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Methods of salt spray testing

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry, through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Surface Finishing Society of Japan (SFJ)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently, **JIS Z 2371:2000** is replaced with this Standard.

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Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, applications for a patent after opening to the public or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, applications for a patent after opening to the public or utility model rights.

Methods of salt spray testing

Introduction

This Japanese Industrial Standard has been prepared based on the third edition of **ISO 9227** published in 2012 with some modifications of the technical contents.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JD.

1 Scope

This Standard specifies the salt solutions, the apparatus, and the procedure (including evaluation of cabinet reproducibility related to corrosivity, test specimens, test conditions, and evaluation of test results) to be used in conducting the neutral salt spray test, acetic acid salt spray test and copper-accelerated acetic acid salt spray (CASS) tests for assessment of the corrosion resistance of metallic materials, with or without electroplating, or inorganic film or organic coating such as painted coat.

WARNING Persons carrying out tests based on this Standard should be familiar with normal laboratory practice. This Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this Standard to establish appropriate safety and health practices.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 9227:2012 *Corrosion tests in artificial atmospheres—Salt spray tests* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS G 3141 *Cold-reduced carbon steel sheet and strip*

JIS K 5600-1-4 *Testing methods for paints—Part 1: General rule—Section 4: Standard panels for testing*

NOTE : Corresponding International Standard: ISO 1514:2004 *Paints and varnishes—Standard panels for testing* (MOD)

JIS K 5600-1-7 *Testing methods for paints—Part 1: General rule—Section 7: Determination of film thickness*

NOTE : Corresponding International Standard: ISO 2808:2007 *Paints and varnishes—Determination of film thickness (MOD)*

JIS K 8145 *Copper (II) chloride dihydrate (Reagent)*

JIS K 8150 *Sodium chloride (Reagent)*

JIS K 8180 *Hydrochloric acid (Reagent)*

JIS K 8284 *Diammonium hydrogen citrate (Reagent)*

JIS K 8355 *Acetic acid (Reagent)*

JIS K 8576 *Sodium hydroxide (Reagent)*

JIS K 8847 *Hexamethylenetetramine (Reagent)*

JIS Z 8802 *Methods for determination of pH of aqueous solutions*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions apply.

3.1 NSS (neutral salt spray test)

test to evaluate the corrosion resistance, performed in an atmosphere in which neutral sodium chloride solution is continuously sprayed by means of a salt spray test apparatus

3.2 AASS (acetic acid salt spray test)

test to evaluate the corrosion resistance, performed in an atmosphere in which sodium chloride solution acidified by acetic acid is continuously sprayed by means of a salt spray test apparatus

3.3 CASS (copper-accelerated acetic acid salt spray test)

test to evaluate the corrosion resistance, performed in an atmosphere in which sodium chloride solution acidified by acetic acid and added with copper (II) chloride dihydrate is continuously sprayed by means of a salt spray test apparatus

4 Salt solution for testing

4.1 Preparation of salt solution for testing

Preparation of salt solution for testing shall be as follows.

- a) Salt used for salt solution for testing shall be sodium chloride of special grade specified in **JIS K 8150**, or any sodium chloride at least equivalent thereto.

Any sodium chloride at least equivalent thereto as referred to above shall contain less than 0.001 % mass fraction of copper and less than 0.001 % mass fraction of nickel, as determined by atomic absorption spectrophotometry or another analytical method of similar sensitivity. Further, it shall not contain more than 0.1 % mass fraction of sodium iodide, or more than 0.5 % mass fraction of total impurities calculated for dry salt. It shall not contain anticaking agent, which may accelerate or inhibit the corrosion.

- b) Water used shall be deionized or distilled water with a conductivity not higher than $20 \mu\text{S}/\text{cm}$ at $25 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$.

The conductivity should preferably be $1 \mu\text{S}/\text{cm}$ or lower.

- c) In a vessel of an inert material such as resin, dissolve a sufficient mass of salt in **a)** in water in **b)** to produce a concentration of $50 \text{ g/L} \pm 5 \text{ g/L}$. After thorough agitation, the specific gravity range of the collected salt solution shall be 1.029 to 1.036 when measured by means of a density meter. The salt solution concentration may be confirmed by means of another electric measuring device such as a salt concentration meter.

If the obtained solution is found to be outside the specified range, prepare a new solution.

NOTE 1 If the pH of the prepared salt solution at $25 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$ is outside the range of 5.0 to 8.0, prepare a new solution.

NOTE 2 High silica concentrations in water may affect the test results.

4.2 pH adjustment of salt solution for testing

4.2.1 NSS test

Use the salt solution prepared in 4.1. Adjust the pH of the salt solution so that the pH of the sprayed salt solution (hereafter referred to as “sprayed solution”) collected within the spray cabinet is 6.5 to 7.2 at $25 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$.

