







# NBS TECHNICAL NOTE 564

## Glass Limit Standards Deposited at NBS for Railway, Highway and Airways Traffic Signal Colors—

### History, Permanence and Colorimetric Properties

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UNITED STATES DEPARTMENT OF COMMERCE

Maurice H. Stans, Secretary

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**Glass Limit Standards Deposited at NBS  
for Railway, Highway and Airways Traffic Signal Colors—  
History, Permanence and Colorimetric Properties**

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National Bureau of Standards  
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Glass Limit Standards Deposited at NBS for  
Railway, Highway and Airway Traffic Signal Colors—  
History, Permanence and Colorimetric Properties

Geraldine W. Haupt

Signal glass limit standards for railway, highway, and aviation colors, selected by user-organizations, are on deposit at the National Bureau of Standards. Many duplicates of these standards have been issued by NBS.

The first standards were selected in 1931 for railway use. Highway standards were adopted in 1940, and selection of aviation standards began in 1942. At the present time the NBS is custodian of 63 standards for these signal colors.

Permanence of the filters is examined, based on colorimetric conversions for CIE standard illuminant A derived from spectrophotometric measurements made on different instruments over periods of years.

Spectral transmittance data and the resulting colorimetric data are given for 9 illuminants ranging in distribution temperature from 1500 to 3250 kelvins and for CIE standard illuminants B and C. Figures show, for several filters of each color, the shifts occurring both in chromaticity (x,y) and in redness and brightness index (u,W\*) with changes in illuminant.

Key words: Aircraft signals; color standards; filter permanence; limit filters; railroad signals; signal colors; signal standards; spectral transmittance of glass filters; traffic signals.

## 1. Development of Standard Filters at NBS

### 1.1. Association of American Railroads

Organization standard limit filters for the colors of signal lights have been deposited with the National Bureau of Standards as early as 1931. At Corning Glass Works, J. C. Mock, Chairman of Sub-committee A under Committee VI-Designs, American Railway Association (ARA) Signal Section, used a diamond stylus to initial and date "J.C.M. 11-6-31" some twenty-two "limit" glasses selected by the Signal Section Committee. All limit glasses were prepared by Corning Glass Works; all are 2-inch polished squares with the exception of two yellow filters, numbers 199 and 200, which are 1-inch polished discs. Prior to this time Corning Glass Works had custody of the six ARA standards in the form of 8 3/8-inch

roundels, engraved with "J. C. Mock, 10/3/30". Both sets include the colors designated as red, yellow, green, blue, purple and lunar white.

The Bureau's work on the color standardization of railroad signal glasses was started in 1930. I. G. Priest, who had attended the meeting of the Committee, brought the 22 limit glasses to the Bureau. Spectrophotometric data on them were obtained by means of the K $\ddot{u}$ nig-Martens visual spectrophotometer (KM) [1]<sup>1</sup> and Gibson direct-reading photoelectric spectrophotometer (PE) [2] and reported in tables 1 and 2 of Report No 3, one of a series of seven which from time to time had been formally reported [3] to the cooperating organizations. Papers [4,5] have been published giving a description of this cooperative work done by the AAR Signal Section, Corning Glass Works, and NBS which led to the formulation of the early AAR Signal Section Specifications for signal colors and glasses designated 69-35 [6] and 69-38 [8], Signal Glasses (Exclusive of Kerosene Lantern Globes) and 59-38 [7], Glasses for Kerosene Hand Lanterns (Exclusive of Electric Lantern Glassware).

Table 1 gives the filter numbers of AAR limit glasses deposited at NBS and shows the various specifications in which they are referenced. The 69-59 Specification [12] is still current in 1970.

Similarly, table 2 gives filter numbers of eight Kerosene hand-lantern limit filters which have remained as limits up to the present time. The 59-61 Specification [11] is still current in 1970.

In 1946 spectrophotometric data for thirty of these glasses (twenty-two from Specifications 69-40 [9] as seen from table 1, column 5, and eight from Specification 59-38 [7] as seen from table 2, column 3) were published in table 3 of a National Bureau of Standards research paper, RP 1688 [5]; also, the chromaticity coordinates  $x, y, z$  and luminous transmittances,  $T_W$ , were given for three distribution temperatures 1900K, 2360K, and 2848K ( $c_2=14,350$  micrometer-kelvins)<sup>2</sup> in table 4 of this research paper. The colorimetric specification is in terms of the 1931 standard observer and coordinate system of the Commission Internationale de l'Eclairage (CIE, International Commission on Illumination, formerly abbreviated ICI).

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<sup>1</sup> Figures in brackets refer to the literature references at the end of this paper.

<sup>2</sup> The definition of distribution temperature and an explanation of values assigned to  $c_2$  are given in Appendix A, page



At the same time that purple was deleted as a signal color the transmittances of filters designated by  $T_{AAR}$  values [4] were eliminated and luminous transmittance values were substituted. The  $T_{AAR}$  values were used to specify the luminous transmittance of the filters. The scale was arbitrary and in reality comprised six scales, one for each color. The value of  $T_{AAR}=100.0$  for each scale had an equivalent luminous transmittance [5] for a distribution temperature of 2360K. The proposed revision of Specification 69-48 [10] was submitted in a letter dated July 15, 1957 to L. E. Barbrow, Chief of Photometry and Colorimetry Section, by R. H. C. Balliet, Secretary, Signal Section, Association of American Railroads.<sup>3</sup> The revision did not reflect any intent to change the colors of signals. Also in the same letter he stated: "Colorimetric and transmittance data for accomplishing all the above have been found in NBS Research Paper by Gibson, Haupt, and Keegan. They clearly foresaw the need to express railroad signaling definitions in terms of color temperature 2848°K closely representative of modern signal lamps. ----As a final step toward putting this specification in effect, it will be necessary to notify owners of certified limit glasses that the  $T_{AAR}$  values of those glasses are superseded by luminous transmittances and inform them of such values. ----Your advice and assistance will be appreciated toward carrying out this final step, data for which were discussed briefly between G. W. Haupt and J. P. Hoxie on May 1st 1957 at the Bureau of Standards."

The computed values of luminous transmittance for 2854K (CIE standard illuminant A) were sent to the owners of 137 certified limit glasses with a letter dated April 6, 1959 to C. J. R. Taylor, Chairman Committee VI, Signal Section, AAR. In this connection, it may be noted that references to 2848K were also changed to 2854K in the revised and current Specifications 69-59 [12] and 59-61 [11].

These several revisions affecting the choice of limit filters and resulting in changes in AAR Signal Section Specifications 69- and 59- occurred over a period of 30 years, since 1931. Purple signals are no longer used, but they are included in the list of filters in this paper to show their values in terms of recent CIE systems of specifying color.

---

<sup>3</sup> A few of the items intended for accomplishment which he listed in his letter are the following:

1. Eliminate purple as an A.A.R. recommended practice while keeping present limit glass standards for all other colors.
2. Eliminate descriptions involving 2360K since this source is no longer employed for service, inspection or standardization.
3. Adopt C.I.E. illuminant A (2848K) for inspection, definition of standards and tolerances on standards.
4. Adopt luminous transmittances in place of old  $T_{AAR}$  values and thus drop the  $T_{AAR}$  scale.

Table 1. Filter Numbers of Limit Glasses deposited at the National Bureau of Standards which appear in AAR 69-Specifications, Signal Glasses (Exclusive of Kerosene Lantern Globes)

(1) Color	(2) Limit	(3) Report No. 3 (1933)	Filter Numbers Used In				(7)
			(4)	(5)	(6)	(7)	
			69-35 ▽	69-40	69-48	69-59	
RED	light	126	†154	154	154	154	
	dark	127	† 86	86	86	86	
Disc	light				154	154	
	dark				86	86	
Highway crossing	light			Δ75	75	75	
	dark			Δ400	400	400	
Electric lantern	light				126	126	
	dark				211	211	
YELLOW	light	141	141	141	141	141	
	dark	142	142	142	142	142	
Disc	green	*199	199	199	199	199	
	red	*200	200	200	200	200	
GREEN	light and blue	134	134	134	134	134	
	dark and blue	87	87	87	87	87	
Kerosene lantern	light	Ø137					
	dark	Ø138					
Disc	light	136	†139	139	139	139	
	dark	135	†140	140	140	140	

BLUE Kerosene	light	47B	47B	47B	47B
	dark	57B	57B	57B	57B
LUNAR WHITE Kerosene	light	45	45	45	45
	dark	74	74	74	74
Electric	light	72	+124	124	124
	dark	73	73	73	73
PURPLE Kerosene	light	56	56	56	56
	dark	47P	47P	47P	47P
Electric	light	80	80	80	80
	dark	81	+P108	P108	P108

Table 1 Footnotes:

∇ No filter numbers are listed in either of these specifications, but they are shown on the chromaticity diagram in 69-38.

\* Formerly G and R; also 1" (green) and 1" (red).

† Six filters having no initials or dates but deposited at NBS which superseded the original filters given in Report No. 3.

θ These glasses became part of Specification 59-38; filter 138 was superseded by 322. See table 2.

Δ Engraved by ASH 9-24-40. (ASH refers to A.S. Haigh, Chairman, Subcommittee C, Committee YI.)

Table 2. Filter Numbers of Limit Glasses deposited at the National Bureau of Standards which appear in AAR 59- Specifications,- Glasses for Kerosene Hand Lanterns (Exclusive of Electric Lantern Glassware)

<u>Color</u>	<u>Limit</u>	Filter Numbers used in Specifications
		59-38Δ 59-39Δ 59-61
Red	light	201
	dark	211
Yellow	light	261
	dark	271
Green	light	137
	dark	322
Blue	light	B141
	dark	B131

Footnotes:

Δ No filter numbers are listed in this specification, but they are shown on the chromaticity diagram.

Filter numbers 201 and B131 engraved by GKT 6-23-33. (GKT refers to G. K. Thomas, Chairman Committee VI)

Filter numbers 211, 261, 271, and B141 engraved by ASH 6-11-35 (See footnote table 1)

Filter number 322 engraved by ASH 5-20-37



## 1.2. Institute of Traffic Engineers

The Institute of Traffic Engineers ITE, with Donald M. McNeil<sup>4</sup> as chairman of a Standards and Specification Committee of fifteen members in 1938-39, decided upon the color requirements "after extensive tests by the Committee both daytime and nighttime with the use of standard traffic signals".

In answer to Mr. McNeil's request of November 20, 1939 for comments or suggestions regarding these specifications, Dr. K. S. Gibson, Chief of Photometry and Colorimetry Section, wrote in his letter of December 18, 1939, "We thank you for giving us this opportunity of examining the specification in its tentative form. We are much interested in having the various signal-glass specifications as consistent with each other as is possible, and are particularly glad that you have been able to use limit glasses which have already been standardized."

This tentative specification [13] included colors designated red, yellow and green. In 1939-40 the committee chairman was Wm. C. Brandes.<sup>5</sup>

The six limit filters selected were:

<u>Color Designation</u>	<u>Filter Number</u>	
	<u>Light Limit</u>	<u>Dark Limit</u>
Red	154	86
Yellow	359	199
Green	134	87

Yellow filter 359 was the only one not previously standardized. In table III of the 1940 Traffic Report [13] are given the trichromatic coefficients (x,y,z) for illuminant at 2848K for the above standard limit glasses. The  $T_{AAR}$  value, with the illuminant at 2360K, was employed for certifying duplicate limit glasses. On June 5, 1942, this Technical Report [13] was approved as an American Standard by the American Standards Association and designated ASA D10.1-1942. It was later revised by Technical Committee No. 4-Design of Equipment, but the six filters listed above were retained.

The report was revised by Technical Committee 7-A and approved as an ITE Standard [14] by the Board of Direction, May 23, 1958, and as an American Standard, October 16, 1958. The revision added two orange limits to be used for pedestrian-control:

<u>Color</u>	<u>Limit</u>	<u>Filter Number</u>
Orange	Yellow	3840A
	Red	3647A

<sup>4</sup>Dept. of Public Safety, Bureau of Traffic Planning, City of Pittsburgh, Pa.

<sup>5</sup>Traffic Signal Engineer, City Hall, Chicago, Illinois.



These two filters had already been standardized and were listed in Federal Standard No. 3 [17]. However, by 1966 these color limits for the orange lens used in traffic signals to indicate "Wait" had been deleted and did not appear in the revised Technical Report [15]. Red limits were changed at that time to include more yellow. The adopted limit filters, previously standardized, were:

<u>Color</u>	<u>Limit</u>	<u>Filter Number</u>
Red	Yellow	75
	Transmittance	154

This revised Standard [15] was developed by Project Committee 7E(61) of the ITE Technical Council consisting of twenty-five members and chaired by Wayne N. Volk.<sup>6</sup> On January 22, 1966, it was approved by the ITE Board of Direction, and on October 4, 1966, by the U.S.A. Standards Institute. It supersedes the 1958 ITE Technical Report [14] and the 1960 supplement thereto, "Twelve-inch Adjustable Face Traffic Control Signal Heads."

### 1.3. Federal Agencies Dealing with Aeronautical Lighting.

Early in 1942, in an effort to unify the various specifications relating to airport lighting and aircraft identification, the War and Navy Departments and the Civil Aeronautics Administration adopted Army-Navy Aeronautical Specification AN-C-56 [16] which set forth the colorimetric specification of ware to be used for aeronautical lighting equipment. This specification superseded AN-C-7 which consisted of U. S. Army Specification 98-12017-A (1936), portions of Navy Aeronautical Specification M-47, and Civil Aeronautics Administration Specification CAA-433. Specification AN-C-56 described the colors in terms of boundaries, given by mathematical equations relating the x,y coordinates of the CIE 1931 chromaticity diagram, and by limit standards. The primary specification was in terms of the chromaticity boundaries.

Unlike the specifications for railroad and traffic signals, which cover signals produced by sources operating at specific distribution temperatures, the aeronautical signals are intended to be produced by sources operating over various ranges of distribution temperature between 1900K and 3000K. The use of limit standards greatly facilitates inspection of ware for compliance since they can easily be used with sources of variable distribution temperature.

Twelve limit standards were listed among twenty primary procurement standards which were given as provisional in the AN-C-56 specification. These twelve are:

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<sup>6</sup> Chief Traffic Engineer, Wisconsin State Highway Commission.

<u>Filter</u> NBS	<u>Color</u>	<u>Use</u>
3647	Aviation Red	Pale Lim., Yl. Lim.
3218A	" "	Tr. Std.
7346A	" Green	Pale Lim., Yl. Lim.
3113A	Identification Red	Pale Lim., Yl. Lim.
3055A	" "	Tr. Std.
3955A	" Yellow	Pale Lim., Gr. Lim.
6319A	" Green	Pale Lim. Yl., Yl. Lim.
6310A	" "	Tr. Std. Yl.
6916A <sup>7</sup>	" "	Pale Lim. Bl.
6905A	" "	Blue Lim., Tr. Std. Bl.
8449A	" Lunar Wh.	Pale Lim., Yl. Lim.
8430A	" " "	Blue Lim., Tr. Std.

In the late 1940's and early 1950's there was an interest in international standardization of color for aeronautical signalling. Definitions of the colors were adopted in 1949 by the International Civil Aviation Organization (ICAO). These definitions were in terms of boundaries only. In order to correlate the older U. S. military specifications with the boundaries adopted by ICAO, Federal Standard No. 3 [17] was prepared and adopted in 1951 for use by all Federal agencies. The definitions of the colors in Federal Standard No. 3 were generally in agreement with those adopted by ICAO. In addition to the mathematical definitions, Federal Standard No. 3 lists twenty-eight limit standards which conformed to the definitions.

Since the military requirements resulted in boundaries somewhat different from the internationally adopted boundaries, and those listed in Federal Standard No. 3, the Air Force and Navy Bureau of Aeronautics adopted MIL-C-25050 (ASG)<sup>8</sup> [18] in 1954 to supersede AN-C-56. No table of NBS filter numbers is given in MIL-C-25050; the entire definition of the colors being by boundaries. However, it is stated that procurement color standards may be adopted which "have been certified by the National Bureau of Standards as conforming to the requirements of this specification".

When MIL-C-25050 was superseded in 1963 by MIL-C-25050A (ASG) [19], definitions of the colors were again in terms of chromaticity boundaries; however, direct reference was made to the limit standards specified in Federal Standard No. 3.

<sup>7</sup> 6916A was broken and 6916J replaced it and became 6916J-A in Fed. Std. No. 3.

<sup>8</sup> Aeronautical Standards Group (ASG).

#### 1.4. U. S. National Committee on Colors of Signal Lights

At the 1948 session of the CIE, a review was made of the more important specifications for signal light colors in use in different countries and variations in these specifications were pointed out. The increased use of signal lights in one country by citizens of other countries necessitated more uniformity between the various national specifications. Following this meeting a committee of the CIE on which the U. S. was represented was established to study the problem. This CIE committee on Color Specifications for Signal Lights assisted ICAO in establishing standards for aeronautical use.

The U. S. National Committee on the Colors of Signal Lights was established in 1952 to assist the U. S. representative in preparing for the 1955 meeting of the CIE and also to provide liaison with those organizations and government agencies which were responsible for the specification and regulation of signal light colors used in USA. The work of this committee resulted in the development of a U. S. Standard for the Colors of Signal Lights. It was prepared as a recommended standard to help to bring specifications for signal light colors used in this country into agreement with international usage as recommended by the CIE. The standard was published as NBS Handbook 95 [20] in 1964.

Eighteen national standard filters are identified. Of these, three are new and different limit filters, namely: red 3.640, yellow 4.166 and green 7.136. The remaining fifteen are previously standardized filters. These fifteen refer to the same filters previously listed in railroad specifications 69-59 [12] and 59-61 [11] but with prefix numbers 3,4,7 and 8 added to indicate the colors red, yellow, green and blue respectively.

#### 2. Permanence and Colorimetric Properties

As noted above, NBS has been the custodian of these sixty-three organization limit standards since the first twenty-two were deposited in 1931. Over the years, spectral transmittance data have been obtained for almost all of them. These measurements of spectral transmittance have been made by means of the following spectrophotometers: K8nig-Martens visual (KM) [1]; Gibson direct reading photoelectric (PE) [2]; General Electric recording with 4 and 8 nanometer spectral bandpass (GE I) [21, 22]; General Electric recording with 10 nanometer spectral bandpass (GE II) [21, 22]; Beckman Model DU manual (DU) [23]; and Cary Model 14M [24].

Spectral transmittance data with acceptably narrow slits were not obtained for four of the aeronautical limit standards (3656A, 3964A, 7342A, and 8219A). However, since spectral transmittance data were obtained for duplicate limit filter 8219B which is of the same melt and thickness as 8219A, this blue filter has been added. These four standards were measured relative to limit standards or other filters of the same type which had been measured previously by means of a spectrophotometer; their chromaticity coordinates and luminous transmittances were determined by visual comparison with these filters by means of a



chromaticity-difference colorimeter (CDC) [25,26] and a Schmidt & Haensch Martens photometer (Mph) [27] respectively. Later models of these early instruments were designed and built about 1955 and are shown in Figures 1, 2 and 3.

The filter designated 6700A in Federal Standard No. 3 has been omitted from the remainder of this paper because the manufacturer was unable to prepare glass suitable for issuance as duplicate filters.

In table 3 the 62 limit standards are identified by the designations used for them in 5 publications. Columns 2 and 3 refer to the railroad signal limit filters; column 4, to the traffic signal limit filters; column 5, to the aeronautical signal limit filters in Federal Standard No. 3; and column 6, to the limit filters in U. S. Standard for the Colors of Signal Lights (NBS Handbook 95). The Corning type numbers, melt numbers when available, and thicknesses are listed in columns 7 to 9. The origin of the spectral transmittance data used in the remainder of this paper, the number of sets of data available (indicated in parentheses) if more than one, together with the date of measurement are listed in column 10. The final column lists the serial number for the measurement; these serial numbers are shown in figures 4 and 5 and in square brackets in the upper right-hand corner of each page of table 7.

The advent of high-speed computers permitted more extensive colorimetric data to be determined. There follows, for each filter, from one to three sets of spectral transmittance data from 380 to 770 nm at each 10 nm interval (40 wavelengths), together with the corresponding computed<sup>9</sup> colorimetric data in terms of three CIE systems of specifying color for eleven illuminants; nine specified by distribution temperatures [28,29] between approximately 1500 and 3250 kelvins ( $c_0=14,388$  micrometer-kelvins) and two as CIE standard illuminants B and C [30,31]. The tristimulus values X,Y,Z and chromaticity coordinates x,y,z [32,33,34] are given according to the CIE 1931 system [35,36], the chromaticity coordinates u, v, according to the CIE 1960 UCS system [37], and brightness index ( $W^*$ )

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<sup>9</sup> The spectral transmittance data were processed by means of an IBM 7094 or UNIVAC 1108 high-speed digital computer which is programmed to convert spectral-transmittance data into colorimetric terms for 10-nm summation intervals by means of the tristimulus functions  $\bar{x}, \bar{y}, \bar{z}$  adopted by the CIE in 1931 and to convert colorimetric data x,y to u,v (CIE 1960 UCS system) and to compute  $W^*, U^*, V^*$  (CIE 1964 system) using the following formulas:

$$u = 4x / (12y - 2x + 3) = 4X / (X + 15Y + 3Z) \quad (1)$$

$$v = 6y / (12y - 2x + 3) = 6Y / (X + 15Y + 3Z) \quad (2)$$

$$W^* = 25Y^{1/3} - 17 \quad (1 \leq Y \leq 100) \quad (3)$$

$$U^* = 13W^*(u - u_0) \quad V^* = 13W^*(v - v_0) \quad (4)$$

where  $u_0, v_0$  are the values of the variables u,v for the achromatic point.

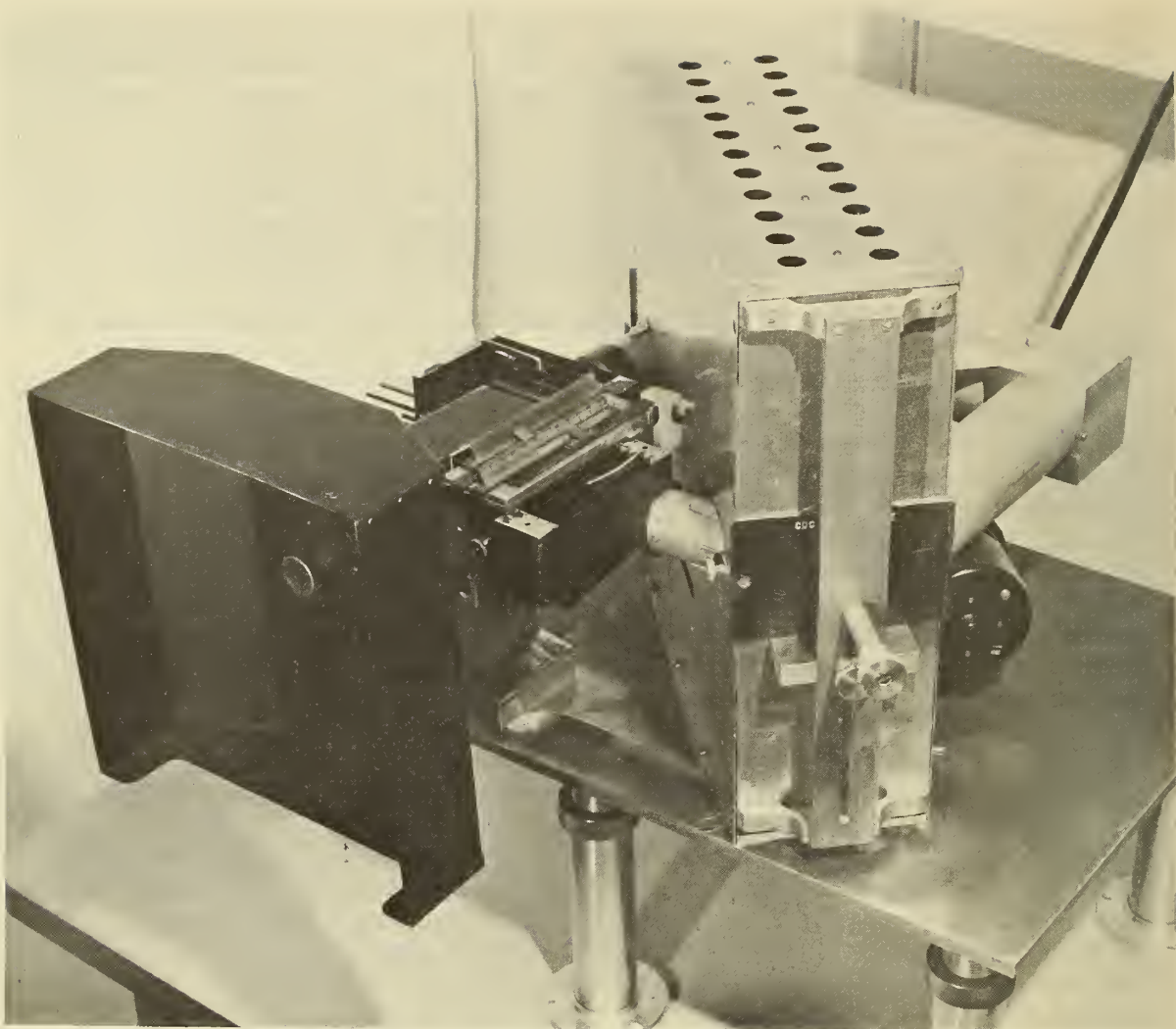


Figure 1. Present model of Judd chromaticity-difference colorimeter (CDC) designed to measure  $\Delta x$ ,  $\Delta y$  directly in CIE 1931 system.



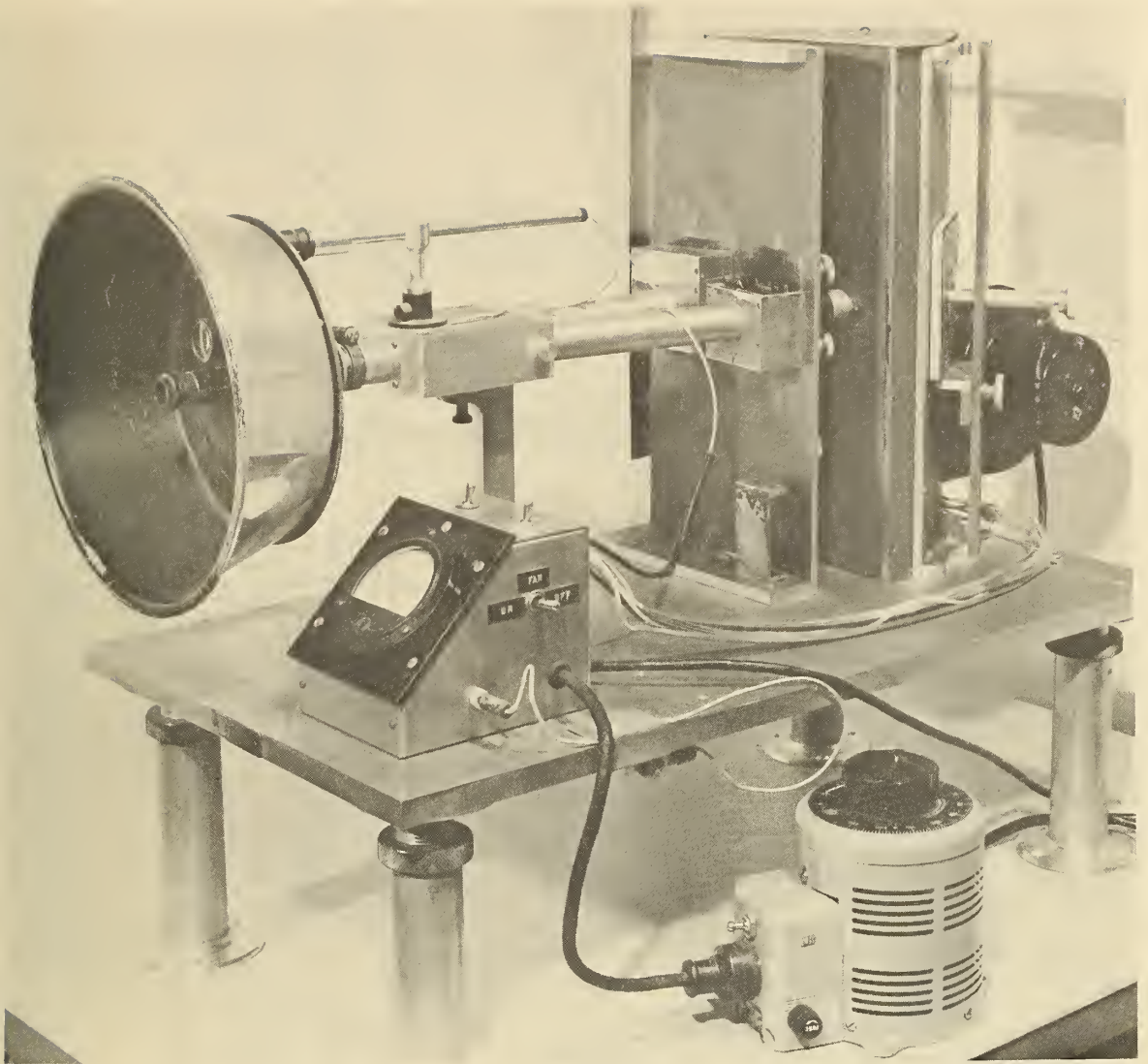


Figure 2. Haupt reflecto-transmissometer which incorporates a Martens photometer (Mph) to measure both luminous transmittance and luminous reflectance.

