Nissan Engineering Standard

N E S	Testing Method for Automotive Paint

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Applicable Standards: See page 141.

1. SCOPE

This Standard specifies the test method of automotive paint for steel sheet. (hereinafter called the test method)

Remark: Units and numerals given in { } in this Standard are based on the conventional unit system, and are appended for informative reference.

2. DEFINITION OF TERMS

Meanings of major terms used in this Standard are as follows:

(1) Stock paint: Refers to the paint before dilution. It is generally called the raw paint.
(2) Diluted paint: Refers to the paint after being diluted as specified.
(3) Sample paint: Refers to the paint used for each test.
(4) Test panel: Refers to the specified steel plate to which the sample paint is to be applied.
(5) Specimen: Refers to the test panel to which the sample paint has been applied.

3. TYPES OF TEST METHODS

Table 1 and Table 2 list 74 types of test methods specified in this Standard. Application examples of paint are shown for reference.

Table 1 Types of Test Methods (Paint)

Classification	Type of test		Application example (Reference)				Test method (Item No.)
			Undercoat		Intermediate coat	Topcoat	
			Electrodeposition	Spraying			
Paint	Paint condition in container		O	O	O	O	5
	Covering power		–	–	–	O	6
	Specific gravity		O	O	O	O	7
	Nonvolatile content		O	O	O	O	8
	Viscosity	Stormer viscometer	–	O	O	O	9
		Rotational viscometer	O	–	–	O	
		Ford cup	–	O	O	O	
	Ash content		O	–	–	–	10
	Electrodeposition paint volatile content		O	–	–	–	11
	Neutralizer concentration		O	–	–	–	12
	pH		O	–	–	–	13
	Sedimentation		O	O	O	O	14
	Storage stability	General paint	–	O	O	O	15
		Electrodeposition paint	O	–	–	–	
	Dilution dispersibility		O	–	–	–	16
	Conductivity		O	–	–	–	17
	Coulomb efficiency		O	–	–	–	18
	Throwing power		O	–	–	–	19
	Secondary run		O	–	–	–	49
	Uneven drying		O	–	–	–	50
	Water-droplet trace		O	–	–	–	51
	Contamination		O	–	–	–	52
	L-effect		O	–	–	–	53
	Paint electrical resistance		–	O	O	O	61

Table 2 Types of Test Methods (Paint Film)

Classification		Type of test		Application example (Reference)				Test method (Item No.)
				Undercoat		Intermediate coat	Topcoat	
				Electrodeposition	Spraying			
Paint film	Appearance	Coated surface status		O	O	O	O	20
		Gloss		O	O	O	O	21
		Contact angle		–	–	–	O	54
		Re-coatability		–	–	–	O	22
		Influence of dust paint		–	–	–	O	23
		Color difference		O	O	O	O	24
		Overbaking resistance		O	O	O	O	25
	Physical properties	Film hardness		O	O	O	O	26
		Impact resistance		O	O	O	O	27
		Chipping resistance	Gravelometer method	O	O	O	O	28
			Diamond shot method	O	O	O	O	
		Adhesion	Square-cut method	O	O	O	O	29
			Cross-cut method	O	O	O	O	
		Bending resistance		O	O	O	O	30
		Resistance to car-washing		–	–	–	O	31
		Scratch resistance		–	–	–	O	55
		Resistance to dry cloth wiping		–	–	–	O	56
		Paint film hardness		–	O	O	O	62
		Topcoat paint film internal stress cracking		–	–	–	O	63
		Two-sided tape adhesive characteristics test		–	–	–	O	67
		Sash black tape compatibility test		–	–	–	O	69
		Two-tone parting characteristic test		–	–	–	O	71
	Chemical properties	Humidity resistance		O	O	O	O	32
		Resistance to warm water		O	O	O	O	57
		Corrosion resistance	Salt water spraying	O	O	–	–	33
			Complex corrosion	O	O	–	O	
		Scab corrosion		O	O	–	O	34
		Filiform corrosion		O	O	–	O	35
		Edge corrosion		O	O	–	O	58
		Acid resistance		–	–	O	O	36
		Alkali resistance		–	–	O	O	37
		Gasoline resistance		–	–	O	O	38
		Engine oil resistance		–	–	O	O	39
		Resistance to windshield washer solution		–	–	–	O	40
		Antifreeze resistance		–	–	–	O	41
		Resistance to protective coating agent		–	–	–	O	42
		Resistance to rust preventive wax		–	–	O	O	43
		Resistance to bird droppings		–	–	–	O	59
		Resistance to iron powder		–	–	–	O	60
		Adhesion to window-glass bonding agent		–	–	–	O	44
		Electrodeposition paint oil repellency		O	–	–	–	45
		Thermal cycle		O	O	O	O	46
		Acid rain resistance		–	–	–	O	64
		Gelatin separation ratio		O	O	O	O	65
		Paint protective film characteristics		–	–	–	O	66
		Yellowing resistance characteristics test		–	–	–	O	68
		Rubber part resistance test	Antenna base	–	–	–	O	70
			Weatherstrip	–	–	–	O	
		Insect resistance test		–	–	–	O	72
		Pollen resistance test		–	–	–	O	73
		Sap resistance test		–	–	–	O	74
	Long-term performance	Outdoor exposure		–	–	O	O	47
		Accelerated exposure		–	–	O	O	48

4. GENERAL TESTING CONDITIONS

4.1 Testing sites standard conditions

Standard conditions for the spray booth and testing room are as follows:

4.1.1 Spray booth

The spray booth must be a closed room with a minimum of drafts, be free from direct exposure to sunlight and any gases or vapors that can affect painting operations, and maintained at a temperature of 20±5°C {293±5 K} at a relative humidity of less than 78%.
If painting is performed under conditions other than these, then the temperature and humidity during the painting operation must be recorded. When spray painting, the draft must basically be kept to within 0.3 to 0.8 m/sec.

4.1.2 Testing room

(1) Standard condition:
The testing room must be a closed room with a minimum of draft, free from direct exposure to sunlight and any gases or vapors that can affect the test, and maintained at a temperature of 20±1°C {293±1 K} at a relative humidity of less than 73±5%. If test is performed under conditions other than these, then the temperature and humidity during the test must be recorded.

(2) Room temperature
The room temperature must be 5 to 35°C {278 to 308 K}, and the relative humidity must be 45 to 85%.

4.2 Test panel preparation

4.2.1 Material

The steel plate shall conform to NES M 2020 (SP120 t = 0.8) and NES M 2036 (SP320 t = 0.8) If necessary, NES M 2036 (SP320R, SP320N, SP320H) and NES M 4064 (NA153, NA161) may be used. Spare blades of a cutting knife (cutting edge angle of 24°; Example: OLFA OP-10) must also be used for the edge corrosion evaluating test panel. The material for test panel must basically be free from rust, damage, creases and any other surface defects.([1]) (The type of dull finishing is not important.)

Note ([1]): The leading edge and rear side of the steel panel must be treated against corrosion.

4.2.2 Dimensions

The following six types are specified as test panels.

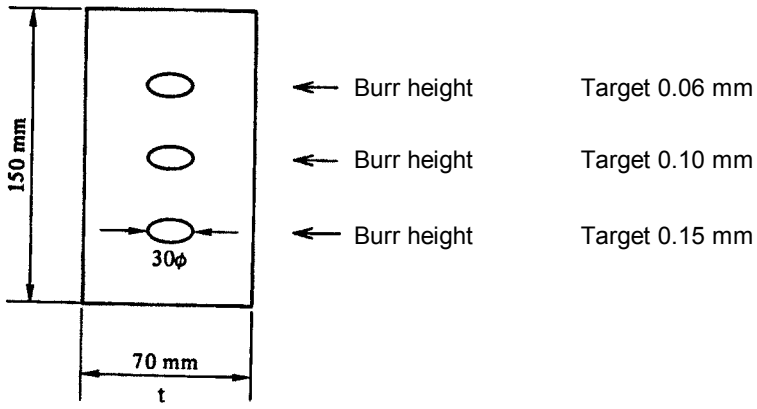
Table 3 Test panel types

Unit: mm

Type	Width	Length	n count	Application example
A	70	150	As agreed upon between concerned parties	General, for outdoor exposure
A'	70	150		For edge corrosion test (burred test plate)
A"	70	110		For accelerated exposure test (Xenon weather meter method)
B	210	300		For outdoor exposure
C	210	300		For appearance check (preliminary check for surface condition)
D	Cutting edge angle 24°			For edge corrosion test (simplified type: reference)

*A': Test panel for testing edge corrosion resistance (burred test panel) (For reference example)
When using SP320, the burrs must be on the organic film coated side.

Figure 1.1



Measuring burr height

Burr height must be measured in eight places for each hole. All test panels to be evaluated must be measured. Burr height must be measured using a surface roughness gauge. (cone tracer) Measurement with a dial gauge is also permissible. Observation of the burr section and measurement of burr height using a microscope is not recommended because this may result in damage to the test panel. However, measurement with microscope is permissible depending on the situation.

Burr test panel preparation

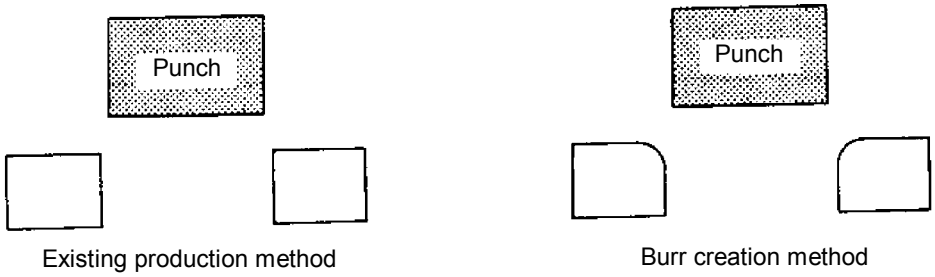
Burrs are punched into a piece of steel sheet using a press. Burr generation depends upon the clearance between the punch and die. Because of wide variation in burr height, R is established for the die before burr creation.

Different presses will result in different relationships between the die R, steel sheet type, and burr height. Each press must be checked and adjusted to ensure that burr height variation is minimized.

Burr height must be measured at a minimum of eight points on the completed test panel. The average height and the standard deviations are determined and are then used to calculate the test burr height value. Use the following equation.

Test burr height value = (average value) + (standard deviation x 2)

Figure 1.2



4.2.3 Pretreatment

(1) Degreasing: The test panel must be pre-treated using alkali degreasing agent.
(2) Chemical conversion treatment: The chemical conversion treatment of test panel shall be as agreed upon between concerned parties.

4.3 Test paint sampling method

4.3.1 Stock paint

Classify the paint to be tested by production lots. Select one container at random from each lot and use it as the stock paint sample representative of that lot.

4.3.2 Test paint

Dilute the stock paint (sampled as above) with the thinner as agreed upon between concerned parties, using the following method:

(1) Dilution of general paint

(a) Thoroughly stir the stock paint and place a suitable amount of the paint in a beaker; then dilute it, while stirring, with the thinner as agreed upon between concerned parties.

(b) Measure the viscosity of the diluted paint at 20±1°C {293±1 K} using a calibrated Ford cup #4 (for thick paint) or Ford cup #3 (for thin paint) ([2]) as shown in Figure 1, and adjust the amount of thinner so that the rate of paint flow will be within the range agreed upon by concerned parties.

(c) Record the dilution ratio obtained in this test in terms of weight ratio, and use this ratio when preparing test paint for other test items.

Note ([2]): Use a Ford cup specified in JIS K 5400 as shown in Figure 1.3.

(d) Calibrate the Ford cup as follows:
Measure the flow time of paint using JS100 or JS200 specified in JIS Z 8809 and using the method specified in JIS K 5400. Plot a graph as shown in Figure 2 using the kinematic viscosity and measure flow time. Confirm that the flow time corresponding to the kinematic viscosity of 1×10^{-4} m^2 × 1/S {100 cSt} is 30.5±0.3 sec, and that the flow time corresponding to 2×10^{-4} m^2 × 1/S {200 cSt} is within the specified range ([3])

Note ([3]): The relationship is shown in Figure 2.

Figure 1.3 Ford cup #4

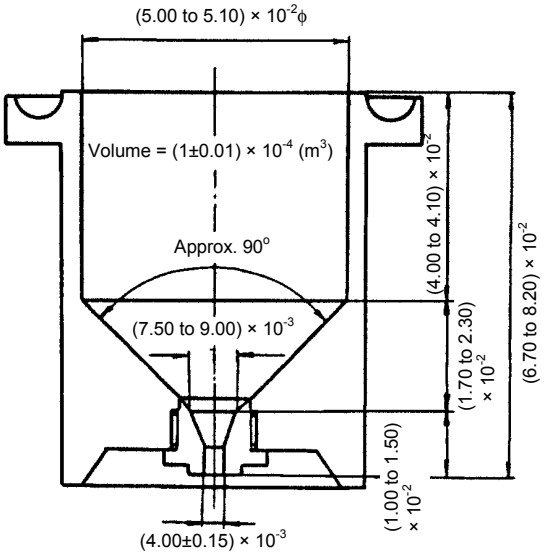
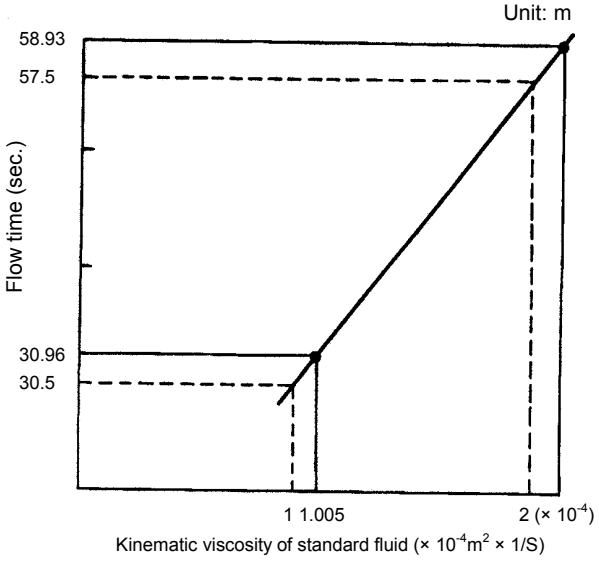


Figure 2 Kinematic viscosity vs. flow time



(2) Dilution of electrodeposition paint
Dilute the paint in a manner as agreed upon between concerned parties so that the nonvolatile content and other properties are within specifications.

Remark: Before starting the test, each test paint must be stirred continuously at the test temperature.

4.4 Coating

4.4.1 Coating the test panel

(1) Spraying

(a) Spray paint on the test panel with a spray gun so that a uniform paint film is created. The spray gun must have a nozzle diameter of 1.0 to 1.3 mm and be equipped with a paint cup. Adjust the air cap so that a uniform stream of atomized paint is achieved. Put the test paint in the cup and spray the paint while maintaining a constant air pressure of 0.29 to 0.49 MPa {3.0 to 5.0 kgf/cm^2}.

(b) Direct the spray gun nozzle toward the test panel. Maintain a constant distance of 15 to 25 cm between the nozzle tip and panel, and move the spray gun horizontally at a constant speed of 40 to 50 cm/sec.

(c) Maintain the direction of the major stream of atomized paint perpendicular to the test panel surface. Move the spray gun so that a uniform paint film is applied at least 10 cm outside the periphery of the panel. Each pass of the gun should overlap with the previous by approximately 1/3 in width.

(2) Electrodeposition

Use a nonconductive plastic tub and stainless steel plates as electrodes for electrodepositing on the test panel. Record the distance between electrodes and the polar ratio. Raise the voltage from 0 V to the specified voltage over a period of 30 seconds. Maintain that voltage for the specified time period. After electrodepositing, wash the test panel with tap water, then wash with deionized water.

(3) Other painting methods

When employing other painting method such as dipping, flow coating and electrostatic coating, apply paint in a manner specified for each method so that a uniform paint film is obtained.

4.4.2 Hardening of paint film

Unless otherwise specified, the topcoat and intermediate coat must be allowed to harden by maintaining the painted panel for 20 minutes at the temperature of 140^{o}C {413 K} for intermediate coat, or 170^{o}C {443 K} for electrodeposition coat. Natural drying type paint must be dried under the conditions agreed upon between concerned parties.

4.4.3 Curing of the specimen

The specimen must be left as is in the test room for more than 24 hours after baking. The specimen with natural drying type paint must be tested immediately after drying.

4.4.4 Coating process and film thickness

(1) Coating process

Basically, the typical coating processes listed in Table 4 must be used. When using any other process, agreement must be achieved between the concerned parties, and the process be recorded.

Table 4 Example of coating processes

(Thickness: μm, temperature: °C)

No.	Process / Drying condition / Film thickness (μm) / Purpose	Pretreatment (degreasing and chemical conversion)	Dewatering and drying	Electrodeposition	Baking	Polishing (partial)	Undercoat	Stone-guard coat (including dust portion)	Touch-up primer coat (including dust portion)	Intermediate coat	Topcoat for interior: Normal	Topcoat for interior: Dust	Black coat for sash: Normal	Black coat for sash: Dust	Baking	Topcoat	Baking
	Drying condition		120°C, 10 minutes		170°C, 20 minutes										140°C, 20 minutes		140°C, 20 minutes
	Film thickness (μm)			15 to 20			Thin film 150 to 250 Thick film 600 to 800	Thin film 90 to 110 Thick film 270 to 330	15 to 20	30 to 40			15 to 20			Base 10 to 15 Clear 20 to 36 Solid 30 to 40	
1	Outer panel in general For dressing up For rust prevention	O	O	O	O					O					O	O	O
2	Rust prevention on floor portion	O	O	O	O		O								O		O
3	Prevention of damage and rust caused by flying pebble (mainly on side portion)	O	O	O	O			O		O					O	O	O
4	Prevention of rust on repaired panel	O	O	O	O	O			O	O					O	O	O
5	For dressing up of sash	O	O	O	O								O		O		O
		O	O	O	O									O	O	O	O
6	For dressing up of engine compartment, etc.	O	O	O	O						O				O		O
		O	O	O	O							O			O	O	O

(2) Film thickness

The thickness of films must be as specified in Table 5. The film thickness of other paint must be as agreed upon between concerned parties.

Table 5 Specimen film thickness

(Unit: μm)

Film type			Film thickness
Electrodeposition film			15 to 20
ACC film			3 to 5
Intermediate coat film			20 to 30 (25 to 30 for thick film)
Intermediate coat black film			15 to 20
Topcoat film	1C1B film		30 to 40
	2C1B film	Base coat	10 to 15
		Clear coat	20 to 30
	3C2B film	Color base coat	30 to 35
		Pearl base coat	15 to 20
		Clear coat	20 to 30
Natural drying black coat film			5 to 10

4.4.5 Measurement of film thickness

Film thickness must be measured using an electromagnetic thickness gauge. Measure the thickness at more than three places for each specimen, and average the measured values.

Perform zero-point adjustment and standard thickness adjustment before measuring each specimen.

4.4.6 Paint evaluation area of specimen

Unless otherwise specified, the evaluation of paint film must be made within an area 5 mm {0.005 m} in from each edge of the specimen.

5. PAINT CONDITIONS TEST METHOD

5.1 Purpose

To check if the stock paint and test paint are in the uniform state ([4]) and suitable for use, by manually stirring the paint in the container.

5.2 Test condition

Room temperature specified in 4.1.2 (2)

5.3 Procedure

(1) Stir the stock paint or test paint in container with a spatula or a rod, and check for separation or gel on the bottom.
(2) Where separation or gel is found, check whether or not the content can be easily and uniformly mixed by stirring.([4])

Note ([4]): Uniform state of paint means there is an absence of any separation, sedimentation or gel in the paint.

5.4 Report

(1) Record the presence or absence of separation, gel and sedimentation in the paint.
(2) Record whether the paint can be easily and uniformly dispersed by stirring.

6. COVERING POWER TEST METHOD

6.1 Purpose

To measure the ability of the test paint to cover up the substrate

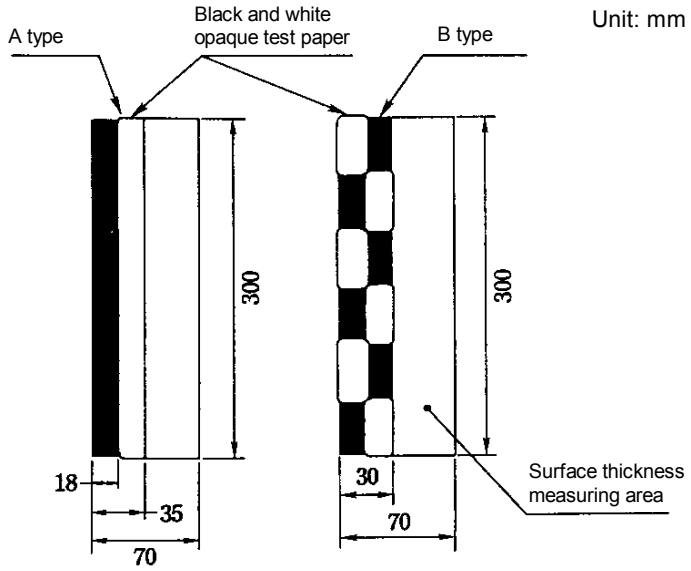
6.2 Equipment and tools

(1) Temperature controlled chamber
(2) Covering power test paper (black and white)
White surface with a diffuse reflectance at 45° and 0° of 80±1 and black surface with a diffuse reflectance not larger than 2.
(3) Electromagnetic thickness gauge

6.3 Specimen preparation

Using double-sided adhesive tapes as shown in Figure 3, bond the test paper on a test panel B specified in 4.2.2, which has been degreased with cleaning thinner.

Figure 3



6.4 Test condition

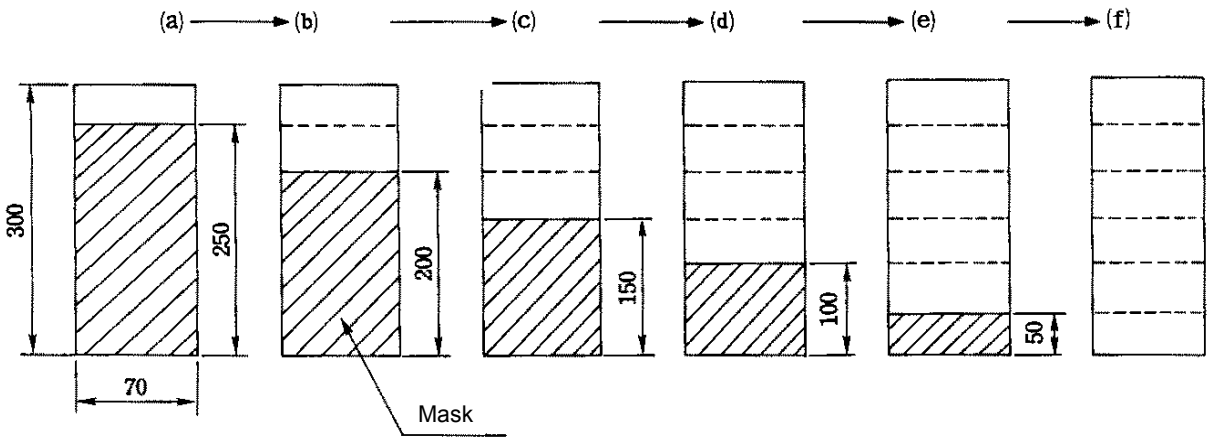
Spray booth specified in 4.1.1

6.5 Procedure

(1) Mask the bottom 25 cm area of the specimen with cardboard and apply test paint using spray, bar coater, or applicator.
(2) Mask the bottom 20 cm area of the specimen with cardboard and apply test paint.
(3) Repeat this operation until the specimen is coated with paint in six steps of thickness ([5]). (Refer to Figure 4.)
(4) Dry or bake the coated test panel under conditions agreed upon between concerned parties.
(5) Using the standard light D_{65} specified in Item 8 of JIS Z 8701 (Colour specification - The CIE 1931 standard colorimetric system and the CIE 1964 supplementary standard colorimetric system), find the point at which the black and white pattern of the test paper is no longer discernible when viewed at an angle of 45^{o}. (within the range from 0^{o} to 90^{o} in the case of metallic coating) Measure the film thickness at this point (in the thickness measuring area in Figure 3) with the electromagnetic thickness gauge.

Figure 4

Unit: mm



Note ([5]): The hidden portion must be at the center of the specimen.

6.6 Report

(1) Take the film thickness at which the black and white pattern of the test paper is no longer discernible as the covering power. Express the power as an integer obtained by rounding the average of three measurements.
(2) Use the unit of μm.
(3) Record the type of the test paper used.

7. SPECIFIC GRAVITY TEST METHOD

7.1 Purpose

To measure the specific gravity of paint and paint film

Remarks: 1. The method using the specific gravity cup and measuring instrument is described as a measuring method.
2. As an example of paint film preparation method for measuring the specific gravity of paint film, the method using mercury is described. The paint film may be prepared using any other method.

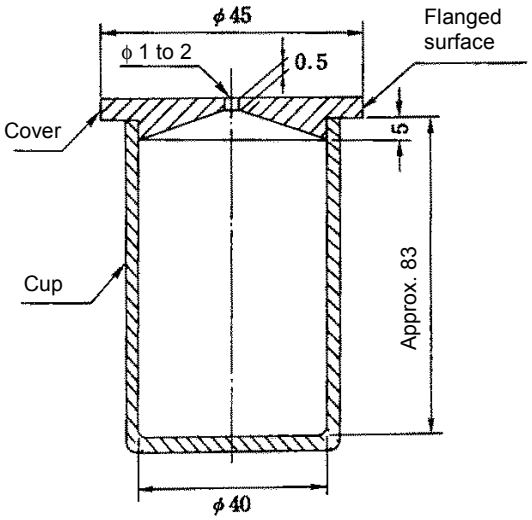
7.2 Equipment and tools

(1).1 When measuring the specific gravity of paint (specific gravity cup method)

1) Specific gravity cup
The specific gravity cup specified in Item 4.6.2(2) of JIS K 5400 (Testing methods for paints) must be used. (Refer to Figure 5.)

Figure 5 Specific gravity cup

Unit: mm



Remarks: 1. The weight of the cup must be less than 200 g.
2. The cup must have a capacity of 100±1 g of water.

2) Weight substitute
3) Pan balance (Capacity: 500 g, sensitivity: 0.5 g)

(1).2 Tools for measuring the specific gravity of paint (Measuring method using a hydrometer)

1) Hydrometer (HD1 manufactured by Malcolm Co., Ltd. or equivalent)
2) Spirit level

(2) When measuring the specific gravity of paint film

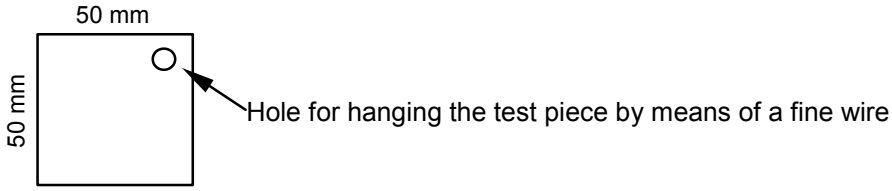
1) Precision balance (1 mg sensitivity)
2) Pendant balance (1 mg sensitivity)
3) Fine wire (e.g., a tag wire or a paperclip)
4) Beaker (500 mℓ)
5) Tin box [for intermediate and topcoats (base, clear)], tin plate [for undercoat (electrodeposition)]
6) Cutter
7) Tweezers
8) Hollow pun
9) Solvent for measurement: Highest quality ethanol (purity: 99.5%)
10) Liquid temperature measuring instrument

7.3 Specimen preparation (measurement of the specific gravity of paint film)

(1) For intermediate and topcoats (base, clear)

1) As the test piece, use a piece of tin foil to which the test paint is applied in accordance with Item 4.4 of this Standard or Item 4.3 of NES M0141. Refer to the corresponding sections of Item 4.4 of this Standard or Item 4.3 of NES M0141 as required.
Quantity of paint to be applied: 100 g/m^2 or so (As a guide, apply 10 g of primer coat and 8 g of intermediate and clear coats to a 300 × 300 mm piece of tin foil.)
2) Using a cutter, cut the test piece referred to in 1) into 50 × 50 mm pieces.
3) Punch a hole in the test piece to hang the test piece by means of a fine wire. (Refer to Figure 6.)
4) Peel the paint film off the test piece using tweezers, starting at a corner.

Figure 6 Preparation of a test piece



(2) Undercoat (electrodeposition)

1) Follow the instructions in 4.4 and use electrodeposition to apply a coat of 30 μm to the tin plate. The size of the tin plate shall be type A as specified in 4.2.2. Use tape to mask the edge before the electrodeposition. (masking width: approximately 5 mm).
2) After electrodeposition is completed, remove the masking tape. Then immerse the tin plate (coated in step 1) in a mercury bath.
3) Step 2 above causes the mercury and the tin on the tin plate to form an amalgam. This allows the electrodeposited coat to be separated as a free film. At this time, use a brush, air blow, or other means to remove impurities, so that no mercury, amalgam, or other impurities remain on the film.
4) Use a cutter and punch to create a test piece from this film, as shown in Figure 6 (the same as the topcoat test piece).

7.4 Test condition

Standard condition specified in 4.1.2(1)

7.5 Procedure

(1).1 When measuring the specific gravity of paint (specific gravity cup method)

1) Maintain the stock paint at 20±2°C for approximately 3 hours. Carefully fill the cup with the stock paint so as not to introduce any air bubbles into the paint. Cover and wipe off any paint that seeps from the hole in the cover.
2) Place the cup on one side of the pan balance and place the counter weight for the cup and the weight of the balance on the other side of the pan, then measure the weight of the paint. Multiply the number of grams of the balance weight by 0.01 to obtain the specific gravity of the paint. The counter weight should be lead shots or similar material, prepared so that the difference in weight is within 0.5 g from the weight of the dry and empty cup.

(1).2 When measuring the specific gravity of paint (Measuring method using a hydrometer)

1) Install the hydrometer horizontally using a sprit level, and then calibrate it.
2) Stir the paint well and immerse the probe completely into it.
3) About 10 seconds after the start of measurement, when the reading has stabilized, take a reading of the hydrometer.

(2) When measuring the specific gravity of coated film

1) Weigh the test paint film in the air in milligrams using a precision balance. [Let W1 represent the weight of the test piece in the air (g).]
2) Fill the beaker with solvent for measurement.
3) Measure the solvent temperature.
4) Hang a fine wire from the pendant balance, dip it into solvent to a depth of about 20 mm, and make a zero adjustment of the balance. (Refer to Figure 7.)
5) Hang the paint film by means of a fine wire and immerse the paint film completely into the solvent. At that time, be sure to immerse the paint film so that the wire is dipped to the same depth it was dipped when the zero adjustment was made. (Refer to Figure 7.)
6) Make sure that no air bubbles are found on the surface of the test piece. Let it stand in the solution for 30 seconds.
7) Weigh the test piece in the solution in milligrams. [Let W2 represent the weight of the test piece in the solution (g).]
8) Calculate the specific gravity and 3σ of the paint film using the following equation.

$$\text{Specific gravity} = \frac{\mathbf{W}1 \times \text{Specific gravity of the solvent}}{\mathbf{W}1 - \mathbf{W}2} \qquad 3\sigma = 3\times \sqrt{\frac{n(\Sigma x^2) - (\Sigma x)^2}{n(n-1)}}$$

9) Carry out the measurement 5 times and calculate the average specific gravity and 3σ to the third decimal place. If one of the five measured values is greatly different from the others, use the four measured values excluding the singular one to calculate the average specific gravity and 3σ of the paint film.

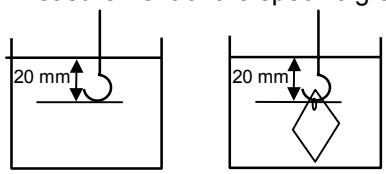
For identifying a singular value, use the formula below. A singular value is judged to exist if the formula is satisfied.

$$| \quad \bar{x} \pm 3\sigma \quad \text{for 4 points excluding the singular value} | \quad < \quad | 1 \text{ (singular value)} |$$

10) Perform the test again if the following condition is not met: or $3\sigma \leq 0.010$ for the intermediate or topcoat, or $3\sigma \leq 0.050$ for the electrodeposited coat.

Remark: Polypropylene test pieces may be used to create separate paint film test pieces as long as this does not adversely affect paint film characteristics.

Figure 7 Measurement of the specific gravity of a paint film



7.6 Report

Take the average of three measurements and record the specific gravity of paint which is rounded off to the second decimal place.
Record the average specific gravity and 3σ of the paint film which is rounded off to the third decimal place. If the condition is not satisfied even though the test was conducted again, report the average value calculated from the values measured in the first or second test, whichever produced the smaller 3σ, along with the smaller 3σ.

8. NONVOLATILE CONTENT TEST METHOD

8.1 Purpose

To measure the nonvolatile content of stock paint

8.2 Test methods

Method A: Heat drying
Method B: Vacuum drying

8.3 Heat drying (method A)

8.3.1 Equipment and tools

(1) Temperature controlled chamber
(2) Aluminum foil or tin plate pan (70 mm in diameter and 15 mm in depth)
(3) Desiccator
(4) Precision balance

8.3.2 Test conditions

(1) Standard condition specified in 4.1.2(1)
(2) Heating temperature: 105 to 110°C
(3) Heating time: 3 hours

Remarks: Baking conditions for checking the appearance of paint film shall be as agreed upon between concerned parties.

8.3.3 Procedure

(1) Quickly place 0.7±0.05 g of stock paint on an aluminum foil or tin plate pan which weight is known, measure the weight of the paint to the second decimal place, and then quickly spread the paint over the entire bottom surface of the pan. [However, for the electrodeposited coat, use the resin clear (F1), pigment paste (F2), and a mixture of F1 and F2 in the designated proportions.]
(2) Evaporate the volatile component by drying for a specified time at a specified temperature in the temperature controlled chamber.

(3) Remove the dried sample from the chamber, allow it to cool in the desiccator, and then measure the total weight of the sample and foil or pan to the second decimal.
(4) Calculate the nonvolatile content using the following equation:

$$\text{Nonvolatile content (\%)} = \frac{A}{S} \times 100$$

where A: Mass of residue in aluminum foil or tin plate pan (g)
S: Mass of stock paint (g)

8.3.4 Report

Record the weight percentage (wt%) of the nonvolatile content and report the average value and 3σ rounded off to the second decimal place.

8.4 Vacuum drying (method B)

8.4.1 Equipment and instruments

(1) Vacuum drying furnace [degree of vacuum: 66.661 Pa (0.5 Torr) or less]
(2) Precision balance (sensitivity: 1 mg)
(3) Aluminum dish (diameter: 70 mm, depth: 15 mm)
(4) Aluminum plate (120 × 120 mm or so)
(5) Petri dish used as a cover (diameter: 100 mm, depth: 35 mm or so)
(6) Glass injection syringe

8.4.2 Test conditions

(1) Standard conditions specified in 4.1.2 (1)
(2) Vacuum drying conditions: Vacuum of 66. 661 Pa (0.5 Torr) or less, at ordinary temperature
(3) Vacuum drying time: 240 hours

8.4.3 Procedure

1) Test piece preparation
(1) Weigh the petri dish in the precision balance. [Let S represent the petri dish weight (g).]
(2) Make a zero adjustment of the precision balance with the aluminum dish placed on top of the balance. After that, do not remove the aluminum dish until the initial weight of the test piece is measured.
(3) Clean the aluminum dish with alcohol and weigh it after it has dried. [Let A represent the aluminum dish weight (g).]
(4) Sample 0.7± 0.05 g of fully stirred test paint using a syringe cleaned with thinner.
(5) Inject test paint onto the aluminum plate on top of the precision balance, and then cover it with the petri dish.
(6) Measure the initial weight of the test piece. [Let W1 represent the initial weight of the test piece (g).]
(7) Remove the aluminum dish and spread the paint all over the dish.

2) Calculating the weight percentage of the nonvolatile content
(1) Place the aluminum dish in the vacuum drying furnace, evacuate the furnace to the specified vacuum, and dry the test piece under the specified vacuum for the specified time.
(2) Take the aluminum dish out of the vacuum drying furnace and weigh it in the precision balance. [Let W2 represent the aluminum dish weight at that time (g).]
(3) Calculate the weight percentage and 3σ of the nonvolatile content using the following equation.

$$\underset{(\%)}{\text{Nonvolatile content}} = \frac{W_2 - A}{W_1 - A - S} \times 100 \qquad 3\sigma = 3 \times \sqrt{\frac{n(\Sigma x^2) - (\Sigma x)^2}{n(n-1)}}$$

(4) Carry out the measurement 5 times, and calculate the average weight percentage and 3σ of the nonvolatile content to the third decimal place. If one of the five measured values is greatly different from the others, use the four measured values excluding the singular one to calculate the average weight percentage and 3σ of the nonvolatile content.
For identifying a singular value, use the formula below. A singular value is judged to exist if the formula is satisfied.

$$\left| \bar{x} \pm 3\sigma \text{ for 4 points excluding the singular value} \right| < \left| 1 \text{ (singular value)} \right|$$

(5) If the condition $3\sigma \leqq 0.50$ (%) is not satisfied, conduct the test all over again.

8.5 Report

Record the weight percentage (wt%) of the nonvolatile content and report its average weight percentage and 3σ rounded off to the second decimal place.

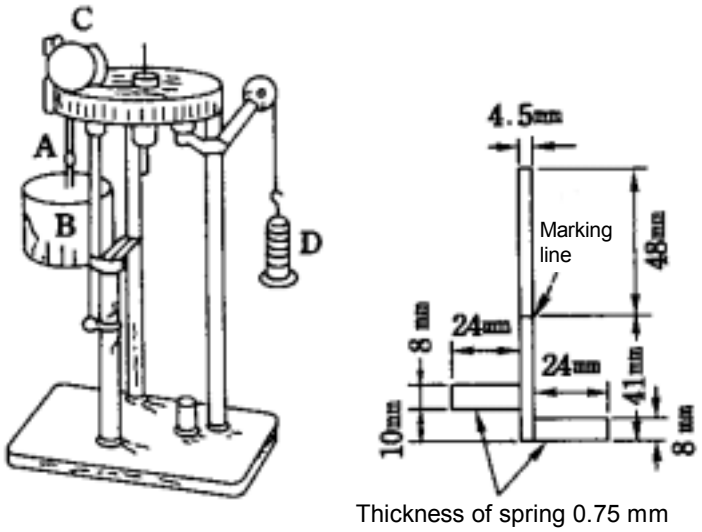
If the condition is not satisfied even though the test was conducted again, report the average weight percentage of the nonvolatile content calculated from the values measured in the first or second test, whichever produced the smaller 3σ, along with the smaller 3σ.

9. VISCOSITY TEST METHOD

9.1 Types of test method

(1) Stormer viscometer method (Refer to Figure 8.)
(2) Rotational viscometer method (Refer to Figure 9.)
(3) Ford cup method

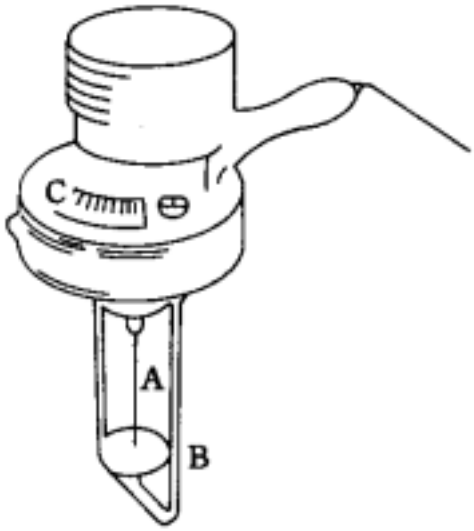
Figure 8 Stormer viscometer



Thickness of spring 0.75 mm

A: Rotor
B: 1-pint can
C: Rotation speed indicator
D: Weight

Figure 9 B type viscometer



A: Loader
B: Guard
C: Indicator

9.2 Stormer viscometer method

9.2.1 Purpose

To measure the viscosity of stock paint with a Stormer viscometer

9.2.2 Equipment and tools

(1) Temperature controlled chamber or temperature controlled water bath
(2) Stormer viscometer
(3) Container (80 mm inside diameter and 120 mm deep)
(4) Stopwatch
(5) Thermometer

9.2.3 Test conditions

Standard condition specified in 4.1.2(1)

9.2.4 Procedure

(1) Put approximately 500 ml of stock paint in the container. Place the container and paint in the temperature controlled chamber or temperature controlled water bath controlled at 20±1°C for approximately 3 hours. Make sure the paint temperature is uniform throughout its entire volume.
(2) Stir the paint with a glass rod, taking care not to introduce any air bubbles. Immerse the rotary spring blades of the viscometer in the paint until the gauge mark is at the liquid surface. Adjust the weight so that the blade will make 100 turns in 30±3 seconds. Measure the time (in seconds) required for the blade to make 100 turns. Find the viscosity from the conversion table furnished with the viscometer.

9.2.5 Report

(1) Calculate the average of three measurements, and record the viscosity to he nearest integer.
(2) Use the unit of KU at 20°C. (KU/20°C)
(3) Record the weights used.

9.3 Rotational viscometer method

9.3.1 Purpose

To measure the viscosity of stock paint using a rotational viscometer

9.3.2 Equipment and tools

(1) Temperature controlled chamber or temperature controlled water bath
(2) Rotational viscometer ([6]) specified in Appendix "Viscometer" of JIS K 7117. (Testing methods for viscosity with a rotational viscometer of resins in the liquid form) (Type BL, BH, BS, or BM viscometer) If higher precision is required in measurement, use the type E viscometer.
(3) Container (80 mm inside diameter and 120 mm in depth)
(4) Stopwatch
(5) Thermometer

Note ([6]): Select the rotor number and revolution speed of the viscometer so that the indicator readings fall within the range of 15 to 85% of full scale.

9.3.3 Test conditions

Standard conditions specified in 4.1.2 (1)

9.3.4 Procedure

(1) Place approximately 500 mℓ of stock paint in the container, and keep the container in a temperature controlled chamber or temperature controlled water bath at 20±1°C for approximately three hours. Make sure the paint temperature is uniform throughout its entire volume.
(2) Stir the paint carefully with a glass rod so as not to introduce any air bubbles. Allow it to stand for about one minute, then set the viscometer in position, taking care not to allow any air bubbles to attach to the rotor. Start measurement.
(3) Take the reading two minutes after starting rotation.
(4) Calculate the viscosity using the following equation:
Type B viscometer:
Viscosity (mPa·S {cPs} /20°C) = Reading × Conversion multiplier

9.3.5 Report

(1) Take the average of three measurements, and report the viscosity in two significant digits.
(2) Use the unit of mPa·S {cPs} /20°C.
(3) Record the type of viscometer used, rotor number and revolution speed([7]).

Notes ([7]): 1. Measurable viscosity range of rotational viscometer
2. Relationship between rotor number, revolution speed of type BH viscometer and applicable viscosity

9.4 Ford cup viscometer method

9.4.1 Purpose

To measure the viscosity of stock paint using a Ford cup viscometer

9.4.2 Equipment and tools

(1) Temperature controlled chamber or temperature controlled water bath
(2) Ford cup viscometer No. 4 (for thick viscosity), No.3 (for thin viscosity)(specified in JIS K 5400. Refer to Figure 1 to 3)
(3) Container attached as an accessory to viscometer
(4) Stopwatch
(5) Thermometer

9.4.3 Test conditions

Standard condition specified in 4.1.2 (1)

9.4.4 Procedure

(1) Place the stock paint in the temperature controlled chamber or temperature controlled water bath controlled at 20±1°C for approximately 3 hours. Make sure the paint temperature is uniform throughout its entire volume.
(2) Stir the stock paint carefully with a glass rod so as not to introduce any air bubbles. Plug the hole in the container bottom with a finger, and slowly pour the paint into the container taking care not to introduce air bubbles.
(3) Stop pouring when the paint is about to overflow. Slide a glass plate along the top edge of the viscometer to cover it while scraping out excess paint. Remove the finger from the bottom hole and quickly slide the glass off the viscometer while simultaneously starting the stopwatch.
(4) Allow the paint to flow from the viscometer into the receiver. Stop the stopwatch the moment the fine stream of poured paint separates for the first time.

9.4.5 Report

(1) Take the average of three measurements, and round to the nearest integer.
(2) Unit of measurement is seconds. (sec)

10. ASH CONTENT TEST METHOD

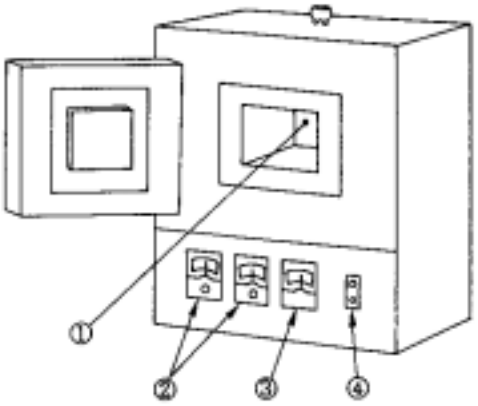
10.1 Essentials

The test specimen is heated until ashing occurs. From this remainder, the ash content is determined as a percentage.

10.2 Equipment

An electric oven that is able to maintain a temperature of 550°C. Figure 10 shows a representative oven.

Figure 10 Representative oven



① Heat-resistance brick chamber
② Temperature-control unit
③ Temperature gauge
④ Power On/Off switch

10.3 Procedure

(1) Set the electric oven to a constant temperature of approximately 550°C. Prepare a 30 ml PC1 B-type crucible. Measure out a test specimen of approximately 10 grams. Prepare a separate heat residue as described in Item 4. Use this residue to determine the ash content of the heat residue.
(2) To remove test specimen evaporation content, heat the test specimen with a hot water bath. Most of the evaporative content will boil off.
(3) Heat the test specimen gradually over a gas burner until ashing occurs. Take care not to scatter the specimen.
(4) Check that the oven([8]) is set to a temperature of approximately 550°C. Place the crucible in the oven for one hour. Remove the crucible from the oven. Place the crucible in a desiccator and allow it to cool. Remove the crucible from the desiccator. Measure the weight of the residual material.
(5) Once again, place the crucible in the oven for 30 minutes. Remove the crucible from the oven. Place the crucible in a desiccator and allow it to cool. Remove the crucible from the desiccator. Measure the weight of the residual material. Repeat this step until the difference in the measured weight of the before and after test specimen reaches a level of less than 1 mg.
(6) Examine the residual matter in the crucible.

Note ([8]): A gas burner may be used in place of the electric oven.

10.4 Calculation

(1) Use the following equation to calculate the ash content of the complete specimen.

$$A_1 = \frac{m_1}{m_2} \times 100$$

where A_1: Ash content of the complete test specimen (%)
m_1: Crucible residue (grams)
m_2: Test specimen weight (grams)

(2) Use the following formula to determine ash content of the heated residue.

$$A_2 = \frac{m_3}{m_4 \times B} \times 100 \times 100$$

where A_2: Ash content of the heated residue (%)
m_3: Crucible residue (grams)
m_4: Test specimen weight (grams)
B: Test specimen heat residue as determined in Step 4 above (%)

10.5 Report

(1) Take the average of three measurements, and record the ash content by rounding to three significant digits.
(2) Indicate the value in mass percentage. (%)

11. VOLATILE CONTENT TEST METHOD FOR ELECTRODEPOSITION PAINT

11.1 Purpose

To measure the amount of resin yielded from electrodeposited coating film

11.2 Sample

Use type A specimen prepared as specified in 4.4.1(2). (No baking is required.)

