**KENYA STANDARD**

**KS 815: 2017**
ICS 43.040.20

# Retro-reflective and fluorescent warning triangles for motor vehicles — Specification



Second Edition 2017

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Pelican Signs
Kenya Police-Traffic Department
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## REVISION OF KENYA STANDARDS

In order to keep abreast of progress in industry, Kenya Standards shall be regularly reviewed. Suggestions for improvements to published standards, addressed to the Managing Director, Kenya Bureau of Standards, are welcome.

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# Retro-reflective and fluorescent warning triangles for motor vehicles — Specification



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## Foreword

This Kenya Standard was prepared by the Technical Committee on Highway Control Materials, under the guidance of the Standards Projects Committee, and it is in accordance with the procedures of the Kenya Bureau of Standards.

This second edition cancels and replaces the first edition of KS 815 published in 2012. This edition constitute a technical revision to include co-efficient of retro reflection.
During the preparation of this standard, reference was made to the following documents:

SANS 1329, Retro-reflective and fluorescent warning signs for road vehicles Part 1: Triangles.

SANS 1519-1, Retro-reflective sheeting materials.

KS 815, Specification for retro reflective sheeting materials for traffic signs.

SANS 279, Paints and Vanishes – Scratch test.

SANS 5146, Paints and Vanishes – Resistance to Impact of paint films.

SANS 7253, Paints and varnishes — Determination of resistance to neutral salt spray (fog)

Information obtained from Kenyan manufacturers.

Assistance obtained from these sources is hereby acknowledged.

# Retro-reflective and fluorescent warning triangles for motor vehicles — Specification

## 1 Scope

This Kenya Standard specifies requirements for retro-reflective and fluorescent triangle signs for advance warning indicating temporary obstruction in a roadway such as an accident, stationary or slow moving vehicle, any of which may constitute traffic hazard.

## 2 Definitions

**2.1**
**fluorescence**
the phenomenon that occurs when light of a certain wavelength is absorbed by a chemical substance in the surface of a material and part of the light energy is re-radiated as light of a longer wavelength

**2.2**
**Retro-reflective**
surface: A surface from which light is reflected in directions close to the direction of incidence within a wide range of angles of incidence at the reflecting surface

**2.3**
**triangle**
a warning sign in the shape of a triangle and intended to be used in accordance with road traffic regulations to indicate a hazard

**2.4**
**warning face**
a surface of a warning sign that is intended to be displayed when the sign is in use

## 3 Requirements

### 3.1 Type

A triangle shall be of type A (Portable) or type B (Fixed i.e. intended to be attached to a road vehicle).

### 3.2 Materials

#### 3.2.1 Substrate materials

The substrate material used for a triangle shall be a metal or a plastic material, as required, and shall be such that the the completed triangle complies with the performance requirements of 3.6. In addition, the substrate material shall comply with the appropriate requirements below:

a) **Metal,** a substrate of metal shall be such that when at an ambient temperature of 20 $^{o}$C ±1 $^{o}$C, a specimen of the substrate of length and width approximately 150 mm and 40 mm respectively is placed on two parallel knife-edge supports that are each not more than 10 mm from an end of the specimen,



and a force of 11 ±1 N is applied vertically downwards at the center of the specimen and maintained for a period of at least 5 s.

1) the deflection does not exceed 3.0 mm; and

2) there is no permanent deflection after the force has been removed.

b) **Plastics**[1], a substrate of plastics shall be such that

1) it is of the thermoplastic type, has a high impact resistance, is water resistant and fuel resistant, contains ultraviolet light absorbers and anti-oxidants and, if required, contains a red fluorescent colorant; and

2) it complies with the requirements given in a) above.

NOTE When it is not practicable to obtain a specimen of the width given in a) above, a specimen having the width of a leg of the triangle may be used and the applied test force shall then be that given by the equation:

$$F = \left( \frac{X}{40} \times 11 \right) \text{N}$$

where,

$F$= required test force, N

$X$= width of leg of triangle, mm

### 3.2.2 Retro-reflective material

Retro-reflective material shall be red, red and white or red and yellow, and shall comply with the requirements for —

a) reflected luminous intensity given in 3.6.3; and

b) the chromaticity co-ordinates given in 3.6.4; and, in the case of a pressure-sensitive adhesive material, When the sheeting material is tested in accordance with 5.14, in neither specimen shall

1) the liner break or tear or remove any of the adhesive backing during its removal from the sheeting material, or

2) the distance of peeling exceed 40 mm.

### 3.2.3 Coefficient of retro-reflection

**3.2.3.1** When the coefficients of retro-reflection of the retro-reflective sheeting are measured in accordance with 5.7, they shall be not less than the relevant values given in table 1, appropriate to the colour and class of the material.

**3.2.3.2** After new retro-reflective sheeting has been weathered in accordance with 5.8, the coefficient of retro-reflection at an observation angle of 0.33° and an entrance angle of 5° shall be at least 80 % of the relevant value given in table 1

1) In the case of a triangle that has retro-reflective material on the warning face(s), before specifying a plastics material for the substrate material the purchaser should consult with the manufacturer or the supplier of the retro-reflective material regarding the compatibility of the retro-reflective material and the plastics material.

Table 1 — Minimum coefficients of retro-reflection (new materials)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Class | Observation angle degrees | Entrance angle degrees | Minimum coefficient of retro-reflection for different colours of material, when measured with standard illuminant A[1] cd/(lx·m²) | | | | | | | | | | | |
| | | | Red | Orange | Yellow | Green | Blue | Purple | White | Brown | Grey | Fluorescent orange | Fluorescent yellow | Fluorescent yellow/green |
| I | 0,33 | 5 | 10,0 | 20,0 | 35,0 | 7,0 | 2,0 | 2,0 | 50,0 | 0,6 | 30,0 | – | – | – |
| | 1,5 | 30 | 0,5 | 0,5 | 1,5 | 0,3 | 0,1 | 0,1 | 2,5 | 0,1 | 1,5 | – | – | – |
| II | 0,33 | 5 | 20,0 | 40,0 | 70,0 | 14,0 | 6,0 | 4,0 | 100,0 | 0,8 | 80,0 | – | – | – |
| | 1,5 | 30 | 0,5 | 0,5 | 1,5 | 0,3 | 0,1 | 0,1 | 2,5 | 0,1 | 1,5 | – | – | – |
| III | 0,33 | 5 | 26,0 | 66,0 | 120,0 | 21,0 | 14,0 | 6,0 | 180,0 | 8,0 | 90,0 | – | – | – |
| | 1,5 | 30 | 0,4 | 1,0 | 1,5 | 0,3 | 0,1 | 0,1 | 2,5 | 0,1 | 1,2 | – | – | – |
| | 0,33 | 40 | 13,0 | 20,0 | 60,0 | 11,0 | 7,0 | 3,2 | 95,0 | 3,0 | 47,0 | – | – | – |
| IV A | 0,2 | 5 | 100,0 | 250,0 | 360,0 | 55,0 | 31,0 | – | 600,0 | 18,0 | – | 180,0 | 340,0 | 435,0 |
| | 0,2 | 30 | 51,0 | 130,0 | 200,0 | 29,0 | 16,0 | – | 325,0 | 10,0 | – | 90,0 | 200,0 | 225,0 |
| | 0,33 | 5 | 78,0 | 190,0 | 250,0 | 36,0 | 25,0 | – | 380,0 | 12,0 | – | 115,0 | 225,0 | 310,0 |
| | 0,33 | 30 | 40,0 | 100,0 | 130,0 | 18,0 | 11,0 | – | 205,0 | 6,0 | – | 65,0 | 125,0 | 158,0 |
| | 0,5 | 5 | 36,0 | 94,0 | 128,0 | 14,0 | 8,0 | – | 165,0 | 5,0 | – | 45,0 | 85,0 | 130,0 |
| | 0,5 | 30 | 20,0 | 45,0 | 70,0 | 8,0 | 3,0 | – | 90,0 | 2,0 | – | 23,0 | 45,0 | 65,0 |
| IV B | 0,33 | 5 | 75,0 | 90,0 | 250,0 | 35,0 | 17,0 | – | 300,0 | 15,0 | – | 90,0 | 180,0 | 240,0 |
| | 0,33 | 30 | 35,0 | 45,0 | 130,0 | 18,0 | 7,0 | – | 150,0 | 7,0 | – | 45,0 | 90,0 | 120,0 |
| | 0,33 | 40 | 7,0 | 9,0 | 25,0 | 4,0 | 2,0 | – | 30,0 | 1,0 | – | 9,0 | 18,0 | 24,0 |
| | 1,0 | 5 | 20,0 | 24,0 | 65,0 | 10,0 | 5,0 | – | 80,0 | 4,0 | – | 24,0 | 45,0 | 65,0 |
| | 1,0 | 30 | 13,0 | 15,0 | 40,0 | 5,0 | 2,5 | – | 50,0 | 2,0 | – | 15,0 | 30,0 | 40,0 |
| | 1,0 | 40 | 5,0 | 4,5 | 13,0 | 2,0 | 1,0 | – | 15,0 | 0,5 | – | 4,5 | 9,0 | 12,0 |

1) See CIE Publication 15 (E.1.3.1).