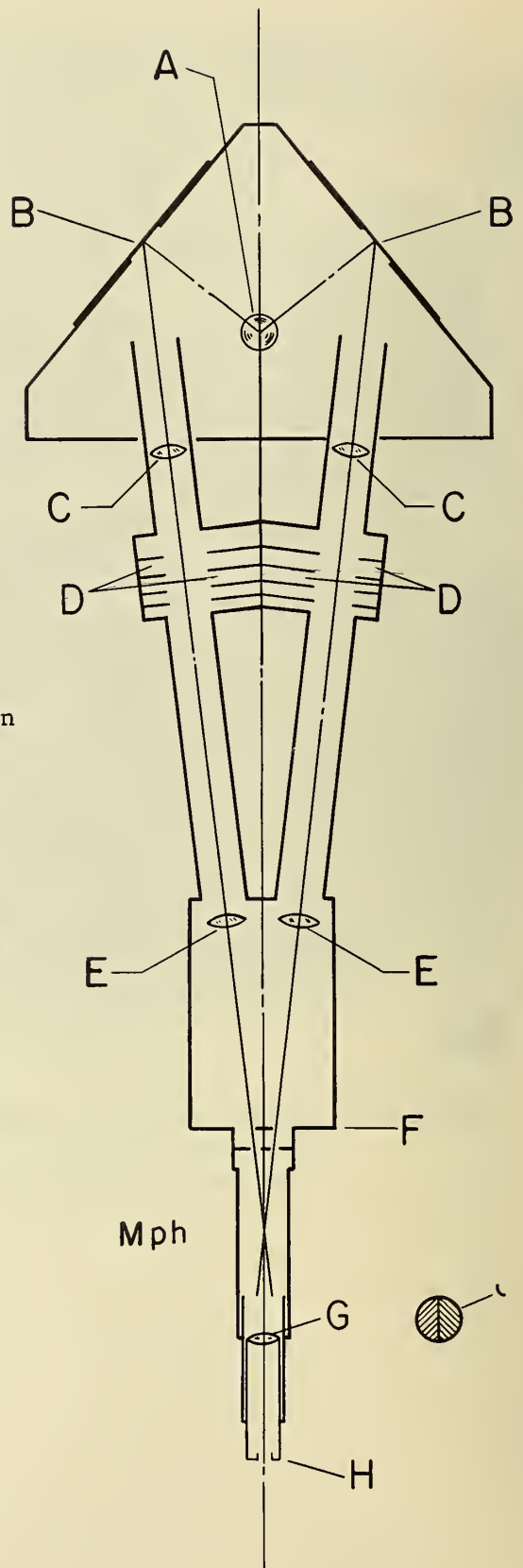


Figure 3. Schematic diagram of Haupt reflecto-transmissometer.

- A Light source, 50 watt projection lamp
- B,B Removable white enamel plaques used as reflecting surfaces
- C,C Collimating lenses (10 diopter) near front of lamp housing
- D,D Boxes with covers to hold glass filters (2-inch squares) of different thicknesses
- E,E Removable collimating lenses (10 diopter) perpendicular to beam in supporting holder
- F Front of supporting holder for Martens photometer
- Mph Martens photometer
- G Lens to magnify viewing field of Martens photometer
- H Eye piece
- J View of photometric field of Martens photometer

Table 3. Description of Red Standards with Spectral Data References

(1) Color	(2)	(3)	(4)		(5)	(6)	(7)	(8)	(9)	(10)	(11)	
			R59 -61	R59 Tr. 1966								
			Filter Number				Corning Type Numbers	Melt	Thick- ness (mm)	Source of Spec- tral data, Year	Identifica- tion No.	
			F. Std. No. 3	Hdbk 95								
RED			3055A		3.086	2404 243			2.13 1.61	GE I RP 1688 Cary	1942 1932 1963	1 2 3
	86											
	211	211			3.154	244 243 244		213	5.14 3.66 2.50	Cary RP 1688 Cary	1961 1934 1963	4 5 6
	154		3113A			R4D 244			2.10	Cary	1961	7
	400				3.126	244			3.01	RSSR No. 3	1932	8
	X 126		3172A			2410		3-10-43	2.56	GE I	1943	9
		201				244			2.99	RP 1688	1937	10
			3218A			G24		1-16-40	4.50	GE I	1942	11
	75	75			3.075	L5b			3.11	RP 1688	1941	12
										Cary	1966	13
					3.640	2424		876	1.79	Cary	1966	14
			3656A			2424		405	2.85	GE II 10mm	1956	15
			3647A			246		235	2.12	GE I (2)	1942	16
										Cary	1961	17
										Cary	1962	18

Table 3. (Continued) Description of Yellow Standards with Spectral Data References

(1) Color	(2)	(3)	(4) Filter Number		(5)	(6)	(7) Corning Type Numbers	(8) Melt	(9) Thickness (mm)	(10) Source of Spectral data, Year	(11) Identification No.
			R59	Tr. 1966							
YELLOW											
					3840A		349		3.14	GE I (2)	1942
		271					349	Y-4	1.90	RP 1688	1937
	X200				4.200		349		1.61	RP 1688	1932
	X142						330	10-19-26	4.80	RP 1688	1932
							351		3.74	GE I	1942
	X199		199		4.199		350	Y-3	1.65	RP 1688	1932
							3482	1-30-43	1.60	GE I 8nm	1946
					4.166		4384		1.22	Cary	1963
	X141						330	5-18-27	2.50	RP 1688	1932
		261			4.261		350	Y-2	3.10	RP 1688	1937
							338-2	12-20-39	2.80	Cary	1966
			359							KM, GE I	1940
										Cary	1964

Table 3• (Continued) Description of Green Standards with Spectral Data References

(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)	(9)	(10)	(11)
			Filter	Tr.							
Color	R69 -59	R59 -61	No. 3	F.Std. 1966	Hdbk 95	Corning Type Numbers	Melt	Thick- ness (mm)	Source of Spec- tral data, Year	Identifica- tion No.	
GREEN			6306A			4010	505	5.36	KM,GE I(2)	1943	32
			6310A			4010	261	5.32	Cary	1961	33
			6327A			4010	399	3.10	KM,GE I(3)	1943	34
			6319A			G401CZ		2.99	Cary	1965	35
			6905A			Kopp	Special	4.56	Cary	1965	36
			6917A			4102	559	3.00	KM,GE I(3)	1943	37
			6916J-A			Kopp	Special	2.80	Cary	1960	38
			7321A			4445	12-21-42	5.68	KM,GE I(2)	1943	39
			7322A			4441	236	4.68	GE I	1942	40
			7327A			4445	12-21-42	4.82	KM,GE I	1944	41
					7.136	4445	2347	4.29	Cary	1964	42
		322			7.322	444	12-04-33	3.79	RP 1688	1937	43
			7342A			4445	12-21-42	3.35	Cary	1966	44
X87					7.087	440	9-10-26	5.79	GE II 10mm	1956	45
						406	4-01-31	1.65	RP 1688	1932	46
140					7.137	444	3-09-31	2.42	Cary	1962	47
		X137				4445	12-21-42	2.66	RP 1688	1932	48
						440	12-19-34	4.36	GE I	1944	49
						440	9-10-26	4.30	GE I(3)	1942	50
X134					7.134	440	4-01-31	1.25	Cary	1966	51
						4060	4-01-31	1.30	RP 1688	1932	52
						406	4-01-31	1.25	Cary	1962	53
						406	4-01-31	1.25	GE I	1943	54
						406	4-01-31	1.25	RP 1688	1932	55
						406	4-01-31	1.25	Cary	1962	56
						406	4-01-31	1.25	GE I	1943	57
						406	4-01-31	1.25	RP 1688	1932	58



Table 3. (Continued) Description of Blue and Lunar White Standards with Spectral Data References

(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)	(9)	(10)	(11)
			Filter Number	Tr. 1966							
Color	R69 -59	R59 -61	F. Std. No. 3	Hdbk 95	Corning Type Numbers	Melt	Thickness (mm)	Source of Spectral data, Year	Identification No.		
BLUE		B131		8.131	554	11-11-26	3.61	RP 1688	1937	59	
					5543	403	3.15	Cary	1965	60	
	X57B		8213A	8.057	556	2-25-27	5.72	KM, GE I	1944	61	
		B141		8.141	554	11-11-26	2.62	RP 1688	1932	62	
	X47B		8.047	556	5543	1-13-27	6.30	Cary	1966	63	
				5543	5543	403	2.38	RP 1688	1937	64	
				8219A		403	2.38	Cary	1965	65	
				8219B		403	2.38	RP 1688	1932	66	
LUNAR WHITE				8449A	557	1-16-35	4.43	GE I	1942	69	
				8430A	557	1-16-35	5.96	GE I (3)	1942	70	
	X74				557	2-23-27	8.45	RP 1688	1932	71	
	X45				557	6-22-26	5.40	Cary	1966	72	
	X73				557	2-23-27	5.40	RP 1688	1932	73	
					557	1-16-35	2.71	Cary	1966	74	
	124				557	1-16-35	2.71	RP 1688	1932	75	
								Cary	1966	76	
								RP 1688	1935	77	
								Cary	1966	78	

Table 3. (Continued) Description of Purple Standards with Spectral Data References

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
											Filter Number
Color	R69	R59	Tr. F. Std	Hdbk							
	-59	-61	1966 No. 3	95							
PURPLE											
	V108					560	1-02-30	1.69	RP 1688	1935	79
	XV80					560	4-07-30	1.40	RP 1688	1932	80
	XV47P					555	8-26-26	5.68	RP 1688	1932	81
	XV56					555	8-26-26	4.34	RP 1688	1932	82

Footnotes for Table 3:

- Columns 2,3. X, one of the original 22 limit filters engraved JCM 11-6-31  
V, purple filters in railroad specifications 69-35 thru 69-48 only  
Column 7. Corning Glass Works is the maker of all the filters except 6905A and 6916J-A.  
Column 10. Except for 3656A, 3964A and 7342A spectral data were obtained with slits of band width 4nm or less  
R59 No. 3, Railroad Signal Section Report No. 3, spectrophotometers used: König-Martens visual (KM) and Gibson direct-reading photoelectric (PE)  
RP 1688, spectrophotometers used: KM and PE  
GE I, General Electric Recording Spectrophotometer, 4nm slits used except where specified 8nm  
GE II, General Electric Recording Spectrophotometer, 10nm slits  
Cary, Cary Recording Spectrophotometer, Model 14M (Serial No. 173)  
Column 11. Used to identify filters of figures 4, 5 and table 7.

and chromaticness indices ( $U^*, V^*$ ) according to the system recommended by CIE in 1964 [38].

Since some spectral transmittance data used in these derivations are much more recent than others (table 3, column 10), it was decided to check again the permanence of these filters. A method for measuring permanence is to determine the total color difference,  $\Delta E$ , between the color recently obtained ( $U^*_r, V^*_r, W^*_r$ ) and the color previously obtained ( $U^*_e, V^*_e, W^*_e$ ) for the same filter. To accomplish this the CIE color difference<sup>10</sup>,  $\Delta E$ , for CIE standard illuminant A was computed for filters for which recent (r) and early (e) spectral transmittance data were available on the same filter. The formula defining the CIE unit of color difference is that given by Wyszecki and Stiles [34, page 461]:

$$\Delta E = [ (U^*_r - U^*_e)^2 + (V^*_r - V^*_e)^2 + (W^*_r - W^*_e)^2 ]^{1/2} \quad (5)$$

Knowledge of the stability of standard filters has always been important in connection with the issuance of duplicates. NBS data have been analyzed for changes in the standards that might result in errors in the certification of duplicate filters calibrated by comparison with the standards on the chromaticity-difference colorimeter and the reflecto-transmissometer. There has been little evidence over the years that the chromaticity of the standards has changed. One of the reasons, perhaps, is that much care has been taken to protect them from improper exposure and use. An analysis of the data, some of which extends over a 34-year period, was undertaken. Table 4 shows, for CIE standard illuminant A, the changes obtained in chromaticity coordinates  $x, y, z, u, v$ , luminous transmittance,  $Y$  and total color difference,  $\Delta E$ , for a number of red, yellow, green, blue and lunar white filters. The most noticeable changes are seen to occur among the red filters where  $\Delta E$  values (column 8) are large and  $\Delta Y$  values (column 5) are also large. Except for one red filter,  $\Delta Y$  values are all positive, indicating an increase in transmittance with age. By keeping the luminous transmittance constant for each red filter but permitting the chromaticity changes, another set of  $\Delta E$  values was computed (column 9 of the same table). This procedure arbitrarily sets  $\Delta Y=0$  and thereby effects considerable reduction in  $\Delta E$ ; for twelve red filters the average chromaticity change is reduced from 1.5 to 0.4. One concludes, therefore, that the limit filters have changed very little, except for red filters where chromaticity has undergone very little change but where luminous transmittance is increasing.

The positive signs in  $\Delta Y$  may be an indication of "blooming" of surfaces. Blevin, [39], observed similar changes in transmittance in a group of neutral filters during a period of about five years. Formation of a reflectance-reducing film on the surface of a glass filter came to

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<sup>10</sup>One CIE unit of color difference is equal, on the average, to about one NBS unit [34, page 468] and one NBS unit is about four times the size of color difference detectable 95% of the time under optimum conditions [26, page 30].



our attention in 1952<sup>11</sup> when a red limit filter (number 154) was remeasured. In November 1955, this red filter was repolished and measured again. Table 5 shows that after polishing, the spectral transmittance values obtained on the Beckman DU manual spectrophotometer [23] had decreased for all wavelengths greater than 600 nm. This decrease in spectral transmittance indicates that a reflectance-reducing film was removed by polishing. The previous upward drift in transmittance is therefore ascribed to the gradual formation of such a film. This subject is also discussed in a 1963 paper [40] by Keegan, Schleter and Belknap, in which the statement is made that the indicated rate of upward drift is slow, and that it takes about 10 years for the drift to exceed the assigned uncertainty. The paper [40] reports a recalibration, made in 1961 and 1962, of four glasses (selenium-red, carbon-yellow, copper-green, cobalt-blue) on three spectrophotometers (Cary 14, Beckman DU, König-Martens). From table 4 it may be seen that the yellow, blue, lunar white and green filters (except for two greens) show  $\Delta E$  values no greater than 0.5 for a period of time ranging from 17 to 34 years. Two identification green filters, 6327A and 6319A, have CIE  $\Delta E^{10}$  values (table 4, column 8) slightly less than 0.9 on the average but the  $\Delta Y$  values (column 5) are not correspondingly large.

To determine whether or not these  $\Delta E$  values are excessively large for this interval of time (20 to 30 years), differences in chromaticity, luminous transmittance and color for a much shorter time were computed. Table 6 shows the differences in x,y,z,Y,u,v, between two sets of measurements made with the same Cary recording photoelectric spectrophotometer [24] (Model 14M, Serial No. 173). The maximum change in luminous transmittance for red filter number 75 was found to be +0.0019 over a period of five years as compared to +0.0034 for a 20 year period and +0.0053 for a 25 year period; see table 4, column 5. Except for this filter, the differences are of the order of the uncertainties which may be expected from repeated measurements on this spectrophotometer for certain red and green glasses used as signal limit filters. The total color difference,  $\Delta E$ , shown in table 6, indicates that the uncertainty of measurement is about 0.5 unit for these red and green glasses.

There are no data with which to make similar comparisons for yellow, blue, lunar white or purple filters but the  $\Delta E$  values (table 4, column 8), computed for the yellow, blue and lunar white filters, indicate that for a period of years ranging from 17 to 34, the changes in these filters are no greater than 0.5.

From the data given in tables 4 and 5 it may be concluded that there has been little or no change in chromaticity in any of these filters, but that a reflectance-reducing film has formed on the surface of the selenium-red glasses causing an increase in transmittance. In some cases this increase in  $\Delta Y$  for CIE standard illuminant A amounts to as much as 0.006 (table 4, column 5) over a period of 20 to 30 years.

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<sup>11</sup> Report 1711 June 10, 1952 by K.S. Gibson and Marion A. Belknap to Alan J. Werner, Corning Glass Works, who had noted certain inconsistencies in results among red glasses.

Table 4. Permanence Study. Colorimetric, photometric and total color difference between recent (r) and early (e) data for each filter shown. (CIE standard illuminant A.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Filter Number	$\Delta x$	$\Delta y$	$\Delta z$	$\Delta Y$	$\Delta u$	$\Delta v$	$\Delta E$	$\frac{\Delta E}{\Delta Y=0}$	Years	
RED										
3055A	.0001	-.0001	.0000	.0006	.0004	.0000	0.8	0.1	19	
86	-.0002	.0002	.0000	.0027	-.0006	.0001	2.9)	.2	29	
	-.0001	.0001	.0000	.0019	-.0003	.0000	2.1)	2.5	31	
211	-.0001	.0001	.0000	.0014	-.0003	.0001	1.1	.1	24	
154	-.0002	.0002	.0000	.0037	-.0003	.0000	2.6	.2	27	
3113A	.0005	-.0005	.0000	-.0009	.0012	-.0001	0.2)	0.3	20	
	.0004	-.0004	.0000	.0001	.0009	-.0001	0.5)	.5	22	
400	-.0006	.0006	.0000	.0045	-.0014	.0001	2.1	.8	20	
126	-.0001	.0002	-.0001	.0034	-.0003	.0001	1.7	.2	29	
201	.0000	.0000	.0000	.0019	.0001	.0000	1.1	.1	24	
3218A	.0001	-.0001	.0000	.0020	.0001	.0000	1.0	.1	19	
75	-.0003	.0003	.0000	.0034	-.0005	.0001	1.3)	1.5	20	
	-.0005	.0005	.0000	.0053	-.0011	.0001	1.8)	.7	25	
3656B <sup>1</sup>	.0008	-.0008	.0000	.0057	.0015	-.0001	2.6)	1.2	17	
	.0008	-.0009	-.0001	.0054	.0016	-.0002	2.7)	2.7	18	
3647A	-.0010	.0010	.0000	.0044	-.0018	.0002	0.6)	0.6	19	
	-.0008	.0008	.0000	.0056	-.0014	.0001	0.5)	1.1	20	
						Average	1.5	0.4		
YELLOW										
3955A	-.0001	.0001	-.0001	.0010	-.0001	.0000	0.1		19	
261	-.0001	.0001	.0000	-.0005	-.0001	.0000	0.2		29	
359	-.0005	.0005	.0000	.0030	-.0005	.0001	0.5		24	
						Average	0.3			
GREEN										
6310A	.0020	-.0004	-.0016	.0005	.0008	.0001	0.2		19	
6327A	-.0032	.0038	-.0005	-.0011	-.0018	.0003	0.7		22	
6319A	.0038	-.0013	-.0025	-.0001	.0018	.0001	1.0		24	



Table 4. (Continued) Permanence Study. Colorimetric, Photometric and total color difference between recent (r) and early (e) data for each filter shown. (CIE standard illuminant A)

Filter Number	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	$\Delta x$	$\Delta y$	$\Delta z$	$\Delta Y$	$\Delta u$	$\Delta v$	$\Delta E$	$\Delta E$	$\frac{\Delta E,}{\Delta Y=0}$	Years
GREEN (continued)										
6905A	.0029	.0007	-.0036	.0006	.0012	.0003	0.4)	0.4		22
	.0036	.0019	-.0055	.0007	.0014	.0006	0.4)			22
6916J-A	.0000	.0020	-.0020	.0000	-.0003	.0004	0.2			19
322	-.0007	-.0007	.0014	-.0009	-.0003	-.0003	0.2			29
87	-.0007	-.0012	.0020	-.0006	-.0002	-.0004	0.3			30
137	-.0006	-.0008	.0014	-.0019	-.0002	-.0003	0.3			34
7346A	.0011	.0001	-.0012	-.0002	.0006	.0001	0.5			19
134	-.0013	-.0005	.0018	-.0012	-.0007	-.0003	0.4)	0.5		29
	-.0016	-.0018	.0034	-.0036	-.0006	-.0006	0.5)			30
						Average	0.4			
BLUE										
B131	-.0001	-.0001	.0002	.0001	-.0001	-.0001	0.3			28
57B	.0002	-.0008	.0007	-.0003	.0006	-.0010	0.4			34
B141	-.0007	-.0010	.0016	.0001	-.0003	-.0010	0.4			28
47B	.0001	.0006	-.0007	.0001	-.0001	.0006	0.1			34
8213B <sup>1</sup>	-.0001	-.0003	.0004	-.0002	.0000	-.0004	0.3			18
8219B <sup>1</sup>	.0008	.0013	-.0021	.0004	.0002	.0012	0.2			17
8240 <sup>1</sup>	.0003	.0015	-.0018	.0004	-.0004	.0018	0.5			18
						Average	0.3			
LUNAR WHITE										
74	.0000	.0001	.0001	.0000	.0000	.0000	0.0			34
45	.0007	.0006	-.0013	.0014	.0002	.0003	0.2			34
73	.0002	.0002	-.0004	-.0032	.0001	.0001	0.4			34
124	-.0004	-.0004	.0008	.0004	-.0001	-.0002	0.2			31
						Average	0.2			

<sup>1</sup>Footnote for Table 4. See Appendix B.

Table 5. Influence of polishing selenium-red filter on its spectral transmittance

<u>Wavelength</u> <u>(nm)</u>	<u>Spectral Transmittance</u> <u>Beckman (Model DU)</u>		<u>Difference</u>
	<u>1952</u>	<u>1956</u>	
590	0.0000		
600	.0003	0.0024	+0.0021
610	.031	.020	- .011
620	.46	.44	- .02
630	.74	.73	- .01
640	.816	.811	- .005
650	.838	.835	- .003
660	.852	.845	- .007
670		.853	
680	.863	.857	- .006
690		.860	
700	.866	.861	- .005
710		.861	
720	.864	.860	- .004
730		.857	
740		.855	
750	.857	.852	- .005
760		.849	

Table 6. Colorimetric and photometric differences between two sets of Cary 14 measurements on the same filter.

Color	Filter Number	Period of Years	2855.6 kelvin						$\Delta E$
			$\Delta x$	$\Delta y$	$\Delta z$	$\Delta Y$	$\Delta u$	$\Delta v$	
Red	86	2	+0.0002	-0.0002	.0000	-0.0008	+0.0003	.0000	0.8
	3113A	2	-0.0001	+0.0001	.0000	+0.0010	-0.0003	.0000	.6
	75	5	-0.0002	+0.0002	.0000	+0.0019	-0.0005	.0000	.5
	3647A	1	+0.0003	-0.0001	-0.0001	+0.0012	+0.0004	.0000	.6
	3656B	1	.0000	-0.0001	+0.0001	-0.0003	+0.0001	-0.0001	.1
			Average						0.5
Green	6905A	0	+0.0007	+0.0012	-0.0019	+0.0001	+0.0002	+0.0003	.1
	134	1	-0.0003	-0.0013	+0.0016	-0.0024	+0.0001	-0.0003	.5

Because of these conclusions, the spectrophotometric data (early or more recent or both) are presented in table 7 for each filter described in table 3 with one exception<sup>12</sup>. The colorimetric data shown have been computed for eleven illuminants. The range of illuminants specified by distribution temperatures is based upon the variation in distribution-temperature of lamps now in use for signal lighting including airport lighting under conditions varying from daytime fog to clear-night darkness (1500 to 3100 kelvins). Two additional CIE standard illuminants (B,C) are included because they are recommended for use in colorimetric specifications of object colors.

The data for table 7 were reproduced directly from the computer output. Therefore the column headings are of necessity limited to the upper-case font available on the printer. The column headings have the following significance: "1931 CIE CAP X, CAP Y, CAP Z," the CIE 1931 system tristimulus values and "X,Y,Z," the chromaticity coordinates x, y, z; "1960 CIE U, V", CIE 1960 system chromaticity coordinates u, v; and "1964 CIE CAP U\*, CAP V\*, CAP W\*", the CIE 1964 system chromaticness indices U\*,V\* and brightness index W\*.

It should be noted that while the values of U\* and V\* have been computed for eleven illuminants and given in table 7, each set of (U\*,V\*) values for a given illuminant has been computed from equation 4 which is dependent upon values of the variables u, v of the achromatic point, designated  $u_0$ ,  $v_0$ , for the respective illuminant. The values  $u_0$ ,  $v_0$  for each illuminant used are given below:

Identification of Illuminant

Distribution temperature kelvins $c_2=14,387.9 \mu\text{mK}$	CIE standard illuminant	$u_0$	$v_0$
1500.8		0.35776	0.36034
1700.9		.33338	.36048
1905.0		.31314	.35970
2101.2		.29713	.35828
2366.3		.27958	.35564
2601.4		.26705	.35285
2855.6	A	.25595	.34955
3051.7		.24875	.34692
3251.8		.24241	.34421
	B	.21363	.32350
	C	.20083	.30733

<sup>12</sup> In table 7, blue filter 8219A which is listed in table 3 is omitted because the only set of spectral data for it was obtained with undesirably wide slits (GE II spectrophotometer, spectral band pass approximately 10nm). Data are presented for filter 8219B because it was from the same melt of glass, polished to the same thickness and has data for narrower slits obtained by means of the Cary spectrophotometer. See table 4 including footnote.



Table 7. Spectrophotometric Data (Identification Nos. [1] to [82]) for Signal-Glass Limit Filters together with Colorimetric Data computed for eleven Illuminants. Source of spectral data and description of standards listed in table 3. (Table 7 continues through page 108.)

