NEMA Z535.1 91 ■ 6470247 0500549 9 ■

American National Standard

ANSI Z535.1-1991

# Safety Color Code

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American National Standard

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# Safety color sheet for use with ANSI Z535.1, Z535.2, Z535.3, Z535.4 and Z535.5-1991

| Color Name | Munsell Notation Hue | Value Chroma | Equivalent CIE Data (Y%) | x | y | Approximate PMS Color |
|---|---|---|---|---|---|---|
|  Safety Red | 7.5R | 4.0/14 | 12.00 | 0.5959 | 0.3269 | 15 parts Warm Red<br>1 part Rubine Red<br>1/4 part Black |
|  Safety Orange | 5.0YR | 6.0/15 | 30.05 | 0.5510 | 0.4214 | 13 parts Yellow<br>3 parts Warm Red<br>1/4 part Black |
|  Safety Brown | 5.0YR | 2.75/5.0 | 5.52 | 0.4766 | 0.3816 | 9 parts Yellow<br>7 parts Warm Red<br>4-1/2 parts Black |
| Safety Yellow | 5.0Y | 8.0/12 | 59.10 | 0.4562 | 0.4788 | Pantone 108 C |
|  Safety Green | 7.5G | 4.0/9.0 | 12.00 | 0.2110 | 0.4121 | Pantone 3415 C |
|  Safety Blue | 2.5PB | 3.5 /10 | 9.00 | 0.1691 | 0.1744 | 13-1/2 parts Process Blue<br>2-1/2 parts Reflex Blue |
|  Safety Purple | 10.0P | 4.5 /10 | 15.57 | 0.3307 | 0.2245 | Pantone 253 C |
|  Safety White | N | 1.0 (5R-5Y) | 78.70 | 0.3101 | 0.3163 | White |
|  Safety Gray | N | 5.0/ | 19.80 | 0.3101 | 0.3163 | 1-1/2 parts Black<br>1/2 part Reflex Blue<br>13 parts Trans. White |
|  Safety Black | N | 5.0/ | 19.80 | 0.3101 | 0.3163 | Black |

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ANSI®
Z535.1-1991

American National Standard

# for Safety Color Code

Secretariat

**National Electrical Manufacturers Association**
**National Institute of Standards and Technology**

Approved June 1991

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# Contents

Page

Foreword . . . . . iii
1 Introduction . . . . . 1
2 Scope . . . . . 1
3 Purpose . . . . . 1
4 Applications . . . . . 2
5 Exceptions . . . . . 2
6 Color meaning . . . . . 2
6.1 Safety Red . . . . . 2
6.2 Safety Orange . . . . . 2
6.3 Safety Yellow . . . . . 5
6.4 Safety Green . . . . . 5
6.5 Safety Blue . . . . . 5
6.6 Safety Purple . . . . . 5
6.7 Safety White, Gray, Black, and Brown . . . . . 5
6.8 Traffic and housekeeping colors . . . . . 5
7 Color specifications and test methods for ordinary surface colors . . . . . 5
7.1 General . . . . . 5
7.2 Visual . . . . . 8
7.3 Instrumental . . . . . 8
8 Color specifications and test methods for retroreflective materials . . . . . 9
8.1 General . . . . . 9
8.2 Visual . . . . . 9
8.3 Instrumental . . . . . 9
9 Color specifications and instrumental test methods for fluorescent materials . . . . . 9
9.1 General . . . . . 9
9.2 Compliance Tests . . . . . 9
9.3 Fundamental specifications of fluorescent safety colors . . . . . 9
10 References . . . . . 13

## Tables

1 Specifications of the safety colors for CIE illuminant C (representative of overcast north sky daylight) and the CIE 1931 2° standard observer . . . . . 3



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2 Equations of the boundary lines for the specified chromaticity regions of fluorescent safety colors illuminated by a source equivalent to CIE $D_{65}$, measured using 45°/0° geometry, and expressed in the CIE 1931 system . . . . . 10

3 Chromaticity coordinates of the corners of the recommended regions of fluorescent safety colors illuminated by a source equivalent to CIE $D_{65}$, measured using 45°/0° geometry, and expressed in the CIE 1931 system . . . . . 10

4 Minimum permissible values of luminance factors and/or spectral (total) radiance factors, within the indicated wavelength range, of fluorescent safety colors illuminated by a source equivalent to CIE $D_{65}$ and measured using 45°/0° geometry . . . . . 11

**Figures**

1 CIE 1931 chromaticity diagram showing the areas representing the Safety Color Code . . . . . 6

2 CIE 1931 chromaticity diagram showing the areas representing the safety color code for white, gray, and black in larger scale . . . . . 7

3 CIE 1931 chromaticity diagram showing the areas representing fluorescent safety colors illuminated by a source equivalent to CIE $D_{65}$ and measured using 45°/0° geometry . . . . . 12



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**Foreword** (This foreword is not part of American National Standard for Safety Color Code, Z535.1-1991.)

This standard, approved by ANSI on June 6, 1991, is a revision of the American National Standard, Safety Color Code for Marking Physical Hazards, Z53.1-1979.

In 1979, the Z53 Committee on Safety Colors was combined with the Z35 Committee on Safety Signs to form the Z535 committee on Safety Signs and Colors. This committee has the following scope:

> "To develop standards for the design, application, and use of signs, colors, and symbols intended to identify and warn against specific hazards and for other accident prevention purposes."

Five subcommittees were created and assigned the tasks of updating the Z53 and Z35 standards, and writing two new standards. The five standards include:

Z535.1 - Safety Color Code, which updates Z53.1 (1979).

Z535.2 - Environmental and Facility Safety Signs, which updates Z35.1 (1972).

Z535.3 - Criteria for Safety Symbols, a new standard.

Z535.4 - Product Safety Signs and Labels, a new standard.

Z535.5 - Accident Prevention Tags (for Temporary Hazards), which updates Z35.2 (1974).

Together, these five standards contain information needed to specify formats, colors, and symbols for safety signs used in environmental and facility applications (Z535.2), product applications (Z535.4), and accident prevention tags (Z535.5).

It is desirable that new signs, labels, symbols and colors specified after the approval of this standard comply with the standard.

The Foreword is not to be considered part of this standard.

This standard, for safety colors, is the fifth revision of the American War Standard, developed at the request of the War Department and approved by the American Standards Association (ASA) on July 16, 1945. The ASA was reconstituted as the USA Standards Institute (USASI) in August 1966, and as the American National Standards Institute (ANSI) in October 1969. Peacetime work on revising the American War Standard containing the Safety Color Code began in 1946 under committee procedures of the ASA, with the National Safety Council serving as sponsor of the project. The Sectional Committee on the Safety Color Code, Z53, reviewed the War Standard and enlarged its application to include the colors orange, blue, and purple. The committee also approved standard definitions and limits for the colors. The revised standard was approved by the ASA on September 11, 1953. In the 1971 revision, the Z53 committee deleted the color blue and modified the application of the color yellow, due to conflicts with other American National Standards.