### 3.2.4 Fluorescent materials

Fluorescent material shall comply with the requirements for colour and for luminance factor given in 3.6.4. Fluorescent material shall be in the form of

a) sheeting having a pre-coated adhesive backing and complying with the requirement for strength of adhesion given in 5.14;

b) fluorescent paint; or

c) in the case of a plastics substrate material, a fluorescent colorant incorporated in the substrate material.

## 3.3 Construction

### 3.3.1 General

A triangle shall be equilateral and generally in accordance with Figure 1. A triangle shall be so constructed that, in the case of a type A sign, it is portable or, in the case of a type B sign, it is suitable to be attached to the rear of a vehicle (see Figure 4).

### 3.3.2 Dimensions

The length of the sides of a triangle measured, when relevant, from the points of intersection of the sides, shall be in the range 450-550 mm. The width of the surface of the warning face(s) onto which the retro-reflective material or retro-reflectors (or both) are to be placed, shall be in the range 25-85 mm and the area of this surface shall be not less than 0.031 $m^2$ and not more than 0.102 $m^2$. The area of the fluorescent surface shall be at least 0.025 $m^2$. The corners of the triangle shall be rounded, and the radius of a rounded corner shall be half the width of the retro-reflective surface shown in Figure 1 a).

### 3.3.3 Tolerances

The dimensions shall, when relevant, be subject to the appropriate of the following tolerances:

**Table 2 – Tolerance**

| Range of dimensions mm | | | Tolerance, ± mm |
|---|---|---|---|
| 0 | - | 50 | 0.5 |
| 51 | - | 200 | 1 |
| 201 | - | 500 | 2 |
| >500 | | | 3 |

### 3.3.4 Type A triangles

A type A triangle

a) may be collapsible and shall be provided with a folding support so constructed that, when the support is in use, there is a gap of height at least 25 mm between the bottom edge of the triangle and the ground (see Figure 1 and Figure 2);

b) shall be provided with a protective cover that completely encloses the triangle when not in use.

NOTE In the case of triangles supplied as original equipment with a road vehicle, the triangles may, provided that the vehicle has a compartment intended only for storing the triangles, be supplied without a protective cover and the triangles shall still comply with the requirements for resistance to heat given in 3.6.2. b).

### 3.3.5 Warning face

At least one face of a type A triangle and only one face of a type B triangle shall be a warning face. A warning face shall consist of an outer triangular area that is retro-reflective and an inner triangular area that is retro-reflective or/and fluorescent, generally as shown in Figure 1. Provided that the fluorescent area is large enough (see 3.3.2), there may be a central triangular area that has a matt black coating or, in the case of a type A triangle, is hollow or has an exclamation mark.

Retro-reflection shall be provided by retro-reflective material or retro-reflectors, or both, and fluorescence shall be provided by fluorescent sheeting, fluorescent paint or an incorporated fluorescent colorant (see 3.2.4), or any appropriate combination of these. Where retro-reflectors are used to provide retro-reflectivity and the retro-reflector units cover less than 30 % of the surface shown in Figure 1 as retro-reflective surface, the rest of the said surface shall, to maintain the integrity of the triangle, be covered with red, yellow or white retro-reflective material or a matt red coating of a shade that is a practical match to colour No. A11 "Signal red". The warning face shall be applied symmetrically to the surface of a triangle.

## 3.4 Application of material and of protective coatings to warning faces

Before the application of any material to the warning face(s) and, when relevant, to the reverse face, both surfaces of a triangle shall have been cleaned of all grease, oil, corrosion products and other foreign matter and dried. A triangle having a substrate of mild steel shall, before the application of the warning face(s), have been so coated as to provide protection from corrosion.[2] The edges of a triangle shall be adequately protected from weathering.

## 3.5 Workmanship

3) It is recommended that, in the case of triangles made of metals other than mild steel and that are to be used in corrosive atmospheres, the purchaser discuss the relevance of added protection with the triangle manufacturer or the paint supplier or both.

The boundaries between the different areas of a triangle shall be clearly defined. Surfaces covered with fluorescent and retro-reflective material and protective and other coatings shall be free from creases, cracks, blisters, discoloration and lack of adhesion. A triangle shall be free from sharp and jagged edges and the edges of a triangle that has a metal substrate shall be free from corrosion.

## 3.6 Performance

### 3.6.1 Strength and stability (type A triangles)

a) When a type A triangle is tested in accordance with 5.3, its strength shall be such that the applied force does not cause the apex of the triangle to be deflected by more than 50 mm and, after the force is removed, any residual deflection does not exceed 5 mm.

b) When a type A triangle is tested in accordance with 5.4, the triangle shall not

1) overturn;

2) slide more than 75 mm away from its original position; or

3) swivel through a horizontal angle of more than 10° (in either direction) from its original position.

### 3.6.2 Resistance to heat (type A triangles)

When a type A triangle together with, when relevant, its protective cover (see note to 3.3.4 b) is tested in accordance with 5.5,

a) the protective cover shall not become difficult to open, and shall show no sign of cracking or of adhering to the triangle; and

b) the triangle shall show no appreciable distortion, shall still be capable of being erected and its warning faces shall show no sign of cracking or loss of adhesion.

### 3.6.3 Reflected luminous intensity

The reflected luminous intensity of each warning face of a triangle, determined in accordance with 5.6 for each observation angle and each angle of incidence given in Table 3, shall be at least equal to the appropriate value given in Table 2.



**Table 3 – Reflected luminous intensities of the warning face of a triangle**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| | **Reflected luminous intensity, min.** cd per incident lux | | | |
| | **Angle of incidence** degrees | | | |
| Vertical<br>Horizontal | 0<br>0[a] | ±20<br>0 | 0<br>±30 | 0<br>±40 |
| Observation angle:<br>20´<br>1º 30´ | 8.00<br>0.60 | 4.00<br>0.20 | 1.75<br>0.10 | 0.60<br>0.05 |
| [a] ± 5º in the case of retro-reflective material ( see 3.2.2). | | | | |

### 3.6.4 Colour and luminance factor of fluorescent surfaces

When the fluorescent surface of a warning face of a triangle is tested in accordance with 5.8,

a) the chromaticity co-ordinates of the surface shall, before artificial weathering, be within the area on the chromaticity diagram bounded by the limits given in Table 4; and

b) the luminance factor shall, before artificial weathering, be not less than 30 % and, after weathering, not more than 60 %.

**Table 4 – Chromaticity co-ordinates of the points of intersection of the boundary lines of the limiting area on the chromaticity diagram – Before weathering**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **Co-ordinate** | **Value of co-ordinate** | | | |
| x<br>y | 0.690<br>0.310 | 0.595<br>0.315 | 0.569<br>0.341 | 0.655<br>0.345 |

### 3.6.5 Resistance to artificial weathering

When a triangle is tested in accordance with 5.9,

a) retro-reflective and fluorescent surfaces shall show no sign of cracking, blistering or lack of adhesion;

b) each value of reflected luminous intensity of each retro-reflective surface shall be at least 50 % of the corresponding value given in 3.6.3;

c) the chromaticity co-ordinates of the fluorescent surface shall be within the area on the chromaticity diagram bounded by the limits given in table 4 and the luminance factor shall comply with the applicable requirement of 3.6.4;

d) protective and other coated surfaces, when relevant, shall show no sign of chalking, checking or a visual colour change rating lower than 4 (based on a figure of 5 for no colour change); and

e) uncoated surfaces, when relevant, shall show no sign of deterioration.

**Table 5– Chromaticity co-ordinates of the points of intersection of the boundary lines of the limiting area on the chromaticity diagram – After weathering**

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| **Co-ordinate** | **Value of co-ordinates** | | | |
| x | 0.690 | 0.595 | 0.535 | 0.610 |
| y | 0.310 | 0.315 | 0.375 | 0.390 |

#### 3.6.6 Resistance to impact

When a triangle is tested in accordance with 5.10, coatings on surfaces, including fluorescent coatings and coverings of retro-reflective material, shall show no evidence of cracking or loss of adhesion.

#### 3.6.7 Resistance of coatings to flaking

When the warning face(s) and other coated surfaces of a triangle having a plastics substrate are tested in accordance with 5.11, coatings shall show no sign of flaking.

#### 3.6.8 Resistance of coatings to scratching

When the warning face(s) and other coated surfaces of a triangle are tested in accordance with 5.12, the scratch produced shall be free from jagged edges and shall not have penetrated to the substrate.