1942 [ 1 ]

RED 3055A(FS3)  
2 DEGREE OBSERVER

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	88300
	.00000	.00000	.00000	.00000	.88300
	.00000	.00000	.00000	.00000	.88300
	.00000	.00000	.00000	.01000	.88300
	.00000	.00000	.00000	.19200	.88400
	.00000	.00000	.00000	.63900	.88300
	.00000	.00000	.00000	.81900	.88100
	.00000	.00000	.00000	.86100	.88000
	.00000	.00000	.00000	.87200	.87900
380	.00000	.00000	.00000	.87900	
390	.00000	.00000	.00000	.88200	

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE		
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W
1500.8	34.704	13.174	.000	.72484	.27516	.00000	.59754	.34025	-10.984
1700.9	28.649	10.895	.000	.72449	.27551	.00000	.59665	.34034	-10.060
1905.0	24.292	9.251	.000	.72421	.27579	.00000	.59594	.34041	-8.897
2101.2	21.217	8.088	.000	.72400	.27600	.00000	.59539	.34046	-7.688
2366.3	18.177	6.937	.000	.72377	.27623	.00000	.59481	.34052	-6.031
2601.4	16.193	6.185	.000	.72360	.27640	.00000	.59439	.34056	-4.614
2855.6	14.549	5.561	.000	.72346	.27654	.00000	.59402	.34060	-3.178
3051.7	13.535	5.176	.000	.72336	.27664	.00000	.59378	.34062	-2.150
3251.8	12.671	4.848	.000	.72328	.27672	.00000	.59357	.34064	-1.175
CIE B	9.350	3.582	.000	.72302	.27697	.00000	.59293	.34071	4.754
CIE C	7.774	2.981	.000	.72284	.27716	.00000	.59246	.34075	8.245
									96.626
									131.056
									131.495
									130.439
									128.668
									125.729
									122.945
									119.953
									117.723
									115.549
									104.784

RED 86(R69),3.086(HB95)  
2 DEGREE OBSERVER

1932

[ 2 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.00050	700	.85800
410	.00000	510	.00000	610	.00190	710	.85900
420	.00000	520	.00000	620	.02200	720	.85800
430	.00000	530	.00000	630	.23000	730	.85700
440	.00000	540	.00000	640	.65000	740	.85500
450	.00000	550	.00000	650	.79800	750	.85200
460	.00000	560	.00000	660	.83300	760	.84900
470	.00000	570	.00000	670	.84400	770	.84600
480	.00000	580	.00010	680	.85200		
490	.00000	590	.00020	690	.85600		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	35.091	13.372	.000	.72407	.27592	.00000	.59558	.34044	130.898	-10.953	42.339
1700.9	29.049	11.092	.000	.72367	.27633	.00000	.59457	.34054	131.586	-10.043	38.754
1905.0	24.688	9.442	.000	.72335	.27665	.00000	.59376	.34062	130.742	-8.886	35.839
2101.2	21.602	8.272	.000	.72310	.27689	.00000	.59313	.34069	129.140	-7.676	33.560
2366.3	18.544	7.111	.000	.72283	.27716	.00000	.59245	.34075	126.388	-6.014	31.074
2601.4	16.544	6.350	.000	.72264	.27736	.00000	.59197	.34080	123.737	-4.586	29.294
2855.6	14.884	5.718	.000	.72247	.27753	.00000	.59154	.34085	120.863	-3.137	27.704
3051.7	13.859	5.327	.000	.72236	.27764	.00000	.59125	.34087	118.710	-2.096	26.662
3251.8	12.985	4.993	.000	.72226	.27774	.00000	.59100	.34090	116.602	-1.109	25.731
CIE B	9.603	3.698	.000	.72195	.27804	.00000	.59024	.34097	106.053	4.922	21.661
CIE C	7.998	3.084	.000	.72173	.27826	.00000	.58969	.34103	98.013	8.493	19.389

RED 86(R69), 3.086(HB95)  
2 DEGREE OBSERVER

1963

[ 3 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.00040	700	.87000
410	.00000	510	.00000	610	.00190	710	.87100
420	.00000	520	.00000	620	.02190	720	.86960
430	.00000	530	.00000	630	.25000	730	.86940
440	.00000	540	.00000	640	.68030	740	.86540
450	.00000	550	.00000	650	.81100	750	.86300
460	.00000	560	.00000	660	.84300	760	.86140
470	.00000	570	.00000	670	.85510	770	.85660
480	.00000	580	.00000	680	.86300		
490	.00000	590	.00010	690	.86860		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	CAP V*	1964 CIE	CAP W*
1500.8	36.139	13.781	.000	.72393	.27606	.00000	.59523	.34048	132.551	-11.088	42.938	
1700.9	29.939	11.440	.000	.72353	.27646	.00000	.59422	.34058	133.366	-10.175	39.331	
1905.0	25.460	9.744	.000	.72322	.27678	.00000	.59341	.34066	132.614	-9.008	36.397	
2101.2	22.288	8.540	.000	.72297	.27703	.00000	.59279	.34072	131.075	-7.785	34.101	
2366.3	19.143	7.345	.000	.72270	.27729	.00000	.59212	.34079	128.381	-6.101	31.596	
2601.4	17.085	6.561	.000	.72251	.27748	.00000	.59165	.34083	125.764	-4.654	29.803	
2855.6	15.376	5.910	.000	.72235	.27765	.00000	.59122	.34088	122.914	-3.181	28.200	
3051.7	14.320	5.507	.000	.72224	.27776	.00000	.59095	.34090	120.773	-2.124	27.149	
3251.8	13.420	5.163	.000	.72214	.27786	.00000	.59070	.34093	118.674	-1.119	26.210	
CIE B	9.929	3.826	.000	.72185	.27815	.00000	.58997	.34100	108.127	5.030	22.101	
CIE C	8.273	3.191	.000	.72163	.27836	.00000	.58943	.34106	100.061	8.683	19.807	

RED 211(R69), 211(R59)  
2 DEGREE OBSERVER

1961

[ 4 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700
	.00000	.00000	.00010	.82400
	.00000	.00000	.00270	.82400
	.00000	.00000	.22500	.82200
	.00000	.00000	.62100	.81900
	.00000	.00000	.640	.81600
	.00000	.00000	.75000	.81200
	.00000	.00000	.650	.80200
	.00000	.00000	.660	.78900
	.00000	.00000	.670	
380	.00000	.00000	.680	
390	.00000	.00000	.690	

C2=14387.9 MU-M K

ILLUMINANT KELVINS	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	CAP U*	CAP V*	CAP W*
1500.8	46.104	18.040	.001	.71875	.28124	.00002	.58229	.34177	141.760	-11.727	48.567
1700.9	38.888	15.262	.001	.71814	.28184	.00002	.58081	.34192	144.783	-10.862	45.012
1905.0	33.560	13.202	.001	.71766	.28232	.00002	.57963	.34203	145.803	-9.664	42.087
2101.2	29.721	11.713	.001	.71729	.28269	.00002	.57873	.34212	145.614	-8.355	39.776
2366.3	25.854	10.209	.001	.71689	.28309	.00002	.57776	.34222	144.334	-6.497	37.234
2601.4	23.287	9.208	.001	.71661	.28337	.00002	.57708	.34229	142.676	-4.859	35.400
2855.6	21.132	8.366	.001	.71636	.28362	.00002	.57647	.34235	140.637	-3.162	33.752
3051.7	19.788	7.841	.001	.71620	.28378	.00002	.57607	.34239	138.999	-1.926	32.666
3251.8	18.635	7.389	.001	.71605	.28393	.00002	.57572	.34242	137.327	-.738	31.693
CIE B	13.972	5.551	.000	.71565	.28433	.00002	.57474	.34252	128.001	6.743	27.266
CIE C	11.763	4.680	.000	.71535	.28463	.00002	.57401	.34259	120.402	11.376	24.818



RED 154(R69),154(TR),3.154(HB95)  
2 DEGREE OBSERVER

1934

[ 5 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.00030	700	.85300
410	.00000	510	.00000	610	.03700	710	.85200
420	.00000	520	.00000	620	.41000	720	.85000
430	.00000	530	.00000	630	.71000	730	.84800
440	.00000	540	.00000	640	.79600	740	.84600
450	.00000	550	.00000	650	.82000	750	.84300
460	.00000	560	.00000	660	.83300	760	.84000
470	.00000	570	.00000	670	.84200	770	.83600
380	.00000	580	.00000	680	.84800		
390	.00000	590	.00000	690	.85100		

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	53.133	21.064	.002	.71608	.28389	.00003	.57581	.34241	147.518	-12.130	52.043
1700.9	45.137	17.959	.002	.71535	.28462	.00003	.57403	.34259	151.631	-11.270	48.469
1905.0	39.181	15.634	.002	.71476	.28521	.00003	.57262	.34273	153.523	-10.038	45.512
2101.2	34.860	13.940	.002	.71431	.28565	.00003	.57154	.34284	153.998	-8.666	43.168
2366.3	30.480	12.218	.001	.71383	.28614	.00003	.57038	.34295	153.410	-6.693	40.580
2601.4	27.555	11.064	.001	.71348	.28648	.00003	.56956	.34304	152.221	-4.936	38.707
2855.6	25.088	10.089	.001	.71318	.28679	.00004	.56883	.34311	150.576	-3.102	37.020
3051.7	23.546	9.478	.001	.71298	.28699	.00004	.56835	.34316	149.182	-1.758	35.906
3251.8	22.217	8.951	.001	.71280	.28716	.00004	.56793	.34320	147.716	-.461	34.907
CIE B	16.750	6.764	.001	.71231	.28766	.00004	.56676	.34332	139.010	7.802	30.281
CIE C	14.160	5.729	.001	.71194	.28802	.00004	.56589	.34340	131.613	13.003	27.732

RED 3113A(FS3)  
2 DEGREE OBSERVER

1963

[ 6 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.00000	700	.88720
410	.00000	510	.00000	610	.00000	710	.88680
420	.00000	520	.00000	620	.00000	720	.88470
430	.00000	530	.00000	630	.00000	730	.88310
440	.00000	540	.00000	640	.00000	740	.88060
450	.00000	550	.00000	650	.00000	750	.87960
460	.00000	560	.00000	660	.00000	760	.87600
470	.00000	570	.00000	670	.00000	770	.87400
480	.00000	580	.00000	680	.00000		
490	.00000	590	.00000	690	.00000		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	56.296	22.328	.002	.71599	.28398	.00003	.57559	.34243	151.206	-12.430	53.398
1700.9	47.837	19.042	.002	.71525	.28472	.00003	.57380	.34261	155.518	-11.556	49.760
1905.0	41.533	16.581	.002	.71466	.28531	.00003	.57238	.34276	157.547	-10.296	46.749
2101.2	36.958	14.787	.002	.71421	.28576	.00003	.57128	.34286	158.110	-8.891	44.362
2366.3	32.319	12.962	.002	.71372	.28625	.00003	.57011	.34298	157.598	-6.867	41.726
2601.4	29.221	11.740	.001	.71337	.28660	.00003	.56928	.34306	156.449	-5.063	39.819
2855.6	26.608	10.706	.001	.71306	.28691	.00004	.56854	.34314	154.827	-3.178	38.100
3051.7	24.974	10.058	.001	.71285	.28711	.00004	.56806	.34319	153.442	-1.796	36.966
3251.8	23.566	9.500	.001	.71267	.28729	.00004	.56763	.34323	151.979	-.460	35.948
CIE B	17.772	7.182	.001	.71217	.28779	.00004	.56643	.34335	143.251	8.060	31.233
CIE C	15.025	6.083	.001	.71180	.28816	.00004	.56556	.34343	135.775	13.439	28.636

RED 400(R69)  
2 DEGREE OBSERVER

1961

[ 7 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	88900
400	.00000	.00000	.01040	.01040	.88900
410	.00000	.00000	.17800	.17800	.88800
420	.00000	.00000	.63900	.63900	.88700
430	.00000	.00000	.81500	.81500	.88600
440	.00000	.00000	.86100	.86100	.88300
450	.00000	.00000	.87300	.87300	.88000
460	.00000	.00000	.88000	.88000	.87500
470	.00000	.00000	.88400	.88400	.86800
480	.00000	.00010	.88700	.88700	
490	.00000	.00060	.88800	.88800	

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	CAP U*	CAP V*	CAP W*
1500.8	64.064	25.912	.004	.71198	.28798	.00004	.56599	.34339	154.238	-12.556	56.979
1700.9	54.937	22.324	.004	.71103	.28893	.00005	.56374	.34362	159.893	-11.704	53.393
1905.0	48.057	19.600	.003	.71026	.28969	.00005	.56195	.34379	163.037	-10.421	50.405
2101.2	43.018	17.595	.003	.70968	.29027	.00005	.56058	.34393	164.474	-8.959	48.024
2366.3	37.867	15.536	.003	.70904	.29091	.00005	.55909	.34408	164.904	-6.822	45.381
2601.4	34.401	14.145	.003	.70859	.29136	.00005	.55804	.34418	164.411	-4.894	43.461
2855.6	31.461	12.961	.002	.70819	.29176	.00006	.55711	.34428	163.358	-2.863	41.725
3051.7	29.613	12.215	.002	.70792	.29202	.00006	.55650	.34434	162.333	-1.364	40.576
3251.8	28.016	11.570	.002	.70769	.29225	.00006	.55596	.34439	161.182	.091	39.543
CIE B	21.284	8.818	.002	.70702	.29292	.00006	.55441	.34454	153.503	9.481	34.649
CIE C	18.090	7.512	.002	.70654	.29339	.00006	.55332	.34465	146.460	15.506	31.961

RED 126(R69), 3.126(HB95)  
2 DEGREE OBSERVER

1932

[ 8 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.02400	700	.86200
410	.00000	510	.00000	610	.31000	710	.86100
420	.00000	520	.00000	620	.68000	720	.85900
430	.00000	530	.00000	630	.80000	730	.85700
440	.00000	540	.00000	640	.83200	740	.85400
450	.00000	550	.00000	650	.84800	750	.85100
460	.00000	560	.00000	660	.85500	760	.84800
470	.00000	570	.00000	670	.86000	770	.84500
480	.00000	580	.00010	680	.86300		
490	.00000	590	.00050	690	.86300		

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	66.188	27.108	.005	.70940	.29054	.00005	.55994	.34399	152.701	-12.348	58.100
1700.9	57.040	23.487	.005	.70830	.29165	.00006	.55737	.34425	158.970	-11.517	54.595
1905.0	50.103	20.718	.004	.70741	.29253	.00006	.55533	.34445	162.657	-10.237	51.663
2101.2	44.997	18.668	.004	.70673	.29321	.00006	.55376	.34461	164.539	-8.766	49.319
2366.3	39.754	16.551	.004	.70599	.29394	.00006	.55207	.34478	165.470	-6.596	46.712
2601.4	36.211	15.115	.003	.70547	.29446	.00007	.55087	.34490	165.342	-4.630	44.812
2855.6	33.196	13.887	.003	.70500	.29493	.00007	.54980	.34500	164.614	-2.549	43.091
3051.7	31.296	13.112	.003	.70470	.29523	.00007	.54911	.34507	163.802	-1.009	41.951
3251.8	29.651	12.439	.003	.70442	.29551	.00007	.54849	.34513	162.839	.490	40.925
CIE B	22.624	9.527	.002	.70364	.29629	.00007	.54670	.34531	155.869	10.209	35.997
CIE C	19.285	8.142	.002	.70309	.29683	.00008	.54547	.34544	149.166	16.491	33.294



RED 3172A(FS3)  
2 DEGREE OBSERVER

1943

[ 9 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.04600	700	.89300
410	.00000	510	.00000	610	.42100	710	.89300
420	.00000	520	.00000	620	.74400	720	.89300
430	.00000	530	.00000	630	.84500	730	.89200
440	.00000	540	.00000	640	.87400	740	.89100
450	.00000	550	.00000	650	.88500	750	.89000
460	.00000	560	.00000	660	.88800	760	.88900
470	.00000	570	.00000	670	.89200	770	.88800
480	.00000	580	.00000	680	.89300		
490	.00000	590	.00000	690	.89400		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	1964 CIE V*	CAP W*
1500.8	72.012	29.746	.006	.70763	.29231	.00006	.55584	.34440	155.684	-12.528	60.461
1700.9	62.267	25.870	.006	.70643	.29350	.00006	.55307	.34468	162.617	-11.695	56.939
1905.0	54.845	22.891	.005	.70548	.29446	.00007	.55088	.34490	166.845	-10.387	53.985
2101.2	49.363	20.677	.005	.70474	.29519	.00007	.54919	.34506	169.145	-8.869	51.617
2366.3	43.716	18.382	.005	.70393	.29599	.00007	.54738	.34524	170.516	-6.619	48.979
2601.4	39.890	16.819	.004	.70337	.29656	.00008	.54609	.34537	170.690	-4.571	47.053
2855.6	36.627	15.480	.004	.70286	.29706	.00008	.54495	.34549	170.220	-2.396	45.307
3051.7	34.567	14.633	.004	.70253	.29740	.00008	.54421	.34556	169.567	-.781	44.148
3251.8	32.781	13.896	.004	.70223	.29769	.00008	.54354	.34563	168.741	.792	43.105
CIE B	25.084	10.677	.003	.70137	.29855	.00008	.54162	.34582	162.241	11.042	38.050
CIE C	21.422	9.144	.003	.70078	.29914	.00008	.54030	.34595	155.687	17.710	35.278

RED 201(R59)  
2 DEGREE OBSERVER

1937

[ 10 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.05100	700	.86200
410	.00000	510	.00000	610	.41000	710	.86000
420	.00000	520	.00000	620	.71500	720	.85700
430	.00000	530	.00000	630	.80500	730	.85500
440	.00000	540	.00000	640	.83500	740	.85200
450	.00000	550	.00000	650	.84600	750	.84800
460	.00000	560	.00000	660	.85300	760	.84400
470	.00000	570	.00000	670	.85800	770	.84100
380	.00000	580	.00000	680	.86000		
390	.00000	590	.00100	690	.86100		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	1964 CIE CAP U*	CAP V*	CAP W*
1500.8	69.210	28.625	.006	.70737	.29256	.00006	.55524	.34446	152.680	-12.278	59.475
1700.9	59.863	24.906	.006	.70615	.29379	.00007	.55242	.34474	159.482	-11.456	56.008
1905.0	52.742	22.046	.005	.70517	.29476	.00007	.55018	.34497	163.628	-10.168	53.100
2101.2	47.481	19.919	.005	.70441	.29552	.00007	.54846	.34514	165.880	-8.675	50.769
2366.3	42.061	17.715	.004	.70359	.29633	.00007	.54661	.34532	167.219	-6.462	48.171
2601.4	38.387	16.213	.004	.70301	.29691	.00008	.54529	.34545	167.382	-4.447	46.274
2855.6	35.253	14.926	.004	.70249	.29743	.00008	.54412	.34557	166.912	-2.308	44.554
3051.7	33.274	14.111	.004	.70215	.29777	.00008	.54336	.34565	166.266	-.721	43.413
3251.8	31.559	13.403	.004	.70185	.29807	.00008	.54268	.34571	165.449	.826	42.385
CIE B	24.158	10.303	.003	.70096	.29896	.00008	.54070	.34591	159.023	10.898	37.400
CIE C	20.637	8.827	.003	.70035	.29956	.00009	.53935	.34604	152.559	17.446	34.667



RED 75(R69),75(TR),3.075(HR95)  
2 DEGREE OBSERVER

1941

[12]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.27000	700	.84100
410	.00000	510	.00000	610	.54000	710	.84600
420	.00000	520	.00000	620	.68500	720	.85100
430	.00000	530	.00000	630	.74200	730	.85400
440	.00000	540	.00000	640	.77100	740	.85700
450	.00000	550	.00000	650	.79000	750	.85700
460	.00000	560	.00000	660	.80400	760	.85700
470	.00000	570	.00000	670	.81700	770	.85700
480	.00000	580	.00000	680	.82600		
490	.00000	590	.03700	690	.83400		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT KELVINS	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	CAP U*	CAP V*	CAP W*
1500.8	71.989	30.839	.010	.70002	.29988	.00010	.53863	.34611	144.363	-11.355	61.399
1700.9	62.882	27.172	.009	.69820	.30170	.00010	.53461	.34652	152.144	-10.556	58.159
1905.0	55.867	24.309	.009	.69673	.30316	.00011	.53140	.34683	157.250	-9.266	55.420
2101.2	50.637	22.152	.008	.69559	.30430	.00011	.52892	.34708	160.348	-7.747	53.212
2366.3	45.200	19.890	.008	.69435	.30554	.00012	.52624	.34735	162.693	-5.469	50.736
2601.4	41.487	18.332	.007	.69346	.30642	.00012	.52434	.34754	163.623	-3.375	48.919
2855.6	38.297	16.986	.007	.69266	.30722	.00013	.52264	.34771	163.865	-1.135	47.264
3051.7	36.273	16.128	.007	.69214	.30774	.00013	.52153	.34782	163.696	.538	46.163
3251.8	34.511	15.378	.006	.69167	.30820	.00013	.52054	.34792	163.312	2.175	45.169
CIE B	26.700	11.980	.005	.69018	.30968	.00014	.51739	.34823	158.766	12.927	40.204
CIE C	22.973	10.356	.005	.68918	.31068	.00014	.51530	.34844	153.273	20.034	37.492



RED 75(R69),75(TR),3.075(HB95)  
2 DEGREE ORSERKVER

1966

[ 13 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	84700
	.00000	.00000	.00000	.28600	.84700
	.00000	.00000	.00000	.57800	.85400
	.00000	.00000	.00000	.70000	.85600
	.00000	.00000	.00000	.75600	.86000
	.00000	.00000	.00000	.78100	.86300
	.00000	.00000	.00000	.79800	.86400
	.00000	.00000	.00000	.81200	.86200
	.00000	.00000	.00000	.82200	.86200
	.00000	.00000	.00000	.83400	
380	.00000	.00000	.00000	.84200	
390	.00000	.00000	.00000		

C2=14387.9 MU=M K

ILLUMINANT KELVINS	1931 CIE			1960 CIE			1964 CIE		
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W
1500.8	73.777	31.678	.010	.69953	.30037	.00010	.53755	.34622	145.149
1700.9	64.505	27.939	.010	.69770	.30219	.00010	.53353	.34662	153.145
1905.0	57.353	25.014	.009	.69623	.30366	.00011	.53032	.34694	158.426
2101.2	52.014	22.809	.009	.69509	.30480	.00012	.52784	.34719	161.658
2366.3	46.460	20.492	.008	.69384	.30604	.00012	.52516	.34746	164.143
2601.4	42.662	18.896	.008	.69295	.30692	.00012	.52326	.34765	165.168
2855.6	39.399	17.516	.007	.69216	.30772	.00013	.52157	.34781	165.491
3051.7	37.326	16.635	.007	.69164	.30824	.00013	.52046	.34792	165.372
3251.8	35.521	15.865	.007	.69117	.30870	.00013	.51947	.34802	165.030
CIE B	27.501	12.368	.005	.68969	.31018	.00014	.51635	.34833	160.625
CIE C	23.672	10.696	.005	.68869	.31117	.00014	.51428	.34854	155.175
									20.400
									38.082

RED 3.640(HB95)  
2 DEGREE OBSERVER

1966

[ 14 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.81600	700	.90800
410	.00000	510	.00000	610	.88000	710	.90800
420	.00000	520	.00000	620	.90000	720	.91000
430	.00000	530	.00000	630	.90400	730	.90800
440	.00000	540	.00010	640	.90600	740	.91000
450	.00000	550	.00020	650	.90800	750	.91000
460	.00000	560	.00060	660	.90800	760	.90600
470	.00000	570	.00400	670	.91000	770	.90600
480	.00000	580	.07000	680	.91000		
490	.00000	590	.51500	690	.90800		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE		
	CAP X	CAP Y	CAP Z	U	V		CAP U*	CAP V*	CAP W*
KELVINS									
1500.8	105.439	49.234	.027	.68157	.31825	.00018	.49969	.34999	.137.692
1700.9	94.161	44.599	.026	.67846	.32135	.00019	.49349	.35061	149.153
1905.0	85.206	40.821	.025	.67596	.32384	.00020	.48857	.35110	157.538
2101.2	78.367	37.880	.024	.67400	.32579	.00021	.48477	.35148	163.342
2366.3	71.101	34.700	.023	.67188	.32790	.00022	.48068	.35189	168.736
2601.4	66.038	32.451	.022	.67036	.32942	.00023	.47778	.35217	171.882
2855.6	61.620	30.467	.021	.66900	.33077	.00023	.47520	.35243	174.103
3051.7	58.782	29.180	.021	.66810	.33166	.00024	.47352	.35260	175.223
3251.8	56.288	28.043	.020	.66731	.33245	.00024	.47203	.35275	175.975
CIE B	44.634	22.543	.017	.66426	.33549	.00025	.46636	.35331	176.178
CIE C	39.017	19.874	.015	.66235	.33739	.00026	.46287	.35366	172.768
									30.543 50.718

RED 3656A(FS3)  
2 DEGREE OBSERVER

1956

[15]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.81600	700	.90600
410	.00000	510	.00000	610	.89000	710	.90500
420	.00000	520	.00000	620	.90400	720	.90400
430	.00000	530	.00000	630	.90900	730	.90200
440	.00000	540	.00000	640	.90900	740	.90000
450	.00000	550	.00000	650	.90900	750	.89900
460	.00000	560	.00000	660	.90900	760	.90000
470	.00000	570	.01500	670	.90900	770	.90000
480	.00000	580	.12600	680	.90800		
490	.00000	590	.51600	690	.90800		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	1964 CIE V*	CAP V*	CAP W*
1500.8	106.446	50.018	.029	.68020	.31962	.00018	.49694	.35027	135.903	-9.839	75.112	
1700.9	95.155	45.388	.028	.67692	.32288	.00020	.49045	.35091	147.383	-8.975	72.177	
1905.0	86.180	41.606	.027	.67427	.32553	.00021	.48528	.35143	155.812	-7.485	69.628	
2101.2	79.319	38.656	.026	.67219	.32759	.00022	.48128	.35183	161.668	-5.668	67.530	
2366.3	72.024	35.461	.024	.66993	.32984	.00023	.47696	.35226	167.137	-2.867	65.135	
2601.4	66.936	33.199	.023	.66830	.33146	.00023	.47389	.35256	170.348	-.235	63.349	
2855.6	62.494	31.199	.023	.66685	.33291	.00024	.47117	.35283	172.635	2.629	61.702	
3051.7	59.639	29.902	.022	.66589	.33386	.00025	.46938	.35301	173.801	4.795	60.596	
3251.8	57.129	28.753	.021	.66503	.33472	.00025	.46780	.35317	174.597	6.937	59.590	
CIE B	45.390	23.195	.018	.66163	.33811	.00026	.46154	.35379	174.997	21.384	54.297	
CIE C	39.723	20.490	.016	.65953	.34020	.00027	.45775	.35417	171.704	31.301	51.410	

RED 3647A(FS3)  
2 DEGREE OBSERVER

1942

[ 16 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.81000	700	.87400
410	.00000	510	.00000	610	.86500	710	.87000
420	.00000	520	.00000	620	.87800	720	.86600
430	.00000	530	.00000	630	.88200	730	.86200
440	.00000	540	.00000	640	.88200	740	.85800
450	.00000	550	.00000	650	.88200	750	.85200
460	.00000	560	.00000	660	.88200	760	.84600
470	.00000	570	.00000	670	.88000	770	.84000
480	.00000	580	.11800	680	.87800		
490	.00000	590	.58600	690	.87600		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	104.571	49.384	.029	.67910	.32071	.00019	.49476	.35048	133.074	-9.576	74.721
1700.9	93.599	44.875	.028	.67579	.32400	.00020	.48825	.35113	144.636	-8.728	71.840
1905.0	84.861	41.182	.027	.67313	.32666	.00021	.48307	.35165	153.165	-7.255	69.333
2101.2	78.171	38.294	.026	.67105	.32873	.00022	.47909	.35204	159.118	-5.455	67.266
2366.3	71.046	35.161	.025	.66878	.33099	.00023	.47480	.35247	164.712	-2.675	64.902
2601.4	66.071	32.938	.024	.66716	.33260	.00024	.47175	.35277	168.024	-.059	63.138
2855.6	61.723	30.971	.023	.66571	.33404	.00025	.46905	.35304	170.409	2.789	61.510
3051.7	58.926	29.694	.022	.66476	.33499	.00025	.46729	.35322	171.643	4.945	60.416
3251.8	56.466	28.562	.022	.66391	.33583	.00025	.46573	.35337	172.501	7.076	59.420
CIE B	44.919	23.061	.018	.66059	.33914	.00027	.45966	.35398	173.227	21.462	54.160
CIE C	39.343	20.383	.017	.65855	.34118	.00028	.45597	.35435	170.124	31.346	51.291



RED 3647A(FS3)  
2 DEGREE OBSERVER

1961

[ 17 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	82000	700	.87300
	.00000	.00000	.00000	.82000	700	.87300
	410	.00000	610	.87000	710	.86900
	420	.00000	620	.87900	720	.86600
	430	.00000	630	.88200	730	.86200
	440	.00000	640	.88400	740	.85800
	450	.00000	650	.88400	750	.85300
	460	.00000	660	.88200	760	.84700
	470	.00000	670	.88000	770	.84000
380	.00000					
390	.00000					

C2=14387.9 MU-M K

ILLUMINANT KELVINS	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	105.301	49.893	.030	.67838	.32142	.00019	.49334	.35062	132.248	-9.479	75.035
1700.9	94.314	45.378	.029	.67502	.32478	.00021	.48673	.35128	143.879	-8.627	72.171
1905.0	85.555	41.675	.028	.67230	.32749	.00022	.48148	.35181	152.479	-7.147	69.676
2101.2	78.844	38.776	.027	.67018	.32960	.00023	.47744	.35221	158.498	-5.338	67.618
2366.3	71.693	35.628	.025	.66787	.33189	.00024	.47308	.35264	164.170	-2.544	65.263
2601.4	66.697	33.392	.024	.66622	.33354	.00024	.46999	.35295	167.543	.086	63.504
2855.6	62.329	31.412	.023	.66474	.33501	.00025	.46725	.35322	169.984	2.950	61.881
3051.7	59.517	30.125	.023	.66377	.33598	.00025	.46546	.35340	171.256	5.119	60.789
3251.8	57.043	28.985	.022	.66290	.33684	.00026	.46387	.35356	172.149	7.265	59.795
CIE B	45.421	23.434	.019	.65948	.34024	.00027	.45766	.35418	173.028	21.754	54.541
CIE C	39.805	20.729	.017	.65738	.34233	.00028	.45390	.35455	170.003	31.719	51.675

RED 3647A(FS3)  
2 DEGREE OBSERVER

1962

[ 18 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	82380	87800
	.00000	.00000	.00000	.00000	.82380	.87800
	410	.00000	.00000	.00000	.87200	.87400
	420	.00000	.00000	.00000	.88480	.87160
	430	.00000	.00000	.00000	.88880	.86840
	440	.00000	.00000	.00000	.88880	.86200
	450	.00000	.00000	.00000	.88880	.85800
	460	.00000	.00000	.00000	.88860	.85160
	470	.00000	.00250	.00000	.88820	.84520
	480	.00000	.12570	.00000	.88450	
380	.00000	.580	.680	.770		
390	.00000	.590	.690			

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 U	CIE V	CAP U*	1964 CIE V*	CAP V*	CAP W*
1500.8	105.851	50.119	.030	.67854	.32127	.00019	.49364	.35059	132.785	-9.525	75.174	
1700.9	94.793	45.575	.029	.67518	.32461	.00020	.48706	.35125	144.438	-8.672	72.299	
1905.0	85.980	41.849	.028	.67247	.32731	.00022	.48182	.35177	153.051	-7.190	69.796	
2101.2	79.229	38.932	.027	.67036	.32941	.00023	.47779	.35217	159.076	-5.379	67.731	
2366.3	72.035	35.766	.025	.66807	.33170	.00024	.47345	.35261	164.753	-2.580	65.369	
2601.4	67.010	33.518	.024	.66642	.33334	.00024	.47037	.35291	168.125	.055	63.605	
2855.6	62.617	31.527	.023	.66495	.33480	.00025	.46764	.35318	170.566	2.923	61.977	
3051.7	59.790	30.234	.023	.66399	.33576	.00025	.46586	.35336	171.835	5.095	60.882	
3251.8	57.302	29.088	.022	.66312	.33662	.00026	.46428	.35352	172.726	7.244	59.886	
CIE B	45.618	23.510	.019	.65973	.34000	.00027	.45811	.35413	173.590	21.753	54.618	
CIE C	39.973	20.792	.017	.65765	.34207	.00028	.45437	.35451	170.547	31.730	51.744	