11.3 Equipment and tools

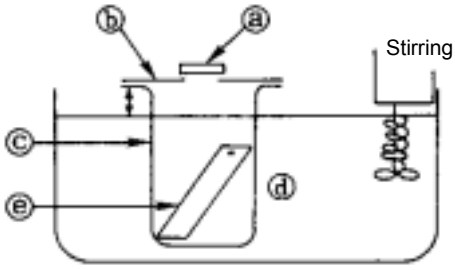
(1) Oil bath (with silicon oil)
(2) Tall beaker (capacity 200 ml)
(3) Resin sampling glass
(4) Sampling surface cover glass
(5) Direct-reading balance (sensitivity 1 mg)
(6) Desiccator

11.4 Procedure

(1) Place the specimen into the beaker, and place the sampling surface cover glass and the resin sampling glass, which has been weighed (A) in advance, on the beaker. Place the beaker into the 185°C oil bath. (Refer to Figure 11.)
(2) After heating the beaker for three hours, dry the resin sampling glass at 90°C for 60 minutes.
(3) After allowing the resin sampling glass to cool in the desiccator, measure the weight (B) of the sampling glass, the sampling area (C) and the resin coated area (D).
(4) Measure the electrodeposition paint coated area (E) and film thickness (F) on the specimen after test.
(5) Calculate the amount of resin using the following equation:

$$\text{Amount of resin} = \frac{(B - A) \times D/C}{E} \div F$$

Figure 11



ⓐ Sampling glass
ⓑ Sampling surface cover glass
ⓒ Tail beaker, 200 mℓ
ⓓ Silicon oil
ⓔ Specimen 70 × 150 mm; electrodeposited wet plate

11.5 Report

(1) Take the average of three measurements and round to the first decimal place.
(2) Use the unit of mg/cm^2·μ.

12. NEUTRALIZER CONCENTRATION TEST METHOD

12.1 Purpose

To measure uniform neutralizer concentration in diluted paint

12.2 Equipment and tools

(1) Potentiometric titration system (equipped with automatic buret, pH meter and recorder)
(2) pH meter
(3) N/10 hydrochloric acid (HCl) solution (Determine the normality in three significant digits in advance.)
(4) N/10 potassium hydroxide ethanol (KOH) solution or N/10 sodium hydroxide (NaOH) solution (Determine the normality in three significant digits in advance.)
(5) Tetrahydrofuran (Class 1) or butylcellosolve (Class 1)

12.3 Test conditions

Room temperature specified in 4.1.2(2)

12.4 Procedure

12.4.1 Anion electrodeposition paint

(1) Place approximately 5 g of sample in a beaker, and accurately weigh. Put a rotor in the beaker and add pure water while stirring to make a total volume of 200 ml.
(2) Calibrate the pH meter with the standard solution([9]) in advance.
(3) Titrate the sample by dripping N/10 hydrochloric acid solution using a 50 ml buret until the end point is reached, that is, until the pH value which has been agreed upon between concerned parties is maintained for one minute. Record the total volume of hydrochloric acid solution consumed.
(4) Calculate the amine value using the following equation:

$$\text{Amine concentration} = \frac{A \times B}{C \times \frac{D}{100}} \times 100$$

where A: Total amount of acid consumed (ml)
B: Normality of N/10 hydrochloric acid solution
C: Weight of sample (g)
D: Nonvolatile content of sample([10])(%)

Notes ([9]) : Use neutral phosphate (pH = 6.88) and phthalate (pH = 4.00) as standard solutions.
([10]): Measure the nonvolatile content in advance according to the method specified in 8. Nonvolatile Content Test Method.

12.4.2 Cationic electrodeposition paint

(1) Take approximately 10 g of sample in a beaker, and accurately weigh. Put a rotor in the beaker and add pure water while stirring to make a total volume of approximately 70 mℓ.
(2) Calibrate the pH meter with standard solution([9]) in advance.
(3) Using the potentiometric titration system, titrate the sample using N/10 potassium hydroxide ethanol solution or N/10 sodium hydroxide solution until pH has reached approximately 13.
(4) Record the total volume (A) of the N/10 potassium hydroxide ethanol solution or N/10 sodium hydroxide solution consumed until the inflection point is reached in the pH titration chart.
(5) Calculate the acid concentration using the following equation:

$$\text{Acid concentration} = \frac{A \times B}{C \times \frac{D}{100}} \times 100$$

where A: Total amount of alkali consumed (mℓ)
B: Normality of N/10 potassium hydroxide ethanol solution or N/10 sodium hydroxide solution
C: Amount of sample (g)
D: Nonvolatile content in sample([10])

12.5 Report

(1) Take the average of three measurements and round to three significant digits.
(2) Use the unit of milligram equivalent (MEQ).

13. pH TEST METHOD

13.1 Purpose

To measure the acidity or alkalinity of stock paint and diluted paint.

13.2 Equipment and tools

pH meter

13.3 Test conditions

Room temperature specified in 4.1.2 (2)

13.4 Procedure

(1) Calibrate the pH meter in advance using the standard solutions shown in Table 6.
(2) Place 100 g of paint in a beaker which is maintained at a temperature agreed upon between concerned parties, and measure the pH value using the method in JIS Z 8802. (Methods for determination of pH of aqueous solutions)

Table 6 pH of standard solutions at different temperatures

Temperature °C	Standard solutions				
	Oxalate	Phthalate	Neutral phosphate	Borate	Carbonate([11])
0	1.67	4.01	6.98	9.46	10.32
5	1.67	4.01	6.95	9.39	(10.25)
10	1.67	4.00	6.92	9.33	10.18
15	1.67	4.00	6.90	9.27	(10.12)
20	1.68	4.00	6.88	9.22	(10.07)
25	1.68	4.01	6.86	9.18	10.02
30	1.69	4.01	6.85	9.14	(9.97)
35	1.69	4.02	6.84	9.10	(9.93)
38	–	–	–	–	9.91
40	1.70	4.03	6.84	9.07	–
45	1.70	4.04	6.83	9.04	–
50	1.71	4.06	6.83	9.01	–
55	1.72	4.08	6.84	8.99	–
60	1.73	4.10	6.84	8.96	–
70	1.74	4.12	6.85	8.93	–
80	1.77	4.16	6.86	8.89	–
90	1.80	4.20	6.88	8.85	–
95	1.81	4.23	6.89	8.83	–

Note ([11]): Figures in ( ) represent secondary interpolated values.

13.5 Report

(1) Take the average of three measurements and round off to the first decimal place.
(2) Record the temperature at the time of measurement.

14. SEDIMENTATION TEST METHOD

14.1 Purpose

To check the degree of pigment sedimentation when diluted paint is allowed to stand for a long period.

14.2 Equipment and tools

(1) Measuring cylinder (500 mℓ)
(2) Glass rod
(3) Spray gun specified in 4.4.1 (1)
(4) Painting booth
(5) Baking oven
(6) Viscometer (Ford cup)
(7) Qualitative filter paper specified in JIS P3801 No. 5A

14.3 Specimen

Type C test panel (210 × 300 mm), specified in 4.2.2 and coated with electrodeposited intermediate coating

14.4 Test conditions

(1) Standard conditions specified in 4.1.2 (1)
(2) Settlement time: 72 hours

14.5 Procedure

(1) Dilute the stock paint by the method agreed upon between concerned parties.
(2) Take 500 ml of the diluted paint in the measuring cylinder. Seal the cylinder with polyethylene film, and allow it to stand for the specified time.

(3) Perform the following operations depending on the type of the paint.

1) Topcoat paint

① Visually and quantitatively check the separation of solvent and resin (including pigment), separation of pigment (original color) in the resin (including pigment), and the sedimentation of aluminum in the resin (including pigment), and show the results through pictures.
② Tightly holding the cover of the measuring cylinder with a hand, turn the cylinder upside down and back. Repeat this operation 10 times in 20 seconds.
③ Pour the upper layer 250 mℓ of paint into the cup of a spray gun by tilting the cylinder, then stir the paint thoroughly in the cup.
④ Stir the lower 250 mℓ layer of paint thoroughly in the cylinder and pour it into the cup of another spray gun.
⑤ Spray each sample paint onto the respective test panels and bake the panels using the method specified in 4.4.
⑥ Check both specimens for their coated surface appearance using the method specified in 20., the gloss as specified in 21., and for the color difference as specified in 24.

2) Intermediate-coat paint
Visually check for separation of layers and also check the amount of sediment.

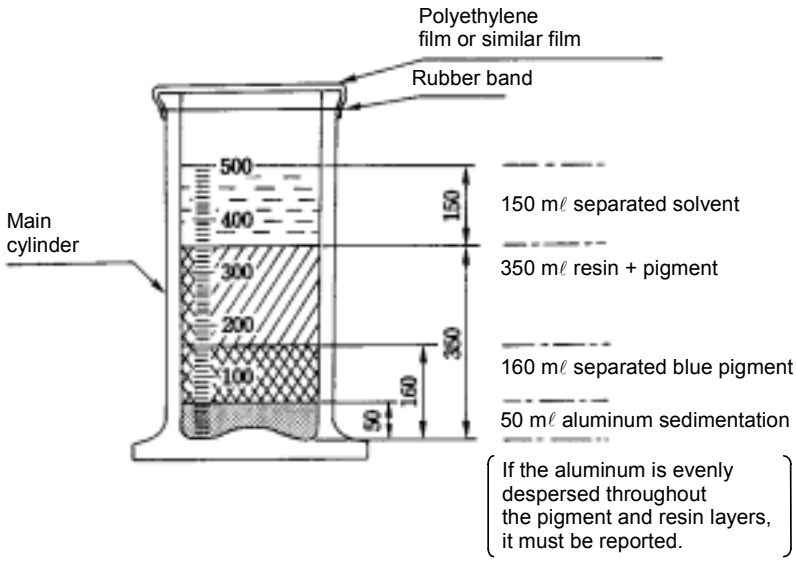
3) Undercoat paint
Stir the paint thoroughly with a glass rod, and filter the paint using No. 5A filter paper to check for undissolved substances.

14.6 Report

(1) Topcoat paint

1) Pictorially show the layer separation and the quantity of sediment in ml as shown in Figure 12.
2) Record the difference in appearance, gloss and color of two specimens.
3) Record the conditions and differences of two specimens according to 20.2, 21.6 and 24.3.

Figure 12



(2) Intermediate-coat paint

1) Record the layer separation in the same manner as (1).
2) Record whether undissolved substances are found.

(3) Undercoat paint
Record whether undissolved substances are found.

15. STORAGE STABILITY TEST METHOD

15.1 Purpose

To measure the stability of stock paint after long-term storage by using the accelerated test method

15.2 Equipment and tools

(1) Temperature controlled chamber
(2) Container
Method A (ordinary paint): 300 ml capacity tin or glass bottle
Method B (electrodeposition paint): 2 l capacity tin or glass bottle

15.3 Specimen preparation

Use type C test panel (210 × 300 mm) specified in 4.2.2.

15.4 Test conditions

(1) Paint room as specified in 4.1.1
(2) Room temperature as specified in 4.1.2(2)
(3) Heating temperature: 50±2°C (40±2°C for cationic electrodeposition paint)
(4) Heating time: 72 hours

15.5 Procedure

15.5.1 Method A (Ordinary paint)

(1) Seal approximately 250 mℓ of stock paint in the container and heat it in the temperature controlled chamber for the specified time at the specified temperature.
(2) Take a portion of the stock paint from the container, and dilute it using the method agreed upon between concerned parties, then measure the quantity of diluted paint.
(3) Using the diluted sample paint, check the painted surface for appearance, difference in color and change in gloss.

15.5.2 Method B (Electrodeposition paint)

(1) Seal approximately 1 ℓ of stock paint in the container, and heat it in the temperature controlled chamber for the specified time at the specified temperature.
(2) Dilute the stock paint using the method agreed upon between concerned parties, and measure the quantity of diluted paint.
(3) Using the diluted paint, check for pH, conductivity, coulomb efficiency, dilution dispersibility, sedimentation, throwing power and the appearance of painted surface.

15.6 Report

(1) Record the rate of dilution.
(2) Method A (ordinary paint): Record the appearance of painted surface, difference in color and change in gloss.
(3) Method B (electrodeposition paint): Record pH value, conductivity, coulomb efficiency, dilution dispersibility, sedimentation, throwing power and the appearance of painted surface.

16. DILUTION DISPERSIBILITY TEST METHOD

16.1 Purpose

To check if the stock paint is easily and uniformly dispersed by dilution

16.2 Material

Quantitative filter paper specified in JIS P3801 as No. 5A

16.3 Test conditions

Room temperature specified in 4.1.2

16.4 Procedure

(1) Dilute the stock paint by the method agreed upon between concerned parties so that nonvolatile content is within the specified range.
(2) Drop approximately 1 mℓ of diluted paint on the filter paper and check for any undissolved substances.

16.5 Report

Record whether undissolved substances are found.

17. CONDUCTIVITY TEST METHOD

17.1 Purpose

To measure the conductivity of diluted paint

17.2 Equipment and tools

(1) Temperature controlled chamber
(2) Conductometer
(3) Beaker (capacity of 100 to 200 mℓ)

17.3 Test conditions

Room temperature specified in 4.1.2 (2)

17.4 Procedure

(1) Dilute the stock paint using the method agreed upon between concerned parties.
(2) Place the sample paint in a beaker and adjust the sample paint's temperature to that agreed upon between concerned parties.
(3) Immerse the cell([12]) of the conductometer in the sample paint, thoroughly agitate the paint, and read the conductivity one minute after agitation.

Note ([12]): After measurement, thoroughly wash the conductometer cell with deionized water, and keep it in a beaker filled with deionized water.

17.5 Report

Report the conductivity in μS/cm |μ℧/cm|.

18. COULOMB EFFICIENCY TEST METHOD

18.1 Purpose

To measure the weight of deposited paint film per unit quantity of electricity or Coulomb.

18.2 Equipment and tools

(1) Electrodeposition system, including DC power supply, electrodeposition vessel, etc.
(2) Ammeter or coulomb-meter
(3) Chemical balance

18.3 Test panel

Type A test panel (70 × 150 mm) specified in 4.4.2

18.4 Test conditions

Room temperature specified in 4.1.2(2)

18.5 Procedure

(1) Measure the weight (W_1) of the test panel.
(2) Perform electrodeposition coating under conditions agreed upon between concerned parties. Wash the specimen with water and bake dry according to the procedure specified in 4.4.2.
(3) Allow the specimen to cool to room temperature and weigh (W_2).
(4) Record the change in the electrodeposition current and measure the amount of electricity([13]) required for coating.

(5) Calculate the Coulomb efficiency using the following equation.

$$\text{Coulomb efficiency (mg/C)} = \frac{W_2 - W_1}{Q}$$

where W_1: Weight of specimen before coating (mg)
W_2: Weight of specimen after electrodeposition and drying (mg)
Q: Quantity of electricity consumed (Coulomb)

$$Q = \int_0^1 idt \text{ (Coulomb)} \qquad t: \text{Energized time}$$

Note ([12]): The amount of electricity is directly indicated on the coulomb-meter.

Remark: The quantity of electricity (Q: Coulomb) is represented by the area surrounded by the curve and the axis of the coordinate in the current (i) vs. time (t) curve. The area can be obtained by using a planimeter or by counting the number of squares on a grid sheet.

18.6 Report

(1) Indicate the coulomb efficiency in mg/C.
(2) Record the conditions under which electrodeposition was performed.

19. THROWING POWER TEST METHOD

19.1 Purpose

To examine the amount of paint attached to the test panel's corner portion as an indicator of paint film formation on closed internal surfaces of car body structure

19.2 Equipment and tools

(1) Throwing power tester (Refer to Figure 13.)
Equipment configuration
Electrodeposition bath: Stainless steel bath of 100 mm inner diameter and 30 mm deep
Stirrer: Magnetic stirrer
Shielding pipe: Steel pipe of 17.5 mm inner diameter and 300 mm long
Film thickness measurement: Electromagnetic film thickness gauge
(2) Box method tester (Refer to Figure 14.)
Film thickness measurement: Electromagnetic film thickness gauge

19.3 Test panel

(1) Test panel a
Use a 30 mm × 150 mm steel plate specified in 4.2.1, and pretreat it in accordance with 4.2.3 (Refer to Figure 16.)
(2) Test panel b
Use a 15 mm × 300 mm steel plate specified in 4.2.1, and pretreat it in accordance with 4.2.3 (Refer to Figure 17.)
(3) Test panel c
Use a 70 mm × 150 mm steel plate specified in 4.2.1, and pretreat it in accordance with 4.2.3 (Refer to Figure 18.)

Figure 13

Unit: mm

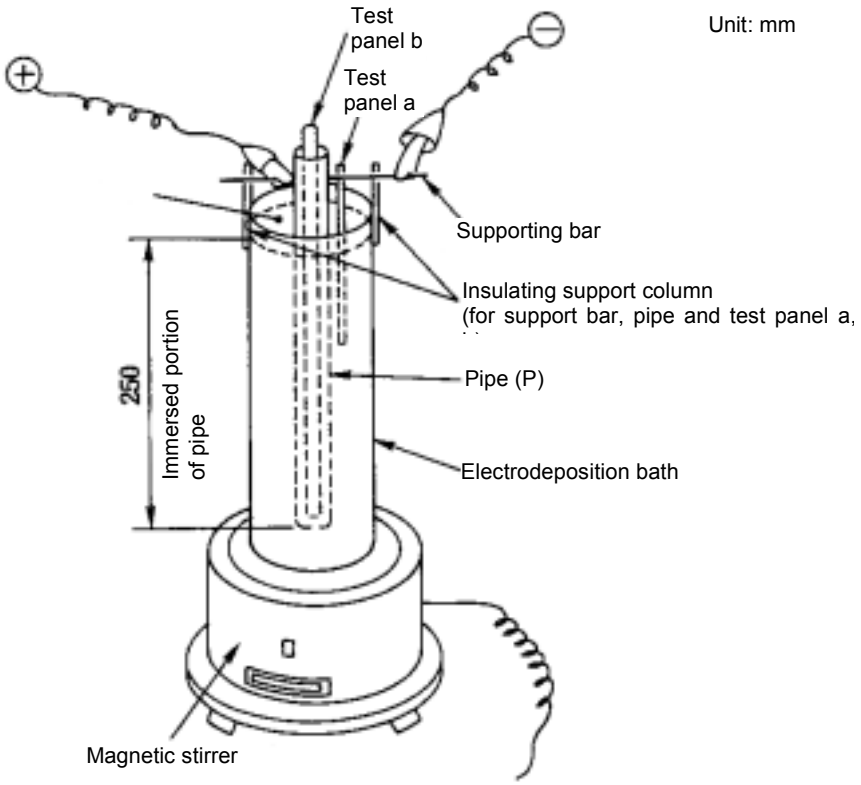


Figure 14

Unit: mm

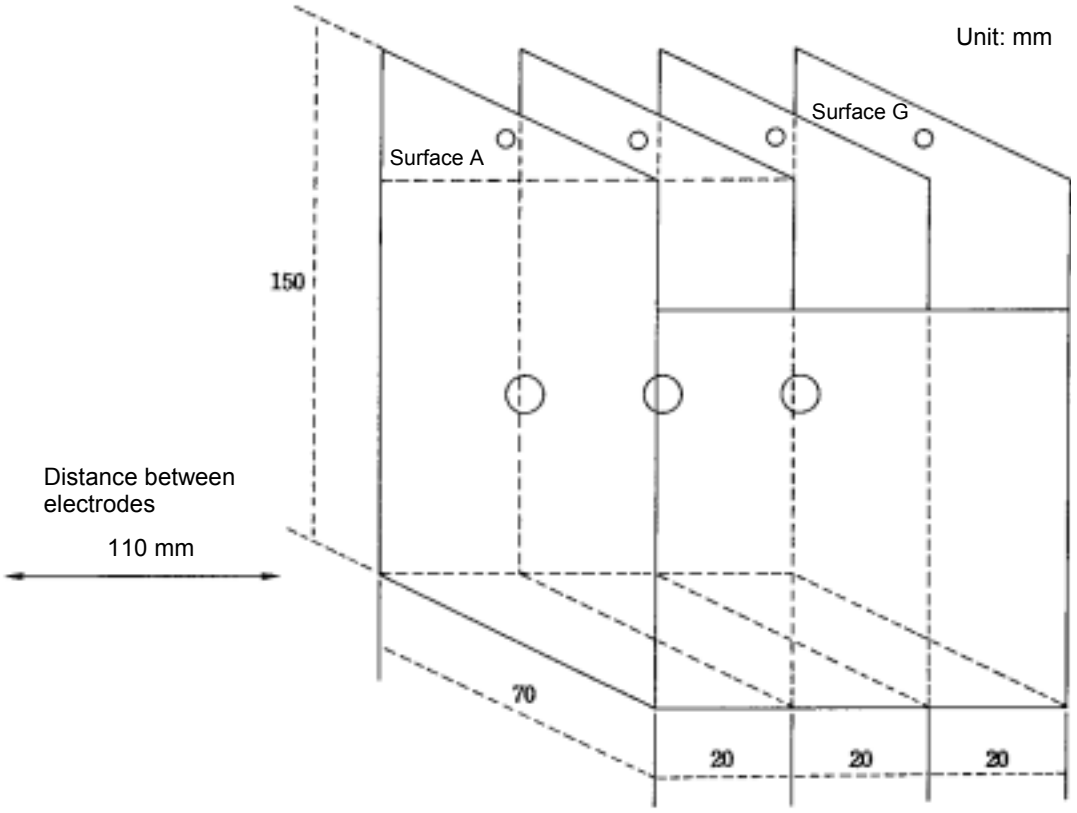


Figure 15 Test panel a
Unit: mm

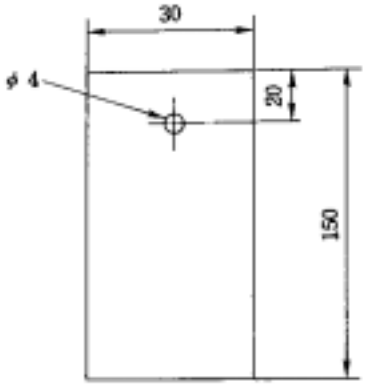


Figure 16 Test panel b
Unit: mm

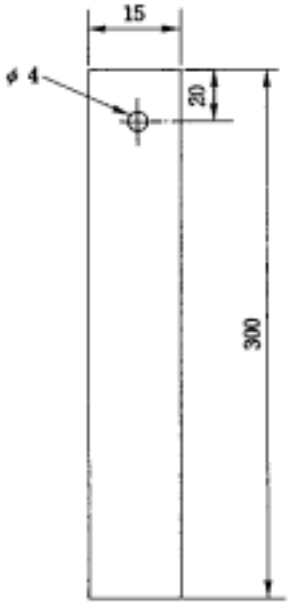
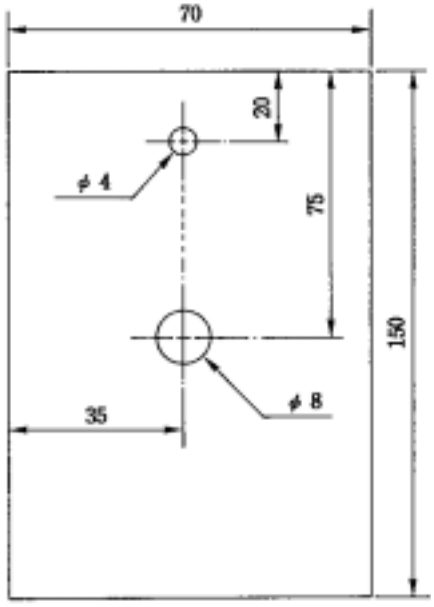


Figure 17 Test panel c
Unit: mm



19.4 Test conditions

Room temperature specified in 4.1.2(2)

19.5 Procedure

(1) Throwing power testing method

1) Pour the test paint in the electrodeposition bath to a level 280 to 290 mm above the bottom. While stirring with the magnetic stirrer, adjust it to the temperature as agreed upon between concerned parties.
2) Attach test panel a, pipe (P) and test panel b to the support bar, which serves as a cathode ([14]), as shown in Figure 13. Immerse these parts into the electrodeposition bath.
3) Perform electrodeposition coating using the electrodeposition bath as the anode, under conditions agreed upon between concerned parties. Rinse the coated panel with water and bake under conditions specified in 4.4.2.
4) Measure the paint thickness on specimen a (in μm) and the height of coating on specimen b (in cm) after baking.
5) Throwing power of the paint shall be determined as the height of coating on specimen “b” when the coating thickness on specimen “a” reaches the specified value. Specimen b height is defined as that portion where no rust was occurred after 24-hour salt spray test.

Note ([14]): This polarity is for cationic electrodeposition. The polarity must be reversed in anion electrodeposition.

(2) Throwing power test by box method

1) By placing four test panels placed at 20 mm intervals, prepare a box-shape test panel.
2) Secure four test panels with adhesive tape, and completely seal the side and bottom face of the box which is formed by four steel plates.
3) Dip the box-shape test plate 140 mm in the electrodeposition fluid. After ensuring the three empty areas partitioned by the steel plates are filled with paint, perform electrodeposition under the following conditions:
   <Coating conditions>
   Coating voltage: Voltage high enough to deposit the specified thickness of paint film on the counter electrode surface of the box by energizing for 3 minutes
   Distance between electrodes: 110 mm
   Polarity ratio: ÷/– = 1 : 1 on counter electrode surface

4) After rinsing with water, bake under the standard conditions, then measure the thickness of film on the top and back sides of the four steel plates. Measure the paint film thicknesses from the test piece diagonal line intersection points (hole centers) to the area 5 cm away in each diagonal line direction.

19.6 Report

(1) Throwing power test

1) Indicate the throwing power in cm.

(2) Throwing power test by box method

1) Indicate the film thickness ratio of the inside and outside panels.
(Obtain the ratio of film thickness of the inside panel with respect to film thickness of the outside panel.)
2) Indicate the film thickness of four plates from surface A to surface G (Refer to Figure 14.)

20. COATED SURFACE REFLECTION SHARPNESS TEST METHOD

20.1 Purpose

To examine the outward appearance of coated surfaces

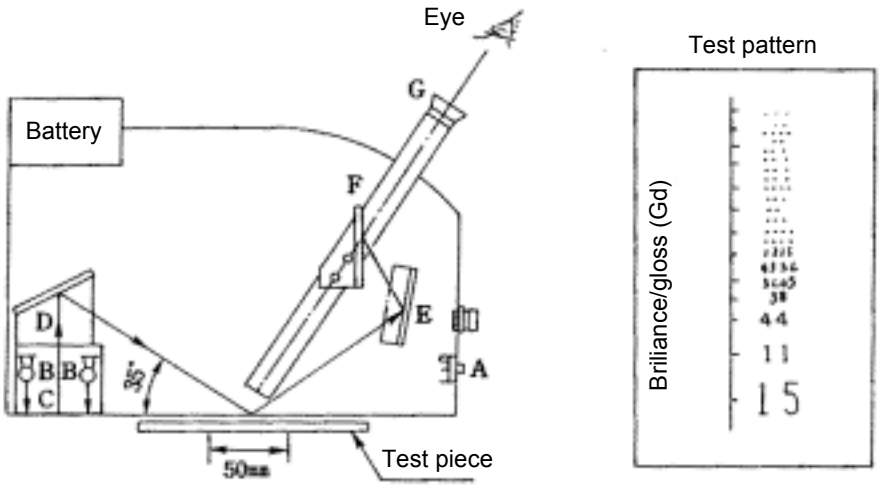
20.2 Test method types

Method A: Test by visual check
Method B: Test by instrument (Using PGD)
Method C: Test by instrument (Using NID)
Method D: Test by instrument (Using Wave scan)

20.3 Equipment

Portable gloss definition (PGD) meter (Refer to Figure 18.)

Figure 18 Portable gloss definition (PGD) meter



A: Switch B: Lamp C: Test pattern D,E, and F: Mirrors G: Eyepiece tube

20.4 Specimen preparation

Coat the test plate C (210 × 300 mm) specified in 4.2.2 using the painting method specified in 4.4.

20.5 Test conditions

Room condition as specified in 4.1.2 (2)

20.6 Procedure

(1) Method A

Visually compare the coated surface of the specimen with that of standard plate ([16]) under a fluorescent lamp or in diffused daylight ([15]). Check the surface for any runs, orange peel appearance ([17]), craters, nonuniformity, pin holes, blistering, water spots, or any other surface defects.

(2) Method B

(a) Place the portable gloss definition (PGD) meter on the specimen and turn the power switch on. Through the eyepiece, find the smallest readable figures reflected on the test pattern.

1) For 0.5 and higher scale points, take the value at which more than 50% of figures are readable.
2) If, for example, the figures at 0.5 and 0.3 scale points are readable while the figures at 0.4 point are not, then take the higher value 0.5.

(b) Read the scale number on the left side of the figures that are readable, and record as the measured value of the reflection sharpness of the painted surface.

Notes ([15]): Diffused daylight means indirect sunlight entering through a north-facing window from 3 hours after sunrise to 3 hours before sunset. The standard light D_{65} specified in Item 8 of JIS Z 8701 may be used as substitute.
([16]): The standard panel must be as agreed upon between concerned parties.
([17]): When orange peel effect is observed, the panel may be recoated with an air pressure of 0.2 to 0.25 MPa {2 to 2.5 kgf/cm^2} and a spray distance of 25 to 30 cm.

(3) Method C
Analyze the image reflected from the specimen surface using the sharpness measuring meter (NID meter) and record the value corresponding to the PGD value.

(4) Method D
Examine the surface of the test piece using WaveScan, and read the values of LongWave, ShortWave, du dullness, Wa, Wb, Wc, Wd, We, and DOI.

20.7 Report

(1) Method A
Record any surface defects.

(2) Methods B and C
Calculate to the first decimal place the average of three measurements taken at different points.

(3) Method D
Record the values of LongWave, ShortWave, du dullness, Wa, Wb, Wc, Wd, We, and DOI.

21. GLOSS TEST METHOD

21.1 Purpose

To measure the gloss of coated surface

21.2 Equipment

Use the specular gloss meter specified in item 7.6 of JIS K 5400, which permits the measurement of specular gloss from 20 to 60 degrees.

21.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, and coat with the sample paint in accordance with 4.4.

21.4 Test conditions

Room temperature specified in 4.1.2 (2)

21.5 Procedure

(1) Calibrate the measuring equipment using the reference surface([18]) specified in item 7.6 (2.2) of JIS K 5400.

(2) Measure the gloss of the specimen with an incident angle of 60^o and reflection angle of 60^o, or 20^o and 20^o. Using a black cloth, cover the area on the specimen not exposed to direct light so that no light other than that from the light source will enter the optical system.

(3) Take measurement at three different points, and calculate the average. Take this average value as the specular gloss at 60^o or 20^o.

(4) If brush marks or other directional nonuniformity are found on the coated surface, measure the gloss in two directions perpendicular to each other at the same point. Take the average of the two measurements at the 60^o gloss or 20^o gloss of that point.

Note ([18]): Use the reference surface, primary standard surface or secondary standard surface for this calibration.

Remark: Prior to measuring, calibrate the measuring equipment using the secondary standard surface having a gloss similar to that of the specimen.

21.6 Report

If the measured value is 10 or greater, round off the value to the nearest integer according to the method specified in JIS Z 8401 (Rules for rounding off of numerical values). If the value is less than 10, round off to the first decimal place.

22. RE-COATABILITY TEST METHOD

22.1 Purpose

To test the appearance of the paint surface obtained by repainting the topcoat surface or other finish coated surface, and also check the adhesion between top layers.

22.2 Equipment and tools

(1) Temperature controlled chamber
(2) Magnetic stirrer
(3) Spray gun
(4) Sand paper (#600) specified in JIS R 6252

22.3 Specimen preparation

Use the test panel specified in 4.2.2. Apply an intermediate coating and bake the panel.

22.4 Test conditions

(1) Painting room specified in 4.1.1
(2) Stirring time: 4 hours before painting

22.5 Procedure

(1) Place the sample paint in a beaker. Place the beaker on the magnetic stirrer and place a stirring bar in the beaker. Allow the stirrer to rotate for the specified time period and at a rate that causes the top surface of liquid to be drawn down approximately 10 mm. Cover the beaker with a polyethylene sheet to prevent the sample paint from overflowing. Secure the beaker to the stirrer.
(2) Place the test plate horizontally and spray the sample paint until a desired film thickness is obtained.
(3) After painting, let the specimen stand for 10 minutes, then bake under the specified conditions with the specimen placed horizontally.
(4) After the specimen returned to the normal temperature, polish a half of the specimen area with #600 sand paper. (Refer to Figure 19.1.)
(5) Using the same conditions as those specified in (1), stir the sample paint in the beaker for 4 hours and pour into the spray gun. Spray the paint on the specimen which has been placed horizontally ([19]) and which was painted and baked in steps (2) and (3) above so that the specified thickness of paint film was created.
(6) After spraying, let the specimen set for 10 minutes, then bake under the specified conditions. Keep the specimen horizontally.
(7) Allow the specimen to cool to room temperature, measure the film thickness, then check the painted surface for craters, uneven dispersion of aluminum, recesses, etc.([20]).
(8) After leaving the specimen set for 24 hours, perform the grid-cutting test on the painted surface in accordance with the procedure specified in 29.2, then check the adhesion between top coating layers.

Notes ([19]): Measure the specimen's film thickness in advance using a film thickness gauge.
([20]): Craters and recesses on the coated surface are shown below:

Figure 19.1

Unit: mm

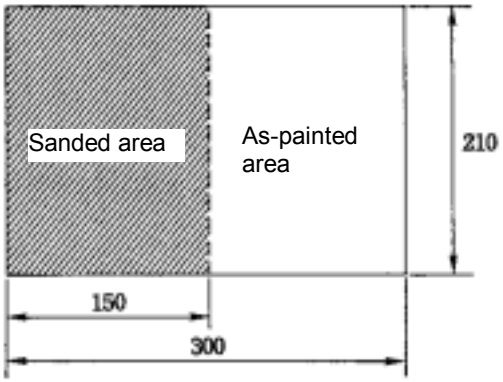
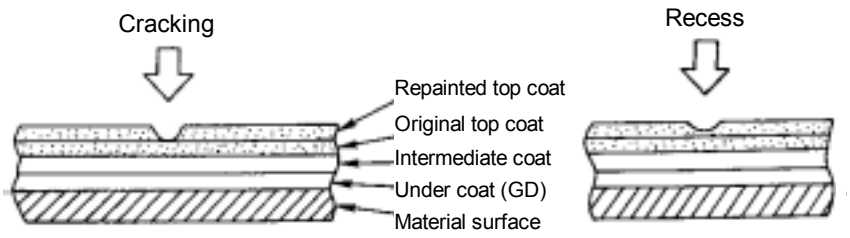


Figure 19.2



22.6 Report

(1) Record the film thickness (μm), the number of craters and recesses, irregular aluminum dispersion, and the adhesion of top-coat layers in accordance with 29.2.6.

23. RESISTANCE TO PAINT DUST MEASURING EQUIPMENT

23.1 Purpose

To check the effect of paint dust which could occur when paints of different colors or of different suppliers are used in the same spray booth.

23.2 Equipment and tools

(1) Temperature controlled chamber
(2) Spray gun

23.3 Specimen preparation

Use type C test panel (210 × 300 mm) specified in 4.2.2, which has been intermediate-coated and polished in the standard process.

23.4 Test conditions

(1) Paint room specified in 4.1.1

23.5 Procedure

(1) Influence of paint on other color

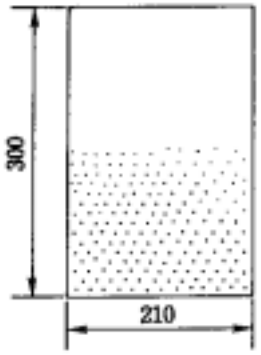
(a) Place the specimen horizontally and spray the sample paint (base paint), agreed upon between concerned parties, until the specified film thickness is obtained.
(b) After spraying, allow the specimen to stand for one minute, and then spray the dust of that paint (paint dust) onto the specimen as illustrated in Figure 20.
(c) After spraying, allow the specimen to stand for five to ten minutes, place the specimen horizontally and bake under the specified conditions.
(d) Allow the specimen to cool, then check the painted surface for craters, recesses, and clouding ([21]).

(2) Influence of other paint color

Using the same procedures as (a) through (d) of (1), coat the test panel that has been prepared as specified in 23.3 with the test paint (base paint), then spray the paint dust agreed upon between concerned parties. Check the condition of the painted surface.

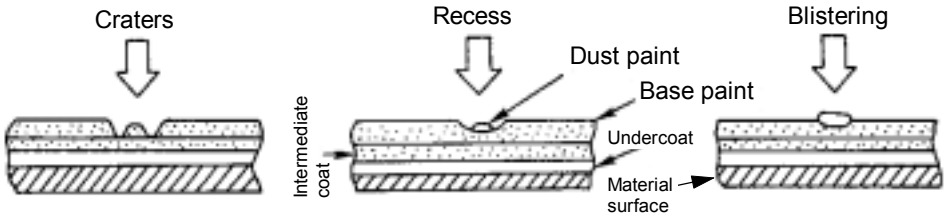
Figure 20

Unit: mm



Remark: The paint dust spraying distance must be 800 to 1000 mm.

Note ([21]): Craters, recesses and clouding on coated surface are shown below:



23.6 Report

Record whether the craters, recesses, or clouding are found, and the degree of these defects, for each of the above two cases [i.e., spraying paint dust on the base paint and spraying paint dust to the base paint].

24. COLOR DIFFERENCE TEST METHOD

24.1 Purpose

To measure the color difference from the standard color panel

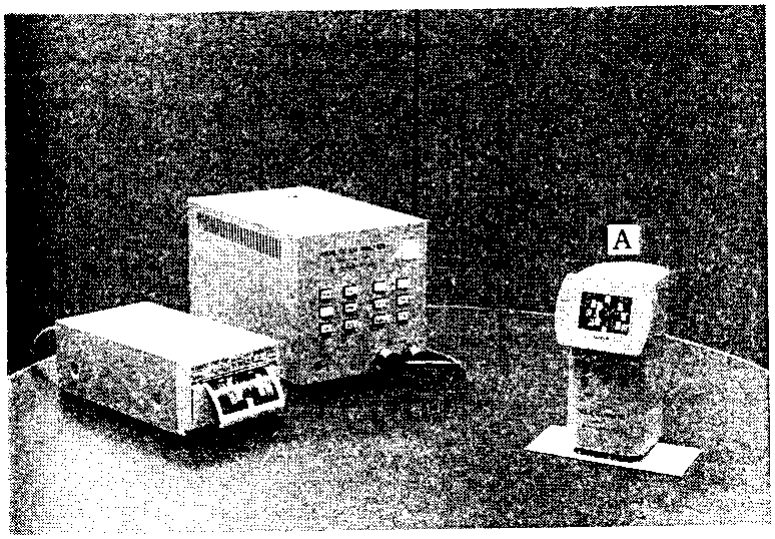
24.2 Equipment

(1) Standard light source
Artificial sunlight or standard light D_{65} specified in JIS Z 8720

(2) Colorimeter
Use the colorimeter with an incident angle 45^{o} and a reflection angle 0^{o} (45-0), or with incident angle 0^{o} and reflection angle 45^{o} (0-45), as specified in 4.3.1 of JIS Z 8722. (Methods of color measurement - Reflecting or transmitting objects) Use the standard light D_{65} specified in JIS Z 8720 (Standard illuminants and sources for colorimetry) for measurement. (These are considered reference values because there is not complete correlation between color difference and visual inspection when different measuring equipment is used.)

(3) Visual color analyzer
NISSAN VISUAL COLOR ANALYZER developed by the Nissan Motor Co., Ltd. (Figure 21)

Figure 21 NISSAN VISUAL COLOR ANALYZER



24.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated with the sample paint according to 4.4

24.4 Test conditions

Room temperature specified in 4.1.2 (2)

24.5 Procedure

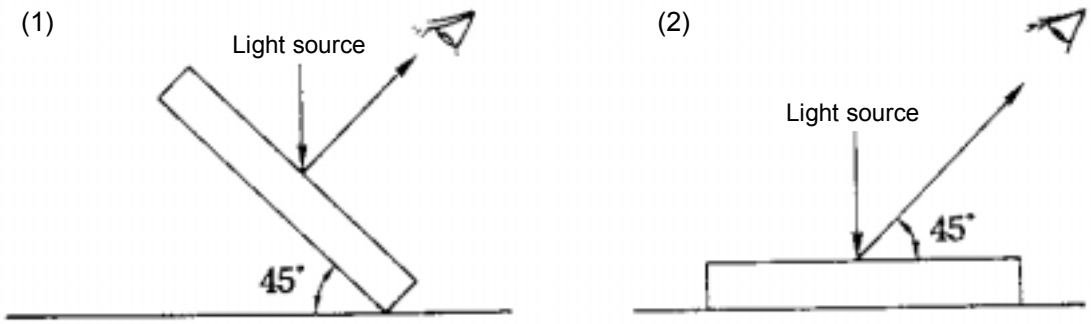
24.5.1 Visual examination

Visually examine the color difference between the specimen and standard panel([22]) under the artificial sunlight or standard light D_{65}.

Actual observation methods are shown in Figure 22. [(1) and (2) shall be evaluated.]

Note ([22]): Use the standard panel.

Figure 22



24.5.2 Measurement by instrument

(Measured values will vary greatly with different measuring equipment. Therefore, n = 5 is taken as the measured value. The values are then averaged.)

(1) Prepare the standard panel([22]), specimen and the chromaticity coordinates L' a' b' using the method as specified in JIS Z 8722. (Methods of color measurement - Reflecting or transmitting objects) Test piece and color gray scale determined with L' a' b'. Measure from the center of the test piece.

(2) As specified in JIS Z 8730 (Colour specification - Colour differences of non-luminous object colours), Standard plate and test piece color differences are determined by L' a' b' factors.

(3) Using the visual color analyzer*

1) Place the measuring head A against the measuring cover surface and measure. Refer to Figure 21.
2) If recording the basic values, show the automatically selected color measured values and the color differences.
3) If not recording the basic values, do the recording before Step (1).
   * Be careful of curved surfaces.

Remark: The photoelectric colorimeter which directly determines the color differences from the indication of the instrument can be used.

24.6 Report

(1) Visual inspection

Note any color differences (hue, brightness, and basic color) and the extent to which they occur. [Record them using the standards shown in Figure 22.(1) and Figure 22.(2).] Table 7 lists standards for evaluation of hue, brightness, and basic color.

Table 7

Hue, lightness, saturation	Red, yellow, blue, green, violet, white, black, bright, dark, pure, impure
Degree of difference	+3: Considerably strong
	+2.5: Between +2 and +3
	+2: Strong
	+1.5: Between +1 and +2
	+1: Slightly strong
	+0.5: Between ±0 and +1
	±0: No difference
	-0.5: Between -1 and ±0
	-1: Slightly weak
	-1.5: Between -2 and -1
	-2: Weak
	-2.5: Between -3 and -2
	-3: Considerably weak

(2) Measurement by instrument

Record the color difference ΔE' (ΔL' Δa' Δb') and ΔL', Δa', Δb' in L' a' b' system.
Record the name of the equipment used.

(3) Using the visual color analyzer

Visual inspection color differences and related values. (identical to indication (1)) ΔL*, Δa* and Δb* (identical to indication (2)) ΔN (NMC) for 17 direction are shown in Figure 23.

- Sample color difference indications and measured values are shown in Figure 24.

Figure 23

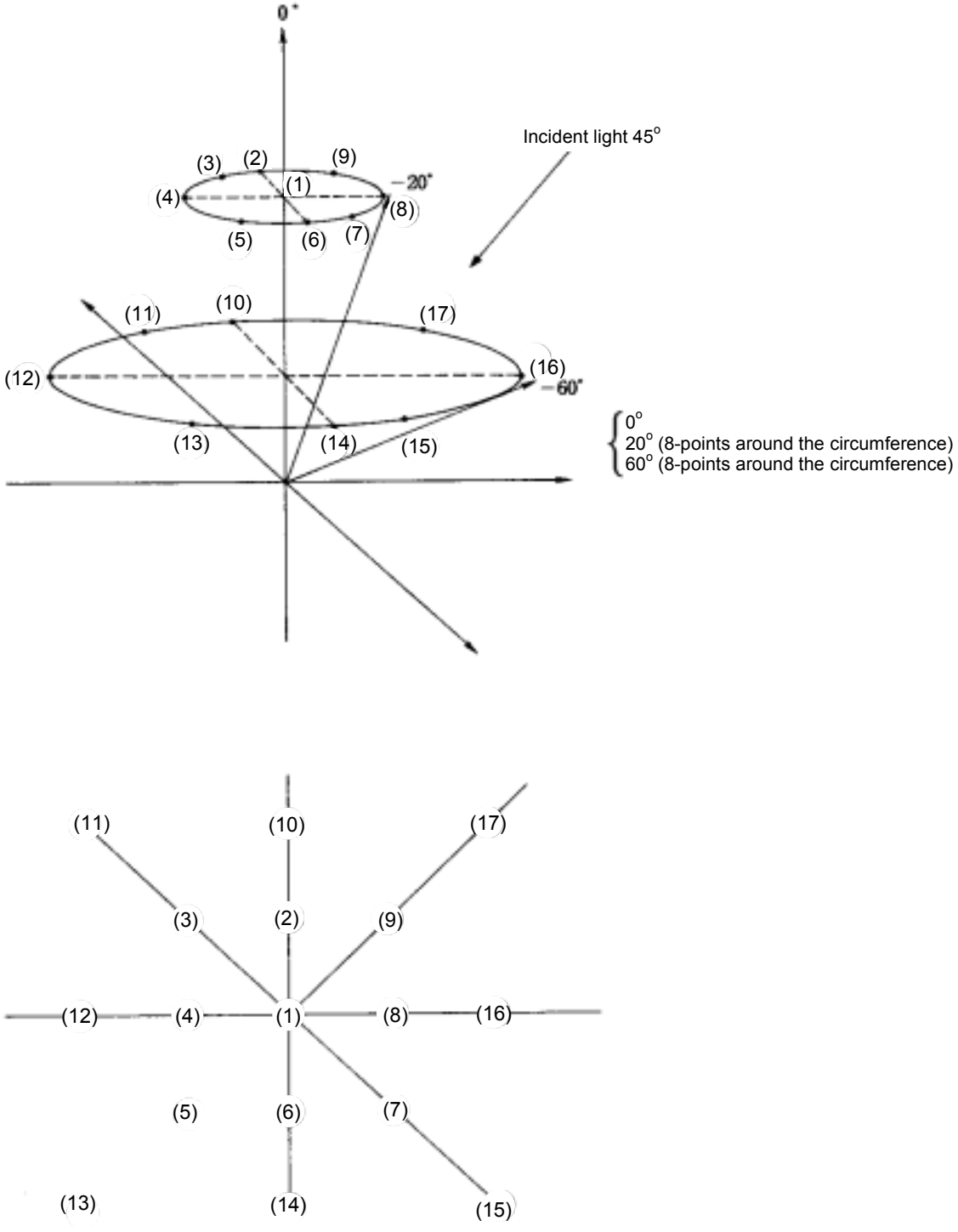
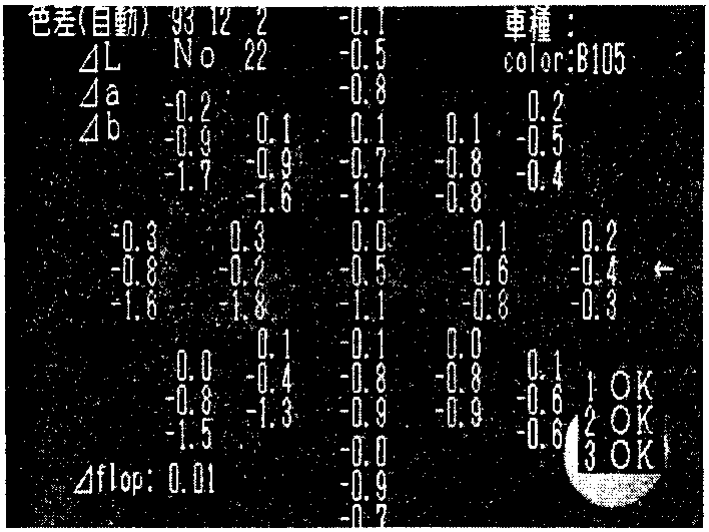
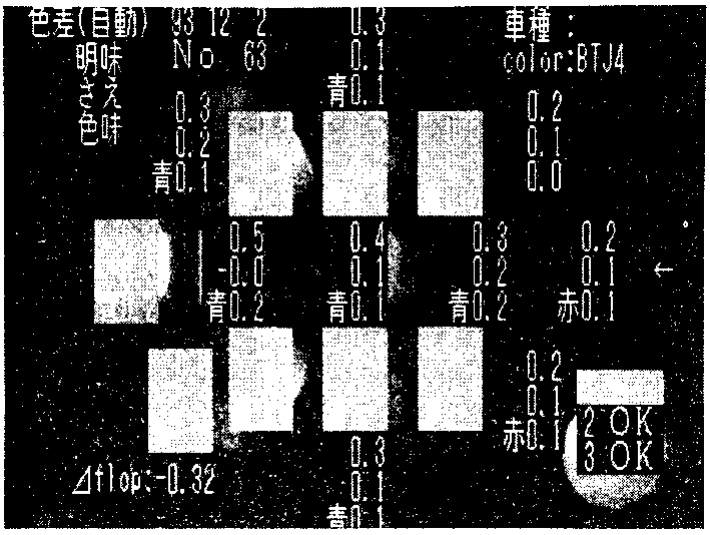

0°
Incident light 45°
(3)
(2)
(9)
(1)
20°
(4)
(8)
(5)
(6)
(7)
(11)
(10)
(17)
(12)
(16)
60°
(13)
(14)
(15)
0°
20° (8-points around the circumference)
60° (8-points around the circumference)
(11)
(10)
(17)
(3)
(2)
(9)
(12)
(4)
(1)
(8)
(16)
(5)
(6)
(7)
(13)
(14)
(15)

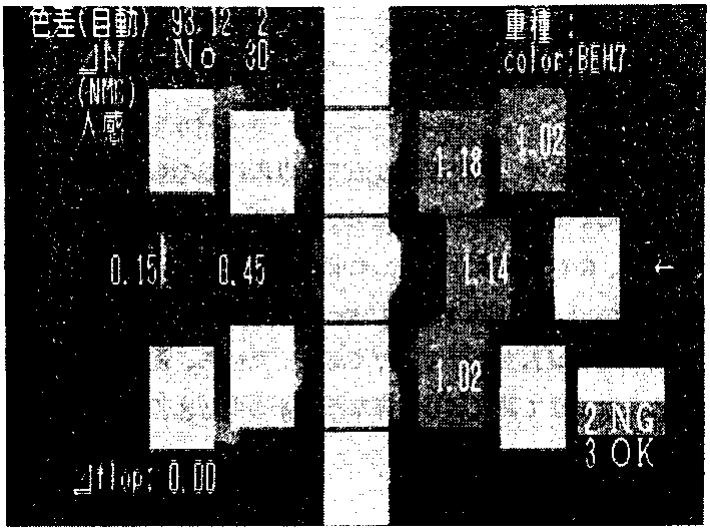
Figure 24　Color difference and measuring example
ΔL' Δa' Δb' indications (1-2-3 ranking is OK)



Sensed indication (1-rank NG ... Side direction) (Visual inspection correlation value)



Judgement value indication (1-rank and 2-rank NG ... Shaded direction)
(ΔN, Value determined from visual inspection and correlation.)



