

**DRAFT FOR COMMENTS ONLY**

*(Not to be reproduced without permission of BIS or used as an Indian Standard)*

*Draft Indian Standard*

**STOVING ENAMEL PAINT FOR GENERAL INDUSTRIAL  
APPLICATIONS — SPECIFICATION**

*(Second Revision of IS 6125)*

ICS 87.040

---

**Paints, Varnishes and Related**

**Last date of comments: 05 December 2024**

**Products Sectional Committee, CHD 20**

---

Paints, Varnishes and Related Products Sectional Committee, CHD 20

**FOREWORD**

*(Formal clauses will be added later)*

Enamel paints are a category of paints formulated with a resin-based binder that dries to form a hard, glossy, and typically opaque finish. It can be oil-based or water-based and is widely used for both interior and exterior surfaces. Known for its durability, resistance to wear and tear, and ability to withstand various environmental conditions, enamel paint provides a smooth, glossy, and easy-to-clean finish, making it ideal for high-use items and surfaces that require a protective and aesthetically pleasing coating.

Stoving enamels require baking at elevated temperatures to cure. This heat-induced process results in a harder, more durable finish that can withstand harsher conditions. Stoving enamels are often used in industrial applications where maximum durability and resistance to chemicals and abrasion are essential.

This standard was initially published in 1950. The first revision, undertaken in 2017, addressed the adverse effects of lead exposure by introducing a lead restriction limit of 300 ppm.

This second revision has been undertaken to harmonize the Indian Standards on enamel paints with the current market demand and practices. During the review of all Indian Standards on stoving enamel paints (excluding two-component enamel paints), it was observed that the requirements and applications across these standards were largely similar. Therefore, the committee has decided to harmonize the enamel standards broadly into two categories: one for air drying enamel for architectural and industrial applications and another for stoving enamel for industrial applications. IS 2932 covers air drying enamel for architectural and industrial applications.

Accordingly, the title and scope of this standard has been modified and the requirements of the following ISs have been merged with this standard:

- IS 150: 1950 - Specification for Ready Mixed Paint, Brushing, Finishing, Stoving, Enamel, Color as required.
- IS 151: 2017 - Specification for Ready Mixed Paint, Spraying, Finishing, Stoving, Enamel for General Purposes, Colour as required.

Additionally, the following major changes have been made;

- a) Recognizing the time constraints associated with the 12-month outdoor exposure test for durability requirements, and considering the availability of advanced simulation technologies like QUV and Xenon Arc accelerated test methods, the need for the extended outdoor exposure has been withdrawn. Additionally, test methods for evaluating the degradation of coatings have been prescribed.
- b) The optional requirements table has been added for specific user applications.
- c) In addition to these changes, the lead restriction limit has been stringent from 300 ppm to 90 ppm, VOC limits have been introduced, and a rating system for evaluating film degradation after durability testing has been added.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Draft Indian Standard*

**STOVING ENAMEL PAINT FOR GENERAL INDUSTRIAL APPLICATIONS —  
SPECIFICATION**

## **1 SCOPE**

**1.1** This standard prescribes the requirements, methods of sampling and tests for enamel, stoving used for general industrial applications, colour as required. The material is typically used for the protection and decoration of metal parts of apparatus, equipment, machines, and similar purposes. It is normally applied as a painting system over the appropriate priming and undercoating paints.

**1.2** The material may also be intended for protection and decoration of metal and steel parts of automobiles and other vehicle bodies like autocycles and scooters.

## **2 REFERENCES**

The standards listed in Annex A contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

## **3 TERMINOLOGY**

For the purpose of this standard, the definitions given in IS 1303 shall apply.

## **4 REQUIREMENTS**

### **4.1 Composition**

**4.1.1** The material shall be based on alkyd resin/ suitable polymer hybrids such that the material shall satisfy the requirement of this standard.

### **4.2 Toxicity**

The material shall be free from toxic solvents like benzene and chlorinated organic solvents when tested as prescribed in Annex B.

### **4.3 Durability**

A film of the sample shall be prepared and tested in any of the accelerated weathering apparatus xenon arc or Quick weatherometer (QUV- A) as prescribed in Annex C. It shall be examined every 100 h for a period of 1 000 h and a complete record of its performance maintained and qualified as per requirement given in Table 1.

### **4.4 Fastness to Light Test**

#### **4.4.1 Panel**

Mild steel plate panel used for this test, unless otherwise mentioned, shall be prepared as prescribed in IS 101(Part 1/Sec 3). The painted panels shall be prepared as described in 6.2.

#### **4.4.2 Test Conditions**

The material shall be tested according to the method prescribed in IS 101(Part 4/Sec 3) in Xenon arc apparatus with the test conditions as prescribed below:

- a) Black panel temperature  $63^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ,
- b) Continuous exposure in light, and
- c) Time of exposure to light for 300 h.

### **4.5 Lead Restriction**

The material shall not contain lead or compounds of lead or mixtures of both, calculated as metallic lead more than 90 ppm, when tested for restriction from lead in accordance with IS 101(Part 8/Sec 5).

**4.6 Optional Suitability for Thinning**

The material shall be suitable for application by spraying when thinned with suitable solvent, compatible with the material.

**4.7** The material shall also comply with the requirements given in Table 1.

**4.8 Optional Requirements**

Material may be tested for optional requirements given in Table 2 whenever required by purchaser.

