The Engineering Society For Advancing Mobility Land Sea Air and Space®

A Product of the Cooperative Engineering Program

SAE J578 MAY88

Color Specification

SAE Standard
Revised May 1988

Submitted for Recognition as an American National Standard

The Engineering Society For Advancing Mobility Land Sea Air and Space®

400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

HIGHWAY VEHICLE STANDARD

Submitted for recognition as an American National Standard

SAE J578

Issued Jan. 1942
Revised May 1988

Superseding J578 OCT87

Ø COLOR SPECIFICATION

1. SCOPE: This standard defines and provides a means for the control of colors employed in motor vehicle external lighting equipment, including lamps and reflex reflectors. The standard applies to the overall effective color of light emitted by the device in any given direction and not to the color of the light from a small area of the lens. It does not apply to pilot, indicator, or tell-tale lights.

2. TEST METHODS:

2.1 Method of Color Measurement: One of the methods listed in paragraphs 2.1.1, 2.1.2, or 2.1.3 shall be used to check the color of the light from the device or its optical components for compliance with the color specifications. The device shall be operated at the design test voltage. Components (bulbs, cap lenses, and the like) shall be tested in a fixture or in a manner simulating the intended application.

In measuring the color of reflex devices, precautions shall be made to eliminate the first surface reflections of the incident light.

Lighting devices that are covered with neutral density filters shall be tested for color with such filters in place.

2.1.1 Visual Method: In this method, the color of the emitted light from the device is visually compared to the light from a filter/source combination of known chromaticity coordinates. The filter/source combinations are generally chosen to describe the limits of chromaticity coordinates of the color being measured. The color of the filter/source combination is determined spectrophotometrically.

In making visual appraisals, the light from the device lights one portion of a comparator field and the filter/source standard lights an adjacent area. The two fields should be in close proximity to each other.

2.1.1 (Continued):

To make valid visual comparisons, the two fields to be viewed must be of near equal luminace (photometric brightness). A means of mechanically adjusting the filter/source standard is generally used to accomplish this. See Appendix for measuring precautions.

2.1.2 Tristimulus Method: In this method, photoelectric detectors with spectral responses that approximate the 1931 CIE standard spectral tristimulus values are used to make the color measurements. These measured tristimulus values are used to calculate the chromaticity coordinates of the color of emitted light from the device. The instrument used for this type of measurement is a colorimeter. These instruments are generally used for production control of color and are satisfactory if calibrated against color filters of known chromaticity coordinates.

Visual tristimulus colorimeters can also be used for color evaluation. See appendix for measuring precautions.

2.1.3 Spectrophotometric Method: The standard CIE method of color measurement is computing chromaticity coordinates from the spectral energy distribution of the device. This method should be used as a referee approach when the commonly used methods produce questionable results.

Refer to ASTM E308-66 for more details on spectrophotometric measurements (reprinted in the SAE Lighting Manual HS34).

ed. 3. DEFINITIONS:

3.1 Chromaticity Coordinates: The fundamental requirements for color are expressed as chromaticity coordinates according to the CIE (1931) standard colorimetric system (see Fig. 1). The following requirements shall apply when measured by the tristimulus or spectrophotometric methods.

3.1.1 Red: The color of light emitted from the device shall fall within the following boundaries:

$$y = 0.33 \text{ (yellow boundary)}$$

$$y = 0.98 - x \text{ (purple boundary)}$$

3.1.2 Yellow (Amber): The color of light emitted from the device shall fall within the following boundaries:

$$y = 0.39 \text{ (red boundary)}$$

$$y = 0.79 - 0.67x \text{ (white boundary)}$$

$$y = x - 0.12 \text{ (green boundary)}$$

3.1.2.1 Selective Yellow (See A-2 Appendix): The color of light emitted from the device shall fall within the following boundaries:

$y = 0.58x + 0.14$ (red boundary)

$y = 1.29x - 0.10$ (green boundary)

$y = 0.97 - x$ (white boundary)

3.1.3 White (Achromatic): The color of light emitted from the device shall fall within the following boundaries:

$x = 0.31$ (blue boundary)

$x = 0.50$ (yellow boundary)

$y = 0.15 + 0.64x$ (green boundary)

$y = 0.05 + 0.75x$ (purple boundary)

$y = 0.44$ (green boundary)

$y = 0.38$ (red boundary)

3.1.3.1 White to Yellow: The color of light emitted from the device shall fall within one of the following areas:

(a) That defined in paragraph 3.1.2 Yellow.