25. OVERBAKING RESISTANCE TEST METHOD

25.1 Purpose

To examine the change in paint film adhesion, color and the condition of painted surface when the baking conditions are changed.

25.2 Specimen preparation

Use the test panel A (70 × 150 mm) specified in 4.2.2, and paint as specified in 4.4 to make the specimen. Bake under specified conditions.

25.3 Procedure

(1) Perform the grid-cutting test in accordance with 29.2 and examine the inter-layer adhesion of paint films.
(2) Use the specimen initially created as the standard panel, and examine the color difference using methods specified in 24.5.1 and 24.5.2. Visually check for surface defects such as loss of gloss, cracks, blisters, or peels.

25.4 Report

(1) Record inter-layer adhesion in accordance with 29.2.6.
(2) Record color difference [in accordance with 24.6(1) and (2)] and surface defects, if any.

26. FILM HARDNESS TEST METHOD

26.1 Purpose

To determine the hardness of paint film by scratching with a pencil lead.

26.2 Equipment and tools

(1) Scratching tester
Specified in 8.4.1 of JIS K 5400.
(2) Test pencils
Use the test pencils specified in JIS S 6006 (Pencils and colored pencils) and approved by the Paint Testing Association of Japan.
(3) #400 sand paper specified in JIS R 6252
(4) Crude rubber eraser or cotton gauze

26.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated with the test paint as specified in 4.4.

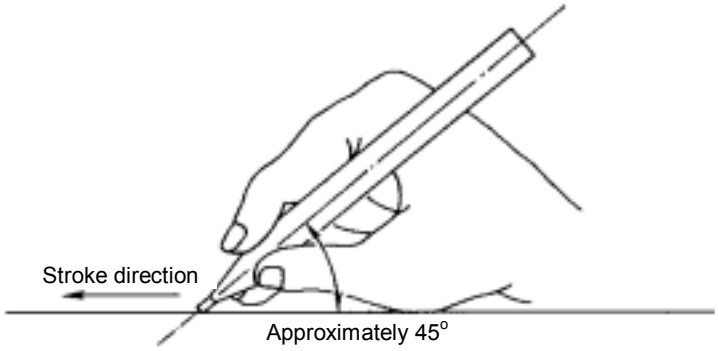
26.4 Test conditions

Room temperature specified in 4.1.2 (2)

26.5 Procedure

(1) Expose approximately 3 mm of unsharpened lead. Hold it vertically on sand paper placed on a hard and flat plate. Polish the lead by slowly moving it in a circle until the end becomes flat with sharp edge. Repeat this sharpening operation before each test scratching.
(2) Hold the pencil by hand or by scratching tester at an angle of 45^{o} to the test plate. (see Figure 25) While applying a force of approximately 30 N {3 kgf} to the coated surface, move the pencil forward approximately 10 mm at a speed of approximately 3 mm/sec. Repeat five times at different places on the coated surface. Remove the graphite powder from the coated surface with a crude rubber eraser or cotton gauze, and check the surface for flaws.

Figure 25 Manual scratching test



Remark: Pencil hardness ratings are as follows, with 9H the hardest and 6B the softest: (9H, 8H, 7H, 6H, 5H, 4H, 3H, 2H, H, F, HB, B, 2B, 3B, 4B, 5B, 6B)

26.6 Report

Record as the hardness of the coated film the hardness rating of the pencil one ranking softer than that with which flaws([23]) are observed for at least two of the five scratching tests.

Note ([23]): The flaw (excluding that created at the start of each scratching) includes deep breaks in the paint film reaching the substrate, and shallow scratches on the surface of paint film. The actual judgment criteria must be established between concerned parties.

27. IMPACT RESISTANCE TEST METHOD

27.1 Purpose

To examine the impact resistance of the coated surface through impact with a steel ball

27.2 Equipment

Dupont impact tester specified in 8.3.2 of JIS K 5400

27.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated with the test paint as specified in 4.4.

27.4 Procedure

(1) Place the tester on a flat and rigid table, such as concrete table, and place the specimen with its coated side facing up between the striker (6.35±0.03 mm radius) and the anvil.
(2) Drop a 500±1 g weight onto the striker from the specified height. Repeat this operation three times at different places on the coated surface, and visually check for damage on the coated surface. Check the back side of the specimen when testing the undercoating.
(3) Repeat this test by increasing the drop height in 5 cm increments until damage on the coated surface is observed in at least two of the three drops.

27.5 Report

(1) Record the impact resistance at the height 5 cm lower than the lowest height at which cracking and peeling are observed at least two of the three shots.
(2) If no damage is observed even at the maximum height of 50 cm, indicate the impact resistance as “greater than 50 cm”.
(3) When a steel plate other than that specified in 4.2 is used as the test panel, record the plate thickness and material.

28. CHIPPING RESISTANCE TEST METHOD

28.1 Purpose

To measure the resistance of coated film against chipping by flying pebbles and sand.

28.2 Test methods

(1) Gravelometer method A
(2) Diamond shot method
(3) Gravelometer method B

28.3 Test with gravelometer method A

28.3.1 Equipment and tools

(1) Gravelometer specified in SAE J 400 (Test for chip resistance of surface coatings) (Refer to Figures 26 and 27.)
(2) Shot materials
The shot materials are listed in Table 8.

Table 8

Shot material type		Grain size range (mm)	Description	
Crushed stone	No. 6	13 to 5	As specified in JIS A 5001 (Crushed stone for road construction)	Those passing through a 13 mm nominal sieve opening, but not passing through a 5 mm opening.
	No. 7	5 to 2.5		Those passing through a 5 mm nominal sieve opening, but not passing through a 2.5 mm opening. The number of use shall be limited to three. After each shot blasting, the stone shall be screened again.
Nut	M2		ISO 4032 Hexagon nuts style 1 - Thread size: M2, Material: Brass, Surface treatment: No plating (one side chamfering)	

Figure 26 Gravelometer

Unit: mm

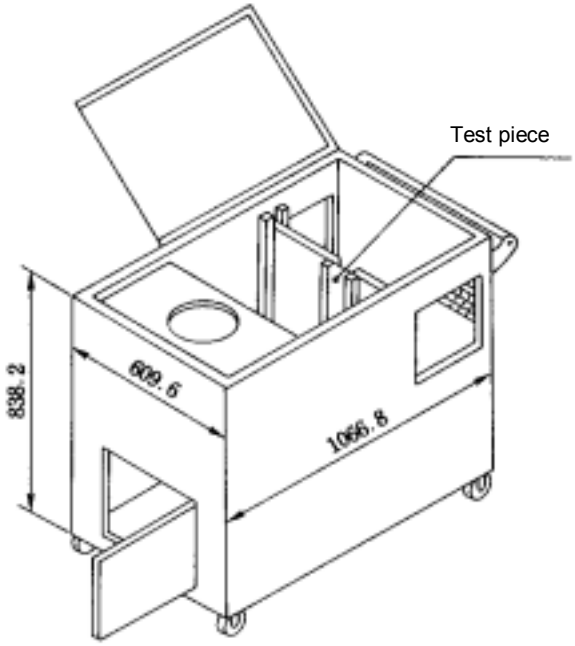
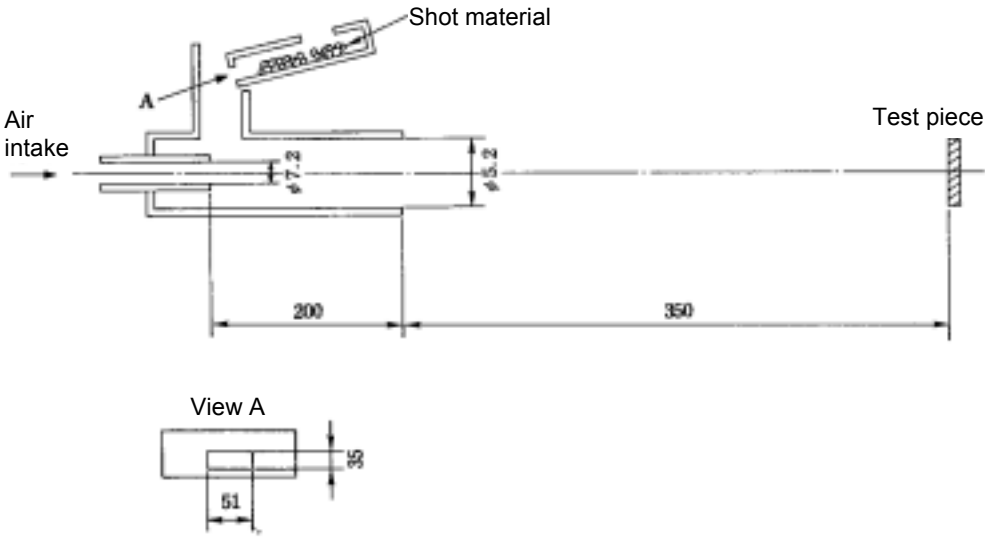


Figure 27 Details of gravelometer

Unit: mm



28.3.2 Specimen preparation

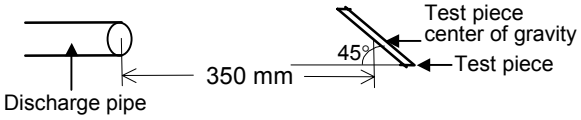
Use five pieces of type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

28.3.3 Test conditions

(1) Specimen temperature: Set the temperature so that the coating film surface temperature may be -20±3°C when the valve is opened.

(2) Shot condition:

(2).1 Evaluation of coating film on outer panels

		Conditions	Remark
Angle		20°, 45°	T/P Rotate the pipe to the specified angle around the center axis of the test piece. Refer to the sketch below for the rotating direction. 
Shot material	Type	M2 nut	The number of use shall be a hundred.
	Quantity	250±2 g	
Discharge pressure		5.0±0.2 kg/cm^2	
N count		3	

(2).2 Test other than the coating film test on outer panels

As agreed between parties.

28.3.4 Procedure

(1) Set the specimen at the test position in the gravelometer so that the shot material will strike the specimen at specified angle.

(2) Load the gravelometer with the shot material within the limit of the sketch below, adjust it to the pressure

(3) After discharging, remove the specimen and remove unnecessary substances from the coated test surface (including the peeled chips of paint film) with cellophane adhesive tape (JIS Z1512) (ICS 55.040.) after wet-cleaning. Check the surface for peeling.

(4) Subject the specimen to the salt spray test for 72 hours according to 32.3.

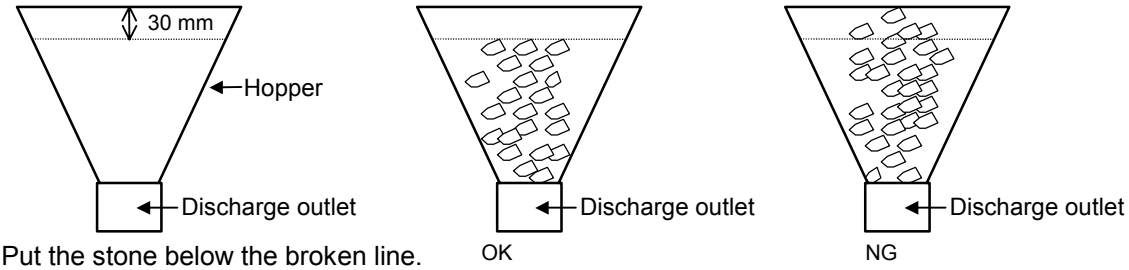


Figure 2 Shot material position in the hopper (plan view)

28.3.5 Judgement

(1) Checking peel condition after chipping test

(1).1 For the paint film on the vehicle outer body

Compare the specimen with the 10 level boundary sample (Item 78 in M0007) for judgment. Indicate the specimen grade at the increment of 0.5 which is equivalent to the grade of the peeled condition of the standard plate.

(1).2 Test other than the paint film on the vehicle outer body

The test method shall be agreed between the parties.

(2) Salt spray test after chipping test

(2).1 For the paint film on the vehicle outer body

The test shall not be performed.

(2).2 Test other than the paint film on the vehicle outer body

The test method shall be agreed between the parties.

28.3.6 Report

(1) Checking peel condition after chipping test

(1).1 For the paint film on the vehicle outer body

Indicate the average (rounded to second decimal place) of the grade from N=3 or evaluate the maximum peel area visually for report.

Report example: Grade 5.7A peel (Report the maximum peel area.)

(A: Base surface and electrodeposition interface, B: Electrodeposition and intermediate coat (ACC) interface, C: Intermediate coat and color base interface, G: Base and clear coat interface, a: Electrodeposition coagulation, b: Intermediate coat (ACC) coagulation, d: Base coagulation)

(1).2 Test other than the paint film on the vehicle outer body

The test method shall be agreed between the parties.

(2) Salt spray test after chipping test

(2).1 For the paint film on the vehicle outer body

The test shall not be performed.

(2).2 Test other than the paint film on the vehicle outer body

The test method shall be agreed between the parties.

Figure 28 Grade (1)

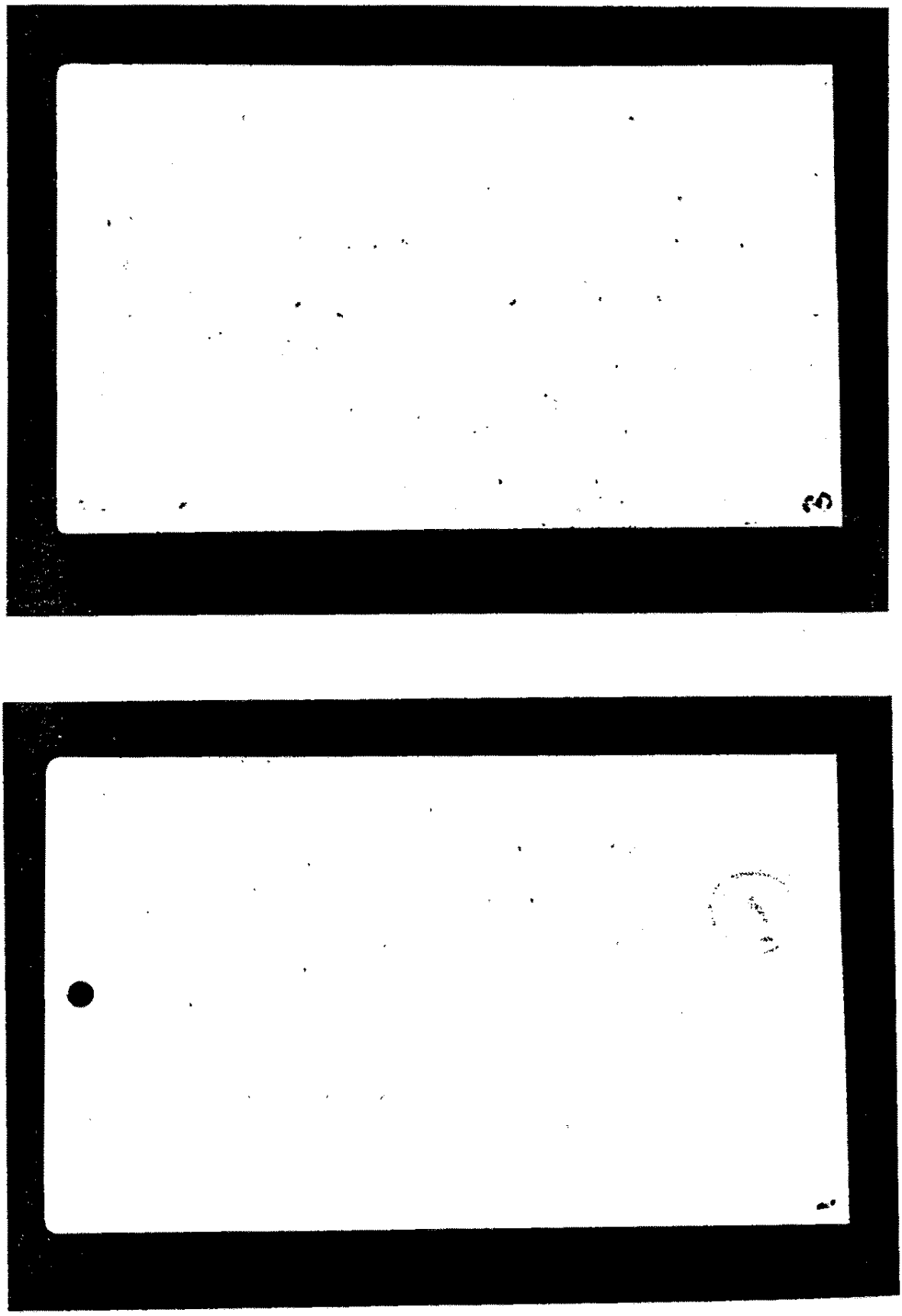


Figure 28 Grade (2)

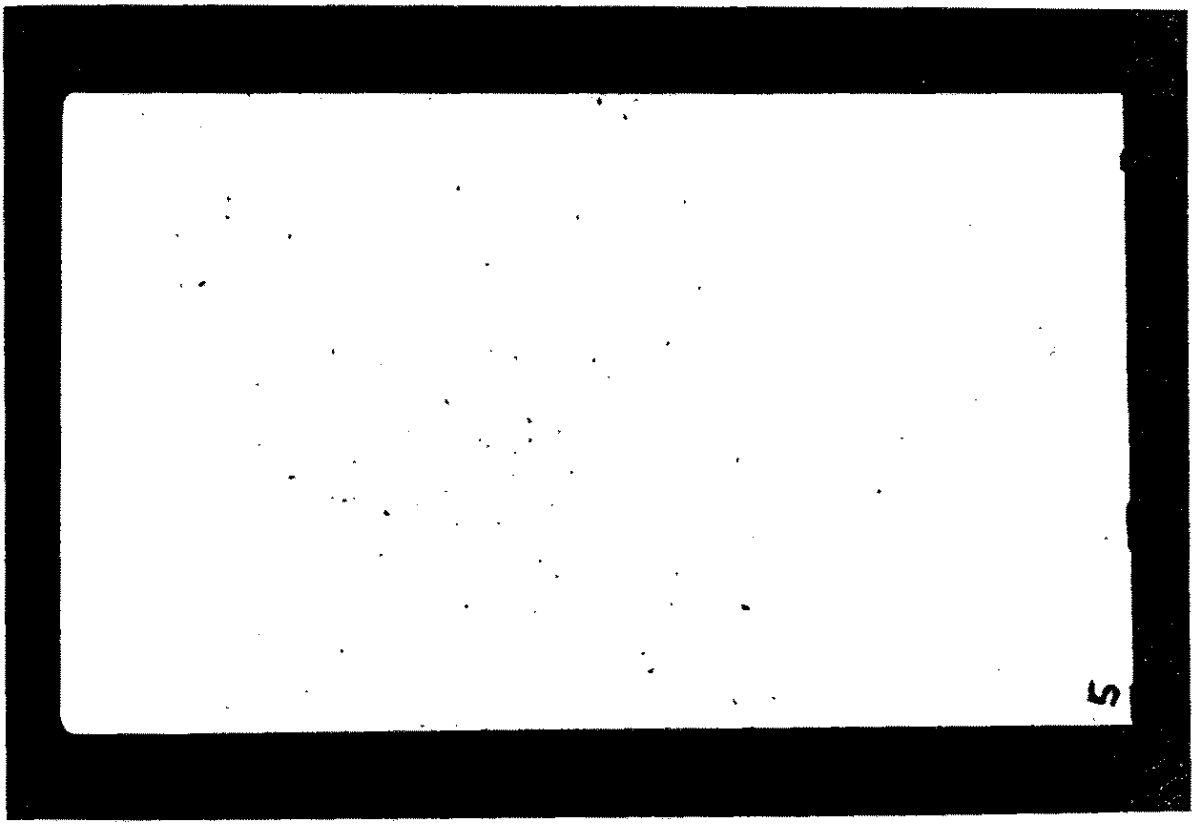


Figure 28 Grade (3)

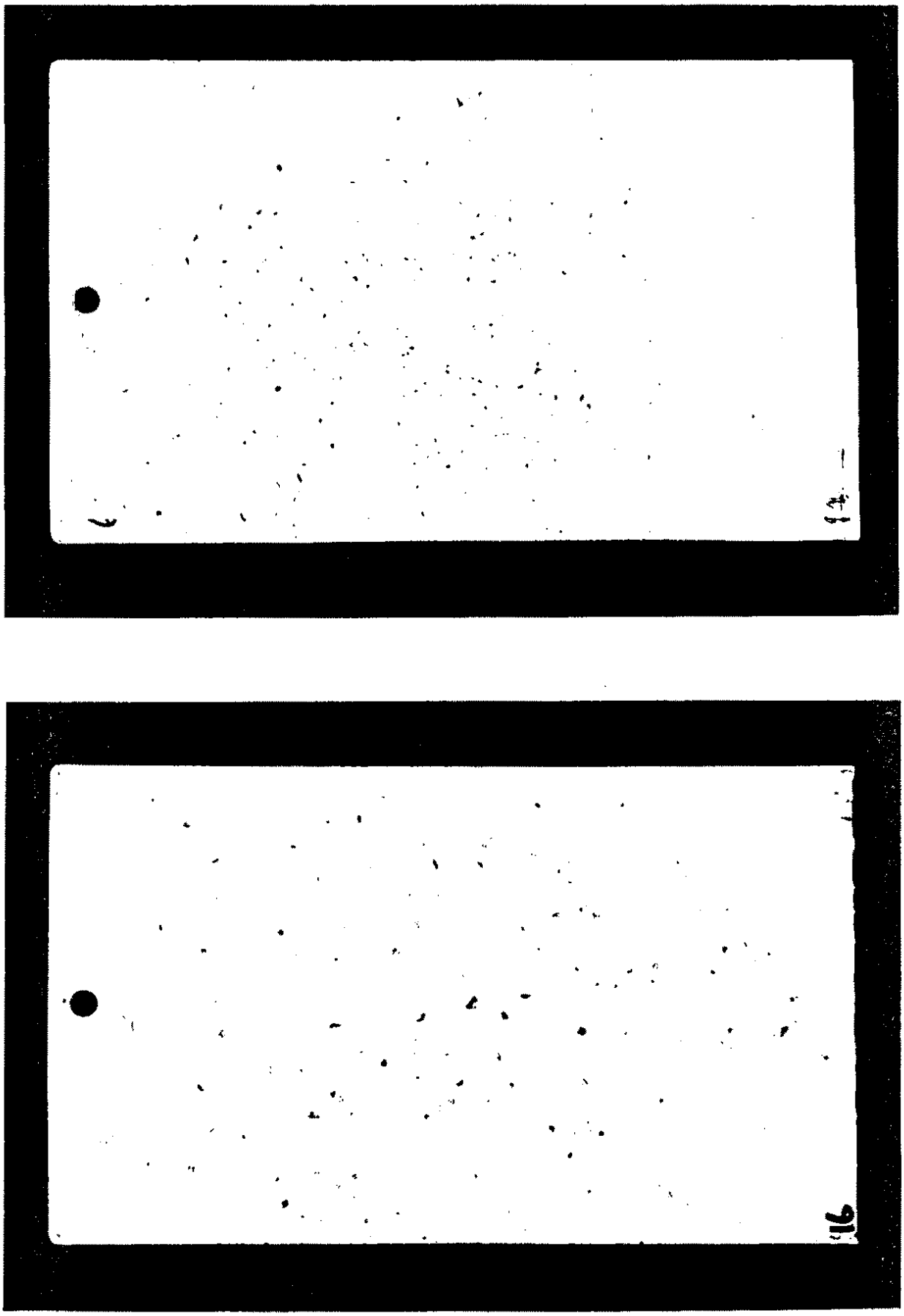
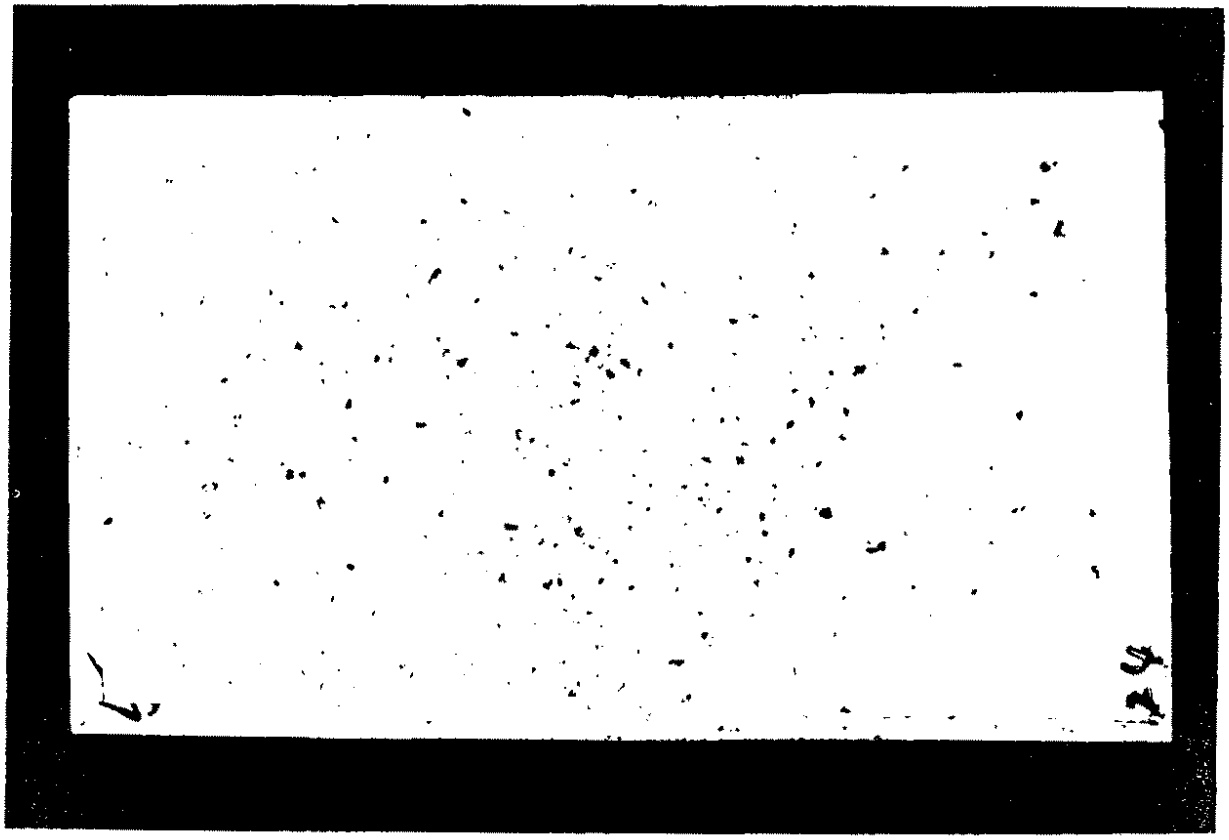


Figure 28 Grade (4)



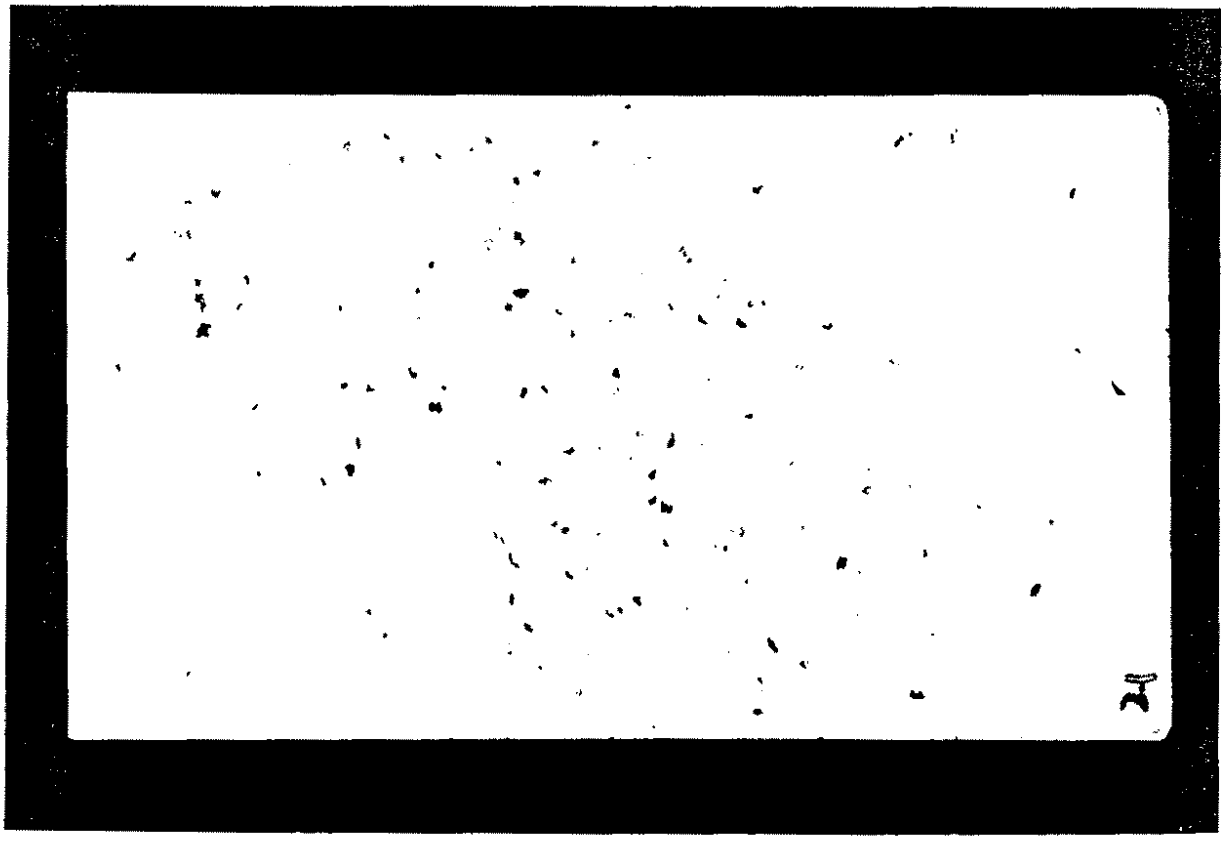
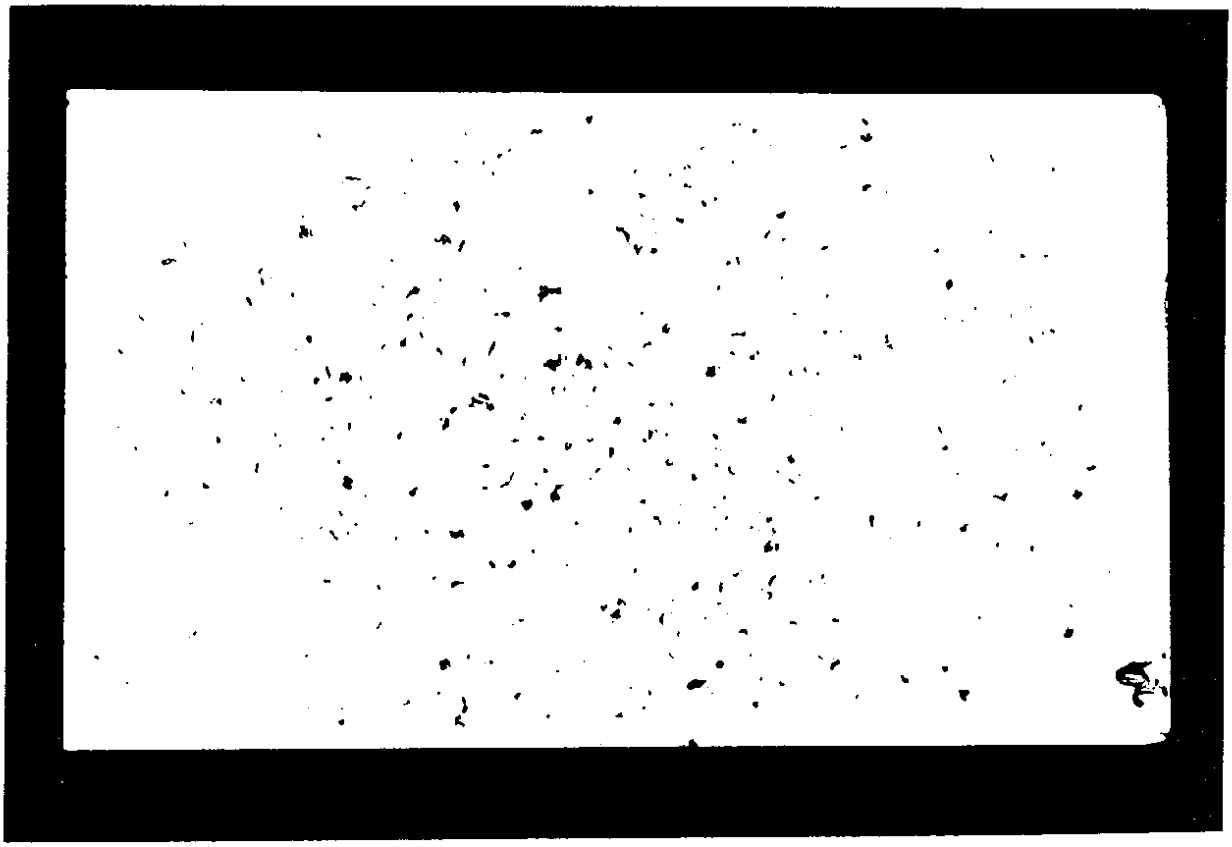
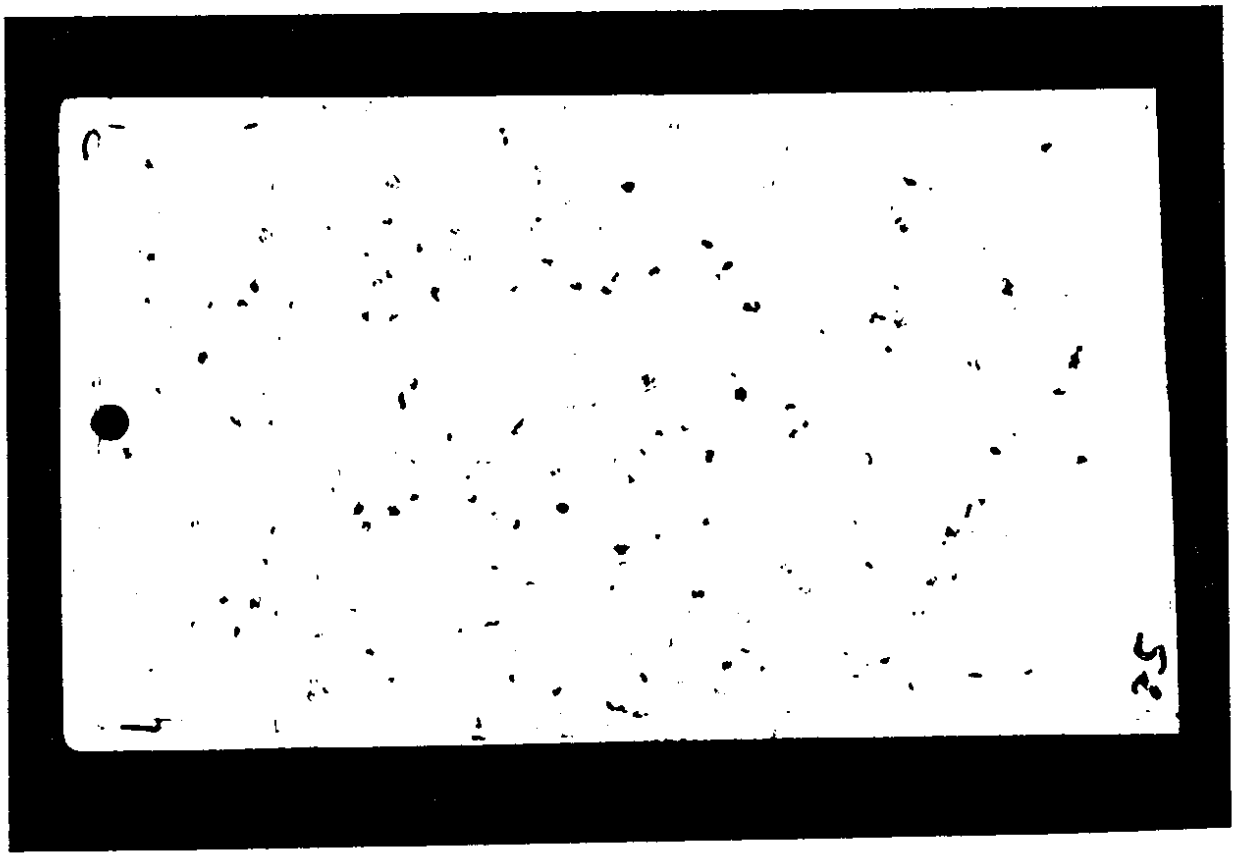


Figure 28 Grade (5)





28.4 Diamond shot method

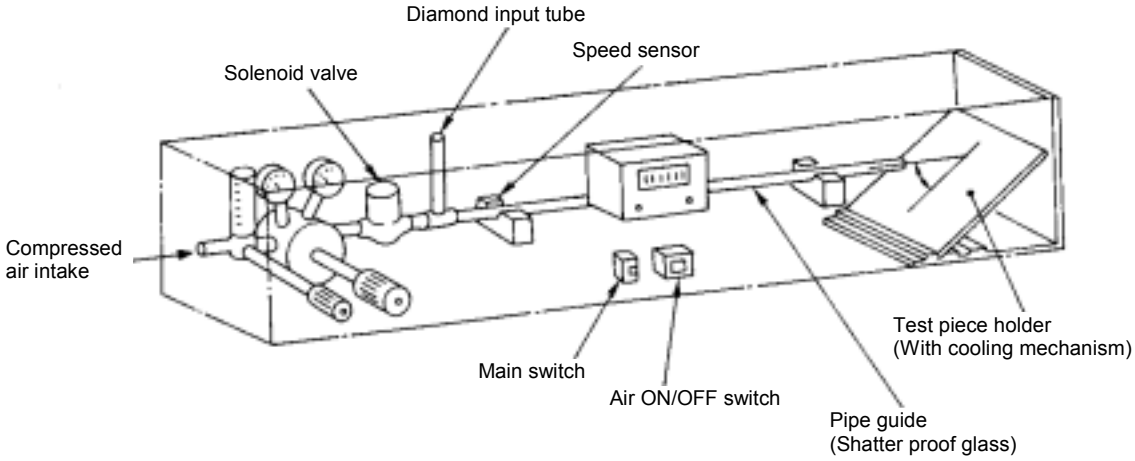
28.4.1 Equipment and tools

(1) Diamond shot tester (with low temperature capability) (Refer to Figure 29.)
(2) Stereoscopic microscope
(3) Shot material: One piece of regular octahedron diamond weighing 10±1 mg (approximately 1/20 carat), having octagonal sharp corners
(4) Cellophane adhesive tape: As specified in JIS Z 1522 (Pressure sensitive adhesive cellophane tapes)
(5) Reference panels for peel evaluation: Standard panels shown in Table 10, made of celluloid material

Table 10 - Standard panel for peel evaluation

Indentation diameter (mm)		Peeled area rating	
Less than ϕ0.5		0	
ϕ0.5	○	0.2	(0.19 mm^2)
ϕ1.0	○	1	(0.78 mm^2)
ϕ1.5	○	2	(1.76 mm^2)
ϕ2.0	○	3	(3.14 mm^2)
ϕ2.5	◯	5	(4.90 mm^2)
ϕ3.0	◯	7	(7.06 mm^2)
ϕ3.5	◯	10	(9.62 mm^2)
ϕ4.0	◯	13	(12.56 mm^2)
ϕ4.5	◯	16	(15.90 mm^2)

Figure 29



28.4.2 Specimen preparation

Use type A panel (70 × 150 mm) specified in 4.2.2 and coat as specified in 4.4. The specimen must be free from surface defects. A piece of panel cut out from an actual vehicle may be used if necessary.

28.4.3 Test conditions

(1) Room temperature specified in 4.1.2 (2)
(2) Test piece surface temperature: -20±2°C
(3) Shot speed and No. of shots

(a) 10 shots at each of 90±20 km/h, 130±20 km/h, and 170±20 km/h
(b) 30 shots at 210±20 km/h
(c) 30 shots at 170±20 km/h

(4) Air pressure: 0.05 to 0.2 MPa {0.5 to 2 kgf/cm^2}

Remark: If testing at low temperature is required, perform test in the low temperature chamber controlled at the specified temperature, or perform the test after cooling to the specified temperature at the time of the shot.

28.4.4 Procedure

(1) Adjust the specimen stand temperature to the specified temperature level by means of the temperature controller, and set the specimen on the stand.
(2) Adjust the air pressure by the shot air pressure regulator so that the specified shot speed is obtained.
(3) Keep the specimen at the specified temperature.
(4) Put a diamond into the diamond inlet, and close the inlet cover. Depress the shot switch to shoot the diamond against the specimen. Record the shot speed of the diamond. Begin at a shot speed of 170 mm, then lower to 130 km, and to 90 km. Shoot in order from above the test piece.
(5) Change the specimen evaluating position, and repeat the operations (2) to (4) using each shot speed.
(6) Apply the cellophane adhesive tape to the test paint surface of the specimen, and remove the paint film of the damaged area.
(7) Determine the peel location, then evaluate peeling by placing the peeling evaluation reference panel on the peeled portion.
(8) Use three specimens for each test.
(9) Perform salt spray test for 72 hours.

28.4.5 Report

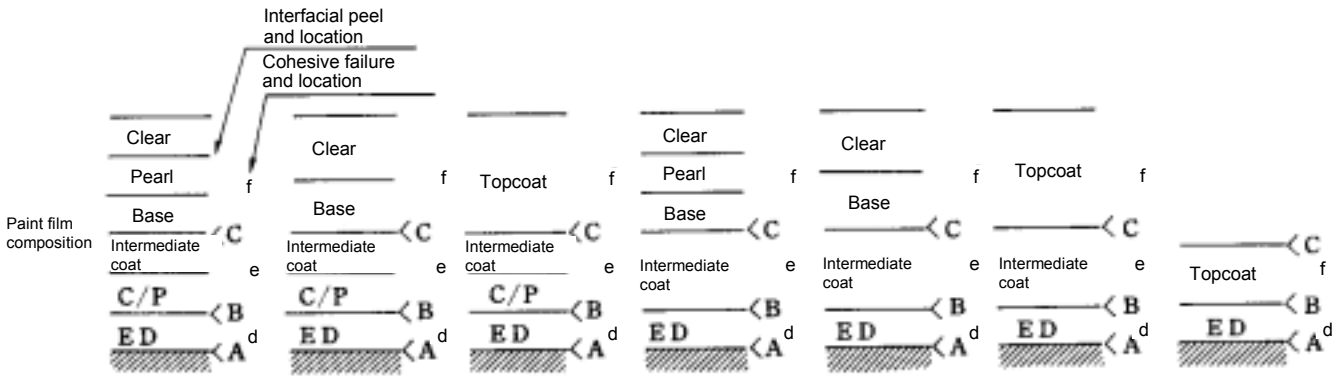
(1) Recording method

1) Record the peeled area at each shot speed by totaling the data, according to the peel form indicated in Figure 30.
2) Calculate the average peel area for each shot speed.
3) Enter the data in the Attached Data Form and make a graph.
4) Attached Figures 1 to 4 show how to arrange the data obtained from the test.