**Table 1 Requirements For Stoving Enamel Paint For General Industrial Applications**

(Clause 4.7)

Sl. No.	Characteristics	Requirements	Methods of test, Annex to this standard	Ref to IS 101
(1)	(2)	(3)	(4)	(5)
i)	Stoving not more than 150 °C and 1.5 h (after flash-off of 30 minutes maximum)	Coated film shall be completely dry, such that it does not deform or leave any wet paint impressions when touched	D	-
ii)	Consistency	Smooth, uniform and suitable for spraying after thinning	E	-
iii)	Finish	Smooth and glossy	-	(Part 3/Sec 4)
iv)	Colour	Close match to the colour specified in IS 5 or to the specified colour where IS colour is not specified	-	(Part 4/Sec 2)
v)	Gloss 60 °, <i>Min</i>		-	
	a) Initial	90	-	(Part 4/Sec 4)
	b) Retention, percent	90	F	-
vi)	Fastness to light (at 300 h)	Passes the test if there shall be no appreciable colour changes observed	-	(Part 4/Sec 3)

vii)	Wet opacity m <sup>2</sup> /10 litre	As given in Table 1 of IS 2932	-	(Part 4/Sec 1)
viii)	Flexibility and adhesion		-	
	a) Bend test with Type 1 apparatus and 6.25 mm dia mandrel	No visible damage or detachment of film	-	(Part 5/Sec 2)
	b) Scratch hardness at a load of 1000 g	No such scratch as to show the bare metal	-	(Part 5/Sec 2)
ix)	Stripping test	Scratches free from jagged edges	G	-
x)	Durability using accelerated weathering equipment's, ratings after exposing stipulated time given in <b>4.3</b>		C	
	a) Degree of Blistering, less than equal to	2(S2)		
	b) Degree of Rusting, less than equal to	Ri 3		
	c) Degree of Cracking less than equal to	2(S2) with crack penetration of type (a)		
	d) Degree of Flaking less than equal to	2(S1)		
	e) Degree of Chalking less than equal to	1		
	f) Degree of colour Change, $\Delta E$ , <i>Max</i>	3.0 for light (L) colours and 5.0 for dark (D) colours ( <i>See</i> Table 1 of IS 2932)		
	g) Gloss retention 60°, percentage of original, <i>Min</i>	85		
xi)	Keeping properties	Not less than one year from date of manufacturing	H	-
xii)	Volatile Organic matter (VOCs), g/L, <i>Max.</i> ( <i>See</i> Note 1, 2 and 3)	500	-	(Part 2/Sec 3)

**NOTES**

1. It is in-can VOC as supplied by manufacturer, without including any thinner. Since the amount of thinner used on-site can vary depending on the application method (brushing, spraying, etc.), it can be challenging to precisely track the extent of thinning during application.
2. VOCs of colorant added at Point of Sale. The VOC content of product including the colorant added at the point-of-sale shall not exceed 50 grams per litre over and above the allowed VOC limit of product without colorant.
3. For the calculation of the VOC content, for solvent and water-based paints, Method 2 and Method 3 may be employed respectively as given in the IS 101 (Part 2/Sec 3) and IS 101 (Part 2/Sec 4).

**Table 2 Optional Requirements for Stoving Enamel Paint**  
**For General Industrial Applications**  
(Clause 4.8)

Sl. No.	Characteristics	Requirements	Methods of test, Annex to this standard	Ref to IS 101
(1)	(2)	(3)	(4)	(5)
i)	Impact resistance (by pendulum impact tester) (mass of steel tube approx. 500 g)	Shall not show any signs of deterioration of the paint film	J	-
ii)	Resistance to humidity under conditions of condensation (expose for 250 h)	No blistering, rusting or loss of adhesion	-	2 of (Part 6/Sec 1)
iii)	Tape test	To pass the test	K	-
iv)	Inter-coat adhesion test	To pass the test	L	-
v)	Resistance to liquid		M	-
	a) Petrol	To pass the test	-	-
	b) Lubricating oil	To pass the test	-	-
vi)	Resistance to soap water and Spotting	To pass the test	N	-
vii)	Resistance to heat (double bake schedule consists of bake-cool bake-cool)	To pass the test	P	-
viii)	Resistance to bleeding	No bleeding	Q	-
ix)	Flash point	Not below 30°C	-	(Part 1/Sec

				6)
x)	Re-touch ability with Cellulose Nitrate Lacquers	To pass the test	R	-

## 5 PACKING AND MARKING

### 5.1 Packing

Unless otherwise agreed to between the purchaser and the supplier, the paint shall be packed in metal containers conforming to IS 1407 and IS 2552. The packing is subject to the provisions of the law in force in the country at that time.

**5.1.1** Each container shall be marked with the following:

- a) Name of the material;
- b) Indication of the source of manufacturer;
- c) Volume of the material;
- d) Batch No. or Lot No. in code or otherwise;
- e) Colour of the material;
- f) Lead content and VOC, *Maximum*;
- g) cautionary note as below:
  - 1) Keep out of reach of children.
  - 2) Dried film of this paint may be harmful if eaten or chewed.
  - 3) This product may be harmful if swallowed or inhale

### 5.1.2 BIS Certification Marking

The container may also be marked with the Standard Mark.