(b) That defined in paragraph 3.1.2.1 Selective Yellow.

(c) That defined in paragraph 3.1.3 White.

(d) The area between Yellow, Selective Yellow, and White as shown by the dashed line in Fig. 1.

3.1.4 Green: The color of light emitted from the device shall fall within the following boundaries:

$y = 0.73 - 0.73x$ (yellow boundary)

$x = 0.63y - 0.04$ (white boundary)

$y = 0.50 - 0.50x$ (blue boundary)

3.1.5 Blue: The color of light emitted from the device shall fall within the following boundaries:

3.1.5.1 Restricted Blue: This color should be elected when recognition of blue as such is necessary.

$$y = 0.07 + 0.81x \text{ (green boundary)}$$

$$x = 0.40 - y \text{ (white boundary)}$$

$$x = 0.13 + 0.60y \text{ (violet boundary)}$$

3.1.5.2 Signal Blue: This color may be elected when, due to other factors, it is not always necessary to identify blue as such.

$$y = 0.32 \text{ (green boundary)}$$

$$x = 0.16 \text{ (white boundary)}$$

$$x = 0.40 - y \text{ (white boundary)}$$

$$x = 0.13 + 0.60y \text{ (violet boundary)}$$

3.2 Visual Method: When checking by the visual method of paragraph 2.1.1, the following subjective guidelines shall be considered:

3.2.1 Red: Red shall not be acceptable if it is less saturated (paler), yellower, or bluer than the limit standards.

3.2.2 Yellow (Amber): Yellow shall not be acceptable if it is less saturated (paler), greener, or redder than the limit standards.

3.2.3 White: White shall not be acceptable if its color differs significantly from that of a blackbody source operating at a color temperature between CIE Illuminant A (2854K) and CIE Illuminant B (5000K).

3.2.4 Green: Green shall not be acceptable if it is less saturated (paler), yellower, or bluer than the limit standards.

3.2.5 Blue: Blue shall not be acceptable if it is less saturated (paler), greener, or redder than the limit standards.

APPENDIX

A1. PRECAUTIONS: The following are applicable to all methods of determining the color of light:

a) Some devices may emit a different color of light in one direction than another. Measurements should be made in as many directions as required to define the color characteristic of emitted light.

Some instruments (tristimulus and spectroradiometric) use an integrating sphere at the inlet port of the device to integrate all the light from the device. Care should be taken to assure that the integrating sphere is not combining different color light emitted in different directions from the device and thereby providing an erroneous reading.

b) The lamp and optical components should be allowed to reach operating temperature before any measurements are made. Lamps should be operated at design voltage.

If visually the device does not appear to be emitting light with a uniform color, additional precautions should be taken.

c) The distance between the test instrument and the device under test should be great enough so that further increases in distance do not affect the results. The visual field of the instrument should view the entire lighted area of the device.

A2. COLOR APPLICATION: Selective yellow is used on a limited basis primarily for fog lights and is not to be used in turn signal, parking, identification, clearance, sidemarker, and school bus warning lamps, or yellow reflex reflector applications as required by FMVSS 108.

A3. NEUTRAL DENSITY: Filtering materials are sometimes used over existing lighting devices to reduce the light intensity but not to change the fundamental color requirements as detailed in SAE J578.