(2) Data read-out and data processing

1) Damage classification:
Use the peeling form recording symbols shown in Figure 30 to identify peeling that has occurred with the paint layers. Capital letters reflect interfacial peel and small letters reflect cohesive failure. If a complex peel occurred, record the peel of greater area.
2) Damage classification and raw data from peel area:
Record the damages classified by the method (1) above and record the peel area evaluation number on the Attached Data Form (1), then obtain raw data from the specimen.
3) Calculation of total peel area for each damage type:
Calculate from the raw data entered on Attached Data Form (1) according to the shot speed and damage type, and enter the results on the Attached Data Form (2).
4) Substrate damage:
After obtaining the raw data, count the number of rust spots after 72 hours of salt spray test, and enter the data on Attached Data Form (3).
5) Reporting:
Make a graph as shown in Attached Data Form (4) from the results entered on Attached Data Forms (2) and (3).

Figure 30 Peeling types



Attached Figure 1 Data Form (1) and example of entry

Damage classification and peel area evaluation (Example)

Shot speed sample	Specimen No. 1 B219					Specimen No. 2 B219					Specimen No.				
	1 (110 μm)	2 (110 μm)	3 (110 μm)	4 (110 μm)	5 (110 μm)	1 (120 μm)	2 (120 μm)	3 (120 μm)	4 (120 μm)	5 (120 μm)	1 ( )	2 ( )	3 ( )	4 ( )	5 ( )
1	C 0.2	d 0	b 0	d 0	b 0.2	C 0	A 1	d 0	d 0	d 0					
	d 0	d 0	d 0	d 0	d 0	d 0	d 0	b 0.2	C 0.2	d 0		Outline, paint color, etc.			
	B 1	d 0	—	d 0	C 0.2	d 0	C 0.2	d 0	C 0	b 0		Total film thickness (Layer composition and film thickness must be shown on a separate sheet.)			
	d 0	d 0	d 0	d 0	d 0	d 0	A 0.2	C 0.2	a 0	d 0		No. of shots			
	d 0	d 0	d 0	b 0	b 0	d 0	d 0	d 0	d 0	d 0					
	d 0	d 0	d 0	d 0.2	d 0	b 0	d 0	d 0	d 0	d 0		Peel area score			
	d 0	d 0	d 0	d 0	d 0	b 0	d 0	d 0	d 0	C 0		Damage classification			
	d 0	b 0	d 0.2	d 0	C 0	d 0	C 0.2	d 0	d 0	d 0					
	d 0	d 0	b 0	d 0	d 0	d 0	d 0	d 0	d 0	d 0					
	A 0	d 0	d 0.2	d 0	d 0	d 0	b 0.2	C 0.2	—	C 0					
2	d 0	b 0.2	A 0.2	b 0.2	d 0	C 0.2	d 0	d 0	d 0	d 0					
	A 0.2	A 0.2	d 0	d 0	B 2	C 0	d 0	C 0.2	d 0	A 1		No damage			
	d 0	B 2	d 0	d 0.2	d 0.2	d 0	d 0	A 1	d 0	d 0					
	d 0	b 0	d 0	d 0	d 0.2	d 0	d 0	d 0	d 0	b 0.2					
	B 2	d 0.2	b 0	d 0	d 0	d 0.2	d 0	C 0.2	C 0.2	A 2					
	C 0	d 0	d 0	d 0	d 0	A 0.2	B 2	d 0	b 0.2	A 0.2					
	C 0	d 0	b 0.2	d 0.2	d 0	C 0	C 0	d 0	d 0	C 1					
	d 0	d 0	C 0	d 0	d 0	C 0	C 0	d 0	A 2	d 0					
	d 0	A 2	d 0	b 0.2	B 0.2	d 0	d 0	C 0	d 0.2	d 0					
	A 1	B 3	B 1	b 0	b 0.2	C 0	d 0	A 0.2	d 0	A 0.2					
3	d 0	d 0	d 0	B 5	A 0.2	C 1	b 0.2	A 2	A 1	A 0.2					
	A 0.2	d 0	B 0.2	d 0.2	A 1	C 0.2	A 0.2	C 0.2	A 0.2	A 1					
	d 0	A 2	C 0.2	d 0	C 0.2	C 0.2	d 0	C 1	A 1	d 0					
	b 0	d 0	A 1	A 1	A 0.2	C 0.2	d 0	A 0.2	A 2	C 0					
	A 2	A 3	A 0.2	A 2	A 0.2	d 0	d 0.2	A 2	C 1	A 0.2					
	a 0.2	B 3	A 0.2	A 0.2	A 0	d 0	b 0.2	b 0	C 0.2	C 0.2					
	B 1	d 0	A 2	A 0.2	d 0	C 2	A 0.2	a 0.2	d 0	A 3					
	A 0.2	A 0.2	d 0.2	A 2	d 0.2	C 2	d 0	A 0.2	A 0	A 0.2					
	d 0	C 0	b 0.2	A 3	A 0.2	b 1	C 1	A 0.2	C 2	C 0.2					
	A 2	A 0.2	A 2	A 3	A 0.2	d 0	d 0	A 0.2	A 2	A 1					

Damage classification

2-intermediate coats

- Clear } d
- Enamel
- <C
- Intermediate coat } b
- C/P
- <B
- ED } a
- <A

- Topcoat } d
- <C
- Intermediate coat } b
- C/P
- <B
- ED } a
- <A

1-intermediate coat

- Clear } d
- Enamel
- <C
- Intermediate coat } b
- <B
- ED } a
- <A

- Topcoat } d
- <C
- Intermediate coat } b
- <B
- ED } a
- <A

Peel area score

Less than 0.5 to 0

0.5 to 0.2

1.0 to 1

1.5 to 2

2.0 to 3

2.5 to 5

3.0 to 7

3.5 to 10

4.0 to 13

4.5 to 16

Attached Figure 2 Data Form (2) and example of entry

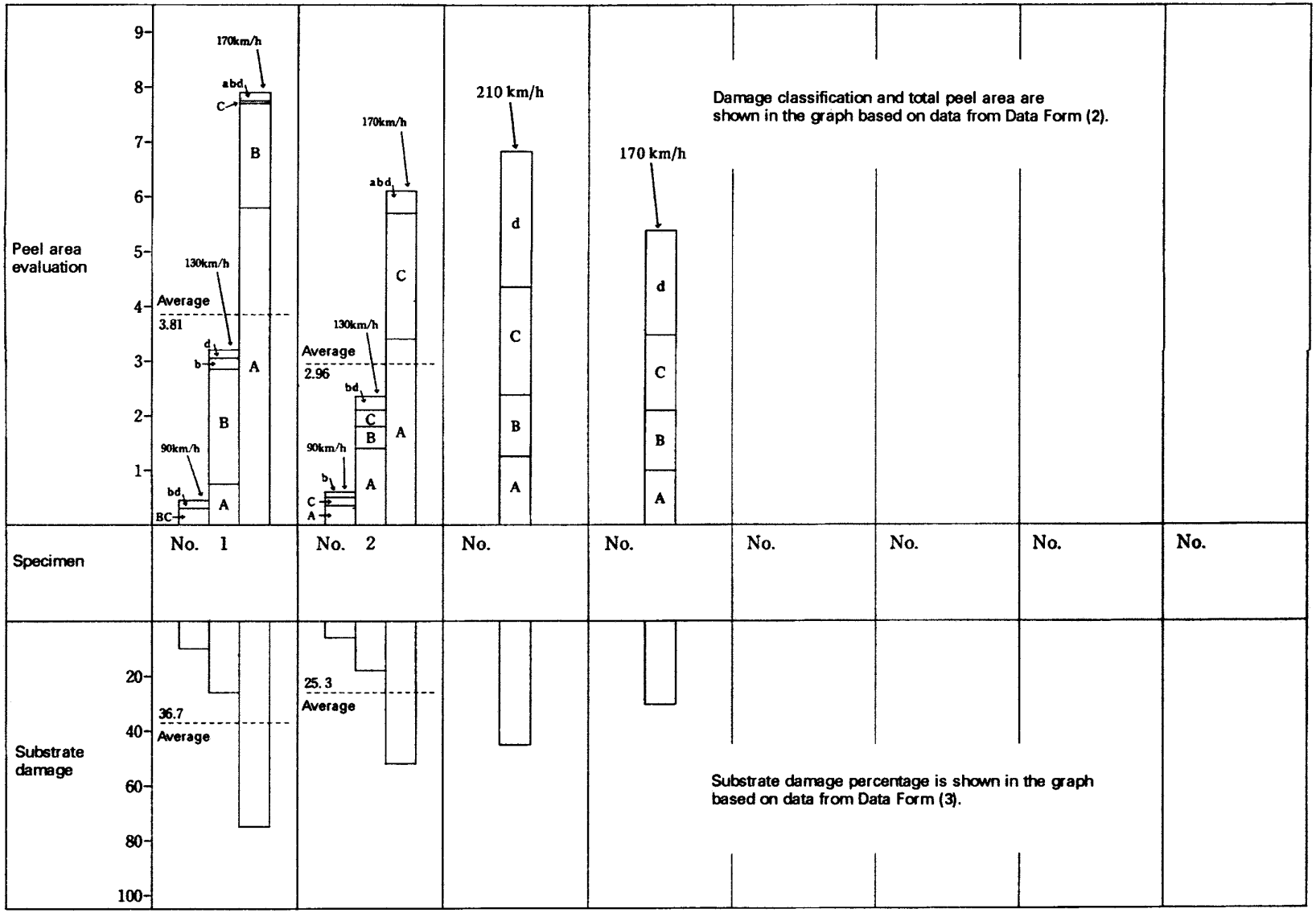
Shot speed sample		Specimen No. 1							Specimen No. 2							Specimen No.						
		1	2	3	4	5	$\bar{X}$	Interfacial peel, cohesive failure area a	1	2	3	4	5	$\bar{X}$	Interfacial peel, cohesive failure area a	1	2	3	4	5	$\bar{X}$	Interfacial peel, cohesive failure area a
1	A									1.2				0.24		$\frac{\text{Total}}{n}$	$\frac{0+0.4+0.4+0.2+0}{5}=0.2$					
	B	1					0.2															
	C	0.2				0.2	0.08	0.28		0.4	0.4	0.2		0.2	0.4		Interfacial peel area					
	a																					
	b					0.2	0.04			0.2	0.2			0.08			Cohesive failure area					
	d			0.4	0.2		0.12	0.16							0.08							
								0.44							0.52		Total area of damage					
2	A	1.2	2.2	0.2			0.72		0.2		1.2	2	3.4	1.36								
	B	2	5	1		2.2	2.04			2				0.4								
	C							2.76	0.2		0.4	0.2	1	0.36	2.12							
	a																					
	b		0.2	0.2	0.4	0.2	0.2					0.2	0.2	0.08								
	d		0.2		0.4	0.4	0.2	0.4	0.2			0.2		0.08	0.16		Total area of damage					
								3.16							2.28							
3	A	4.4	5.4	5.4	11.4	2	5.72			0.4	4.8	6.2	5.6	3.4								
	B	1	3	0.2	5		1.84															
	C			0.2		0.2	0.08	7.64	5.6	1	1.2	3.2	0.4	2.28	5.68							
	a	0.2					0.4				0.2			0.4								
	b			0.2	0.2	0.2	0.12		1	0.4				0.28								
	d			0.2			0.04	0.2		0.2				0.04	0.36		Total area of damage					
								7.84							6.04							
$\bar{X}$								3.81							2.95	Average damage $\frac{0.52+2.28+6.04}{3}=2.95$						

Attached Figure 3　Data Form (3) and example of entry

Substrate damage percentage (example)

Shot speed km/h	Specimen No. 1						Specimen No.						Specimen No.						Specimen No.						Specimen No.					
	1	2	3	4	5	%	1	2	3	4	5	%	1	2	3	4	5	%	1	2	3	4	5	%	1	2	3	4	5	%
90	1	2	2	0	0	10																								
130	2	3	2	4	2	26			$\frac{1+2+2+0+0}{50} \times 100 = 10$																					
170	7	5	7	8	10	74																								
(%)						36.7																								
Shot speed km/h	Specimen No.						Specimen No.						Specimen No.						Specimen No.						Specimen No.					
210	1	1	0	1	0	6																								
210	1	1	2	1	4	18			$\frac{10+26+74}{3} = 36.7$																					
210	2	4	6	8	6	52																								
(%)						25.3																								
Shot speed km/h	Specimen No.						Specimen No.						Specimen No.						Specimen No.						Specimen No.					
170																														
170																														
170																														
(%)																														
Shot speed km/h	Specimen No.						Specimen No.						Specimen No.						Specimen No.						Specimen No.					
(%)																														

Attached Figure 4 Data From (4) and example of entry
Substrate damage percentage (Example)



28.5 Test with gravelometer method B

28.5.1 Equipment and tools

(1) Test equipment: VDA508 manufactured by Erichsen
(2) Shooting material: 4 to 5 mm diameter metal chips shaped like pebbles

28.5.2 Test piece preparation

As the test piece, use test plate A specified in 4.2.2 (70 x 150 mm) and painted in accordance with 4.4.

28.5.3 Test conditions

(1) Test room temperature: 23±2°C
(2) Test room humidity: 50±5%RH
(3) Shot conditions
  (3)-1 Shooting quantity of chips: 500±10 g/time
  (3)-2 Number of shots: 2 times
  (3)-3 Shot pressure: 2.0 bar (0.19 MPa)
  (3)-4 Shot temperature: -30°C and +80°C

28.5.4 Test method

(1) Set the test equipment so that it will shoot 500 g of metal chips within 10±1 seconds.
(2) Fix the test piece to the test equipment set to the specified temperature.
(3) Load the specified quantity of metal chips into the test equipment and discharge them to the specified shot pressure.
(4) After discharging, remove the test piece from the test equipment, and rinse it in clean water. Affix tape to the surface coated with the test paint, then peel off the tape to remove impurities (including peeled fragments of paint) from the surface, and examine the painted surface to see how the paint has peeled off.

28.5.5 Judgement

As agreed between parties

28.5.6 Report

As agreed between parties

29. ADHESION TEST METHOD

29.1 Test method types

(1) Grid-cutting method (Method A)
(2) Cross-cutting method (Method B)

29.2 Grid-cutting method (Method A)

29.2.1 Purpose

To measure adhesion between substrate and paint film, and adhesion between paint films.

29.2.2 Equipment and tools

(1) Knife: As specified in item 7.2 (2) (e) of JIS K 5400.
(2) Cellophane adhesive tape: As specified in JIS Z 1522 (Pressure sensitive adhesive cellophane tapes)

29.2.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated as specified in 4.4.

29.2.4 Test conditions

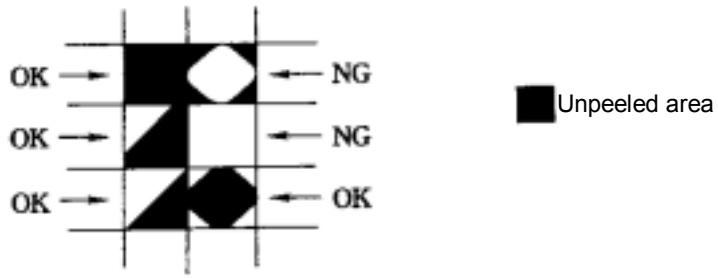
Standard conditions specified in 4.1.2(1)

29.2.5 Procedure

(1) Using a knife, cut a grid pattern with 11 crosswise and 11 lengthwise lines near the center of the specimen, with intervals of 2 mm, each reaching the substrate.
(2) Attach 18 mm to 30 mm wide cellophane adhesive tape to the pattern, then quickly peel the tape upward. Check the number of squares([24]) remaining in the grid pattern, the peeled portion and degree of damage. Peel the tape total of three times in vertical and horizontal directions.

Note ([24]): If a square section has more than 50% of paint film unpeeled, this section must be regarded as the unpeeled square. (Refer to Figure 31.)

Figure 31 Examples of remaining paint films



29.2.6 Report

(1) Indicate the percentage of remaining squares, and also indicate the evaluation number.
(2) Indicate the location where peel has occurred. (example: peel from substrate, from intermediate coat, etc.)

29.3 Cross-cutting method (Method B)

29.3.1 Purpose

To examine the adhesion between the substrate and paint film, and adhesion between paint films.

29.3.2 Equipment and tools

(1) Knife: As specified in 7.2 (2) (e) of JIS K 5400
(2) Cellophane adhesive tape: As specified in JIS Z 1522

29.3.3 Specimen preparation

Use the type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

29.3.4 Test condition

Standard condition specified in 4.1.2 (1)

29.3.5 Procedure

(1) Using a knife, cut two cross lines, reaching the surface of substrate, near the center of the specimen as shown in Figure 32.
(2) Attach approximately 18 mm wide cellophane adhesive tape to the cross cut portion, and quickly peel it upward. Check for separation between paint films.

Figure 32

29.3.6 Report

Indicate whether peeling occurred in the paint film.

30. BENDING RESISTANCE TEST METHOD

30.1 Purpose

To examine the adhesion of paint film to the substrate when it is subjected to bending.

30.2 Equipment and tools

(1) Temperature and humidity controlled chamber
(2) Knife: As specified in 7.2 (2) (e) of JIS K 5400
(3) Mandrel: Diameter 20 mm

30.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

30.4 Test conditions

(1) Standard condition specified in 4.1.2 (1)
(2) Temperature and humidity: 50°C, 95%RH or higher
(3) Test time: 120 hours

30.5 Procedure

30.5.1 Initial bending resistance test

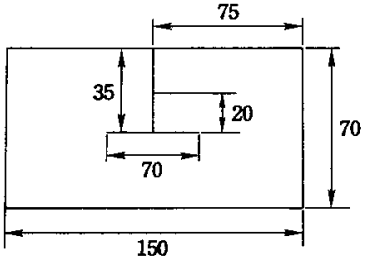
(1) Cut a line reaching the surface of the substrate as shown in Figure 33 near the center of the specimen.
(2) Apply the mandrel to the center of the specimen in the longitudinal direction. Bend the specimen to 180° in one second. Check the degree of peeling that occurs in the paint film.

30.5.2 Secondary bending resistance test

(1) Keep the specimen in the temperature and humidity controlled chamber which has been adjusted to the specified conditions for the specified time period.
(2) Remove the specimen, and allow to stand at room temperature for 24 hours. Conduct the test as described in items (1) and (2) of 30.5.1, and check the degree of peel that has occurred in the paint film.

Figure 33.1

Unit: mm

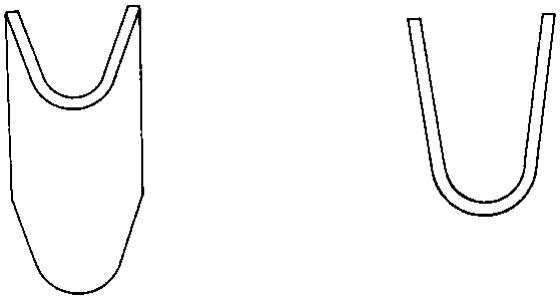
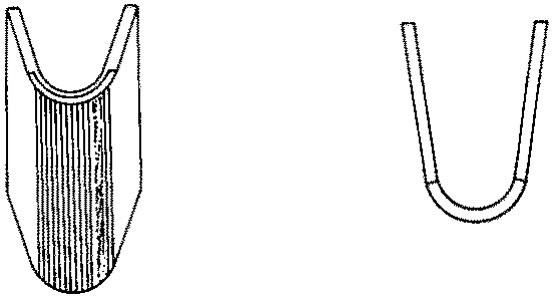
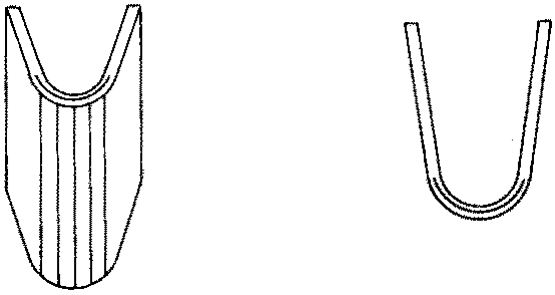
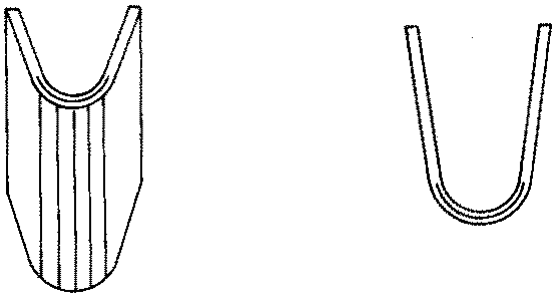
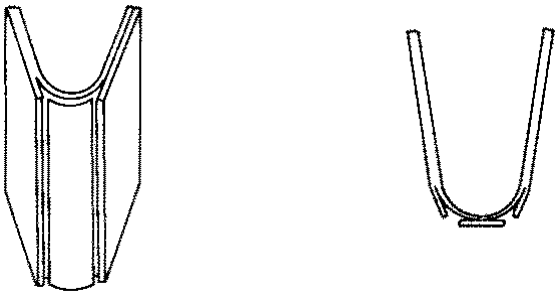


30.6 Report

(1) Record the degree of paint film peel that has occurred in the substrate due to bending at the cut and non-cut portion according to the standard shown in Table 11.

(2) Also report cracking at the bent portion.

Table 11 Peel evaluation criteria

Rating	Evaluation criteria
5	
4	
3	
2	
1	

31. RESISTANCE TO CAR-WASHING TEST METHOD

31.1 Purpose

To examine whether the paint film is vulnerable to damage caused by the brushing of car washing machine.

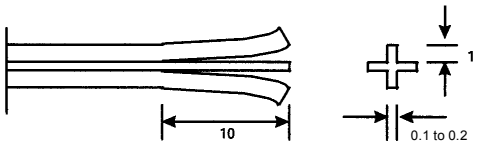
31.2 Equipment and tools

(1) Car washing brush:

The material must be 6-nylon, and the bristle must have a cross-tip split shape (10 mm split from bristle end).

Overall brush length = 220 mm

Figure 33.2



(2) Motor: The motor must permit installation of car washing brush, and be capable of maintaining a rotating speed of 150 rpm.

(3) Soiling solution composed of type 8 dust [JIS Z 8901 (Dusts and aerosols for industrial testing)], water, and water solution of polyoxymethylene lauryl ether sulfate sodium 0.75% mixed in the weight ratio of 3 : 10 : 2

(4) Varied-angle color difference meter

(5) Brush

31.3 Specimen preparation

Use a 70 × 75 mm plate cut out of test plate A specified in 4.2 (70 × 150 mm) and painted in accordance with 4.3.3 as the test piece.

31.4 Test conditions

(1) Room temperature specified in 4.1.2(2)

(2) Car wash brush rotating speed and time: 150 rpm for 10 seconds

(3) Quantity of water: 4 liters/minute

31.5 Procedure

(1) Face the testing surface of the specimen upward and apply the soiling solution using the brush. (0.5 cm^3/70 × 150 mm)

(2) Place the fouled specimen at 150 mm from the center of the car wash brush. Rotate the brush for the specified time under the specified conditions while applying the specified flow rate of water to the specimen.

(3) Perform required cycle as per one cycle consisting of operations (1) and (2).

(4) Remove muddy water from the test piece. Wipe it in the direction of flaws with a double-sided flannel cloth and moistened with alcohol in order to remove dirt resulting from brushing, and determine the brightness difference (ΔL' 10°).

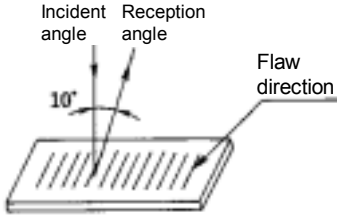
$\Delta L'10^o$ = ($L'10^o$ after fouling) - ($L'10^o$ before fouling)

$\Delta L'10^o$ must be measured at: Incident angle = 0^o

Reception angle = 10^o

Reception of reflected light must be made in a direction perpendicular to the direction of flaws. (Refer to Figure 34.)

Figure 34



31.6 Report

Report the brightness difference $\Delta L'10^o$.

32. HUMIDITY RESISTANCE TEST METHOD

32.1 Purpose

To examine the degree of paint film blistering in high temperature and humidity conditions.

32.2 Test methods

Method A: Directly putting a test piece in a temperature and humidity controlled oven
Method B: Cataplasm method

32.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

32.4 Directly putting a test piece in a temperature and humidity controlled oven

32.4.1 Equipment Temperature and humidity controlled oven (capable of maintaining the specified temperature and humidity)

32.4.2 Test conditions

(1) Temperature and humidity: 50±1°C, 95%RH or over
(2) Testing time: 120 hours

32.4.3 Procedure

(1) Place the specimen in the temperature and humidity controlled oven at an angle of 45° for the specified time.
(2) Remove the specimen, and examine the degree of paint film blistering. 24 hours after, conduct the grid-cutting test in accordance with 29.2.

32.5 Cataplasm method

32.4.1 Equipment Temperature controlled oven (capable of maintaining the specified temperature and humidity)

32.4.2 Test conditions

(1) Test temperature : 60°C±2°C
(2) Test time : 8 hours

32.4.3 Procedure

(1) Wrap up the test piece in a cotton cloth 15 g in weight, moistened with 150 ml of distilled water, and seal it as it is in a polyethylene bag.
(2) Put and leave the test piece in the oven set to the specified temperature.
(3) After letting the test piece stand for the specified time, cool it down for 15 minutes, and then take it out of the oven.
(4) 24 hours after taking the test piece out of the oven, examine whether the paint film has blistered, and then subject the test piece to the cross cut test specified in 29.2.

32.6 Report (Common to methods A and B)

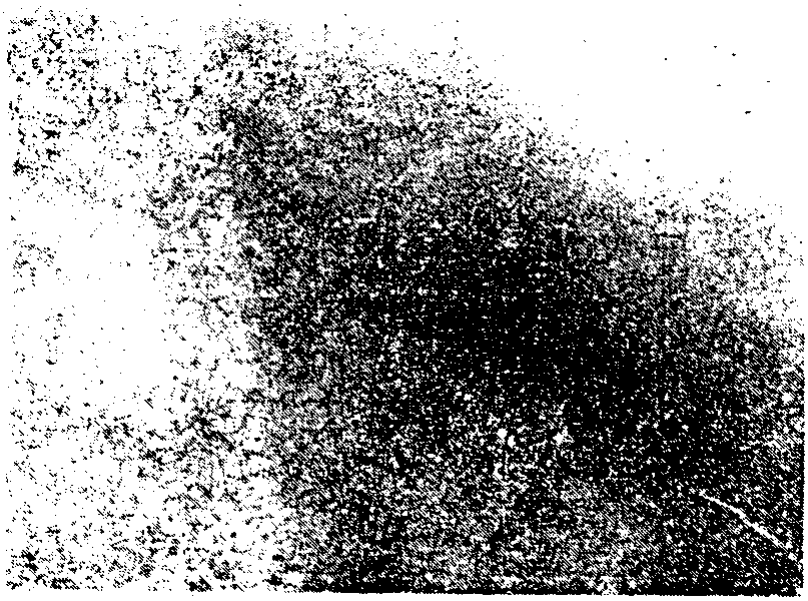
(1) Record the extent of blistering.
Refer to Table 12 for the size and density of blister occurrence.
If no blisters are found, the test piece may be judged to have no problems with its appearance.
(2) Record the grid-cutting test results according to 29.2.6.

Table 12 Blister size and density classification

Size		Density		Illustration example (according to ASTM D 714)
Symbol	Description	Symbol	Description	
A	Very small (hardly visible to 0.1 mm dia.)	a	Low	—
		b	Medium	
		c	High	
		d	Very high	
B	Small (0.2 to 0.5 mm dia.)	a	Low (less than 10 blisters)	Figure 35.1 (ASTM D714-8F, 8M)
		b	Medium (less than 20 blisters)	
		c	High (less than 150 blisters)	Figure 35.2 (ASTM D714-8MD, 8D)
		d	Very high (Greater than 150 blisters)	
C	Medium (0.5 to 1.0 mm dia.)	a	Low (less than 4 blisters)	Figure 35.3 (ASTM D714-4F, 4M)
		b	Medium (less than 20 blisters)	
D	Large (1.5 to 3.0 mm dia.)	a	Low (less than 3 blisters)	Figure 35.4 (ASTM D714-6F, 6M)
		b	Medium (less than 20 blisters)	

Figure 35.1 Size and density of blisters

B-a (Small size; Low density)



B-b (Small size; Medium density)

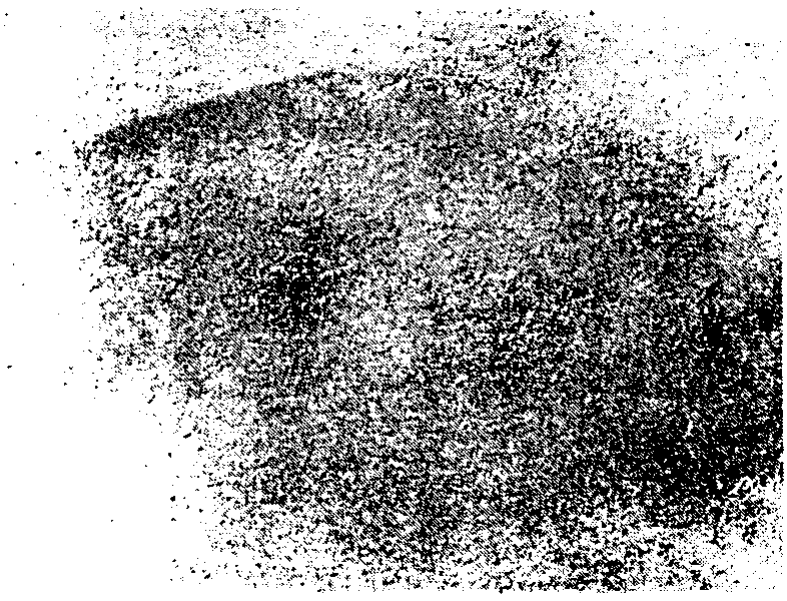
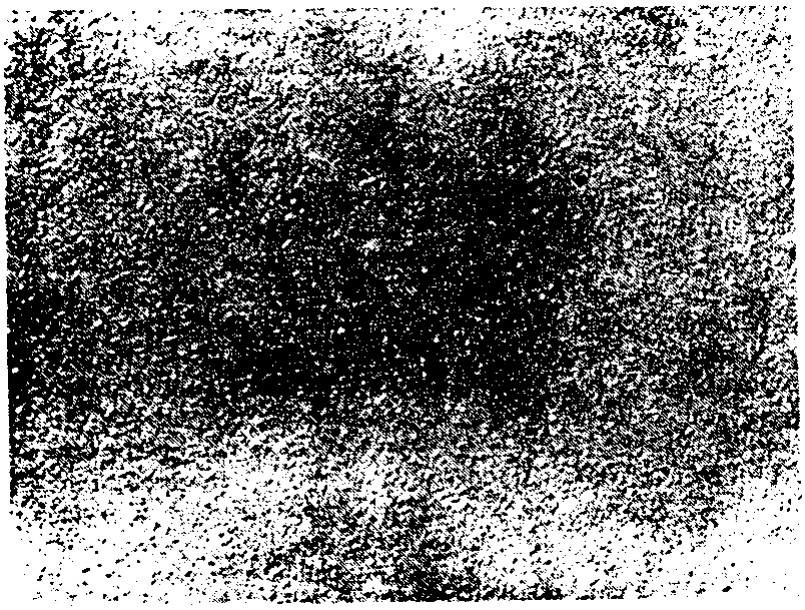


Figure 35.2 Size and density of blisters

B-c (Small size; High density)



B-d (Small size; Very high density)

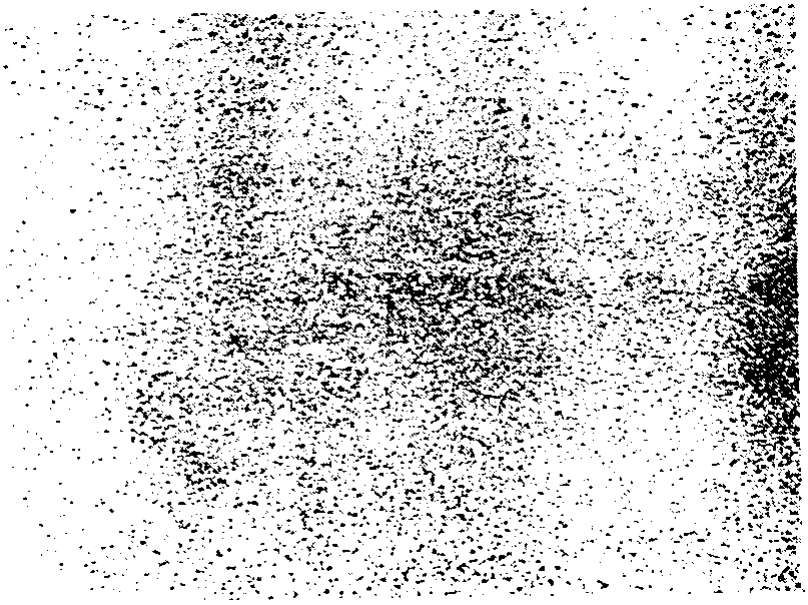


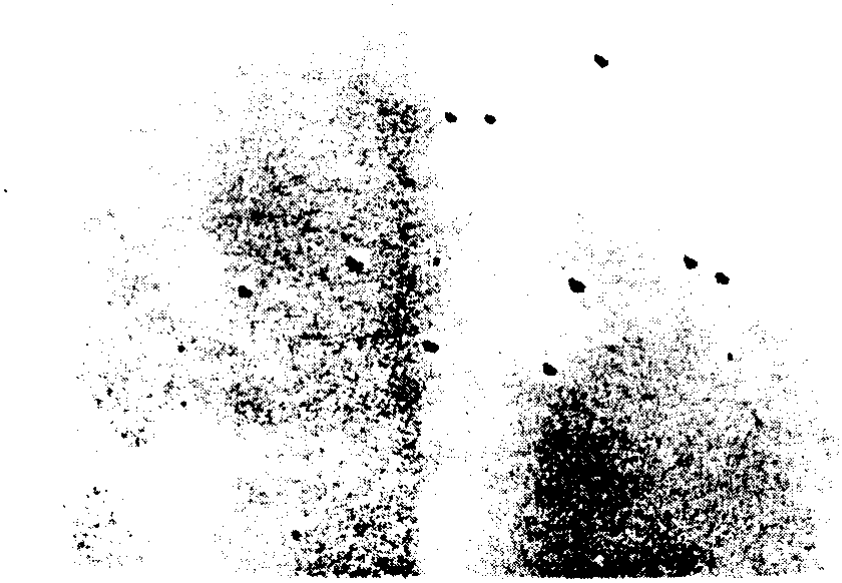
Figure 35.3 Size and density of blisters

C-a (Medium size; Low density)

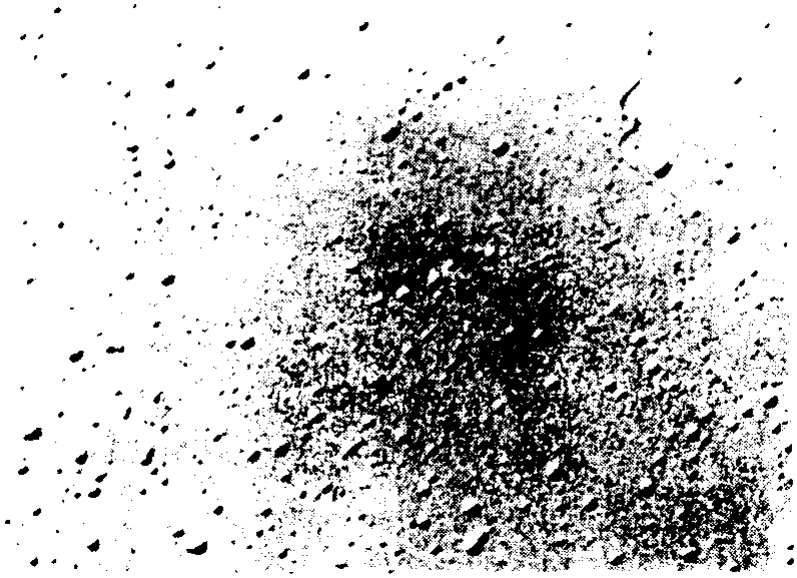
C-b (Medium size; Medium density)

Figure 35.4 Size and density of blisters

D-a (Large size Low density)



D-a (Large size; Medium density)



33. CORROSION RESISTANCE TEST METHOD

33.1 Purpose

To examine the degree of rusting, blistering and adhesion of paint film in corrosive environments (salt water spraying, heat drying, and humidifying).

33.2 Test method types

(1) Salt spray test (Method A)
(2) Combination corrosion test (Method B)

33.3 Salt spray test (Method A)

33.3.1 Equipment and tools

(1) Salt spray tester: As specified in Item 2 of NES M 0140 (Salt Spray Testing)
(2) Knife: As specified in 7.2(e) of JIS K 5400, or a commercial cutter for plastics
(3) Cellophane adhesive tape: As specified in JIS Z 1522

33.3.2 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

33.3.3 Test conditions

Salt spray test must be performed using a salt solution of 5±1 weight % concentration at the spray bath temperature of 35±1°C. Other detailed conditions must be in accordance with item 3 of NES M 0140.

33.3.4 Procedure

(1) Protect the edges of the specimen with a coat of film which can withstand the test conditions ([25]). Using a knife, cut two cross lines, reaching the substrate and extending to 10 mm from each edge of the specimen.
(2) Place the specimen in the salt spray tester, with the test paint surface facing up. Set the specimen parallel to three directions of spray mist flow and at an angle of 15° with respect to the vertical line so that the spray mist will be evenly applied to the testing surface. After adjusting the specimen in this way, perform test for the specified time period.
(3) Check the cross-cut portion on the paint film for rusting and blistering. After 24 hours, attach approximately 18 mm wide cellophane adhesive tape to the cross cut portion, and quickly peel it upward. Check for separation between paint films.

Note ([25]): No protection is required when checking for corrosion of the edge portion.

33.3.5 Report

(1) Record the width of rust and blisters extending from the cross cut portion ([26]) in mm. Exclude abnormal values.
(2) Record the width of peeled area in mm.

Note ([26]): To evaluate the corrosion resistance of the panel edge, regard the cross cut portion as the edge.

33.4 Combination corrosion test (Method B)

33.4.1 Equipment and tools

(1) As specified in item 3 of NES M 0158 (Methods of Compound Corrosion Test)
(2) Knife as specified in 7.2 (2) (e) of JIS K 5400, or a commercial cutter for plastics
(3) Cellophane adhesive tape as specified in JIS Z 1522

33.4.2 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

33.4.3 Test conditions

Repeat any one of the following test cycles as agreed upon between concerned parties.

CCT-I method: Salt spray (35°C, 4 hours) → Drying (60°C, 2 hours) → Humidifying (50°C, 95%RH, 2 hours)

CCT-II method: Salt spray (35°C, 2 hours) → Drying (60°C, 2 hours) → Humidifying (50°C, 95%RH, 4 hours)

CCT-IV method: Salt spray (50°C, 10 minutes) → Drying (60°C, 155 minutes) → Humidifying (60°C, 95%RH, 75 minutes) → Drying (60°C, 160 minutes) → Humidifying (60°C, 95%RH, 80 minutes)

Repeat this cycle five times

33.4.4 Procedure

(1) Protect the edges of the specimen with a coat of film which can withstand the test conditions ([27]). Using a knife, cut two cross lines, reaching the substrate and extending to 10 mm from each edge of the specimen.
(2) Place the specimen in the composite corrosion tester, with the test paint surface facing up. Set the specimen at an angle of 15° with respect to the vertical line so that the testing surface is uniformly subjected to various environmental conditions. Next, perform test for the specified time period.
(3) Check the cross-cut portion on the paint film for rusting and blistering. After 24 hours, attach an approximately 18 mm wide cellophane adhesive tape to the cross cut portions, and quickly peel it upward. Check for separation between paint films.

Note ([27]): No protection is required when checking for corrosion from the edge portion.

33.4.5 Report

(1) Record the width of rust and blisters extending from the cross cut portion ([28]) in mm. Exclude abnormal values.
(2) Record the width of peeled area in mm.

Note ([28]): To evaluate the corrosion resistance of the panel edge, regard the cross cut portion as the edge.

34. SCAB CORROSION TEST METHOD

34.1 Purpose

To examine the degree of scab corrosion ([29]) developed on an area of damaged paint film when exposed to corrosive environment (salt spray, heat drying, humidity).

Note ([29]): Scab corrosion develops where the paint film is damaged by flying pebbles or sand while the car is running. This type of corrosion propagates along the substrate surface under the paint layer, and lifts the paint film up to form a scab.

34.2 Equipment and tools

(1) Composite corrosion tester: As specified in 33.4.1
(2) Cellophane adhesive tape: As specified in JIS Z 1522

34.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4. and then subjected to the chipping resistance test specified in 28.

34.4 Test conditions

Repeat any one of the three methods, CCT-I, CCT-II and CCT-IV, as specified in 33.4.3 for the specified number of cycles ([30]) as agreed upon between concerned parties.

Note ([30]): Salt spray test conditions are specified in 33.3.3.

34.5 Procedure

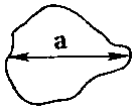
(1) Protect the edges of the specimen with a coat of film which can withstand the test conditions.
(2) Using the method specified in 34.4, continue the test for the specified number of cycles.
(3) Measure the size of the scab corrosion formed on the damaged paint film area. After 24 hours, attach approximately 18 mm wide cellophane adhesive tape to the affected portion, and quickly peel it upward. Measure the size of the hole in the paint film created by peeling.

34.6 Report

(1) Record the maximum scab diameter ([31]) in mm.
(2) Record the maximum peel diameter ([32]) in mm.

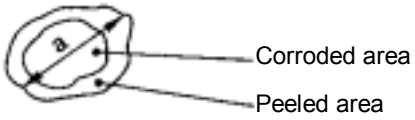
Note ([31]): The scab diameter is shown below:

a mm



Note ([32]): The peel diameter is shown below:

a mm



Remark: The blistered area may also be determined by using an image analyzer.

35. FILIFORM CORROSION TEST METHOD

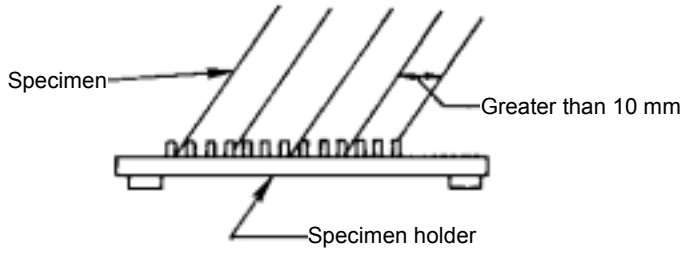
35.1 Purpose

To check the degree of filiform corrosion extending from damage in the paint film using the accelerated test method.

35.2 Equipment and tools

(1) Salt spray tester: As specified in Item 2 of NES M 0140.
(2) Temperature and humidity controlled oven
(3) Specimen holder as shown in Figure 36
(4) Knife: As specified in Item 7.2 (2) (e) of JIS K 5400, or a commercial cutter for plastics

Figure 36



35.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

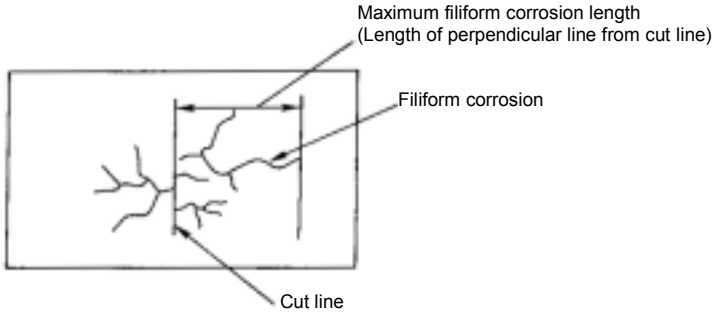
35.4 Test conditions

(1) Salt spray duration: 24 hours (Details of the salt spray test are in accordance with NES M 0140.)
(2) Humidifying condition: 40°C, 80 to 85% RH, 240 hours

35.5 Procedure

(1) Cut the paint film in a straight line at the center of the specimen to a depth reaching the substrate. (Refer to Figure 34.)
(2) Perform the salt spray test for the specified time according to the method of 32.3.4.
(3) Remove the specimen from the salt spray tester and thoroughly rinse with pure water. Keep the specimen wet until the next step.
(4) Place the specimen in the temperature and humidity controlled oven which is adjusted to the specified conditions. Specimens must be separated from each other in the oven by more than 10 mm. (Refer to Figure 36.)
(5) Remove the specimen from the oven, and measure the length of the filiform corrosion starting from the cut line. (Refer to Figure 37.)

Figure 37



35.6 Report

(1) Record the length of the filiform corrosion from the cut line in mm.
(2) Record the maximum lengths.

36. ACID RESISTANCE TEST METHOD

36.1 Purpose

To examine the effect of soot and other acid substances on the paint film.

36.2 Equipment and chemicals

36.2.1 Spot method (Method A)

(1) Temperature controlled oven
(2) 10 w/v% sulfuric acid solution
(Preparation method)
Dilute 100 g of 96 to 97 w/w% sulfuric acid with distilled water to create 1 liter of mixture. (10 w/v% sulfuric acid solution)

36.2.2 Immersion method (Method B)

(1) Temperature controlled water bath or temperature controlled oven and beaker
(2) 1 w/v% sulfuric acid solution
(Preparation method)
Dilute 10 g of 96 to 97 w/w% sulfuric acid with distilled water to create 1 liter of mixture. (1 w/v% sulfuric acid solution)
(3) Gloss meter: As specified in 21.2

36.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

36.4 Test conditions

36.4.1 Spot method (Method A)

(1) Standard conditions specified in 4.1.2(1)
(2) Testing time: 24 hours

36.4.2 Immersion method (Method B)

(1) Sulfuric acid solution heated to the specified temperature
(2) Testing time: 24 hours

36.5 Procedure

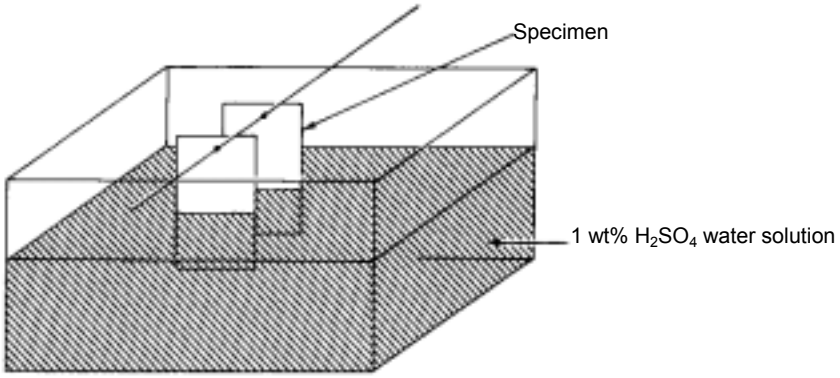
36.5.1 Spot method (Method A)

(1) Immerse approximately 0.2 mℓ of 10 w/v% sulfuric acid solution onto the specimen surface and leave the specimen as it is for the specified time under the standard conditions.
(2) Rinse the specimen with water and wipe water with a clean cloth, then check the paint film for discoloration, dulling, softening, stain, swelling, etc.

36.5.2 Immersion method (Method B)

(1) Immerse the specimen in 1 w/v% sulfuric acid solution which has been heated to the specified temperature, and leave as is for the specified time period. Refer to Figure 38.
(2) Rinse the specimen with water, and remove the water with a clean cloth, then visually check the paint film for discoloration, dulling, softening, staining, swelling, etc.

Figure 38 Acid resistance test (Immersion method: Method A)



36.6 Report

36.6.1 Spot method (Method A)

Record whether discoloration, dulling, staining, softening, or swelling is found in the paint film.