**5.1.2.1** The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the Bureau of Indian Standards Act, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark. The details of conditions under which the licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

**5.2** Other details of packing and marking shall be in accordance with the instructions given by the purchaser.

## 6 SAMPLING

**6.1** Representative samples of the material shall be drawn as per IS 101(Part 1/Sec 1).

### 6.2 Preparation of Test Samples

**6.2.1** During preparation of samples for tests the following stoving/baking schedule shall be adhered to:

Not more than 30 min at 150°C

### 6.2.2 For Drying Time and Other Tests

Prepare mild steel panel of sizes 150 mm × 100 mm × 1.25 mm as prescribed in IS 101 (Part 1/Sec 3). Apply the paint on one side of the panel uniformly by brushing to give a dry film mass commensurate with the mass per 10 litre as specified in IS 101(Part 3/Sec 4). The coated test

panels shall be flash dried at  $(27 \pm 2)^\circ\text{C}$  and relative humidity of  $65 \pm 5$  percent for approximately half an hour and then place the panels in a ventilated oven maintained for stoving at a schedule as prescribed in 6.2.1. Prepared test panel then subjected to the drying time test as specified in Annex D as soon as possible. For other tests like finish, gloss, colour and fastness to light keep the stoved panels at room temperature for 24 h.

### **6.2.3 For Flexibility, Adhesion and Stripping Test**

For all the tests prepare separate burnished tin plate panels, rectangular, of sizes  $100\text{ mm} \times 50\text{ mm} \times 0.3\text{ mm}$  as prescribed in IS 101(Part 1/Sec 3). Apply one coat of material uniformly by brushing on each of the panels as to give a dry film mass commensurate with the mass per 10 litre as specified in IS 101(Part 3/Sec 4). The coated test panels shall be flash dried at a temperature of  $(27 \pm 2)^\circ\text{C}$  and relative humidity of  $(65 \pm 5)$  percent for approximately half an hour and then place the panels in a ventilated oven maintained for stoving at a schedule as prescribed in 6.2.1. The stoved panels then be placed in a well-ventilated chamber, free from draughts and dust for 24 h at room temperature. During this period the film shall be exposed to diffused daylight for at least 6 h and care should be taken to protect it from direct sunlight. The panels then shall be conditioned at a temperature of  $27^\circ \pm 2^\circ\text{C}$  and relative humidity of  $(65 \pm 5)$  percent for a minimum time of 16 h. Prepared test panel then subjected to the tests as prescribed in IS 101 (Part 5/Sec 2). Prepared test panel then subjected to the stripping test as prescribed in Annex G.

### **6.2.4 For Resistance to Humidity under Conditions of Condensation Test**

Prepare mild steel panel of sizes  $150\text{ mm} \times 100\text{ mm} \times 1.25\text{ mm}$  as prescribed in IS 101 (Part 1/Sec 3). Apply the paint uniformly on each side of the panel by brushing to give a dry film mass commensurate with the mass per 10 litre as specified in IS 101(Part 3/Sec 4). Seal the edges of the panel with wax up to a depth of 6 mm by dipping in molten wax. The coated test panels shall be flash dried at a temperature of  $(27 \pm 2)^\circ\text{C}$  and relative humidity of  $65 \pm 5$  percent for approximately half an hour and then place the panels in a ventilated oven maintained for stoving at a schedule as prescribed in 6.2.1. The stoved panels then be placed in a well-ventilated chamber, free from draughts and dust for 24 h. During this period the film shall be exposed to diffused daylight for at least 6 h and care should be taken to protect it from direct sunlight. Prepared test panel then subjected to the test as prescribed in IS 101(Part 6/Sec 1).

### **6.2.5 For Resistance to Heat Test**

Prepare mild steel panel of sizes  $150\text{ mm} \times 100\text{ mm} \times 1.25\text{ mm}$  as prescribed in IS 101 (Part 1/Sec 3). Apply the paint uniformly on each side of the panel by brushing to give a dry film mass commensurate with the mass per 10 litre as specified in IS 101(Part 3/Sec 4). The coated test panels shall be flash dried at a temperature of  $(27 \pm 2)^\circ\text{C}$  and relative humidity of  $65 \pm 5$  percent for approximately half an hour and then place the panels in a ventilated oven maintained for baking at a schedule as prescribed in 6.2.1. The panel then be cooled for minimum 30 min and then again place the panel in oven for baking further at the schedule as prescribed in 6.2.1. The double baked panel then be cooled for minimum 30 min. The panels then shall be conditioned at a temperature of  $27^\circ\text{C} \pm 2^\circ\text{C}$  and relative humidity of  $(65 \pm 5)$  percent for a minimum time of 24 h.

## **6.3 Criteria for Conformity**

A lot shall be declared as conforming to the requirements of this standard if the test results of the composite sample satisfy the requirements prescribed under 4.

## **7 TEST METHODS**

**7.1** Tests shall be conducted as prescribed in **4.1** to **4.8** and in column 4 and 5 of Table 1 and Table 2.

### **7.2 Quality of Reagents**



Unless otherwise specified, pure chemicals and distilled water (*see* IS 1070) shall be employed in tests.

NOTE — ‘Pure chemicals’ shall mean chemicals that do not contain impurities which affect the results of analysis.