In the fourth revision, a significant step forward was made toward increased safety through uniformity in safety color coding. The safety color codes formerly used in this standard were combined and adjusted to give the best feasible discrimination for observers with either normal or color-deficient (color-blind) vision. For the first time, safety color codes color tolerance charts were available for use with this standard. Each color tolerance chart shows the standard color and six color tolerances illustrating acceptable ranges in hue, value (lightness) and chroma (saturation). Each color tolerance chart also lists the Munsell notation and equivalent CIE[1] specifications (x, y, Y) for each standard color and tolerance sample. The colors brown, blue, and gray were added, and Table 1 was expanded to include the same information on most of the levels of the Universal Color Language (UCL) for the tolerance samples as for the

[1] Commission Internationale de l'Eclairage - International Commission on Illumination.



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standard or central sample of each Safety Color. Sections 1-6 of the present standard contain material similar to the fourth revision (Z53.1, 1979).

The intent of this, the fifth revision of the safety color standard, is to provide a series of visually distinguishable safety colors, each with specific uses. However, the color-rendering characteristics of several modern, high-efficiency light sources differ markedly from those of the average daylight source (CIE Source C) specified in Table 1. It is therefore essential that candidate safety colors be examined under the actual light sources to be used in order to ensure that they can be suitably differentiated and individually identified with their assigned color names.

Recent research is providing conclusive evidence that highly chromatic colors, in some chromaticities, serve to increase or decrease the perception of lightness (for reflective materials) and brightness (for self-luminous objects). The effect is more dramatic in the case of colored lights and colored retroreflective materials. Future revisions of this standard should consider opportunities for improving the visibility of safety signs, colors and symbols through the selective use of vividly colored retroreflectors. Future revisions of this standard should also include test methods and color specifications for retroreflective materials.

The limited color gamut and aging characteristics of fluorescent colorants combine to restrict the number and chromaticities of fluorescent safety colors. For this reason, categories of unrestricted red-orange and unrestricted yellow fluorescent colors have been added to supplement the restricted specifications that are equivalent to CIE international standards. The unrestricted specifications may be used when no more than three distinguishable fluorescent safety colors are required for outdoor use for up to two years.

Suggestions for improvement of this standard are welcome. They should be sent to the American National Standards Institute, 11 W. 42nd Street, New York, New York 10036.

Special appreciation and thanks are extended to Dr. Fred W. Billmeyer, Jr., Chairman, Color Subcommittee Task Force, and members LCDR Daniel G. Henderson (United States Coast Guard), and Mr. Robert C. Vanstrum (The 3M Company) for their efforts in revising Section 7, Color Specifications and Test Methods for Ordinary Surface Colors, and for developing Section 9, Color Specifications and Instrumental Test Methods for Fluorescent Materials.

This standard was processed and approved for submittal to ANSI by the American National Standards Committee on Safety Signs and Colors, Z535. Committee approval of this standard does not necessarily imply that all committee members voted for its approval, but that a consensus of all members was obtained.

(This Foreword is not a part of American National Standard Safety Color Code, ANSI Z535.1-1991.)

At the time it approved this standard, the Z535 Committee had the following members:

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Carrol E. Burtner, P.E., Secretary
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# American National Standard

# for Safety Color Code

## 1 Introduction

Color schemes for the identification and location of fire extinguishers, first aid kits, traffic aisleways, stumbling and tripping hazards, radiation, etc., have been developed in the past by a large number of industrial firms and other organizations.

Generally speaking, these color schemes have given satisfaction to those using them in individual plants. They suffer, however, from lack of uniformity among plants or organizations. As a result, spontaneity of action in times of emergency is lost, particularly by employees who have moved from one plant to another, when each has a different system.

In order to increase uniformity of safety color coding within and between plants and organizations, and to increase spontaneity of action in times of emergency, the safety color code has been adjusted to give the best feasible color discrimination for observers of both normal and color-deficient vision (colorblind). As a result, the Safety Colors are the same as those used with: American National Standard for Environmental and Facility Safety Signs, ANSI Z535.2-1991; American National Standard for Criteria for Safety Symbols, ANSI 535.3-1991; American National Standard for Product Safety Signs and Labels, ANSI Z535.4-1991; American National Standard for Accident Prevention Tags (for Temporary Hazards), ANSI Z535.5-1991; American National Standard Scheme for the Identification of Piping Systems, ANSI A13.1 (1985); American National Standard Radio Frequency Radiation Hazard Warning Symbol, ANSI C95.2 (1982) (R 1988); the Department of Transportation (DOT) Hazardous Materials Warning Labels and Placards; and the National Highway Traffic Safety Administration (NHTSA, DOT) Ambulance Orange and Ambulance Blue (see References 10-11).

It is intended that use of this Safety Color Code will supplement the proper guarding or warning of hazardous conditions. The marking of a physical hazard by a standard color warning should never be accepted as a substitute for the reduction or elimination of the hazard wherever possible.

It is recognized also that too many color identifications constantly in the field of vision of the employees are both confusing and fatiguing. Each location should, therefore, be carefully studied in order to keep the number of markings at a minimum, thereby providing even greater emphasis for the markings that are finally adopted and used.

## 2 Scope

This standard sets forth the technical definitions, color standards and color tolerances for Safety Colors, and the applications of these Safety Colors to specific purposes in connection with accident prevention.

## 3 Purpose

**3.1** The intent of this standard is to establish a safety color code that will alert and inform persons to take precautionary action or other appropriate action in the presence of hazards.

**3.2** This standard is not a substitute for engineering or administrative controls, including training, to eliminate identifiable hazards.

**3.3** There are a number of existing American national standards which are recognized for particular industries or specific uses. Compliance with these standards may be considered for such particular industries or uses. It is not the intent of this ANSI Z535.1 standard to replace existing standards or regulations which are uniquely applicable to a spe-



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cific industry or use. It is the intent to encourage adoption of this standard in subsequent revisions of other standards and regulations.

## 4 Applications

**4.1** The criteria of this standard shall[2] apply to the use of safety color coding for the identification of physical hazards, the location of safety equipment, protective equipment, stationary machinery, portable powered hand tools, structures and facilities. For chemical products and chemical mixtures follow ANSI Z129.1-1988.

**4.2** The colors specified in this standard are intended for use on safety signs and symbols, as set forth by other Z535 standards. See Z535.2, Z535.3, Z535.4, and Z535.5.

**4.3** This standard shall apply to the use of the Safety Colors to minimize the possibility of accident or injury.

**4.4** This standard sets forth the specifications of the Safety Colors for as wide a range of materials as possible to satisfy the many applications for these colors.

**4.5** Locations, objects, or safety signs that are color coded and for which illumination must be provided shall be illuminated to levels which will permit positive identification of the color and the hazard or situation which the color identifies. These locations, objects, or safety signs shall be illuminated with a light source which will not overly distort the color and, therefore, the message the color identification conveys.

**4.6** To ensure optimum visibility, colors selected for safety signs should[3] have maximum color contrast, especially lightness contrast. Likewise, contrast must be achieved between the sign and its visual environment. Thus, dark colors (Red, Brown, Green, Blue, and Purple) should be used with white letters, while light colors (Orange and Yellow) are better seen contrasted with black.