36.6.2 Immersion method (Method B)

(1) Measure the initial gloss and after-test gloss of the specimen, then calculate the gloss retention rate using the following equation:
Gloss retention rate = After-test gloss/Initial gloss × 100
(2) Record whether discoloration, dulling, staining, softening, or swelling is found in the paint film.
Also measure brilliance and color differences.

37. ALKALI RESISTANCE TEST METHOD

37.1 Purpose

To examine the effect of alkaline substances on paint films.

37.2 Chemicals

5 w/v% caustic soda solution
(Preparation method)
Dilute 50 g of NaOH solid in distilled water to create 1 liter of mixture.

37.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

37.4 Test conditions

(1) Standard conditions as specified in 4.1.2(1)
(2) Testing time: 4 hours

37.5 Procedure

(1) Using a syringe, drip 0.2 mℓ of 5% caustic soda solution onto the surface of the specimen and leave the specimen as is in a horizontal position under the standard condition.
(2) Rinse the specimen with water and remove water with a clean cloth, then visually check the paint film for discoloration, dulling, softening, staining, swelling, etc. Also measure brilliance and color differences.

37.6 Report

Record whether discoloration, dulling, staining, softening, or swelling is found in the paint film. Also record brilliance and color differences.

38. GASOLINE RESISTANCE TEST METHOD

38.1 Purpose

To examine the effect of gasoline on the paint film.

38.2 Materials

Lead-free regular gasoline, high-octane gasoline and leaded premium gasoline specified in NES M 5052 (Motor Gasoline).

38.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

38.4 Test conditions

(1) Standard conditions as specified in 4.1.2(1)
(2) Testing time: 24 hours

38.5 Procedure

(1) Set the specimen on an angle of approximately 45^{o} with the coated side facing up.
(2) Drop 1 mℓ of gasoline every 3 seconds from the upper part of the specimen. Repeat this operation 10 times.
(3) After testing, remove the gasoline with a clean cloth.
Examine the paint film for discoloration, dulling, softening, staining, swelling, etc., directly after wiping, and again 24 hours after leaving under the standard conditions.

38.6 Report

Record whether discoloration, loss of gloss, stain, softening, or swelling is found in the paint film.

39. ENGINE OIL RESISTANCE TEST METHOD

39.1 Purpose

To examine the effect of engine oil attached on paint film.

39.2 Equipment and materials

(1) Temperature controlled oven
(2) Beaker: 300 mℓ capacity or larger
(3) Engine oil: SJ 5W-30 specified in NES M 5051 (Lubricating Oil for Automobile Gasoline Engines)

39.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

39.4 Test conditions

(1) Standard condition as specified in 4.1.2(1)
(2) Testing time: 24 hours

39.5 Procedure

(1) Pour engine oil into a beaker, and immerse half of the specimen in the engine oil, then keep under the standard condition for the specified time.
(2) Remove the specimen from the beaker, remove the engine oil with a cloth, or use benzine to remove the engine oil more thoroughly if necessary. Immediately after cleaning, examine the paint film for any discoloration, dulling, softening, staining, swelling, or other defects. Also record brilliance and color differences.

39.6 Report

Record whether discoloration, dulling, staining, softening, or swelling is found in the paint film. Also record brilliance and color differences.

40. RESISTANCE TO WINDSHIELD WASHER SOLUTION TEST METHOD

40.1 Purpose

To examine the effect of washer solution on paint film.

40.2 Equipment and materials

(1) Temperature controlled oven
(2) Buret of 10 mℓ capacity, with a stop cock, specified in the Attached Table 1 of JIS R 3505 (Volumetric glassware)
(3) Watch glass of diameter 50 to 60 mm
(4) Undiluted washer solution as specified in NWL of NES M 5069 (Windshield Washer Liquid for Automobiles)

40.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

40.4 Test conditions

(1) Test temperature: 50±2°C
(2) Testing time: 24 hours

40.5 Procedure

(1) Using a buret, drop 0.2 cm^3 of washer solution onto three different places on the specimen.
(2) Cover each wet area on the specimen with a watchglass, place the specimen in the temperature controlled oven which is adjusted to the specified temperature. Allow the specimen to stand for the specified time period.
(3) Remove the specimen from the temperature controlled oven. Remove the watchglass and allow the specimen to stand until it reaches room temperature.
(4) Rinse the specimen with water to remove washer solution, then wipe with a cloth. Check the paint film for any discoloration, fixing of color pigment contained in the washer solution, dulling, softening, staining, swelling, or other defects.

40.6 Report

Record discoloration, fixing of washer solution color pigment, dulling, softening, staining and swelling, if any.

41. ANTIFREEZE RESISTANCE TEST METHOD

41.1 Purpose

To examine the effect of antifreeze attached on the paint film.

41.2 Equipment and materials

(1) Beaker: Capacity 300 mℓ
(2) Antifreeze: Undiluted solution of class 3 antifreeze (LLC) specified in NES M 5059 (Engine Antifreeze)

41.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

41.4 Test conditions

(1) Standard conditions as specified in 4.1.2 (1)
(2) Testing time: 24 hours

41.5 Procedure

(1) Pour antifreeze solution into a beaker, and immerse half of the specimen in engine oil, then keep under the standard condition for the specified time.
(2) Remove the specimen from the beaker, remove the antifreeze with a cloth, or use benzine to remove the engine oil more thoroughly if necessary. Immediately after cleaning, examine the paint film for any discoloration, fixing of antifreeze pigment, dulling, softening, staining, swelling, or other defects. Also record brilliance and color differences.

41.6 Report

Record whether discoloration, dulling, staining, softening, or swelling is found in the paint film. Also record brilliance and color differences.

42. RESISTANCE TO PROTECTIVE COATING AGENT TEST METHOD

42.1 Purpose

To examine the effect of protective coating applied to the paint film.

42.2 Equipment and materials

(1) Temperature controlled oven
(2) Sunshine weatherometer
(3) Paint film protecting agent: As specified in NES M 5067 [Paint Guard Coating (Transportation Protection) – Automotive]

42.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

42.4 Test conditions

42.4.1

(1) Method A: Temperature 80°C, 336 hours
(2) Method B: Temperature 50°C, humidity more than 95%RH, 120 hours
(3) Method C: Sunshine weatherometer ([32]), 250 hours
(4) Method D: Outdoor exposure for 3 months (including summer)

Note ([32]): The black panel temperature of the sunshine weatherometer must be 63±3°C.

42.5 Procedure

(1) Apply the paint film protective agent to the specimen to the coating thickness agreed upon between concerned parties with the method specified in 4.4.1 (1), then allow the specimen to stand for 24 hours.
(2) After standing, subject the specimen to the specified aging conditions, then completely remove the protective coating by wiping with a cloth moistened with kerosene. Examine the paint film for any discoloration, loss of gloss, softening, stain, swell, or other detects.

42.6 Report

Record whether discoloration, dulling, staining, softening, or swelling is found in the paint film.

43. RESISTANCE TO RUST PREVENTIVE WAX TEST METHOD

43.1 Purpose

To examine the influence of rust preventive wax on paint film.

43.2 Equipment and materials

(1) Temperature controlled oven
(2) Rust preventive wax: Rust preventive wax for vehicle body interior, exterior and underflooring as specified in NES M 5070 (Rust Preventive Agents) and rust preventive agent for engine compartment as specified in NES M 5075 (Engine Compartment Rust Preventive Materials)

43.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

43.4 Test conditions

(1) Standard condition as specified in 4.1.2 (1)
(2) Test temperature: 40±2°C
(3) Testing time: 168 hours

43.5 Procedure

(1) Drop 0.2 mℓ of rust preventive wax onto the center portion of the specimen. Keep the specimen horizontal and allow to stand for the specified time period in a temperature controlled oven which is adjusted to the specified temperature.
(2) Remove the specimen from the temperature controlled oven, and leave as is until it reaches room temperature.
(3) Remove the rust preventive wax from the specimen using kerosene, then check the paint film for any discoloration, dulling, softening, staining, swelling, or other defects.

43.6 Report

Record whether discoloration, dulling, staining, softening, or swelling is found in the paint film.

44. ADHESION TO WINDOW-GLASS BONDING AGENT TEST METHOD

44.1 Purpose

To examine adhesion between paint film and window glass adhesives.

44.2 Equipment and materials

(1) Temperature controlled oven
(2) Cutter knife
(3) Adhesive tape of 20 mm width
(4) Adhesive agent: Single-solution urethane type adhesive specified in NES M 8504 (Direct Adhesives of Window Glass - Automotive)

44.3 Specimen preparation

(1) Condition of preparation site: Standard condition as specified in 4.1.2
(2) Specimen types: Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

44.4 Test conditions

Standard conditions specified in 4.1.2 (1)

44.5 Procedure

(1) Under the standard conditions specified in 4.1.2 (1), apply primer for painted surface uniformly to the specimen using a flannel or sponge as shown in Figure 39.1. (Film thickness 5 to 20 μm)
(2) After applying the primer to the specimen, allow it to stand for 10 minutes to 2 hours under the standard condition as specified in 4.1.2 (1). Apply adhesive tape of approximately 20 mm width to one end of the specimen, as shown in Figure 39.2.
(3) Apply the window glass adhesive to the surface of the primer in a thickness of 5 to 7 mm and a width of 10 mm (Refer to Figure 39.3.), then allow to dry for 7 days under the standard conditions specified in 4.1.2 (1).
(4) Note the adhesive tape specimen shown in Figure 39.2. Turn the tip of the peeled adhesive 180° and attach it to the chuck of the Tensiron tester.
(5) Secure the peeled adhesive test piece to one side of the Tensiron tester. (Figure 40)

(6) Draw the test piece at a tensile speed of 400 mm/min using the Tensilon tester. Each time the tensile force reaches 13.5 N {15 kg/cm^2}, make a cut between the adhesive and the painted surface by moving a cutter down in a direction perpendicular to the test piece.
(7) While performing step (6) above, check for peeling between the adhesive and painted area. (Figure 40)

Figure 39.1

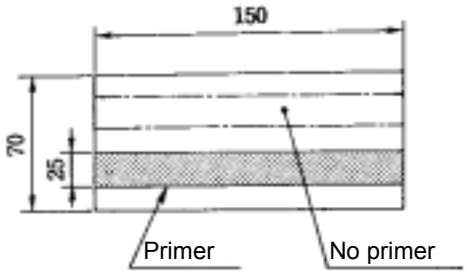


Figure 39.2

Unit: mm

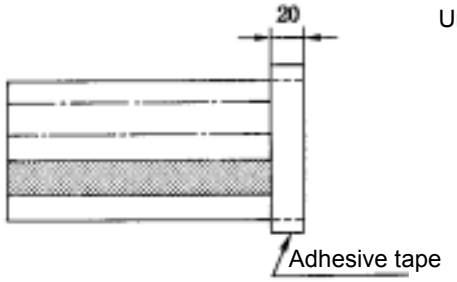


Figure 39.3

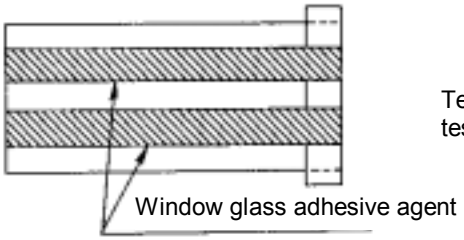
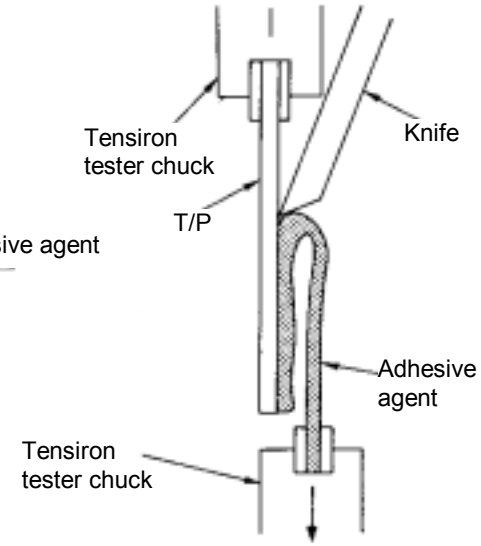


Figure 40



44.6 Report
(1) Record whether or not the internal peeling is found, and visually check and record the ratio and degree of any peeling. Exclude local peel due to knife cuts.
Symbols
CF: Coagulation and peeling of the adhesive
PF: Coagulation and peeling of the painted film
(Measure the coagulation width and record the average value with the most undesirable value reckoned as 10 points.)
AF: Interfacial separation between the painted film and the adhesive or primer (Record the percentage of the separated area.)
(2) Record the standing time after application of primer.

45. ELECTRODEPOSITION PAINT OIL REPELLENCY TEST METHOD
45.1 Purpose
To examine the repelling ability of electrodeposition paint film when rust preventive oil is spread onto the chemical conversion or electrodeposition coating.
45.2 Equipment and materials
(1) Temperature controlled oven
(2) Spray gun
(3) Mixed solution of rust preventive oil ([33]) and xylene
(4) Rust preventive oil ([33])

Note ([33]): Use the rust preventive oil as agreed upon between concerned parties.

45.3 Specimen preparation
Use type A test panel (70 × 150 mm) specified in 4.2.2. Apply chemical conversion treatment to the panel according to 4.2.3.

45.4 Procedure

(1) Method A (Rust preventive oil spreading on chemical conversion coating)

(a) Place the specimen in a vertical position. Using a spray gun, apply the mixed solution of rust preventive oil and xylene specified in 45.2 (3) to the surface of the specimen at a distance of 1 meter away from it.
(b) Place the specimen in a horizontal position in the temperature controlled oven, and allow to dry for 20 minutes at 110°C, then coat using electrodeposition to harden the surface.
(c) Examine the specimen for the number of points where the oil is repelled on the specimen.

(2) Method B (Rust preventive oil spreading on the electrodeposition paint)

(a) Coat the specimen by electrodeposition, then dry with air after rinsing with water.
(b) Place the specimen in a vertical position. Using a spray gun, apply the mixed solution of rust preventive oil and xylene specified in 45.2 (3) to the surface of the specimen at a distance of 1 meter away from it.
(c) Place the specimen horizontally in the temperature controlled oven, and harden the electrodeposited surface under the specified conditions, then examine the specimen for the number of points where the solution is repelled.

(3) Method C (Anti-corrosive oil added to electrolytic bath)

(a) Add anti-corrosive oil (oil type and quantity to be agreed upon between concerned parties) to the electrolytic paint. Stir the paint for one hour.
(b) Apply the electrodeposition paint to the specimen. Wash the specimen in water. Bake-dry the specimen.
(c) Note the number of points where the solution is repelled.

45.5 Report

Record the ability to repel. (number of points where the specimen repells the solution, etc.)

46. THERMAL CYCLE TEST METHOD

46.1 Purpose

To check the effect of repeated exposure of paint film to humidity, low temperature and high temperature conditions.

46.2 Equipment, tools and fittings

(1) Constant temperature and humidity controlled chamber
(2) Low temperature controlled chamber
(3) Constant temperature controlled chamber
(4) Knife: As specified in 7.2 (2) (e) of JIS K 5400
(5) Testing pencil: As specified in JIS S 6006 and approved by the Paint Testing Association of Japan.

46.3 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

46.4 Test conditions

(1) Room temperature as specified in 4.1.2 (2)
(2) Thermal cycle condition:
The specified number of cycles, each cycle consisting of the following sequence:

90±2°C, 20%RH max. 4 hours → room temperature, 0.5 hour → -40±2°C, 1.5 hours → room temperature, 0.5 hour → 70±2°C, 95%RH, 3 hours → room temperature, 0.5 hour → -40±2°C, 1.5 hour → room temperature, 0.5 hour

46.5 Procedure

(1) Place the specimen into the equipment which are controlled to the specified thermal cycle conditions, and retain there for the specified time.

(2) After completing the specified thermal cycle test, remove the specimen, and perform the following tests:

(a) Check for the presence and degree of surface defects (cracks, dulling, etc.)

(b) Perform the grid-cutting test according to the procedure specified in 29.2 and the film hardness test according to the procedure specified in 26.

46.6 Report

(1) Record surface abnormalities and extent of damage.

(2) Record the results of the grid-cutting test and film hardness test according to 29.2.6 and 26.6.

47. OUTDOOR EXPOSURE TEST METHOD

47.1 Purpose

To examine the effects of exposure to natural environmental conditions on paint film.

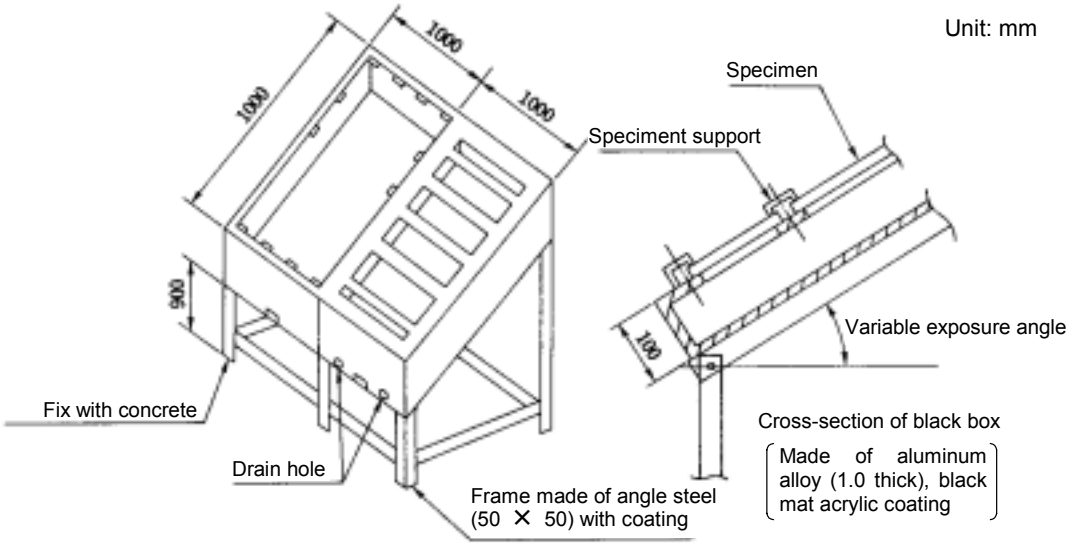
47.2 Test conditions

The exposure site must be in a location free of objects which obstruct direct sunlight at any time from 30 minutes after sunrise to 30 minutes before sunset. The site must be free from dust, soot, sand, etc. The exposure test stand must face south. The selected angle must be 20° between October and April and 5° between May and September in Okinawa or equivalent location.

47.3 Equipment and tools

(1) Exposure stand (variable angle black box) (Refer to Figure 41.)

Figure 41 Black box



(2) Gloss meter: As specified in 21.2

(3) Standard light source: As specified in 24.2 (1)

(4) Color-difference meter, photoelectric colorimeter: As specified in 24.2 (2)

(5) Knife: As specified in 29.2.2 (1)

(6) Cellophane adhesive tape: As specified in 29.2.2 (2)

(7) Wax: Genuine Nissan car wax (NISSAN CAR WAX SHIELD SOFT)

47.4 Specimen preparation

(1) Specimen type A test panel (70 × 150 mm) or type B test panel (70 × 300 mm) specified in 4.2.2, coated in accordance with 4.4.

(2) When evaluating the intermediate coat's adhesion by acceleration test, coat the test panel up to the intermediate coating stage in the normal coating process, then apply a clear 2-coat metallic basecoat and 2-coat metallic clear coat in w/w process without polishing. Bake the coated test panel under the specified conditions to create a specimen. Three specimens shall be prepared; one for control standard without exposure, one each for a one year test and two year test. Protect the edges and the back side of the specimen with appropriate masking material (tape, paint), if necessary, so that there are no undesirable effects during the test period. (Refer to Figure 42.1.)

(3) Using a non-fading writing material, write the paint color, maker, date of test start, due day of test completion, film thickness and other necessary items. (Refer to Figure 42.2.)

Figure 42.1 Masking example

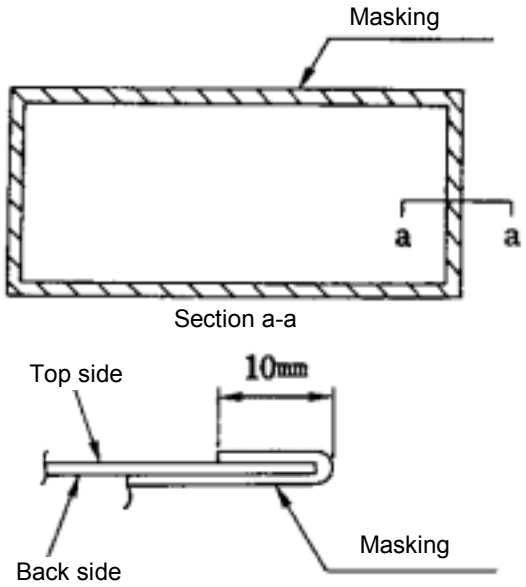


Figure 42.2 Example of notes on back side of specimen

Paint color: ○○○○ Film thickness: ○○

Maker: ○○○○○○○○○○

Test period: Mar. 1, 1986 to Feb. 28, 1987

47.5 Exposure period

(1) Minimum 2 years

(2) 3 summer months for evaluating the adhesion of intermediate coat

47.6 Procedure

(1) Start of test: After leaving the specimen as is for at least 24 hours in a room, measure the film thickness, gloss and three stimulus values of color difference X, Y and Z, then attach the specimen to the exposure stand with its top side facing up.

(2)Test period: Unless otherwise specified, test and observe the paint film every six months. After one year, test the specimen every 3 months. Observe and record the weather, as necessary.

(3) Preparation for test: Remove the specimen from the exposure stand, and rinse with clean water using sponge, then dry at room temperature.

(4) Observation

Test the following items:

1) Gloss
2) Discoloration (color difference)
3) External appearance (chalking, rust, blister, stain, cracks, peels)
4) Physical properties (Check the pencil hardness, grid-cutting, chipping or others.)

47.7 Report

(1) Gloss: As specified in 21.6

(2) Discoloration: As specified in 24.6

(3) External appearance: Surface abnormalities.

(4) Physical properties: As specified in 26.6 (Film hardness), 29.2.6 (Adhesion) and 28.3.6 (Chipping resistance)

(5) Weather observation: Weather condition as specified in Table 13.
Record the test results using Attached Figure 5 as reference.

Table 13 Weather observation items

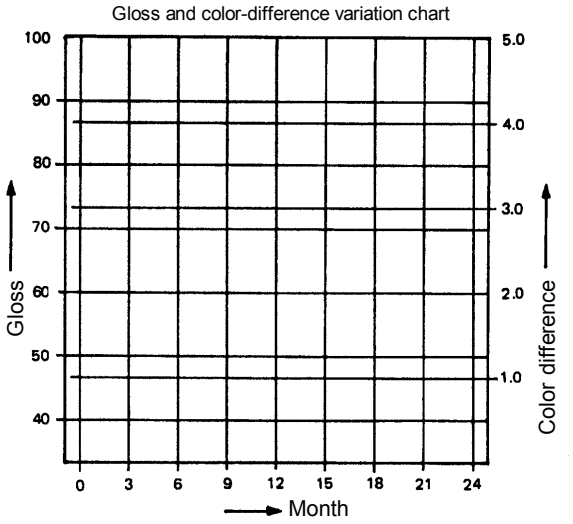
No.	Observation item	Measuring method
1	Temperature °C	Measure daily temperature as specified in JIS B 7305 (Thermographs) (Inside an instrument screen)
2	Humidity %RH	Measure daily humidity as specified in JIS B 7306 (Hygrographs) (Inside an instrument screen)
3	Solar radiation time h	Measure the duration of solar radiation per day with a Jordan sunshine recorder.
4	Quantity of solar radiation (Langley = g cal/$cm^{2)}$	Using a sunshine meter or integrating illumination meter, measure the amount of solar energy per day, then convert it into the Langley value for recording. When measuring the solar energy in the specific wavelength range, use a selective wavelength filter.
5	Black box temperature °C	Measure daily temperature using the black panel temperature specified in JIS B 7753. (Light and water exposure apparatus: open-flame sunshine carbon-arc type) Record the highest and lowest temperature of the day.
6	Wetting time h	Measure the amount of daily wetting time according to the conductometric method.
7	Sea salt particles (mg NaCl/d/100m^2)	Use the method using gauze as specified in Reference 3 of JIS H 0521.

Attached Figure 5 Natural Exposure Test Results

Condition

Description of specimen	(Material, shape, size, quantity)
Name of manufacturer	
Purpose and content	
Exposure site	
Exposure stand No. and position on the stand	
Starting date	
Remarks (Overall judgment on results)	

Dept.



Observation Results

No.	Item		Period (Months) / Date of observation	3	6	9	12	15	18	21	24
1	Gloss										
2	Discoloration	Instrumental									
		Visual									
3	Chalking										
4	Rust										
5	Blister										
6	Stain										
7	Cracking										
8	Peeling										
9	Physical properties	Pencil hardness									
		Resistance to impact									
		Erichsen									
		Cross-cut									
		Chipping									
10	Others										
Judgement											

Name of observer: _____

48. ACCELERATED EXPOSURE TEST METHOD

48.1 Purpose

To examine paint film deterioration under simulated environmental conditions.

48.2 Test method types

(1) Sunshine weatherometer method

(1.1) Continuous method
(1.2) Accelerated cycling method

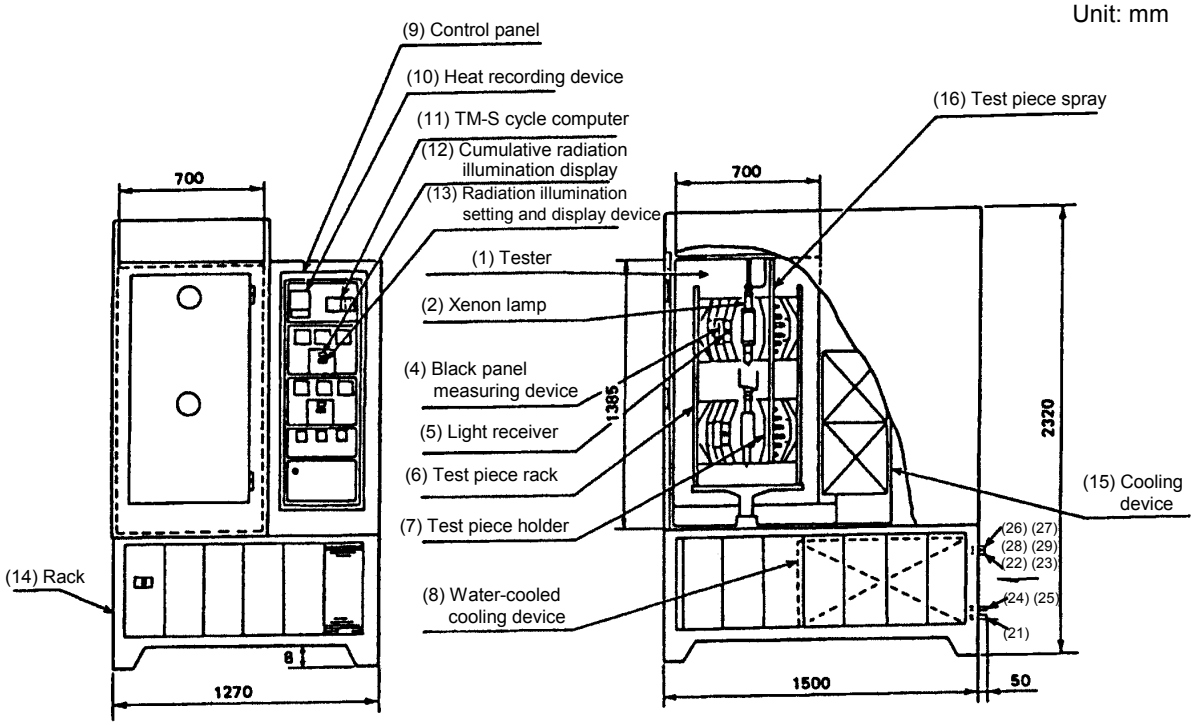
(2) Xenon weatherometer method
(3) Fluorescent-ultraviolet condensation method
(4) Super UV tester method

48.3 Equipment

(1) Sunshine weatherometer: As specified in JIS B 7753 [Light-exposure and light-and-water-exposure apparatus (Open-flame sunshine carbon-arc type)]
(2) Xenon weatherometer (Refer to Figure 43.)

Figure 43 Xenon weatherometer

Unit: mm



The xenon weatherometer must be made of anti-corrosive material, and be fitted with a xenon arc lamp, sample rotating frame, rainfall simulating device, illuminance control device, temperature and humidity controller and recorder.

(3) Ultra-violet fluorescent lamp condensation tester:
Dew panel weatherometer (DPW: Suga Tester Co.)
QUV (Q Panel Co.) (Figure 44)
UVCON (Atlas Co.)

Figure 44 Ultra-violet fluorescent lamp condensation tester (Example)

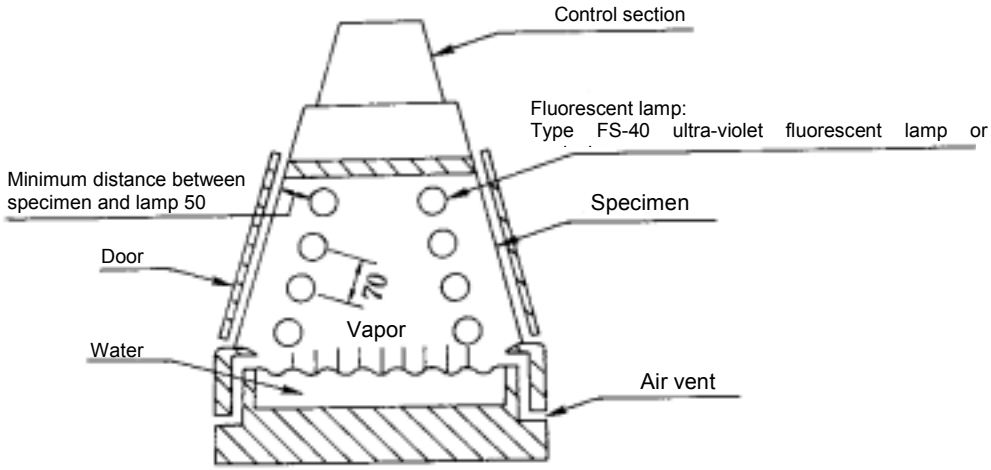
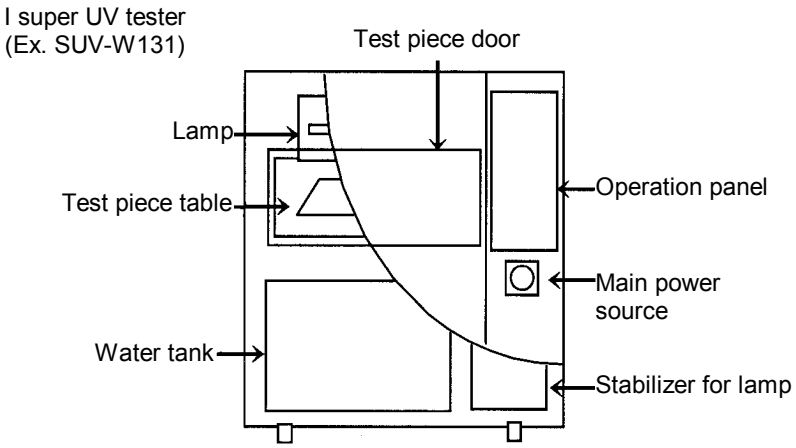


Figure 44.1



(4) Super UV tester
(5) Constant temperature and humidity controlled chamber
(6) Integrating actinometer
(7) Gloss meter: As specified in 21.2
(8) Standard light source: As specified in 22.2 (1)
(9) Color difference meter: As specified in 24
(10) Knife: As specified in 29.2.2 (1)
(11) Cellophane adhesive tape: As specified in 29.2.2 (2)
(12) Wax: Genuine Nissan car wax (NISSAN CAR WAX SHIELD SOFT)

48.4 Specimen preparation

As specified in 47.4.

48.5 Test conditions

Table 14

<table>
<tr><th colspan="2">Type</th><th colspan="5">Condition</th><th>Applicable paint film</th></tr>
<tr><td rowspan="2">Sunshine weatherometer</td><td>Continuous method</td><td colspan="5">Black panel temperature: 63°C±2°C
Rainfall duration: 18 min, Interval 102 min.
(Rainfall cycle: 120 min.)
Water quality: Deionized water of 2 μs/cm^3 or more, with pH6 to 8</td><td>Topcoat</td></tr>
<tr><td>Accelerated cycling method</td><td colspan="5">One cycle comprised of the following sequence:
Sunshine weatherometer 200 hours → room temperature 30 minutes → humidity (50°C, 95%RH) 120 hours → room temperature 30 minutes.</td><td>Intermediate coat</td></tr>
<tr><td colspan="2">Xenon weatherometer</td><td colspan="5">Radiated illumination: 180 W/m^2 [400 nm or lower]
(Uniformity ratio of illuminance must be ±10% within the effective evaluation area.)
Start-up wavelength: 290 nm
Temperature:
During irradiation: 63±3°C (black panel temperature)
During rainfall: 28±3°C (temperature of atmosphere)
Humidity:
During irradiation: 50%±5%RH
During rainfall: 95%RH or higher
Air speed in tank: 2 m/sec. or lower
Rainfall cycle: 24 minutes during irradiation of 360 minutes
Rainfall conditions:
Pressure: Approximately 98 kPa {1.0 kgf/cm^2}
Water temperature: 20±1°C
Water quantity: Approximately 800 to 1000 mℓ/min
Water quality: Deionized water of pH6.0 to 8.0, and 2 μs/cm^3 or higher</td><td>Topcoat</td></tr>
<tr><td colspan="2">Super UV tester</td><td colspan="5">Ultraviolet beam strength: A method 102 mW/cm^2, A method 90 mW/cm^2
Wave length area: 295 to 450 nm
Rainfall conditions: Water temperature: 20±1°C
Water quantity: Approximately 500 mℓ/min
Water quality: Deionized water of pH6.0 to 8.0, and 2 μs/cm^3 or higher</td><td>Topcoat</td></tr>
<tr><td colspan="2" rowspan="4">Fluorescent ultraviolet ray condensation method</td><td colspan="5">Repeat the ultraviolet irradiation cycle for 8 hours at 70°C → condensation for 4 hours at 50°C</td><td rowspan="4">Topcoat (2C2B)</td></tr>
<tr><td rowspan="3">Specimen surface energy</td><td>Lamp type / Tester</td><td>Sug FS-40</td><td>Q-Panel UVB-313</td><td>Atlas UVB-313</td></tr>
<tr><td>DPW</td><td>2.6 mW/cm^2</td><td>2.8 mW/cm^2</td><td>2.6 mW/cm^2</td></tr>
<tr><td>QUV</td><td>—</td><td>1.5 mW/cm^2</td><td>—</td></tr>
<tr><td>UVCON</td><td>—</td><td>—</td><td>2.0 mW/cm^2</td></tr>
</table>

48.6 Procedure

48.6.1 Sunshine weatherometer continuous method

(1) Specimen installation

a. Remove specimen holders from the frame inside the sunshine weatherometer. Set the specimen in the holder so that the surface of the specimen faces the filter. Place the specimen holder back in the frames.

b. When the number of specimens is less than that of the specimen holders, place blank steel panels in the vacant specimen holders.

(2) Exposure test

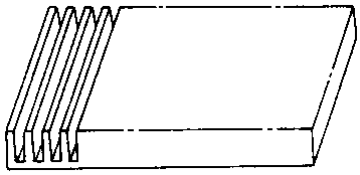
After installing the specimens, operate the tester and expose the specimens to the specified test conditions for the specified time period.

48.6.2 Sunshine weatherometer accelerated cycling method

(1) Exposure test
After placing the specimens as specified in 48.6.1 (1), expose the specimens to the specified test conditions for 200 hours.

(2) Humidity test
After completing the test described in (1), place the specimens in PVC holders. Allow the specimens to stand for 30 minutes at room temperature, then place the specimens in the temperature and humidity controlled chamber which has been adjusted to conditions shown in Table 14. Keep the specimens in the chamber for 120 hours. (Refer to Figure 45.)

Figure 45 Specimen holder



Specimen holder
Material: PVC, aluminum, or wood

(3) After completing the humidity test described in step (2), allow the specimens to stand for 30 minutes at room temperature.

(4) Conduct the test for the specified number of cycles, each cycle consisting of the above-mentioned operations.

48.6.3 Xenon weatherometer method

(1) Place the specimens in the specimen holder, then install the holder onto the specimen frame so that the testing surface of the specimen faces the xenon lamp.

(2) Observe the specimen every 240 hours. After each observation, place the specimens upside down in the specimen holder.

(3) After completing the test, remove the specimen from the tester, clean the painted surface with neutral detergent using a soft sponge, then rinse with clean water.

(4) After drying, measure the following items without polishing:
1. Gloss in accordance with item 21
2. Discoloration in accordance with item 24
3. External appearance (chalking, rust, blistering, staining, cracking, peeling, etc.) in accordance with item 20
4. Physical properties (paint film hardness test and grid-cutting test, as necessary) in accordance with items 26 and 29

48.6.4 Fluorescent ultraviolet ray condensation method

(1) Put the specimens on the specimen shelves so that the testing surface of the specimen faces the lamp. If the number of specimens is less than the number of setting positions in the shelves, cover the vacant positions completely with blank steel plates.

(2) Program the specified test conditions and repeat for the specified number of test cycles.

48.6.5 Super UV tester method

(1) Test device

Metal dried lamp test device (I Super UV Tester: Equivalent to Iwasaki Denki make in Figure 44-1.)

(2) Procedure

1. Create a test piece according to NES M0007 47.4. Size must be larger than 50 × 65 mm and use the excess for extras.
2. Test conditions are as follows.

Method A: (Conditions below are for 1 cycle. Conduct specified cycle, verifying each cycle.)

Conditions	Light	Shower	High-temperature humidity	Shower	Ordinary temperature
Time	24 hours	10 seconds	24 hours	10 seconds	—
Ultraviolet beam strength	102m W/cm^2	—	—	—	—
Black panel temperature	63°C	—	50°C	—	RT (undecided)
Humidity	70%	—	95%	—	RH (undecided)

Method B: (Conditions below are for 1 cycle. Conduct specified cycle, verifying every 10 cycles.)

Conditions	Light	High-temperature humidity	Shower	Ordinary temperature	Shower
Time	4 hours	4 hours	10 seconds	4 hours	10 seconds
Ultraviolet beam strength	90m W/cm^2	—	—	—	—
Black panel temperature	63°C	70°C	—	RT (undecided)	—
Humidity	70%	90%	—	RH (undecided)	—

48.6.6 Correction of test time according to irradiance measurement (Sunshine weatherometer)

The tester allows a tolerance of ±15% for the standard irradiance. In this test, however, the deviation from the standard irradiance must be corrected by changing the test time.

Correction of test time must be made prior to the test. If the test is to be performed successively, the irradiance must be controlled by measuring its intensity during the test. If stable test conditions are assured, irradiance may be controlled by measuring once a month.

1) Test time correction method

a. Place a measuring instrument in the specimen frame, and let it revolve around the light source so that it is evenly exposed to the light. Obtain the integrated irradiance (J/m^2) for 200 hours. (If the continuous test time is 20 hours, repeat the test 10 times. If 50 hours, repeat 4 times.)
b. Divide the integrated irradiance by the test time to obtain the average irradiance (W/m^2).
c. Correct the test time according to the ratio of difference between the average irradiance and standard irradiance based on the continuous test time (20 hours or 50 hours). The standard irradiance is 255 W/m^2 (per hour).
d. Use an hour as the unit of time correction by rounding to the nearest whole number.

2) Example of test time correction

Assume that the average irradiance for 200-hour operation is 228 W/m^2.

In case of 20-hour continuous operation,

$$\text{Corrected time} = \frac{255\ \text{W/m}^2}{228\ \text{W/m}^2} \times 20\ \text{h} = 22.4 \qquad 22\ \text{hours}$$

In case of 50-hour continuous operation,

$$\text{Corrected time} = \frac{255\ \text{W/m}^2}{228\ \text{W/m}^2} \times 50\ \text{h} = 55.9 \qquad 56\ \text{hours}$$

48.6.7 Observation

1) Sunshine weatherometer continuous method and xenon weatherometer method Super UV:
Observe the specimen for each specified interval.

2) Fluorescent ultraviolet ray condensation method:
Observe the specimen daily when the test period is one week or shorter. When the test period is longer than one week, observe weekly or at the specified interval. After each observation, randomly change the specimen's positions.

3) After completing the test, measure the following items without polishing the specimens.

(1) Gloss as specified in item 21
(2) Discoloration as specified in item 24
(3) External appearance (chalking, rust, blistering, staining, cracking, peeling, etc.) as specified in item 20
(4) Physical properties (Perform film hardness test, adhesion test, etc. as necessary) as specified in item 26 and 29

48.7 Report

1. Gloss: As specified in 21.6
2. Discoloration: As specified in 24.6
3. Appearance: Record the extent of any abnormalities as specified in 29.7.
4. Physical properties: As specified in 26.6 (film hardness test) and 29.6 (adhesion test)
5. Record the following conditions:

1) Equipment type and model
2) Test conditions
3) Total irradiation time and test time
4) Fluorescent lamp model name for fluorescent ultraviolet ray condensation tester

49. ELECTRODEPOSITION PAINT SECONDARY RUN TEST METHOD

49.1 Purpose

To examine the secondary run of the electrodeposition paint.

49.2 Specimen preparation

Use type A test panel (70 × 150 mm) as specified in 4.2.2, and pretreat according to 4.2.3.

49.3 Procedure

(1) Perform electrodeposition coating on the specimen according to 4.4.1(2).
(2) Rinse the specimen with water, then dry until water no longer drips from the bottom when the specimen is held in a vertical position.
(3) Hold the specimen horizontally, and drop on it one droplet (approximately 0.2 mℓ) of electrodeposition liquid which has been diluted to non-volatile content of 5% with pure water.
(4) After five minutes, bake the specimen in the horizontal position under the specified conditions.

49.4 Report

Record softening, swelling, or any other surface defects.

50. ELECTRODEPOSITION PAINT UNEVEN DRYING TEST METHOD

50.1 Purpose

To examine the electrodeposition paint for uneven drying.

50.2 Specimen preparation

Use type A test panel (70 × 150 mm) as specified in 4.2.2, and pretreat according to 4.2.3.

50.3 Equipment

Temperature and humidity controlled chamber

50.4 Procedure

(1) Dip the specimen in the electrodeposition bath leaving its upper 10 mm portion not immersed, and perform electrodeposition coating according to 4.4.1 (2).
(2) Rinse the specimen with water, then leave the specimen as is for one, two, and three minutes, respectively, in 30°C 90%RH ambient.
(3) Bake each specimen under the specified conditions.

50.5 Report

Record change in paint film and other surface defects if any.

51. ELECTRODEPOSITION PAINT WATER-DROPLET TRACE TEST METHOD

51.1 Purpose

To examine water droplet traces on the electrodeposition coated surface.

51.2 Specimen preparation

Use type A test panel (70 × 150 mm) as specified in 4.2.2, and pretreat according to 4.2.3.

51.3 Procedure

(1) Perform electrodeposition coating on the specimen according to 4.4.1 (2).
(2) Rinse the specimen with water, then leave as is for 3 minutes in a vertical position.
(3) Holding the specimen in horizontal position, place two water droplets (approximately 0.2 ml each), respectively having conductivity of 2 μΩ/m and 200 μΩ/m, in two places each (total of four places).
(4) Immediately after placing the water droplets, bake the specimen in the horizontal position for 20 minutes at 165°C.
(5) Apply an intermediate coat and topcoat to half of the specimen's area. (Coat so that one water spot created by the water drop discussed in step (3) above is covered.)
(6) Visually check the specimen to see if water spots are found on both of the electrodeposition coated surface and topcoat surface.

51.4 Report

Record change in paint film and other surface defects, if any, for each water droplet.

52. ELECTRODEPOSITION PAINT SURFACE CONTAMINATION TEST METHOD

52.1 Purpose

To examine contamination characteristics of the chemical conversion surface of electrodeposition coating.

52.2 Specimen preparation

Use type C test panel (70 × 150 mm) as specified in 4.2.2, and pretreat according to 4.2.3.

52.3 Procedure

(1) Holding the specimen horizontally, place three water droplets (approximately 0.2 ml each), respectively having conductivity of 2 μΩ/m, 50 μΩ/m and 200 μΩ/m, in two places each. (total six places)
(2) Immediately after attaching water droplets, dry the specimen at 120°C for 20 minutes.
(3) Perform electrodeposition coating according to 4.4.1 (2) by fully immersing the specimen into the bath.
(4) Rinse the specimen with water, then bake under the standard conditions.
(5) Apply intermediate coat and topcoat to the specimen so that the water spots created by the water droplet of each conductivity is covered.
(6) Visually check the electrodeposition coating and topcoat surfaces for any water spots.

52.4 Report

Record change in paint film and other surface defects, if any, for each water droplet.

53. ELECTRODEPOSITION PAINT L-EFFECT TEST METHOD

53.1 Purpose

To examine the L-effect of electrodeposition paint.

53.2 Specimen preparation

Use type C test panel (70 × 150 mm) as specified in 4.2.2, and pretreat as specified in 4.2.3, then bend to 90^{o} at the center portion of its lengthwise direction.

53.3 Equipment

Surface roughness measuring tester (JIS B 0651)

53.4 Procedure

(1) Place the specimen in the electrodeposition bath so that the horizontal surface of the specimen is parallel to the bath liquid surface.
(2) Leave the specimen as is for one minute, then apply electrodeposition coating according to 4.4.1 (2).
(3) Rinse the specimen with water and bake, then measure Ra of both the horizontal and vertical portions.

53.5 Report

Record the extent of and mean surface roughness of 6 horizontal and vertical areas.

54. CONTACT ANGLE TEST METHOD

54.1 Objective

To examine water repellency of the painted surface.

54.2 Equipment

Contact angle tester

54.3 Specimen preparation

Use type A test panel (70 × 150 mm) as specified in 4.2.2, coat as specified in 4.4, then bake under condition a.

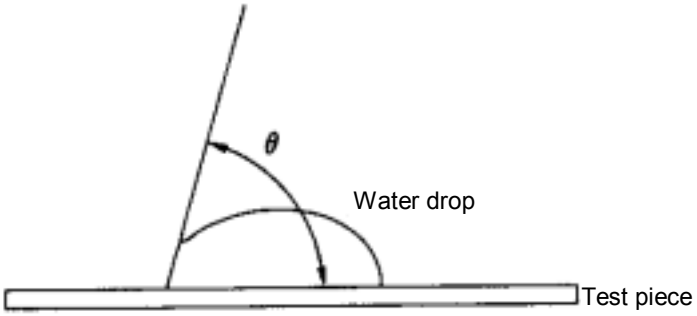
54.4 Test conditions

Standard conditions as specified in 4.1.2

54.5 Procedure

Carefully place approximately 5 μl of distilled water on the specimen, then measure the contact angle θ of the water drop using a contact angle tester. (Refer to Figure 46.)

Figure 46



54.6 Report

Record the contact angle θ of water drop.