## ANNEX A

(Clause 2)

### LIST OF REFERRED INDIAN STANDARDS

<i>IS No.</i>	<i>Title</i>
IS 101	Methods of sampling and test of paints, varnishes and related products:
Part 1	Test on liquid paints (general and physical)
Sec 1: 2023	Sampling ( <i>fourth revision</i> )
Sec 3: 1986	Preparation of panels ( <i>third revision</i> )
Sec 5: 2024	Consistency ( <i>fourth revision</i> )
Sec 6: 1987	Flash point ( <i>third revision</i> )
Part 3	Tests on paint film formation
Sec 1: 1986	Drying time ( <i>third revision</i> )
Sec 2: 1989	Film thickness ( <i>third revision</i> )
Sec 4: 1987	Finish ( <i>third revision</i> )
Part 4	Optical test on paint films
Sec 1: 1988	Opacity ( <i>third revision</i> )
Sec 2: 2021	Colour-visual comparison of colour of paints ( <i>fourth revision</i> )
Sec 3: 1988	Light fastness test ( <i>third revision</i> )
Sec 4: 2020	Gloss – determination of gloss value at 20° , 60° , 85° ( <i>fourth revision</i> )
Part 5	Mechanical test on paint films
Sec 1: 1988	Hardness Test ( <i>third revision</i> )
Sec 2: 1988	Flexibility and adhesion ( <i>third revision</i> )
Part 6	Durability tests on paint films,
Sec 1: 1988	Resistance to humidity under conditions of condensation ( <i>third revision</i> )
Sec 2: 1989	Keeping properties ( <i>third revision</i> )
Part 7	Environmental tests on paint films,
Sec 2: 1990	Resistance to liquids ( <i>third revision</i> )
Part 8	Tests for pigments and other solids,
Sec 5: 2022	Lead restriction test ( <i>fourth revision</i> )

IS 264 : 2005	Nitric acid — Specification ( <i>third revision</i> )
IS 266 : 1993	Sulphuric acid ( <i>third revision</i> )
IS 285 : 2021	Laundry soaps — Specification ( <i>fourth revision</i> )
IS 513 : 2008	Cold reduced low carbon steel sheets
IS 1017 : 1983	Chamois leather ( <i>second revision</i> )
IS 1070 : 2023	Reagent grade water ( <i>fourth revision</i> )
IS 1303 : 1983	Glossary of terms relating to paints
IS 1407 : 1977	Specification for round paint tins ( <i>second revision</i> )
IS 1604 : 2022	Aviation gasoline — Specification ( <i>fifth revision</i> )
IS 2552 : 1979	Specification for steel drums (galvanized and ungalvanized) ( <i>second revision</i> )
IS 3618 : 1966	Specification for phosphate treatment of iron and steel for protection against corrosion
IS 5691 : 1970	Specification for lacquer, cellulose, nitrate, pigmented, finishing, glossy
IS 6126 : 1971	Nitrocellulose surfacer

## ANNEX B

(Clause 4.2)

### TEST FOR TOXICITY

#### **B-1 OUTLINE OF METHOD**

The material is steam distilled and solvents collected. It is subjected to test for benzene and chlorinated hydrocarbons qualitatively.

#### **B-2 APPARATUS**

**B-2.1 Steam Distillation Apparatus**

**B-2.2 Distilling Flask** — 100 ml capacity.

#### **B-3 REAGENTS**

**B-3.1 Nitric Acid** — conforming to IS 264.

**B-3.2 Sulphuric Acid** — conforming to IS 266.

**B-3.3 Copper Wire** — of 1 mm diameter.

#### **B-4 PROCEDURE**

**B-4.1** Steam distill 100 ml of the material using a receiver cooled in ice. Separate the solvent layer, wash with several times its volume of distilled water, discard the washings dry and redistill, collecting all solvents within the agreed specified boiling range. Subject this to the tests prescribed in B-4.1.1 and B-4.1.2.

##### **B-4.1.1 Test for Benzene**

Mix equal volumes of nitric acid and sulphuric acid in a test tube and cool. To 2 ml of this solution add 10 drops of the solvent and shake. Warm, if necessary and examine for the odour of

nitrobenzene which is given by 5 percent benzene or larger amounts of toluene. Boil the contents for at least 30 s, allow to cool and add 10 ml of water. Mix the contents and examine for odour of nitrobenzene, which should be no longer present if the contents were boiled enough. Allow the tube to stand for some time. A yellow cloudy solution or flocculent precipitate changing to yellow needles is evidence of the presence of benzene. It may further be confirmed by separating the yellow needles and finding out its melting point which should be 89° to 90°C.

In case of dispute gas chromatography may be employed to detect the presence of benzene using analytical grade benzene as standard.

#### **B-4.1.2 Test for Chlorinated Hydrocarbons**

Form a small loop in the copper wire and heat in a small Bunsen flame until it no longer colours the flame. Allow the loop to cool and then dip it into the test solution. Immediately place in the outer part of the flame and when the first luminous flame disappears, examine for the green colouration due to chlorinated compounds.

**B-4.2** The material shall be deemed to have passed the test if the solution, when tested as prescribed in B-4.1.1, does not give off smell of nitrobenzene or forms yellow crystals and when tested as prescribed in B-4.1.2 does not impart a green colouration to the Bunsen flame.

### ANNEX C

[Clause 4.3, Table 1, Sl. No. (x)]

## DURABILITY TEST

### **C-1 GENERAL**

Accelerated weatherometer test on paints being done to simulate and predict the effects of long-term exposure to various environmental conditions such as sunlight, moisture, temperature fluctuations, and other atmospheric elements.