YELLOW 3840A(FS3)  
2 DEGREE OBSERVER

1942

[ 19 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.82500	700	.86700
410	.00000	510	.00000	610	.83800	710	.86600
420	.00000	520	.00000	620	.84600	720	.86300
430	.00000	530	.00000	630	.85200	730	.86200
440	.00000	540	.00000	640	.85800	740	.85900
450	.00000	550	.03500	650	.86100	750	.85700
460	.00000	560	.46000	660	.86400	760	.85500
470	.00000	570	.72600	670	.86600	770	.85400
480	.00000	580	.78800	680	.86800		
490	.00000	590	.81000	690	.86800		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT KELVINS	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	118.605	66.140	.071	.64175	.35787	.00039	.42705	.35722	75.753	-3.415	84.102
1700.9	108.598	62.660	.073	.63385	.36572	.00043	.41422	.35849	86.482	-2.121	82.297
1905.0	100.446	59.599	.074	.62732	.37222	.00046	.40395	.35952	95.209	-.189	80.653
2101.2	94.080	57.063	.074	.62215	.37736	.00049	.39602	.36030	101.883	2.085	79.248
2366.3	87.164	54.163	.073	.61644	.38304	.00052	.38747	.36115	108.831	5.562	77.589
2601.4	82.244	52.003	.073	.61230	.38716	.00054	.38142	.36176	113.468	8.841	76.315
2855.6	77.876	50.017	.072	.60857	.39087	.00056	.37605	.36229	117.277	12.436	75.111
3051.7	75.029	48.688	.071	.60611	.39332	.00058	.37255	.36264	119.560	15.177	74.288
3251.8	72.500	47.483	.071	.60390	.39552	.00059	.36945	.36295	121.429	17.907	73.529
CIE B	60.517	41.590	.067	.59229	.40705	.00066	.35360	.36452	126.683	37.129	69.617
CIE C	54.504	38.459	.065	.58589	.41342	.00069	.34519	.36536	126.460	50.831	67.387

YELLOW 271(R59)  
2 DEGREE OBSERVER

1937

[ 20 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.82400	700	.88400
410	.00000	510	.00000	610	.84000	710	.88200
420	.00000	520	.00000	620	.85400	720	.88000
430	.00000	530	.00100	630	.86300	730	.87900
440	.00000	540	.04800	640	.87100	740	.87700
450	.00000	550	.43300	650	.87700	750	.87500
460	.00000	560	.67000	660	.88000	760	.87300
470	.00000	570	.73800	670	.88300	770	.87100
480	.00000	580	.77400	680	.88400		
490	.00000	590	.80300	690	.88500		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT KELVINS	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	121.311	70.288	.101	.63282	.36666	.00053	.41265	.35863	61.480	-1.914	86.173
1700.9	111.400	67.263	.107	.62315	.37626	.00060	.39762	.36012	70.710	-.389	84.672
1905.0	103.329	64.562	.111	.61505	.38429	.00066	.38552	.36132	78.375	1.762	83.292
2101.2	97.025	62.295	.113	.60856	.39073	.00071	.37614	.36225	84.341	4.240	82.104
2366.3	90.173	59.665	.116	.60134	.39789	.00077	.36600	.36326	90.655	7.991	80.689
2601.4	85.292	57.682	.117	.59607	.40312	.00082	.35879	.36397	94.935	11.514	79.595
2855.6	80.955	55.840	.117	.59129	.40785	.00086	.35240	.36461	98.497	15.372	78.555
3051.7	78.125	54.596	.118	.58812	.41099	.00089	.34822	.36502	100.656	18.314	77.840
3251.8	75.609	53.461	.118	.58527	.41382	.00091	.34451	.36539	102.438	21.245	77.178
CIE B	63.734	47.956	.118	.57003	.42892	.00105	.32541	.36728	107.286	42.021	73.828
CIE C	57.743	44.949	.117	.56166	.43721	.00113	.31539	.36827	107.066	56.947	71.889



YELLOW 200 (R69), 4.200 (HB95)  
 2 DEGREE OBSERVER

1932

[ 21 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00100	500	.02890	600	.88200	700	.89200
410	.00140	510	.05260	610	.88700	710	.89000
420	.00200	520	.08260	620	.89000	720	.88800
430	.00280	530	.11250	630	.89200	730	.88600
440	.00390	540	.15700	640	.89300	740	.88400
450	.00540	550	.27700	650	.89400	750	.88300
460	.00750	560	.54400	660	.89400	760	.88200
470	.01010	570	.77000	670	.89400	770	.88100
480	.01370	580	.84800	680	.89400		
490	.01900	590	.87300	690	.89300		

380 .00080  
 390 .00090

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE					
	KELVINS	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	CAP U*	CAP V*	CAP W*
1500.8	126.114	72.948	.206	.63289	.36608	.00103	.41317	.35848	62.990	-2.115	87.458	
1700.9	115.858	69.842	.256	.62304	.37558	.00138	.39805	.35993	72.262	-.610	85.955	
1905.0	107.484	67.079	.308	.61465	.38359	.00176	.38574	.36109	79.819	1.538	84.578	
2101.2	100.932	64.768	.359	.60781	.39003	.00216	.37608	.36199	85.597	4.022	83.398	
2366.3	93.801	62.098	.426	.60004	.39724	.00273	.36550	.36295	91.595	7.794	81.999	
2601.4	88.719	60.093	.484	.59425	.40251	.00324	.35789	.36363	95.571	11.340	80.922	
2855.6	84.200	58.236	.544	.58890	.40730	.00380	.35107	.36421	98.805	15.226	79.903	
3051.7	81.252	56.984	.588	.58529	.41048	.00424	.34657	.36459	100.718	18.192	79.204	
3251.8	78.631	55.845	.632	.58199	.41334	.00467	.34254	.36492	102.259	21.147	78.558	
CIE B	66.191	50.187	.933	.56423	.42781	.00796	.32218	.36642	106.142	41.970	75.216	
CIE C	59.936	47.113	1.158	.55390	.43540	.01070	.31131	.36706	105.265	56.912	73.293	

YELLOW 142(R69)  
2 DEGREE OBSERVER

1932

[ 22 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00020	500	.04240	600	.53200	700	.58000
410	.00020	510	.07120	610	.55900	710	.57000
420	.00030	520	.11020	620	.57900	720	.56000
430	.00040	530	.15800	630	.59300	730	.54800
440	.00070	540	.21400	640	.59900	740	.53500
450	.00140	550	.27700	650	.60200	750	.52200
460	.00300	560	.33900	660	.60300	760	.50700
470	.00640	570	.39900	670	.60100	770	.49200
480	.01260	580	.45100	680	.59600		
490	.02380	590	.49500	690	.58800		

380 .00020  
390 .00020

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 U	CIE V	CAP U*	1964 CIE V*	CAP W*
1500.8	79.715	46.094	.195	.63264	.36581	.00154	.41319	.35838	52.335	-1.853	72.637
1700.9	72.948	44.233	.246	.62122	.37668	.00209	.39582	.36002	57.972	-.426	71.414
1905.0	67.476	42.619	.297	.61124	.38607	.00269	.38141	.36136	62.411	1.518	70.325
2101.2	63.227	41.293	.344	.60295	.39378	.00328	.36994	.36240	65.701	3.719	69.410
2366.3	58.635	39.780	.404	.59336	.40256	.00409	.35723	.36354	68.991	7.017	68.342
2601.4	55.381	38.655	.453	.58611	.40909	.00480	.34800	.36435	71.071	10.095	67.529
2855.6	52.502	37.618	.503	.57935	.41511	.00555	.33966	.36506	72.665	13.456	66.767
3051.7	50.630	36.923	.538	.57475	.41914	.00611	.33415	.36552	73.543	16.016	66.247
3251.8	48.970	36.290	.572	.57053	.42281	.00666	.32919	.36593	74.196	18.567	65.770
CIE B	41.152	33.118	.783	.54831	.44126	.01043	.30468	.36779	74.906	36.443	63.284
CIE C	37.235	31.380	.923	.53547	.45126	.01327	.29164	.36867	73.021	49.317	61.854

YELLOW 3955A(FS3)  
2 DEGREE OBSERVER

1942

[ 23 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	410	420	430	440	450	460	470	380	390	500	.00000	600	.72300	700	.83600	1960	1964	1964	1964
	480	490	CAP X	CAP Y	CAP Z	CIE X	CIE Y	CIE Z	U	V	U*	V*	U*	V*	U*	V*	U*	V*	U*	V*
	.00000	.00000	109.329	64.809	.139	.62733	.37187	.00080	.40422	.35942	50.375	-.995	50.375	.35942	50.375	-.995	50.375	-.995	50.375	83.420
	.00000	.00000	100.401	62.452	.155	.61593	.38312	.00095	.38704	.36112	57.326	.684	57.326	.36112	57.326	.684	57.326	.684	57.326	82.187
	.00000	.00000	93.166	60.350	.167	.60622	.39269	.00109	.37307	.36249	63.154	2.947	63.154	.36249	63.154	2.947	63.154	2.947	63.154	81.061
	.00000	.00000	87.535	58.582	.176	.59835	.40044	.00121	.36217	.36356	67.724	5.501	67.724	.36356	67.724	5.501	67.724	5.501	67.724	80.094
	.00000	.00000	81.431	56.523	.186	.58948	.40917	.00135	.35031	.36473	72.588	9.327	72.588	.36473	72.588	9.327	72.588	9.327	72.588	78.943
	.00000	.00000	77.093	54.962	.193	.58295	.41560	.00146	.34184	.36556	75.893	12.901	75.893	.36556	75.893	12.901	75.893	12.901	75.893	78.052
	.00000	.00000	73.244	53.503	.198	.57697	.42147	.00156	.33430	.36630	78.639	16.805	78.639	.36630	78.639	16.805	78.639	16.805	78.639	77.203
	.00000	.00000	70.735	52.513	.202	.57299	.42538	.00163	.32937	.36678	80.296	19.780	80.296	.36678	80.296	19.780	80.296	19.780	80.296	76.619
	.00000	.00000	68.506	51.606	.205	.56938	.42892	.00170	.32497	.36721	81.654	22.745	81.654	.36721	81.654	22.745	81.654	22.745	81.654	76.077
	.00000	.00000	58.009	47.144	.215	.55054	.44742	.00204	.30299	.36936	85.173	43.714	85.173	.36936	85.173	43.714	85.173	43.714	85.173	73.312
	.00000	.00000	52.704	44.637	.218	.54023	.45753	.00224	.29162	.37048	84.606	58.839	84.606	.37048	84.606	58.839	84.606	58.839	84.606	71.683

C2=14387.9 MU-M K

YELLOW 199(R69), 199(TR), 4.199(HR95)  
 2 DEGREE OBSERVER

1932

[ 24 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.86400	700	.89100
410	.00000	510	.00010	610	.86900	710	.89100
420	.00000	520	.00030	620	.87400	720	.89000
430	.00000	530	.01260	630	.87900	730	.88900
440	.00000	540	.28900	640	.88300	740	.88800
450	.00000	550	.65400	650	.89700	750	.88600
460	.00000	560	.78400	660	.88900	760	.88400
470	.00000	570	.82600	670	.89000	770	.88200
480	.00000	580	.84400	680	.89100		
490	.00000	590	.85700	690	.89100		

380 .00000  
 390 .00000

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE		
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W
1500.8	126.818	76.323	.142	.62385	.37545	.00070	.39877	.35999	47.469
1700.9	116.959	73.738	.155	.61282	.38636	.00081	.38238	.36161	55.944
1905.0	108.897	71.366	.164	.60355	.39554	.00091	.36918	.36291	63.161
2101.2	102.577	69.331	.171	.59610	.40290	.00099	.35896	.36392	68.889
2366.3	95.683	66.925	.178	.58779	.41112	.00109	.34791	.36502	75.066
2601.4	90.756	65.079	.182	.58171	.41713	.00117	.34007	.36579	79.327
2855.6	86.365	63.341	.185	.57618	.42258	.00124	.33312	.36647	82.928
3051.7	83.494	62.155	.187	.57252	.42620	.00128	.32859	.36692	85.139
3251.8	80.937	61.065	.189	.56921	.42946	.00133	.32457	.36732	86.987
CIE B	68.832	55.737	.195	.55170	.44674	.00156	.30407	.36933	92.296
CIE C	62.684	52.733	.196	.54219	.45612	.00169	.29351	.37037	92.467
									62.898
									76.749



YELLOW 3964A(FS3)  
2 DEGREE OBSERVER

1946

[ 25 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.90000	700	.90400
410	.00000	510	.00000	610	.90300	710	.90300
420	.00000	520	.00000	620	.90400	720	.90200
430	.00000	530	.00500	630	.90500	730	.90000
440	.00000	540	.25100	640	.90600	740	.89800
450	.00000	550	.70600	650	.90600	750	.89700
460	.00000	560	.85000	660	.90600	760	.89500
470	.00000	570	.88100	670	.90600	770	.89400
480	.00000	580	.89100	680	.90600		
490	.00000	590	.89600	690	.90600		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 U	1964 CIE V	CAP U*	CAP V*	CAP W*
1500.8	131.464	79.526	.145	.62265	.37666	.00069	.39694	.36017	46.091	-.196	90.508
1700.9	121.383	76.910	.157	.61165	.38755	.00079	.38066	.36179	54.896	1.520	89.317
1905.0	113.120	74.488	.166	.60243	.39669	.00089	.36759	.36308	62.423	3.878	88.188
2101.2	106.630	72.398	.173	.59503	.40401	.00096	.35748	.36408	68.416	6.571	87.196
2366.3	99.540	69.917	.179	.58679	.41216	.00106	.34658	.36516	74.901	10.636	85.991
2601.4	94.465	68.007	.183	.58077	.41810	.00112	.33885	.36592	79.390	14.453	85.045
2855.6	89.938	66.204	.186	.57532	.42349	.00119	.33201	.36659	83.197	18.636	84.135
3051.7	86.975	64.971	.187	.57170	.42707	.00123	.32756	.36703	85.544	21.830	83.503
3251.8	84.334	63.837	.189	.56844	.43028	.00127	.32360	.36742	87.512	25.018	82.915
CIE B	71.820	58.300	.194	.55113	.44738	.00149	.30339	.36942	93.279	47.720	79.939
CIE C	65.455	55.173	.194	.54174	.45665	.00161	.29298	.37044	93.648	64.132	78.174

YELLOW 4.166(HB95)  
2 DEGREE OBSERVER

1963

[ 26 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.90990	700	.91410
410	.00000	510	.00030	610	.91100	710	.91370
420	.00000	520	.00280	620	.91260	720	.91160
430	.00000	530	.07660	630	.91260	730	.91200
440	.00000	540	.57970	640	.91410	740	.90950
450	.00000	550	.84370	650	.91480	750	.90950
460	.00000	560	.88820	660	.91410	760	.90680
470	.00000	570	.89950	670	.91410	770	.90470
480	.00000	580	.90410	680	.91410		
490	.00000	590	.90740	690	.91410		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE					
	KELVINS	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	CAP U*	CAP V*	CAP W*
1500.8	133.750	82.964	.194	.61662	.38248	.00090	.38802	.36103	.36103	36.200	.822	92.036
1700.9	123.730	80.771	.216	.60439	.39455	.00106	.37046	.36276	.36276	43.901	2.702	91.067
1905.0	115.515	78.698	.233	.59407	.40473	.00120	.35634	.36415	.36415	50.617	5.219	90.134
2101.2	109.061	76.880	.246	.58576	.41292	.00132	.34540	.36523	.36523	56.047	8.062	89.303
2366.3	102.006	74.688	.259	.57646	.42208	.00146	.33360	.36639	.36639	62.001	12.332	88.282
2601.4	96.953	72.977	.268	.56965	.42878	.00158	.32524	.36721	.36721	66.170	16.331	87.472
2855.6	92.442	71.344	.275	.56346	.43486	.00168	.31783	.36793	.36793	69.736	20.711	86.687
3051.7	89.487	70.218	.280	.55935	.43890	.00175	.31300	.36841	.36841	71.948	24.057	86.139
3251.8	86.853	69.175	.284	.55564	.44254	.00182	.30872	.36883	.36883	73.811	27.397	85.626
CIE B	74.353	64.010	.299	.53622	.46162	.00215	.28725	.37093	.37093	79.442	51.183	83.005
CIE C	67.973	61.004	.303	.52578	.47188	.00234	.27633	.37200	.37200	79.906	68.439	81.415

YELLOW 141(R69)  
2 DEGREE OBSERVER

1932

[ 27 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00750	500	.13240	600	.65400	700	.72000
410	.00740	510	.18600	610	.67600	710	.71700
420	.00760	520	.24100	620	.69300	720	.71200
430	.00870	530	.30300	630	.70500	730	.70600
440	.01130	540	.36700	640	.71300	740	.70000
450	.01690	550	.43000	650	.71800	750	.69200
460	.02710	560	.49200	660	.72100	760	.68300
470	.04230	570	.54200	670	.72300	770	.67300
380	.00800	580	.58900	680	.72300		
390	.00800	590	.62500	690	.72200		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 U	V	1964 CAP U*	CIE V*	CAP W*
1500.8	97.952	59.009	.492	.62211	.37477	.00312	.39795	.35961	41.969	-.768	80.330
1700.9	89.994	57.251	.670	.60842	.38705	.00453	.37862	.36129	46.664	.841	79.354
1905.0	83.548	55.710	.863	.59625	.39758	.00616	.36255	.36262	50.406	2.985	78.481
2101.2	78.536	54.431	1.053	.58600	.40614	.00786	.34976	.36362	53.197	5.393	77.745
2366.3	73.110	52.957	1.309	.57397	.41575	.01028	.33560	.36464	55.992	8.991	76.882
2601.4	69.260	51.849	1.531	.56474	.42277	.01249	.32532	.36531	57.747	12.351	76.222
2855.6	65.851	50.819	1.762	.55602	.42910	.01488	.31605	.36586	59.069	16.023	75.601
3051.7	63.632	50.123	1.933	.55003	.43326	.01671	.30992	.36618	59.775	18.824	75.176
3251.8	61.663	49.487	2.100	.54449	.43697	.01855	.30441	.36645	60.276	21.617	74.784
CIE B	52.412	46.216	3.273	.51434	.45354	.03212	.27751	.36705	60.387	41.173	72.716
CIE C	47.786	44.369	4.134	.49628	.46079	.04293	.26338	.36683	58.147	55.302	71.505

YELLOW 261(R59),4.261(HR95)  
 2 DEGREE ORSEKVER

1937

[28]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.00000	600	.85900	700	.87300
410	.00000	510	.00100	610	.86600	710	.87100
420	.00000	520	.12000	620	.87000	720	.86800
430	.00000	530	.51800	630	.87300	730	.86500
440	.00000	540	.70500	640	.87500	740	.86200
450	.00000	550	.76700	650	.87600	750	.85900
460	.00000	560	.79600	660	.87700	760	.85600
470	.00000	570	.81800	670	.87700	770	.85300
480	.00000	580	.83500	680	.87600		
490	.00000	590	.84800	690	.87500		

380 .00000  
 390 .00000

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	126.966	79.977	.285	.61269	.38594	.00137	.38258	.36148	29.262	1.348	90.712
1700.9	117.432	78.286	.330	.59899	.39932	.00168	.36336	.36336	35.060	3.368	89.947
1905.0	109.638	76.688	.369	.58726	.41077	.00197	.34776	.36487	40.154	6.004	89.214
2101.2	103.528	75.282	.400	.57769	.42007	.00223	.33560	.36605	44.294	8.945	88.561
2366.3	96.863	73.576	.434	.56687	.43059	.00254	.32239	.36733	48.847	13.332	87.758
2601.4	92.098	72.236	.459	.55887	.43834	.00279	.31299	.36823	52.032	17.427	87.118
2855.6	87.849	70.949	.481	.55154	.44544	.00302	.30463	.36904	54.741	21.906	86.496
3051.7	85.069	70.056	.495	.54664	.45017	.00318	.29917	.36956	56.407	25.327	86.060
3251.8	82.592	69.225	.508	.54221	.45446	.00333	.29432	.37003	57.794	28.741	85.650
CIE B	70.811	64.863	.552	.51981	.47614	.00405	.27094	.37227	62.175	52.913	83.447
CIE C	64.798	62.249	.569	.50776	.48778	.00446	.25913	.37340	62.207	70.499	82.080





YELLOW 359(TR)  
2 DEGREE OBSERVER

1940

[ 30 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.01800	600	.83800	700	.82100
410	.00000	510	.15000	610	.84200	710	.81600
420	.00000	520	.37500	620	.84300	720	.81000
430	.00000	530	.56200	630	.84400	730	.80400
440	.00000	540	.67700	640	.84300	740	.79800
450	.00000	550	.74200	650	.84100	750	.79200
460	.00000	560	.78100	660	.83900	760	.78600
470	.00000	570	.80400	670	.83600	770	.78000
380	.00000	580	.81900	680	.83200		
390	.00000	590	.83000	690	.82600		

C2=14387.9 MU-M K

ILLUMINANT	1931			1960			1964				
	KELVINS	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	CAP U*	CAP V*
1500.8	123.132	78.555	.396	.60931	.38873	.00196	.37810	.36183	23.809	1.738	90.069
1700.9	114.002	77.197	.478	.59476	.40275	.00249	.35811	.36374	28.751	3.793	89.449
1905.0	106.525	75.899	.552	.58218	.41480	.00301	.34179	.36529	33.093	6.461	88.849
2101.2	100.657	74.748	.614	.57185	.42466	.00349	.32902	.36650	36.617	9.430	88.311
2366.3	94.249	73.341	.687	.56008	.43584	.00408	.31510	.36780	40.476	13.855	87.646
2601.4	89.663	72.229	.742	.55132	.44412	.00456	.30515	.36873	43.156	17.986	87.114
2855.6	85.571	71.154	.792	.54325	.45172	.00503	.29629	.36955	45.412	22.508	86.595
3051.7	82.893	70.405	.826	.53783	.45681	.00536	.29049	.37008	46.781	25.963	86.230
3251.8	80.505	69.705	.857	.53291	.46142	.00567	.28532	.37056	47.905	29.414	85.887
CIE B	69.122	65.866	.978	.50838	.48443	.00720	.26083	.37281	51.523	53.826	83.962
CIE C	63.308	63.527	1.037	.49509	.49680	.00811	.24843	.37394	51.207	71.649	82.753

YELLOW 359(TR)  
2 DEGREE OBSERVER

1964

[ 31 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.01600	600	.83800	700	.82100
410	.00000	510	.14900	610	.84200	710	.81700
420	.00000	520	.38000	620	.84400	720	.81100
430	.00000	530	.57000	630	.84600	730	.80700
440	.00000	540	.68300	640	.84500	740	.80000
450	.00000	550	.74700	650	.84200	750	.79400
460	.00000	560	.78400	660	.83900	760	.78900
470	.00000	570	.80800	670	.83400	770	.78000
480	.00000	580	.82400	680	.83100		
490	.00010	590	.83200	690	.82500		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT

KELVINS	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	123.349	78.791	.398	.60902	.38902	.00197	.37767	.36187	23.339	1.788	90.176
1700.9	114.218	77.451	.480	.59443	.40308	.00250	.35765	.36378	28.261	3.850	89.565
1905.0	106.740	76.167	.554	.58181	.41517	.00302	.34132	.36534	32.593	6.524	88.973
2101.2	100.871	75.027	.617	.57146	.42505	.00350	.32854	.36654	36.113	9.500	88.442
2366.3	94.460	73.631	.690	.55966	.43625	.00409	.31460	.36785	39.973	13.933	87.784
2601.4	89.871	72.526	.745	.55088	.44456	.00456	.30465	.36878	42.657	18.073	87.257
2855.6	85.777	71.457	.795	.54279	.45217	.00503	.29578	.36960	44.919	22.603	86.742
3051.7	83.097	70.711	.829	.53737	.45727	.00536	.28998	.37013	46.293	26.066	86.380
3251.8	80.707	70.014	.859	.53244	.46189	.00567	.28481	.37061	47.421	29.524	86.039
CIE B	69.315	66.183	.981	.50788	.48494	.00719	.26034	.37286	51.082	53.987	84.124
CIE C	63.494	63.846	1.039	.49458	.49732	.00809	.24795	.37399	50.793	71.849	82.920

GREEN 6306A(FS3)  
2 DEGREE OBSERVER

1943

[ 32 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.08700	600	.00110	700	.00000
410	.00000	510	.13000	610	.00030	710	.00000
420	.00000	520	.16000	620	.00010	720	.00000
430	.00000	530	.16200	630	.00000	730	.00000
440	.00000	540	.12900	640	.00000	740	.00000
450	.00100	550	.08600	650	.00000	750	.00000
460	.00300	560	.04800	660	.00000	760	.00000
470	.00900	570	.02260	670	.00000	770	.00000
380	.00000	580	.00880	680	.00000		
390	.00000	590	.00330	690	.00000		

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
KELVINS	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	CAP U*	CAP V*	CAP W*
1500.8	1.002	2.651	.204	.25982	.68717	.05301	.09689	.38438	-59.684	5.500	17.599
1700.9	1.129	3.146	.279	.24793	.69085	.06123	.09187	.38401	-61.638	6.005	19.633
1905.0	1.232	3.580	.355	.23837	.69286	.06876	.08798	.38359	-62.182	6.598	21.244
2101.2	1.310	3.936	.427	.23095	.69378	.07526	.08504	.38318	-61.958	7.274	22.472
2366.3	1.393	4.339	.519	.22290	.69406	.08305	.08193	.38265	-61.087	8.348	23.774
2601.4	1.450	4.634	.595	.21715	.69375	.08911	.07975	.38221	-60.089	9.420	24.679
2855.6	1.499	4.901	.671	.21201	.69308	.09490	.07785	.38176	-58.959	10.662	25.466
3051.7	1.530	5.078	.725	.20865	.69243	.09891	.07663	.38144	-58.111	11.653	25.970
3251.8	1.557	5.236	.777	.20565	.69170	.10265	.07554	.38113	-57.292	12.676	26.411
CIE B	1.675	5.897	1.099	.19315	.68006	.12679	.07171	.37871	-51.967	20.217	28.167
CIE C	1.722	6.202	1.308	.18650	.67185	.14165	.06979	.37712	-49.287	26.247	28.932



GREEN 6310A(FS3)  
2 DEGREE OBSERVER

1961

[ 33 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.09020	600	.00130	700	.00000
410	.00000	510	.13950	610	.00040	710	.00000
420	.00000	520	.17550	620	.00010	720	.00000
430	.00000	530	.17700	630	.00000	730	.00000
440	.00000	540	.14500	640	.00000	740	.00000
450	.00010	550	.09740	650	.00000	750	.00000
460	.00100	560	.05550	660	.00000	760	.00000
470	.00480	570	.02690	670	.00000	770	.00000
380	.00000	580	.01110	680	.00000		
390	.00000	590	.00400	690	.00000		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	1964 CIE V*	CAP W*
1500.8	1.156	2.985	.209	.26583	.68616	.04801	.09935	.38468	-63.809	6.010	18.994
1700.9	1.299	3.533	.282	.25397	.69094	.05510	.09421	.38445	-65.532	6.568	21.076
1905.0	1.413	4.011	.356	.24444	.69405	.06151	.09020	.38417	-65.855	7.229	22.722
2101.2	1.500	4.403	.424	.23704	.69597	.06700	.08717	.38389	-65.440	7.982	23.975
2366.3	1.591	4.845	.511	.22900	.69750	.07350	.08394	.38352	-64.347	9.171	25.302
2601.4	1.652	5.167	.581	.22326	.69822	.07852	.08169	.38321	-63.183	10.351	26.221
2855.6	1.705	5.459	.651	.21814	.69857	.08329	.07971	.38290	-61.903	11.712	27.020
3051.7	1.737	5.651	.700	.21479	.69864	.08657	.07843	.38267	-60.957	12.795	27.530
3251.8	1.765	5.823	.747	.21179	.69860	.08961	.07730	.38246	-60.050	13.909	27.976
CIE B	1.885	6.537	1.026	.19953	.69188	.10858	.07320	.38073	-54.301	22.131	29.745
CIE C	1.928	6.862	1.199	.19301	.68693	.12006	.07111	.37962	-51.447	28.668	30.507

GREEN 6327A(FS3)  
2 DEGREE OBSERVER

1943

[ 34 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.23700	600	.02100	700	.00010
410	.00000	510	.30600	610	.01080	710	.00000
420	.00000	520	.34700	620	.00550	720	.00000
430	.00000	530	.34900	630	.00260	730	.00000
440	.00100	540	.30900	640	.00150	740	.00000
450	.00500	550	.24500	650	.00090	750	.00000
460	.01600	560	.17800	660	.00050	760	.00000
470	.04200	570	.11800	670	.00030	770	.00000
480	.09200	580	.07100	680	.00020		
490	.16300	590	.03930	690	.00010		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	CAP V*	CIE	CAP W*
1500.8	4.712	8.475	.578	.34231	.61570	.04198	.14111	.38070	-95.681	8.990	33.971	
1700.9	5.053	9.731	.804	.32417	.62425	.05158	.13174	.38054	-95.347	9.486	36.373	
1905.0	5.307	10.802	1.042	.30942	.62980	.06078	.12453	.38021	-93.820	10.203	38.264	
2101.2	5.489	11.666	1.271	.29789	.63313	.06898	.11913	.37981	-91.860	11.111	39.699	
2366.3	5.666	12.626	1.570	.28528	.63566	.07907	.11346	.37922	-89.000	12.633	41.213	
2601.4	5.779	13.320	1.822	.27624	.63666	.08710	.10954	.37809	-86.535	14.196	42.261	
2855.6	5.869	13.941	2.077	.26815	.63695	.09491	.10612	.37812	-84.080	16.030	43.169	
3051.7	5.922	14.348	2.262	.26283	.63679	.10038	.10393	.37770	-82.365	17.504	43.748	
3251.8	5.965	14.709	2.439	.25809	.63641	.10551	.10200	.37729	-80.778	19.029	44.254	
CIE B	6.157	16.265	3.618	.23645	.62462	.13893	.09437	.37393	-71.846	30.383	46.342	
CIE C	6.216	16.970	4.408	.22527	.61497	.15976	.09075	.37162	-67.607	39.481	47.244	