55. SCRATCH TEST METHOD

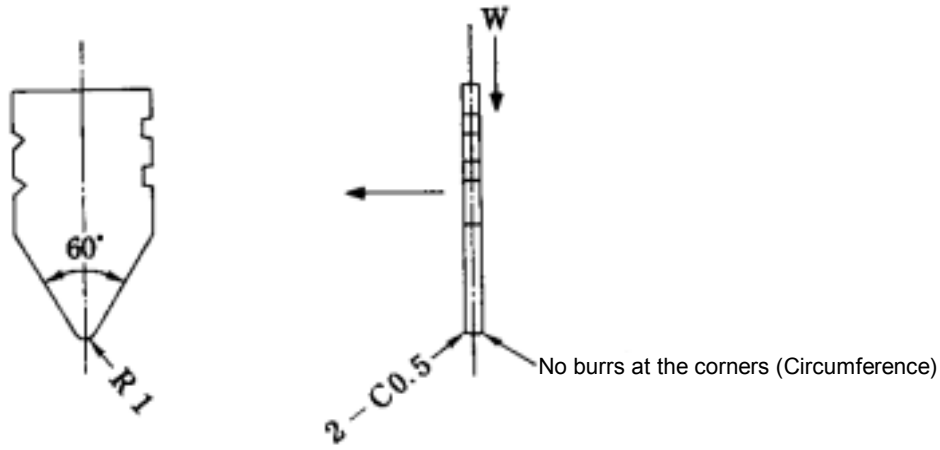
55.1 Purpose

To examine if the paint film is vulnerable to scratching with a key or a ring.

55.2 Equipment

(1) Jig as illustrated in Figure 47. Material: C3713PH (JIS H 3100), t = 2.0, surface treatment: MB Ni II (JIS H 8617)

Figure 47 Scratching jig



(2) Weight: 900 g

55.3 Specimen preparation

Use type A panel (70 × 150 mm) as specified in 4.2, and coat in accordance with 4.3.3.

55.4 Test conditions

(1) Room temperature as specified in 4.1.2 (2)
(2) Load: 9 N {900 gf}
(3) Scratching speed: 10 mm/sec.

55.5 Procedure

(1) Place the specimen in the horizontal position and set the jig vertically on it, then apply the specified load.
(2) Move the jig horizontally by approximately 50 mm at the specified speed. (Refer to Figure 47.)
(3) Examine the extent of damage caused to the paint surface.

55.6 Report

Record the damage and its extent.

56. DRY CLOTH WIPING RESISTANCE TEST METHOD

56.1 Purpose

To examine paint film abrasion caused by wiping with a dry cloth.

56.2 Equipment and devices

56.2.1 Equipment

(1) Reciprocating tester (Refer to Figure 48.)
(2) Nutsche (85 mm inside diameter) (Refer to Figure 49.)
(3) Variable angle colorimeter (Refer to Figure 50.)

Figure 48

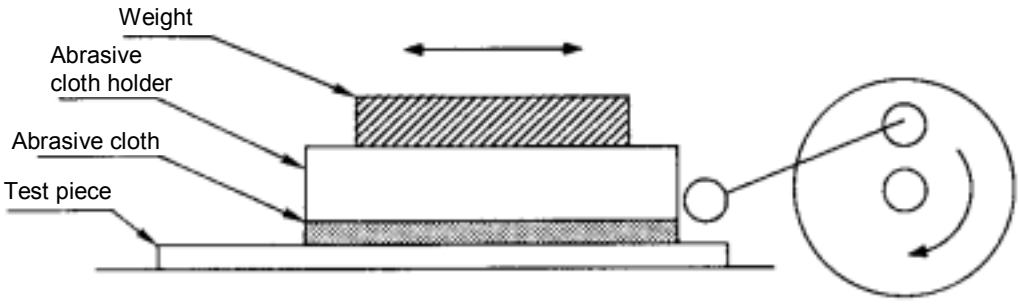


Figure 49 Nutsche

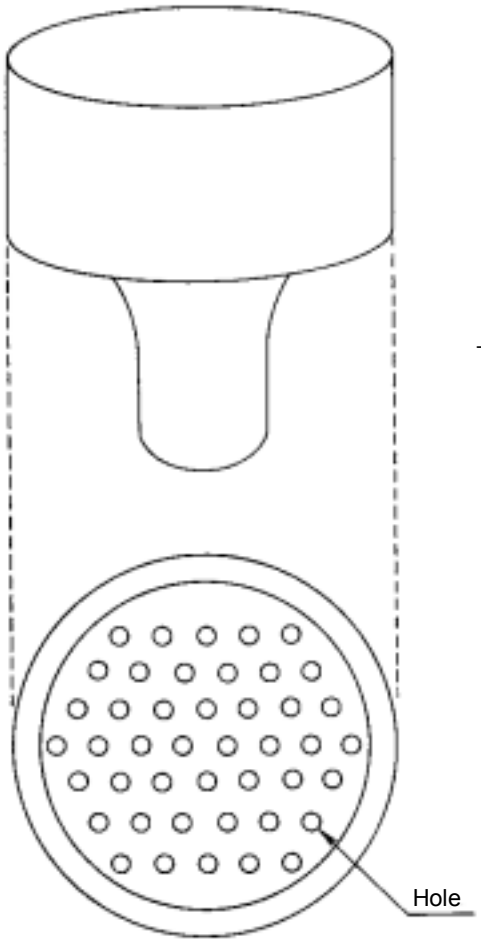
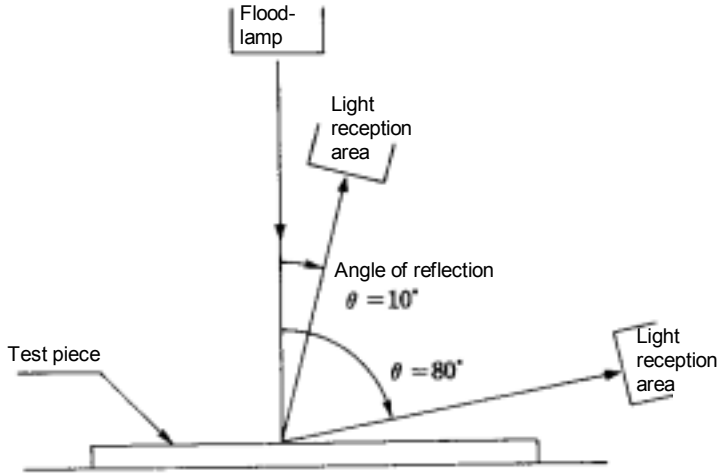


Figure 50 Variable angle colorimeter



56.2.2 Materials

(1) Flannel (APPLE 20000 manufactured by SANSEI-SENKO Co.)
(2) Class 8 testing dust (Kanto-loam) (JIS Z 8901)

56.3 Test method

56.3.1 Specimen preparation

Use type A test panel (70 × 150 mm) specified in 4.2.2, coat with sample paint in accordance with 4.4.

56.3.2 Test site condition

Room temperature as specified in 4.1.2 (2)

56.3.3 Test conditions

(1) Specified dust concentration: 5 g/ℓ (Dust : water = 5 : 1000)

(2) Specified quantity of turbid liquid: 100 mℓ

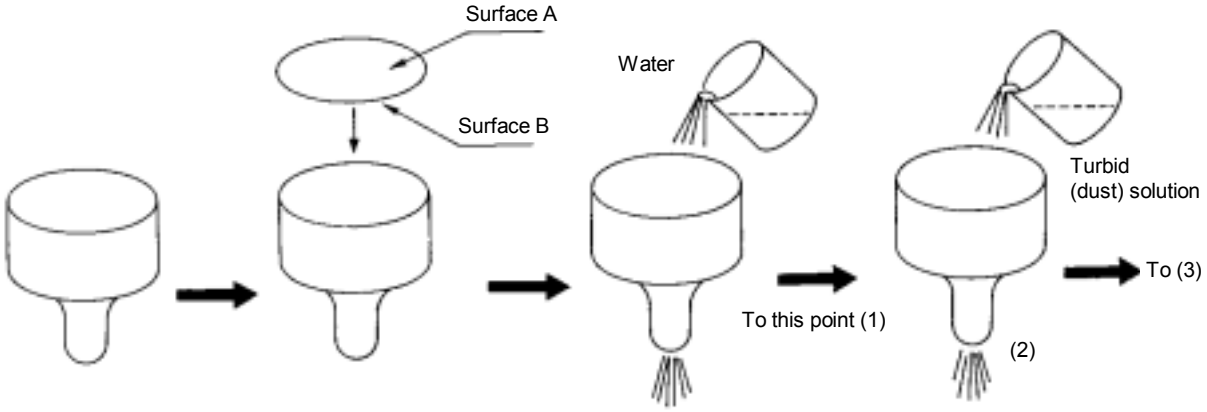
(3) Specified flannel size: 83 mm diameter
(4) Specified friction cloth size: 15 × 15 to 30 × 30 mm
(5) Specified loads: 2.18 mN/mm^2 {0.22 gf/mm^2}
(6) Specified stroke: 30 mm
(7) Specified No. of reciprocations: 50 reciprocations
(8) Specified speed of reciprocation: 30 reciprocations per minute
(9) Specified incident angle: 0°
(10) Specified reflection angle: 10 to 80° (Measure every 5°.)

56.3.4 Procedure

(1) Rubbing cloth preparation (Refer to Figure 51.)

1) Place flannel of the specified size on the Nutsche of inside diameter 85 mm, and moisten with water.
2) Pour the specified quantity of turbid solution which is adjusted to the specified dust concentration into the Nutsche. The solution will flow down from the Nutsche. Define the top side of flannel as side A and the bottom side as side B.

Figure 51 Preparing rubbing cloth



3) Remove the flannel from the Nutsche after waterdrops has ceased to drip, and place it on the gauze with side A facing down, then allow to dry naturally.
4) Cut the cloth into the specified size rubbing cloth.

Figure 52

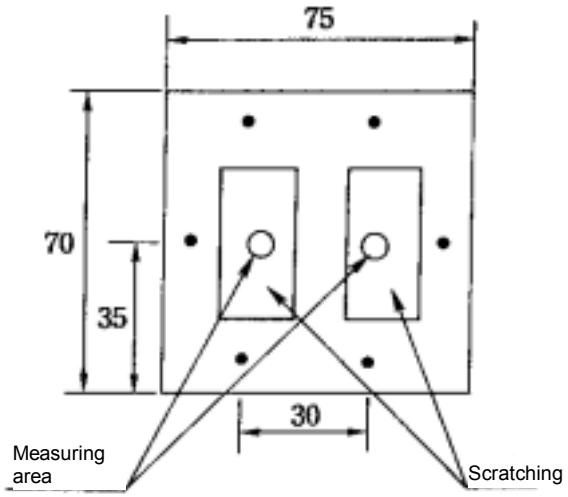
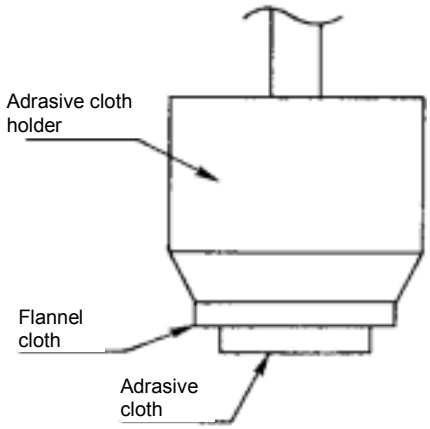


Figure 53.1



(2) Scratching method

1) Mark the top and back sides of the specimen, as shown in Figure 52, so that the scratching area and measuring area can be clearly identified. (Mark •)
2) Rinse the specimen with water to remove dust.
3) Measure the initial lightness of the measuring area according to step 2) of (3).
4) Cut the ordinary flannel cloth (which is not treated with turbid solution) into 20 × 20 mm size, and affix to the slider of the reciprocating tester.
   Affix the rubbing cloth prepared in 5)(1) to the flannel cloth, affixed in step 4), so that the side B faces out. (Refer to Figure 53.1.)
5) Fix the specimen to the reciprocating tester, attach the slider in a vertical position, then move the tester back and forth by the specified number of times with the specified weight, stroke, and speed.

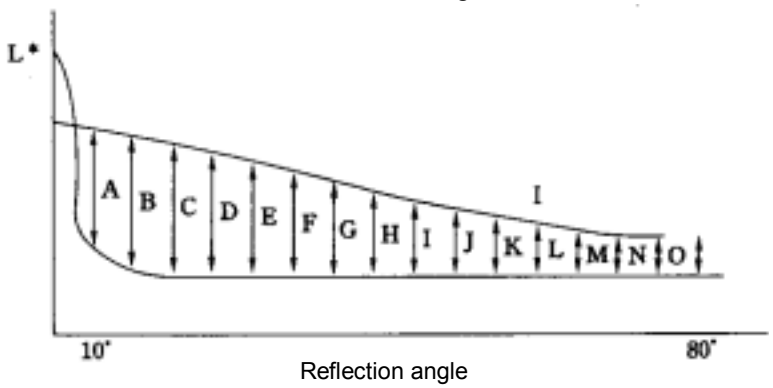
(3) Scratch estimation method

1) Rinse the tested specimen with water.
2) Measure the lightness of specimen at 5^o intervals using a variable angle colorimeter set at the specified incident angle and reflection angle.
3) Integrate the initial lightness and the after-test lightness respectively at 5^o intervals. Subtract the integrated value of initial lightness from that of after-test lightness to obtain the differential lightness integrated value.
4) Divide the value obtained in step 3) by the number of integrations (15) to obtain the mean value. (Δ L10 to '80) ([34])

Note ([34]): $\Delta L10 \text{ to } 80^* = \left\{\sum_{k=2}^{16} L^*_{5k} \text{ (after test)}\right\} - \left\{\sum_{k=2}^{16} L^*_{5k} \text{ (initial)}\right\} /15$

=A+B+C+ .. +0/15

Figure 53.2



I: Lightness after scratching
II: Lightness before scratching

56.4 Report

Record the value of ΔL_{10} to 80*.

57. RESISTANCE TO WARM WATER TEST METHOD

57.1 Purpose

To examine the degree of deterioration in paint film adhesion when the painted surface is dipped in warm water.

57.2 Equipment

Temperature controlled bath

57.3 Specimen preparation

Use type A test panel (70 × 150 mm) as specified in 4.2.2, coated in accordance with 4.4.

57.4 Test conditions

1) Temperature: 40±1°C
2) Water type: Pure water (5 μs/cm^3, 25°C or lower)

57.5 Procedure

1) Dip the specimen vertically halfway into the temperature controlled water bath for the specified period of time. Compare with the standard specimen.
2) After the specified time, remove the test piece and evaluate the pain swelling. Then 24 hours after removal, conduct a visual matrix check according to 29.2.

57.6 Report

1) Record the degree of swelling. The swelling size and density classifications are shown in Table 12.
2) Record the percentage of remaining squares, and indicate the evaluation number.
3) Indicate the location where the peel has occurred (example: peel from substrate, peel from intermediate coat, etc.)

58. EDGE CORROSION TEST METHOD

58.1 Purpose

To examine the degree of edge corrosion that may occur in a corrosive environment (salt spray, drying and humidifying, etc.).

58.2 Test method types

(1) Using burred test plate (Method A)
(2) Using knife edge type test plate (Method B)

58.3 Using burred test plate (Method A)

58.3.1 Equipment

Composite corrosion tester as specified in 38.4.1

58.3.2 Specimen preparation

Use type A' plate as specified in 4.2.2, coated in accordance with 4.4.

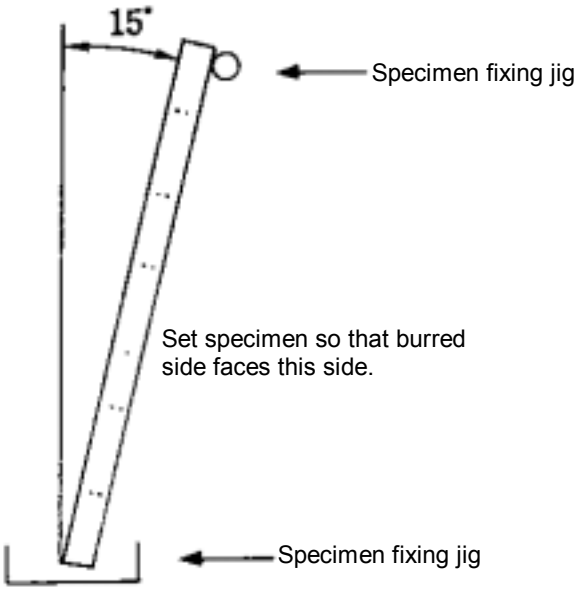
58.3.3 Test conditions

Repeat the test cycle of CCT-IV (CCT-I, II) specified in 38.4.3.

58.3.4 Procedure

1) Protect the outer edges of the specimen with a film that can withstand the test conditions.
2) Place the specimen in the composite corrosion tester in a position tilted by 15° from the vertical with the burred side facing down, then perform test continuously for the specified number of cycles. Use care to prevent interference between the burr and the specimen fixing jig in the tester. (Refer to Figure 54.)

Figure 54



3) After test completion, examine rust formation on the burred area.

58.3.5 Report

Record rust formation in the burred area for each burr height. Rusting in burred area at higher than the specified level must be excluded from evaluation.

58.4 Using knife edge test plate (Method B)

58.4.1 Equipment

Salt spray tester: As specified in item 2 of NES M 0140 (Salt Spray Testing)

58.4.2 Specimen preparation

Use type D test panel as specified in 4.2.2, coated in accordance with 4.4.

58.4.3 Test conditions

The salt water concentration must be 5±1 wt% and spray chamber temperature 35±1°C. Other test conditions must be in accordance with item 3 of NES M 0140.

58.4.4 Procedure

1) Protect the non-evaluated edges (other than the blade portion) of the specimen with a film that can withstand the test conditions.
2) Place the specimen with the blade portion facing up, then perform test continuously until the specified time period has elapsed.
3) After completing the test, examine rust formation on the blade area.

58.4.5 Report

Record the number of rust points appearing on the blade area.

59. RESISTANCE TO BIRD DROPPINGS TEST METHOD

59.1 Purpose

To examine the effect of bird droppings on paint film

59.2 Test methods Method A: Method using albumin

Method B: Method using gum arabic

59.3 Method using albumin

59.3.1 Equipment and chemicals

Equipment: Temperature and humidity controlled chamber

Chemicals: 3% water solution of albumin
Albumin must be made from egg, containing total nitrogen of 12 to 14%.

59.3.2 Specimen preparation

Use type A test plate (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

59.3.2 Test conditions

(1) Specified temperature: 50±1°C
(2) Specified humidity: 30±5%RH
(3) Specified time: 1.0 hour
(4) Specified drip amount: 0.2 mℓ

59.3.3 Procedure

(1) Dissolve pure albumin in water to make a 3% water solution.
(2) Accurately drip the specified quantity of albumin solution on the specimen which is at room temperature.
(3) Allow the specimen horizontally to stand in the temperature and humidity controlled chamber for the specified time.
(4) Remove the specimen and rinse the specimen with clean water.
(5) Wipe off water droplets using soft dry cloth, then leave the specimen at room temperature for 24 hours.
(6) Observe the specimen surface.

59.3.4 Report

Record the paint film surface status rating by referring to the following table.

Table 15

Rating	Status
Class 0	No change
Class 1	Swelling
Class 2	Shrinking
Class 3	Cracking

Figure 55.1 Standard judgement sample for resistance against bird droppings

Class 0

Class 1

Class 2

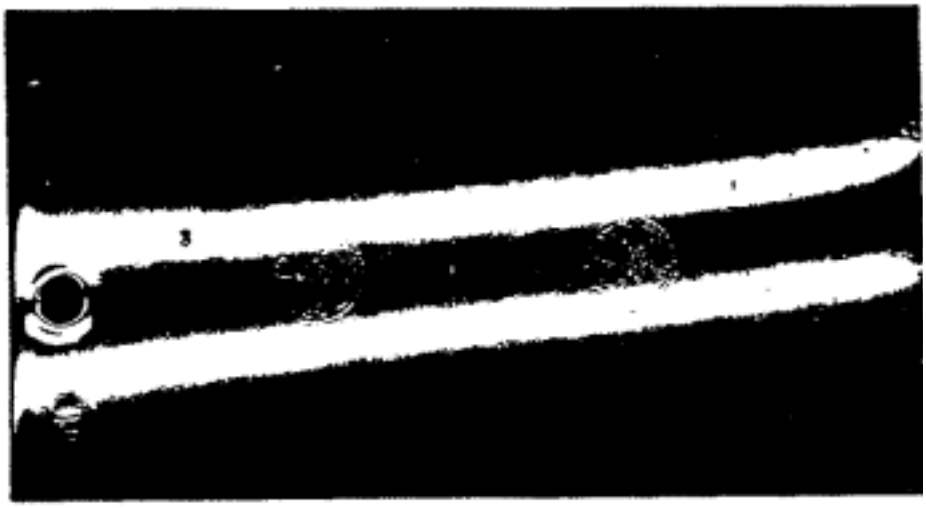
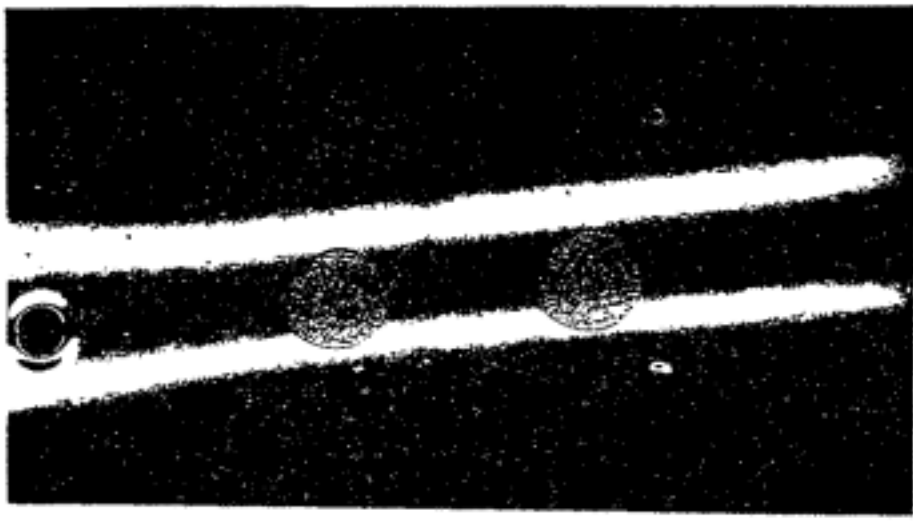


Figure 55.1 Standard judgement sample for resistance against bird droppings (Cont'd)

Class 3



59.4 Method using gum arabic

59.4.1 Equipment and chemicals

Equipment: Xenon weather meter
Thermostatic oven

Chemicals: 50% aqueous solution of gum arabic
Use gum arabic with a drying loss of 15% or less and an ignition residue of 5% or less.

59.4.2 Use type A test plate (70 × 150 mm) specified in 4.2.2, coated in accordance with 4.4.

59.4.3 Test conditions

(1) Xenon weather meter: As specified in Table 14 of Item 48.5
Time: 700 hours

(2) Thermostatic oven: Temperature: 60±1°C
Time: 72 hours

(3) Dropping quantity of aqueous solution of gum arabic: 0.2 ml

59.4.4 Procedure

(1) Place and leave the test piece in the xenon weather meter for the specified time.
(2) Within 20 minutes after the specified time has elapsed, drop the specified quantity of 50% aqueous solution of gum arabic prepared 48 hours before onto the test piece.
(3) Place the test piece horizontally in thermostatic oven set to the specified temperature and let it stand for the specified time.
(4) After the specified time has elapsed, take the test piece out of the oven and wash away chemical under running water.
(5) Wipe water drops off the test piece with a soft cloth, and then subject the test piece to a tape peeling test.
(6) After peeling off the tape, visually examine the test piece to determine how its surface is and whether the paint has flaked off.

59.4.5 Report Indicate the surface condition of the paint film in degrees.

Degree 0: No change at all
Degree 1: The paint is wrinkled or cracked (but not flaked off at all.)
Degree 2: The paint is flaked off slightly.
Degree 3: The paint is flaked off in some degree.
Degree 4: The paint is flaked off considerably.

60. RESISTANCE TO IRON POWDER TEST METHOD

60.1 Purpose

To examine the effect of iron powder on paint film.

60.2 Equipment

Temperature and humidity controlled chamber (The temperature error must be within $\pm 2^{o}$C.)

60.3 Chemicals

Iron powder	Purity: 99.5% Part name: Iron powder Standard: JIS H 2601 Particle size: 150 to 200 mesh

60.4 Test method

60.4.1 Specimen preparation

Use type A test panel (70 × 150mm) specified in 4.2, coated in accordance with 4.3.3.

60.4.2 Test conditions

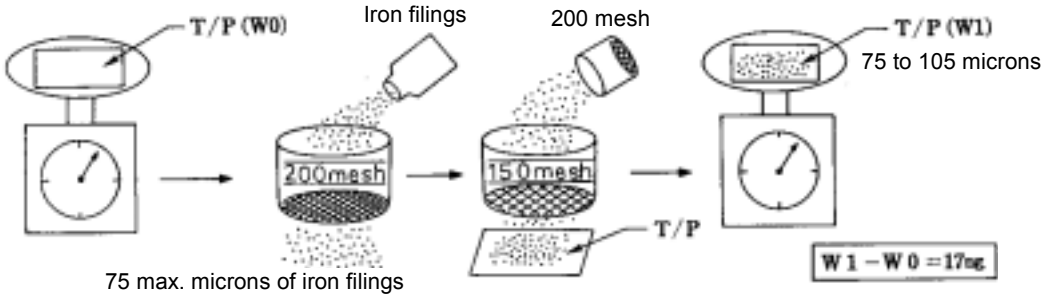
(1) Testing temperature and humidity: 50±1°C × 95%RH or higher

(2) Test time: 24 hours

60.4.3 Procedure

(1) Pass iron powder through a 200 mesh sieve. Pass the remaining iron powder (greater than 75 microns) through a 150 mesh sieve while uniformly scattering over the specimen of 70 × 150 mm in the amount of 17±0.5 mg. (75 to 105 microns) (Refer to Figure 55.2.)

Figure 55.2



(2) Before placing the specimen, on which 17±0.5 mg of iron powder has been scattered, in the temperature and humidity controlled chamber, cover the specimen with a sheet of aluminum foil to prevent the powder from flying about.

(3) Place the specimen horizontally into the chamber which is adjusted to the specified temperature and keep for the specified time period.

(4) Remove the specimen and rinse with clean water using flannel cloth.

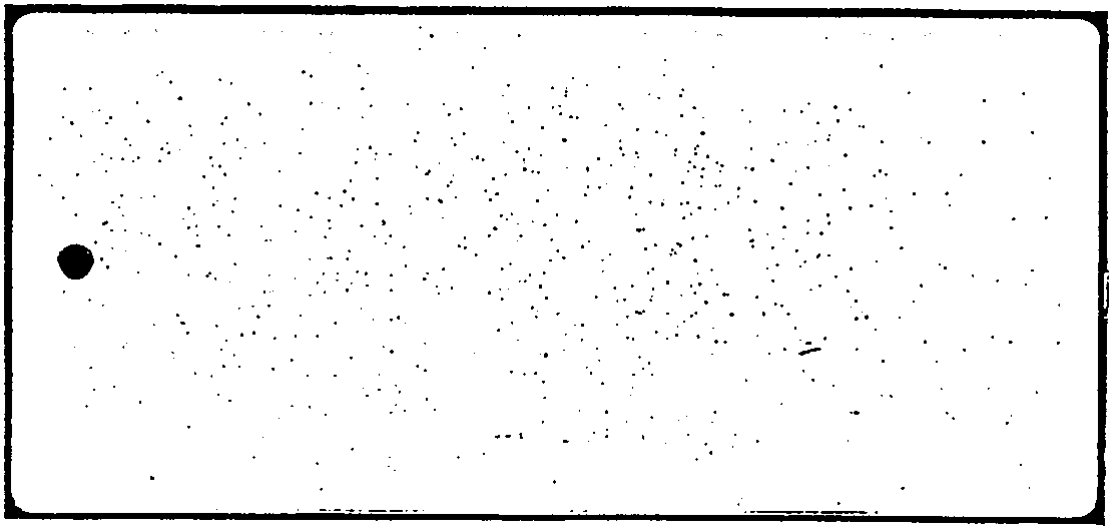
(5) Observe the specimen surface according to the judgment standard specified in 60.5.

60.5 Report

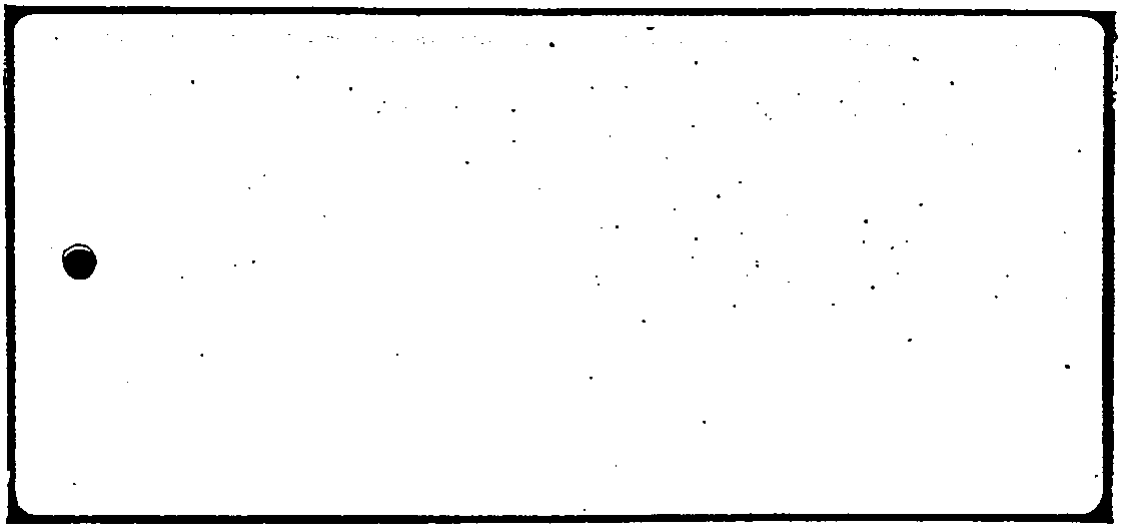
Record the degree of iron powder attachment according to the judgment standard shown in Figure 56.1 to 4.

Figure 56.1 Standard sample for evaluating iron powder attachment (for body)

Class 2 (0.15%)



Class 1 (0.05%)



Class 0 (0.00%)

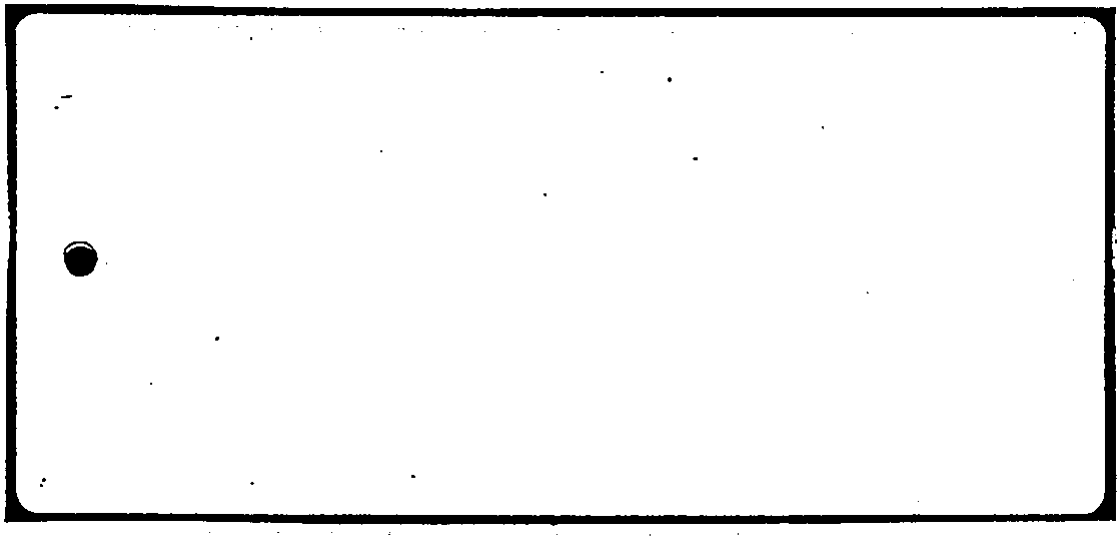
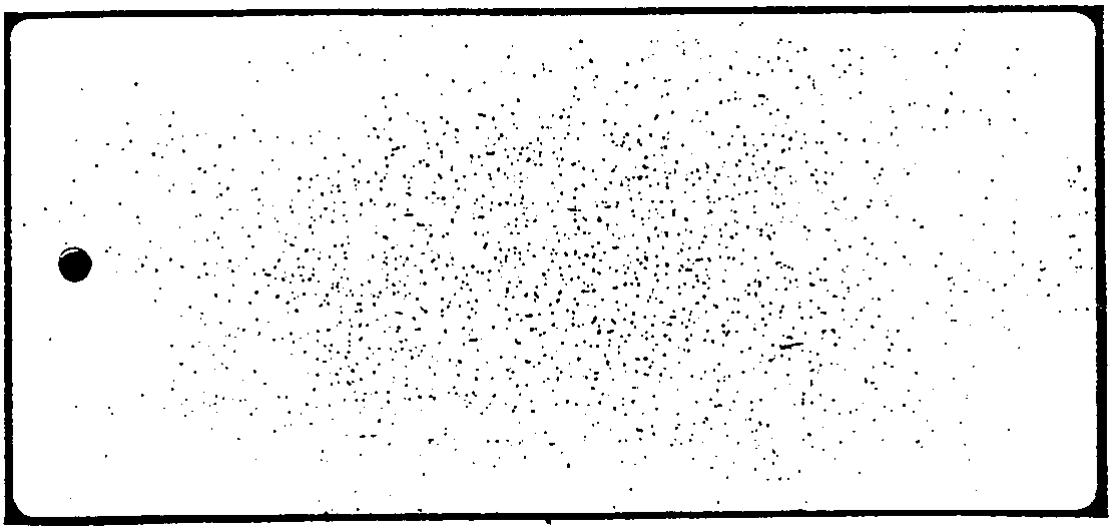


Figure 56.2 Standard sample for evaluating iron powder attachment (for body)

Class 5 (1.10%)

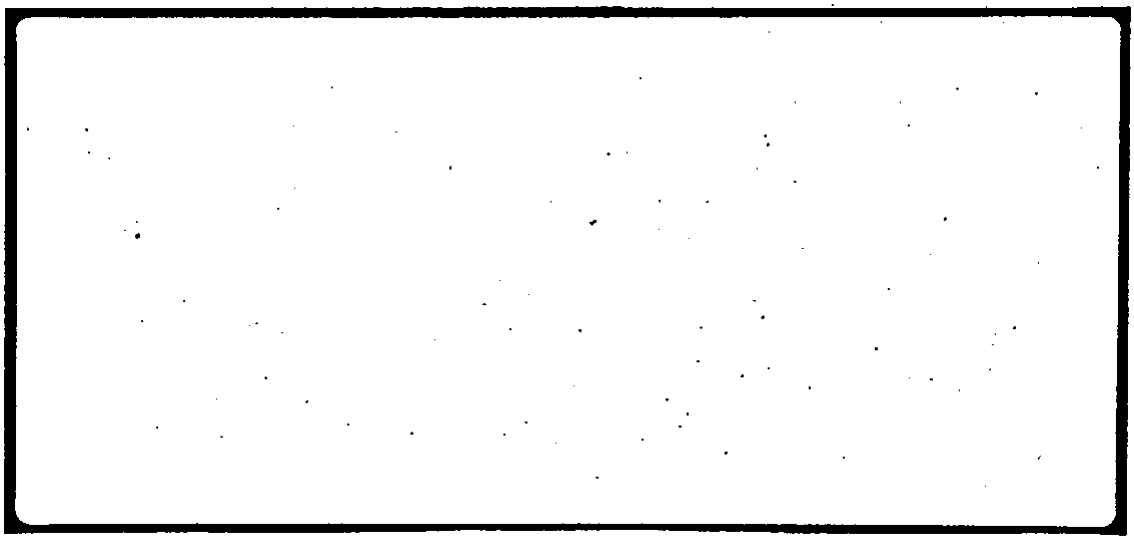


Class 4 (0.66%)

Class 3 (0.46%)

Figure 56.3 Standard sample for evaluating iron powder attachment (for bumper)

Class 1 (0.12%)



Class 0 (0.00%)

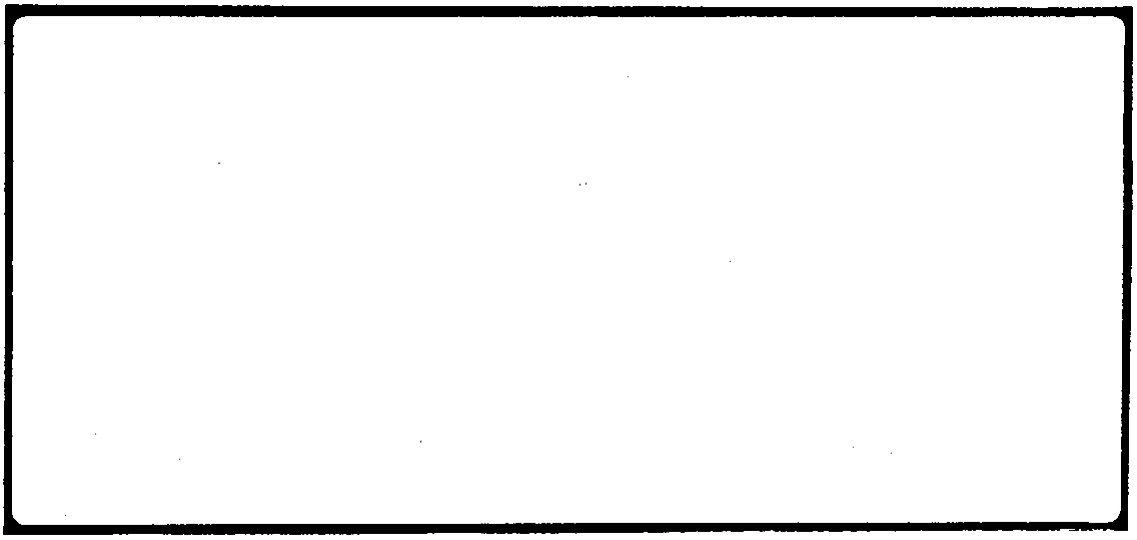
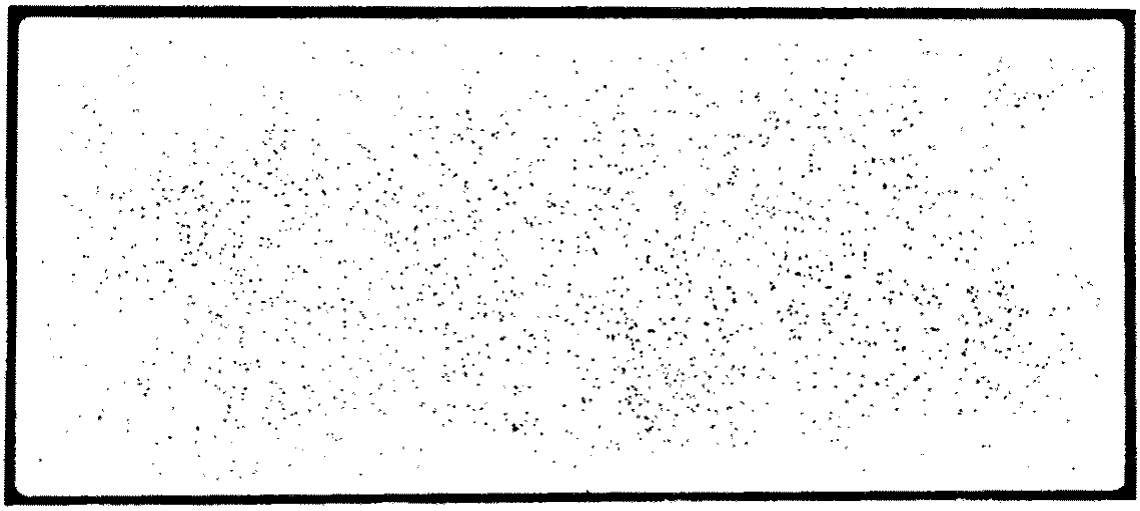
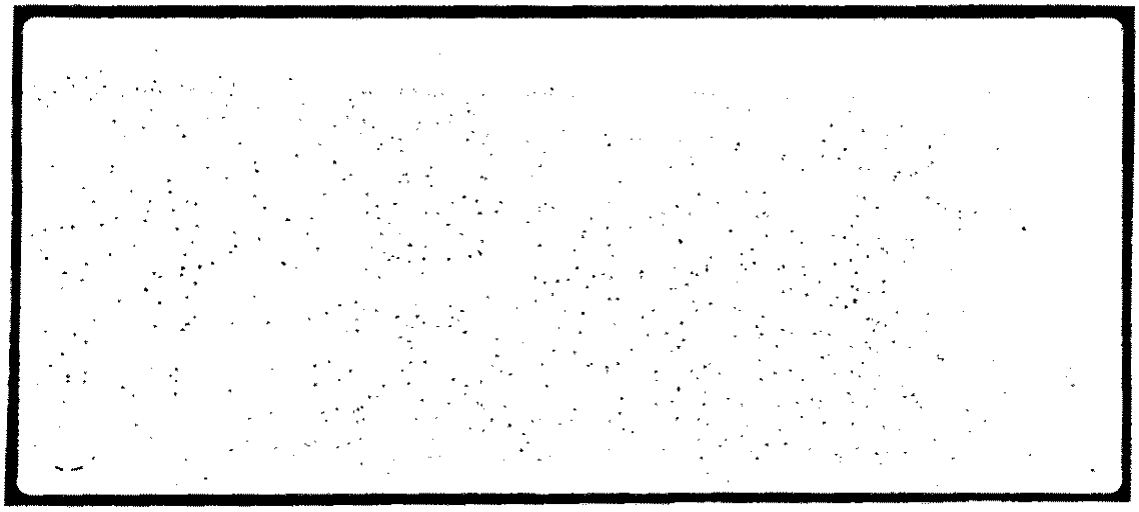


Figure 56.4 Standard sample for evaluating iron powder attachment (for bumper)

Class 4 (1.15%)



Class 3 (0.61%)



Class 2 (0.36%)

61. TEST METHOD FOR PAINT ELECTRICAL RESISTANCE VALUES

61.1 Purpose

To establish standards for electrostatic painting ([35]) safety, cobwebbing, framing, and other areas.

Note ([35]): High levels will result in cobwebbing. Low levels will effect painting efficiency.

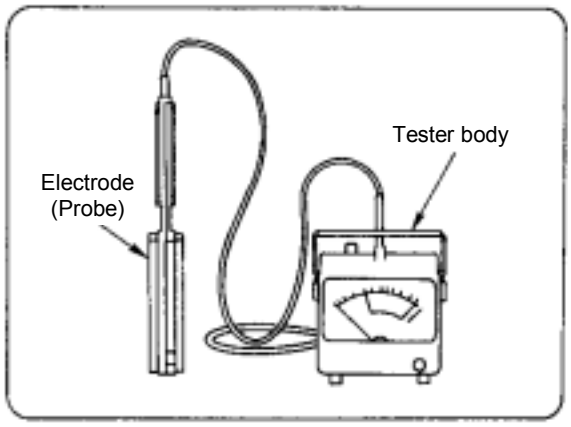
61.2 Equipment and tools

(1) Paint electrical resistance measuring equipment.

- Landsberg paint tester
  Example (Model 234)
  Body: 125 × 80 × 112 mm (dimensions) and 1.36 kg (weight)
  Electrode: 280.7 mm long cylinder with a diameter of 40.3 mm (dimensions) and 0.79 kg (weight)
  Measuring range: 0 to 20 MΩ

(2) Beaker (500 mℓ or larger capacity)

Figure 57



61.3 Test conditions

As specified in Item 4.1.2(1)

61.4 Procedure

(1) Thoroughly stir the diluted paint to be tested in its original container. Pour the paint from the original container into the beaker.

(2) Prepare the paint resistance measuring equipment. (tester)

1) Insert the electrode (probe) plug into the hole at the top of the tester.
2) Move the change lever to the “Zero-point adjust” position. Use the adjusting knob to set the meter needle to zero. (extreme right of the meter scale)

(3) Press the tester probe firmly into the hole at the side of the cylindrical electrode. Keep the paint heated by 20±5°C previously.

(4) Read the meter indication.

Cautions
- Take care not to spill paint on the cylinder sheathing. If paint is accidentally spilled, use a clean dry cloth to remove it.
- When the tester is not in use, disconnect the electrode.

61.5 Report

Record the meter reading in MΩ rounded off to one point to the right of the decimal point.

62. PAINT FILM HARDNESS TEST METHOD

62.1 Purpose

To quantitatively measure the paint film hardness. Note that this test procedure is restricted to paints used for automotive steel plating and/or appropriate test pieces.

62.2 Equipment and tools

(1) Vickers microhardness tester or some other appropriate tester as specified in JIS B 7734. (Micro hardness testing machines for Vickers and Knoop hardness)

62.3 Test sample

Use type-A test pieces (70 × 150 mm) as specified in Item 4.2.2. Paint film thickness of 70 to 100 μ is desirable. Measure each paint film separately. Measurements are to be made at least 24 hours after bake-drying.

62.4 Test conditions

(1) Paint room conditions as specified in Item 4.1.1.
(2) Room temperature as specified in Item 4.1.2 (2).

62.5 Procedure

(1) Test load size is 0.098 to 0.2452 N {10 to 25 gf}.
(2) Load handling time is not specified. However, it is limited to 30 seconds.
(3) Place the test pieces on the tester measuring table. Apply the specified load for the specified time. The test piece test surface must be placed perpendicular to the indentator fitting axis.
(4) Measure the length of the diagonal line along the concave portion of the test piece. Calculate the hardness from the load at the time the concave area was pressed into the test piece.

$$Hv = \frac{F}{S} = \frac{1.8544\,F}{d^2}$$

Hv: Vickers hardness
F: Load (gf)
S: Concave portion area (mm^2)
d: Concave portion diagonal line length (mm)

62.6 Report

(1) Calculate the average of the measured values taken from at least 3 different measuring positions. Record the average in 3 significant figures rounded off to the nearest whole number.
(2) Units are not appended to Hv values.

63. TOPCOAT SURFACE INTERNAL STRESS CRACKING TEST METHOD

63.1 Purpose

Test paint surfaces are repeatedly exposed to humidity, high temperatures and cooling. Chipping and other damages leading to paint surface cracking are inflicted upon the test surface and observed.

63.2 Equipment, tools and fittings

(1) Constant temperature and humidity controlled chamber
(2) Low-temperature controlled chamber
(3) Constant temperature controlled chamber
(4) Diamond-shot tester (Refer to Figure 29 in Item 28.4.1.)
(5) Shot material. The shot material should be one rough octahedral diamond with sharply angled edges. Diamond weight should be 10±1 mg. (approximately 1/20th of a carat)

63.3 Specimen preparation

Use type-A test pieces (70 × 150 mm) as specified in Item 4.2.2. These test pieces are painted as specified in Item 4.4. However, electrodeposition paints and paints used as intermediate coatings must be hardened as specified in Item 4.4.2. Note also the 3 conditions for topcoat surfaces specified below. Use hardened paint for each topcoat surface.

(1) Standard baking conditions: 140°C maintained for 20 minutes
(2) Overbaking conditions: 160°C maintained for 20 minutes
(3) Recoat overbaking conditions
Single overbaking conditions for topcoat paints: 160°C maintained for 20 minutes. Following hardening, paint the surface a second time. Bake at 160°C maintained for 20 minutes. Perform hardening.
(4) Individual paint films are as specified in Item 4.4.4 (2).

