

OPAQUE COLOURED PRODUCTS POINT OF COLOUR (SPECTROCOLORIMETRY)

Page 1/7

NO USE RESTRICTION

This is a translation, the French original shall be used in all cases of litigation

Date of translation : 23/07/2004

FOREWORD

This document is in technical conformity with RENAULT test method D15 5083.

It must not be modified without prior consultation with RENAULT.

It is in conformity with the agreement reached between the Normalisation Departments of PEUGEOT S.A. and RENAULT in APRIL 1994.

1.OBJECT AND FIELD OF APPLICATION

The object of this method is to define a method of operation for determining the point of colour in the visible field of opaque coloured products. It applies mainly to plastic parts, textiles, leather trim and plain paints (opaque), with the exclusion of luminescent materials and metallic or pearlescent paint coatings.

Surface appearance parameters interact with the colour and are included in the colour point measurements (gloss, tension, graining of plastic parts, scratching of textiles, crushed velvet,...).

2.PRINCIPLE

The point of colour trichromatic components X , Y , Z are determined from the reflectance measurements, carried out by means of a spectrophotometer with integrating sphere, over the complete visible spectrum from at least 400 to 700 nanometres according to the following formulas :

$$X = \sum E_{\lambda} \cdot \bar{x}_{\lambda} \cdot R_{\lambda} \cdot \Delta\lambda$$

$$Y = \sum E_{\lambda} \cdot \bar{y}_{\lambda} \cdot R_{\lambda} \cdot \Delta\lambda$$

$$Z = \sum E_{\lambda} \cdot \bar{z}_{\lambda} \cdot R_{\lambda} \cdot \Delta\lambda$$

In which :

- E corresponds to the spectral emission of the type of illuminant selected. The two types of illuminants used are defined below :
- A : illuminant based on the lamp with tungsten filament : yellow light (2856 K),
- D_{65} : illuminant near the average daylight including within the proximity of ultraviolet rays (6504 K).
- \bar{x}_{λ} , \bar{y}_{λ} , \bar{z}_{λ} , are values of average response by the eye of a standard observer of 10° presenting a visual field with a varying angle between 4 and 10° (spectral trichromatic component).
- R_{λ} is the measurement of the spectral reflectance of the test specimen at wavelength λ .
- $\Delta\lambda$ is the wavelength interval.

R_{λ} only is the effective measurement of the equipment : E_{λ} , x_{λ} , y_{λ} , z_{λ} , are values set by the standards of the Commission Internationale d'Eclairage (CIE 1964) [Lighting International Commission] (see tables in the appendix).

3.DEFINITION OF TERMS

Trichromatic components :

Quantity of each of the three primaries or reference stimuli which, when mixed, restitutes an equivalent stimulus.

Specular component :

Reflected radiation symmetrical to the incident radiation in relation to the perpendicular.

Illuminant :

Source of light recommended for the usual colorimetry and for which the relative spectral distributions of energy are known.

| | | |
|-------------------------------------|----------|-----|
| COLOURED PRODUCTS – POINT OF COLOUR | D15 5083 | 2/7 |
|-------------------------------------|----------|-----|

Reflectance :

Luminance ratio between a surface (not emissive) and a perfect diffuser in terms of wavelength.

Observer :

Radiation receiver associated to a determined trichromatic system and for which the colorimetric characteristics are defined by spectral trichromatic components of the system.

Integrating sphere :

Sphere with an internal surface covered with a white diffusing coating which enables a surface to be lit or observed according to all directions.

Luminance :

It is the concept of brightness from black to white.

Chroma :

Attribute of colour perception which expresses the proportion of pure colour within a complete sensation.

Tone:

Attribute of visual sensation which gave rise to prevailing colours such as blue, green, yellow, etc.

4.EQUIPMENT

4.1.SPECTROCOLORIMETER

placed in a dust free and air conditioned room and deposited on a support free from vibrations ; the power supply is stabilised in order to avoid any drift.

It consists of the following elements :

- integrating sphere with the possibility of including or excluding the specular component,
- diffuse lighting system,
- observation system close to the perpendicular (0 to 8° angle),
- illuminant D₆₅ and A (for measuring the metamerism),
- standard observer 10°,
- spectral field, visible from 400 to 700 nm with a recording every 10 nm minimum,
- halogen lamp which must systematically be changed every 2000 hours.

