation = 8 KV; Current Density = 1.5 to 2.0 μa/cm²; Defocused Spot. For apparatus and method of measurement, see page 3.

RCA PHOSPHOR Nos. 33-Z-265, 33-W-2A, AND 33-Z-639D JEDEC GROUP PHOSPHOR P22— SULFIDE-SILICATE-PHOSPHATE TYPE

COMPONENT COLOR	C.I.E. COORDINATES X	Y
BLUE	0.146	0.052
GREEN	0.218	0.712
RED	0.674	0.326

ORDINATES FOR CURVES A, B, AND C ARE INDEPENDENT.

CURVE	RCA PHOSPHOR No.
A	33-Z-265
B	33-W-2A
C	33-Z-639D



Persistence of Group Phosphor P22 Sulfide-Silicate-Phosphate Type

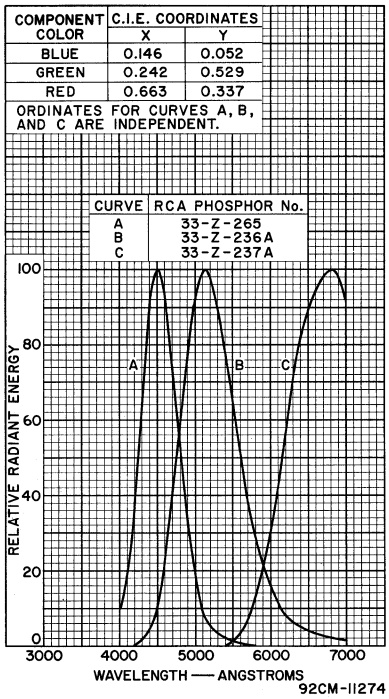
Initial brightness will decay to 10% point in 28 milliseconds after excitation is removed.

RCA PHOSPHOR Nos. 33-Z-265, 33-Z-236A, AND 33-Z-237A JEDEC GROUP PHOSPHOR P22— ALL-SULFIDE TYPE

COMPONENT COLOR	C.I.E. COORDINATES X	Y
BLUE	0.146	0.052
GREEN	0.242	0.529
RED	0.663	0.337

ORDINATES FOR CURVES A, B, AND C ARE INDEPENDENT.

CURVE	RCA PHOSPHOR No.
A	33-Z-265
B	33-Z-236A
C	33-Z-237A



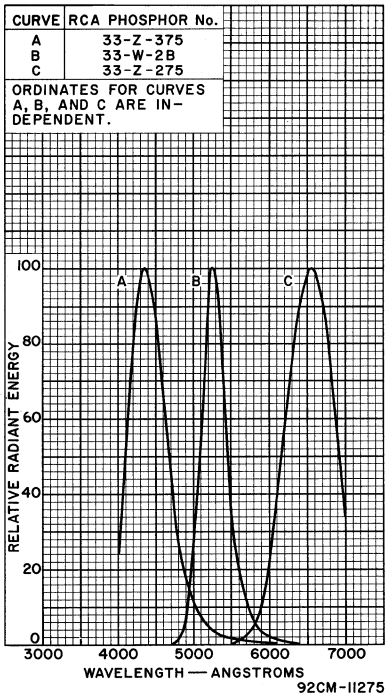
Persistence of Group Phosphor P22 All-Sulfide Type

Initial brightness will decay to 10% point in 60 microseconds after excitation is removed.

RCA PHOSPHOR Nos. 33-Z-375, 33-W-2B, AND 33-Z-275 FOR PROJECTION COLOR PICTURE TYPES

CURVE	RCA PHOSPHOR No.
A	33-Z-375
B	33-W-2B
C	33-Z-275

ORDINATES FOR CURVES A, B, AND C ARE INDEPENDENT.



Persistence of Phosphors for Projection Color Picture Tubes

Initial brightness will decay to 10% point in 35 milliseconds after excitation is removed.

FLUORESCENT SCREENS

Phosphor P1 produces a brilliant spot having yellowish-green fluorescence and medium persistence. Types having this phosphor are particularly useful for general oscillographic applications in which recurrent wave phenomena are to be observed visually.

Phosphor P2 is a medium-short persistence screen which exhibits yellowish-green fluorescence and phosphorescence. The phosphorescence may have useful persistence for over a minute under conditions of adequate excitation and low-ambient illumination. Types utilizing this phosphor are particularly useful for observing either low- or medium-speed non-recurring phenomena.