GREEN 6327A(FS3)  
2 DEGREE OBSERVER

1965

[ 35 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700
	.00000	.00000	.01900	.00010
	.00000	.00000	.00940	.00010
	.00000	.00000	.00460	.00010
	.00010	.00010	.00220	.00010
	.00070	.00070	.00130	.00010
	.00400	.00400	.00070	.00010
	.01610	.01750	.00040	.00010
	.04240	.07530	.00030	.00010
380	.00000	.08780	.00020	.00010
390	.00000	.08840	.00020	.00010
	.00000	.03690	.00020	.00010

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE		
	CAP X	CAP Y	CAP Z	U	V	W	CAP U*	CAP V*	CAP W*
1500.8	4.537	8.353	.570	.13796	.38100	.38100	-96.367	9.059	33.725
1700.9	4.882	9.610	.792	.12896	.38083	.38083	-96.072	9.564	36.152
1905.0	5.140	10.684	1.026	.12203	.38049	.38049	-94.563	10.289	38.062
2101.2	5.325	11.550	1.250	.11683	.38009	.38009	-92.606	11.203	39.511
2366.3	5.509	12.514	1.543	.11138	.37951	.37951	-89.739	12.733	41.041
2601.4	5.626	13.210	1.789	.10760	.37898	.37898	-87.264	14.302	42.099
2855.6	5.720	13.835	2.038	.10431	.37842	.37842	-84.797	16.142	43.016
3051.7	5.776	14.243	2.218	.10219	.37801	.37801	-83.071	17.620	43.600
3251.8	5.822	14.606	2.391	.10034	.37761	.37761	-81.473	19.149	44.111
CIE B	6.027	16.167	3.537	.09303	.37432	.37432	-72.455	30.532	46.214
CIE C	6.092	16.874	4.305	.08956	.37206	.37206	-68.166	39.650	47.122

GREEN 6319A(FS3)  
2 DEGREE OBSERVER

1965

[ 36 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.00000	500	.20870	600	.02180	700	.00020
410	.00000	510	.27810	610	.01090	710	.00020
420	.00000	520	.32260	620	.00550	720	.00020
430	.00010	530	.32790	630	.00280	730	.00020
440	.00070	540	.29680	640	.00170	740	.00020
450	.00350	550	.24130	650	.00100	750	.00020
460	.01370	560	.17670	660	.00060	760	.00020
470	.03680	570	.11800	670	.00050	770	.00020
480	.07660	580	.07290	680	.00040		
490	.13570	590	.04100	690	.00030		

380 .00000  
390 .00000

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	CAP V*	CIE	CAP W*
1500.8	4.727	8.278	.514	.34962	.61232	.03806	.14494	.38077	-92.885	8.917	33.573	
1700.9	5.055	9.471	.713	.33173	.62151	.04676	.13547	.38072	-92.348	9.447	35.894	
1905.0	5.297	10.483	.921	.31717	.62770	.05512	.12818	.38050	-90.688	10.200	37.715	
2101.2	5.468	11.295	1.119	.30577	.63164	.06259	.12270	.38019	-88.645	11.137	39.093	
2366.3	5.633	12.194	1.379	.29329	.63491	.07180	.11694	.37972	-85.720	12.690	40.543	
2601.4	5.736	12.841	1.597	.28432	.63652	.07916	.11294	.37927	-83.224	14.272	41.543	
2855.6	5.816	13.418	1.817	.27629	.63739	.08632	.10946	.37879	-80.754	16.119	42.407	
3051.7	5.863	13.795	1.976	.27101	.63764	.09135	.10723	.37843	-79.035	17.598	42.957	
3251.8	5.900	14.128	2.129	.26628	.63765	.09607	.10526	.37808	-77.448	19.125	43.437	
CIE B	6.058	15.553	3.136	.24480	.62847	.12673	.09741	.37513	-68.596	30.477	45.404	
CIE C	6.097	16.188	3.810	.23365	.62036	.14599	.09368	.37307	-64.415	39.518	46.241	



GREEN 6905A(FS3)  
2 DEGREE OBSERVER

1963

[ 37 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.01640	500	.11080	600	.00030	700	.00000
410	.02480	510	.12280	610	.00010	710	.00000
420	.02800	520	.11860	620	.00000	720	.00000
430	.02790	530	.09730	630	.00000	730	.00000
440	.02830	540	.06830	640	.00000	740	.00000
450	.03150	550	.04030	650	.00000	750	.00000
460	.04000	560	.02080	660	.00000	760	.00000
470	.05200	570	.00890	670	.00000	770	.00000
480	.06800	580	.00330	680	.00000		
490	.08930	590	.00120	690	.00000		

380 .00170  
390 .00680

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 U	CIE V	CAP U*	1964 CIE V*	CAP V*	CAP W*
1500.8	.491	1.512	.341	.20946	.64506	.14548	.08117	.37497	-42.040	2.223	11.692	
1700.9	.574	1.838	.515	.19603	.62798	.17599	.07730	.37145	-45.361	1.944	13.626	
1905.0	.650	2.135	.717	.18559	.60963	.20478	.07465	.36782	-47.102	1.605	15.192	
2101.2	.717	2.387	.927	.17779	.59220	.23002	.07293	.36440	-47.828	1.305	16.410	
2366.3	.798	2.681	1.225	.16973	.56989	.26038	.07147	.35996	-47.962	.995	17.729	
2601.4	.865	2.903	1.494	.16431	.55171	.28398	.07073	.35625	-47.632	.827	18.664	
2855.6	.931	3.110	1.785	.15976	.53388	.30637	.07032	.35251	-47.038	.749	19.493	
3051.7	.978	3.250	2.006	.15693	.52136	.32171	.07019	.34981	-46.500	.752	20.032	
3251.8	1.024	3.378	2.226	.15452	.50964	.33584	.07018	.34722	-45.922	.802	20.510	
CIE B	1.326	3.970	3.858	.14486	.43373	.42141	.07321	.32879	-41.230	1.554	22.586	
CIE C	1.550	4.283	5.143	.14123	.39019	.46858	.07634	.31638	-38.191	2.774	23.599	

GREEN 6917A(FS3)  
2 DEGREE OBSERVER

1943

[ 38 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.51400	500	.28400	600	.00710	700	.00000
410	.41400	510	.32000	610	.00320	710	.00000
420	.30000	520	.33000	620	.00100	720	.00000
430	.20000	530	.30000	630	.00040	730	.00000
440	.14900	540	.23900	640	.00010	740	.00000
450	.12900	550	.16900	650	.00000	750	.00000
460	.13400	560	.11100	660	.00000	760	.00000
470	.15300	570	.06600	670	.00000	770	.00000
380	.65500	580	.03190	680	.00000		
390	.60000	590	.01510	690	.00000		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	1964 CIE V*	CAP W*
1500.8	2.651	5.906	1.053	.27586	.61454	.10960	.11234	.37538	-89.937	5.510	28.188
1700.9	2.975	6.969	1.638	.25689	.60166	.14145	.10587	.37193	-90.952	4.577	30.751
1905.0	3.265	7.907	2.345	.24155	.58496	.17349	.10132	.36804	-90.339	3.557	32.806
2101.2	3.517	8.687	3.107	.22970	.56735	.20295	.09828	.36412	-88.902	2.611	34.392
2366.3	3.829	9.580	4.231	.21709	.54308	.23983	.09560	.35875	-86.329	1.460	36.096
2601.4	4.087	10.245	5.285	.20836	.52226	.26938	.09417	.35406	-83.822	.588	37.297
2855.6	4.351	10.856	6.455	.20085	.50116	.29799	.09329	.34915	-81.106	-.202	38.356
3051.7	4.545	11.265	7.366	.19612	.48604	.31784	.09294	.34552	-79.081	-.713	39.042
3251.8	4.736	11.635	8.294	.19204	.47171	.33625	.09281	.34197	-77.110	-1.158	39.649
CIE B	6.031	13.347	15.115	.17486	.38694	.43820	.09590	.31831	-64.741	-2.850	42.301
CIE C	7.071	14.226	20.844	.16779	.33758	.49462	.09995	.30162	-57.151	-3.237	43.576

GREEN 6916J-A(FS3)  
2 DEGREE OBSERVER

1960

[ 39 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.07630	500	.24300	600	.00600	700	.00000
410	.09810	510	.26000	610	.00320	710	.00000
420	.10600	520	.25500	620	.00150	720	.00000
430	.10600	530	.22700	630	.00070	730	.00000
440	.10500	540	.18300	640	.00030	740	.00000
450	.11200	550	.13400	650	.00020	750	.00000
460	.12900	560	.08800	660	.00010	760	.00000
470	.15200	570	.05180	670	.00000	770	.00000
480	.17900	580	.02830	680	.00000		
490	.21200	590	.01460	690	.00000		

380 .01860  
390 .04480

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 U	V	CAP U*	CAP V*	CIE	CAP W*
1500.8	2.210	4.716	.898	.28252	.60273	.11475	.11689	.37407	-78.044	4.448	4.448	24.923
1700.9	2.461	5.553	1.385	.26187	.59079	.14734	.10950	.37057	-79.367	3.577	3.577	27.270
1905.0	2.683	6.294	1.962	.24528	.57534	.17938	.10422	.36671	-79.190	2.659	2.659	29.158
2101.2	2.873	6.910	2.573	.23253	.55922	.20824	.10060	.36291	-78.223	1.843	1.843	30.618
2366.3	3.106	7.619	3.455	.21902	.53730	.24368	.09724	.35782	-76.309	.912	.912	32.192
2601.4	3.294	8.148	4.266	.20969	.51872	.27159	.09526	.35346	-74.379	.266	.266	33.306
2855.6	3.483	8.635	5.150	.20168	.50005	.29827	.09383	.34898	-72.263	-.254	-.254	34.289
3051.7	3.620	8.961	5.829	.19662	.48677	.31661	.09309	.34572	-70.678	-.547	-.547	34.927
3251.8	3.753	9.257	6.510	.19224	.47424	.33352	.09258	.34256	-69.135	-.763	-.763	35.493
CIE B	4.672	10.654	11.629	.17334	.39525	.43141	.09375	.32063	-59.237	-1.415	-1.415	38.010
CIE C	5.382	11.381	15.763	.16548	.34990	.48462	.09638	.30569	-53.275	-.841	-.841	39.234

GREEN 7321A(FS3)  
2 DEGREE OBSERVER

1943

[ 40 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.13500	500	.46800	600	.00370	700	.00000
410	.18200	510	.42400	610	.00170	710	.00000
420	.23000	520	.35800	620	.00070	720	.00000
430	.28500	530	.27700	630	.00030	730	.00000
440	.33400	540	.19400	640	.00010	740	.00000
450	.38100	550	.12500	650	.00000	750	.00000
460	.42600	560	.07400	660	.00000	760	.00000
470	.46100	570	.03850	670	.00000	770	.00000
480	.48300	580	.01950	680	.00000		
490	.48600	590	.00890	690	.00000		

380 .05900  
390 .09200

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	2.010	5.080	2.197	.21641	.54702	.23657	.09480	.35943	-88.806	-.307	25.977
1700.9	2.385	6.173	3.501	.19781	.51190	.29029	.09045	.35113	-91.142	-3.507	28.860
1905.0	2.769	7.180	5.079	.18422	.47780	.33798	.08809	.34271	-91.371	-6.898	31.231
2101.2	3.138	8.049	6.774	.17474	.44812	.37714	.08706	.33492	-90.393	-10.053	33.101
2366.3	3.639	9.081	9.249	.16566	.41334	.42099	.08686	.32509	-88.080	-13.962	35.158
2601.4	4.081	9.877	11.544	.16004	.38730	.45266	.08736	.31713	-85.586	-17.010	36.640
2855.6	4.552	10.631	14.063	.15565	.36351	.48085	.08830	.30933	-82.754	-19.855	37.971
3051.7	4.908	11.148	16.002	.15309	.34774	.49916	.08918	.30385	-80.588	-21.752	38.848
3251.8	5.263	11.625	17.957	.15104	.33362	.51534	.09015	.29870	-78.448	-23.448	39.633
CIE B	7.882	14.083	32.899	.14367	.25669	.59965	.09920	.26586	-64.517	-32.496	43.372
CIE C	10.006	15.496	45.059	.14181	.21961	.63858	.10599	.24621	-55.885	-36.017	45.327



GREEN 7322A(FS3)  
2 DEGREE OBSERVER

1942

[ 41 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700
	.17900	.53400	.00800	.00000
	.410	.49000	.00300	.00000
	.29200	.42000	.00000	.00000
	.430	.33300	.00000	.00000
	.440	.41000	.00000	.00000
	.450	.46000	.00000	.00000
	.460	.50100	.00000	.00000
	.470	.53300	.00000	.00000
380	.10000	.06200	.00000	.00000
390	.14000	.03300	.00000	.00000
	.490	.01700	.00000	.00000

C2=14387.9 MU-M K

ILLUMINANT KELVINS	1931 CIE			1960 CIE			1964 CIE			
	CAP X	CAP Y	CAP Z	U	V	W	CAP U*	CAP V*	CAP W*	
1500.8	2.855	6.587	2.567	.23776	.54848	.21375	.10444	.36139	-.98.346	.406 29.863
1700.9	3.326	7.916	4.098	.21682	.51604	.26715	.09902	.35350	-100.007	-2.978 32.824
1905.0	3.797	9.130	5.957	.20106	.48348	.31547	.09575	.34536	-.99.626	-6.571 35.252
2101.2	4.246	10.169	7.958	.18977	.45452	.35570	.09401	.33774	-.98.128	-9.925 37.163
2366.3	4.849	11.396	10.887	.17872	.42002	.40126	.09305	.32802	-.95.198	-14.096 39.259
2601.4	5.379	12.338	13.609	.17170	.39387	.43443	.09303	.32009	-.92.228	-17.362 40.768
2855.6	5.941	13.226	16.601	.16611	.36976	.46413	.09352	.31226	-.88.945	-20.423 42.122
3051.7	6.367	13.833	18.908	.16280	.35371	.48349	.09412	.30673	-.86.468	-22.473 43.013
3251.8	6.790	14.391	21.236	.16008	.33928	.50064	.09485	.30153	-.84.042	-24.310 43.810
CIE B	9.920	17.258	39.038	.14981	.26063	.58955	.10282	.26833	-.68.574	-34.143 47.606
CIE C	12.465	18.894	53.583	.14674	.22244	.63082	.10919	.24827	-.59.074	-38.076 49.586

GREEN 7327A (FSJ)  
2 DEGREE OBSERVER

1944

[ 42 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.18200	500	.51800	600	.00920	700	.00000
410	.23000	510	.47600	610	.00460	710	.00000
420	.28100	520	.41100	620	.00230	720	.00000
430	.33700	530	.32800	630	.00110	730	.00000
440	.38700	540	.24100	640	.00050	740	.00000
450	.43600	550	.16300	650	.00020	750	.00000
460	.47800	560	.10600	660	.00010	760	.00000
470	.51100	570	.06200	670	.00000	770	.00000
480	.53200	580	.03440	680	.00000		
490	.53600	590	.01760	690	.00000		

380 .09600  
390 .13400

C2=14387.9 MU-M K

ILLUMINANT KELVINS	1931 CIE			1960 CIE			1964 CIE			
	CAP X	CAP Y	CAP Z	U	V	W	CAP U*	CAP V*	CAP W*	
1500.8	2.973	6.584	2.469	.24721	.54748	.20532	.10896	.36196	.626	29.855
1700.9	3.422	7.885	3.937	.22448	.51725	.25826	.10253	.35436	-2.605	32.759
1905.0	3.870	9.071	5.718	.20740	.48617	.30643	.09854	.34647	-6.041	35.139
2101.2	4.296	10.085	7.632	.19516	.45814	.34670	.09629	.33905	-9.252	37.014
2366.3	4.869	11.282	10.434	.18315	.42438	.39247	.09482	.32956	-13.246	39.071
2601.4	5.371	12.199	13.036	.17550	.39859	.42591	.09445	.32179	-16.373	40.551
2855.6	5.905	13.064	15.895	.16938	.37470	.45592	.09465	.31410	-19.304	41.879
3051.7	6.308	13.654	18.099	.16574	.35873	.47553	.09507	.30866	-21.265	42.753
3251.8	6.710	14.197	20.323	.16276	.34433	.49291	.09565	.30353	-23.023	43.535
CIE B	9.681	16.976	37.314	.15133	.26537	.58330	.10292	.27070	-32.429	47.252
CIE C	12.097	18.557	51.187	.14781	.22675	.62544	.10898	.25076	-36.173	49.188

GREEN 7.136(HB95)  
2 DEGREE OBSERVER

1964

[43]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
KELVINS	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
CAP X	3.606	7.583	11.446	15.309	19.172	23.035	26.898	30.761	34.624	38.487	42.350	46.213	50.076	53.939	57.802	61.665	65.528	69.391	73.254	77.117	80.980	84.843	88.706	92.569	96.432	100.295	104.158	108.021	111.884	115.747	119.610	123.473	127.336	131.199	135.062	138.925	142.788																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
CAP Y	4.107	9.025	13.943	18.861	23.779	28.697	33.615	38.533	43.451	48.369	53.287	58.205	63.123	68.041	72.959	77.877	82.795	87.713	92.631	97.549	102.467	107.385	112.303	117.221	122.139	127.057	131.975	136.893	141.811	146.729	151.647	156.565	161.483	166.401	171.319	176.237	181.155	186.073																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
CAP Z	4.602	10.333	16.064	21.795	27.526	33.257	38.988	44.719	50.450	56.181	61.912	67.643	73.374	79.105	84.836	90.567	96.298	102.029	107.760	113.491	119.222	124.953	130.684	136.415	142.146	147.877	153.608	159.339	165.070	170.801	176.532	182.263	188.094	193.825	199.556	205.287	211.018	216.749	222.480	228.211	233.942	239.673	245.404	251.135	256.866	262.597	268.328	274.059	279.790	285.521	291.252	296.983	302.714	308.445	314.176	319.907	325.638	331.369	337.100	342.831	348.562	354.293	360.024	365.755	371.486	377.217	382.948	388.679	394.410	400.141	405.872	411.603	417.334	423.065	428.796	434.527	440.258	445.989	451.720	457.451	463.182	468.913	474.644	480.375	486.106	491.837	497.568	503.299	509.030	514.761	520.492	526.223	531.954	537.685	543.416	549.147	554.878	560.609	566.340	572.071	577.802	583.533	589.264	594.995	600.726	606.457	612.188	617.919	623.650	629.381	635.112	640.843	646.574	652.305	658.036	663.767	669.498	675.229	680.960	686.691	692.422	698.153	703.884	709.615	715.346	721.077	726.808	732.539	738.270	744.001	749.732	755.463	761.194	766.925	772.656	778.387	784.118	789.849	795.580	801.311	807.042	812.773	818.504	824.235	829.966	835.697	841.428	847.159	852.890	858.621	864.352	870.083	875.814	881.545	887.276	893.007	898.738	904.469	910.200	915.931	921.662	927.393	933.124	938.855	944.586	950.317	956.048	961.779	967.510	973.241	978.972	984.703	990.434	996.165	1001.896	1007.627	1013.358	1019.089	1024.820	1030.551	1036.282	1042.013	1047.744	1053.475	1059.206	1064.937	1070.668	1076.399	1082.130	1087.861	1093.592	1099.323	1105.054	1110.785	1116.516	1122.247	1127.978	1133.709	1139.440	1145.171	1150.902	1156.633	1162.364	1168.095	1173.826	1179.557	1185.288	1191.019	1196.750	1202.481	1208.212	1213.943	1219.674	1225.405	1231.136	1236.867	1242.598	1248.329	1254.060	1259.791	1265.522	1271.253	1276.984	1282.715	1288.446	1294.177	1299.908	1305.639	1311.370	1317.101	1322.832	1328.563	1334.294	1340.025	1345.756	1351.487	1357.218	1362.949	1368.680	1374.411	1380.142	1385.873	1391.604	1397.335	1403.066	1408.797	1414.528	1420.259	1425.990	1431.721	1437.452	1443.183	1448.914	1454.645	1460.376	1466.107	1471.838	1477.569	1483.300	1489.031	1494.762	1500.493	1506.224	1511.955	1517.686	1523.417	1529.148	1534.879	1540.610	1546.341	1552.072	1557.803	1563.534	1569.265	1574.996	1580.727	1586.458	1592.189	1597.920	1603.651	1609.382	1615.113	1620.844	1626.575	1632.306	1638.037	1643.768	1649.499	1655.230	1660.961	1666.692	1672.423	1678.154	1683.885	1689.616	1695.347	1701.078	1706.809	1712.540	1718.271	1724.002	1729.733	1735.464	1741.195	1746.926	1752.657	1758.388	1764.119	1769.850	1775.581	1781.312	1787.043	1792.774	1798.505	1804.236	1809.967	1815.698	1821.429	1827.160	1832.891	1838.622	1844.353	1850.084	1855.815	1861.546	1867.277	1873.008	1878.739	1884.470	1890.201	1895.932	1901.663	1907.394	1913.125	1918.856	1924.587	1930.318	1936.049	1941.780	1947.511	1953.242	1958.973	1964.704	1970.435	1976.166	1981.897	1987.628	1993.359	1999.090	2004.821	2010.552	2016.283	2022.014	2027.745	2033.476	2039.207	2044.938	2050.669	2056.400	2062.131	2067.862	2073.593	2079.324	2085.055	2090.786	2096.517	2102.248	2107.979	2113.710	2119.441	2125.172	2130.903	2136.634	2142.365	2148.096	2153.827	2159.558	2165.289	2171.020	2176.751	2182.482	2188.213	2193.944	2200.675	2206.406	2212.137	2217.868	2223.599	2229.330	2235.061	2240.792	2246.523	2252.254	2257.985	2263.716	2269.447	2275.178	2280.909	2286.640	2292.371	2298.102	2303.833	2309.564	2315.295	2321.026	2326.757	2332.488	2338.219	2343.950	2349.681	2355.412	2361.143	2366.874	2372.605	2378.336	2384.067	2389.798	2395.529	2401.260	2406.991	2412.722	2418.453	2424.184	2429.915	2435.646	2441.377	2447.108	2452.839	2458.570	2464.301	2470.032	2475.763	2481.494	2487.225	2492.956	2498.687	2504.418	2510.149	2515.880	2521.611	2527.342	2533.073	2538.804	2544.535	2550.266	2556.097	2561.828	2567.559	2573.290	2579.021	2584.752	2590.483	2596.214	2601.945	2607.676	2613.407	2619.138	2624.869	2630.600	2636.331	2642.062	2647.793	2653.524	2659.255	2664.986	2670.717	2676.448	2682.179	2687.910	2693.641	2699.372	2705.103	2710.834	2716.565	2722.296	2728.027	2733.758	2739.489	2745.220	2750.951	2756.682	2762.413	2768.144	2773.875	2779.606	2785.337	2791.068	2796.799	2802.530	2808.261	2813.992	2819.723	2825.454	2831.185	2836.916	2842.647	2848.378	2854.109	2859.840	2865.571	2871.302	2877.033	2882.764	2888.495	2894.226	2899.957	2905.688	2911.419	2917.150	2922.881	2928.612	2934.343	2940.074	2945.805	2951.536	2957.267	2963.098	2968.829	2974.560	2980.291	2986.022	2991.753	2997.484	3003.215	3008.946	3014.677	3020.408	3026.139	3031.870	3037.601	3043.332	3049.063	3054.794	3060.525	3066.256	3071.987	3077.718	3083.449	3089.180	3094.911	3100.642	3106.373	3112.104	3117.835	3123.566	3129.297	3135.028	3140.759	3146.490	3152.221	3157.952	3163.683	3169.414	3175.145	3180.876	3186.607	3192.338	3198.069	3203.800	3209.531	3215.262	3220.993	3226.724	3232.455	3238.186	3243.917	3249.648	3255.379	3261.110	3266.841	3272.572	3278.303	3284.034	3289.765	3295.496	3301.227	3306.958	3312.689	3318.420	3324.151	3329.882	3335.613	3341.344	3347.075	3352.806	3358.537	3364.268	3370.099	3375.830	3381.561	3387.292	3393.023	3398.754	3404.485	3410.216	3415.947	3421.678	3427.409	3433.140	3438.871	3444.602	3450.333	3456.064	3461.795	3467.526	3473.257	3478.988	3484.719	3490.450	3496.181	3501.912	3507.643	3513.374	3519.105	3524.836	3530.567	3536.298	3542.029	3547.760	3553.491	3559.222	3564.953	3570.684	3576.415	3582.146	3587.877	3593.608	3599.339	3605.070	3610.801	3616.532	3622.263	3628.094	3633.825	3639.556	3645.287	3651.018	3656.749	3662.480	3668.211	3673.942	3679.673	3685.404	3691.135	3696.866	3702.597	3708.328	3714.059	3719.790	3725.521	3731.252	3736.983	3742.714	3748.445	3754.176	3759.907	3765.638	3771.369	3777.100	3782.831	3788.562	3794.293	3800.024	3805.755	3811.486	3817.217	3822.948	3828.679	3834.410	3840.141	3845.872	3851.603	3857.334	3863.065	3868.796	3874.527	3880.258	3885.989	3891.720	3897.451	3903.182	3908.913	3914.644	3920.375	3926.106	3931.837	3937.568	3943.299	3949.030	3954.761	3960.492	3966.223	3971.954	3977.685	3983.416	3989.147	3994.878	4000.609	4006.340	4012.071	4017.802	4023.533	4029.264	4034.995	4040.726	4046.457	4052.188	4057.919	4063.650	4069.381	4075.112	4080.843	4086.574	4092.305	4098.036	4103.767	4109.498	4115.229	4120.960	4126.691	4132.422	4138.153	4143.884	4149.615	4155.346	4161.077	4166.808	4172.539	4178.270	4184.001	4189.732	4195.463	4201.194	4206.925	4212.656	4218.387	4224.118	4229.849	4235.580	4241.311	4247.042	4252.773	4258.504	4264.235	4269.966	4275.697	4281.428	4287.159	4292.890	4298.621	4304.352	4310.083	4315.814	4321.545	4327.276	4333.007	4338.738	4344.469	4350.200</

GREEN 322 (R59), 7.322 (HB95)  
 2 DEGREE OBSEKVER

1937

[ 44 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000		
400	.24700	.58000	.600	.02170	.700	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	
410	.30400	.54000	.610	.01240	.710	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
420	.36200	.48100	.620	.00720	.720	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
430	.41600	.40400	.630	.00410	.730	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
440	.46500	.31900	.640	.00240	.740	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
450	.51200	.23400	.650	.00150	.750	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
460	.55200	.16400	.660	.00100	.760	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
470	.58100	.10500	.670	.00000	.770	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
480	.60000	.06400	.680	.00000		.00000	.00000	.00000	.00000		.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
490	.60000	.03720	.690	.00000		.00000	.00000	.00000	.00000		.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	1964 CIE U*	V*	CAP W*
1500.8	4.946	9.284	2.846	.28965	.54368	.16666	.12953	.36469	-105.462	2.009	35.544
1700.9	5.500	10.905	4.544	.26256	.52054	.21689	.12042	.35811	-106.415	-1.180	38.438
1905.0	6.036	12.359	6.608	.24141	.49429	.26430	.11430	.35103	-105.469	-4.596	40.800
2101.2	6.537	13.586	8.834	.22575	.46919	.30507	.11041	.34420	-103.536	-7.808	42.654
2366.3	7.202	15.019	12.097	.20986	.43763	.35251	.10718	.33527	-100.136	-11.832	44.681
2601.4	7.782	16.106	15.135	.19942	.41273	.38785	.10560	.32783	-96.830	-15.005	46.135
2855.6	8.397	17.123	18.480	.19085	.38916	.42000	.10474	.32037	-93.245	-17.996	47.437
3051.7	8.862	17.814	21.062	.18564	.37316	.44120	.10449	.31505	-90.568	-20.008	48.292
3251.8	9.326	18.447	23.670	.18129	.35859	.46013	.10448	.31000	-87.963	-21.820	49.056
CIE B	12.767	21.656	43.595	.16364	.27758	.55878	.10903	.27741	-71.638	-31.565	52.684
CIE C	15.585	23.455	59.931	.15747	.23699	.60554	.11393	.25718	-61.644	-35.574	54.563



GREEN 322(R59), 7.322(HB95)  
2 DEGREE OBSERVER

1966

[ 45 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	0.00020
	.25100	.58100	.690	.02140	700
	.30800	.53900	.610	.01220	710
	.36200	.48100	.620	.00670	720
	.41800	.40100	.630	.00380	730
	.46400	.31800	.640	.00210	740
	.51100	.23400	.650	.00120	750
	.55200	.16000	.660	.00070	760
	.58200	.10400	.670	.00050	770
380	.12400	.06300	.680	.00030	
390	.18600	.03720	.690	.00020	