#### 3.6.9 Resistance to salt fog

When a triangle including, when relevant, its support, is tested in accordance with 5.13,

a) there shall be no sign of cracking, blistering or loss of adhesion on any fluorescent coating, or, when relevant, on retro-reflective material;

b) there shall be no sign of corrosion or lack of adhesion on any retro-reflector or its fastener(s);

c) in the case of a triangle (and, when relevant, its support) having a protective coating, there shall be no sign of corrosion of the substrate, except at the scribe mark where corrosion, creep or blisters (or any combination of these) shall not extend further than 2 mm on each side of the mark; and

d) there shall be no sign of deterioration of surfaces or of edges.

## 4 Packing, marking and labeling

### 4.1 Packing

Triangles shall be so packed that they are protected from damage during normal transportation and storage.

### 4.2 Marking

Each triangle shall bear, in legible and indelible marking on a warning face, the manufacturer's name, trade name or trade mark. The space occupied by the marking shall be of height and length approximately 5 mm and 25 mm, respectively. The quality of the marking shall be such that, when the triangle is tested in accordance with 5.9 and 5.13, there is no loss of integrity of the marking.

### 4.3 Labelling

#### 4.3.1 Portable triangles



Instructions, in legible and indelible printing, regarding the erection of the triangle and its location relative to a stationary vehicle[4] shall be printed on the protective cover of each type A triangle or printed on a label permanently attached to the protective cover or firmly attached to the triangle (see also Figure 4)[3].

**4.3.2 Fixed triangles**

Each type B triangle shall bear, on the reverse face, a securely attached label that provides, in legible and indelible printing, at least the following information:

a) a warning that the triangle should not be fastened by any means that interferes with or diminishes its visibility;

b) in the case of a triangle that has an aluminium alloy substrate, a warning that fasteners used for attaching the triangle to a vehicle must on no account be made from copper, brass, bronze or unprotected mild steel;

c) in the case of a triangle that has a mild steel substrate, a warning of the danger that steel surfaces that become exposed during the fitting of the triangle will corrode unless they are adequately protected from corrosion, e.g. by being coated with a zinc phosphate primer.

## 5 Inspection and methods of test

### 5.1 Inspection

Visually examine and measure each triangle in the sample for compliance with all the relevant requirements of this part of the specification for which tests to assess compliance are not given in 5.3 to 5 and 13 (inclusive).

### 5.2 Test specimens

From the triangles in the sample prepare the following test specimens:

a) **Reflected luminous intensity**, an erected triangle.

b) **Colour and luminance factor of fluorescent surface**, three test specimens of size approximately 70 mm x 150 mm, the faces of which are entirely covered by the fluorescent material.

c) **Resistance to weathering**, three test specimens of size approximately 70 mm x 150 mm that include as much of the fluorescent and, when relevant, the retro-reflective surfaces, edges, marking (see 4.2) and, when relevant, holes (for attachment) and any other coating, as is practicable. In the case of triangles that have a mild steel substrate, seal the newly cut edges.

d)

d) **Resistance to impact,** a test specimen of any convenient size that, when relevant, includes no retro-reflector.

e) **Resistance of coatings to flaking**, in the case of a triangle that has a plastics substrate, a test specimen of size approximately 50 mm x 50 mm that includes as much of the fluorescent material and, when applicable, retro-reflective material and protective coating as is practicable.

f) **Resistance to scratching**, a test specimen of size approximately 55 mm x 100 mm that includes as much of the fluorescent material and, when applicable, retro-reflective material and protective coating as is practicable.

g) **Resistance to salt fog**, one test specimen in the case of a triangle without any protective coating, and two specimens in other cases, each specimen being similar to the specimens described in (c) above but of size approximately 100 mm x 150 mm.

4) The manufacturer should ascertain, from the relevant road traffic regulations, the requirements for the location of the triangle.



## 5.3 Strength test (type A triangles)

So clamp the bottom edge of the triangle (if necessary, after removing its support) that the width of material held in the clamp is approximately 15 mm. Apply a force of 2 N to the apex of the triangle in a direction that is normal to the face of the triangle and measure the deflection of the apex from its initial position. Then remove the applied force and measure the residual deflection of the apex from the face of the triangle. Check for compliance with 3.6.1.a)

## 5.4 Stability test (type A triangles)

Erect the triangle on a horizontal base of size at least 2 m x 1.5 m located in a wind tunnel and so formed of bituminous or concrete road surfacing that it has a medium surface texture with a geometric roughness of 0.50 ± 0.05 mm and a coefficient of friction with respect to rubber of 0.60 ± 0.5[5)]. Then subject the triangle for three consecutive periods, each period of duration at least 3 min, to a horizontal wind of speed 60 km/h and applied in a direction most likely to cause the triangle to fail to comply with the requirements for stability.[4] Check for compliance with 3.6.1. b)

## 5.5 Test for resistance to heat (type A triangles)

Place the triangle in its protective cover, when applicable, and store the assembly for 12 ± 0.5 h in an atmosphere that is dry and maintained at a temperature of 60 ± 2 °C. After this period has elapsed, check for compliance with the requirements of 3.6.2.

## 5.6 Reflected luminous intensity test

Using a photometric test, determine the reflected luminous intensity of the specimen in accordance with the procedures in 5.6.1 and 5.6.2.

### 5.6.1 Single side approach

With any one of the three sides of the triangle (see 5.2 a) in a horizontal position take, for one of the observation angles and one of the angles of incidence given in Table 1, three readings of the reflected luminous intensity along the longitudinal axis of the horizontal side, one reading being taken at the middle and one reading near each end. Use the average of the three readings and calculate the reflected luminous intensity of the warning face of the triangle.

NOTE Where the warning face comprises non-continuous retro-reflector units, only whole units shall be included in the test section.

Repeat the procedure for every other combination of observation angle and angle of incidence and check for compliance with 3.6.3. Repeat the test after the specimen has been weathered in accordance with 5.9 and check for compliance with 3.6.5.b)

### 5.6.2 Assembly approach

With the complete erected triangle mounted symmetrically (in its normal operating position) in the goniometer take, for one of the observation angles and one of the angles of incidence given in Table 1, a reading of the reflected luminous intensity of the warning face of the triangle. Repeat the procedure for every other combination of observation angle and angle of incidence and check for compliance with 3.6.3.

## 5.7 Test for coefficient of retro-reflection

Determine the coefficients of retro-reflection of the material in accordance with CIE Publication 54. On each specimen, take a reading at a 0° orientation angle. Check for compliance with 3.2.3.1 and 3.2.3.2

5) Methods for determining the coefficient of friction and the geometric roughness are given in Annex C.

## 5.8 Colour and luminance factor test for fluorescent surfaces

Use a suitable colorimeter with illumination and viewing conditions as recommended by the International Commission of Illumination, i.e. angles of incidence and observation of 45° and 0° respectively. Illuminate the specimen (see 5.2 b)) with illuminant C and determine the chromaticity co-ordinates and the luminance factor of the light diffusely reflected from the surface. Check for compliance with the applicable requirements of 3.6.4.

NOTE If the colorimetric characteristics have been calculated in the *XYZ* system, determine the luminance factor by applying the ratio $Y:Y_0$ where $Y$ is the tristimulus value of the sample and $Y_0$ is that of a perfect diffuser observed under the same conditions. The test report shall contain at least the following information:

– the type of instrument (spectrophotometer, tristimulus colorimeter, etc.),

– its designation (manufacturer and type),

– identification of the illuminant used, and

– lighting and viewing angles.

### 5.8.1 After weathering

Repeat the test after the specimen has been weathered in accordance with 5.9 and check for compliance with 3.6.5 c).

### 5.8.2 Painted surfaces

Test as described in 5.8 and check for compliance with the applicable requirements of 3.6.4 before weathering. After the specimen has been weathered in accordance with 5.9, check for compliance with the applicable requirements of 3.6.5.d)

## 5.9 Test for resistance to artificial weathering

### 5.9.1 Apparatus

A weathering unit consisting of a test chamber constructed of corrosion-resistant materials and enclosing eight fluorescent UV lamps, a heated water pan and test specimen racks, and providing means for controlling and recording operating times and temperatures. The essential features of the unit are as follows:

a) **Lamps**, the lamps are of type FS 40 fluorescent UV lamps or equivalent, the spectral energy distribution curve having a maximum at a wavelength of 313 nm with less than 1 % of the peak intensity at 280 nm. The lamps have a length of 1 220 mm and a nominal rating of 40 W when operated from a ballast providing a controlled current of 430 mA at 102 V. The lamps are so mounted in two banks of four lamps each as to provide a uniform distribution of irradiance. The lamps in each bank are parallel and spaced at 70 mm centres.

b) **Racks for test specimens**, two racks for mounting the test specimens (see 5.2(c)) are provided in the chamber, each rack being of height 300 mm and width 1 154 mm and so positioned that a surface of each test specimen is parallel to the plane of one bank of lamps and at a distance of 50 mm from the nearest surface of the lamps. The specimen racks and the test specimens themselves constitute the side walls of the chamber. The back surface of each test specimen is thus exposed to the ambient air. The test specimens are so arranged that condensate forming on each test surface is caused by gravity to run off the test surface and is replaced by fresh condensate in a continuous process. Vents provided along the bottom of the test chamber admit ambient air and so prevent oxygen depletion of the condensate.