Phosphor P4-Sulfide Type is a highly efficient screen having white fluorescence and medium-short persistence. Types having this phosphor are of particular interest for television picture tubes.

Phosphor P4-Silicate Type exhibits white fluorescence and has medium to medium-short persistence. Types having this phosphor are of particular interest for projection-type kinescopes.

Phosphor P4-Silicate-Sulfide Type exhibits white fluorescence and has medium to medium-short persistence. Types having this phosphor are of particular interest for monitor-type kinescopes.

Phosphor P5 emits highly actinic blue fluorescence and has medium-short persistence. Types having this phosphor are especially useful in photographic applications involving film moving at very high speeds.

Phosphor P7 is a long-persistence, cascade (two-layer) screen. During excitation by the electron beam, this phosphor produces a white fluorescence. After excitation, the screen exhibits a yellowish-green phosphorescence which persists for several minutes. Types having this phosphor are particularly useful where either extremely low-speed recurrent phenomena or medium-speed non-recurrent phenomena are to be observed.

P10 is not a luminescent material. Its normally white screen darkens under cathode-ray excitation. Persistence is long and variable. Types having this scotophor are of interest in radar and other special cathode-ray tube applications.

Phosphor P11 emits high intensity actinic blue fluorescence and has medium-short persistence to permit its use in all photographic applications except those in which film moves at high speed. P11 screens, because of their unusually high brightness characteristic, may also be used for visual observation of phenomena.

Phosphor P12 is a long-persistence phosphor which exhibits both orange fluorescence and phosphorescence. Types utilizing this phosphor are particularly useful for observing low- and medium-speed recurring phenomena.

Phosphor P14 is a medium-persistence cascade (two-layer) screen. During excitation by the electron beam, this phosphor exhibits purplish-blue fluorescence. After excitation, it exhibits a yellowish-orange phosphorescence which persists for a little over a minute. Types utilizing this phosphor are particularly useful for observing either low- and medium-speed non-recurring phenomena or high-speed recurring phenomena.

Phosphor P15 emits radiation in the visible green region and in the invisible near-ultraviolet region. The ultraviolet radiation has very-short persistence which is appreciably shorter than that of the visible radiation. This phosphor finds application in flying-spot cathode-ray tubes.

Phosphor P16 has bluish-purple as well as near-ultraviolet fluorescence and phosphorescence with very-short persistence. This phosphor has a stable, exponential decay characteristic and is particularly useful for the high-speed scanning requirements of a flying-spot video-signal generator.

Phosphor P20 has high luminous efficiency, yellow-green fluorescence and medium to medium-short persistence. The screen may be used in applications requiring relatively short persistence and good visual efficiency.

Group Phosphor P22 consists of an orderly array of three phosphors each of which emits light of one of the three additive primary colors — blue, green, or red. This phosphor screen finds application in color picture tubes.

Phosphor P24 is a short-persistence phosphor with green fluorescence and phosphorescence. Its spectral-energy emission characteristic has sufficient range to provide usable energy over the visible spectrum required for generating color signals from color transparencies.

Phosphor P31 is a medium-short persistence screen which exhibits green fluorescence and phosphorescence. Types utilizing this phosphor are particularly useful for observing either low- or medium-speed non-recurring phenomena.

JEDEC PERSISTENCE CLASSIFICATION CHART FOR RCA PHOSPHORS

PHOSPHOR	DESCRIPTION	PHOSPHOR	DESCRIPTION	PHOSPHOR	DESCRIPTION
P1	Medium	P10	Very Long	P22— Sulfide-Silicate-Phosphate Type	Blue - Medium Short Green - Medium Red - Medium
P2	Medium Short	P11	Medium Short		
P4— Sulfide	Medium Short	P12	Long		
P4— Silicate	Medium to Medium Short	P14	Purplish-blue— Medium Short Yellowish-orange— Medium	P22— All-Sulfide Type	Blue - Medium Short Green - Medium Short Red - Medium Short
P4— Silicate-Sulfide	Medium to Medium Short	P15	Visible-Short Near Ultraviolet— Very Short	P24	Short
P5	Medium Short	P16	Very Short	P31	Medium Short
P7	Purplish-blue— Medium Short Yellowish green— Long	P20	Medium to Medium Short		

Description of Persistence	Time to decay to 10% of initial brightness
Very Long	1 second and over
Long	100 millisec to 1 sec
Medium	1 millisec to 100 millisec
Medium Short	10 microsec to 1 millisec
Short	1 microsec to 10 microsec
Very Short	Less than 1 microsec


RCA