[2] Shall. This word is understood to be mandatory.

[3] Should. This word is understood to be permissive.

## 5 Exceptions

The authority having jurisdiction may permit variations from this standard only when equal or greater safety is provided.

## 6 Color Meaning[4]

This section provides meanings for the safety colors which are specified in this standard. Table 1 provides fundamental colorimetric specifications for each color.

**6.1 Safety red.** Safety Red shall be the color for the identification of DANGER and STOP.

**6.1.1 Commonly used examples.** The following are some common examples of applications of the color Safety Red:

(1) Flammable liquid containers such as safety cans.

(2) Emergency stop bars on machines.

(3) Stop buttons or electrical switches used for emergency stopping of machinery.

(4) Fire protection equipment and apparatus.

(5) References 1, 8, 9, 10, 11, 12, 13, and 14.

**6.2 Safety orange** Safety Orange shall be the color for the identification of hazardous parts of machines. Where an intermediate level of hazard (that is, WARNING), is used, the color shall be Safety Orange.

**6.2.1 Commonly used examples.** The following are examples of applications of the color Safety Orange:

(1) Marking hazardous parts of machines which may cut, crush, or otherwise injure; and emphasizing such hazards when enclosure doors are open or when gear, belt, or other guards around moving equipment are open or removed, exposing unguarded hazards.

(2) Marking the inside of movable guards or the inside of transmission guards for gears, pulleys, chains, etc. Marking exposed parts (edges only) of

[4] Safety Brown, Safety Gray and Safety Purple, have been adopted but have not been assigned safety color meanings. They have been included in Table 1 for establishing color boundaries and for guidance in use.



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## Table 1

**Specifications of the safety colors for CIE illuminant C (representative of overcast north sky daylight) and the CIE 1931 2° standard observer**

| Color Names | Standard and Tolerances | Specification | | | | | Boundary Equations on the CIE 1931 Chromaticity Diagram † | ISCC-NBS Descriptive Color Name of Standard |
|---|---|---|---|---|---|---|---|---|
| | | Munsell Notation | | Equivalent CIE Data | | | | |
| | | Hue | Value/Chroma | x | y | (Y%) | | |
| Safety Red | Standard | 7.5R | 4.0/14 | 0.5959 | 0.3269 | 12.00 | Purple y = 0.4181 - 0.1700x<br>White y = 1.1084x - 0.2892<br>Orange y = 0.4054 - 0.1099x | Vivid Red |
| | Hue + | 8.5R | 4.0/14 | 0.6037 | 0.3389 | 12.00 | | |
| | Hue - | 6.5R | 4.0/14 | 0.5869 | 0.3184 | 12.00 | | |
| | Value + | 7.5R | 4.5/14 | 0.5775 | 0.3320 | 15.57 | | |
| | Value - | 7.5R | 3.5/14 | 0.6226 | 0.3141 | 9.00 | | |
| | (Chroma + | 7.5R | 4.0/16 | 0.6260 | 0.3192 | 12.00)* | | |
| | Chroma - | 7.5R | 4.0/12 | 0.5603 | 0.3321 | 12.00 | | |
| Safety Orange | Standard | 5.0YR | 6.0/15 | 0.5510 | 0.4214 | 30.05 | Red y = 0.2678 + 0.2545x<br>White x = 0.5331<br>Yellow y = 0.3722x + 0.2301 | Vivid Orange |
| | Hue + | 6.25YR | 6.0/15 | 0.5452 | 0.4329 | 30.05 | | |
| | Hue - | 3.75YR | 6.0/15 | 0.5551 | 0.4091 | 30.05 | | |
| | Value + | 5.0YR | 6.5/15 | 0.5427 | 0.4206 | 36.20 | | |
| | Value - | 5.0YR | 5.5/15 | 0.5606 | 0.4218 | 24.58 | | |
| | (Chroma + | 5.0YR | 6.0/16 | 0.5597 | 0.4239 | 30.05)* | | |
| | Chroma - | 5.0YR | 6.0/13 | 0.5311 | 0.4154 | 30.05 | | |
| Safety Brown | Standard | 5.0YR | 2.75/5 | 0.4766 | 0.3816 | 5.52 | Red y = 0.2317 + 0.2729x<br>White x = 0.4450<br>Yellow y = 0.1636 + 0.4926x | |
| | Hue + | 7.0YR | 2.75/5 | 0.4762 | 0.3981 | 5.52 | | |
| | Hue - | 2.5YR | 2.75/5 | 0.4728 | 0.3607 | 5.52 | | |
| | Value + | 5.0YR | 3.25/5 | 0.4608 | 0.3801 | 7.71 | | |
| | Value - | 5.0YR | 2.25/5 | 0.4955 | 0.3826 | 3.82 | | |
| | (Chroma + | 5.0YR | 2.75/6 | 0.5081 | 0.3912 | 5.52)* | | |
| | Chroma - | 5.0YR | 2.75/4 | 0.4450 | 0.3720 | 5.52 | | |
| Safety Yellow | Standard | 5.0Y | 8.0/12 | 0.4562 | 0.4788 | 59.10 | Red y = 0.9837x + 0.0112<br>White y = 1.1007 - 1.4631x<br>Yellow y = 1.2183x - 0.0615 | Vivid Yellow |
| | Hue + | 6.5Y | 8.0/12 | 0.4498 | 0.4865 | 59.10 | | |
| | Hue - | 3.5Y | 8.0/12 | 0.4632 | 0.4669 | 59.10 | | |
| | Value + | 5.0Y | 8.5/12 | 0.4508 | 0.4754 | 68.40 | | |
| | Value - | 5.0Y | 7.5/12 | 0.4620 | 0.4823 | 50.68 | | |
| | (Chroma + | 5.0Y | 8.0/14 | 0.4699 | 0.4920 | 59.10)* | | |
| | Chroma - | 5.0Y | 8.0/10 | 0.4376 | 0.4601 | 59.10 | | |
| Safety Green | Standard | 7.5G | 4.0/9 | 0.2111 | 0.4121 | 12.00 | Yellow y = 0.7598 - 1.4306x<br>White y = 1.8471x - 0.0417<br>Blue y = 0.4935 - 0.5714x | Stong Green |
| | Hue + | 0.5BG | 4.0/9 | 0.1974 | 0.3809 | 12.00 | | |
| | Hue - | 5.0G | 4.0/9 | 0.2237 | 0.4399 | 12.00 | | |
| | Value + | 7.5G | 4.5/9 | 0.2204 | 0.4060 | 15.57 | | |
| | Value - | 7.5G | 3.5/9 | 0.2027 | 0.4163 | 9.00 | | |
| | (Chroma + | 7.5G | 4.0/11 | 0.1848 | 0.4319 | 12.00)* | | |
| | Chroma - | 7.5G | 4.0/7 | 0.2350 | 0.3922 | 12.00 | | |
| | Chroma - - †† | 7.5G | 4.0/6 | 0.2467 | 0.3822 | 12.00 | | |
| Safety Blue | Standard | 2.5PB | 3.5/10 | 0.1691 | 0.1744 | 9.00 | Green y = 0.8725x + 0.0457<br>White y = 0.2852 - 0.4696x<br>Purple y = 1.1134x - 0.0290 | Strong Blue |
| | Hue + | 4.5PB | 3.5/10 | 0.1796 | 0.1711 | 9.00 | | |
| | Hue - | 10.0B | 3.5/10 | 0.1557 | 0.1815 | 9.00 | | |
| | Value + | 2.5PB | 4.0/10 | 0.1805 | 0.1888 | 12.00 | | |
| | Value - | 2.5PB | 3.0/10 | 0.1576 | 0.1600 | 6.55 | | |
| | (Chroma + | 2.5PB | 3.5/12 | 0.1516 | 0.1547 | 9.00)* | | |
| | Chroma - | 2.5PB | 3.5/8 | 0.1888 | 0.1964 | 9.00 | | |