c) **Water pan**, water vapour is generated by the heating of water in a water pan extending under the entire specimen area and containing water to a depth of at least 25 mm.



d) **Water supply**, the water supply has an automatic control to regulate the level in the water pan. (Distilled, de-ionized or potable tap water may be used.)

e) **Cycle timer**, the test chamber has a continuously operating cycle timer and a controller that controls the UV radiation periods and the condensation periods as selected. An hour meter records the total time of operation and the total time of UV exposure.

f) **Thermometer**, the temperature in the test chamber is measured by means of a thermocouple, the junction of which is inserted in a black aluminium panel of size 75 mm x 100 mm x 25 mm. The thermometer measures a range of 30-80 °C and is accurate to within 1 °C. The indicator dial of the thermometer is located outside the test chamber. The aluminium panel and thermocouple junction are so positioned in the centre of the exposure rack that they are subjected to the same conditions as the specimens.

g) **Temperature control**

1) During UV exposure, the selected equilibrium temperature is maintained to within 3 °C by the supply of heated air to the test chamber.

2) During condensation exposure, the selected equilibrium temperature is maintained to within 3 °C by the heating of the water in the pan.

3) The UV temperature and condensation temperature are controlled independently of each other.

4) Doors are located on the ambient air side of the specimen rack to act as insulation during the UV exposure and to minimize draughts. The doors are so arranged that they do not interfere with the ambient air cooling of the specimens during the condensation exposure.

### 5.9.2 Procedure

a) Seal the cut edge of each specimen, when relevant (see 5.2(c)).

b) Mount the test specimens in the specimen racks with the test surfaces facing the lamps.

c) Select the following cycle conditions:

1) 4 h of UV exposure at 60 °C;

2) 4 h of condensation exposure at 50 °C..

d) Except for servicing the apparatus and inspecting the specimens, repeat the cycle continuously over a period of 240 h for fluorescent material and 800 h for retro-reflective material.

e) At the end of the specified exposure period, examine the specimens under 10x magnification.

f) Check for compliance with the applicable requirements of 3.6.5 and 4.2.

## 5.10 Test for resistance to impact

Use the apparatus and procedure described in 5.14 to subject each coating and covering (see 3.6.6) of each specimen (see 5.2) to an impact energy of 2.25 J in the case of a triangle having a steel substrate, 1.15 J in the case of a triangle having an aluminium alloy substrate and an impact energy of a suitable value in the case of a triangle having a substrate of another material[6)]. Check for compliance with the requirements of 3.6.6.[5]

## 5.11 Test for resistance of coatings to flaking (triangles having a plastics substrate)

[6] In the case of a triangle having a substrate of a material other than steel or aluminium alloy, the value of the impact energy to be applied should be obtained from a recognized testing authority.

On the specimen (see 5.2 e) make, with a razor blade, a series of parallel cuts 2 mm apart through the coating to the plastics substrate, then make a second similar series of cuts at right angles to the first, and check for compliance with 3.6.7. When relevant, repeat the test on the other coating(s) on the specimen.

## 5.12 Test for resistance of coatings to scratching

Use the apparatus and procedure described in 5.15, with the needle loaded with mass pieces of total mass 2000 g, to test the coating on each specimen (see 5.2 f). Check for compliance with 3.6.8.

## 5.13 Test for resistance to salt fog

In the case of specimens that have one or more coated surfaces, make on each such surface (with the cutting edge of the cutting tool held at an angle of about 30° to the surface and the plane of the blade perpendicular to the surface), a scribe mark of length about 75 mm and that penetrates through the coating to the substrate. Then, using the apparatus and method described in 5.16, subject the specimen(s) (see 5.2 g) to the test for a period of 240 h. After a 24 h recovery period, examine for compliance with the applicable requirements of 3.6.9 and 5.2.

## 5.14 Test for adhesion

### 5.14.1 Equipment

**5.14.1.1 Oven**, maintained at 70 °C ± 2 °C.

**5.14.1.2 Two specimens** (of each type of material), each of size 50 mm × 150 mm.

**5.14.1.3 Flat metal sheet**, of size at least 100 mm × 150 mm and of mass 225 g.

**5.14.1.4 Two mass pieces**, each of mass 750 g.

### 5.14.2 Procedure

**5.14.2.1 Pressure-sensitive material**, place two specimens side by side in the oven and cover them with the metal sheet for 4 h. Remove the specimens from the oven and condition them at 25 °C ± 2 °C for 24 h. Then cut one 25 mm × 150 mm piece from each specimen, remove the liner by hand without the use of water or other solvent(s), and examine the liner and the adhesive backing for compliance with 4.3.4.

**5.14.2.2 Heat-sensitive material**, cut two 25 mm × 150 mm pieces from the specimen, remove the liner by hand without the use of water or other solvent(s), and examine the liner and the adhesive backing for compliance with 4.3.4.

**5.14.2.3 All material**, apply 75 mm of one end of each specimen to a test panel in accordance with the manufacturer's instructions and condition the specimens at 25 °C ± 2 °C for 24 h. Suspend the panels in a horizontal position, with the specimens hanging downward. Attach a 750 g masspiece to the free end of each specimen and allow it to hang free at right angles to the panel surface for 5 min. Measure the distance of peeling and check for compliance with 4.3.4.

## 5.15 Test for resistance to impact

### 5.15.1 Apparatus

**5.15.1.1 Mass-piece**, of cylindrical steel of 900 g and of approximate length 230 mm and diameter 25 mm, having a hardened steel ball of diameter 12.7 mm mounted at its lower end.

**5.15.1.2 Tube**, slotted or split vertical tube graduated in millimetres, of length approximately 1.5 m and wide enough to enable the mass-piece to drop freely through it on to the test panel on the base plate.

**5.15.1.3 Base plate**, steel plate with a hole of diameter 16 mm. The plate and the tube are assembled so that the hole in the plate is concentric with and directly below the opening of the tube.



**5.15.1.4 Panels**, clean, mild steel panels of thickness approximately 0.7 mm.

### 5.15.2 Preparation of test panels

Apply one coat of the paint to a clean panel at the specified film thickness, by spraying, brushing, dipping, or by means of an applicator blade as relevant. Allow the paint to dry and age for the specified period under standard conditions.

### 5.15.3 Procedure

Place the panel flat on the base plate with the painted side upward or downward (as specified in the relevant standard). Lift the mass-piece to the height that will give the specified impact and drop it on to the panel. Using a 10-power lens, examine the dented part of the panel for cracking of the paint film and for lack of adhesion of the film to the substrate. If the impact failure end point has to be determined, increase the height that the mass-piece is lifted with small increments, until failure is reported.

## 5.16 Test for resistance of coatings to scratching

### 5.16.1 Apparatus

**5.16.1.1** Scratch apparatus, the principle of which is illustrated in Figure 1; other arrangements which give a similar performance can be used, however. This apparatus consists essentially of a horizontally sliding test panel holder

a) driven by a constant-speed motor

b) at a rate of 30 mm/s to 40 mm/s beneath the point of a scratching needle

c) which is perpendicular to the test panel. The needle is fixed in a chuck, directly above which is a holder capable of carrying weights up to a mass of 2 kg. The maximum load for which the apparatus is designed shall be marked on the test apparatus.

The apparatus is adjusted so that the needle comes smoothly into contact with the film, i.e. before the stop (D) (see Figure 1) reaches the bottom of the sloping ramp, to form a straight scratch not less than 60 mm in length. A ramp with an angle of 10 °C to 15 °C to the horizontal has been found to be satisfactory. The panel holder can be designed to allow a lateral movement of test pieces so that more than one scratch test tan be carried out on the Same test piece.

NOTE Apparatus is now becoming available which will permit a scratch test to be conducted under continuously increasing load.

**5.16.1.2** Indicating device, based on electrical contact between the needle and the metallic substrate to show when the paint film has been penetrated.

NOTE This device is not suitable for paints containing electrically conducting pigments, or if the substrate is non-metallic, or if penetration to an intermediate non-conducting coat is required.

**5.16.1.3 Needle**, having a hard hemispherical tip of 1 mm diameter. The hemispherical tip shall be firmly attached and the exposed part shall be free from any contaminants.

### 5.16.2 Sampling

Take a representative sample of the product to be tested. Examine and prepare each sample for testing.

### 5.16.3 Test panels

#### 5.16.3.1 Substrate



Unless otherwise agreed, the substrate shall be of burnished tinplate, burnished steel prepared by acid chromating or hard aluminium. The test panels may be cut to fit the apparatus after coating the substrate and drying, provided no distortion occurs.