4.2.COMPUTER SYSTEM

to pilot the spectrophotometer (4.1), display the reflectance curves and analyse the measurements.

4.3.PRINTER WITH GRAPHIC PRINTOUT OR PLOTTER

4.4.STANDARDS

for calibrating the spectrophotometer (4.1).

- Black standard 0 % : consisting of a light trap.
- Approved white standard : ceramic, white porcelain or disc in baryum sulphate (BaSO₄) with spectral graph.
- Intermediate standards in ceramic of various colours for checking the calibration.

4.5.VARIOUS WIPING EQUIPMENT

Chamois leather, soft cloths, etc.

5.METHOD OF OPERATION

5.1.CALIBRATION

- Select inclusion or exclusion of the specular component (4.2) and check the positioning of this component on the spectrophotometer (4.1).
- Select the greatest possible opening in relation to the test specimens to be measured.
- Calibrate the spectrometer (4.1) according to the supplier's procedure, at the beginning of each half-day minimum.

5.2.PREPARATION OF TEST SPECIMENS

- Proceed carefully, if required, with the wiping of test specimens using the equipment (4.5) before taking the measurements.

5.3.MEASUREMENTS

- Select the illuminant(s) and the observer 10° (4.1).
- Choose an area on the test specimen which is as flat as possible. Carry out a minimum of 5 measurements according to the procedure specific to the spectrophotometer (4.1), in various places of the selected area and in various orientations by angular rotations.

6.EXPRESSION OF RESULTS

The mean of 5 measurements determines the trichromatic components of the colour point X, Y, Z.

The computer system (4.2) enables these components to be expressed in the colorimetric space CIE 1976 (L^* , a^* , b^*) and the mean reflectance curve to be retained.

Calculate the standard variation σ for each component according to the following formula :

$$\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n - 1}}$$

in which : x_i = measurement i (with i = 1 to n),
 \bar{x} = mean of the measurements,
n = number of measurements = 5.

The results of a measurement must always be analysed in the form of colorimetric variations in conformity with test method D15 5084.

7.TEST REPORT

As well as the results obtained, the test report must mention :

- the reference to this method,
- the type of equipment (4.1) used (make, reference, geometry),
- the dimension of the measuring diaphragm,
- whether the specular radiation is included or excluded, the type of illuminant,
- the complete reference of the test specimen (colour code, date it was produced, grain, material reference, batch number, etc.),
- the definition of the measurement area (size, location), with a diagram if required,
- the number of average measurements if less than 5 and the standard variations if these differ from the values set in the documents,
- the gloss value determined in conformity with test method D25 1413 at an angle of 20 or 60° at the same location as the colour measurement,
- the operating details not specified in the method as well as any incidents likely to have affected the results.