A4. ORANGE FLUORESCENT INFORMATION GUIDELINE: Definitions and Requirements for Orange Fluorescent color can be found in the appropriate SAE Recommended Practice or Standard. Refer to SAE J774, Emergency Warning Device, or SAE J943, Slow-moving Vehicle Identification Emblem or to FMVSS No. 125, Warning Devices, 39 FR 28636, Aug. 9, 1974 as amended at 40 FR4, Jan. 2, 1975.

A5. COLOR MEASUREMENTS OF GASEOUS DISCHARGE LIGHTING DEVICES: Some laboratories cannot measure the color of light from the short pulses of lamps that use discharge tubes and, therefore, these lamps need a steady burning test source, operated at the color temperature of the gaseous discharge warning lamp. Use of CIE Illuminant C for strobe lights has been confirmed by independent testing laboratories.

A6. CITED ASTM REPORT: ASTM E 308-66, Standard Practice for Spectrophotometry and Description of Color in CIE 1931 System. Reprinted in SAE Ground Vehicle Lighting Manual, HS-34.

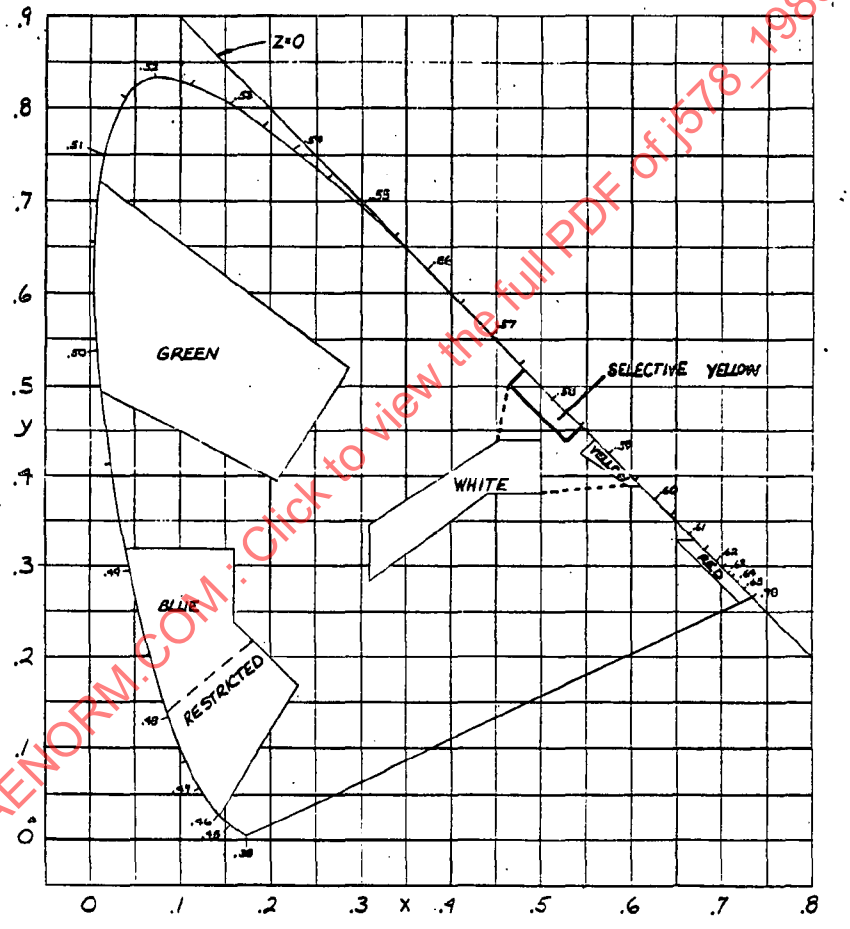

FIG. 1 – CHROMATICITY DIAGRAM

The phi (Ø) symbol is for the convenience of the user in locating areas where technical reivsions have been made to the previous issue of the report. If the symbol is next to the report title, it indicates a complete revision of the report.