#### 5.16.3.2 Preparation and coating

Unless otherwise specified, prepare each test panel and then coat it by the specified method with the product or system under test. If the product under test is applied by brushing, any brush marks shall be parallel to the direction of the scratch on the panel.

NOTE Poorer precision is often obtained if the coating has been applied by brush.

#### 5.16.3.3 Drying and conditioning

Dry (or stove) and age each coated test panel for the specified time and under the specified conditions. Then condition the coated panels at (23 ± 2) °C and a relative humidity of (50 + 5) %, unless otherwise agreed, for a minimum period of 16 h. Carry out the test procedure as soon as possible.

#### 5.16.3.4 Thickness of coating

Determine the thickness, in micrometres, of the dried coating

### 5.16.4 Procedure

#### 5.16.4.1 Test conditions

Carry out the test at (23 ± 2) °C and a relative humidity of (50 + 5) %, unless otherwise agreed. Conduct the test on a bench free from vibrations.

#### 5.16.4.2 Procedure for a single specified load ("pass/fail" test)

Examine a needle under x 30 magnification to check that the hard tip is smooth, hemispherical and free from contamination. Fix the needle in the chuck so that, when in position on the test panel, the needle will be perpendicular to the panel holder. Balance the needle holder arm by means of the adjustable counterweight. Ensure that the indicating device if used, is operational by contacting the needle with the panel holder. Clamp the test panel, with the coating under test uppermost, to the panel holder of the apparatus, with the longer side of the panel parallel to the direction in which the scratch will be made. Place weights on the holder above the needle to obtain the specified load. Start the motor of the apparatus and allow the scratch to be made on the coating. Observe the indicating device during the test, if appropriate, to determine whether electrical contact between the needle and the panel occurs. Remove the panel and examine the scratch to see if the coating has been penetrated to the extent specified. If, by agreement between the interested parties, the scratch is observed under suitable magnification, state the degree of magnification in the test report. The sequence of operations shall be carried out three times on each of two test panels. If on none of the six test surfaces the coating has been penetrated beyond the performance required under the specified conditions, report the result as "pass". If the coating has been penetrated beyond the performance required on one or more of the six test surfaces, report the result as "fail".

#### 5.16.4.3 Procedure for determination of minimum load to cause penetration

Carry out the procedure given in 5.16.4.2, using a different part of the test panel for each scratch, starting at a load somewhat less than that expected to cause penetration of the coating and successively increasing the mass on the needle by suitable increments (for example masses of 50 g), until the coating is penetrated. Record the minimum load at which the needle penetrates the coating to the extent specified. Repeat the procedure on a further two panels. Report the lowest result of the three determinations. Conduct the test on a bench free from vibrations.

### 5.16.5 Precision

The repeatability of results by the "pass/fail" test will usually be ± 10 % of the load.



NOTE The precision of the result is strongly dependent an the (uniformity of the) film thickness of the coating.

## 5.17 Test for resistance to salt fog

### 5.17.1 Principle

A coated test panel is exposed to neutral salt spray (fog).

### 5.17.2 Procedure

The test solution shall be prepared by dissolving sodium chloride in water of at least grade 3 purity to produce a concentration of (50 + 5) g/l. The sodium chloride shall be white, of minimum assay 99.6 % (mm), and substantially free from copper and nickel; it shall contain not more than 0.1 % (mm) of sodium iodide. If the pH of the solution is outside the range 6.0 to 7.0, the presence of undesirable impurities in the salt or the water or both shall be investigated. The pH of the test solution shall be adjusted so that the pH of sprayed solution collected within the test cabinet shall be between 6.5 and 7.2. Any necessary adjustment to the pH shall be made by additions of solutions of either hydrochloric acid or sodium bicarbonate of analytical grade.

NOTE Attention is drawn to the possible changes in pH resulting from loss of carbon dioxide from the test solution when it is sprayed. Such changes may be avoided by reducing the carbon dioxide content of the solution by, for example, heating it to a temperature above 35 ºC before it is placed in the apparatus or by making the solution from freshly boiled water.

The test solution shall be filtered before it is placed in the reservoir of the apparatus in order to remove any solid matter which might block the nozzle(s) of the spraying device.

### 5.17.3 Apparatus

Ordinary laboratory apparatus and glassware, together with the following:

**5.17.3.1** A spray cabinet, made of, or lined with, material resistant to corrosion by the spray and with a roof which prevents condensed moisture dripping on to the test panels. The cabinet shall have a capacity of not less than 0.4 $m^3$ since, with smaller volumes, difficulties are experienced in ensuring even distribution of spray. The size and shape of the cabinet shall be such that the quantity of solution collected in the spray-collecting devices is within the limits stated under operating conditions. Cabinets with a volume greater than 2 $m^3$ will be difficult to operate unless careful consideration is given to their design and construction.

**5.17.3.2** Adjustable heater, adequate to maintain the cabinet and its contents at the specified temperature The temperature shall be controlled by a thermostat element placed within the cabinet at least 100 mm from the walls. A thermometer, capable of being read from the outside, shall be placed wholly within the cabinet at least 100 mm from the walls, roof or floor.

**5.17.3.3** Spraying device, comprising a supply of clean compressed air of constant pressure and humidity, a reservoir containing the solution to be sprayed and one or more spray nozzles made of material resistant to the solution. The compressed air supply to each spray nozzle shall be passed through a filter to remove all traces of oil or solid matter and shall be at a pressure of 70 kPa to 170 kPa). In order to prevent evaporation of the spray droplets, the air shall be humidified before entering each nozzle by passage through a saturation column containing water of at least grade 3 purity at a temperature several degrees celsius higher than that of the cabinet. The actual temperature of the water will depend on the pressure used and on the type of spray nozzle, and shall be adjusted so that the rate of collection of spray in the cabinet and the sodium chloride concentration of the spray collected are kept within the specified limits. The reservoir containing the test solution shall be made of material resistant to the solution and shall be provided with a means of delivering a constant volume of solution to the spray nozzles at all times. The spray nozzles shall be made of inert material, for example glass or plastic. The cabinet shall be vented to ensure that there is no build up of pressure within the cabinet and in such a way that the environment outside the cabinet does not influence that inside the cabinet.

NOTE Baffles may be used to prevent direct impingement of spray on the test panels and the use of adjustable baffles is helpful in obtaining uniform distribution of Spray throughout the cabinet.

**5.17.3.4** Spray-collecting devices, of chemically inert material. The collecting devices shall be placed in the zone of the cabinet where the test panels are placed, at least one close to a spray nozzle and one remote from

a spray nozzle. They shall be placed so that only spray is collected, and not liquid dripping from test panels or parts of the holders or cabinet. The number of collecting devices shall be at least twice the number of spray nozzles.

NOTE Glass or plastic funnels with their sterns inserted into graduated cylinders have be en found to be suitable collecting devices. Funnels with a diameter of 100 mm have a collecting area of approximately 8 0 $cm^2$.

**5.17.3.5** Test panel holders, capable of supporting the test panels at an angle of between 15º and 25º to the vertical, normally racks made of inert non-metallic material such as glass, plastic or suitably coated wood. Exceptionally, if it is necessary to suspend the test panels, the material used shall be synthetic fibre, cotton thread or another inert insulating material, but on no account metallic material. The test panels may be located at different levels in the cabinet but they shall be positioned so that the solution cannot drip from panels or holders at one level on to other panels below. If the equipment has been used for a spray test, or for any other purpose, with a solution differing from that specified for this test, it shall be thoroughly cleaned before use.

**5.17.4 Sampling**

Take a representative sample of the product to be tested (or of each product in the case of a multi-coat system).

**5.17.5 Material and dimensions**

Unless otherwise specified or agreed, the test panels shall be of burnished steel, and of approximate dimensions 150 mm x 100 mm x 1 mm. 2) 1 kPa = 1 $kn/m^2$ (= 0.01 bar).

**5.17.6 Preparation and coating of panels**

Prepare each test panel and then coat it with the product or system under test. Unless otherwise specified, the back and edges of the panel shall also be coated with the product or system under test. If the coating on the back and edges of the panel differs from that of the product under test, it shall have a corrosion resistance greater than that of the product under test.

**5.17.7 Drying and conditioning**

Dry (or stove) and age (if applicable) each coated test panel for the specified time under the specified conditions, and, unless otherwise specified, condition them at a temperature of (23 ± 2) $^oC$ and a relative humidity of (50 ± 5) % for at least 16 h, with free circulation of air and without exposing them to direct sunlight. The test procedure shall then be carried out as soon as possible.

**5.17.8 Thickness of coating**

Determine the thickness, in micrometres, of the dried coating by one of the non-destructive procedures

**5.17.9 Preparation of scratches**

All scratches shall be at least 25 mm from each other and from any edge of the test panel. If specified, make a straight scratch or scribed mark through the coating to the substrate. To apply the scratch, use a scratch instrument with a hard tip. The scratch shall have either parallel sides or an upwards-broadening cross-section which shows a width of 0.3 mm to 1.0 mm of the metallic substrate, unless otherwise agreed. One or two scratches may be applied. The scratch(es) shall be parallel to the longer edge of the test panel, unless otherwise agreed. Cutting the scratch with a knife is not allowed.