63.4 Test conditions

(1) Room temperature as specified in Item 4.1.2 (2).
(2) Heat cycle conditions:
The following is one complete heat test cycle. Each cycle shall be performed 10 times for each test procedure.
90±2°C for 4 hours → room temperature for 30 minutes → -40±2°C for 1 and 1/2 hours → room temperature for 30 minutes → 70±2°C at 95% relative humidity for 3 hours → room temperature for 30 minutes → -40±2°C for 1 and 1/2 hours → room temperature for 30 minutes.
(3) Diamond-shot test conditions

1) Temperature: -20±2°C
2) Shot speed and number of shots: 20 shots at 90±10 km/h
3) Air pressure: 0.05 to 0.2 mPa {0.5 to 2 kgf/cm^2}

63.5 Procedure

(1) Inflict chipping and other damage upon the test piece surface as described in steps (1) to (5) of Item 28.4.4, but do not peel tape off the test piece.
(2) Set the applicable test equipment to perform the specified heat cycles. Place the test pieces, in order, in the test equipment. Run the heat cycles, allowing the test pieces to remain in the test equipment for the specified time.
(3) After completion of the test cycles, remove the test pieces from the test equipment. Continue the test procedure as follows. Check the test pieces for cracks in areas where chipping was inflicted prior to heat cycle testing. Check the test piece edges. Look for any defect or imperfection.

63.6 Report

Note any paint surface cracking and its severity. Record the length of any cracks.

64. ACID RAIN RESISTANCE TEST METHOD

64.1 Purpose

To confirm and/or evaluate acid rain damage to paint surfaces. This problem is currently being reported in some market areas.

64.2 Equipment, tools and fittings

(1) Acid rain evaluation tester (Refer to Figure 58.) or a gradient oven
(2) Flannel cloth (Apple 2000 manufactured by Yamanishi Dyeing Ltd.)
(3) Ethanol and water solution (Water : ethanol = 1 : 1)
(4) Artificial acid rain (The production of artificial acid rain is outlined later in this Section)
(5) Surface roughness measuring meter (JIS B 0651)
(6) Micro-pipette
(7) pH meter

64.3 Procedure

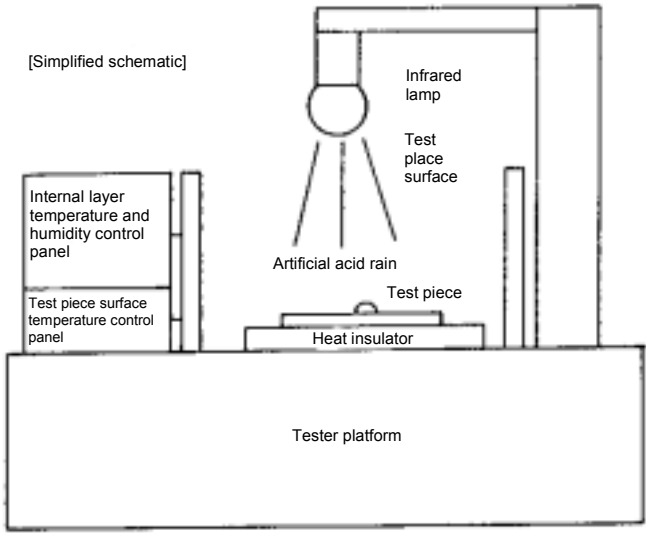
(1) Soak the flannel cloth with the ethanol and water solution. Carefully press the wet cloth firmly to the test piece surface. Do not allow air bubbles to form.
(2) Place a 600 gram load evenly on the flannel cloth attached to the test piece. Allow the test piece, flannel cloth, and load assembly to set on a flat surface for 45 minutes.
(3) Remove the load and the flannel cloth from the test piece surface. Wash the test piece surface with clean tap water. Then dip the test piece in distilled water ([36]).
(4) Set the test piece to the acid rain evaluation tester platform. Set the tester lamp to a brightness of less than 5. This will bring the test piece surface temperature to 70°C ([37]).
(5) Use a micro-pipette to extract 0.2 mℓ of artificial acid rain from its container. Drip the artificial acid rain onto the test piece surface. Then open the pipette tip just enough to allow dripping.
(6) Allow the artificial acid rain to evaporate from the test piece surface. Wait an additional 30 minutes. Remove the test piece form the tester platform. Set the test piece aside and allow it to cool to room temperature.
(7) Wash the test piece surface with ordinary tap water. Use compressed air to blow away any water droplets clinging to the test piece surface. Apply rubbing compound to a flannel cloth. Use the cloth and compound to polish the test piece surface ([38]).
(8) Use a surface roughness meter to measure the depth of any acid rain-related etching in the paint surface.

Notes ([36]): After immersing the test piece in distilled water, remove it from the water very slowly. This will discourage the retention of water droplets on the test piece surface.
([37]): Dripping temperature should be within ±1.5°C of the target temperature.
([38]): For the rubbing compound, use # 300 Brilliant-Super manufactured by the Mitsui Chemical Co., Ltd. To polish, apply a load of 147 kPa {1.5 kgf/cm^2} to the polisher. Rub back and forth for 40 complete cycles.

64.4 Report

Record the depth of the acid rain-caused etchings in the paint surface.

Figure 58 Acid rain evaluation tester



64.4.1 Procedure for artificial acid rain solution arrangement

1) To measure the weight and the capacity of each reagent. Pour distilled water to each reagent of fixed weight until each solution increase to 500 mℓ. 500 mℓ solution is regarded as standard solution. Mix all the standard solutions of fix capacity and pour distilled water into the solution until the mixture increases to 850 mℓ as salt-mixed solution.

Reagents (above the first class)	Fixed weight	Fixed capacity
$NaNO_3$	0.4625 g	20 mℓ
KNO_3	0.6500 g	5 mℓ
$CaCl_2$	0.5000 g	10 mℓ
$MgSO_4 \cdot 7H_2O$	0.6375 g	20 mℓ
$(NH_4) \cdot SO_4$	0.5500 g	50 mℓ
NaF	0.4500 g	5 mℓ
$CaSO_4 \cdot 2H_2O$	0.5000 g	50 mℓ

2) Use the mixture of 200 ml distilled water and each reagents shown as follows and use it as pure acid solution. (Be careful of using reagents due to their strong acid characteristics.)

	Reagent	Fixed weight
HNO_3	Stock solution of 61 wt%	24.8 g
HCl	Stock solution of 36 wt%	12.7 g
H_2SO	Stock solution of 97 wt%	62.5 g

3) Pour pure acid solution into salt-mixed solution until pH meter shows pH 2.3.

Remarks: All the capacity is to increase to approximately 900 mℓ.

4) Pour distilled water into the solution measured at pH 2.3 until the capacity increases 1000 mℓ. Use it as artificial acid rain solution.

65. GELATIN SEPARATION RATIO TEST METHOD

65.1 Purpose

Molecules not involved in the three-dimensional bridge reaction are extracted from a solvent. They are examined in order to estimate paint surface bridge density.

65.2 Equipment

1) Wide-mouthed flask with a capacity of 1 or 2 liters
2) Cooling pipe with ball insert
3) Water bath or mantle heater
4) Solutions: Acetone and acetone methanol in a 1 : 1 ratio; MIBK and ethyl Cellosolve in a 1 : 1 ratio
5) Drier

65.3 Procedure

1) Prepare a 1 to 2 g sample of separated paint film. Use a chemical balance to precisely measure the weight.
2) Place approximately 0.5 liters of solution in the wide-mouthed flask. Add the precisely measured paint film sample. Place the flask in a running water bath or mantle heater for 5 hours.
3) Remove the flask from the water bath or mantle heater. Remove the paint film sample from the flask, then clean it 2 or 3 times with solvent. Place the sample in a drier. Dry the sample at 105°C for 30 minutes.
4) Remove the paint sample from the drier. Use a chemical balance to precisely measure the weight of the paint film sample.

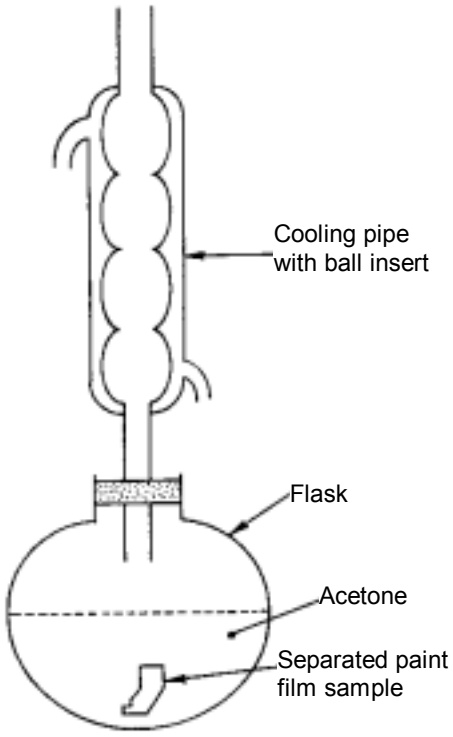
65.4 Report

Calculate the gelatin separation ratio using the following equation:

$$\text{Gelatin separation ratio (\%)} = \frac{\text{Separated paint film sample weight after drying}}{\text{Original separated paint sample weight}} \times 100$$

Record the calculated gelatin separation ratio, type of solvent used and extraction temperature.

Figure 59



66. PAINT PROTECTIVE FILM CHARACTERISTICS TEST METHOD

66.1 Purpose

To determine the effect of applying a protective film to the paint surface.

66.2 Equipment and materials

1) Constant temperature controlled chamber
2) Constant temperature and humidity controlled chamber
3) Sunshine weatherometer
4) Exposure platform
5) Tensile tester with constant temperature tank
6) Surface roughness measuring equipment (JIS B 0651)
7) Paint protective film. Use the specified protective film ([39]) as much as possible.

Note ([39]): Use a protective film that is currently in use and that is appropriate to the paint film to be tested and the test conditions as a general rule.

66.3 Specimen preparation

Use type-A test pieces (70 × 150 mm) as specified in Item 4.2.2. These test pieces are painted as specified in Item 4.4. As a general rule, the paint color should be solid black.

66.4 Test conditions

1) 70°C for 672 hours
2) 50°C and 95% relative humidity for 240 hours

3) Sunshine weatherometer (black panel temperature at 63±3°C) for 300 hours
4) Outside exposure: 6-month period. The actual exposure site may be determined as agreed upon between concerned parties. During the summer months, the exposure period may be shortened to 3 months.

66.5 Applying the paint protective film to the test pieces

(1) Paint film secondary imperfection conditions test
Refer to Figure 60-1 below. Note the configuration of the paint protective films listed. Test each of the configurations. Also test the wrinkled, bubbled, and parting line areas of the test pieces as shown in Figure 60-1, 60-2 below.

Figure 60-1

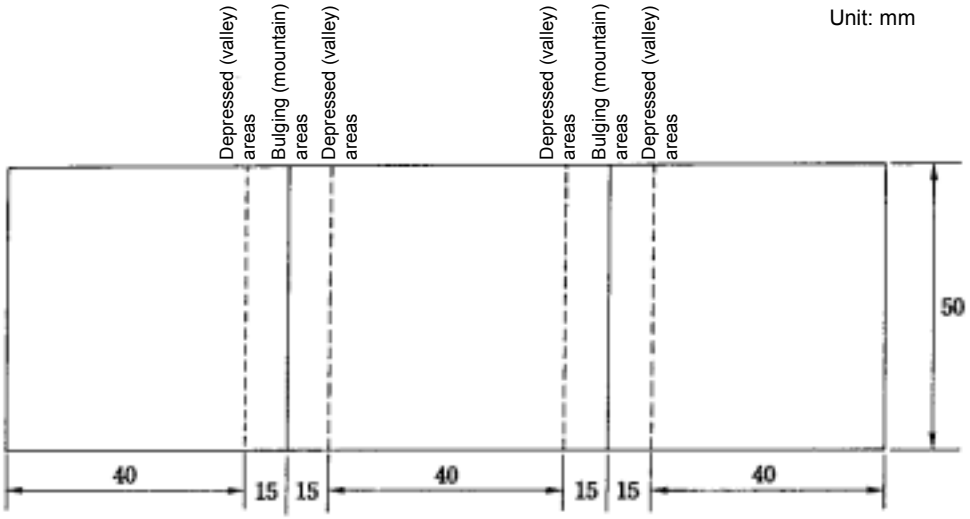
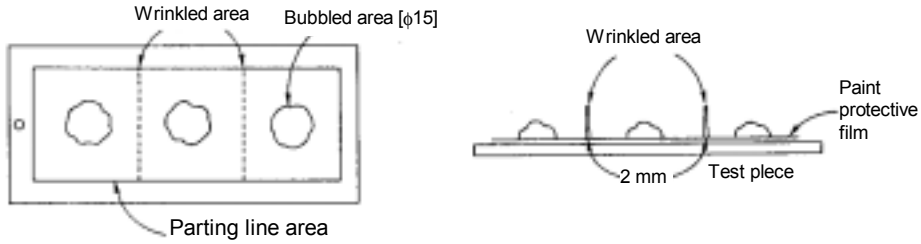


Figure 60-2



(2) Adhesion strength test

1) Apply a sample of the paint protective film to the test piece as shown in Figure 61. The film sample must be the specified size and must adhere to the test piece. Use a 5-kilogram roller to smooth out any wrinkles or bubbles in the film sample.
2) Use hand pressure to press any parts of the sample film not adhering to the test piece into place. Refer to Figure 62.

Figure 61

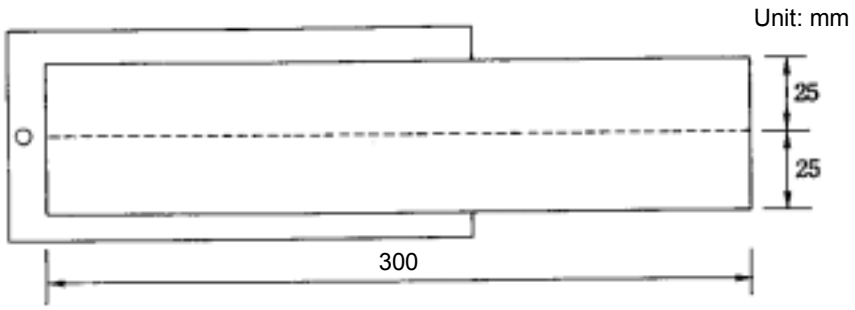


Figure 62

66.6 Procedure

(1) Paint film secondary imperfection test

1) Visual inspection

1. Prepare test piece A. Allow the prepared test piece to set for 24 hours under the conditions specified in Item 4.1.2 (1).
2. After 24 hours, peel the paint protective film away from the test piece.
3. Once again, allow the prepared test piece to set for 24 hours under the conditions specified in Item 4.1.2 (1). Then check for paint surface imperfections and color change. Note the degree of each.

2) Surface imperfection depth measurement

1. Following visual inspection, determine the most obvious areas of imperfection on the test piece surface.
2. Use surface roughness measuring equipment to measure the depth of the imperfections isolated in Step 1. Draw a graph to show the test piece surface measured profile and imperfection depths in two dimensions.
3. On the profile and depth graph, indicate imperfection depth differences in units of μm. Refer to Figure 63.

Figure 63 Surface profile showing imperfection depth differences

(2) Adhesive strength test

1. Prepare test piece B. Allow the prepared test piece to set for 24 hours under the conditions specified in Item 4.1.2 (1).
2. After 24 hours, use a new cutter blade to cut a 25 mm wide strip of paint away from the test piece. The cut must extend to the base of the paint.
3. Once again, allow the prepared test piece to set for 24 hours under the conditions specified in Item 4.1.2 (1).
4. Carefully pull the paint protective film partially away from the bottom surface of the test piece.
5. Attach the area of the protective film peeled away from the bottom of the test piece to the clamps at one end of the tensile strength tester. Attach the test piece with the film attached to the clamps at the other end of the tester.
6. Note the test conditions listed in Table 16 below. Measure the paint protective film to approximately 10 mm. Draw a curved line on a graph to show the film's tensile strength at the time it completely peeled from the test piece. Draw another line to indicate the average up and down values. Refer to Figure 64.

Table 16 Adhesive strength test conditions

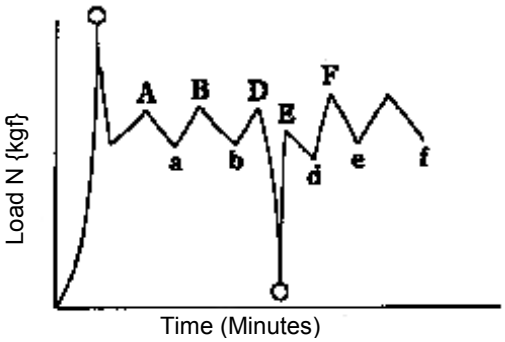
Pulling speed	300 mm/minute
Test temperatures	40°C, 20°C, -20°C
Pulling angle	180°

Figure 64

Average values

$$= \frac{A+B+D+E+F+a+b+d+e+f}{10}$$

A “O” mark indicates an abnormal value which must be excluded.



66.7 Report

1) Paint surface secondary problem characteristics

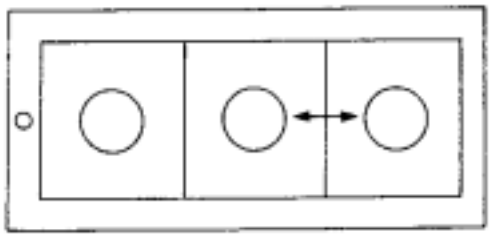
1. Table 17 below shows the gravity of paint surface imperfections (bubbling, wrinkling and traces of parting line) and provides a rating system. Use the table as a guide when recording test results.

Table 17

Classification	Gravity of imperfection
Class 0	No imperfections
Class 1	Slight imperfections found
Class 2	Moderate imperfections found
Class 3	Serious imperfections found

2. Record any instance of paint surface damage or color change. (contamination)
3. Indicate the difference between projections and depressions in μm units. Round off the numbers to one place beyond the decimal point. Indicate the projection and depression measuring points as shown in Figure 65.

Figure 65



Projection and depression measuring points

2) Adhesive strength

Indicate adhesive strength in calculated units of kgf/25 mm or kgf/10 mm using real numbers (n = average value of 2). Include the measuring temperatures.

67. TWO-SIDED TAPE ADHESIVE CHARACTERISTICS TEST METHOD

67.1 General instructions for testing

67.1.1 Test site conditions

(1) Standard conditions. Temperatures must be in the 2nd class standard condition range as specified in JIS Z 8703. (Standard atmospheric conditions for testing) In other words, the temperature must be 20±2°C. Relative humidity must be 65±10%.

(2) Testing room temperature: Room temperature must be in the 5 to 35°C range. Relative humidity must be in the 45 to 85% range.

Remark: Testing room temperature and humidity must be indicated in the test report.

67.1.2 Test material gathering

The number of tape rolls required for testing is discretionary. Peel off the first several layers of tape and discard them. Use the remaining tape as test material.

67.1.3 Test specimen and test piece preparation

Allow sufficient time for test specimen and test piece preparation. Follow the standard procedure described in Item 67.1.1 (1) to prepare specimens and test pieces. Begin testing only after the required materials have been prepared.

67.1.4 Test specimen and test piece classification and surface treatment

General guidelines for test specimen and test piece classification and surface treatment are given in Table 18. Where indicated in the table, classification and surface treatment may be determined as agreed upon between concerned parties.

Table 18

Test piece material classification	Characteristics	Surface treatment
Painted steel sheeting	SP120 as specified in NES M 2020 (Cold Rolled Carbon Steel Sheets and Strips). Thickness: 0.7 mm or greater	As specified in Items 4.2.3 and 4.4. Pretreatment, base coat treatment and final coat treatment are performed. The painted surfaces are then baked. Following baking, the surfaces are wiped clean with a dry cloth.
Vinyl leather cloth	As specified in NES M 7081. (Polyvinylchloride Coated Fabric for Automobiles) The exact details may be determined as agreed upon between concerned parties.	Wipe the surfaces clean with a dry cloth.
Vinyl sheeting	As specified in NES M 7083. (Vinyl Sheet for Automobiles) The exact details may be determined as agreed upon between concerned parties.	Wipe the surfaces clean with a dry cloth.
Synthetic fibers (Both rigid and non-rigid materials)	Use the same material as used on the line or substitute a similar material. Mold the material into a flat plate. The exact details may be determined as agreed upon between concerned parties. Molding ([40]) and emblem ([41])	Wipe the surfaces clean with a dry cloth.

Notes ([40]): PVC: Riken Vinyl TN6002 (HSA60) or equivalent
([41]): ABS: Mitsubishi Rayon 3001M or equivalent

67.1.5 Crimping conditions during test piece preparation

Table 19 specifies crimping conditions during test piece preparation.

Table 19

Classification		Pertinent information
Class 1	No. 1	Crimp the material with your hand applying 1 to 2 kg of pressure.
	No. 2	Same as above
Class 2		Heat emblem vehicle body to 20°C. Apply 5 kg or more of crimping pressure at one side only.
Class 3	No. 1	Heat Mold vehicle body to 20°C. Apply 5 kg or more of crimping pressure at one side only.
	No. 2	Same as above

67.1.6 Test piece setting times:

Setting time may be required between test piece creation and actual testing. Additionally, for certain environmental conditions to be satisfied, setting time may be required. Setting times are specified in the description of the individual test procedures.

67.1.7 Test piece number and value rounding off method

For identical test requiring multiple test pieces, a minimum of at least three test pieces is generally considered standard. Values are rounded off as specified in JIS Z 8401. (Rules for rounding off of numerical values)

67.2 Holding power test procedures

67.2.1 Purpose

A load is applied both in the normal direction of shear and in the direction of peeling. Adhesive characteristics are determined.

67.2.2 Equipment

(1) Constant temperature controlled chamber
(2) Low-temperature controlled chamber
(3) Constant temperature and humidity controlled chamber
(4) Weights (200 gram, 1.5 kilogram and 2.0 kilogram)
(5) Roller (No. 1 or 2 types weighing 5 kilograms)

67.2.3 Shearing test piece and peeling test piece preparation

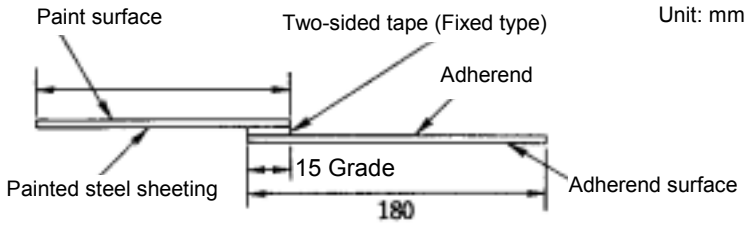
(1) Prepare the shearing test piece as specified in Item 67.2.4 and Figure 67-1 below. Prepare the peeling test piece as described in Item 67.2.5 and Figure 67-2 below.
(2) Test piece setting time prior to testing: Crimped test piece must be allowed to set for 24 hours before they are used for actual testing.

67.2.4 Specimen preparation

(1) Test piece materials
1) Painted steel sheeting: Prepare the test pieces as specified in Item 67.1.4. Test piece thickness must be 0.7 mm or more. Test piece width is 50 mm. Test piece length is 150 mm.
2) Adhesive application: Prepare the vinyl leather cloth and vinyl sheeting test pieces as specified in Item 67.1.4. Test piece width is 25 mm. Test piece length is 180 mm.

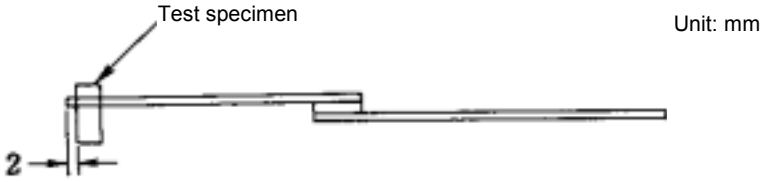
(2) Adhesive application
1) Use your hand to firmly press the two-sided tape onto the adhesive body at one end of a piece of painted steel sheeting. Refer to Figure 66-1 below.

Figure 66.1



2) Apply the test specimen (two-sided tape) to the end of the painted steel sheeting (the end opposite the two-sided tape adhesion surface shown in Figure 66-1) as shown in Figure 66-2.

Figure 66.2

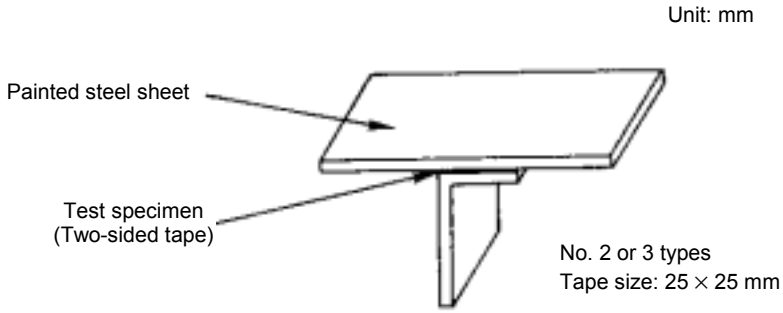


67.2.5 Specimen preparation

(1) Test piece materials: Use the painted steel sheeting specified in Item 67.1.4. Sheeting thickness is 0.7 mm. Width is 25 mm and length is 150 mm.
Use pieces of vinyl leather or vinyl film having a length of 180 mm and a width of 25 mm.

(2) Adhesive application: Place a 75 mm long piece of the test specimen on the painted surface of the steel sheeting. On top of the test specimen, place the adherend. Press the adherend into place under the conditions specified in Item 4.1.5. Refer to Figure 67 below.

Figure 67



67.2.6 Procedure

(1) Place the test piece in a holder as shown in Figure 68. Use the weights to apply the specified load (^{42}) to the test piece.

(2) Suspend the test piece with load attached in an atmosphere having the specified standard ambient conditions. Check the adhesive surfaces for slippage (note the extent of the slippage) and/or separation. (weighted end of the test piece falling to the floor)

Figure 68.1

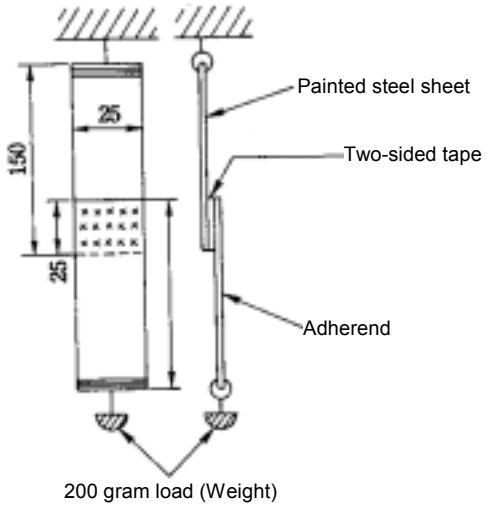
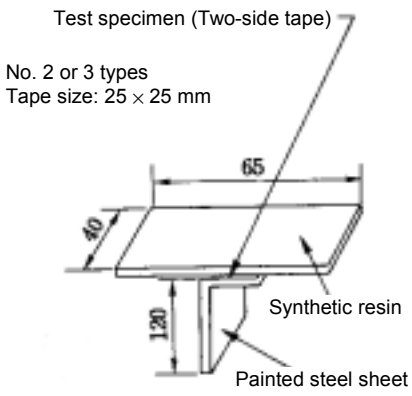


Figure 68.2



Note ([42]): Apply the load evenly across the entire width of the adhesive.

68. YELLOWING RESISTANCE CHARACTERISTICS TEST METHOD

68.1 Purpose

To investigate changes in paint color and paint surface conditions resulting from changes in baking process conditions.

68.2 Specimen preparation

Use the A-type test piece (70 × 150 mm) specified in Item 4.2.2. Paint the test pieces as specified in Item 4.4. Topcoat operations and baking conditions are specified in Item 25.3.

68.3 Procedure

68.3.1 Paint conditions

(1) Paint condition
Prepare 300 mℓ of the test paint. Heat the test paint to 40°C. Immerse a piece of 99.9% or greater purity copper (20 × 20 mm with a thickness of 0.3 mm) in the test paint. Allow the copper to set in the test paint for 24 hours. Remove the copper from the paint and use it as a test piece.

Remark: Use acid to thoroughly clean the copper surfaces before immersion in the test paint.

(2) Paint film thickness
Complete paint film adjustment as specified in Item 4.4.4.

(3) Baking conditions
180±0.5°C for 10 minutes in an atmosphere containing a 10 ppm concentration of NOx gas.

68.3.2 Report

(1) Visual inspection: Note any color differences (hue, brightness, and basic color). Refer to entries (1) of Item 24.6.
Table 7 lists standards for evaluation of hue, brightness and basic color.

(2) Color differences are specified in entries (2) of Item 24.6 in this Standard. Record any differences discovered during visual inspection.

69. SASH BLACK TAPE COMPATIBILITY TEST METHOD

69.1 Purpose

To examine the adhesiveness between sash black tape and painted surface

69.2 Equipment

(1) Tensile tester with constant temperature controlled chamber (specified in item 24 of NES M 0084)
(2) Peeling test jig (The attaching jig must have the structure of maintaining a right angle between the adherend and the peeling direction during the peeling strength test so that the adherend can move horizontally. An example is shown in Figure 69.
(3) Roller (2 kg)

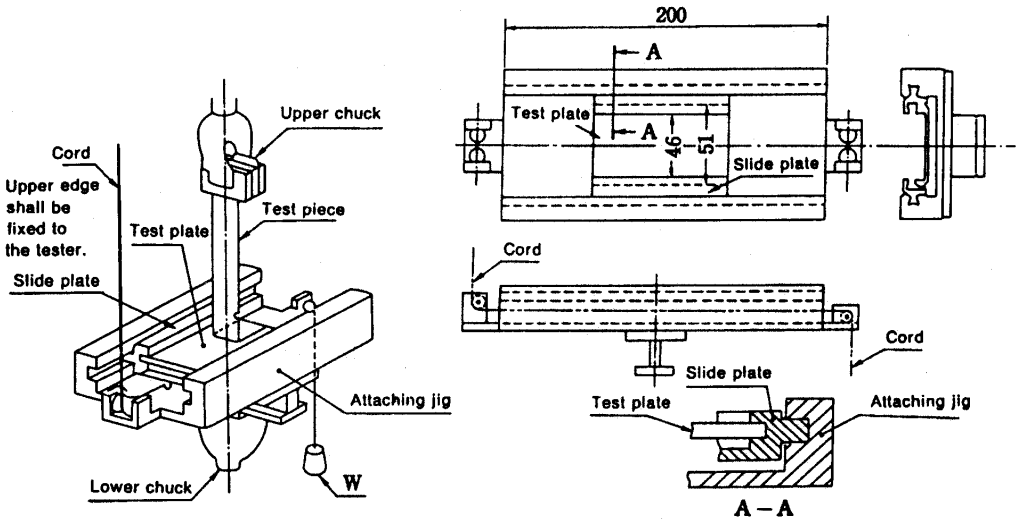


Figure 69 Tensile tester

69.3 Specimen preparation

(1) Materials of specimen
Coated copper plate with a minimum width of 50 mm and a minimum length of 130 mm specified in item SP120 of NES M 2020 (pretreatment, intermediate coat, and top coat should have been applied beforehand in accordance with 4.2.3 and 4.4) Sash black tape with a minimum width of 25 mm and a minimum length of 130 mm.
(2) Adhesion method
Wipe the coated copper plate and sash black tape with isopropyl alcohol, and allow them to stand at a room temperature of 23±1°C for more than 1 hour. Peel the release paper from the bonded surface of the tape, adhere tape lightly to the adherend with each center line matched with fingers, and press it with a roller of specified weight.
(3) Standing time before the test
Allow the test piece to stand with the tape applied 23±1°C for 24 hours.
(4) Number of tests
"n" shall be 3 unless otherwise specified.

69.4 Test conditions

(1) Test temperature: 23±1°C
(2) Peeling method: 90° peeling test
(3) Stretching speed: 300 mm/min.

69.5 Procedure

(1) Allow the test piece to stand at the test temperature in atmospheric test condition for more than 1 hour.
(2) Fix the coated copper plate side of the test piece to the peeling jig.
(3) Fix the tape side of the test piece to the tester securely with the chuck of the tensile tester.
(4) Carry out the peeling test in accordance with the conditions mentioned in 69.4, and record its load.
(5) Based on the measured load curve, the range where the load is stable shall be defined as tensile strength with the exception of 10 mm from the beginning and the end of the load curve.

69.6 Report

(1) Record the average data by rounding numbers up or down to three effective digits.
(2) Record the test result in N/25 mm {kgf/25 mm} unit.

70. TEST METHOD FOR RESISTANCE CHARACTERISTICS TO RUBBER PART

70.1 Purpose

Regarding discoloration, to examine the effect of rubber parts of the antenna base, weatherstrip, etc. on the coating

70.2 Test methods

(1) Coating discoloration test by antenna base rubber

(A) Heating discoloration test
(B) Exposure discoloration test

(2) Coating discoloration test by weatherstrip

70.3 Coating discoloration test by antenna base rubber

A. Heating discoloration test

A.1 Equipment and materials

Tester and test materials are as follows.

(1) Constant temperature controlled chamber which can maintain $80 \pm 1^{\circ}C$.
(2) Ultraviolet rays carbon weatherometer or sunshine carbon weatherometer {specified in the item 7.6 of JIS D 0205 (Test method of weatherability for automotive parts)}
(3) Test plate (70×150 mm) shall be coated in accordance with the specified coating process and shall be left for more than 24 hours after the coating process.
(4) Cut the rubber used for antenna base (Daishin Chemical make, 50 degree base) into pieces. (approx. 15×20 mm, with a thickness of 10 mm) Use them as test pieces.

A.2 Test method

A.2.1 Test location conditions

Test location conditions shall be in accordance with the conditions specified in item 4.1 of NES M 0141.

A.2.2 Test conditions

(1) Heating temperature: $80 \pm 1^{\circ}C$
(2) Heating time: 24 hours
(3) Exposure time: 16 hours for the sunshine carbon weatherometer, or 32 hours for the ultraviolet rays carbon weatherometer

(3) A.2.3 Procedure

(1) Heat treatment

(a) Take two test pieces out of the same lot, place them between two test plates as shown in Figure 70, and tighten them using four bolts with a tightening torque of 16.7 kgf·cm.

(b) After setting the temperature of the constant temperature controlled chamber to the specified value, put the test plates in it making sure that there is no foreign materials in the chamber.

(c) After allow the test plate to stand in the constant temperature controlled chamber for the specified time, take the test plate out of the chamber, remove the test pieces, rinse the surface of the test plate with water, and check for discoloration.

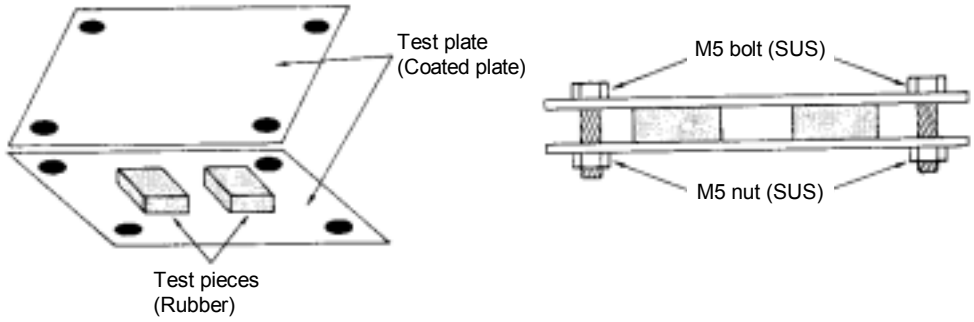


Figure 70 Rubber tightening method

(2) Exposure treatment

(a) After checking for the discoloration, have the test plates exposed with the weatherometer for the specified time.

(b) After exposure for the specified time, rinse the surface of the test plate with water, and check for discoloration.

B. Exposure discoloration test

B.1 Equipment and materials

Tester and materials are as follows.

(1) Weatherometer specified in A-1.(2)

(2) Test plates specified in A-3.(3)

(3) For test pieces, cut the rubber used for the antenna base into pieces (approx. 20 x 20 mm, with a thickness of 10 mm), and make a hole with a diameter of 10 mm in the center of the piece. Use them as test pieces.

B.2 Test method

B.2.1 Test location conditions

Test location conditions shall be in accordance with the conditions specified in A-2-1.

B.2.2 Test conditions are as shown in Table 21.

Table 21 Exposure Discoloration Test Conditions

Tester	Primary exposure	Secondary exposure
Sunshine carbon weatherometer	100 hours	16 hours
Ultraviolet rays carbon weatherometer	200 hours	32 hours

B.2.3 Procedure

(1) Primary exposure

(a) Place the test pieces on the painted surface keeping the distance of 25 mm from the edge of the test plate, tighten them using M5 SUS bolts with a tightening torque wrench of 33.4 kgf·cm, and fix them to the plate securely.

(b) Have the test plates exposed with the weatherometer for the specified time.

(c) After the exposure, remove the test pieces, rinse the surface of the test plate with water, and check for discoloration.

(2) Secondary exposure

(a) Have only the test plates exposed again with the same weatherometer that was used in (1) (a) for the specified time.
(b) After the exposure, rinse the surface of the test plate with water, and check for discoloration.

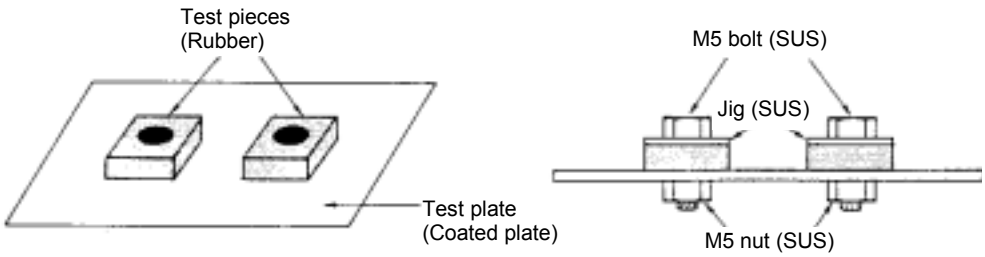


Figure 71 Rubber tightening method

70.4 Coating discoloration test by weatherstrip

A Equipment and materials

Tester and materials are as follows.

(1) Constant temperature controlled chamber which can maintain 80±1°C
(2) Constant temperature controlled water tank which can maintain 50±1°C
(3) Test plate (70 × 150 mm) shall be coated in accordance with the specified coating process and shall be left for more than 24 hours after the coating process.
(4) Cut the rubber used for weatherstrip into pieces (approx. 40 to 50 mm). Then, use them as test pieces.

B Test method

B.1 Test location conditions

Test location conditions shall be in accordance with the conditions specified in the item 4.1 of NES M 0141.

B.2 Test conditions

(1) Heating temperature: 80±1°C
(2) Heating time: 72 hours
(3) Warm water heating temperature: 50±1°C
(4) Warm water heating time: 24 hours

B.3 Procedure

(1) Cut a test piece out of the weatherstrip, put the test piece and spacers between the test plate and the presser plate as shown in Figure 72, and fix the test piece to the test plate with clips.
(2) After setting the temperature of the constant temperature controlled chamber to the specified value, put the test plates in it making sure that there is no foreign materials in the chamber.
(3) After allowing the test plate to stand in the constant temperature controlled chamber for the specified time, take the test plate out of the chamber, remove the test pieces, and check for the discoloration. Do not rinse the plate with water at this time.
(4) Remove the test piece, and put the test plate in the constant temperature controlled water tank where the temperature has been set to the specified value beforehand making sure that there is no foreign materials in the tank.
(5) After allowing the test plate to stand in the temperature controlled water tank for the specified time, take the test plate out of the tank, rinse the surface of the test plate with water, and check for the discoloration.

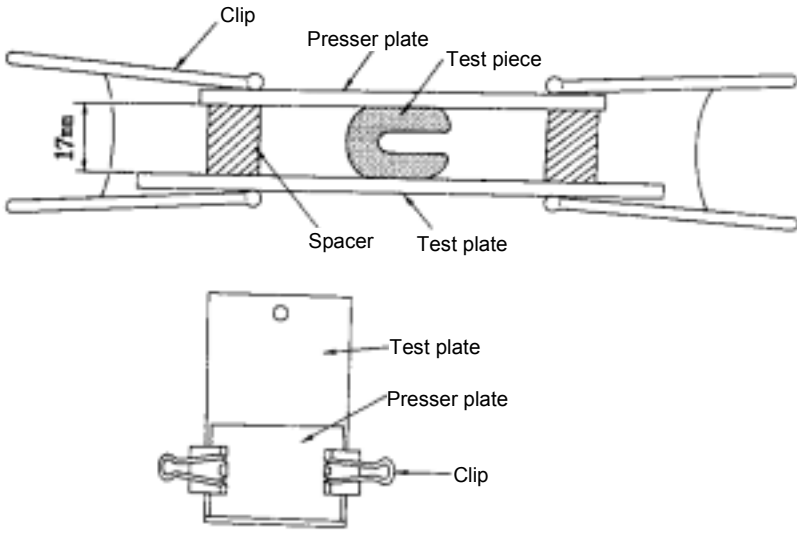


Figure 72 Weatherstrip Holding Method

C Judgement

Compare the area which has contacted the rubber with the other area which has not contacted the rubber. Then, make a judgement on the discoloration of the test piece by Δb value, ΔL value, and visual inspection.

D Report

(1) Discoloration after heating and its level (Δb, ΔL values)
(2) Discoloration after heating with warm water and its level (Δb, ΔL values)
(3) Other necessary items

71. TWO-TONE PARTING CHARACTERISTIC TEST METHOD

71.1 Purpose

To examine adhesion between the upper color and the lower color at the two-tone parting position.

71.2 Equipment

Tension tester

71.3 Test conditions

Standard conditions specified in 4.1.2 (1)

71.4 Coating method

Coat from the chemical conversion to the clear according to 4.2.3 and 4.4. Concerning the baking, follow the following conditions.

Table 22

Electrodeposition Baking	Intermediate Coat Baking	Top Coat (Lower color) Baking	Top Coat (Upper color) Baking
170±5°C × 20±0.5 min.	140±5°C × 20±0.5 min.	160±5°C × 20±0.5 min.	140±5°C × 20±0.5 min.

71.5 Specimen preparation and test method

(1) Coat the lower color on the entire SP120 (70 mm × 150 mm, t=0.8 mm) of NES M2020.
(2) Cool the specimen to the room temperature, and adhere the masking parting tape (used at each factory) first vertically, then horizontally as shown in Figure 73. Then, adhere it with hands.
The length of the vertical tape should be twice of the specimen length + α (approx. 310 mm). (To perform the 180 degree peeling test)

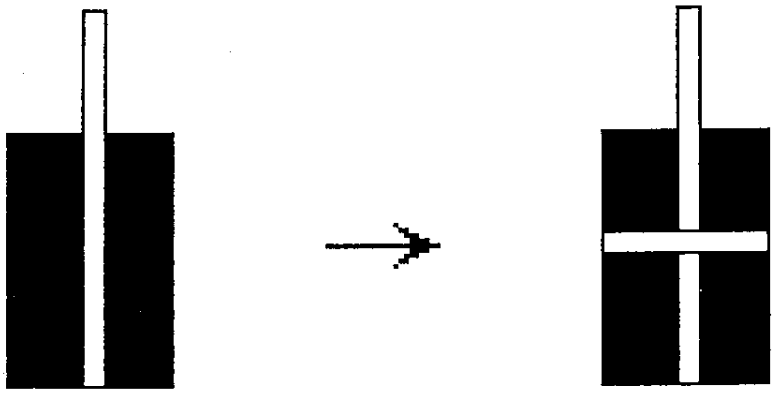


Figure 73

(3) After the tape adhesion, coat the upper color on the whole specimen.
(4) After cooling the specimen to the room temperature, set the terminal of the vertical tape on the clamp unit to perform the 180 degree peeling test at the speed of 1000 mm/min.

72. INSECT RESISTANCE TEST METHOD

72.1 Purpose

To examine the effect of insects on the coat film.

72.2 Equipment

Shall keep the constant temperature controlled chamber: 70±1°C.

72.3 Reagent

Beeswax (Beeswax made by Wako Reagent)

72.4 Test method

72.4.1 Specimen preparation

Use the test plate A (70 × 150 mm) specified in 4.2.2, and coated in accordance with 4.4.

72.4.2 Test conditions

(1) Specified temperature: 70±1°C
(2) Specified period: 30 min.
(3) Specified dripping amount: 0.05 g

72.4.3 Procedure

(1) Drip the specified amount of reagent on the specimen at room temperature.
(2) Set the above-mentioned specimen horizontally in the constant temperature controlled chamber, adjusted to the specified temperature. Then, allow it to stand for a specified period.
(3) After allowing it to stand for a specified period, wipe the reagent off with a soft cloth, and take it out from the constant temperature controlled chamber.
(4) After allowing it to stand for 24 hours at room temperature, observe the surface of the specimen.

72.4.4 Report

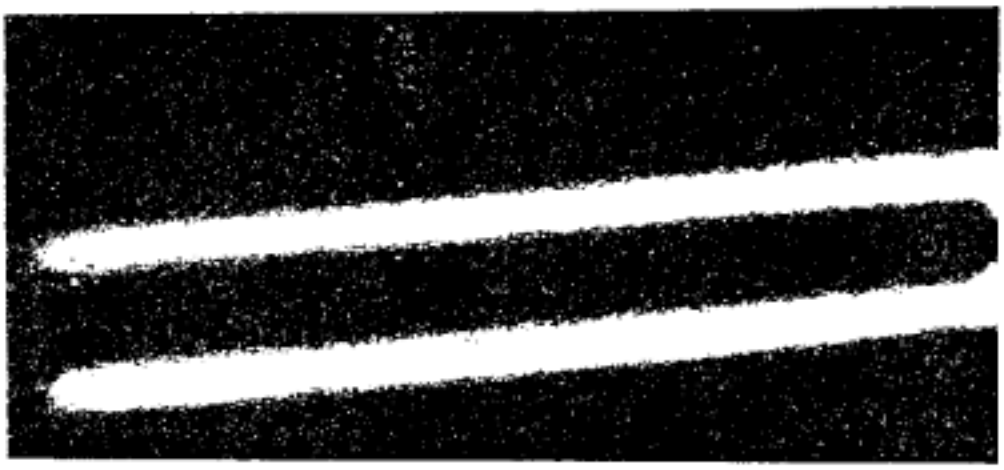
According to the following, record the surface status of the coat film as a classification. (Refer to Table 23 and Figure 74.)

Table 23

Classification	Degradation
Class 0	No change
Class 1	Swelling
Class 2	Swelling, gloss lowering, & discoloration

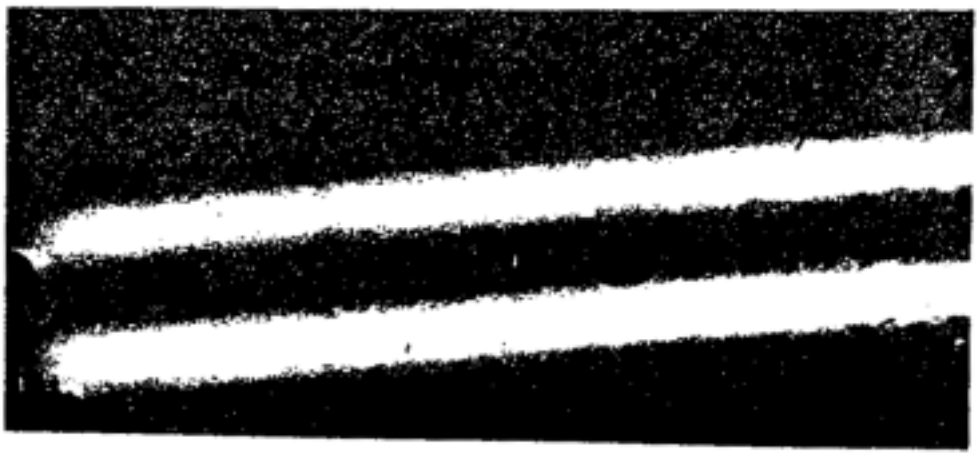
Figure 74　Standard sample to judge insect resistance

Class 0



Class 1

Class 2



73. POLLEN RESISTANCE TEST METHOD

73.1 Purpose

To examine the effect of the pollen on the coat film.