Make any necessary pH corrections by adding the solution of sodium hydroxide of special grade specified in **JIS K 8576** or hydrochloric acid of special grade specified in **JIS K 8180**, agitating well, and then measuring the pH.

Measure the pH at $25 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$ using the procedures described in **JIS Z 8802**.

In routine checks, the pH may be checked using a short range pH paper which can be read in increments of 0.2 pH units.

NOTE : The concentration of sodium hydroxide solution and hydrochloric acid should be 0.1 mol/L.

4.2.2 AASS test

The pH adjustment of salt solution for AASS test shall be according to the following procedure.

- a) Add 1 ml of acetic acid of special grade specified in **JIS K 8355** per litre of salt solution prepared in 4.1, agitate well, and measure the pH.
- b) If the pH of the prepared salt solution at $25 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$ is outside the range of 3.0 to 3.1, add more acetic acid of special grade specified in **JIS K 8355** or the solution of sodium hydroxide of special grade specified in **JIS K 8576**, agitate well, and then measure the pH again.
- c) Repeat the above procedure until the pH at $25 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$ is adjusted to 3.0 to 3.1.
- d) Check that the pH of samples of the sprayed solution collected in the test cabinet at $25 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$ is between 3.1 and 3.3.

Measure the pH at $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ using the procedures described in **JIS Z 8802**.

NOTE : The concentration of sodium hydroxide solution should be 0.1 mol/L.

4.2.3 CASS test

The pH adjustment of salt solution for CASS test shall be according to the following procedure.

- a) Dissolve $0.26\text{ g} \pm 0.02\text{ g}$ of copper (II) chloride dihydrate of special grade specified in **JIS K 8145** per litre of the salt solution prepared in 4.1. This solution is equivalent to copper chloride of $0.205\text{ g/L} \pm 0.015\text{ g/L}$.
- b) Add 1 ml of acetic acid of special grade specified in **JIS K 8355** per litre of salt solution, and agitate well, and measure the pH. If the pH of the prepared salt solution at $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ is outside the range of 3.0 to 3.1, add more acetic acid of special grade specified in **JIS K 8355** or sodium hydroxide solution of special grade specified in **JIS K 8576**, agitate well, and then measure the pH again.
- c) Repeat the above procedure until the pH at $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ is adjusted to 3.0 to 3.1.
- d) Check that the pH of samples of sprayed solution collected in the spray cabinet at $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ is between 3.1 and 3.3.

Measure the pH at $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ using the procedures described in **JIS Z 8802**.

NOTE : The concentration of sodium hydroxide solution should be 0.1 mol/L.

4.3 Filtration of suspended matter

It shall be ensured that the salt solution for testing is free from suspended matter prior to spraying. If after thorough agitation suspended matter is still observed, filter the solution by using filter paper or the like. If considered necessary, filter the solution before placing it in the salt solution reservoir of the apparatus, to remove any solid matter which might block the apertures of the mist dispersion tower or atomizer nozzle.

5 Apparatus

5.1 General

The apparatus used for this test shall be composed of a spray cabinet provided with mist dispersion tower or atomizer nozzle, salt solution reservoir, test specimen supports, fog collectors, and salt solution tank, air compressor, air saturator, temperature controls, exhaust duct, etc. and shall be as follows.

- a) The apparatus shall be maintained and controlled so that the test can be performed normally.
- b) The exhaust duct shall not be influenced by the wind pressure of the open air.
- c) Preference shall be given to apparatus that has a means for properly dealing with sprayed solution after the test, prior to releasing it from the building for environmental conservation, and for drawing water prior to discharging it to the drainage system (see Annex A).

5.2 Component protection

All components in contact with the salt solution or sprayed solution (such as spray cabinet or test specimen supports) shall be made of materials resistant to corrosion by the salt solution and sprayed solution and shall not influence the corrosivity of the sprayed test solutions.

5.3 Spray cabinet

The spray cabinet shall be as follows.

- a) The cabinet shall be such that the distribution of the sprayed solution and the temperature can be controlled to be homogeneous, and its form and size may be optional. Where the cabinet volume is less than 0.4 m^3 , sufficient attention shall be paid to the distribution of the spray and temperature.
- b) The mist dispersion tower and the atomizer nozzle shall be made of inert material such as plastics, and shall be capable of spraying the solution uniformly over the test specimens from upper part of the spray cabinet (see Annex A).
- c) The spraying shall be performed by free circulation of sprayed solution, and the direction of the mist dispersion tower or the atomizer nozzle shall be adjusted so that the sprayed solution does not directly fall on the test specimen. The mist dispersion tower is suitable for this purpose. The upper parts of the cabinet shall be designed so that drops of the sprayed solution formed on its surface do not fall on the specimens being tested.
- d) The sprayed solution and temperature inside the spray cabinet shall not be affected by the open air.
- e) The test specimen supports shall be capable of holding the test specimens at the specified angle ¹⁾.