For aluminium panels, two scratches shall be made which are perpendicular to but do not intersect, each other. one scratch shall be parallel to the rolling direction and the other at right angles.

NOTE If zinc- or zinc-alloy-coated steel is used as a test panel the intention is that the scratch should be to the zinc coating and not further, to the steel, unless otherwise agreed.

**5.17.10 Method of exposure of test panels**



Place the panels in the cabinet such that they are not in the direct line of travel of spray from a spray nozzle. Each test surface shall be placed in the cabinet facing upwards at an angle of between $15^{o}$ and $25^{o}$ to the vertical.

NOTE The angle at which each Panel is exposed in the cabinet is very important.

It is sometimes necessary to expose painted components of different shapes. When such tests are conducted, it is of particular importance to expose the shaped components in their normal attitude in use. Within this restriction the component shall be placed so as to minimize the disruption of flow. Furthermore, other test panels and components cannot be tested at the same time if the shape of the painted component interferes with the general direction of flow.

The degree of film breakdown at different angles of orientation may vary, and due consideration shall be given to this in the interpretation of the results.

Arrange the panels so that they do not come into contact with one another or with the cabinet and so that the surfaces to be tested are exposed to the spray only where it is settling freely.

**5.17.11 Operating conditions**

The measured temperature inside the spray cabinet shall be (35 + 2) °C. The average rate of collection of spray solution, measured over a minimum period of 24 h, shall be 1 ml/h to 2.5 ml/h for a horizontal spray-collecting device of area 80 $cm^2$.

This solution collected shall have a sodium chloride concentration of (50 ± 10) g/l and a pH of 6.5 to 7.2. Test solution which has been sprayed shall not be re-used.

**5.17.12 Procedure**

Carry out the determination in duplicate, unless otherwise agreed. Set up the apparatus and adjust it to meet the conditions specified in clause 5.17.11. Arrange the test panels in the cabinet as described in clause 5.17.9. Close the cabinet and start the flow of the test solution through the spray nozzle(s). Continuously spray throughout the prescribed test period, except for a short daily interruption to inspect, re-arrange or remove test panels, to check and replenish the solution in the reservoir and to check that the conditions specified in clause 5.17.11 are still being met.

Make periodic examinations of the panels, taking care not to damage the surfaces under test. The panels shall be assessed as quickly as possible and the cabinet shall be turned off for no more than 30 min in any 24 h. Do not allow the panels to dry. Whenever possible, the examination shall be made at the same time of day.

At the end of the specified test period, remove the panels from the apparatus and rinse with clean, warm water to remove residues of test solution from the surface. Immediately dry the panel and examine the test surfaces for signs of deterioration, for example blistering, rusting or creep of corrosion from the scratch(es). If required, keep the panels in the standard conditions for the specified period and then reexamine the test surfaces for deterioration.

NOTE Users of this standard should be aware that, because of the subjective nature of the assessment of the deterioration of the coating, precision will depend upon a number of factors. These include the evaluation method, the preparation of the test panels, the thickness of the coating, the drying and conditioning of the test panels and the preparation of the scratch(es). However, the method has been found to be useful in comparing the salt spray resistance of different coatings. It is most useful in providing relative ratings for a series of coated panels exhibiting significant differences in salt spray resistance.