### **C-2 TEST PANELS**

**C-2.1** The panel shall be of 135 mm × 40 mm × 1.25 mm for the accelerated weathering test or any other sizes as suitable for the equipment but in any case the panel size shall not be less than 60 mm × 40 mm. The panels shall be free from surface defects (*see* IS 513).

### **C-3 PREPARATION OF TEST PANELS**

**C-3.1** Prepare mild steel panels of sizes as mentioned in **C-2.1** by the method as prescribed in IS 101 (Part 1/Sec 3). The complete painting system on the panels shall consist of the following steps:

- a) The cleaned panel shall be rinsed in cold or hot water to remove such residues of cleaning materials as might affect the phosphating process. The phosphate treatment shall be of zinc-phosphate coating (*see* IS 3618) and with a minimum coating weight of 4.3 g/m<sup>2</sup>. After phosphate treatment, rinse the panel thoroughly to remove any residues of the phosphating solution first with water and then with a chromate solution at a temperature not below 60°C and having chromate (as CrO<sub>3</sub>) concentration of 0.125 to 0.50 kg/1 000 litres.

NOTE — The chromate rinse shall consist of a solution of chromic acid or alkali metal chromate or alkali metal dichromate or a mixture of equal parts of chromic and phosphoric acids.

After final rinsing, dry the panel thoroughly and use for painting without much delay.

- b) Apply two coats of primer surfacer suitably thinned to spraying consistency using appropriate thinner wet-on-wet allowing a flash off time of 10 min between coats and bake for 30 min at 130°C to give a total dry film thickness of minimum 60 microns.

- c) Rub down wet with emery paper No. 280, followed by No. 400 until the surface is sufficiently smooth and even to take a coat of the material. About 50 microns thickness of the film shall be left after flattening. Wash the surface with water to remove all loosely adhered dust and dry for 30 min.
- d) Wipe with petrol damped rag. Apply two coats of the material thinned suitably to spraying consistency with appropriate thinner wet-on-wet with a flash of time of 10 min, between coats and bake for 30 min at 130°C to give a dry film thickness of this finish to be 32.5 to 50 microns.

**C-4 ACCELERATED WEATHERING TEST**

Testing can be conducted using any of the two accelerated weathering apparatus, namely QUV-A or Xenon arc, with exposure times set at 1 000 hours. Both side of the panels for these tests shall be prepared as described under C-3. Duplicate samples are to be tested in an appropriate accelerated weathering apparatus, as detailed in C-4.1 and C-4.2. For details of method of tests for both xenon arc and QUV-A apparatus, refer to IS 101 (Part 6/ Sec 5).

**C-4.1 Xenon arc** — An artificial weathering apparatus of the xenon arc type for uniform and controlled exposure to the effects of heat, light and water.

**C-4.1.1** Commonly used cycles and test conditions for Xenon arc apparatus are given below:

- a) Black panel temperature :  $(63 \pm 3) ^\circ\text{C}$
- b) Continuous exposure in light for 17 minutes and intermittent exposure to water spray for 3 minutes light and spray.
- c) Irradiance :  $0.55 \text{ W/m}^2/\text{nm}$
- d) Total exposure time is 1 000 h.

However, any other cycle may be used if mutually agreed upon between the purchaser and the supplier.

**C-4.2 QUV-A** — An artificial weathering apparatus of the QUV-A type for uniform and controlled exposure to the effects of UV and condensation.

**C-4.2.1** Commonly used cycles and test conditions for UV type apparatus are given below:

1) Lamp type	UVA 340
2) Test cycle	UV – (4 h at $60 \pm 3^\circ\text{C}$ ) Condensation – (4 h at $50 \pm 3^\circ\text{C}$ )
3) Irradiance	$0.67 \text{ W/m}^2/\text{nm}$
4) UV-A wavelength (approx.)	340 nm
5) Total exposure time	1 000 h

However, any other cycle may be used if mutually agreed upon between the purchaser and the supplier.

**C-5 Evaluation and Rating of Film Characteristics of Test Panel**

The test panels before and after the specified periods of exposure tests shall be assessed for the various film characteristics as prescribed in **C-5.1** to **C-5.8**.

#### **C-5.1 Degree of blistering**

The exposed panel shall be examined for the degree of blistering at the interval of 100 h up to the stipulated exposed time. The rating for the quantity (density) and size of the blister shall be provided by matching with the figures given in the IS 101 (Part 11/Sec 2)/ISO 4628 Part 2.

#### **C-5.2 Freedom from Rusting**

After exposure of the film is discontinued, examine for corrosion of the metal surface of the panel underneath by removing film. The paint film shall be removed by solvent type paint remover. When the film is softened by the paint remover it shall be removed by gently rubbing with cotton swab or waste jute taking care to remove adhering film of primer and/or undercoating. After removal of the film, the exposed metal shall be covered by thick mineral oil or petroleum jelly. The rating for the degree of rusting shall be provided by matching with the figures given in the IS 101 (Part 11/Sec 3) /ISO 4628 Part 3.

#### **C-5.3 Freedom from Cracking**

The exposed panel shall be examined for the degree of cracking at the interval of 100 h up to the stipulated exposed time. The rating for the quantity, size and depth of cracking shall be provided by matching with the figures given in the IS 101 (Part 11/Sec 4) /ISO 4628 Part 4.

#### **C-5.4 Freedom from Flaking**

The exposed panel shall be examined for the degree of flaking at the interval of 100 up to the stipulated exposed time. The rating for the degree of flaking shall be provided by matching with the figures given in the IS 101 (Part 11/Sec 5) / ISO 4628 Part 5.