appendix

EXAMPLES OF CALCULATIONS

| Wavelength λ (nm) | Spectral sensitivity of the standard observer 10° in | | | Relative spectral distribution of energies from illuminants | |
|------------------------------|--|-------------------------|-------------------------|--|----------------|
| | Red | Green | Blue | | |
| | $\bar{x}_{10}(\lambda)$ | $\bar{y}_{10}(\lambda)$ | $\bar{z}_{10}(\lambda)$ | $E_{D_{65}}(\lambda)$ | $E_A(\lambda)$ |
| 390 | 0,0024 | 0,0003 | 0,0105 | 54,60 | 12,09 |
| 400 | 0,0191 | 0,0020 | 0,0860 | 82,80 | 14,71 |
| 410 | 0,0847 | 0,0088 | 0,3894 | 91,50 | 17,68 |
| 420 | 0,2045 | 0,0214 | 0,9725 | 93,40 | 20,99 |
| 430 | 0,3147 | 0,0387 | 1,5535 | 86,70 | 24,67 |
| 440 | 0,3837 | 0,0621 | 1,9673 | 104,90 | 28,70 |
| 450 | 0,3707 | 0,0895 | 1,9948 | 117,00 | 33,09 |
| 460 | 0,3023 | 0,1282 | 1,7454 | 117,80 | 37,81 |
| 470 | 0,1956 | 0,1852 | 1,3176 | 114,90 | 42,87 |
| 480 | 0,0805 | 0,2536 | 0,7721 | 115,90 | 48,24 |
| 490 | 0,0162 | 0,3391 | 0,4153 | 108,80 | 53,91 |
| 500 | 0,0038 | 0,4608 | 0,2185 | 109,40 | 59,86 |
| 510 | 0,0375 | 0,6067 | 0,1120 | 107,80 | 66,06 |
| 520 | 0,1177 | 0,7618 | 0,0607 | 104,80 | 72,50 |
| 530 | 0,2365 | 0,8752 | 0,0305 | 107,70 | 79,13 |
| 540 | 0,3768 | 0,9620 | 0,0137 | 104,40 | 85,95 |
| 550 | 0,5298 | 0,9918 | 0,0040 | 104,00 | 92,91 |
| 560 | 0,7052 | 0,9973 | 0,0000 | 100,00 | 100,00 |
| 570 | 0,8787 | 0,9556 | 0,0000 | 96,30 | 107,18 |
| 580 | 1,0142 | 0,8689 | 0,0000 | 95,80 | 114,44 |
| 590 | 1,1185 | 0,7774 | 0,0000 | 88,70 | 121,73 |
| 600 | 1,1240 | 0,6583 | 0,0000 | 90,00 | 129,04 |
| 610 | 1,0305 | 0,5280 | 0,0000 | 89,60 | 136,35 |
| 620 | 0,8563 | 0,3981 | 0,0000 | 87,70 | 143,62 |
| 630 | 0,6475 | 0,2835 | 0,0000 | 83,30 | 150,84 |
| 640 | 0,4316 | 0,1798 | 0,0000 | 83,70 | 157,98 |
| 650 | 0,2683 | 0,1076 | 0,0000 | 80,00 | 165,03 |
| 660 | 0,1526 | 0,0603 | 0,0000 | 82,20 | 171,96 |
| 670 | 0,0813 | 0,0318 | 0,0000 | 82,30 | 178,77 |
| 680 | 0,0409 | 0,0159 | 0,0000 | 78,30 | 185,43 |
| 690 | 0,0199 | 0,0077 | 0,0000 | 69,70 | 191,93 |
| 700 | 0,0096 | 0,0037 | 0,0000 | 71,60 | 198,26 |
| 710 | 0,0046 | 0,0018 | 0,0000 | 74,30 | 204,41 |

| | | |
|-------------------------------------|----------|-----|
| COLOURED PRODUCTS – POINT OF COLOUR | D15 5083 | 6/7 |
|-------------------------------------|----------|-----|

EXAMPLES OF CALCULATIONS (CONTINUED)