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**Table 1 (Continued)**

| Color Names | Standard and Tolerances | Specification | | | | | Boundary Equations on the CIE 1931 Chromaticity Diagram† | ISCC-NBS Descriptive Color Name of Standard |
|---|---|---|---|---|---|---|---|---|
| | | Munsell Notation | | Equaivalent CIE Data | | | | |
| | | Hue | Value/Chroma | x | y | (Y%) | | |
| Safety Purple | Standard | 10.0P | 4.5/10 | 0.3307 | 0.2245 | 15.57 | Blue y = 30.8485x - 9.2485<br>White y = 0.4644x + 0.0869<br>Red y = 0.8209 - 1.6273x | Strong Reddish Purple |
| | Hue + | 2.5RP | 4.5/10 | 0.3584 | 0.2377 | 15.57 | | |
| | Hue - | 7.5P | 4.5/10 | 0.3068 | 0.2145 | 15.57 | | |
| | Value + | 10.0P | 5.0/10 | 0.3308 | 0.2328 | 19.77 | | |
| | Value - | 10.0P | 4.0/10 | 0.3306 | 0.2162 | 12.00 | | |
| | (Chroma + | 10.0P | 4.5/12 | 0.3333 | 0.2100 | 15.57)* | | |
| | Chroma - | 10.0P | 4.5/8 | 0.3280 | 0.2391 | 15.57 | | |
| | Chroma - - †† | 10.0P | 4.5/6.5 | 0.3254 | 0.2519 | 15.57 | | |
| Safety White | Standard | | N 9.0/ | 0.310 | 0.3163 | 78.00 | See figure 2 | White |
| | Hue + | | | – | – | | | |
| | Hue - | | | – | – | | | |
| | (Value + | | N 9.5/ | – | – | 90.00)* | | |
| | Value - | | N 8.75/ | – | – | 73.40 | | |
| | (Chroma + | | /1.0 (5R-5Y<br>/0.5 (5G-5P | – | – | | | |
| | Chroma- | | /0.0 | | – | | | |
| Safety Gray | Standard | | N 5.0/ | 0.3101 | 0.3163 | 19.80 | See figure 2 | Medium Gray |
| | Hue + | | | – | – | | | |
| | Hue - | | | – | – | | | |
| | Value + | | N 5.5/ | | – | 24.60 | | |
| | Value - | | N 4.5/ | | – | 15.60 | | |
| | (Chroma + | | /0.5 | | – | | | |
| | Chroma | | /0.0 | | | | | |
| Safety Black | Standard | | N 1.5/ | 0.3101 | 0.3163 | 2.02 | See figure 2 | |
| | Hue + | | | – | – | – | | |
| | Hue - | | | – | – | – | | |
| | Value++ | | N 2.5/** | | – | 4.61 | | |
| | Value + | | N 2.0/ | | – | 3.13 | | |
| | (Value - | | N 0.5/ | | – | 0.58)* | | |
| | Chroma + | | /0.5 | | | | | |
| | Chroma | | /0.0 | | | | | |

**NOTES:**

* Safety Red, Safety Orange, Safety Yellow, Safety Green, Safety Blue, Safety Purple, and Safety Brown colors may be stronger (more saturated) than the C+ (plus) color as long as they comply with the hue and value tolerances. White Safety Colors may be lighter (higher value) than the V+ (plus) color, and Black Safety Colors may be darker (lower value) than the V- (minus) color as long as each complies with the applicable hue and chroma tolerances.

† The Y values in Table 1 apply to the colors of glossy or matte reflecting samples and may not be appropriate for the colors of fluorescent or retroreflective samples.

** V++ for matte Safety Blacks only. For the purpose of this standard, matte is defined as having a 60° gloss of less than 30 (ASTM D 523).

†† Porcelain enamel only.

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pulley, gears, rollers, cutting devices, power jaws, etc.

(3) References 1, 8, 9, 10, 11, and 13.

**6.3 Safety yellow.** Safety Yellow shall be the color for the identification of CAUTION. Solid yellow, yellow and black stripes, or yellow and black checkers shall be used for maximum contrast with the particular background.

**6.3.1 Commonly used examples.** The following are examples of applications of the color Safety Yellow.

(1) Marking physical hazards which might result in: striking against, stumbling, falling, tripping, or being caught in-between.

(2) Storage cabinets for flammable materials. For containers of flammable or combustible materials (see Section 6.1.1).

(3) Containers for corrosives, or unstable materials. Such containers shall be yellow or identified by a yellow band around their middle at least 1/4 their height. The contents of the container shall be identified thereon.

(4) References 1, 8, 9, 10, and 13.

**6.4 Safety green.** Safety Green shall be the color for the identification of SAFETY, emergency egress, and the location of FIRST AID and SAFETY EQUIPMENT.

**6.4.1 Commonly used examples.** The following are examples of applications of the color Safety Green to show the locations of:

(1) Gas masks.

(2) First aid kits.

(3) First aid dispensary.

(4) Stretchers.

(5) Safety deluge showers.

(6) Safety bulletin boards and signs.

(7) Emergency Egress Routes.

(8) References 1, 8, 9, 10, 13.

**6.5 Safety blue.** Safety Blue shall be the color for the identification of SAFETY INFORMATION used on informational signs and bulletin boards. Safety Blue also has specific applications in the railroad area to designate warnings against the starting, use of, or movement of equipment that is under repair or being worked upon.

**6.5.1 Commonly used examples.** The following are examples of application of the color Safety Blue:

(1) Mandatory action signs for wearing of personal protective gear such as hard hats.

(2) References 1, 8, 9, 10, and 11.

**6.6 Safety purple.**[5] Color meanings have not been assigned for Safety Purple. References 8, 9, 10, and 15.

**6.7 Safety white, gray, black, and brown.** Individual color meanings and applications have not been assigned for Safety White, Safety Gray, Safety Black, and Safety Brown.

**6.8 Traffic and housekeeping colors.** Safety Black, Safety White, Safety Yellow, or combinations of Safety Black with Safety White or Safety Yellow shall be the colors for the designation of Traffic[6] or Housekeeping Markings.

Examples of applications of the color Safety White and Safety Black are given in footnote references 1, 8, 9, 10, and 12.