#### **C-5.5 Freedom from Chalking**

The exposed panel shall be examined for the degree of flaking at the interval of 100 h up to the stipulated exposed time. The rating for the degree of chalking shall be provided by matching with the figures given in the IS 101 (Part 11/Sec 7) /ISO 4628 Part 7.

#### **C-5.6 Degree of Colour Change**

**C-5.6.1** The colour of the test panel shall be compared against the stipulated shade as given in IS 5 or any agreed standard sample between purchaser and supplier. The colour difference between a pair of painted panels shall be calculated in terms of  $\Delta E$  (Delta E) by using CMC (2:1) colour difference equation. From spectral measurement, QC program calculate CIE colour specifications-  $L^* a^* b^* C^* h^*$  based on daylight illumination, as described in **C-5.6.2**. For passing the sample the  $\Delta E$  shall not be more than 3.0 for Light colours (L) and not more than 5.0 for Dark colours (D) during the exposure period and after completing the stipulated time in the respective accelerated weatherometers.

**C-5.6.2** A reflectance spectrophotometer is used for reflectance measurement. Like Visual Assessment requirement, the sample should be sufficiently large enough to measure using Large Area of View (LAV). Small sized samples measured using Small Area of View (SAV) may not have high repeatability. Sample size should be minimum 2x2". The spectral measurement should be carried out using a reflectance spectrophotometer having following features:

Repeatability – Short-Term	: Better than 0.15 $\Delta E_{CIELAB}$
Inter-Instrument Agreement	: Better than 0.25 $\Delta E_{CIELAB}$
Wavelength Range	: 400-700 nm (360-780 nm preferable)
Wavelength Increment	: 10 nm

### **C-5.7 Gloss loss at 60°**

The exposed panel shall be examined for the loss of gloss at the interval of 100 h up to the stipulated exposed time. The percentage of gloss loss shall be calculated with the initial taken gloss value, for measurement of gloss IS 101 (Part 4/Sec 4) may be referred. For passing the sample loss of gloss shall not be more 50 percent both during the exposure period and after completing the stipulated time in the respective accelerated weatherometers.

## **ANNEX D**

### **DRYING TIME**

(Table 1 (i))

**D-1** The test panels shall be prepared as specified in **6.2**. After the flash-off period, the panels shall be baked according to the manufacturer's recommended schedule, provided that the flash-off time does not exceed 30 minutes and the baking schedule does not exceed 150°C for 1.5 hours.

**D-2** Once baked, the coated film shall be completely dry, such that it does not deform or leave any wet paint impressions when touched. The film shall also be tested using a fingernail penetration method, ensuring no deformation or cracking occurs in the coating.

## **ANNEX E**

[Table 1, Sl No. (ii)]

### **CONSISTENCY**

#### **E-1 APPARATUS**

**E-1.1** Palette Knife or Metal Rod

**E-1.2** Glass Panels

**E-1.2.1** Unless specified otherwise, glass panels of size 150 mm × 50 mm shall be prepared as prescribed in IS 101 (Part 1/Sec 3).

#### **E-2 PROCEDURE**

**E-2.1** Insert a clean metal rod or palette knife into the original container and examine the nature of settling.

#### **E-2.2 Observations**

The material shall not cake hard inside the container and shall be in such a condition that stirring easily produces a smooth uniform paint suitable for brushing/ spraying on glass panels.

## **ANNEX F**

[Table 1, Sl No. (v) (b)]

### **DETERMINATION OF GLOSS RETENTION**

#### **F-1 OUTLINE OF METHOD**

The painted panels after specified period of ageing are examined for shrinkage and loss of gloss.

#### **F-2 PROCEDURE**

**F-2.1** The painted panel as prepared in **6.2.2** shall be put for ageing in a well-ventilated

chamber, free from draughts and dust at room temperature for 10 days.

### **F-2.2 Observations**

The paint shall be deemed to have passed the test if the painted panels shall not exhibit film shrinkage and the loss of gloss shall not be more than 10 percent of the original gloss.

## **ANNEX G**

[Table 1, Sl No.(ix) and Clause 6.2.3]

### **STRIPPING TEST**

#### **G-1 OUTLINE OF THE METHOD**

The minimum load required to produce a scratch showing the bare metal surface of the panel painted with the material is determined.

#### **G-2 APPARATUS**

The apparatus used for determining scratch hardness as prescribed in IS 101(Part 5/Sec 2) shall be used.

#### **G-3 PROCEDURE**

##### **G-3.1 Preparation of Test Panels**

Mild steel panels described under 6.2.3 shall be prepared.

**G-3.2** Test the dried film in the apparatus under such a load that a scratch is produced showing the bare metal surface.

#### **G-4 OBSERVATIONS**

**G-4.1** The paint shall be deemed to have passed the test if the scratch so produced shall be free from jagged edges

## **ANNEX H**

### **KEEPING PROPERTIES**

(Table 1 Sl No.(xi))

**H-1** When stored under cover in a dry place in the original sealed containers under normal temperature conditions, the material shall meet the requirement as specified in 4 for the specified period after the date of manufacture. Slight changes in viscosity may be allowed provided the material satisfies the other requirements prescribed in the material specification.