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	U	1960 CIE V	CAP U*	1964 CIE V*	CAP V*	CAP W*
KELVINS												
1500.8	4.882	9.212	2.843	.28823	.54389	.16788	.12882	.36461	-105.382	1.965	35.406	
1700.9	5.435	10.826	4.540	.26129	.52046	.21825	.11982	.35799	-106.346	-1.236	38.305	
1905.0	5.971	12.275	6.603	.24027	.49399	.26573	.11377	.35087	-105.408	-4.665	40.670	
2101.2	6.472	13.499	8.827	.22472	.46875	.30653	.10995	.34401	-103.480	-7.888	42.527	
2366.3	7.137	14.928	12.090	.20896	.43707	.35397	.10679	.33505	-100.084	-11.926	44.557	
2601.4	7.718	16.014	15.127	.19861	.41211	.38928	.10525	.32759	-96.781	-15.110	46.014	
2855.6	8.334	17.029	18.471	.19012	.38849	.42139	.10444	.32011	-93.196	-18.111	47.318	
3051.7	8.799	17.718	21.052	.18497	.37247	.44256	.10422	.31478	-90.519	-20.132	48.174	
3251.8	9.263	18.349	23.659	.18067	.35789	.46145	.10423	.30971	-87.913	-21.951	48.940	
CIE B	12.707	21.555	43.579	.16324	.27691	.55985	.10889	.27707	-71.582	-31.729	52.575	
CIE C	15.526	23.352	59.913	.15716	.23638	.60646	.11384	.25683	-61.583	-35.755	54.457	

GREEN 7342A(FS3)  
2 DEGREE OBSERVER

1956

[ 46 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.30800	500	.61500	600	.03600	700	.00000
410	.36400	510	.57900	610	.02200	710	.00000
420	.41600	520	.52300	620	.01400	720	.00000
430	.46400	530	.45000	630	.00800	730	.00000
440	.50900	540	.36200	640	.00500	740	.00000
450	.55000	550	.27800	650	.00200	750	.00000
460	.58600	560	.19900	660	.00000	760	.00000
470	.61300	570	.13700	670	.00000	770	.00000
380	.20000	580	.09000	680	.00000		
390	.25000	590	.05700	690	.00000		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	1964 CIE U*	V*	CAP W*
1500.8	6.667	11.260	3.039	.31800	.53705	.14495	.14440	.36581	-108.268	2.777	39.033
1700.9	7.264	13.063	4.853	.28849	.51876	.19275	.13343	.35991	-108.853	-.308	41.877
1905.0	7.831	14.666	7.064	.26490	.49613	.23897	.12579	.35338	-107.637	-3.629	44.194
2101.2	8.355	16.009	9.449	.24709	.47345	.27946	.12072	.34697	-105.509	-6.766	46.008
2366.3	9.048	17.567	12.953	.22867	.44397	.32736	.11622	.33846	-101.909	-10.716	47.988
2601.4	9.653	18.743	16.219	.21636	.42011	.36353	.11374	.33129	-98.465	-13.845	49.408
2855.6	10.295	19.838	19.819	.20610	.39714	.39676	.11211	.32404	-94.758	-16.808	50.677
3051.7	10.782	20.579	22.601	.19980	.38137	.41883	.11136	.31883	-92.001	-18.809	51.509
3251.8	11.268	21.256	25.413	.19448	.36689	.43863	.11092	.31386	-89.323	-20.617	52.253
CIE B	14.903	24.670	46.884	.17237	.28534	.54228	.11342	.28162	-72.663	-30.366	55.777
CIE C	17.907	26.566	64.536	.16427	.24370	.59203	.11742	.26130	-62.453	-34.466	57.596



GREEN 87(R69),87(TR),7.087(HB95)  
 2 DEGREE OBSERVER

1962

[ 48 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.23970	500	.61990	600	.03750	700	.00030
410	.30580	510	.58470	610	.02300	710	.00020
420	.36710	520	.52540	620	.01320	720	.00010
430	.42870	530	.44820	630	.00780	730	.00010
440	.48170	540	.36360	640	.00460	740	.00010
450	.54300	550	.27970	650	.00280	750	.00010
460	.59350	560	.20360	660	.00170	760	.00010
470	.62780	570	.14110	670	.00100	770	.00010
380	.07140	580	.09390	680	.00070		
390	.15310	590	.06000	690	.00040		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	1964 CIE CAP U*	CAP V*	CAP W*
KELVINS											
1500.8	6.840	11.441	3.048	.32070	.53640	.14290	.14585	.36592	-108.359	2.852	39.333
1700.9	7.436	13.256	4.857	.29105	.51885	.19010	.13468	.36014	-108.922	-.184	42.167
1905.0	7.998	14.869	7.054	.26730	.49695	.23575	.12685	.35375	-107.709	-3.437	44.475
2101.2	8.515	16.219	9.418	.24932	.47491	.27577	.12161	.34748	-105.602	-6.497	46.283
2366.3	9.195	17.785	12.882	.23068	.44616	.32316	.11691	.33918	-102.047	-10.330	48.257
2601.4	9.787	18.967	16.102	.21818	.42284	.35898	.11426	.33217	-98.655	-13.349	49.671
2855.6	10.413	20.067	19.645	.20774	.40034	.39192	.11247	.32510	-95.008	-16.193	50.936
3051.7	10.886	20.811	22.377	.20131	.38486	.41382	.11160	.32002	-92.300	-18.104	51.766
3251.8	11.358	21.491	25.135	.19588	.37064	.43348	.11104	.31517	-89.671	-19.822	52.507
CIE B	14.892	24.922	46.208	.17312	.28971	.53717	.11296	.28355	-73.318	-29.090	56.024
CIE C	17.799	26.826	63.450	.16469	.24822	.58709	.11661	.26363	-63.326	-32.861	57.839



GREEN 140(R69)  
2 DEGREE OBSERVER

1932

[ 49 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.12600	500	.50100	600	.04280	700	.00000
410	.17400	510	.48300	610	.02760	710	.00000
420	.22200	520	.45000	620	.01730	720	.00000
430	.27300	530	.39600	630	.01090	730	.00000
440	.32600	540	.33300	640	.00700	740	.00000
450	.37300	550	.26600	650	.00460	750	.00000
460	.42300	560	.20100	660	.00310	760	.00000
470	.45900	570	.14420	670	.00210	770	.00000
480	.48300	580	.09960	680	.00140		
490	.50100	590	.06600	690	.00100		

380 .04000  
390 .08200

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	1964 CIE U*	V*	CAP W*
1500.8	7.132	10.992	2.289	.34940	.53848	.11213	.15949	.36870	-99.457	4.191	38.585
1700.9	7.600	12.580	3.610	.31946	.52881	.15174	.14676	.36441	-99.817	2.104	41.144
1905.0	8.018	13.973	5.200	.29488	.51387	.19125	.13753	.35949	-98.660	-.116	43.215
2101.2	8.389	15.127	6.901	.27580	.49732	.22688	.13108	.35454	-96.766	-2.178	44.829
2366.3	8.862	16.450	9.376	.25548	.47422	.27030	.12494	.34785	-93.643	-4.717	46.581
2601.4	9.265	17.438	11.665	.24147	.45450	.30403	.12117	.34211	-90.703	-6.674	47.830
2855.6	9.685	18.351	14.172	.22947	.43477	.33577	.11831	.33623	-87.570	-8.475	48.941
3051.7	10.001	18.964	16.099	.22192	.42082	.35725	.11671	.33197	-85.258	-9.658	49.668
3251.8	10.314	19.521	18.040	.21544	.40776	.37681	.11548	.32786	-83.023	-10.698	50.315
CIE B	12.673	22.272	32.831	.18698	.32862	.48440	.11385	.30013	-69.188	-16.200	53.339
CIE C	14.606	23.758	44.830	.17556	.28558	.53886	.11558	.28201	-60.808	-18.061	54.870

GREEN 137(K59),7.137(HB95)  
2 DEGREE OBSERVER

1932

[ 50 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.35600	500	.65800	600	.06530	700	.00200
410	.40800	510	.62800	610	.04370	710	.00150
420	.45700	520	.57800	620	.02890	720	.00100
430	.50500	530	.50900	630	.01900	730	.00000
440	.54500	540	.43400	640	.01270	740	.00000
450	.58200	550	.34700	650	.00880	750	.00000
460	.62000	560	.26500	660	.00620	760	.00000
470	.64500	570	.19600	670	.00450	770	.00000
480	.66200	580	.13900	680	.00300		
490	.66600	590	.09680	690	.00250		

380 .23000  
390 .29400

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	1964 CIE U*	V*	CAP W*
1500.8	10.235	14.870	3.245	.36102	.52451	.11447	.16846	.36713	-109.453	3.924	44.477
1700.9	10.836	16.926	5.176	.32899	.51387	.15714	.15467	.36237	-109.633	1.162	47.188
1905.0	11.389	18.727	7.527	.30256	.49748	.19996	.14469	.35684	-108.157	-1.831	49.389
2101.2	11.895	20.219	10.065	.28202	.47935	.23863	.13777	.35125	-105.876	-4.671	51.107
2366.3	12.563	21.932	13.795	.26017	.45417	.28567	.13124	.34365	-102.163	-8.261	52.978
2601.4	13.149	23.213	17.272	.24516	.43280	.32204	.12730	.33710	-98.674	-11.116	54.315
2855.6	13.775	24.398	21.108	.23237	.41156	.35607	.12436	.33039	-94.952	-13.826	55.508
3051.7	14.252	25.195	24.072	.22438	.39665	.37898	.12276	.32552	-92.197	-15.662	56.290
3251.8	14.732	25.920	27.070	.21753	.38275	.39972	.12156	.32083	-89.528	-17.322	56.987
CIE B	18.398	29.539	49.942	.18796	.30180	.51024	.12038	.28993	-73.073	-26.307	60.281
CIE C	21.483	31.518	68.767	.17643	.25884	.56474	.12266	.26994	-62.973	-30.124	61.970

GREEN 137(R59),7.137(HB95)  
2 DEGREE OBSERVER

1966

[51]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.35000	500	.65500	600	.06440	700	.00200
410	.40500	510	.62400	610	.04330	710	.00170
420	.45700	520	.57100	620	.02840	720	.00150
430	.50200	530	.50900	630	.01830	730	.00140
440	.54200	540	.42800	640	.01260	740	.00140
450	.58300	550	.34600	650	.00860	750	.00140
460	.61800	560	.26500	660	.00600	760	.00140
470	.64600	570	.19200	670	.00440	770	.00160
480	.66100	580	.13600	680	.00320		
490	.66600	590	.09660	690	.00250		

380 .21200  
390 .28600

G2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	KELVINS	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	CAP U*	CAP V*
1500.8	10.119	14.735	3.238	.36020	.52454	.11526	.16804	.36706	-109.237	3.870	44.290
1700.9	10.718	16.778	5.165	.32817	.51370	.15813	.15428	.36227	-109.429	1.095	47.001
1905.0	11.271	18.568	7.511	.30176	.49713	.20111	.14435	.35671	-107.963	-1.913	49.201
2101.2	11.777	20.052	10.045	.28124	.47887	.23988	.13746	.35108	-105.689	-4.767	50.919
2366.3	12.445	21.755	13.767	.25944	.45355	.28700	.13097	.34344	-101.984	-8.374	52.790
2601.4	13.030	23.030	17.237	.24448	.43211	.32341	.12706	.33687	-98.501	-11.243	54.128
2855.6	13.656	24.209	21.065	.23174	.41081	.35745	.12415	.33013	-94.783	-13.967	55.321
3051.7	14.133	25.002	24.023	.22378	.39587	.38036	.12257	.32524	-92.031	-15.811	56.103
3251.8	14.613	25.725	27.014	.21696	.38195	.40109	.12139	.32054	-89.365	-17.480	56.800
CIE B	18.276	29.331	49.838	.18755	.30100	.51145	.12028	.28957	-72.927	-26.508	60.099
CIE C	21.357	31.304	68.622	.17609	.25811	.56580	.12260	.26956	-62.838	-30.344	61.791

GREEN 7356A(FS3)  
2 DEGREE OBSERVER

1944

[ 52 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.37500	500	.67000	600	.06600	700	.00080
410	.42800	510	.63900	610	.04400	710	.00040
420	.47800	520	.59000	620	.02800	720	.00030
430	.52800	530	.52200	630	.01900	730	.00020
440	.56900	540	.44100	640	.01200	740	.00010
450	.60600	550	.35700	650	.00800	750	.00000
460	.63900	560	.28000	660	.00500	760	.00000
470	.66400	570	.20700	670	.00320	770	.00000
480	.67900	580	.14400	680	.00200		
490	.68100	590	.10000	690	.00120		

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	U*	V*	W*
1500.8	10.478	15.301	3.339	.35985	.52548	.11468	.16764	.36721	-111.383	4.023	45.065
1700.9	11.116	17.418	5.330	.32826	.51434	.15740	.15419	.36240	-111.358	1.195	47.804
1905.0	11.701	19.269	7.758	.30213	.49755	.20032	.14445	.35682	-109.701	-1.869	50.024
2101.2	12.234	20.802	10.381	.28178	.47912	.23910	.13769	.35118	-107.270	-4.778	51.755
2366.3	12.935	22.559	14.237	.26010	.45362	.28628	.13131	.34351	-103.385	-8.459	53.639
2601.4	13.548	23.873	17.835	.24519	.43204	.32277	.12747	.33691	-99.769	-11.389	54.985
2855.6	14.203	25.086	21.806	.23247	.41061	.35691	.12461	.33014	-95.927	-14.177	56.184
3051.7	14.701	25.903	24.875	.22452	.39559	.37990	.12306	.32523	-93.093	-16.067	56.970
3251.8	15.201	26.645	27.980	.21770	.38159	.40071	.12190	.32050	-90.351	-17.779	57.670
CIE B	19.021	30.354	51.678	.18822	.30038	.51140	.12089	.28938	-73.524	-27.050	60.985
CIE C	22.232	32.381	71.203	.17670	.25737	.56593	.12325	.26926	-63.223	-31.027	62.684



GREEN 7346A(FS3) [ 53 ]  
 2 DEGREE OBSERVER 1942

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	800	900
400	.33700	.500	.69400	.8400	.700	.00000
410	.39800	.510	.66300	.05600	.710	.00000
420	.45400	.520	.61600	.03700	.720	.00000
430	.51800	.530	.54600	.02500	.730	.00000
440	.57000	.540	.46300	.01600	.740	.00000
450	.62600	.550	.38200	.01000	.750	.00000
460	.67000	.560	.30500	.00600	.760	.00000
470	.70000	.570	.23300	.00300	.770	.00000
480	.71000	.580	.16900	.00100		
490	.70900	.590	.12000	.00000		

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	U	V	W	CAP U*	CAP V*	CAP W*		
1500.8	12.237	16.945	3.469	.37477	.51899	.10624	.17681	.36728	-111.063	4.260	47.213
1700.9	12.867	19.161	5.529	.34261	.51018	.14721	.16243	.36282	-110.888	1.519	49.897
1905.0	13.436	21.089	8.035	.31569	.49551	.18880	.15187	.35757	-109.166	-1.442	52.070
2101.2	13.950	22.679	10.738	.29451	.47879	.22670	.14443	.35220	-106.723	-4.248	53.764
2366.3	14.627	24.497	14.706	.27173	.45508	.27319	.13728	.34487	-102.865	-7.788	55.607
2601.4	15.219	25.852	18.401	.25590	.43469	.30941	.13286	.33852	-99.296	-10.599	56.922
2855.6	15.854	27.102	22.474	.24230	.41421	.34348	.12947	.33199	-95.516	-13.263	58.094
3051.7	16.338	27.941	25.619	.23374	.39974	.36652	.12757	.32724	-92.733	-15.064	58.861
3251.8	16.826	28.704	28.797	.22638	.38619	.38744	.12609	.32265	-90.044	-16.691	59.546
CIE B	20.601	32.506	53.067	.19403	.30616	.49981	.12347	.29224	-73.587	-25.514	62.786
CIE C	23.799	34.578	73.000	.18115	.26320	.55565	.12501	.27246	-63.520	-29.220	64.447

GREEN 7346A(FS3)  
2 DEGREE OBSERVER

1961

[ 54 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.33400	500	.69000	600	.08460	700	.00230
410	.39950	510	.66200	610	.05760	710	.00180
420	.45680	520	.61200	620	.03900	720	.00150
430	.51500	530	.54480	630	.02620	730	.00130
440	.56500	540	.46650	640	.01760	740	.00130
450	.62200	550	.38180	650	.01180	750	.00160
460	.66880	560	.30200	660	.00810	760	.00360
470	.69800	570	.23050	670	.00560	770	.00970
380	.13100	580	.16900	680	.00410		
390	.23700	590	.12100	690	.00300		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	CAP V*	CIE	CAP W*
1500.8	12.399	16.987	3.455	.37754	.51725	.10521	.17867	.36719	-110.045	4.211	47.266	
1700.9	13.004	19.188	5.507	.34495	.50898	.14607	.16391	.36279	-109.999	1.499	49.929	
1905.0	13.552	21.104	8.003	.31769	.49472	.18760	.15308	.35757	-108.382	-1.437	52.086	
2101.2	14.051	22.684	10.694	.29625	.47828	.22548	.14545	.35224	-106.019	-4.221	53.770	
2366.3	14.710	24.491	14.644	.27319	.45484	.27197	.13812	.34494	-102.248	-7.737	55.601	
2601.4	15.290	25.839	18.324	.25717	.43461	.30822	.13358	.33861	-98.739	-10.529	56.909	
2855.6	15.913	27.081	22.379	.24342	.41426	.34232	.13010	.33210	-95.012	-13.176	58.075	
3051.7	16.390	27.916	25.510	.23476	.39985	.36539	.12813	.32736	-92.263	-14.965	58.839	
3251.8	16.871	28.675	28.674	.22731	.38635	.38634	.12661	.32278	-89.605	-16.581	59.520	
CIE B	20.606	32.455	52.835	.19459	.30648	.49893	.12377	.29241	-73.292	-25.352	62.744	
CIE C	23.778	34.514	72.677	.18155	.26353	.55492	.12522	.27265	-63.295	-29.034	64.397	

GREEN 134 (R69), 134 (TR), 7.134 (HB95) [ 55 ]  
 2 DEGREE OBSERVER 1932

PREVIOUSLY CORRECTED TRANSMITTANCE DATA		1960 CIE										
		400	500	600	700	U	V	W	U*	V*	W*	
	400	.33500	500	.68000	600	.08560	700	.00200				
	410	.40500	510	.65600	610	.05880	710	.00150				
	420	.46400	520	.61000	620	.04020	720	.00100				
	430	.52100	530	.54000	630	.02700	730	.00000				
	440	.56500	540	.46200	640	.01820	740	.00000				
	450	.61700	550	.38200	650	.01240	750	.00000				
	460	.65900	560	.30100	660	.00880	760	.00000				
	470	.68600	570	.23000	670	.00600	770	.00000				
	380	.12100	580	.17100	680	.00400						
	390	.24200	590	.12110	690	.00300						

C2=14387.9 MU-M K

ILLUMINANT		1964 CIE										
KELVINS	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W	U*	V*	W*
1500.8	12.493	16.987	3.416	.37977	.51640	.10383	.18005	.36723	4.232	-109.201	4.232	47.266
1700.9	13.084	19.168	5.445	.34709	.50847	.14444	.16513	.36287	1.553	-109.157	1.553	49.906
1905.0	13.620	21.066	7.916	.31970	.49448	.18582	.15418	.35770	-1.351	-107.553	-1.351	52.046
2101.2	14.109	22.631	10.583	.29814	.47823	.22363	.14646	.35240	-4.110	-105.208	-4.110	53.715
2366.3	14.755	24.419	14.499	.27491	.45496	.27013	.13902	.34512	-7.598	-101.463	-7.598	55.530
2601.4	15.326	25.752	18.149	.25876	.43481	.30643	.13442	.33880	-10.373	-97.976	-10.373	56.826
2855.6	15.940	26.981	22.172	.24488	.41450	.34062	.13088	.33230	-13.008	-94.272	-13.008	57.982
3051.7	16.410	27.806	25.280	.23613	.40010	.36376	.12888	.32755	-14.791	-91.538	-14.791	58.739
3251.8	16.885	28.556	28.422	.22860	.38660	.38479	.12732	.32298	-16.404	-88.894	-16.404	59.414
CIE B	20.583	32.286	52.412	.19551	.30666	.49783	.12435	.29257	-25.167	-72.660	-25.167	62.606
CIE C	23.733	34.318	72.137	.18230	.26360	.55410	.12575	.27276	-28.878	-62.700	-28.878	64.242

GREEN 134(R69), 134(TR), 7.134(HB95)  
 2 DEGREE OBSERVER

1962

[ 56 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	68230	700	00230
	.33650	.51586	.10562	.08400	.36702	.00180
	.40380	.50765	.14675	.05790	.36258	.00150
	.46180	.49338	.18854	.03920	.35733	.00120
	.51760	.47690	.22665	.02640	.35196	.00110
	.56600	.45340	.27341	.01800	.34460	.00100
	.61700	.43310	.30982	.01210	.33823	.00080
	.66040	.41269	.34407	.00820	.33166	.00080
	.68830	.39825	.36721	.00580	.32688	.00080
380	.13580	.38472	.38823	.670	.32228	.00080
390	.24040	.30479	.50094	.680	.29171	.00080
	.490	.26188	.55686	.690	.27185	
		.26188	.55686			

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	12.252	16.696	3.418	.37853	.51586	.10562	.17954	.36702	-108.656	4.070	46.897
1700.9	12.836	18.855	5.450	.34561	.50765	.14675	.16456	.36258	-108.719	1.355	49.539
1905.0	13.369	20.736	7.924	.31808	.49338	.18854	.15358	.35733	-107.204	-1.589	51.683
2101.2	13.855	22.289	10.593	.29645	.47690	.22665	.14585	.35196	-104.926	-4.385	53.356
2366.3	14.501	24.066	14.513	.27320	.45340	.27341	.13843	.34460	-101.250	-7.922	55.179
2601.4	15.072	25.393	18.165	.25707	.43310	.30982	.13384	.33823	-97.808	-10.735	56.481
2855.6	15.688	26.617	22.191	.24324	.41269	.34407	.13032	.33166	-94.139	-13.406	57.643
3051.7	16.159	27.439	25.301	.23454	.39825	.36721	.12834	.32688	-91.427	-15.214	58.405
3251.8	16.636	28.187	28.444	.22705	.38472	.38823	.12680	.32228	-88.800	-16.849	59.084
CIE B	20.340	31.911	52.449	.19427	.30479	.50094	.12396	.29171	-72.620	-25.739	62.297
CIE C	23.495	33.944	72.179	.18126	.26188	.55686	.12544	.27185	-62.672	-29.502	63.946



GREEN 7044A(FS3)  
2 DEGREE OBSERVER

1943

[ 57 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	2900	3000	3100	3200	3300	3400	3500	3600	3700	3800	3900	4000	
400	.19400	.57400	.600	.08100	.00400																																	
510	.24900	.56000	.610	.05700	.00400																																	
620	.30000	.52900	.620	.04000	.00000																																	
730	.35800	.48200	.630	.02800	.00000																																	
840	.40900	.41600	.640	.02000	.00000																																	
950	.45500	.34700	.650	.01400	.00000																																	
1060	.49600	.27900	.660	.01000	.00000																																	
1170	.53100	.21800	.670	.00700	.00000																																	
1280	.55600	.16100	.680	.00500	.00000																																	
1390	.57100	.11600	.690	.00400	.00000																																	

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 U	V	1964 CIE U*	V*	CAP W*
1500.8	11.834	15.627	2.696	.39242	.51819	.08939	.18612	.36867	-101.532	4.926	45.503
1700.9	12.295	17.540	4.260	.36061	.51444	.12495	.17066	.36519	-101.442	2.940	47.956
1905.0	12.695	19.193	6.151	.33374	.50455	.16171	.15917	.36095	-99.952	.811	49.935
2101.2	13.048	20.546	8.180	.31235	.49184	.19581	.15094	.35652	-97.817	-1.179	51.473
2366.3	13.506	22.083	11.142	.28901	.47256	.23843	.14285	.35036	-94.450	-3.648	53.139
2601.4	13.904	23.222	13.890	.27255	.45519	.27226	.13770	.34496	-91.345	-5.566	54.325
2855.6	14.331	24.266	16.907	.25820	.43719	.30461	.13361	.33935	-88.069	-7.345	55.378
3051.7	14.657	24.964	19.231	.24905	.42418	.32677	.13122	.33523	-85.665	-8.522	56.065
3251.8	14.986	25.596	21.574	.24110	.41180	.34710	.12929	.33123	-83.349	-9.564	56.676
CIE B	17.586	28.691	39.444	.20515	.33470	.46014	.12422	.30399	-69.195	-15.094	59.534
CIE C	19.808	30.342	54.026	.19014	.29126	.51860	.12438	.28579	-60.601	-17.078	60.975

GREEN 139(R69)  
2 DEGREE OBSERVER

1932

[ 58 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	410	420	430	440	450	460	470	380	390	500	510	520	530	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730	740	750	760	770		
	.20700	.26600	.31500	.37100	.41400	.45900	.50300	.54000	.09700	.15000	.57800	.56900	.53600	.49300	.43000	.35800	.29200	.22400	.17200	.12400	.57800	.56900	.53600	.49300	.43000	.35800	.29200	.22400	.17200	.12400	.57800	.56900	.53600	.49300	.43000	.35800	.29200	.22400	.17200	.12400
	.20700	.26600	.31500	.37100	.41400	.45900	.50300	.54000	.09700	.15000	.57800	.56900	.53600	.49300	.43000	.35800	.29200	.22400	.17200	.12400	.57800	.56900	.53600	.49300	.43000	.35800	.29200	.22400	.17200	.12400	.57800	.56900	.53600	.49300	.43000	.35800	.29200	.22400	.17200	.12400
	.09020	.06420	.04600	.03220	.02300	.01670	.01220	.00930	.00700	.00540	.09020	.06420	.04600	.03220	.02300	.01670	.01220	.00930	.00700	.00540	.09020	.06420	.04600	.03220	.02300	.01670	.01220	.00930	.00700	.00540	.09020	.06420	.04600	.03220	.02300	.01670	.01220	.00930	.00700	.00540

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	1964 CIE U*	V*	CAP W*
KELVINS											
1500.8	12.761	16.399	2.736	.40009	.51413	.08579	.19121	.36858	-100.713	4.981	46.515
1700.9	13.197	18.343	4.325	.36796	.51145	.12059	.17519	.36526	-100.628	3.040	48.932
1905.0	13.572	20.019	6.245	.34070	.50252	.15678	.16323	.36114	-99.158	.957	50.882
2101.2	13.905	21.389	8.306	.31893	.49057	.19050	.15465	.35682	-97.048	-.994	52.397
2366.3	14.341	22.943	11.317	.29507	.47208	.23285	.14617	.35078	-93.717	-3.415	54.038
2601.4	14.723	24.093	14.110	.27819	.45522	.26660	.14074	.34546	-90.644	-5.299	55.205
2855.6	15.137	25.146	17.179	.26342	.43762	.29896	.13641	.33992	-87.400	-7.047	56.243
3051.7	15.454	25.849	19.543	.25399	.42483	.32118	.13386	.33583	-85.019	-8.204	56.919
3251.8	15.776	26.486	21.928	.24578	.41262	.34160	.13179	.33187	-82.723	-9.229	57.521
CIE B	18.358	29.599	40.104	.20846	.33612	.45541	.12603	.30480	-68.708	-14.663	60.333
CIE C	20.587	31.256	54.946	.19278	.29269	.51453	.12586	.28664	-60.181	-16.615	61.750

BLUE B131(R59),8.131(HB95)  
2 DEGREE OBSERVER

1937

[ 59 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.65500	500	.11200	600	.00020	700	.02700
410	.68500	510	.05290	610	.00020	710	.03700
420	.69100	520	.02150	620	.00030	720	.04100
430	.68000	530	.00750	630	.00020	730	.04000
440	.65900	540	.00440	640	.00010	740	.03900
450	.63000	550	.00670	650	.00010	750	.03700
460	.57600	560	.01090	660	.00020	760	.03500
470	.47000	570	.00710	670	.00060	770	.03300
480	.32000	580	.00160	680	.00320		
490	.18600	590	.00030	690	.01400		

380 .45000  
390 .58000

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE		
KELVINS	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W
1500.8	.576	.563	2.009	.18301	.17880	.63819	.15316	.22445	*****
1700.9	.814	.715	3.473	.16277	.14287	.69435	.14835	.19532	*****
1905.0	1.137	.878	5.363	.15407	.11899	.72694	.14960	.17330	*****
2101.2	1.509	1.037	7.494	.15031	.10332	.74638	.15263	.15737	-15.606
2366.3	2.087	1.251	10.748	.14818	.08882	.76300	.15724	.14138	-15.807
2601.4	2.651	1.435	13.882	.14753	.07988	.77259	.16109	.13082	-15.428
2855.6	3.293	1.626	17.424	.14739	.07276	.77984	.16476	.12200	-14.694
3051.7	3.802	1.766	20.212	.14748	.06850	.78403	.16725	.11652	-14.004
3251.8	4.326	1.902	23.071	.14764	.06493	.78742	.16952	.11183	-13.245
CIE B	8.384	2.862	45.166	.14862	.05074	.80064	.17952	.09193	-8.201
CIE C	11.924	3.556	64.173	.14970	.04465	.80565	.18502	.08277	-4.348
									-61.772
									21.160