| Wavelength λ (nm) | Distribution coefficient relative to the illuminant D ₆₅ and to the observer 10° (Without dimension) | | | Reflectance value R (Without dimension) | Spectral trichromatic components | | |
|---------------------------------|---|-----------------------------|-----------------------------|---|----------------------------------|---------------------------------|---------------------------------|
| | | | | | X* | Y* | Z* |
| | D ₆₅ · \bar{x} | D ₆₅ · \bar{y} | D ₆₅ · \bar{z} | | R · D ₆₅ · \bar{x} | R · D ₆₅ · \bar{y} | R · D ₆₅ · \bar{z} |
| 400 | 1,5815 | 0,1656 | 7,1208 | 0,6866 | 1,0858 | 0,1137 | 4,889 |
| 410 | 7,7501 | 0,8052 | 35,6301 | 0,7038 | 5,4545 | 0,5667 | 25,076 |
| 420 | 19,1003 | 1,9988 | 90,8315 | 0,7140 | 13,6376 | 1,4271 | 64,854 |
| 430 | 27,2845 | 3,3553 | 134,6885 | 0,7278 | 19,8577 | 2,4420 | 98,026 |
| 440 | 40,2501 | 6,5143 | 206,3698 | 0,7350 | 29,5838 | 4,7880 | 151,682 |
| 450 | 43,3719 | 10,4715 | 233,3916 | 0,7429 | 32,2210 | 7,7793 | 173,387 |
| 460 | 35,6109 | 15,1020 | 205,6081 | 0,7478 | 26,6299 | 11,2932 | 153,754 |
| 470 | 22,4744 | 21,2795 | 151,3922 | 0,7526 | 16,9143 | 16,0149 | 113,938 |
| 480 | 9,3300 | 29,3922 | 89,4864 | 0,7569 | 7,0618 | 22,2470 | 67,732 |
| 490 | 1,7626 | 36,8941 | 45,1846 | 0,7602 | 1,3399 | 28,0469 | 34,349 |
| 500 | 0,4157 | 50,4115 | 23,9039 | 0,7656 | 0,3183 | 38,5951 | 18,301 |
| 510 | 4,0425 | 65,4023 | 12,0736 | 0,7660 | 3,0966 | 50,0981 | 9,248 |
| 520 | 12,3350 | 79,8366 | 6,3614 | 0,7668 | 9,4584 | 61,2187 | 4,878 |
| 530 | 25,4711 | 94,2590 | 3,2849 | 0,7684 | 19,5720 | 72,4286 | 2,524 |
| 540 | 39,3379 | 100,4328 | 1,4303 | 0,7711 | 30,3335 | 77,4437 | 1,103 |
| 550 | 55,0992 | 103,1472 | 0,4160 | 0,7738 | 42,6358 | 79,8153 | 0,322 |
| 560 | 70,5200 | 99,7300 | 0,0000 | 0,7769 | 54,7870 | 77,4802 | 0,000 |
| 570 | 84,6188 | 92,0243 | 0,0000 | 0,7792 | 65,9350 | 71,7053 | 0,000 |
| 580 | 97,1604 | 83,2406 | 0,0000 | 0,7791 | 75,6976 | 64,8528 | 0,000 |
| 590 | 99,2110 | 68,9554 | 0,0000 | 0,7794 | 77,3250 | 53,7438 | 0,000 |
| 600 | 101,1600 | 59,2470 | 0,0000 | 0,7810 | 79,0060 | 46,2719 | 0,000 |
| 610 | 92,3328 | 47,3088 | 0,0000 | 0,7815 | 72,1581 | 36,9718 | 0,000 |
| 620 | 75,0975 | 34,9134 | 0,0000 | 0,7830 | 58,8014 | 27,3372 | 0,000 |
| 630 | 53,9368 | 23,6156 | 0,0000 | 0,7801 | 42,0761 | 18,4225 | 0,000 |
| 640 | 36,1249 | 15,0493 | 0,0000 | 0,7783 | 28,1160 | 11,7128 | 0,000 |
| 650 | 21,4640 | 8,6080 | 0,0000 | 0,7747 | 16,6282 | 6,6686 | 0,000 |
| 660 | 12,5437 | 4,9564 | 0,0000 | 0,7728 | 9,6938 | 3,8305 | 0,000 |
| 670 | 6,6910 | 2,6171 | 0,0000 | 0,7745 | 5,1822 | 2,0270 | 0,000 |
| 680 | 3,2025 | 1,2450 | 0,0000 | 0,7755 | 2,4835 | 0,9655 | 0,000 |
| 690 | 1,3870 | 0,5367 | 0,0000 | 0,7741 | 1,0737 | 0,4155 | 0,000 |
| 700 | 0,6874 | 0,2649 | 0,0000 | 0,7737 | 0,5318 | 0,2050 | 0,000 |
| 710 | 0,3418 | 0,1337 | 0,0000 | 0,7752 | 0,2649 | 0,1037 | 0,000 |
| | | | | | 848,72 | 896,93 | 924,06 |
| | | | | | S = X* + Y* + Z* = 2669,72 | | |

$$\Sigma = \Sigma D_{65} \cdot \bar{y} = 1161,79$$

Through factor k, component Y is returned as equal to 100 for perfect white.

$$k = 100/\Sigma = 0,0861$$

Trichromatic components :

$$\begin{aligned} X &= k \cdot X^* = 73,05 \\ Y &= k \cdot Y^* = 77,20 \\ Z &= k \cdot Z^* = 79,53 \end{aligned}$$

Trichromatic co-ordinates :

$$\begin{aligned} x &= X/S = 0,31 \\ y &= Y/S = 0,33 \\ z &= Z/S = 0,34 \end{aligned}$$

8.RECORDS AND REFERENCE DOCUMENTS

8.1.RECORDS

8.1.1.CREATION

- OR : 01/03/1981 – CREATION OF THE NORME.

8.1.2.SUBJECT OF THE MODIFICATION

- A : 01/04/1994 – COMPLETE REWRITE OF THE NORME WITH FOREWORD ADDED.
- B : 17/06/1997 – INTRODUCED INTO IDEM (*French only*).

8.2.REFERENCE DOCUMENTS

8.2.1.PSA DOCUMENTS

8.2.1.1.Normes

D155084, D251413.

8.2.1.2.Others

8.2.2.EXTERNAL DOCUMENTS

8.3.EQUIVALENT TO :

REND155083

8.4.CONFORMS TO :

8.5.KEY WORDS