Note ¹⁾ The test specimen supports shall be made of, or coated with, inert materials such as plastics, and shall support the test specimen at the bottom or side surfaces of the specimen. Instead of using such supports, test specimens may be hung with a glass hook or vinyl string as long as they can be held at the specified position, in which case, they shall be supported at the bottom surfaces if necessary.

5.4 Temperature controls

The temperature near the test specimen supports inside the spray cabinet shall be maintained at $35 \text{ }^{\circ}\text{C} \pm 2 \text{ }^{\circ}\text{C}$ for NSS and AASS tests and $50 \text{ }^{\circ}\text{C} \pm 2 \text{ }^{\circ}\text{C}$ for CASS test. The temperature shall be measured at least 100 mm from the walls.

5.5 Spraying device

The spraying device shall be as follows.

- a) The compressed air supplied to the mist dispersion tower or atomizer nozzle for spraying the salt solution shall be passed through a filter to remove all traces of oil or solid matter, and the atomizing pressure shall be at an overpressure of 70 kPa to 170 kPa.

The pressure should be $98 \text{ kPa} \pm 10 \text{ kPa}$.

- b) In order to prevent the evaporation of water from the sprayed droplets, the compressed air shall be humidified before entering the mist dispersion tower or atomizer nozzle by passing through a humidifier or an air saturator. The compressed air supplied to the mist dispersion tower or atomizer nozzle shall be heated so that it does not cause the temperature inside the spray cabinet to fluctuate severely when mixed with the salt solution. An air saturator should be used to control the humidity and temperature of the compressed air. Table 1 shows the guiding values that are given for the hot-water temperature in the air saturator at different pressures.
- c) The water used for the humidifier or the air saturator for humidifying the compressed air supplied to the mist dispersion tower or atomizer nozzle shall be as specified in 4.1 b).

NOTE : High silica concentrations in water may affect the performance of the heater and the water level sensor.

- d) The salt solution to be supplied to the mist dispersion tower or the atomizer nozzle shall be maintained to be continuous and uniform spray mist. For a stable spraying, the level of the salt solution in the salt solution reservoir, or flow of the salt solution supplied to the mist dispersion tower or atomizer nozzle shall be controlled.

Table 1 Guiding values for the hot-water temperature in the air saturator at different pressures

Pressure of compressed air kPa	Water temperature °C	
	NSS test and AASS test	CASS test
70	45	61
84	46	63
98	47	63
112	49	66
126	50	67
140	52	69

5.6 Fog collectors

The fog collectors shall be as follows.

- a) The fog collectors for collecting the sprayed fog shall be made of chemically inert material such as plastics.
- b) The fog collector shall have a diameter of about 100 mm, which corresponds to a collecting area of approximately 80 cm² and at least two of these collectors shall be placed at positions of the cabinet where the homogeneity of the mist can be confirmed, e.g., one close to the mist dispersion tower or atomizer nozzle, and one remote therefrom.
- c) They shall be placed so that only mist from the mist dispersion tower or atomizer nozzle, and not liquid falling from specimens or from parts of the cabinet, is collected.

5.7 Re-use of the apparatus

If the cabinet has been used once for an AASS test or CASS test, or has been used for any other purpose with a solution differing from that specified for the NSS test, it shall not be used for the NSS test.

Where such re-use is unavoidable, the apparatus shall be thoroughly cleaned and checked using the method described in clause 6.

6 Evaluation of cabinet reproducibility related to corrosivity

6.1 General

To check the reproducibility and repeatability of the test results for one piece of apparatus, or for similar items of apparatus in different laboratories, it is necessary to verify the apparatus at regular intervals as described in 6.2 to 6.4.

NOTE : During permanent operation, a reasonable time period between two checks of the corrosivity of the apparatus is generally considered to be 3 months.

To determine the corrosivity of the tests, reference-metal specimens made of steel shall be used. As a complement to the reference-metal specimens made of steel, high-purity zinc reference-metal specimens may also be exposed in the tests in order to determine the corrosivity against this metal (see Annex B).

6.2 NSS test

6.2.1 Reference specimens

The reference specimens used for evaluation of cabinet reproducibility related to corrosivity shall be as follows.