RATIONALE:

This technical report is being revised in accordance with the five (5) year update requirements. It has been rewritten to incorporate resolved disapprovals, comments, and various editorial changes up to and including approval by the Subcommittee and the Lighting Committee in June 1986.

The title of the technical report is being changed to reflect the fact that color specifications are needed for more than electric signal lighting devices. The Scope has therefore been expanded to list the appropriate devices involved.

Detailed description of the Tristimulus method, paragraph 2.1.1 has been condensed, since the complete ASTM Standard, E 308-66 has been reprinted in the Lighting Manual.

Information Guidelines for fluorescent orange have been included in the Appendix rather than as a specific requirement, since this color relates to specific devices as seen in SAE J774, SAE J943 and FMVSS 125. Each standard uses different means of measurement within the common practices of the appropriate industry.

In order to reflect current usage and state of the art technology, statements on neutral density filters in relation to color and on color measurement of gaseous discharge devices have been added to the appendix.

The statement about the use of blue as a secondary rather than a primary signal color was deleted from the Appendix since the individual SAE recommended practice for each warning device notes how blue is to be used.

RED:

Red as defined in paragraph 3.1.1 and graphically indicated on the chromaticity diagram has worldwide acceptance as meaning STOP or DANGER. The current chromaticity coordinates have been in effect since 1974.

There have been no reported problems with meeting the required color from device manufacturers or suppliers of lens materials. There is a wide range of standard red colored material available for lens use.

YELLOW:

Yellow as defined in paragraph 3.1.2 and graphically indicated on the chromaticity diagram has worldwide acceptance as meaning CAUTION, TO INDICATE A HAZARD, TO INDICATE A CHANGE IN DIRECTION, and TO DELINEATE THE LENGTH, WIDTH, and HEIGHT OF AN OBJECT. Current chromaticity coordinates have been in effect since the 1974 revision.

There have been no reported problems in meeting the required color from device manufacturers or suppliers of lens materials. There is a wide range of standard yellow colored material available.

RATIONALE (Continued):

WHITE:

White is defined in paragraph 3.1.3 and graphically indicated on the chromaticity diagram. In the 1977 revision to the color standard, the boundaries for white were expanded to the current chromaticity coordinates. The change allowed for a whiter light, more to blue and expanded the range.

GREEN:

Green as defined in paragraph 3.1.4 and graphically indicated on the chromaticity diagram has international acceptance as meaning GO, IT IS SAFE.

There are no SAE standards calling for the color green in lighting devices. However, some states and local governmental units have used green in addition to emergency warning lamps to identify emergency medical units. Green highway reflectors have been used for identification purposes.

BLUE:

Blue as defined in paragraphs 3.1.5.1 and 3.1.5.2 and graphically indicated on the chromaticity diagram has limited acceptance as an emergency warning color.

In the 1977 revision to the color standard, the boundaries for blue were expanded to the current chromaticity coordinates. The expanded area was towards green and called signal blue. This allowed for a greater selection of materials but with some visibility restrictions as stated in the standard.

Blue is being used by an increasing number of law enforcement agencies and has been used for highway reflectors to identify fire hydrants and to identify hazards for snow removal. As the ambient light levels decrease, the attention-getting properties of blue increases, making it a better nighttime signal.

SELECTIVE YELLOW:
WHITE TO YELLOW:

Selective yellow and white to yellow are defined in paragraphs 3.1.2.1 and 3.1.3.1 and graphically indicated on the chromaticity diagram.

In the 1978 revision to the standard, selective yellow and white to yellow were added. These two colors have very limited use as specified in the standard and are basically limited to fog lamps.

There have been no reported problems regarding glare, meeting color requirements from device manufacturers or lens material suppliers. There is a wide range of materials available to meet the color requirements.

We are still searching for the SAE demonstration and documentation data from test conducted some 15 years ago. If and as this information becomes available, it will be added to the rationale.

RELATIONSHIP OF SAE STANDARD TO ISO STANDARD:

Not applicable.