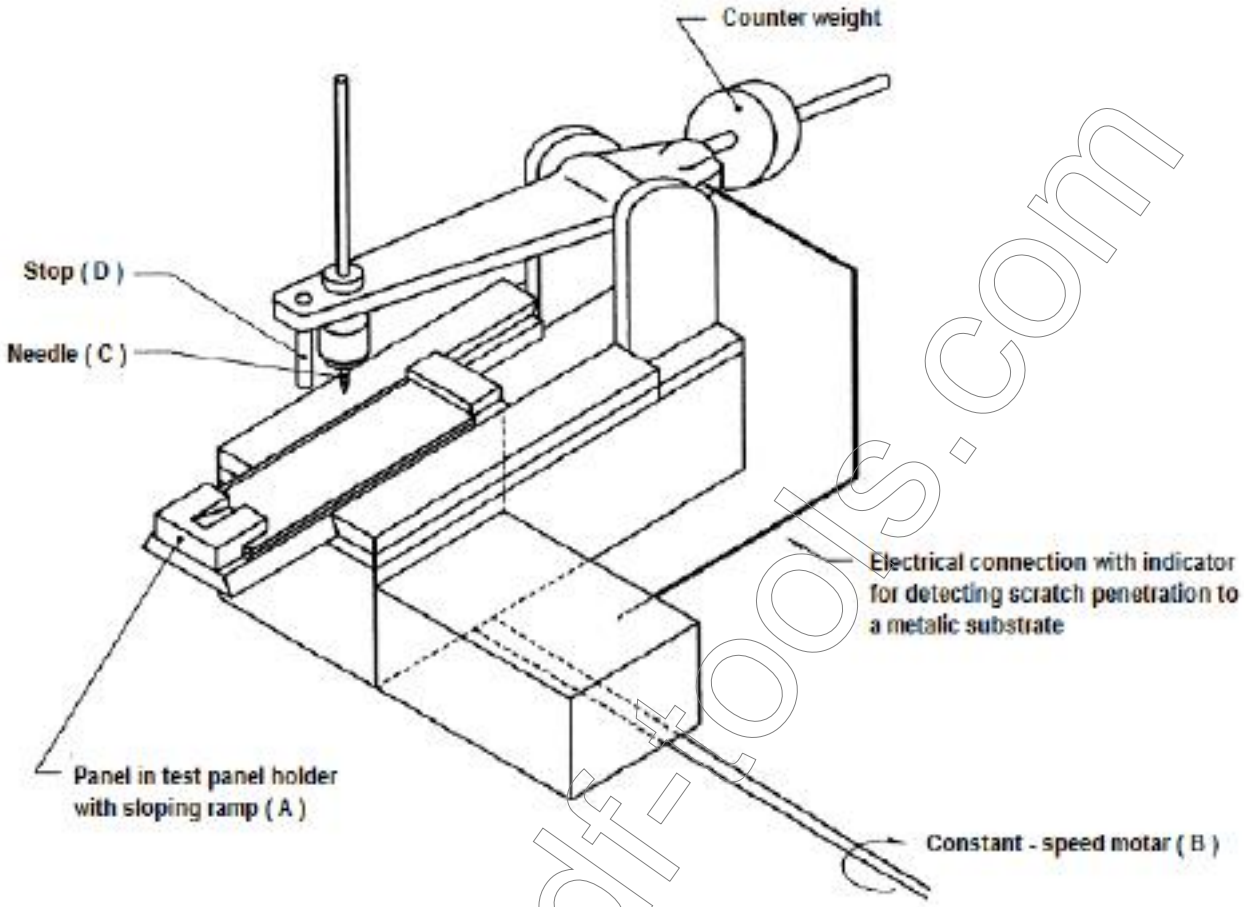



**Figure 1 — Scratch apparatus**

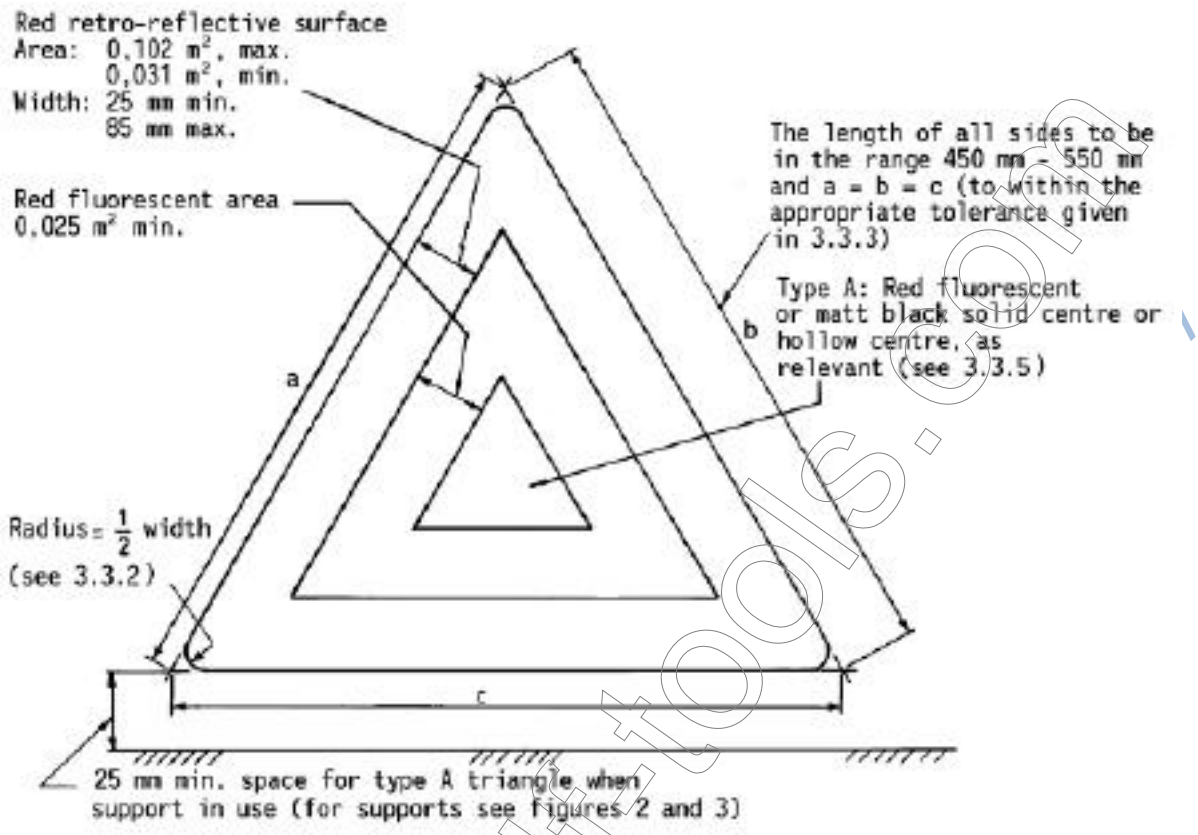



**Figure 1(a) — Dimensions**

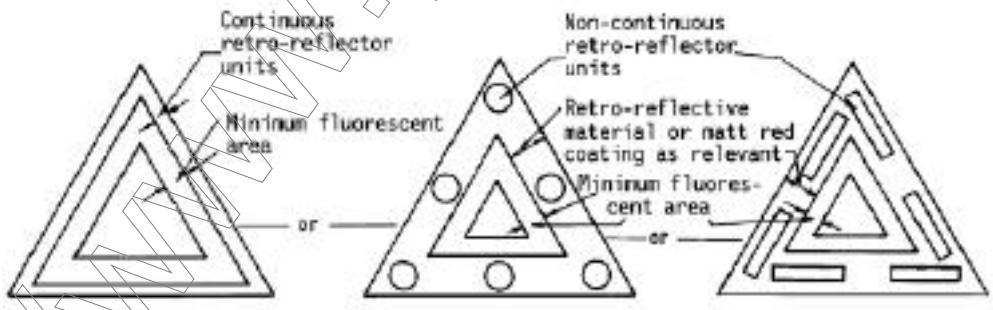
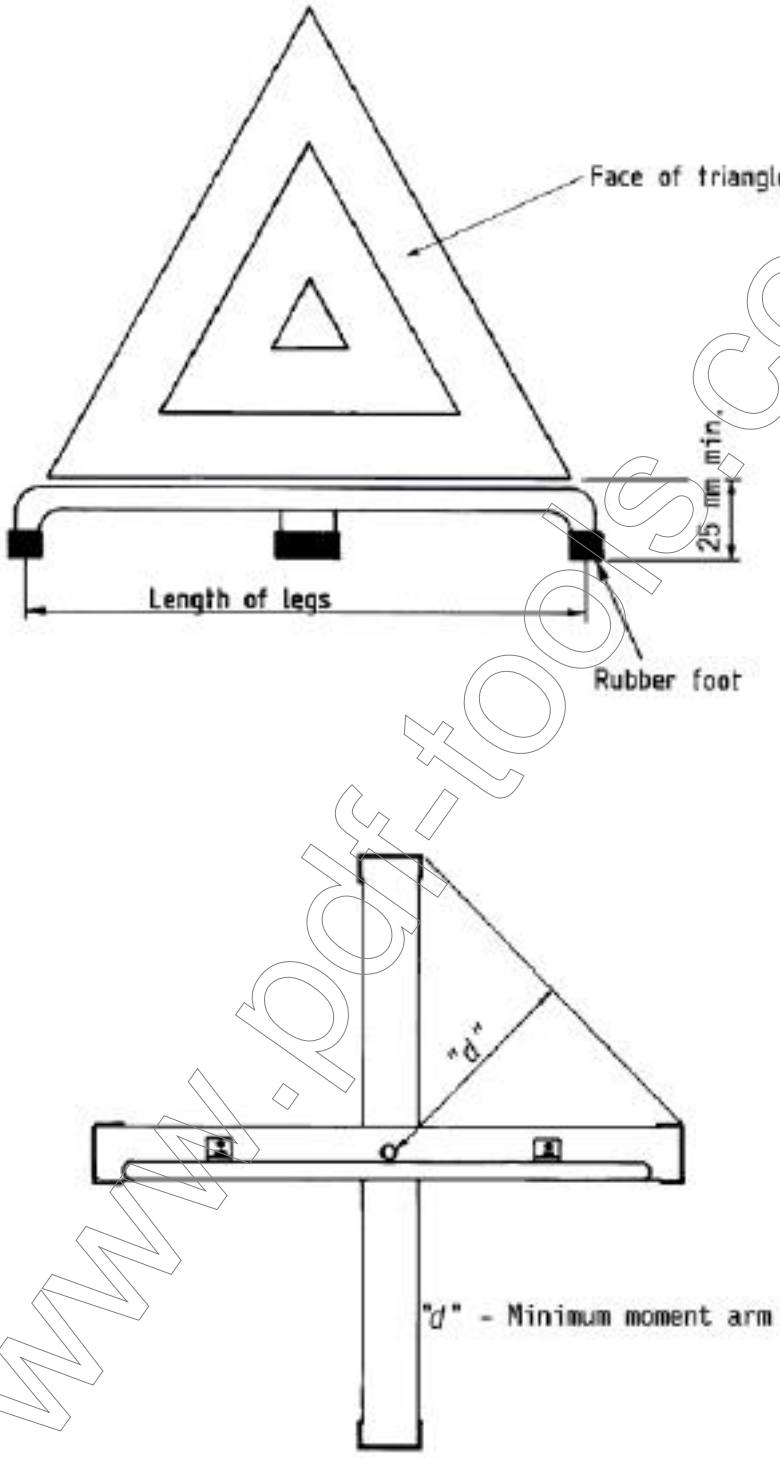



**Figure 1 (b) — Layouts of retro-reflective surfaces incorporating retro-reflector units**

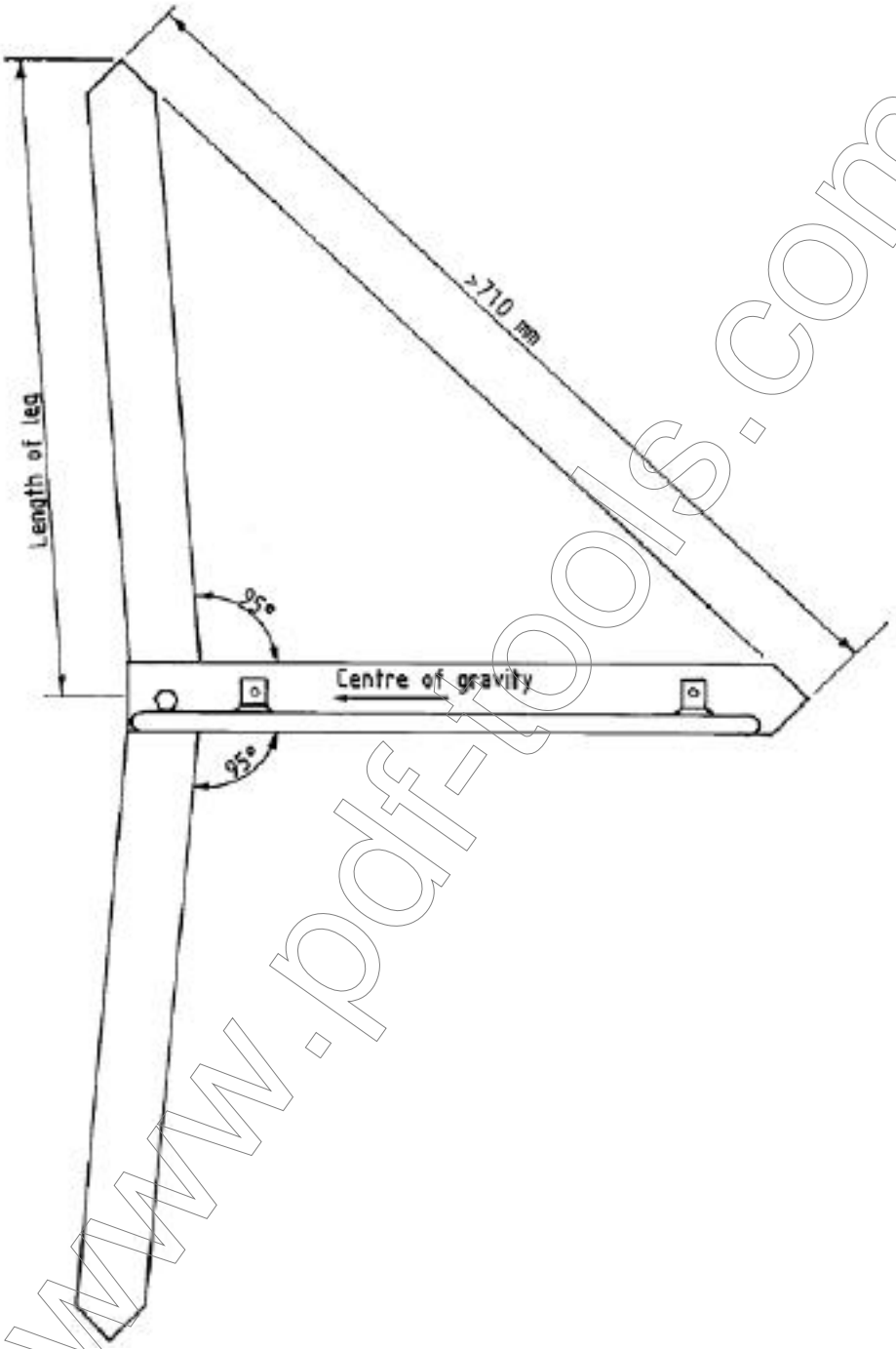
NOTE The drawings given in Figures 1-3 are purely to identify parts and to specify dimensions. They are not intended as design guides.