## 7 Color specifications and test methods for ordinary surface colors[7]

### 7.1 General

**7.1.1** The primary color specifications are in terms of the Munsell Notation System, a color identification and specification system based on equal visual spacing as described in American National Standard Method for Specifying Color by the Munsell System, ASTM D1535 (16). Table 1 lists the Munsell notations for each standard and its surrounding tolerance limits, and provides equivalent data in the CIE 1931 system for use in section 7.3.

**7.1.2** The Color Tolerance Charts designed for use with this standard (see 7.2.1) display the standard color and three pairs of tolerance colors, repre-

[5] Colorants used to produce this color have been found to have poor aging characteristics in outdoor uses. This limitation should be considered in future application of this color.

[6] The preferred usage for combinations of Safety Black with Safety Yellow is for traffic markings, and the preferred usage for combinations of Safety Black with Safety White is for information purposes.

[7] Ordinary surface colors are defined as colors of non-retroreflective and non-fluorescent materials.



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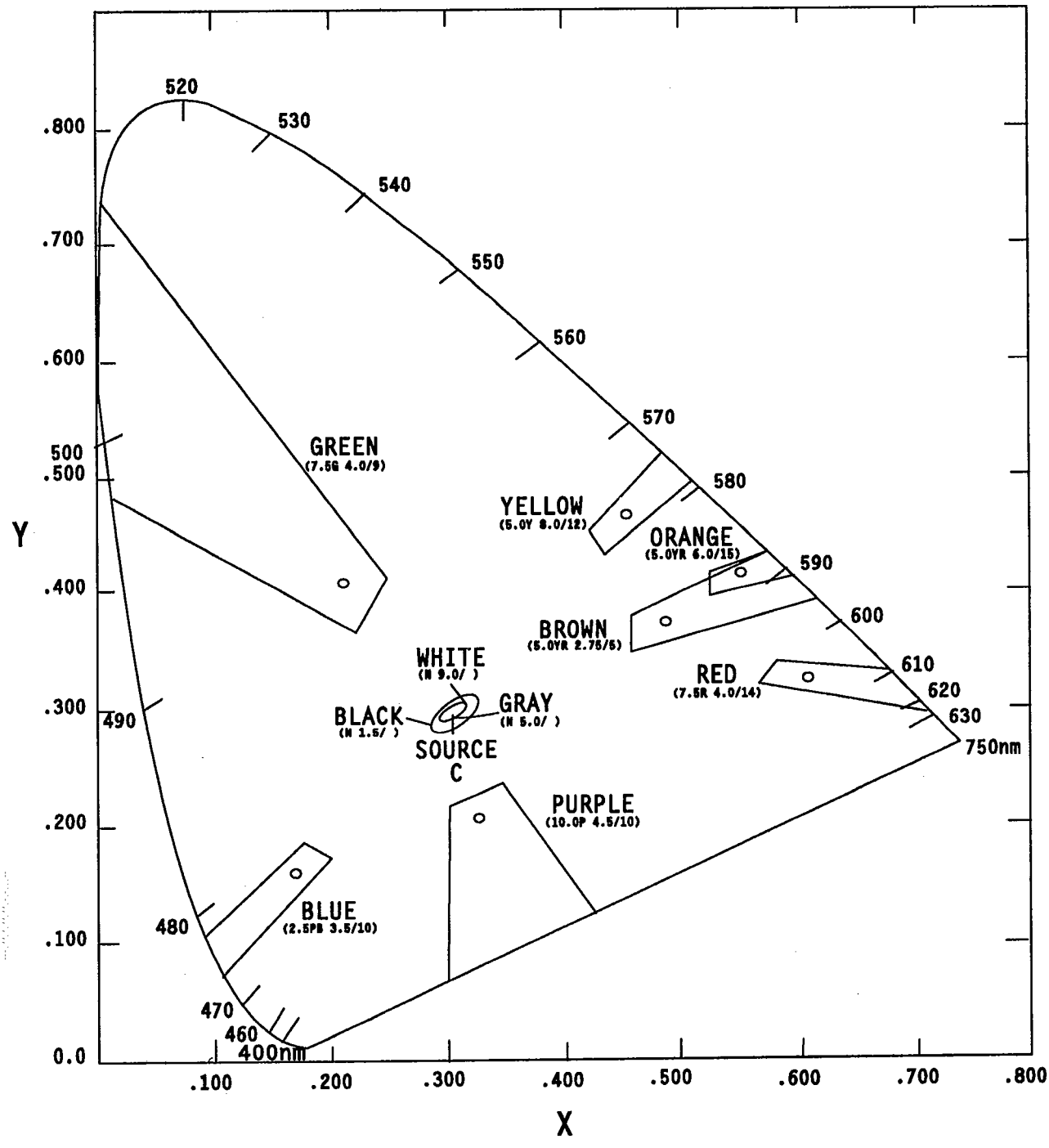
**Figure 1**
**CIE 1931 chromaticity diagram showing the areas representing the safety color code**




Note: The small circles identify the chromaticities of the standard colors.



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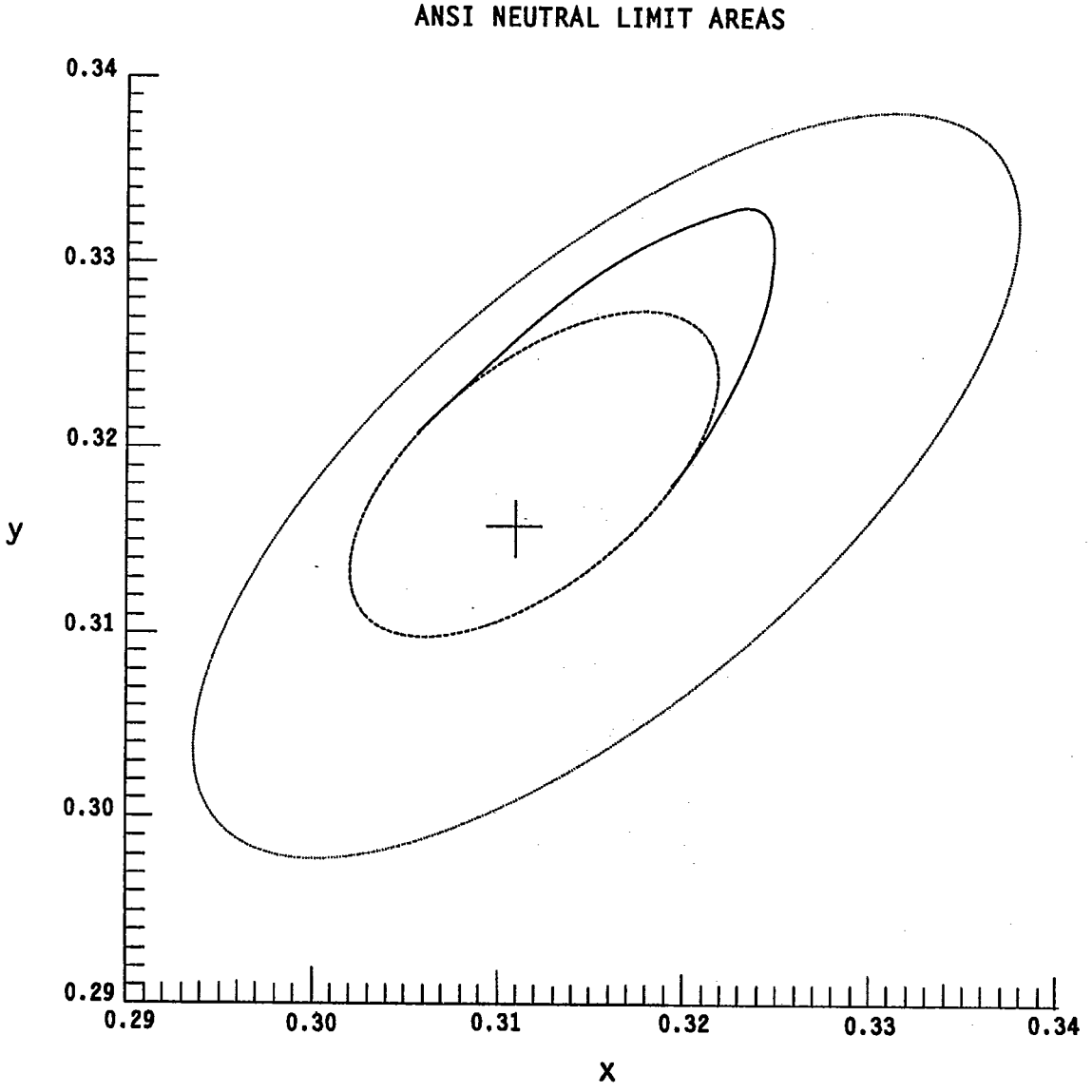
**Figure 2**
**CIE 1931 chromaticity diagram showing the areas representing the safety color code for white, gray, and black in larger scale**