## ANNEX J

[Table 2, Sl No. (i)]

### IMPACT TEST

#### **J-1 OUTLINE OF METHOD**

The painted panel is subjected to pendulum impact test and the test piece is examined for deterioration of paint coating.

#### **J-2 APPARATUS**

##### **J-2.1 Pendulum impact tester**

As described in IS 101 (Part 5/Sec 1).

#### **J-3 PREPARATION OF TEST PIECE**

Take test pieces as described in IS 101 (Part 5/ Sec 1). Prepare the test piece as prescribed in C-2.

#### **J-4 PROCEDURE**

**J-4.1** Prepared test piece then subjected to the test as specified in IS 101(Part 5/Sec 1) as soon as possible. Ensure that the test piece is subjected to an impact of 0.92 kgfm directed on to the painted side (impact-in). Examine the points of impact for any deterioration of the paint film utilizing the same piece, age in an oven at a temperature of 60°C for 10 days and repeat the impact test.

##### **J-4.2 Observations**

Remove the test pieces and examine the points of impact for the loss of adhesion or removal of the coating or any deterioration of the paint film.

## ANNEX L

[Table 2, Sl No. (iii)]

### TAPE TEST

#### **K-1 OUTLINE OF METHOD**

A tape is applied to the painted panel and stoved at an elevated temperature for a certain time. Afterwards the tape is removed and the film is examined for staining and permanent print.

#### **K-2 PROCEDURE**

##### **K-2.1 Preparation of Test Panels**

Prepare mild steel panel of sizes 150 mm × 100 mm × 1.25 mm as prescribed in IS 101 (Part 1/Sec 3). Apply the paint on each side of the panel uniformly by brushing to give a dry film mass commensurate with the mass per 10 litre as specified in IS 101(Part 3/Sec 4).

**K-2.2** Apply a 2.5 cm strip of masking tape over the length of the painted surface half an hour after the normal bake at a temperature of 105°C is performed. The taped panel shall then be further baked for 30 min at a temperature of 130°C. Upon cooling, the tape shall be removed and the



panel inspected for staining and permanent printing.

### **K-2.3 Observations**

The material shall be deemed to have passed the test if no stain and permanent print is left on the film after the tape is removed

## **ANNEX L**

[Table 2, Sl No. (iv)]

### **TEST FOR INTERCOAT ADHESION**

#### **L-1 OUTLINE OF METHOD**

Two diagonally intersecting lines were cut through the painted panel and a tape is applied to cover the cuts. These tapes are pulled sharply and any lifting of the top coat is examined.

#### **L-2 PROCEDURE**

##### **L-2.1 Preparation of Test Panels**

Prepare panel as prescribed in **C-3.1**.

**L-2.2** Cool the stoved panels for 30 min. Cut through the metal two lines, diagonally intersecting, at least 20 cm in length. Apply masking tape, of 2.5 cm width to cover the cut through lines completely. Pull the tapes sharply upwards and check for any lifting of the top coat from the primer.

##### **L-2.3 Observations**

The material shall be deemed to have passed the test if tape could be pulled off sharply.

## **ANNEX M**

[Table 2, Sl No. (v)]

### **TEST FOR RESISTANCE TO PETROL AND LUBRICATING OIL**

## **M-1 OUTLINE OF THE METHOD**

The painted panels, after specified drying period, is dipped in petrol and lubricated oil separately and at specified temperature and time. On completion of the specified time periods, the panels are subjected for visual examination.

## **M-2 PREPARATION OF TEST PANELS**

**M-2.1** Prepare mild steel plate panel as prescribed in **C-3.1**. The back and edges of the panels shall be protected with two coats of a suitable paint. The coated test pieces shall be air dried in a horizontal position for 7 days and shall be conditioned as described in IS 101(Part 7/Sec 2).

## **M-3 REAGENTS**

**M-3.1** Motor Gasoline — (*see* IS 2796)

### **M-3.2 Lubricating Oil**

Mineral lubricating oil having a viscosity of 18.0 cSt or having a time of flow of approximately 80 s for 50 ml in a No. 1 Redwood Viscometer.

## **M-4 PROCEDURE**

**M-4.1** Follow the procedure as prescribed in IS 101 (Part 7/Sec 2). Immerse one prepared panel in gasoline (*see* **M-3.1**) at room temperature for 15 min.

**M-4.1.1** Take out the panel from gasoline and allow the panel to stand in a vertical position for 5 min at room temperature and then swab it vigorously for about 5 s with a pad of cotton wool. Observe the paint films after cooling for 30 min at room temperature.

**M-4.2** Follow the procedure as prescribed in IS 101 (Part 7/Sec 2). Immerse one prepared panel in lubricating oil (*see* M-3.2) at 50°C for 2 h.

**M-4.2.1** Take out the panel from the oil and remove any residual lubricating oil from the surface by dabbing with a suitable absorbent paper or cloth or a pad of cotton wool and examine the test piece after a recovery period of 30 min at room temperature.

## **M-5 OBSERVATIONS**

The sample shall be treated as passing if there is no blistering, flaking and corrosion. The material shall be deemed to have passed the test if the film shall not show signs of disintegration, permanent injury or change of colour to a greater extent. The loss of gloss shall not be more than 50 percent of the original gloss.

## **ANNEX N**

[Table 2, Sl No. (vi)]

### **DETERMINATION OF RESISTANCE TO WATER AND SOAP SPOTTING**

## **N-1 OUTLINE OF METHOD**

The painted panel is subjected to normal outdoor exposure for a specified period and then subjected to water and soap solution spotting. After keeping the panel in sunlight for a specified period the paint film is examined.