73.2 Equipment

Shall keep the constant temperature controlled chamber: 40±1°C.

73.3 Reagent

Oleic acid (Class 1 reagent)

73.4 Test method

73.4.1Specimen preparation

Use the test plate A (70 × 150 mm) specified in 4.2.2, and coated in accordance with 4.4.

73.4.2 Test conditions

(1) Specified temperature: 40±1°C
(2) Specified period: 1 hour
(3) Specified dripping amount: 0.02 mℓ

73.4.3 Procedure

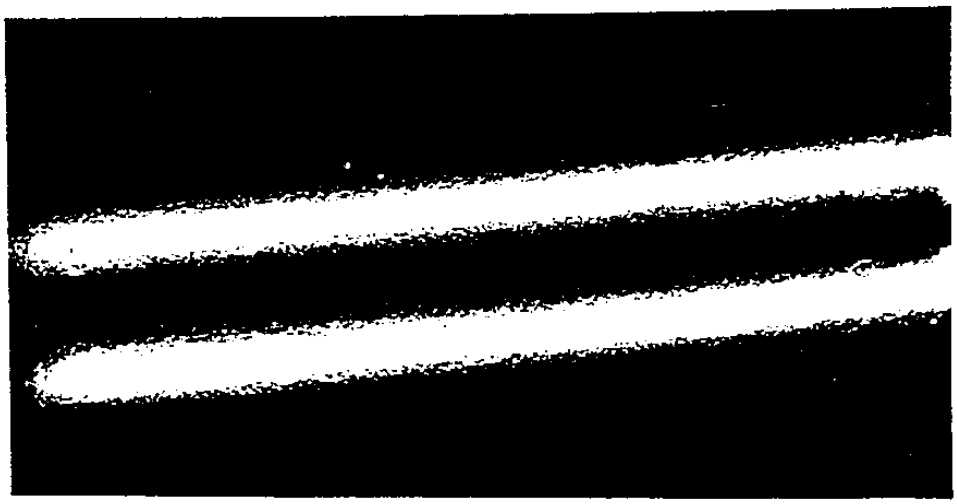
(1) Drip a specified amount of reagent on the specimen at the room temperature.
(2) Set the above-mentioned specimen horizontally in the constant temperature controlled chamber adjusted to the specified temperature. Then, allow it to stand for a specified time.
(3) After allowing the specimen to stand for a specified time, remove it from the constant temperature controlled chamber. Then, rinse it with ethanol.
(4) Blow the water droplet with air, and polish the specimen with flannel waste cloth, if necessary. Then, allow it to stand at the room temperature for 24 hours.
(5) After standing it, observe the surface of the specimen.

(6) 73.4.4 Report

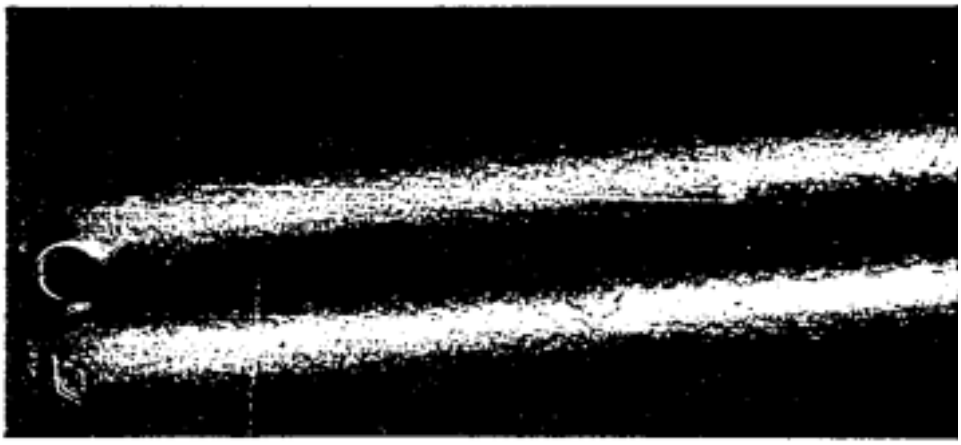
Record the surface status of the coat film with classification according to Table 23 in 72.4.4. (Refer to Figure 75.)

Figure 75 Standard sample to judge pollen resistance

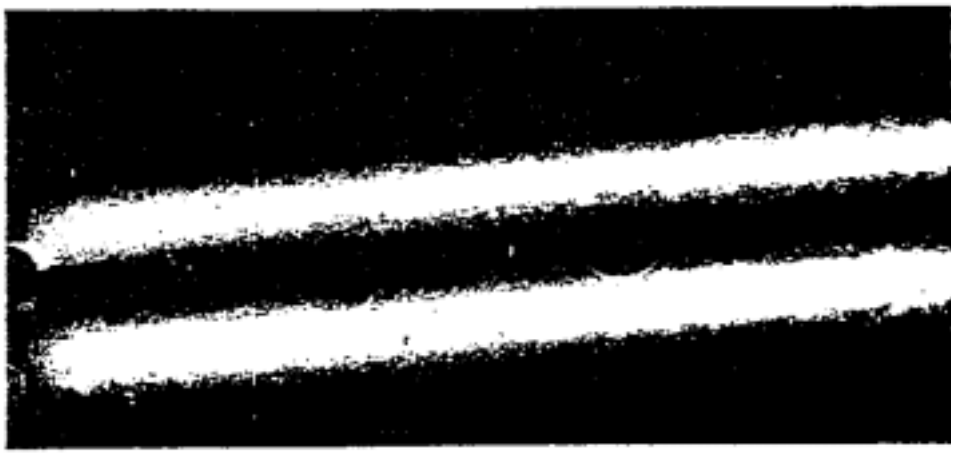
Class 0



Class 1



Class 2



74. SAP RESISTANCE TEST METHOD

74.1 Purpose

To examine the effect of sap on the coat film.

74.2 Equipment

Constant temperature controlled chamber maintaining at 40±1°C.

74.3 Reagent

Cedar oil (Class 1 reagent)

74.4 Test method

74.4.1 Specimen preparation

Use the test plate A (70 × 150 mm) specified in 4.2.2 coated in accordance with 4.4.

74.4.2 Test conditions

(1) Specified temperature: 50±1°C
(2) Specified period: 1 hour
(3) Specified dripping amount: 0.05 g

74.4.3 Procedure

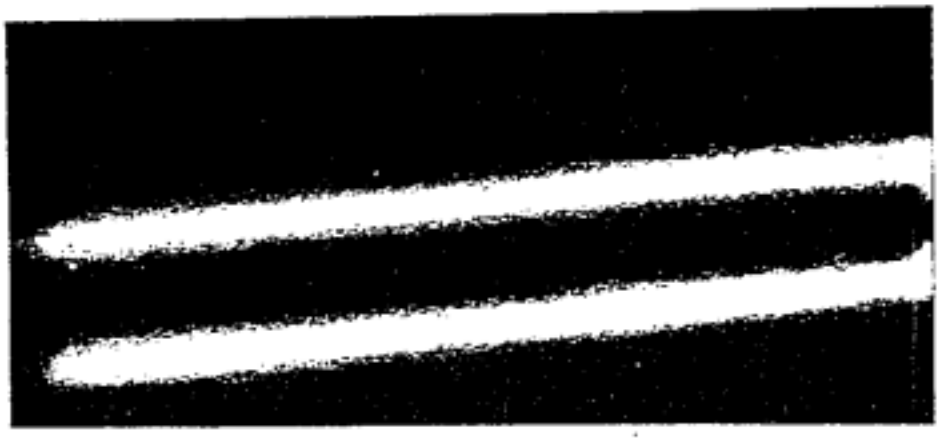
(1) Drop the specified amount of reagent on the specimen at room temperature
(2) Set the above-mentioned specimen horizontally in the constant temperature controlled chamber adjusted to the specified temperature. Then, leave it for a specified period.
(3) After standing it for a specified period, remove the specimen from the constant temperature controlled chamber. Then, wipe it with ethanol.
(4) Blow it with air, and polish it with flannel waste cloth, if necessary. Then, stand it for 24 hours at room temperature.
(5) After standing it, observe the surface of the specimen to check the coat film abnormality.

74.4.4 Report

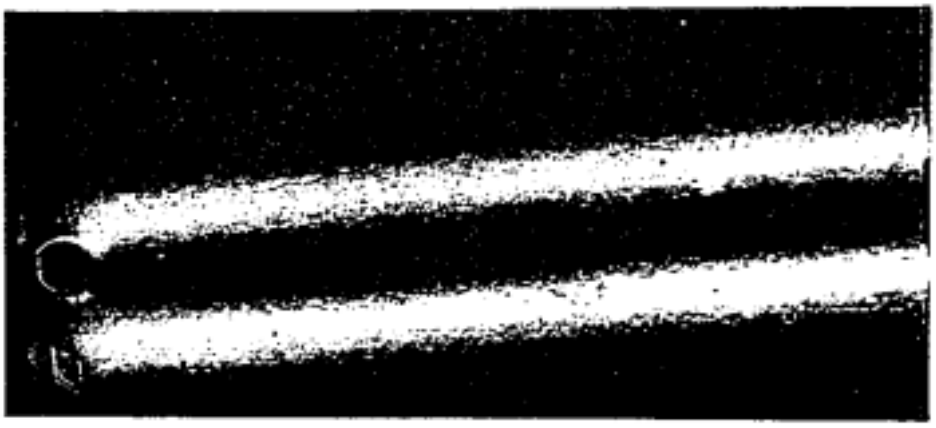
Record the surface status of the coat film with classification, according to Table 23 in 72.4.4. (Refer to Figure 76.)

Figure 76 Standard sample to judge SAP resistance

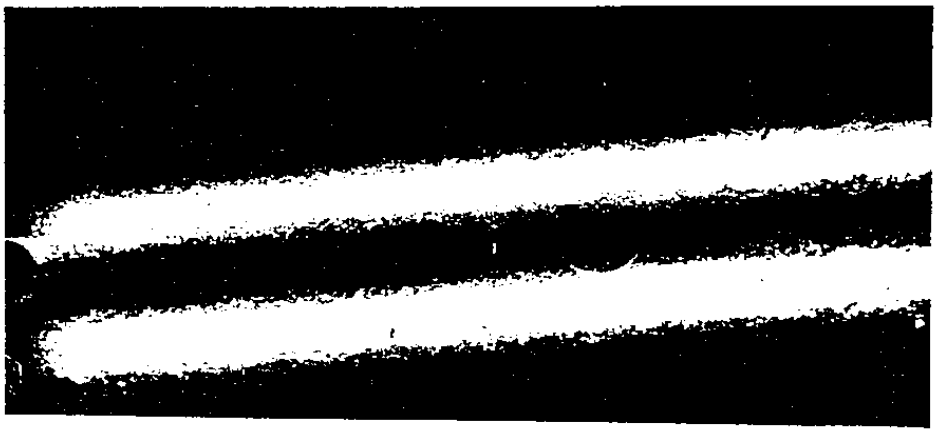
Class 0



Class 1



Class 2



75. PGF UNDERSTAIN TEST METHOD

75.1 Purpose

To investigate the effects of intrusion of liquid between the coating and PGF caused by wrinkles in the PGF, etc.

75.2 Equipment and Materials

(1) Constant temperature controlled chamber: Capable of maintaining 60±1°C.
(2) Constant temperature and humidity controlled chamber: Capable of maintaining 50±1°C, 95%±3 RH.
(3) PGF
(4) NWL base liquid of washer liquid NES M 5069 (Windshield Washer Liquid)
(5) Paint a test plate of the size 70 × 150 mm using the prescribed painting method and let this stand for at least 24 hours after baking.

75.3 Test conditions

(1) Heating conditions 60±1°C 48 h → 50±1°C, 95%±3 RH 24 h.

75.4 Procedure

(1) Cut the PGF into 40 × 40 mm size pieces and then glue and stack 30 pieces together. In the center make a hole with a 5mm dia. punch or other tool. (Refer to Figure 77.)
(2) Glue the PGF in (1) to the test plate and drip 0.2mℓ of test liquid into the hole.
(3) Place this in a constant temperature controlled chamber that has already attained the specified temperature. (60±1°C 48 h)
(4) After allowing the test piece to stand in the constant temperature controlled chamber for the prescribed time, immediately remove the test piece and peel off the PGF. At this time wipe off any remaining test liquid.
(5) Place the test piece from (4) in a constant temperature and humidity controlled chamber that has already attained the specified temperature. (50±1°C, 95%±3 RH 24 h).
(6) After allowing the test piece to stand in the constant temperature and humidity controlled chamber for the prescribed time, immediately remove the test piece. At this time wipe off any remaining test liquid.
(7) After allowing for the prescribed time at all the environmental temperatures shown in Figure 78, check the coating for any surface abnormalities.

Figure 78 Relationship between the time required to recover to where the level of swelling is OK and the environmental temperature.

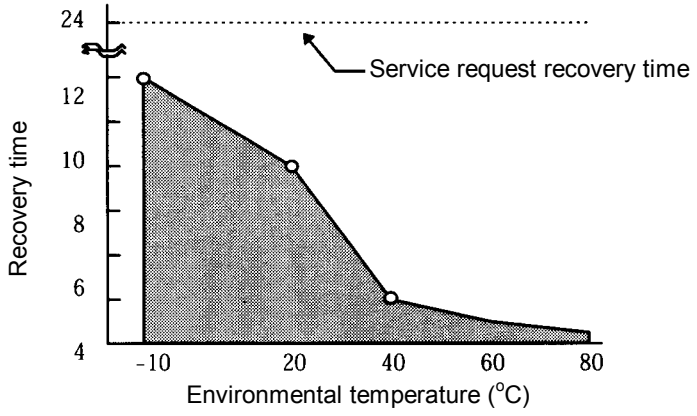
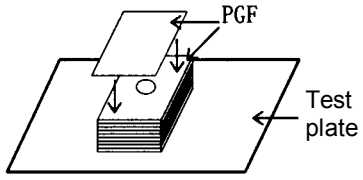


Figure 77



75.5 Evaluation method

Evaluate with the naked eye by comparing with the sample limit plate. (No stains can be seen by the naked eye.)

76. STEEL BALL DROPPING TEST METHOD

76.1 Measuring equipment

Fix the test piece on the fixing table with the angle of 30°. Install the equipment that drops a steel ball at the height of 2,000 mm. Place a microphone 150 mm from the center of the test piece and measure the collision sound against the test piece when the steel ball is dropped. (Refer to Figures 1 and 2.)

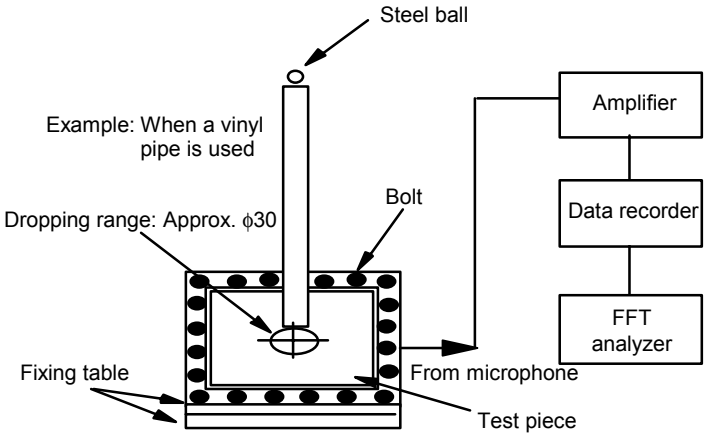


Figure 1 Outline of measuring equipment

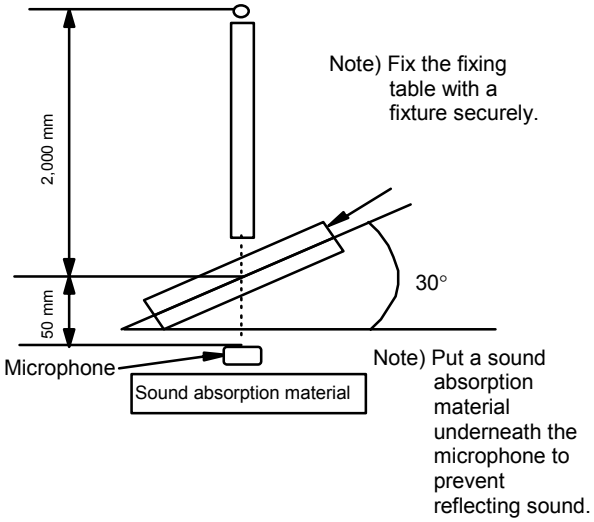


Figure 2 Position of microphone

76.2 Preparation of test piece

1) Test piece
Use a steel plate (SPCC) of 0.8t x 300 x 300 mm.

2) Preparation of test piece
Mask the circumference (fixing allowance) of the test piece by 55 mm with a tape. Apply the coating sample evenly to the masked test piece with a spray. Remove the masking from the test piece with coating and complete the test piece.
The film thickness after drying shall be within ±10% of the specified film thickness. Measure the film thickness at 9 points show below.

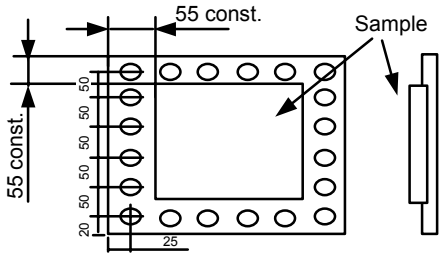


Figure 3 Outline of sample preparation

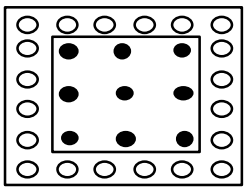


Figure 4 Measuring points of film thickness

76.3 Test conditions

- Dropping method: Drop a steel ball freely 2,000 mm above the center of the test piece.
- Support method: Fix the test plate completely with 20 bolts (M8 or larger) using the fixing table.
- Test temperature: 20±5°C
- Test room: Use the anechoic room. If the anechoic room is not available, the equivalent room may be acceptable.
- Steel ball: Use a bearing ball of 2 g in weight and ϕ8.

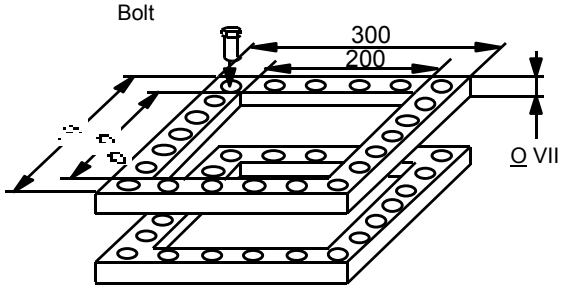


Figure 5 Fixing table

76.4 Procedure

(1) Fix the test piece on the fixing table securely with bolts.
(2) Measure the collision sound (sound pressure) against the test piece when the steel ball is dropped from the specified height.
(3) Measure the collision sound 5 times.

76.5 Report

(1) Report of test result
Report the test result with the average value of 5 collision sounds.
(2) Describe the test result of standard plate A. (the plate without application of the sample)
(3) Describe the test result of standard plate B. (the sound performance target plate supplied by Nissan)
(4) Describe the test result of the testing material.
(5) Indicate the weight of the bearing ball and the film thickness of the testing material after drying.
(6) Description of test results
1) The sound pressure level for each 1/3 octave frequency in the range of 0.8 KHz to 8 KHz shall be indicated to the first decimal place.
2) The overall value of the sound pressure level in the range of 0.8 KHz to 8 KHz shall be indicated.

76.5 Additional remark

FFT setting:
(1) Frequency analysis: 1/3 octave
Perform A characteristic correction.
(2) Window: Rectangular window
(3) Frequency range: 10 KHz 800 line (Resolution: 12.5 Hz)
(4) Data loading time: 80 msec.

77 NUT DROP TEST METHOD

77.1 Purpose

Coating film impact resistance test assuming contact with adjacent parts when the door is opened.

77.2 Equipment and material

(1) Nut drop tester (Refer to Figure 78.)

(2) Shot material M6 nut (ISO4032-Hexagon nuts, style 1 Thread size: M6
Material: Brass (Brass material, Surface treatment: No plating) (JIS B1181)
300±2 g

(3) Cloth gum tape: (JIS Z1512 ICS (International standard classification 55:040)

77.3 Preparation of test piece

The coated piece according to 4.4.4 using the test piece (70 x 150 mm) in 4.4.2 shall be the test piece.

77.4 Test conditions

(1) Test piece temperature: -20±2℃

(2) Temperature at test piece holding area: Room temperature

(3) Nut feeding speed to the funnel: Quick loading

77.5 Procedure

(1) Set the test piece on the test piece holding area.

(2) When the test piece temperature has reached the specified value, feed the nut into the funnel as quickly as possible.

(3) Remove the test piece and wash it. Then wipe the test piece to remove moisture and affix a cloth gum tape to remove unwanted matter (including peeled coating film) from the coating surface.

77.6 Judgement

(1) When the condition after the chipping test is checked, compare the test piece with the standard plate for judgment. Indicate the grade of the standard plate that represents the test piece condition. In this case, the judgment area shall be the entire surface of the test piece.

(2) After the chipping test, check the number of rust on the test piece if the salt water spray test is performed. In this case, the judgment area shall be the same as (1).

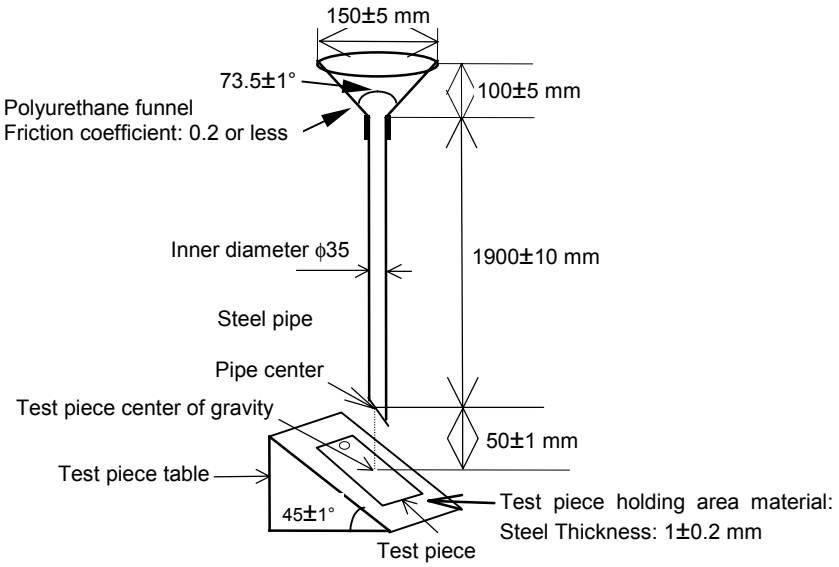
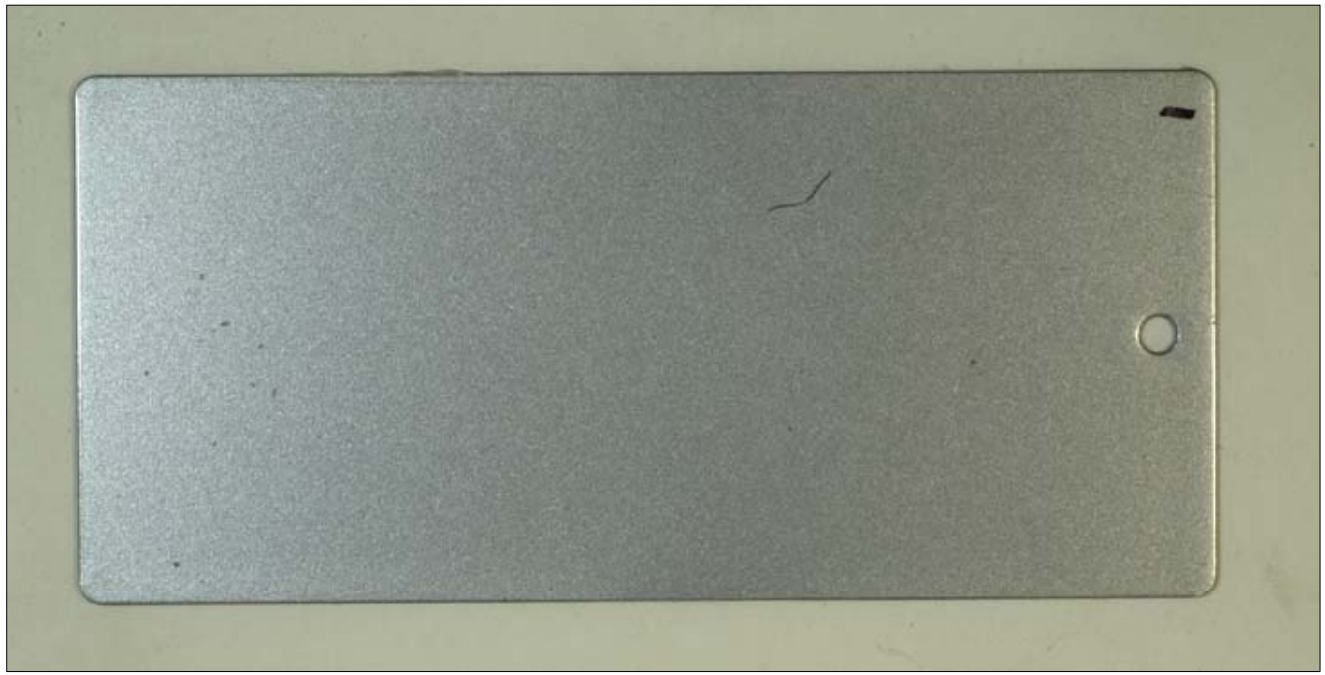
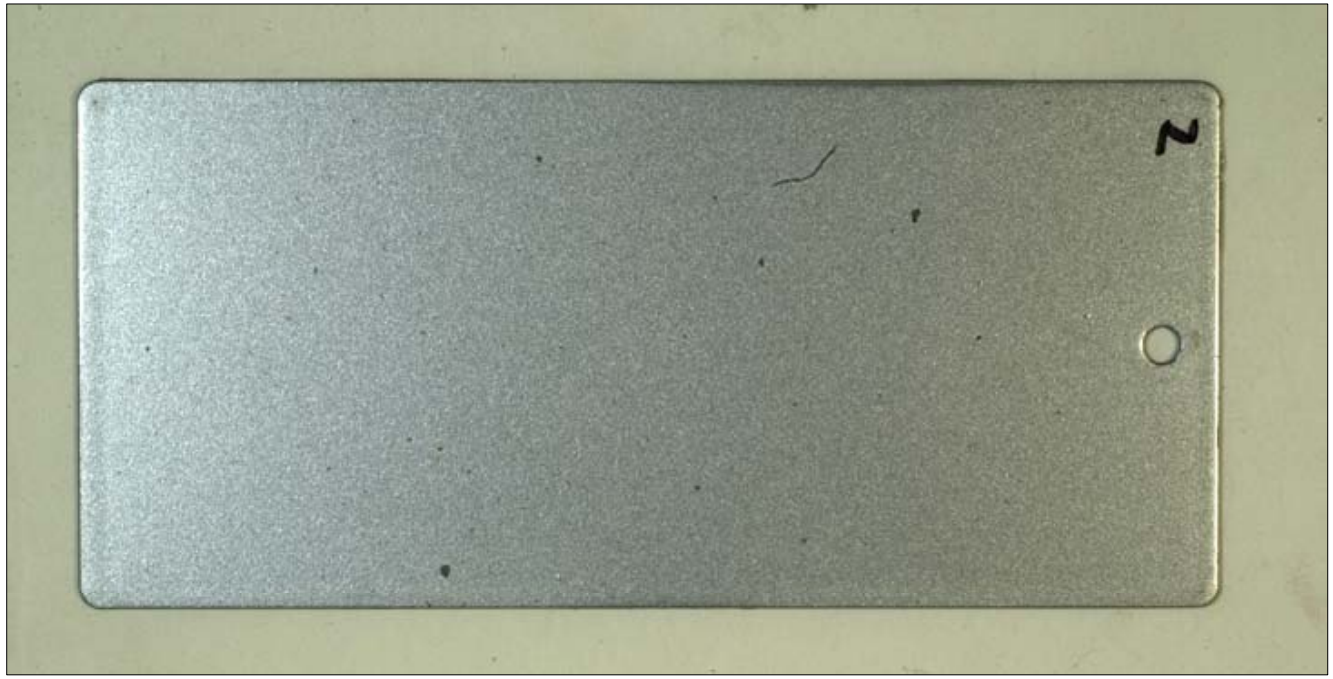
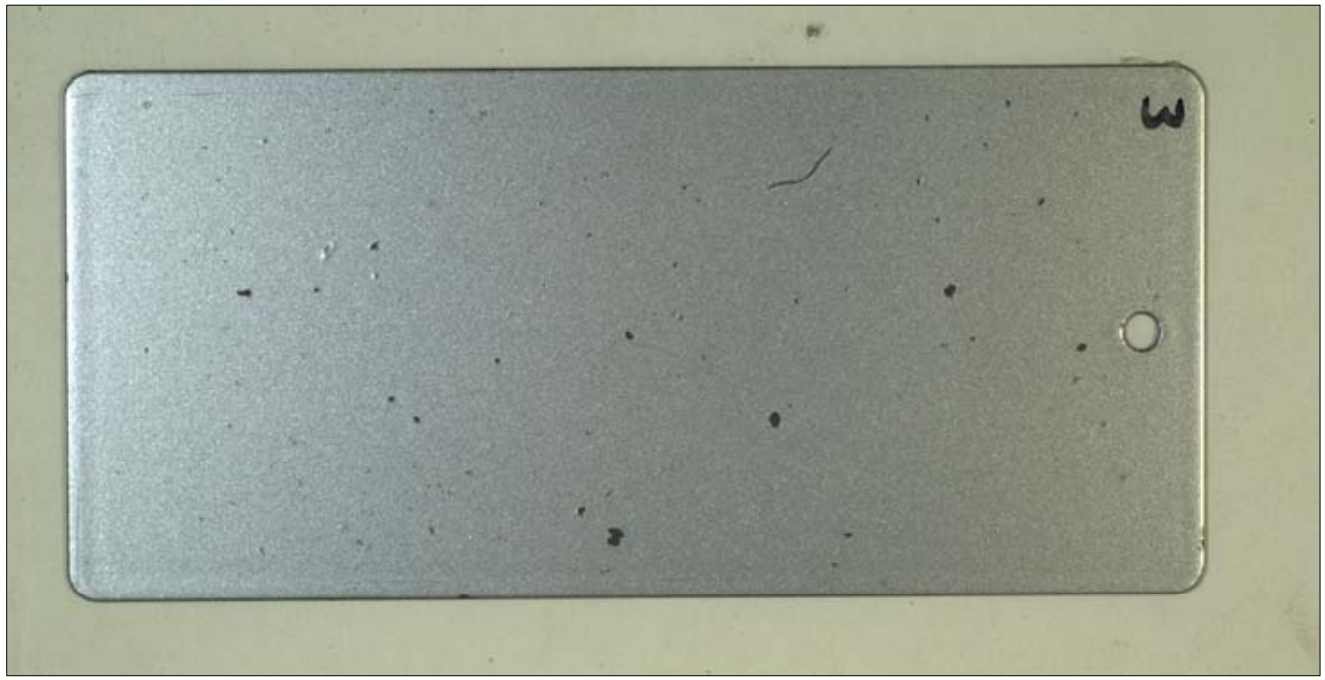


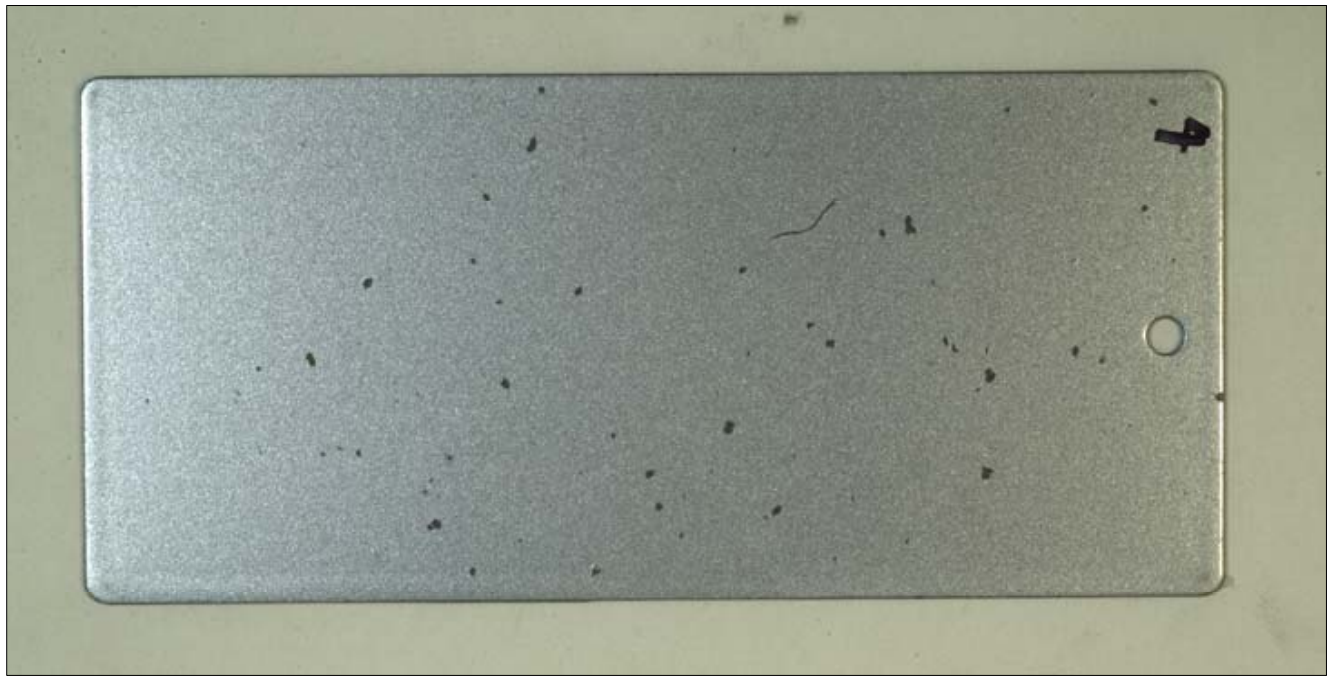
Figure 79 Nut drop tester

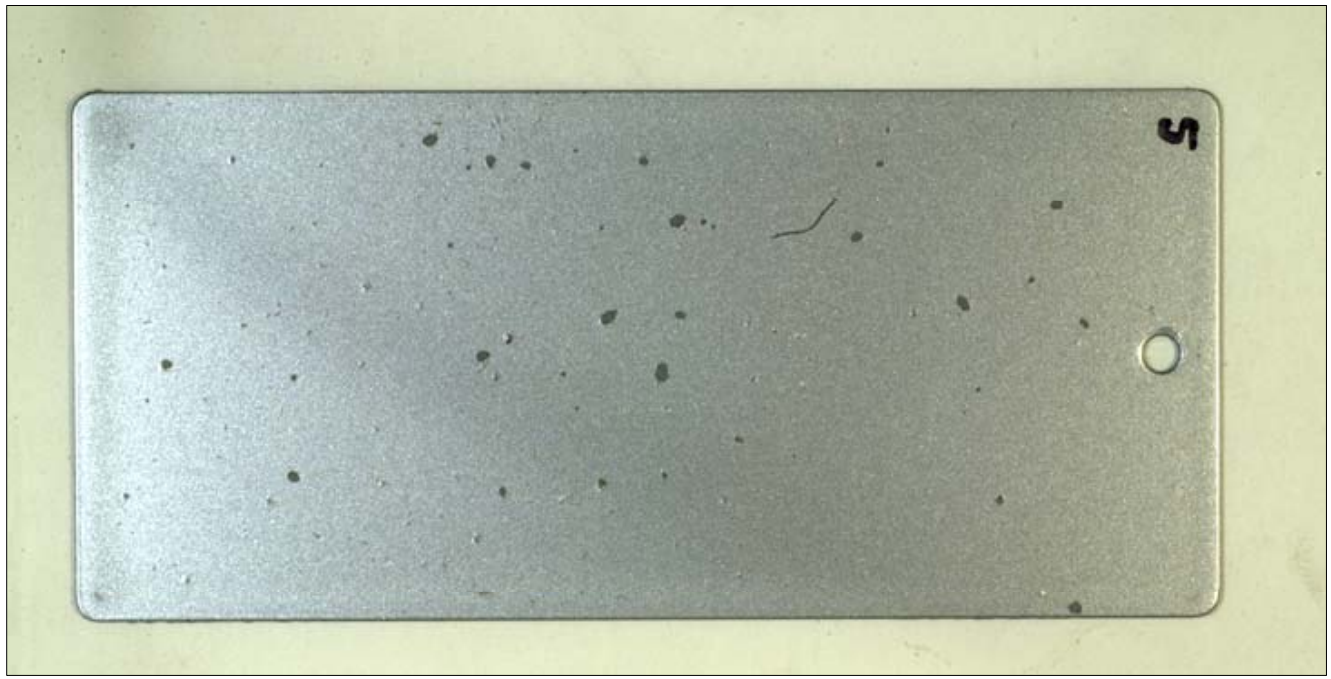
78. TEN-STAGE LIMIT SAMPLE FOR CHIPPING TEST







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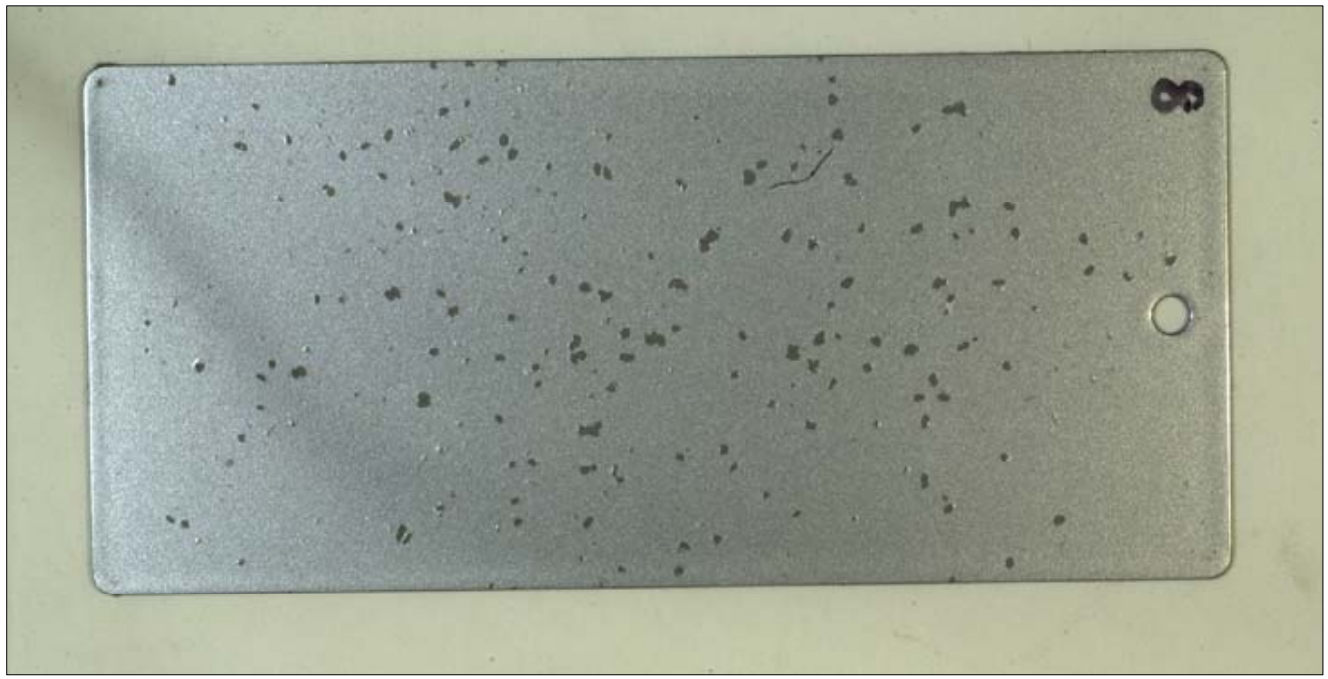


01

79 TEST METHOD FOR DETERMINING THE PERCENTAGE OF THE HEATING RESIDUE

79.1 Purpose

To determine the percentage of the heating residue in paint

79.2 Equipment and tools

(1) Baking oven (Use a baking oven capable of heating the test piece to the specified temperature within 10 to 20 minutes.)
(2) Precision balance (sensitivity: 1 mg)
(3) Aluminum dish (diameter: 70 mm, depth: 15 mm)
(4) Aluminum plate (120 × 120 mm or so)
(5) Petri dish used as a cover (diameter: 100 mm, depth: 35 mm or so)
(6) Glass injection syringe
(7) Desiccator

79.3 Test conditions

(1) Standard conditions specified in 4.1.2. (1)
(2) Baking conditions: Paint for steel plates: Baked at 140°C for 20 min. and at 150°C for 20 min. (reference value)
Paint for resin materials: Baked at 120°C for 20 min. and at 130°C for 20 min. (reference value)
Paint for mild steel plates: Baked at 130°C for 20 min. and at 140°C for 20 min. (reference value)
Electrodeposition coat: Baked a 170°C for 20 min. and at 190°C for 20 min. (reference value)

79.4 Procedure

79.4.1 Test piece preparation

(1) Weigh the petri dish in the precision balance. [Let S represent the petri dish weight (g).]
(2) Make a zero adjustment of the precision balance with the aluminum plate placed on top of it. After that, do not remove the aluminum plate until the initial weight of the test piece is measured.
(3) Clean the aluminum dish with alcohol and weigh it after it has dried. [Let A represent the aluminum dish weight (g).]
(4) Using a syringe cleaned with thinner, sample 0.7± 0.05 g of enough stirred test paint.
(5) Inject test paint onto the aluminum dish on top of the precision balance, and then cover it with the petri dish.
(6) Measure the initial weight of the test piece. [Let W1 represent the initial weight of the test piece (g).]
(7) Remove the aluminum dish and spread the paint over the entire bottom surface of the dish.

79.4.2 Heating residue measurement

(1) Put the aluminum dish in the baking oven, and heat and maintain it at the specified temperature for the specified time.
(2) Take the aluminum dish out of the baking oven, put it in the desiccator and cool it down to ordinary temperature.
(3) Weigh the aluminum dish in the precision balance. (Let W2 represent the weight of the test piece at that time (g).)
(4) Calculate the percentage and 3σ of the heating residue using the following equation.

$$\text{Heat residue}(\%) = \frac{W_2 - A}{W_1 - A - S} \times 100 \qquad 3\sigma = 3 \times \sqrt{\frac{n(\Sigma x^2) - (\Sigma x)^2}{n(n-1)}}$$

(5) Carry out the measurement 5 times and calculate the average percentage and 3σ of the heating residue to the second decimal place. If one of the five measured values is greatly different from the others, use the four measured values excluding the singular one to calculate the average percentage and 3σ of the heating residue.
For identifying a singular value, use the formula below. A singular value is judged to exist if the formula is satisfied

$$\left| \bar{x} \pm 3\sigma \text{ for 4 points excluding the singular value} \right| < \left| 1 \text{ (singular value)} \right|$$

(6) If the condition $3\sigma \leqq 0.50$ (%) is not met, conduct the test all over again.

79.5 Report

Record the average weight percentage (wt%) and 3σ of the heating residue rounded off to the second decimal place. If the condition is not met even though the test was conducted again, report the average value calculated from the values measured in the first or second test, whichever produced the smaller 3σ, along with the smaller 3σ.

Applicable Standards:	NES M 5069-1992	Windshield Washer Liquid for Automobiles
	NES M 0158-1996	Method of Compound Corrosion Test
	NES M 0140-1995	Salt Spray Testing
	NES M 5052-1991	Motor Gasoline
	NES M 5051-1993	Lubricating Oil for Automobiles Gasoline Engine
	NES M 5059-1992	Engine Antifreeze
	NES M 5067-1995	Paint Guard Coating (Transportion Protection) – Automotive
	NES M 5070-1994	Rust Preventive Agents
	NES M 5075-1994	Engine Compartment Rust Preventive Materials
	NES M 8504-1995	Direct Adhesives of Window Glass - Automotive
	NES M 2020-1996	Cold Rolled Carbon Steel Sheets and Strips
	NES M 7081-1994	Polyvinylchloride Coated Fabric for Automobiles
	NES M 7083-1994	Vinyl Sheet for Automobiles
	NES M 2036-1996	“Durasteel” Corrosion Control Coated Steel Sheets and Strips – Automobile
	NES M 4064-1995	Cold Rolled Aluminium Alloy Sheets for Automobiles (for Bodies)
	NES M 0084-1993	Test Methods for Adhesives and Sealants for Automobiles
	JIS K 5400-1990	Testing methods for paints
	JIS Z 8809-1992	Standard liquids for calibrating viscometers
	JIS Z 8701-1995	Colour specification – The CIE 1931 standard colorimetric system and the CIE 1964 supplementary standard colori-metric system
	JIS K 7117-1987	Testing methods for viscosity with a rotational viscometer of resins in the liquid form
	JIS Z 8802-1984	Methods for determination of pH of aqueous solutions
	JIS P 3801-1995	Filter paper (for chemical analysis)
	JIS R 6252-1994	Abrasive papers
	JIS Z 8720-1983	Standard illuminants and sources for colorimetry
	JIS Z 8722-1994	Methods of color measurement – Reflecting or transmitting objects
	JIS Z 8730-1995	Colour specification – Color differences of non-luminous object color
	JIS S 6006-1996	Pencils and colored pencil
	JIS A 5001-1995	Crushed stone for road construction
	JIS Z 1522-1994	Pressure sensitive adhesive cellophane tapes
	JIS Z 8901-1995	Dusts and aerosols for industrial testing
	JIS R 3505-1994	Volumetric glassware
	JIS B 7305-1989	Thermographs
	JIS B 7306-1993	Hygrographs
	JIS B 7753-1993	Light-exposure and light-and-water-exposure apparatus (Open-flame sunshine carbon-arc type)
	JIS H 0521-1968	Testing method for atmospheric corrosion of aluminium and aluminium alloys
	JIS B 0651-1976	Instruments for the measurement of surface roughness by the stylus method
	JIS H 3100-1992	Copper and copper alloy sheets, plates and strips
	JIS H 8617-1991	Electroplated coatings nickel and chromium
	JIS H 2601-1983	Iron powder
	JIS B 7734-1991	Micro hardness testing machines for Vickers and Knoop hardness
	JIS Z 8703-1983	Standard atmospheric conditions for testing
	JIS Z 8401-1061	Rules for rounding off of numerical values
	SAE J 400	Test for Chip Resistance of Surface Coatings
	ASTM D 714	
	JIS D 0205-1987	Test method of weatherability for automotive parts