| Legend | Color | Munsell Value | Munsell Chroma Tolerance |
|---|---|---|---|
| ——— | white | N 9/ | 10.5 to 11.0 |
| - - - - - - - - - - | gray | N 5/ | 10.5 |
| ..... | black | N 1.5/ | 19.5 |

+ = CIE STANDARD ILLUMINANT C



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senting the upper (+) and lower (-) limits for the visual attributes of hue, value and chroma. Table I shows the Munsell notations for each of these seven colors and the equivalent CIE x,y,Y data, for CIE Standard Illuminant C and the 2 degree CIE 1931 Standard Observer. Table 1 also gives the boundary equations of premissible areas on the CIE 1931 Chromaticity Diagram and the luminous reflectance of the standard (Y) and the ISCC-NBS color names for the standard colors. Figure 1 shows the CIE 1931 Chromaticity Diagram on which the permissible areas are defined by the boundary equations and the color names and Munsell Notations for each Safety Color.

**7.1.3** The specification for Safety White (a neutral) is given in Table 1. The intent of the permissible color range specified in Table 1 for SAFETY WHITE is to permit greater deviation from neutral white in the red to orange to yellow hue range, and lesser deviation in the rest of the hue circle. This deviation is necessary because most white colorants are really off-whites in the red-to-yellow range. Ageing of white also results in shifts in the same direction. Because it is difficult to express this transition between chroma levels with change in hue without listing a large number of data points, users should be guided by the ovoid shown in Figure 2.

**7.1.4** The colors in the Safety Color Code have been chosen to provide maximum feasible recognition by both normal and color-deficient (specifically red-green confusing) observers.

**7.1.5** The ISCC-NBS (Inter-Society Color Council - National Bureau of Standards) Color Names Dictionary designation of the Universal Color Language (17) may be used as an auxiliary specification to describe approximately the standard of each Safety Color (see Table 1).

### 7.2 Visual

**7.2.1** The visual specifications and test methods for daytime color are contained in the Hazardous Materials Labels and Placards Color Tolerance Charts adopted by the U S. Department of Transportation, Research and Special Programs Administration.[8]

**7.2.2** Testing for compliance shall be by visual examination using visual reference standards annotated with Munsell notations, and appropriate to the color region of interest. Such standards include the Hazardous Materials Labels and Placards Color Tolerance Charts, appropriate colors from the Munsell Book of Color (18), and other color samples whose values have been determined by instrumental measurement and converted to Munsell notation, provided that the restrictions of 7.2.3 are observed. Visual examination shall be conducted in accordance with ASTM D1729 (19), Standard Practice for Visual Examination of Color Differences of Opaque Materials.

**7.2.3** Testing for compliance by visual examination shall be limited to cases in which the specimens to be tested and the visual reference standards have similar spectral characteristics; that is, the specimens shall not be noticeably metameric to the standards as judged by ASTM D4086 (20), Standard Practice for Visual Evaluation of Metamerism. If these conditions are met, the test for compliance shall be made under actual daylight or any source designated for color matching of appropriate daylight quality, and by any observer having normal color vision.

### 7.3 Instrumental

**7.3.1** The instrumental color specification for each color is a set of CIE 1931 chromaticity coordinates, x, y, and luminous reflectance Y, calculated for CIE Standard Illuminant C and the CIE 1931 2° Standard Observer. These data are equivalent to the Munsell notations described in Section 7. From them are derived boundary equations defining areas in CIE color space (CIE 1931 Chromaticity Diagram) at the luminous reflectance of the standard (Y), as listed in Table 1. The permissible areas appear on Figures 1 and 2.

**7.3.2** Testing for compliance can be done through the use of spectrophotometers[9] designed to measure reflecting materials, with the data processed to yield CIE x, y, Y data for Standard Illuminant C and the CIE 1931 2° Standard Observer.[10] The primary standard for reflectance shall be the perfect reflecting diffuser as defined by the CIE. See ASTM E1164-87 (21) Standard Practice for Obtaining Spectrophotometric Data for Object Color Evaluation; ASTM E308-85 (22) Standard Method for Computing the Colors of Objects by Using the CIE

[8] Information of availability of Hazardous Materials Labels and Placards Color Tolerance Charts may be obtained from the Office of Hazardous Materials Transportation, Washington, DC 20590.

[9] Colorimeters may be used, but may not measure accurately samples which are metameric to the calibration standards.

[10] CIE Illuminant C and the CIE 1931 2° Standard Observer are used because these are the conditions for which the Munsell Notation System is defined in terms of CIE chromaticity coordinates and luminous reflectance.



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System; or ASTM D2244 (23), Standard Method for Calculation of Color Differences From Instrumentally Measured Color Coordinates.

## 8 Color specifications and test methods for retroreflective materials

**8.1 General.** To date, instrumental test methods for measuring the daytime color of retroreflective materials have required the use of a specific colored working standard for each color, with the colorimeter being calibrated against this standard before making the measurement. Furthermore, working standards in retroreflective material matching the Safety Color specifications and having adequate long-term color stability are not known to exist. Without the availability of the Safety Colors in this medium, test methods and color specification do not currently exist.

Specifications and test methods are available for a series of six colors used by the Federal Highway Administration (2). It is recommended that these be used as the colors are quite close to Safety Red, Safety Orange, Safety Yellow, Safety Green and Safety Blue.