## **N-2 TEST PANELS**

**N-2.1** At least two panels of mild steel plate of sizes 300 mm × 300 mm × 1.25 mm shall be prepared as prescribed in **C-3.1**.

## **N-3 PROCEDURE**

**N-3.1** Ensure to carry out this test at laboratory temperature.

**N-3.2** The panels so prepared (*see N-2.1*) shall be cured for 24 h and then expose for 168 h to outdoor exposure facing south at an angle of 45°. On each panel place two cotton pads of 4 cm diameter, one soaked with water and other soaked with one percent soaps solution (conforming to IS 285) to be referred a spotted zone. Cover the pads with watch glass and keep it exposed in sunlight for 4 h.

**N-3.3** Remove the pads, wash with running water and remove any residual liquid from the surface by a clean cloth. Allow to dry for 1 h.

#### **N-3.4 Observations**

Examine visually any change in colour in spotted zones. The material shall be deemed to have passed the test if the film does not show any change in colour in spotted zones.

## **ANNEX P**

[Table 2, Sl No. (vii)]

### **DETERMINATION OF RESISTANCE TO HEAT**

#### **P-1 OUTLINE OF THE METHOD**

**P-1.1** An air-dried panel is heated to a maximum temperature under stipulated conditions. After this, it is cooled and dipped in water. The extent of deterioration of the film is examined and may also be compared with that of an approved sample (if any) tested at the same time.

#### **P-2 APPARATUS**

##### **P-2.1 Electric Furnace**

With a maximum attainable temperature of 900°C. The minimum dimensions of the heating chamber shall be 380 mm × 150 mm × 80 mm.

#### **P-3 PROCEDURE**

**P-3.1** Prepare steel panel as described in 6.2.5. Heat the panel in a vertical position in an electrical furnace, the temperature of which is gradually raised from room temperature up to a temperature of 300°C in 30 min time. Maintain the panel at the maximum temperature of 300°C for 2 h. Remove the panel from the furnace, cool to room temperature for 1 h. Test the approved sample (if any) in the same manner and at the same time.

##### **P-3.2 Observations**

The material shall be deemed to have passed the test if the paint film remains firmly adherent and shows no sign of cracking, blistering or flaking. Formation of hair-lines shall not be a cause for rejection. For bulk supplies, the deterioration, if any, shall not be greater than that shown by the registered sample, if any.

## **ANNEX Q**

[Table 2, Sl No. (viii)]

### **RESISTANCE TO BLEEDING**

#### **Q-1 OUTLINE OF METHOD**

The painted panel is coated with a white finishing enamel and examined for bleeding.

#### **Q-2 PROCEDURE**

##### **Q-2.1 Preparation of Panels**

Prepare mild steel panel of sizes 300 mm × 100 mm × 1.25 mm as prescribed in IS 101 (Part 1/Sec

3). Apply the paint (except white colour) on one side of the panel (except for 25 mm lengthwise) uniformly by brushing/spraying to give a dry film mass commensurate with the mass per 10 litre as specified in IS 101(Part 3/Sec 4). Tape off 40 mm lengthwise, which will include the unpainted section and enamel in the remainder of the panel.

**Q-2.2** The panel then shall be baked at 130 °C and then cooled to room temperature. After that the bottom half of the enamelled area is lightly abraded with silicon carbide paper, grade 400 until the surface is completely free from gloss. Remove all of the dust with a cloth dampened with petroleum hydrocarbon solvents. Remove the mask of tape and overcoat the entire panel uniformly by spraying/brushing with another coat of white enamel synthetic, stoving, conforming to this standard. Bake for 30 min at a temperature of 130 °C. Cool the panel at room temperature.

### **Q-2.3 Examinations**

Immediately after the film is dry, compare, in diffuse daylight, the degree of bleeding, as shown by the difference in colour between the areas of the panels coated with one coat paint only and overcoated with the paint sample. If daylight is not available, make the comparison in artificial daylight. The comparison shall be repeated after 24 h.

NOTE — If required and agreed, the degree of bleeding may be assessed by using a suitable colorimeter.

### **Q-3 OBSERVATIONS**

The material shall be deemed to have passed the test if there is no bleeding.

## **ANNEX R**

[Table 2, Sl No. (x)]

### **TEST FOR RETOUCHABILITY WITH CELLULOSE NITRATE LACQUERS**

#### **R-1 OUTLINE OF METHOD**

The panels prepared as prescribed in **C-3.1** are coated with nitrocellulose surfacer and cellulose nitrate lacquer and film examined for compatibility.

#### **R-2 PROCEDURE**

##### **R-2.1 Preparation of Panels**

Prepare the painted panels as described in **C-3.1**.

**R-2.2** Slightly wet with silicon carbide paper, grade 400 to give a smooth surface. Wash thoroughly with water and dry for 30 min. Then, apply a coat of surfacer, nitrocellulose (conforming to IS 6126), dry for 30 min and apply a coat of lacquer, cellulose, pigmented, glossy (conforming to IS 5691). Dry for 15 to 30 min at room temperature and examine the film.

##### **R-2.3 Observations**

The material shall be deemed to have passed the test if the film when examined should be smooth, with a glossy finish, free from sagging and wrinkling and also firmly adhered to the enamel film.