**Figure 1 — Triangle**




NOTE Recommended mass for stability:
2 kg for triangle with sides of length 450 mm.
2,5 kg for triangle with sides of length 550 mm.
Not to scale

**Figure 2 — Typical support for type A triangle**




NOTE Recommended mass for stability:

2 kg for triangle with sides of length 450 mm.
2.5 kg for triangle with sides of length 550 mm.
Not to scale

**Figure 3 — Typical support for type A triangle**

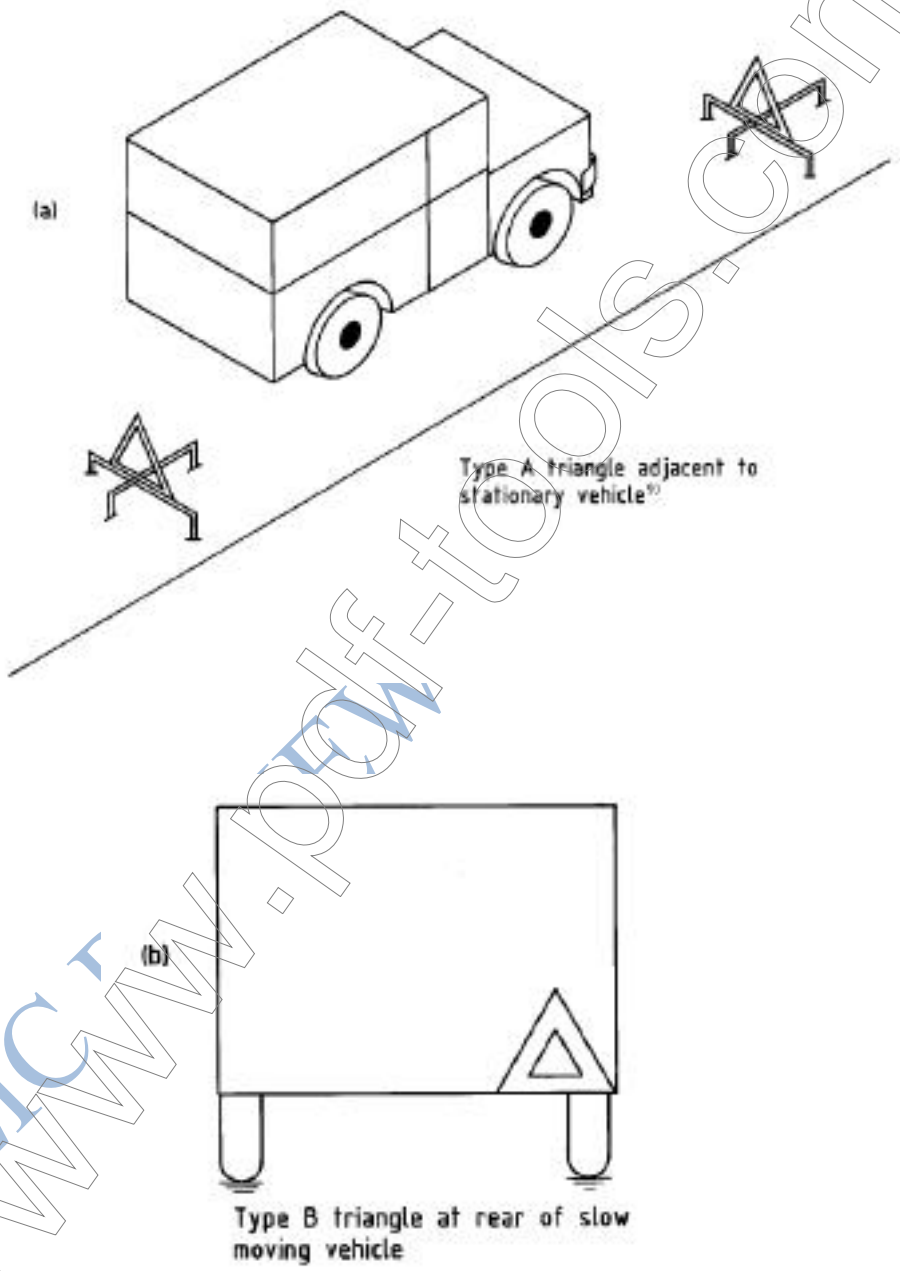
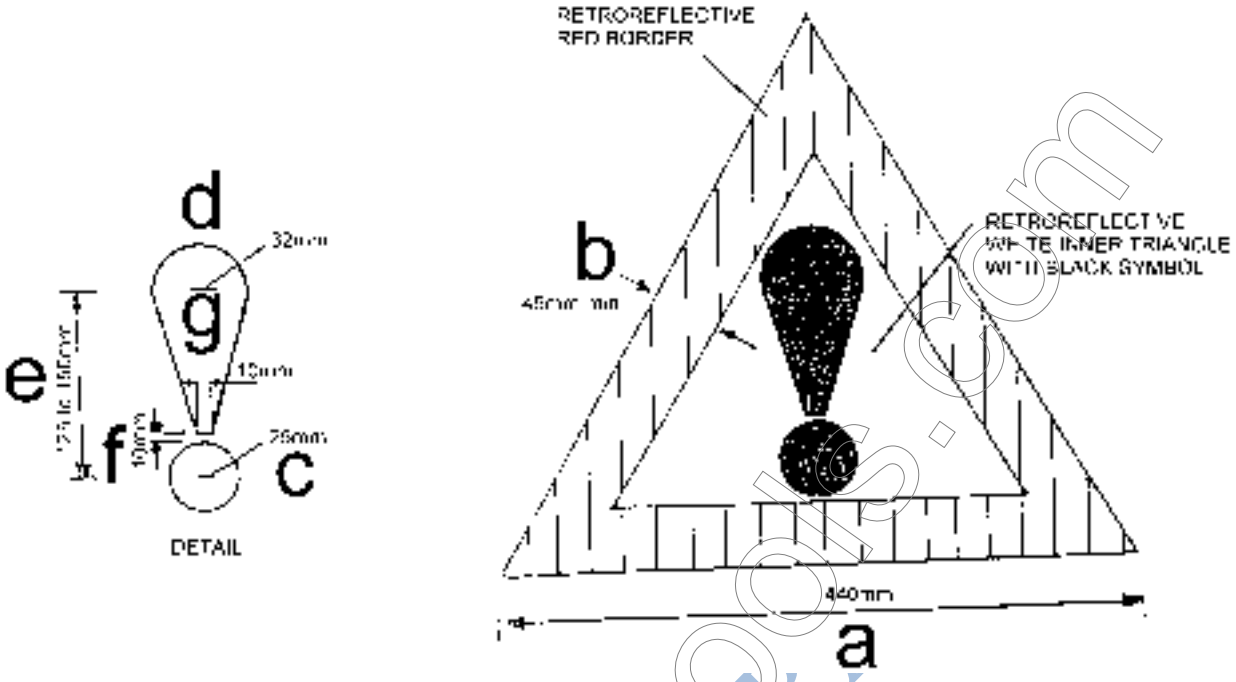



**Figure 4 — Typical locations of triangles[9]**

9) To ensure the correct use of these triangles, the user should consult the relevant road traffic regulations.




**NOTES**: 1. Not to scale.
2. Triangle is equilateral.
3. All dimensions give the minimum requirements.

**Figure 5 — Portable warning triangle with an exclamation mark**