### 8.2 Visual

**8.2.1** The visual specifications and test methods for daytime color are contained in the Highway Color Tolerance Charts adopted by the U.S. Department of Transportation, Federal Highway Administration.[11]

### 8.3 Instrumental

**8.3.1** The instrumental specifications and test methods for daytime color are contained in FP-85 and LS-300C (2).

[11] Information on availability of Highway Color Tolerance Charts can be obtained from the Federal Highway Administration, Washington, DC 20590.

[12] Current state of the art in manufacturing fluorescent surface-color materials is such that specimens meeting the "restricted" specifications are likely to be significantly poorer in resistance to light and outdoor exposure than those meeting only the "unrestricted specifications.

## 9 Color specifications and instrumental test methods for fluorescent materials

**9.1 General.** This section provides specifications for measuring colors of fluorescent specimens as they would be perceived with the specimen illuminated by standard daylight, in terms of CIE tristimulus values and chromaticity coordinates for these conditions calculated in the CIE 1931 system.

**9.2 Compliance tests.** Test for compliance shall be through the use of spectrophotometers designed to measure fluorescent materials, utilizing $45^{\circ}/0^{\circ}$ or $0^{\circ}/45^{\circ}$ geometry in which the specimen is directly illuminated by a suitable simulator of CIE Standard Illuminant $D_{65}$. The data shall be processed to yield the spectral radiance factor (sum of reflected and fluoresced radiation) at the wavelength (to the nearest 10 nm) of maximum radiance factor, and CIE x, y, Y data for Standard Illuminant $D_{65}$ and the 1931 $2^{\circ}$ Standard Observer. The primary standard for reflectance shall be the perfect reflecting diffuser as defined by the CIE. See ASTM E-991, Standard Practice for Color Measurement of Fluorescent Specimens (24).

Two sets of specifications are provided: Those designated "restricted" are identical with the current CIE specifications for fluorescent colors for visual signaling (25); they should be used when the primary consideration is the differentiation among the three fluorescent colors red, orange, and yellow, used together in a single system.[12] The specifications designated "unrestricted" should be used when the primary consideration is the differentiation between only yellow and red-orange fluorescent colors, but it is required that these colors remain distinguishable for long periods of time (26). There is only one specification for the color green.

**9.3 Fundamental specifications of fluorescent safety colors.** The fundamental specifications for each fluorescent safety color are given in Table 2 in terms of the equations of the boundary lines on the CIE chromaticity diagram within which the colors will fall both before and after exposure. The chromaticity coordinates of the corners of the chromaticity regions are provided in Table 3, and these regions are shown on the CIE chromaticity diagram in Figure 3. Similar regions are contained in the United States Coast Guard Specifications for fluorescent signal colors for use in long term exposure in a marine environment (26). Minimum values of the spectral (total) radiance factors and luminance factors are given in Table 4.



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**Table 2 — Equations of the boundary lines for the specified chromaticity regions of fluorescent safety colors illuminated by a source equivalent to CIE $D_{65}$, measured using $45^{\circ}/0^{\circ}$ geometry, and expressed in the CIE 1931 system**

| Color | Boundary | Equation of the Boundary Line |
|---|---|---|
| Restricted Red | Purple | $y = 0.345 - 0.051x$ |
| | White | $y = 0.910 - x$ |
| | Orange | $y = 0.314 + 0.047x$ |
| Restricted Orange | Red | $y = 0.265 + 0.205x$ |
| | White | $y = 0.910 - x$ |
| | Yellow | $y = 0.207 + 0.390x$ |
| Unrestricted Red-Orange | Purple | $y + 0.345 - 0.051x$ |
| | White | $y = 0.910 - x$ |
| | Yellow | $y = 0.207 + 0.390x$ |
| Restricted Yellow | Orange | $y = 0.108 + 0.707$ |
| | White | $y = 0.910 - x$ |
| | Green | $y = 1.35x - 0.093$ |
| Unrestricted Yellow | Orange | $y = 0.108 + 0.707x$ |
| | White | $y = 0.697 - 0.547x$ |
| | Green | $y = 1.667x - 0.100$ |
| Green | Yellow | $x = 0.313$ |
| | White | $y = 0.243 + 0.670x$ |
| | Blue | $y = 0.493 - 0.524x$ |

**Table 3 — Chromaticity coordinates of the corners of the recommended regions of fluorescent safety colors illuminated by a source equivalent to CIE $D_{65}$, measured using $45^{\circ}/0^{\circ}$ geometry, and expressed in the CIE 1931 system**

| Color | 1 | | 2 | | 3 | | 4 | |
|---|---|---|---|---|---|---|---|---|
| | x | y | x | y | x | y | x | y |
| Restricted Red | 0.690 | 0.310 | 0.595 | 0.315 | 0.569 | 0.341 | 0.655 | 0.345 |
| Restricted Orange | 0.610 | 0.390 | 0.535 | 0.375 | 0.506 | 0.404 | 0.570 | 0.429 |
| Unrestricted Red-Orange | 0.690 | 0.310 | 0.595 | 0.315 | 0.506 | 0.404 | 0.570 | 0.429 |
| Restricted Yellow | 0.522 | 0.477 | 0.470 | 0.440 | 0.427 | 0.483 | 0.465 | 0.534 |
| Unrestricted Yellow | 0.522 | 0.477 | 0.470 | 0.440 | 0.360 | 0.500 | 0.412 | 0.587 |
| Green | 0.313 | 0.682 | 0.313 | 0.453 | 0.209 | 0.383 | 0.013 | 0.486 |



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**Table 4 — Minimum permissible values of luminance factors and/or spectral (total) radiance factors, within the indicated wavelength range, of fluorescent safety colors illuminated by a source equivalent to CIE $D_{65}$ and measured using $45^{\circ}/0^{\circ}$ geometry**

| Color | Minimum luminance factor (Y%) | Minimum spectral radiance factor (%) | Wavelength range (nm) |
|---|---|---|---|
| Restricted Red | 25 | — | — |
| Restricted Orange | 40 | — | — |
| Unrestricted Red-Orange | — | 100 | 600-630 |
| Restricted Yellow | 60 | — | — |
| Unrestricted Yellow | — | 100 | 520-540 |
| Green | 25 | 30 | 510-530 |