BLUE 0131(R59), 8.131(HB95)  
 2 DEGREE OBSERVER

1965

[ 60 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.66865	500	.11306	600	.00021	700	.02782
410	.68992	510	.05158	610	.00025	710	.03802
420	.69615	520	.02136	620	.00025	720	.04121
430	.68834	530	.00719	630	.00018	730	.04074
440	.66497	540	.00433	640	.00011	740	.03916
450	.63241	550	.00655	650	.00011	750	.03728
460	.58103	560	.01132	660	.00020	760	.03577
470	.47228	570	.00719	670	.00071	770	.03459
380	.44340	580	.00152	680	.00340		
390	.59402	590	.00024	690	.01376		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	1964 CIE V*	CAP V*	CAP W*
1500.8	.581	.566	2.030	.18295	.17812	.63893	.15337	.22398	*****	*****	*****	*****
1700.9	.821	.719	3.508	.16266	.14237	.69497	.14844	.19489	*****	*****	*****	*****
1905.0	1.146	.883	5.416	.15395	.11862	.72743	.14963	.17294	*****	*****	*****	*****
2101.2	1.522	1.044	7.567	.15019	.10304	.74677	.15263	.15707	-15.709	-21.875	8.363	
2366.3	2.105	1.260	10.852	.14807	.08863	.76330	.15721	.14115	-15.911	-27.889	10.002	
2601.4	2.673	1.446	14.014	.14743	.07973	.77284	.16104	.13064	-15.530	-32.552	11.269	
2855.6	3.321	1.638	17.588	.14729	.07266	.78005	.16470	.12186	-14.793	-36.914	12.471	
3051.7	3.834	1.780	20.402	.14738	.06841	.78421	.16719	.11641	-14.100	-39.847	13.297	
3251.8	4.363	1.918	23.287	.14755	.06486	.78758	.16944	.11173	-13.338	-42.496	14.061	
CIE B	8.456	2.889	45.579	.14854	.05076	.80070	.17940	.09196	-8.280	-56.011	18.608	
CIE C	12.026	3.592	64.755	.14963	.04469	.80568	.18490	.08284	-4.410	-62.125	21.287	



BLUE 8213A(FS3)  
2 DEGREE OBSERVER

1944

[ 61 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.67500	500	.13600	600	.00050	700	.01700
410	.71000	510	.06800	610	.00050	710	.02400
420	.72500	520	.03200	620	.00050	720	.02500
430	.72200	530	.01200	630	.00040	730	.02500
440	.70000	540	.00800	640	.00020	740	.02400
450	.66700	550	.01000	650	.00020	750	.02300
460	.61600	560	.01600	660	.00020	760	.02200
470	.51000	570	.01100	670	.00070	770	.02100
380	.46500	580	.00300	680	.00300		
390	.59900	590	.00070	690	.00800		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	1964 CIE V*	CAP W*
1500.8	.672	.756	2.179	.18622	.20958	.60421	.14484	.24452	*****	*****	*****
1700.9	.941	.949	3.755	.16673	.16816	.66511	.14236	.21539	*****	*****	*****
1905.0	1.296	1.151	5.786	.15739	.13982	.70278	.14429	.19228	-20.196	-20.025	9.201
2101.2	1.700	1.344	8.072	.15291	.12093	.72616	.14755	.17503	-20.594	-25.230	10.591
2366.3	2.322	1.599	11.558	.15002	.10329	.74669	.15232	.15732	-20.237	-31.540	12.233
2601.4	2.926	1.815	14.911	.14889	.09236	.75875	.15629	.14543	-19.432	-36.390	13.496
2855.6	3.613	2.037	18.698	.14838	.08366	.76796	.16010	.13540	-18.304	-40.898	14.690
3051.7	4.156	2.199	21.677	.14825	.07844	.77330	.16270	.12913	-17.351	-43.912	15.510
3251.8	4.715	2.356	24.730	.14825	.07409	.77766	.16506	.12374	-16.357	-46.623	16.267
CIE B	9.039	3.440	48.322	.14867	.05658	.79475	.17585	.10039	-10.184	-60.153	20.740
CIE C	12.805	4.213	68.586	.14959	.04922	.80120	.18179	.08972	-5.787	-66.136	23.378

BLUE 57B(R69), 8.057(HR95)  
2 DEGREE OBSERVER

1932

[ 62 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.67500	500	.16500	600	.00030	700	.00300
410	.71800	510	.08540	610	.00030	710	.00400
420	.73100	520	.03760	620	.00020	720	.00410
430	.72600	530	.01350	630	.00020	730	.00370
440	.70700	540	.00720	640	.00010	740	.00340
450	.67300	550	.00840	650	.00010	750	.00310
460	.62500	560	.01230	660	.00020	760	.00260
470	.53000	570	.00830	670	.00030	770	.00210
380	.44200	580	.00220	680	.00050		
390	.59600	590	.00040	690	.00200		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	CAP V*	CAP W*
1500.8	.568	.724	2.278	.15903	.20287	.63810	.12433	.23791	*****	*****	*****
1700.9	.855	.942	3.908	.14987	.16507	.68506	.12807	.21158	*****	*****	*****
1905.0	1.224	1.168	6.002	.14587	.13915	.71498	.13328	.19070	-21.812	-20.494	9.328
2101.2	1.642	1.384	8.353	.14426	.12167	.73407	.13833	.17500	-22.424	-25.883	10.863
2366.3	2.281	1.669	11.930	.14361	.10511	.75127	.14455	.15870	-22.215	-32.401	12.655
2601.4	2.898	1.910	15.365	.14367	.09470	.76162	.14931	.14762	-21.460	-37.406	14.021
2855.6	3.600	2.157	19.239	.14401	.08631	.76968	.15370	.13818	-20.340	-42.052	15.303
3051.7	4.154	2.337	22.284	.14435	.08123	.77442	.15664	.13223	-19.374	-45.155	16.179
3251.8	4.723	2.512	25.402	.14471	.07696	.77832	.15928	.12707	-18.355	-47.944	16.984
CIE B	9.123	3.700	49.483	.14642	.05939	.79419	.17126	.10419	-11.933	-61.773	21.668
CIE C	12.947	4.540	70.119	.14779	.05182	.80039	.17772	.09348	-7.329	-67.824	24.396



BLUE B141(R59) 8.141(HB95)  
 2 DEGREE OBSERVER

1937

[ 64 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.71000	500	.19700	600	.00210	700	.07100
410	.73800	510	.11700	610	.00210	710	.09000
420	.74200	520	.06010	620	.00230	720	.09600
430	.73400	530	.02700	630	.00210	730	.09600
440	.71700	540	.01880	640	.00160	740	.09300
450	.69300	550	.02440	650	.00150	750	.09000
460	.65200	560	.03610	660	.00200	760	.08700
470	.56400	570	.02800	670	.00540	770	.08400
380	.50000	580	.00960	680	.01700		
390	.63000	590	.00260	690	.04200		

C2=14387.9 MU-M K

ILLUMINANT KELVINS	-----1931 CIE-----			-----1960 CIE-----			-----1964 CIE-----				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	1.419	1.601	2.416	.26105	.29446	.44448	.17370	.29390	-29.299	-10.576	12.245
1700.9	1.663	1.885	4.124	.21672	.24569	.53760	.15719	.26730	-31.795	-16.814	13.881
1905.0	2.010	2.174	6.311	.19150	.20712	.60138	.15012	.24355	-32.603	-23.227	15.384
2101.2	2.417	2.443	8.761	.17743	.17938	.64319	.14793	.22433	-32.335	-29.031	16.672
2366.3	3.053	2.790	12.480	.16661	.15229	.68110	.14829	.20331	-31.056	-36.034	18.196
2601.4	3.674	3.079	16.045	.16117	.13506	.70378	.14908	.18852	-29.478	-41.378	19.370
2855.6	4.383	3.370	20.060	.15759	.12116	.72125	.15231	.17565	-27.593	-46.303	20.481
3051.7	4.945	3.580	23.214	.15580	.11279	.73142	.15418	.16743	-26.116	-49.569	21.243
3251.8	5.523	3.781	26.440	.15451	.10578	.73971	.15606	.16026	-24.638	-52.485	21.947
CIE B	10.019	5.116	51.336	.15073	.07697	.77230	.16645	.12750	-15.992	-66.447	26.078
CIE C	13.929	6.036	72.619	.15045	.06519	.78436	.17286	.11235	-10.369	-72.286	28.518



BLUE B141(R59), 8.141(HB95)  
 2 DEGREE OBSERVER

1965

[ 65 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.73063	500	.20082	600	.00211	700	.07208
410	.74955	510	.11482	610	.00235	710	.09016
420	.75544	520	.05832	620	.00231	720	.09605
430	.74783	530	.02704	630	.00179	730	.09528
440	.72661	540	.01892	640	.00124	740	.09253
450	.70065	550	.02567	650	.00126	750	.08954
460	.65948	560	.03754	660	.00206	760	.08690
470	.56781	570	.02673	670	.00508	770	.08463
380	.54802	580	.00840	680	.01626		
390	.67344	590	.00225	690	.04234		

C2=14387.9 MU-M K

91

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	1.399	1.591	2.447	.25735	.29256	.45010	.17168	.29275	-.29.472	-10.705	12.183
1700.9	1.648	1.878	4.177	.21396	.24374	.54230	.15569	.26605	-31.974	-16.992	13.841
1905.0	2.001	2.169	6.393	.18947	.20536	.60517	.14903	.24229	-32.775	-23.447	15.363
2101.2	2.416	2.442	8.875	.17590	.17783	.64627	.14713	.22311	-32.496	-29.284	16.665
2366.3	3.062	2.793	12.643	.16552	.15099	.68350	.14776	.20218	-31.200	-36.323	18.207
2601.4	3.693	3.085	16.256	.16032	.13393	.70576	.14960	.18746	-29.608	-41.694	19.393
2855.6	4.412	3.379	20.326	.15692	.12018	.72290	.15205	.17466	-27.709	-46.643	20.515
3051.7	4.982	3.591	23.522	.15523	.11189	.73288	.15399	.16650	-26.221	-49.924	21.284
3251.8	5.569	3.795	26.793	.15402	.10496	.74102	.15591	.15937	-24.733	-52.853	21.996
CIE B	10.130	5.149	52.025	.15051	.07651	.77299	.16644	.12691	-16.054	-66.882	26.171
CIE C	14.095	6.082	73.600	.15031	.06485	.78484	.17288	.11189	-10.403	-72.751	28.634

BLUE 47B(R69), 8.047(HB95)  
 2 DEGREE OBSERVER

1932

[ 66 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.77000	500	.22500	600	.00200	700	.04200
410	.79000	510	.13620	610	.00220	710	.05000
420	.78500	520	.07100	620	.00190	720	.05100
430	.77100	530	.03190	630	.00150	730	.04900
440	.75100	540	.01910	640	.00100	740	.04700
450	.71900	550	.02190	650	.00100	750	.04500
460	.67000	560	.03250	660	.00150	760	.04300
470	.59000	570	.02540	670	.00350	770	.04100
380	.57900	580	.00920	680	.01090		
390	.71600	590	.00240	690	.02750		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 U	CIE V	CAP U*	CAP V*	CAP W*
1500.8	1.255	1.571	2.564	.23279	.29149	.47572	.15436	.28993	-31.897	-11.042	12.063
1700.9	1.543	1.893	4.365	.19775	.24268	.55956	.14339	.26394	-34.400	-17.478	13.928
1905.0	1.928	2.218	6.668	.17827	.20512	.61661	.13968	.24109	-35.188	-24.061	15.605
2101.2	2.369	2.521	9.245	.16758	.17833	.65409	.13951	.22269	-34.882	-30.007	17.024
2366.3	3.048	2.909	13.155	.15950	.15219	.68831	.14155	.20260	-33.531	-37.179	18.687
2601.4	3.708	3.230	16.900	.15554	.13552	.70894	.14418	.18843	-31.877	-42.655	19.957
2855.6	4.457	3.554	21.116	.15302	.12202	.72496	.14720	.17607	-29.903	-47.705	21.152
3051.7	5.049	3.787	24.427	.15180	.11385	.73434	.14946	.16815	-28.357	-51.056	21.968
3251.8	5.659	4.011	27.814	.15097	.10700	.74203	.15165	.16122	-26.809	-54.049	22.720
CIE B	10.377	5.476	53.920	.14873	.07848	.77279	.16325	.12920	-17.724	-68.357	27.064
CIE C	14.476	6.479	76.225	.14896	.06667	.78437	.17014	.11422	-11.812	-74.324	29.605



BLUE 8219B(FS3)  
2 DEGREE OBSERVER

1960

[ 68 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	700
	.72100	.21600	.00300	.05130	
	.75000	.13000	.00340	.06340	
	.76200	.07360	.00320	.06660	
	.75800	.03560	.00260	.06640	
	.74000	.02640	.00180	.06380	
	.71200	.03290	.00160	.06020	
	.66800	.04620	.00220	.05860	
	.57800	.03390	.00480	.05680	
380	.55100	.01340	.01420		
390	.65900	.00380	.03020		

C2=14387.9 MU-M K

ILLUMINANT KELVINS	1931 CIE			1960 CIE			1964 CIE		
	CAP X	CAP Y	CAP Z	U	V		CAP U*	CAP V*	CAP W*
1500.8	1.600	1.938	2.513	.16750	.30434		-35.053	-10.317	14.171
1700.9	1.880	2.279	4.281	.15379	.27958		-37.118	-16.720	15.899
1905.0	2.256	2.615	6.542	.14768	.25677		-37.521	-23.341	17.444
2101.2	2.687	2.924	9.073	.14572	.23783		-36.902	-29.359	18.749
2366.3	3.352	3.315	12.914	.14604	.21662		-35.199	-36.644	20.276
2601.4	3.998	3.636	16.593	.14762	.20142		-33.291	-42.213	21.444
2855.6	4.731	3.957	20.736	.14984	.18800		-31.095	-47.346	22.543
3051.7	5.311	4.187	23.988	.15166	.17935		-29.405	-50.748	23.295
3251.8	5.908	4.407	27.316	.15348	.17176		-27.733	-53.782	23.989
CIE B	10.540	5.842	52.984	.16397	.13632		-18.090	-68.193	28.026
CIE C	14.564	6.817	74.915	.17055	.11975		-11.967	-74.141	30.404



LUNAR WHITE 8449A(FS3)  
 2 DEGREE OBSERVER

1942

[ 69 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	75800
	.88200	.55500	.600	.13100	.75800
	.88200	.46200	.610	.14300	.83800
	.87300	.36900	.620	.14900	.87800
	.86500	.27600	.630	.14200	.89400
	.85500	.23800	.640	.12900	.90000
	.84100	.26700	.650	.13600	.90000
	.82400	.31700	.660	.17300	.90000
	.78500	.30000	.670	.26200	.90000
380	.88200	.580	.680	.42400	
390	.88200	.590	.690	.61000	

C2=14387.9 MU-M K

ILLUMINANT KELVINS	-----1931 CIE-----			-----1960 CIE-----			-----1964 CIE-----				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	27.458	21.064	3.709	.52570	.40328	.07102	.30978	.35647	-32.462	-2.621	52.043
1700.9	25.794	21.752	6.110	.48073	.40539	.11388	.27855	.35235	-37.624	-5.578	52.786
1905.0	24.720	22.438	9.115	.43929	.39873	.16198	.25443	.34641	-40.842	-9.242	53.513
2101.2	24.094	23.056	12.427	.40442	.38699	.20859	.23668	.33971	-42.556	-13.073	54.154
2366.3	23.685	23.815	17.386	.36503	.36702	.26795	.21877	.32995	-43.418	-18.347	54.926
2601.4	23.616	24.416	22.087	.33680	.34821	.31499	.20711	.32118	-43.267	-22.857	55.526
2855.6	23.753	24.997	27.338	.31218	.32853	.35929	.19765	.31199	-42.513	-27.393	56.097
3051.7	23.967	25.402	31.436	.29660	.31436	.38904	.19200	.30525	-41.674	-30.605	56.490
3251.8	24.254	25.780	35.611	.28319	.30101	.41580	.18737	.29873	-40.682	-33.614	56.853
CIE B	27.864	28.031	67.606	.22562	.22697	.54741	.17117	.25829	-32.533	-49.963	58.943
CIE C	31.656	29.410	94.575	.20339	.18896	.60765	.16737	.23325	-26.169	-57.949	60.168

LUNAR WHITE 8430A(FS3)  
2 DEGREE OBSERVER

1942

[ 70 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.87000	500	.47000	600	.06700	700	.71000
410	.86900	510	.36500	610	.07500	710	.81500
420	.86000	520	.26800	620	.07900	720	.86300
430	.85000	530	.18300	630	.07400	730	.88400
440	.83400	540	.15000	640	.06600	740	.89100
450	.81800	550	.17400	650	.07000	750	.89400
460	.79600	560	.21800	660	.09900	760	.89500
470	.74600	570	.20400	670	.17300	770	.89600
480	.66000	580	.12800	680	.32500		
490	.55200	590	.06900	690	.53200		

380 .87100  
390 .87100

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	1964 CIE V*	CAP W*
1500.8	16.784	13.307	3.426	.50075	.39702	.10223	.29619	.35224	-33.815	-4.448	42.242
1700.9	15.796	13.874	5.692	.44670	.39234	.16096	.26220	.34544	-39.858	-8.422	43.072
1905.0	15.273	14.462	8.542	.39901	.37783	.22316	.23695	.33655	-43.493	-13.212	43.909
2101.2	15.076	15.004	11.694	.36089	.35917	.27994	.21911	.32710	-45.295	-18.103	44.661
2366.3	15.131	15.683	16.430	.32027	.33196	.34777	.20197	.31401	-45.981	-24.666	45.577
2601.4	15.389	16.229	20.929	.29287	.30885	.39829	.19140	.30277	-45.526	-30.138	46.296
2855.6	15.816	16.764	25.965	.27015	.28634	.44351	.18329	.29140	-44.380	-35.518	46.983
3051.7	16.216	17.140	29.901	.25636	.27095	.47269	.17869	.28329	-43.228	-39.259	47.458
3251.8	16.668	17.494	33.915	.24485	.25697	.49819	.17508	.27562	-41.926	-42.710	47.898
CIE B	20.995	19.654	64.720	.19925	.18652	.61423	.16468	.23124	-32.114	-60.527	50.467
CIE C	25.111	21.012	90.767	.18344	.15350	.66306	.16396	.20580	-24.917	-68.618	51.987

LUNAR WHITE 74 (R69)  
 2 DEGREE OBSERVER

1932

[ 71 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.86700	500	.44600	600	.06510	700	.70000
410	.85800	510	.35000	610	.07430	710	.81200
420	.83000	520	.25800	620	.07780	720	.86200
430	.82000	530	.17400	630	.07400	730	.88400
440	.80700	540	.14300	640	.06540	740	.89300
450	.79200	550	.16400	650	.06880	750	.89500
460	.76900	560	.21100	660	.09420	760	.89500
470	.71800	570	.19500	670	.16100	770	.89500
480	.63700	580	.12310	680	.30300		
490	.53500	590	.06750	690	.51400		

380 .83500  
 390 .85400

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE		
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W
1500.8	16.313	12.851	3.305	.50243	.39579	.10178	.29797	.35209	-.32.302
1700.9	15.343	13.383	5.492	.44841	.39110	.16049	.26391	.34527	-.38.253
1905.0	14.825	13.937	8.243	.40062	.37662	.22276	.23853	.33636	-.41.864
2101.2	14.626	14.450	11.288	.36235	.35799	.27966	.22057	.32687	-.43.681
2366.3	14.669	15.093	15.862	.32152	.33081	.34767	.20328	.31373	-.44.420
2601.4	14.912	15.612	20.209	.29393	.30773	.39834	.19259	.30244	-.44.024
2855.6	15.319	16.121	25.076	.27106	.28524	.44369	.18437	.29103	-.42.945
3051.7	15.702	16.479	28.879	.25716	.26987	.47296	.17970	.28288	-.41.846
3251.8	16.136	16.816	32.758	.24557	.25591	.49853	.17604	.27518	-.40.595
CIE B	20.302	18.880	62.526	.19961	.18563	.61476	.16537	.23067	-.31.099
CIE C	24.274	20.182	87.702	.18368	.15271	.66361	.16454	.20520	-.24.090
									-.67.801
									51.065

LUNAR WHITE 74(R69)  
2 DEGREE OBSERVER

1966

[ 72 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.87300	500	.44700	600	.06550	700	.70500
410	.86200	510	.34800	610	.07460	710	.81700
420	.83000	520	.25800	620	.07830	720	.86600
430	.82000	530	.17600	630	.07340	730	.88600
440	.80500	540	.14200	640	.06540	740	.89600
450	.79200	550	.16400	650	.06920	750	.90000
460	.77100	560	.21300	660	.09420	760	.89900
470	.71800	570	.19400	670	.16300	770	.90400
480	.63800	580	.12200	680	.31000		
490	.53600	590	.06590	690	.51900		

C2=14387.9 MU-M K

ILLUMINANT

KELVINS	1931			1960			1964				
	CAP X	CAP Y	CAP Z	CIE X	CIE Y	CIE Z	U	V	W		
1500.8	16.340	12.855	3.307	.50275	.39551	.10174	.29834	.35205	-32.109	-4.478	41.564
1700.9	15.360	13.384	5.495	.44862	.39089	.16049	.26415	.34524	-38.121	-8.392	42.356
1905.0	14.835	13.936	8.248	.40075	.37646	.22280	.23868	.33632	-41.779	-13.115	43.162
2101.2	14.632	14.448	11.294	.36241	.35786	.27973	.22066	.32684	-43.628	-17.941	43.890
2366.3	14.672	15.091	15.870	.32151	.33071	.34777	.20331	.31369	-44.397	-24.419	44.780
2601.4	14.913	15.610	20.218	.29390	.30764	.39846	.19260	.30241	-44.018	-29.822	45.480
2855.6	15.318	16.119	25.086	.27101	.28518	.44382	.18435	.29099	-42.952	-35.137	46.152
3051.7	15.701	16.477	28.891	.25710	.26981	.47309	.17968	.28284	-41.860	-38.832	46.616
3251.8	16.134	16.814	32.771	.24550	.25585	.49865	.17601	.27515	-40.614	-42.241	47.047
CIE B	20.298	18.881	62.546	.19954	.18561	.61485	.16531	.23065	-31.134	-59.829	49.570
CIE C	24.270	20.184	87.725	.18362	.15270	.66368	.16449	.20519	-24.128	-67.812	51.068



LUNAR WHITE 45(R69)  
2 DEGREE OBSERVER

1932

[ 73 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	800	900
	.87300	.54200	.600	.12800	.700	.73400
	.86700	.45000	.610	.14100	.710	.82100
	.84700	.35700	.620	.14500	.720	.85400
	.83800	.26600	.630	.13800	.730	.87200
	.83000	.23000	.640	.12800	.740	.87700
	.81800	.25500	.650	.13100	.750	.87800
	.80000	.30600	.660	.16500	.760	.87800
	.76400	.29100	.670	.24800	.770	.87800
380	.82800	.580	.680	.39800		
390	.85600	.590	.690	.58700		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	CAP V*	CIE	1964 CIE CAP V*	CAP W*
KELVINS													
1500.8	26.640	20.408	3.607	.52590	.40289	.07121	.31014	.35639	-31.774	-2.637	51.319		
1700.9	25.031	21.072	5.941	.48095	.40489	.11416	.27895	.35224	-36.835	-5.573	52.052		
1905.0	23.991	21.734	8.863	.43949	.39815	.16236	.25482	.34628	-40.005	-9.205	52.768		
2101.2	23.385	22.331	12.082	.40460	.38636	.20904	.23705	.33955	-41.704	-13.002	53.400		
2366.3	22.988	23.064	16.903	.36515	.36636	.26849	.21911	.32976	-42.573	-18.226	54.163		
2601.4	22.921	23.646	21.471	.33688	.34754	.31558	.20742	.32097	-42.444	-22.691	54.756		
2855.6	23.055	24.208	26.575	.31223	.32786	.35991	.19793	.31176	-41.720	-27.181	55.320		
3051.7	23.262	24.600	30.558	.29663	.31370	.38967	.19227	.30500	-40.907	-30.361	55.709		
3251.8	23.541	24.967	34.616	.28320	.30036	.41644	.18761	.29847	-39.941	-33.339	56.068		
CIE B	27.043	27.150	65.708	.22554	.22644	.54802	.17132	.25799	-31.978	-49.509	58.138		
CIE C	30.724	28.489	91.914	.20330	.18851	.60819	.16748	.23294	-25.733	-57.400	59.354		

LUNAR WHITE 45(R69)  
2 DEGREE OBSERVER

1966

[ 74 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.87400	500	.54000	600	.13000	700	.75000
410	.86600	510	.44600	610	.14200	710	.82600
420	.84500	520	.35700	620	.14600	720	.86500
430	.83800	530	.26600	630	.13800	730	.87700
440	.82400	540	.23200	640	.12600	740	.88300
450	.81800	550	.25900	650	.13400	750	.88400
460	.80300	560	.31200	660	.17000	760	.88400
470	.76600	570	.29200	670	.25600	770	.88600
380	.80800	580	.20400	680	.40700		
390	.86000	590	.13000	690	.60000		

C2=14387.9 MU-M K

ILLUMINANT KELVINS	1931 CIE			1960 CIE			1964 CIE		
	CAP X	CAP Y	CAP Z	U	V	W	CAP U*	CAP V*	CAP W*
1500.8	26.867	20.559	3.611	.52643	.40283	.07074	.31053	.35643	-.31.615
1700.9	25.230	21.218	5.946	.48154	.40497	.11349	.27929	.35232	-.36.714
1905.0	24.171	21.879	8.869	.44013	.39838	.16149	.25514	.34640	-.39.906
2101.2	23.552	22.474	12.089	.40526	.38671	.20803	.23734	.33972	-.41.618
2366.3	23.142	23.206	16.911	.36584	.36684	.26733	.21938	.32997	-.42.498
2601.4	23.066	23.786	21.479	.33756	.34809	.31434	.20767	.32122	-.42.375
2855.6	23.192	24.347	26.583	.31289	.32847	.35863	.19816	.31204	-.41.657
3051.7	23.395	24.738	30.565	.29727	.31434	.38839	.19249	.30531	-.40.848
3251.8	23.669	25.104	34.622	.28382	.30102	.41516	.18782	.29880	-.39.886
CIE B	27.154	27.286	65.706	.22601	.22711	.54688	.17144	.25840	-.31.954
CIE C	30.824	28.624	91.898	.20367	.18913	.60721	.16755	.23339	-.25.731

LUNAR WHITE 73(R69)  
2 DEGREE OBSERVER

1932

[ 75 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.90000	500	.58300	600	.17000	700	.76600
410	.88800	510	.49500	610	.18500	710	.84600
420	.86900	520	.40800	620	.19000	720	.88000
430	.86000	530	.31900	630	.18300	730	.89200
440	.85100	540	.28100	640	.16800	740	.89700
450	.84200	550	.30700	650	.17400	750	.89900
460	.82600	560	.35700	660	.21400	760	.90000
470	.79200	570	.34200	670	.30200	770	.90000
480	.73300	580	.25300	680	.45300		
490	.65600	590	.17300	690	.62800		

380 .81900  
390 .89000

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	CIE X	Y	Z	U	V	CAP U*	CAP V*	CAP W*
1500.8	33.317	25.047	3.788	.53606	.40299	.06095	.31702	.35748	-29.743	-2.085	56.146
1700.9	31.260	25.740	6.219	.49448	.40715	.09837	.28679	.35421	-34.414	-4.632	56.814
1905.0	29.859	26.425	9.254	.45560	.40319	.14120	.26308	.34923	-37.396	-7.818	57.464
2101.2	28.974	27.038	12.595	.42232	.39410	.18358	.24537	.34346	-39.049	-11.178	58.035
2366.3	28.279	27.789	17.591	.38392	.37726	.23882	.22719	.33488	-39.988	-15.847	58.723
2601.4	28.003	28.381	22.321	.35580	.36059	.28360	.21513	.32704	-39.991	-19.876	59.257
2855.6	27.956	28.951	27.601	.33081	.34258	.32661	.20517	.31871	-39.447	-23.963	59.765
3051.7	28.048	29.348	31.720	.31474	.32932	.35594	.19913	.31253	-38.782	-26.878	60.114
3251.8	28.227	29.718	35.915	.30074	.31662	.38264	.19409	.30651	-37.967	-29.625	60.436
CIE B	31.316	31.905	68.033	.23859	.24308	.51833	.17544	.26811	-30.921	-44.849	62.291
CIE C	34.838	33.235	95.072	.21354	.20371	.58275	.17023	.24361	-25.209	-52.508	63.378

LUNAR WHITE 73(R69)  
2 DEGREE OBSERVER

1966

[ 76 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.88500	500	.57600	600	.16900	700	.77900
410	.87700	510	.49200	610	.18300	710	.85100
420	.86100	520	.40000	620	.18800	720	.88000
430	.85300	530	.31400	630	.18000	730	.89200
440	.84200	540	.27900	640	.16700	740	.90000
450	.83400	550	.30800	650	.17600	750	.90100
460	.81400	560	.36000	660	.21600	760	.90000
470	.77900	570	.33800	670	.31300	770	.90200
380	.84500	580	.24100	680	.46400		
390	.87900	590	.16800	690	.64800		