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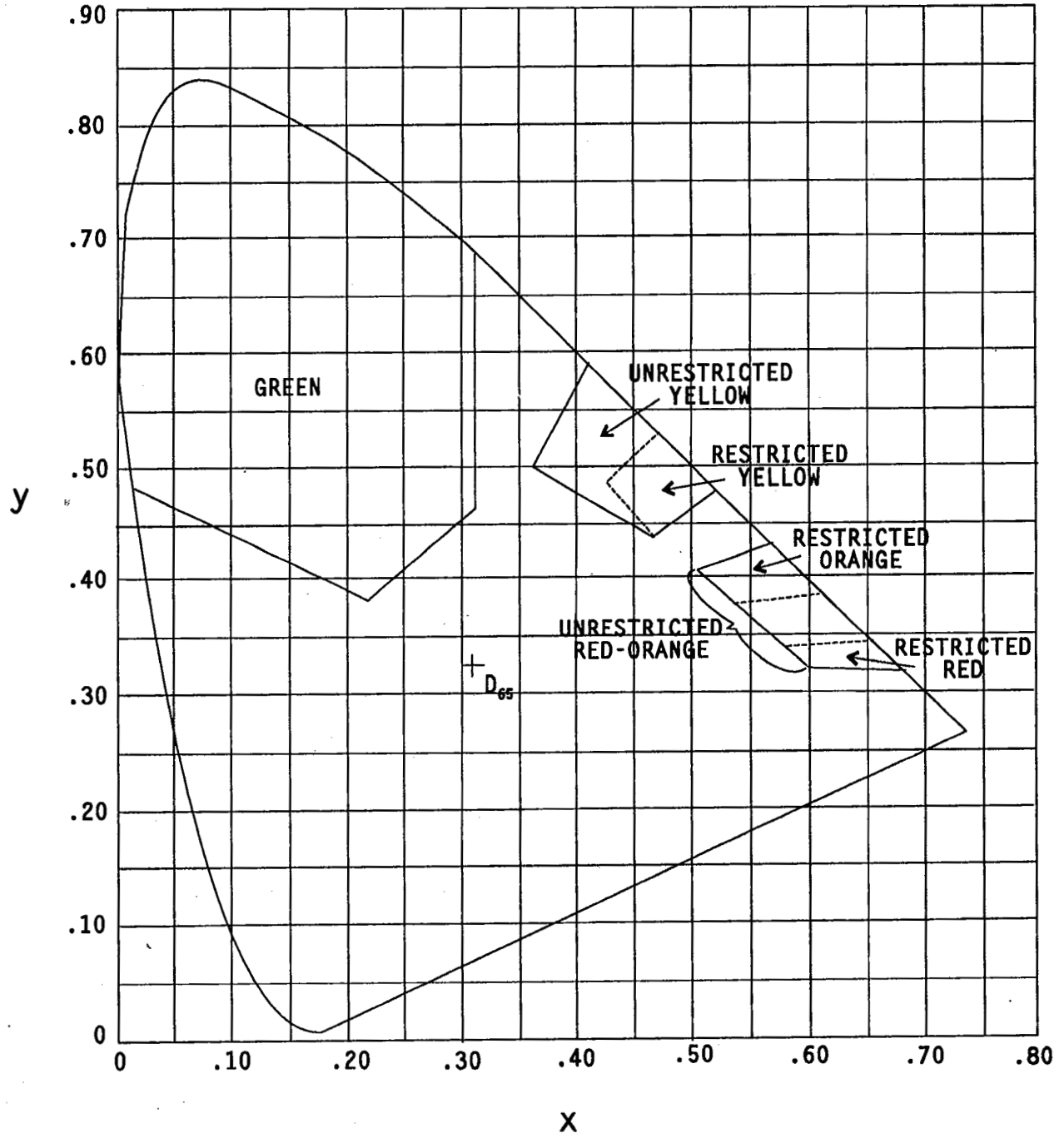
**Figure 3**

**CIE 1931 chromaticity diagram showing the areas representing fluorescent safety color illuminated by a source equivalent to CIE $D_{65}$ and measured using $45^{\circ}/0^{\circ}$ geometry**



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## 10 References

See the following documents for reference and information.

1. Highway Transportation: American National Standard Manual on *Uniform Traffic Control Devices for Streets and Highways.* ANSI D6.1e-1989.

2. FP-85, *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects,* Federal Highway Administration, DOT. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. LS 300C, General Services Administration, also available from GPO.

3. American National Standard *Adjustable Face Vehicle Traffic Control Signal Heads.* ANSI D10.1-1966 (R1970).

4. Railroad Transportation: *Standard Code of the Association of American Railroads - Operating Rules, Block Signal Rules, Interlocking Rules.*

5. Navigation of Waterways: United States Coast Guard - Ocean Engineering Division, Report No. 37, *Visual Signaling, Theory and Application of Aids to Navigation.*

6. Air Navigation: Federal Aviation Administration - AC 70 7460-1, *Obstruction Marking and Lighting, Federal Standard No. 3.* MIL-C-25050.

7. *School Buses: Minimum Standards for School Buses, 1970 Revised Edition.* Recommendations of National Conference on School Transportation, NEA Education Center, Washington, D.C., May 4-7, 1970.

8. Other American National Standards in the Z535 series: ANSI Z535.2-1991, *Environmental and Facility Safety Signs;* ANSI Z535.3-1991, *Criteria for Safety Symbols;* ANSI Z535.4-1991, *Product Safety Signs and Labels;* and ANSI Z535.5-1991, *Accident Prevention Tags (for Temporary Hazards).*

9. American National Standard *Scheme for the Identification of Piping Systems.* ANSI A13.1-1985.

10. Hazardous Materials Warning Placards and Labels, Title 49, *Code of Federal Regulations,* Parts 100-199.

11. *Ambulance Blue and Orange.* Federal Specification KKK-A-1822, January 2, 1974.

12. American National Standard *Radio Frequency Radiation Hazard Warning Symbol.* ANSI C95.2-1982 (R1988).

13. *Uniform Marking of Fire Hydrants.* NFPA No. 291-1988.

14. *Automotive Fire Apparatus.* NFPA No. 1901-1985.

15. American National Standard *Radiation Symbol.* ANSI N2.1 1989.

16. American National Standard *Method of Specifying Color by the Munsell System.* ANSI/ASTM D1535-80.

17. Kelly, Kenneth L. and Judd, Deane B., *Color: Universal Language and Dictionary of Names (Combination of the Universal Color Language and the Color Names Dictionary),* NBS Special Publication SP440, December 1976. Obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (order by SD Catalog No. C13.10:440, Stock No. 003-003-01705-1).

18. *Munsell Book of Color.* Munsell Color, Kollmorgen Corporation, 2441 North Calvert Street, Baltimore, MD 21218, 1976.

19. *Standard Practice for Visual Examination of Color Differences of Opaque Materials.* ASTM D1729-82.

20. *Standard Practice for Visual Evaluation of Metamerism.* ASTM D4086-82.

21. *Standard Practice for Obtaining Spectrophotometric Data for Object Color Evaluation.* ASTM E 1164-87.

22. *Standard Method for Computing the Colors of Objects by Using the CIE System.* ASTM E308-85.

23. *Standard Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.* ASTM D 2244-85.

24. *Standard Practice for Color Measurement of Fluorescent Specimens.* ASTM E991-84.

25. Fluorescent Colours, in Publication CIE No. 39.2 (TC-1.6) 1983, *Recommendations for Surface Colours for Visual Signalling.* Bureau Central de la CIE, Paris, 1983.



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26. Fluorescent Elastomeric Films Specification No. G-EOE-339B, April 1984, Ocean Engineering Division, U.S. Coast Guard, Washington, D.C. 20593.

27. American National Standard for *Hazardous Industrial Chemicals - Precautionary Labeling.* ANSI Z129.1-1988.



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