C2=14387.9 MU-M K

ILLUMINANT

KELVINS	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	33.104	24.815	3.737	.53692	.40247	.06061	.31790	.35744	-28.979	-2.107	55.919
1700.9	31.020	25.485	6.136	.49521	.40684	.09795	.28742	.35420	-33.796	-4.615	56.570
1905.0	29.602	26.153	9.132	.45620	.40305	.14074	.26354	.34925	-36.888	-7.765	57.208
2101.2	28.705	26.754	12.431	.42282	.39408	.18310	.24571	.34351	-38.619	-11.094	57.772
2366.3	27.999	27.492	17.364	.38431	.37735	.23834	.22742	.33495	-39.634	-15.725	58.452
2601.4	27.715	28.074	22.036	.35612	.36074	.28315	.21529	.32712	-39.686	-19.726	58.982
2855.6	27.659	28.636	27.252	.33106	.34275	.32618	.20528	.31880	-39.180	-23.786	59.485
3051.7	27.745	29.027	31.321	.31495	.32950	.35554	.19921	.31262	-38.538	-26.684	59.832
3251.8	27.918	29.392	35.465	.30092	.31681	.38227	.19415	.30660	-37.742	-29.415	60.152
CIE B	30.961	31.554	67.197	.23869	.24326	.51805	.17545	.26822	-30.768	-44.556	62.000
CIE C	34.440	32.868	93.920	.21361	.20386	.58253	.17024	.24370	-25.088	-52.182	63.081





LUNAR WHITE 124 (R69)  
2 DEGREE OBSERVER

1966

[ 78 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.88900	500	.67100	600	.27800	700	.81800
410	.88900	510	.59800	610	.29400	710	.86800
420	.88500	520	.52200	620	.30000	720	.89000
430	.87900	530	.43600	630	.29000	730	.89800
440	.87300	540	.39800	640	.27500	740	.90200
450	.86800	550	.42600	650	.28400	750	.90500
460	.85600	560	.47600	660	.33300	760	.90400
470	.82900	570	.45600	670	.42200	770	.90500
380	.84900	580	.37200	680	.56600		
390	.88100	590	.28000	690	.71200		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	1964 CIE V*	CAP V*	CAP W*
KELVINS												
1500.8	49.586	36.170	4.084	.55194	.40261	.04545	.32817	.35907	-25.267	-1.081	65.678	
1700.9	46.428	36.889	6.653	.51604	.41002	.07394	.29967	.35715	-29.021	-2.863	66.222	
1905.0	44.123	37.586	9.846	.48193	.41053	.10754	.27687	.35378	-31.469	-5.135	66.743	
2101.2	42.530	38.202	13.349	.45205	.40605	.14189	.25948	.34962	-32.883	-7.568	67.198	
2366.3	41.064	38.945	18.574	.41654	.39505	.18841	.24121	.34315	-33.786	-11.001	67.741	
2601.4	40.241	39.526	23.509	.38964	.38272	.22763	.22875	.33703	-33.931	-14.011	68.160	
2855.6	39.709	40.081	29.009	.36497	.36839	.26663	.21820	.33036	-33.645	-17.107	68.557	
3051.7	39.487	40.465	33.295	.34868	.35732	.29400	.21163	.32530	-33.219	-19.343	68.829	
3251.8	39.387	40.821	37.654	.33418	.34634	.31948	.20604	.32030	-32.666	-21.471	69.080	
CIE B	41.215	42.886	70.997	.26573	.27651	.45775	.18369	.28671	-27.443	-33.722	70.508	
CIE C	44.141	44.117	98.990	.23574	.23561	.52866	.17606	.26394	-22.972	-40.239	71.337	

PURPLE 108(R69)  
2 DEGREE OBSERVER

1935

[ 79 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.82700	500	.01300	600	.00000	700	.16000
410	.78000	510	.00450	610	.00010	710	.38000
420	.71400	520	.00170	620	.00010	720	.60000
430	.62500	530	.00070	630	.00010	730	.75000
440	.52700	540	.00080	640	.00000	740	.83000
450	.42200	550	.00190	650	.00000	750	.87500
460	.30200	560	.00290	660	.00010	760	.89500
470	.17200	570	.00110	670	.00040	770	.90200
380	.87500	580	.00020	680	.00450		
390	.85800	590	.00000	690	.03600		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	1964 CIE U*	V*	CAP W*
1500.8	.984	.381	1.067	.40455	.15670	.43876	.39747	.23093	*****	*****	*****
1700.9	.925	.341	1.929	.28951	.10664	.60385	.31293	.17290	*****	*****	*****
1905.0	1.008	.337	3.087	.22752	.07596	.69653	.26330	.13185	*****	*****	*****
2101.2	1.179	.352	4.431	.19774	.05909	.74317	.23870	.10700	*****	*****	*****
2366.3	1.506	.391	6.539	.17854	.04631	.77515	.22327	.08687	*****	*****	*****
2601.4	1.860	.434	8.617	.17044	.03977	.78979	.21738	.07608	*****	*****	*****
2855.6	2.285	.485	11.009	.16583	.03523	.79894	.21459	.06839	*****	*****	*****
3051.7	2.633	.527	12.919	.16376	.03277	.80347	.21367	.06414	*****	*****	*****
3251.8	2.999	.570	14.898	.16239	.03085	.80676	.21330	.06078	*****	*****	*****
CIE B	5.859	.914	30.076	.15901	.02480	.81619	.21346	.04994	*****	*****	*****
CIE C	8.455	1.196	43.589	.15881	.02247	.81872	.21518	.04567	1.780	-32.449	9.539

PURPLE 80 (R69)  
2 DEGREE OBSERVER

1932

[ 80 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

	400	500	600	700	18000
	.83800	.00010	.00010	.00010	.41000
	.78700	.00010	.00010	.00010	.62000
	.72700	.00010	.00010	.00010	.76000
	.64700	.00160	.00010	.00010	.84000
	.55800	.00170	.00010	.00010	.87800
	.44800	.00390	.00010	.00010	.89700
	.32800	.00560	.00020	.00020	.90200
	.19700	.00230	.00120	.00120	
380	.88600	.00040	.00040	.00800	
390	.86700	.00010	.00010	.04500	

C2=14387.9 MU-M K

ILLUMINANT

KELVINS	1931			1960			1964		
	CAP X	CAP Y	CAP Z	CAP X	CAP Y	CAP Z	CAP U*	CAP V*	CAP W*
1500.8	1.094	.471	1.163	.40102	.17268	.42630	.37565	.24264	.24264
1700.9	1.033	.438	2.093	.28984	.12292	.58724	.29763	.18933	.18933
1905.0	1.122	.443	3.335	.22898	.09035	.68068	.25258	.14949	.14949
2101.2	1.303	.467	4.773	.19916	.07139	.72946	.23035	.12386	.12386
2366.3	1.650	.517	7.023	.17953	.05629	.76418	.21653	.10184	.10184
2601.4	2.024	.571	9.235	.17109	.04824	.78067	.21143	.08943	.08943
2855.6	2.474	.633	11.778	.16619	.04251	.79131	.20919	.08026	.08026
3051.7	2.841	.682	13.805	.16395	.03934	.79671	.20858	.07507	.07507
3251.8	3.227	.732	15.903	.16246	.03684	.80070	.20847	.07091	.07091
CIE B	6.250	1.127	32.014	.15867	.02861	.81272	.20973	.05674	.05674
CIE C	8.986	1.445	46.311	.15837	.02547	.81617	.21194	.05112	.05112
							1.627	-37.517	11.264



PURPLE 47P(R69)  
2 DEGREE OBSERVER

1932

[ 81 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.85200	500	.07130	600	.00010	700	.35000
410	.82300	510	.02750	610	.00010	710	.61000
420	.77900	520	.00870	620	.00010	720	.77000
430	.73300	530	.00220	630	.00010	730	.84000
440	.68400	540	.00100	640	.00010	740	.87400
450	.62500	550	.00170	650	.00010	750	.88500
460	.55200	560	.00420	660	.00030	760	.88900
470	.42600	570	.00310	670	.00150	770	.89000
380	.78300	580	.00060	680	.01600		
390	.84900	590	.00010	690	.11000		

C2=14387.9 MU-M K

ILLUMINANT	CAP X	CAP Y	CAP Z	1931 CIE X	Y	Z	1960 CIE U	V	CAP U*	1964 CIE V*	CAP V*	CAP W*
1500.8	1.592	.723	1.890	.37866	.17183	.44951	.35186	.23951	*****	*****	*****	*****
1700.9	1.503	.708	3.303	.27251	.12841	.59908	.27279	.19281	*****	*****	*****	*****
1905.0	1.622	.751	5.146	.21569	.09994	.68437	.22897	.15915	*****	*****	*****	*****
2101.2	1.868	.823	7.239	.18808	.08293	.72899	.20789	.13749	*****	*****	*****	*****
2366.3	2.336	.945	10.456	.17006	.06881	.76113	.19516	.11845	*****	*****	*****	*****
2601.4	2.838	1.064	13.571	.16243	.06092	.77666	.19075	.10730	-8.457	-27.215	8.526	
2855.6	3.438	1.197	17.110	.15811	.05505	.78685	.18910	.09876	-8.294	-31.119	9.545	
3051.7	3.926	1.299	19.906	.15620	.05169	.79210	.18888	.09376	-8.000	-33.827	10.279	
3251.8	4.435	1.401	22.781	.15498	.04897	.79605	.18914	.08964	-7.602	-36.326	10.977	
CIE B	8.465	2.180	44.944	.15228	.03921	.80851	.19240	.07431	-4.252	-49.932	15.414	
CIE C	12.050	2.773	64.177	.15253	.03510	.81237	.19580	.06758	-1.184	-56.480	18.121	

PURPLE 56(R69)  
2 DEGREE OBSERVER

1932

[ 82 ]

PREVIOUSLY CORRECTED TRANSMITTANCE DATA

400	.85700	500	.13050	600	.00050	700	.44000
410	.83100	510	.06360	610	.00070	710	.68000
420	.79800	520	.02660	620	.00080	720	.80000
430	.76300	530	.00880	630	.00070	730	.85900
440	.72700	540	.00500	640	.00050	740	.88200
450	.67600	550	.00730	650	.00060	750	.89200
460	.61500	560	.01470	660	.00180	760	.89500
470	.50400	570	.01190	670	.00750	770	.89600
380	.83500	580	.00330	680	.04300		
390	.85300	590	.00060	690	.19000		

C2=14387.9 MU-M K

ILLUMINANT	1931 CIE			1960 CIE			1964 CIE				
	CAP X	CAP Y	CAP Z	X	Y	Z	U	V	W		
1500.8	2.172	1.245	2.197	.38688	.22174	.39138	.31665	.27223	-5.288	-11.332	9.893
1700.9	2.036	1.278	3.797	.28635	.17974	.53391	.24986	.23525	-11.001	-16.494	10.132
1905.0	2.142	1.376	5.865	.22824	.14667	.62509	.21214	.20449	-14.191	-21.808	10.808
2101.2	2.393	1.501	8.200	.19785	.12414	.67801	.19331	.18194	-15.692	-26.653	11.627
2366.3	2.886	1.693	11.768	.17656	.10355	.71990	.18158	.15973	-16.299	-32.583	12.794
2601.4	3.421	1.870	15.208	.16687	.09121	.74192	.17749	.14551	-16.063	-37.189	13.798
2855.6	4.061	2.060	19.100	.16103	.08167	.75730	.17609	.13396	-15.373	-41.506	14.809
3051.7	4.583	2.203	22.167	.15830	.07609	.76562	.17606	.12694	-14.676	-44.411	15.530
3251.8	5.129	2.344	25.314	.15643	.07150	.77206	.17650	.12102	-13.890	-47.038	16.211
CIE B	9.473	3.369	49.573	.15177	.05398	.79424	.18153	.09685	-8.545	-60.339	20.479
CIE C	13.325	4.120	70.485	.15154	.04685	.80161	.18599	.08625	-4.453	-66.324	23.076

Due to the large amount of data in table 7, the 1964 CIE  $U^*$ ,  $V^*$ ,  $W^*$  indices are also presented in graphical form to show changes in indices with change of illuminant for a single filter. Diagrams were published previously [41] showing change in indices with change in thickness of the filter for CIE standard illuminant A. Such a diagram was created in the  $U^*$ ,  $W^*$  cross-section of the  $U^*$ ,  $V^*$ ,  $W^*$  color solid. It was found that this diagram had no relevance to the change in effect for a given filter when used with a given light source as in signal practice. As the lamps vary or are varied over a wide range of distribution temperatures, the signal color varies but not in a manner which would be indicated in a  $U^*$ ,  $W^*$  diagram formed by connecting, for a single filter, the data points obtained from equations 3 and 4 and represented by the various illuminants given. The values of  $U^*$ ,  $V^*$ ,  $W^*$ , correlate with the appearance of the filters viewed as objects against a light gray background, both filter and background having the same illuminant. Thus, the created  $U^*$ ,  $W^*$  diagram indicated the appearance of the filters when the observer is adapted to each single illuminant, taken one at a time. For example, if the filters were viewed in a daylight illuminated room and then the room illuminant changed to approximately 1500 kelvins, the yellow filters would indeed appear red as would be indicated by the  $U^*$ ,  $W^*$  diagram. However, to an observer adapted to one kind of light, say daylight, the appearance of the signals produced by the yellow filters changes in the opposite direction; that is, the signals appear more reddish, the lower the distribution temperature of the source.

The light from a point source transmitted by the filter is far different than the light appearing in the usual land or sea scape and so makes a distinctive signal. To illustrate the properties of these filters to produce signal colors, figure 4 shows data of  $u$ ,  $W^*$  for several filters of each color and for all illuminants listed in table 7. Chromaticity coordinate,  $u$ , indicates the redness of the signal resulting from the illuminant-filter combination and  $W^*$  is a measure of its brightness.

Note from figure 4 that when distribution temperature of illuminant is lowered all red and yellow filters are seen as redder ( $u$  increases) and brighter ( $W^*$  increases); all of lunar white, green, blue and purple filters are seen as darker ( $W^*$  decreases); all lunar white filters and two green filters, identification numbers 33 and 36 respectively (6310A and 6319A), are seen as redder ( $u$  increases); and finally all remaining green filters, the purple filters and two blue filters are seen as greener followed by redder as the distribution temperature of the illuminant is lowered. Some filters were omitted from figure 4 for clarity, but the same conclusions apply.

It may also be noted that not all of the filters included in figure 4 have completed lines connecting all eleven symbols. One of the purples (identification number 79) has one symbol only, namely that for CIE standard illuminant C. The explanation is that  $W^*$  is not defined for  $Y$  less than one percent; see equation 3 which shows  $W^* = 8.000$  for  $Y = 1.000$ . Note also that  $U^*$  and  $V^*$ , which depend on  $W^*$ , are likewise undefined for  $Y$  less than one percent. Thus neither table 7 nor figure 4 shows these values for such filter-illuminant combinations.



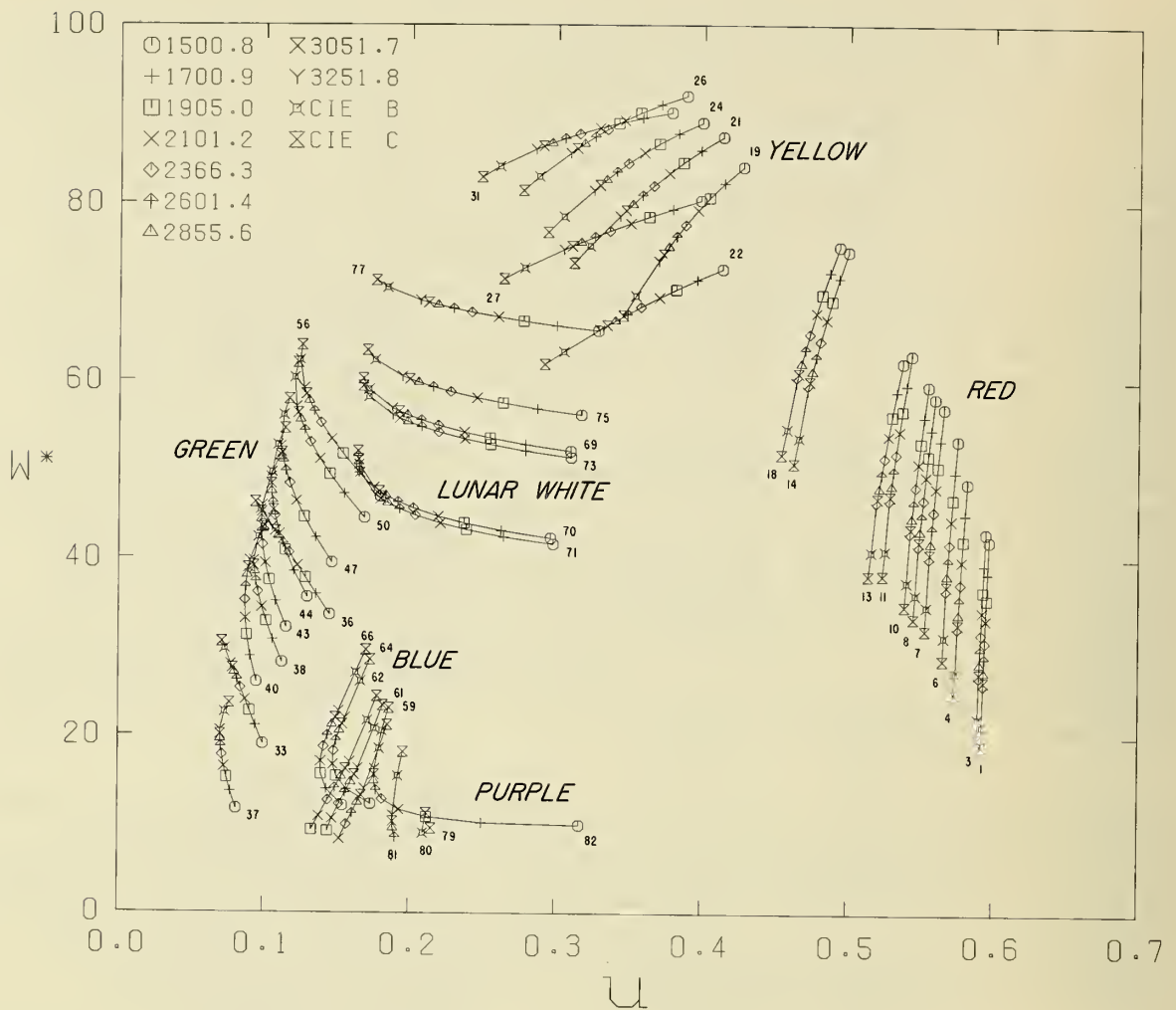


Figure 4. Changes in  $u$  (redness) and  $W^*$  (brightness) for several signal-glass limit filters of each color with changes in illuminant. Note that red filters (group having highest values of  $u$ ), and yellow filters (group having the highest values of  $W^*$ ) change toward red and become brighter. Two of the ten green filters (group having lowest values of  $u$ ) and all six lunar-white filters become redder. The remaining green filters, two blue filters, and all purple filters, become first greener then redder. The remaining three blue filters are seen still to be changing toward green as they approach  $W^*=8$ , the lower limit. In the legend, the numbers to the right of the symbols are the applicable distribution temperatures, in kelvins, based upon a value of  $c_2=14,387.9$  micrometer-kelvins. The illuminants having the highest values of correlated color temperature are CIE standard illuminant B (4872.7K) and CIE standard illuminant C (6743.7K).



Color specifications dealing with signals are usually written in colorimetric terms according to the CIE 1931 standard observer and coordinate system. Figure 5 shows the variations in  $x$  and  $y$  created by changes in illuminant for several filters of each color. In practice CIE standard illuminants B and C are not used in filter-illuminant combinations dealing with colors of signal lights but these two illuminants have been included in this study and are shown in figure 5 for completeness. To avoid confusion in figure 5, 13 of the 43 filters and some illuminant symbols (mostly for red and yellow filters), included in figure 4 have been omitted. Of the data for the 11 red, 7 yellow, and 6 lunar white filters included in figure 4, only the data of 4 red, 4 yellow and 3 lunar white are shown in figure 5.

### 3. Summary

The National Bureau of Standards has been the custodian of signal-glass limit filters since 1931. At that time twenty-two filters were selected at Corning Glass Works and deposited at NBS by the Signal Section, American Railway Association, now the Association of American Railroads. Through the cooperative efforts of these three organizations the work of standardization began. By 1948 a few substitutions together with some additions increased this number of railroad standards to thirty-one. The Institute of Traffic Engineers added only one new limit filter in 1940 when they designated six standards, five of which had already been standardized. Federal Agencies dealing with aeronautical lighting began with twelve limits in 1942, but by 1951 twenty-eight were listed in Federal Standard No. 3. In 1964 the U. S. National Committee on the Colors of Signal Lights under the sponsorship of the U. S. National Committee of CIE selected eighteen national standard filters, three of which are new and different from the above organization limit filters. Therefore, the National Bureau of Standards is the custodian of sixty-three signal-glass limit filters.

Spectrophotometric measurements obtained by means of several of four instruments, as they became available, were the basis for the formulation of specifications in colorimetric terms and diagrams according to the CIE 1931 standard observer and coordinate system combined with the appropriate illuminants used in signal practice.

A permanence study was made possible because of colorimetric computations for CIE standard illuminant A based upon both early and recent spectrophotometric measurements on the same filter.

This paper presents tables which list spectrophotometric data, within the visible spectrum, for each filter together with the corresponding colorimetric data recently obtained, in tabular and graphical form, by means of an electronic computer and a digital-incremental plotter. The colorimetric data are given for eleven illuminants, nine of which are specified by distribution temperatures ranging from approximately 1500 to 3250 kelvins, and the remaining two as CIE standard illuminants B and C. The colorimetric data listed are tristimulus values,  $X, Y, Z$ , chromaticity coordinates,  $x, y, z$ , in the CIE 1931 system; chromaticity coordinates,

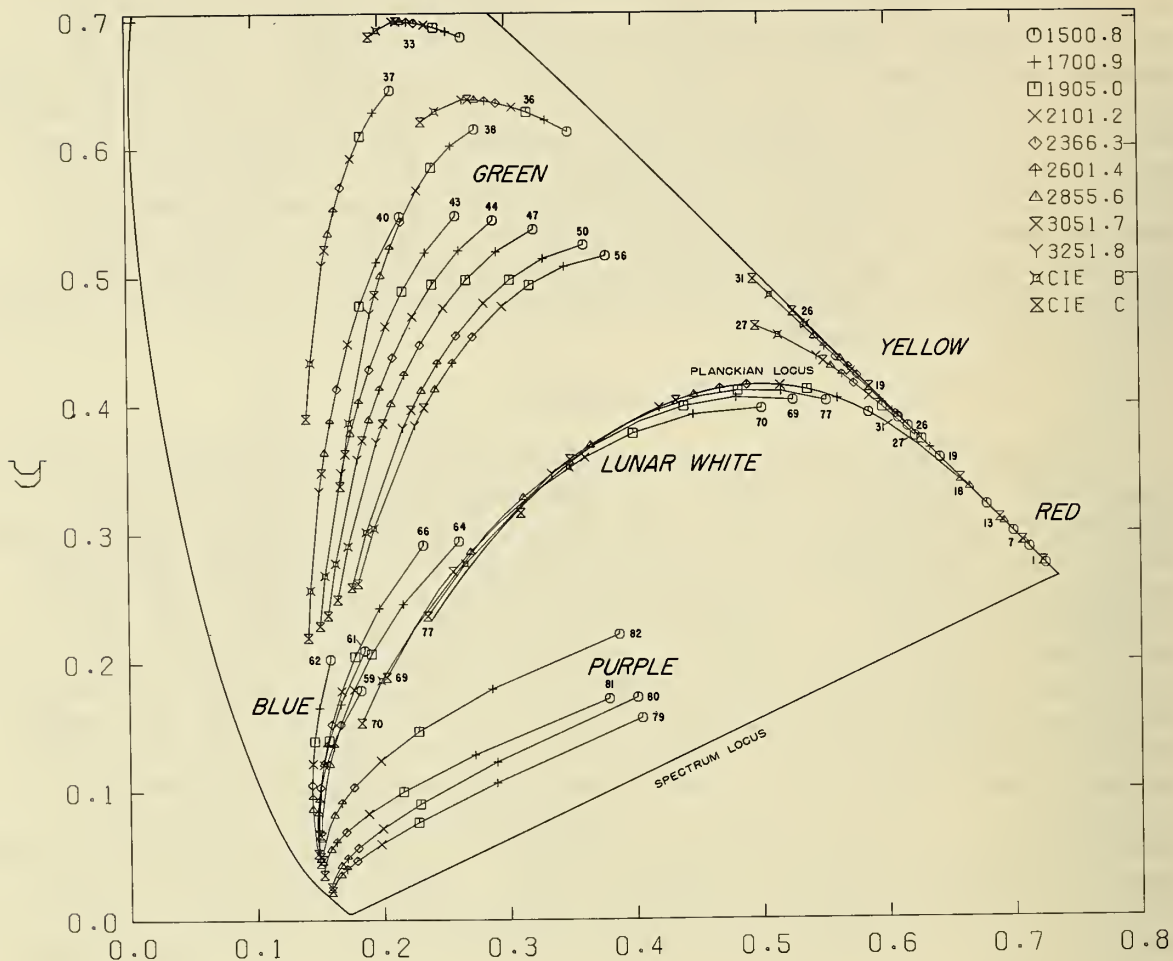


Figure 5. Chromaticity changes for several signal-glass limit filters of each color caused by changes in illuminant. The (x,y)-chromaticity diagram of the CIE 1931 system is used. The Planckian locus and spectrum locus are given for orientation. Symbols are the same as in figure 4. Identification numbers are the same as in tables 3 and 7, and in figure 4. Note that as the distribution temperature of the illuminant increases, the motion of the point representing the chromaticity coordinates of a filter moves counterclockwise. This is the same direction in which the illuminant point moves as the color temperature is increased.

u,v, in the CIE 1960 UCS system; and the chromaticness indices  $U^*$ ,  $V^*$  and brightness index  $W^*$  in the 1964 CIE uniform color space. Figures show, for several filters of each color, the shifts occurring in x and y and in u and  $W^*$  with change in illuminant.

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## Appendix A

Distribution temperature of a source is the temperature of a complete (Planckian) radiator having the same spectral distribution, or nearly so, as the source within stated wavelength limits. For an incandescent lamp, distribution temperature between 400 and 700 nanometers (1 nanometer (nm) =  $10^{-9}$  meters, formerly called millimicron) is closely the same as its color temperature. By color temperature is meant the temperature of a complete radiator having approximately the same chromaticity as the source in question. The numerical value of a distribution temperature depends on the value assigned to the constant  $c_2$  in Planck's radiation equation for the complete radiator. The units of  $c_2$  are micrometer-kelvins ( $\mu\text{mK}$ ). For example, with the several values of  $c_2$  indicated, the following values of distribution temperature, T, all represent the spectral energy distribution of CIE standard illuminant A. The assigned value of  $c_2$  has been adjusted over the years and the time interval during which the assignments listed below were in use is indicated in the column headed year.

$c_2$	T	Year
14350 $\mu\text{mK}$	2848K	Prior to 1934
14320 $\mu\text{mK}$	2842K	1934 to 1948
14380 $\mu\text{mK}$	2854K	1949 to 1970
14388 $\mu\text{mK}$	2856K	After 1970

In this Technical Note, distribution temperature is generally expressed by values given to the nearest 0.1K, based upon  $c_2=14388$  micrometer-kelvins. Internationally,  $c_2$  is now (1970) defined as 14387.9  $\mu\text{mK}$ . The values of distribution temperature are given in table 7 and figures 4 and 5 to the nearest 0.1K because it was a convenient form of computer output. Normally for colorimetric applications, distribution temperature is given to the nearest 10K with the exception of CIE standard illuminant A which is usually listed to the nearest 1K. Colorimetric specifications generally follow the latter usage.



Appendix B

Footnotes for Table 4:

These filters, although not standards, have been included in the permanence study because (1) they have been cut from the same melt of glass as their respective standards and (2) recent (r) data were available on them but not on their respective standards. Pertinent data are given below.

<u>Filter Number</u>	<u>Corning Type Number</u>	<u>Melt</u>	<u>Thickness (mm)</u>	<u>Source of Data, Year</u>	
3656B	2424	405	3.00	CDC, Mph, rel. 3647A Cary	1944 1961 1962
8213B	5543	403	3.15	CDC, Mph, rel. 8213A Cary	1944 1962
8219B	5543	403	2.38	CDC, Mph, rel. 8242 Cary	1943 1960
8240	5543	403	3.20	GE I Cary	1944 1962

CDC indicates chromaticity-difference colorimeter

Mph indicates Martens photometer (first model for the determination of luminous transmittance by direct visual comparison with NBS standard filters)



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<p>16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)</p> <p>Signal glass limit standards for railway, highway, and aviation colors, selected by user-organizations, are on deposit at the National Bureau of Standards. Many duplicates of these standards have been issued by NBS.</p> <p>The first standards were selected in 1931 for railway use. Highway standards were adopted in 1940, and selection of aviation standards began in 1942. At the present time the NBS is custodian of 63 standards for these signal colors.</p> <p>Permanence of the filters is examined, based on colorimetric conversions for CIE standard illuminant A derived from spectrophotometric measurements made on different instruments over periods of years.</p> <p>Spectral transmittance data and the resulting colorimetric data are given for 9 illuminants ranging in distribution temperature from 1500 to 3250 kelvins and for CIE standard illuminants B and C. Figures show, for several filters of each color, the shifts occurring both in chromaticity (x, y) and in redness and brightness index (u, W*) with changes in illuminant.</p>			
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