- a) Use four or six reference specimens, depending on the size of the spray cabinet, that are of $1\text{ mm} \pm 0.2\text{ mm}$ thickness and $150\text{ mm} \times 70\text{ mm}$ size, cut from SPCE-grade cold rolled sheets or strips in accordance with **JIS G 3141** with an essentially faultless surface and a matt finish (arithmetical mean deviation of the profile $Ra = 0.8\text{ }\mu\text{m} \pm 0.3\text{ }\mu\text{m}$).
- b) Clean the reference specimens carefully to eliminate all traces of dirt, oil or other foreign matter that could influence the test results with an organic solvent such as ethanol by means of a clean soft brush or an ultrasonic bath. Carry out the cleaning in a vessel full of organic solvent such as ethanol. After cleaning, rinse the reference specimens with fresh organic solvent such as ethanol, and then dry them.
- c) Determine the mass of the reference specimens to $\pm 1\text{ mg}$.
- d) Protect one face of the reference specimens with a removable coating, for example an adhesive plastic film. The edges of the reference test specimens may be protected by the adhesive tape as well.

6.2.2 Arrangement and test of reference specimens

The arrangement and test of reference specimens used for evaluation of cabinet reproducibility related to corrosivity shall be as follows.

- a) Position four steel reference specimens in four quadrants (if six specimens are available, place them in six different positions including the four quadrants) in the zone of the spray cabinet where the test specimens are placed, with the unprotected face upwards and at an angle of $20^\circ \pm 5^\circ$ from the vertical.
- b) The support for the reference specimens shall be made of, or coated with, inert materials such as plastics. The lower edge of the reference specimens shall be level with the top of the fog collector.
- c) The parts of the test specimen support where the reference specimens are not placed shall be filled with dummy specimens of inert materials such as plastics or glass during the verification procedure.
- d) If agreed upon between the interested parties, test specimens may be placed on the supports in the spray cabinet instead of the dummy specimens of inert materials like plastics or glass, and the test may be performed on both specimens simultaneously. Where this has been the case, it shall be reflected in the test report.

NOTE : Care shall be taken that the reference specimens and test specimens do not affect the test results of their counterparts.

- e) Perform the test for 48 h under the test conditions shown in table 2.

6.2.3 Determination of mass loss

The determination of mass loss in evaluation of cabinet reproducibility related to corrosivity shall be as follows.

- a) At the end of the test, immediately take the reference specimens out of the spray cabinet and remove the protective coating. Remove the corrosion products with running water at 40°C or lower by light brushing or by other mechanical or chemical cleaning method. The chemical cleaning shall be performed by immersing the reference specimen in the solution prepared by adding distilled water to 200 mg of diammonium hydrogen citrate $[(\text{NH}_4)_2\text{HC}_6\text{H}_5\text{O}_7]$ specified in **JIS K 8284** to make 1 L, at $23^\circ\text{C} \pm 2^\circ\text{C}$ for 10 min.

The solution used for chemical cleaning may be that prepared by mixing 500 ml of hydrochloric acid specified in **JIS K 8180** and 500 ml of water in **4.1 b)** and adding as a corrosion inhibitor 3.5 g of hexamethylene tetramine ($\text{C}_6\text{H}_{12}\text{N}_4$) specified in **JIS K 8847** per litre of the solution.

- b) After each stripping, clean the reference specimens with running water at 40°C or lower, lightly brush, and rinse with an organic solvent such as ethanol, followed by drying.
- c) Weigh the reference specimens to the nearest 1 mg. Divide the determined mass loss by the area of the exposed surface area of the reference specimen in order to assess the metal mass loss per square metre (g/m^2) of the reference specimen. Perform this removal procedure several more times until variation in the mass loss is hardly observed, and determine the mass loss.

NOTE : It is recommended to use freshly prepared solution during every procedure for removal of corrosion products.

6.2.4 Checking of apparatus operation

The operation of the test apparatus is satisfactory if the mass loss of each reference specimen is $70 \text{ g/m}^2 \pm 20 \text{ g/m}^2$ for 48 h of operation.

6.3 AASS test

6.3.1 Reference specimens

The reference specimens used for evaluation of cabinet reproducibility related to corrosivity shall be as follows.

- a) Use four or six reference specimens, depending on the size of the spray cabinet, that are of $1 \text{ mm} \pm 0.2 \text{ mm}$ thickness and $150 \text{ mm} \times 70 \text{ mm}$ size, cut from SPCE-grade cold rolled sheets or strips in accordance with JIS G 3141 with an essentially faultless surface and a matt finish (arithmetical mean deviation of the profile $Ra = 0.8 \text{ } \mu\text{m} \pm 0.3 \text{ } \mu\text{m}$).
- b) Clean the reference specimens carefully to eliminate all traces of dirt, oil or other foreign matter that could influence the test results with an organic solvent such as ethanol by means of a clean soft brush or an ultrasonic bath. Carry out the cleaning in a vessel full of organic solvent such as ethanol. After cleaning, rinse the reference specimens with fresh organic solvent such as ethanol, and then dry them.
- c) Determine the mass of the reference specimens to $\pm 1 \text{ mg}$.
- d) Protect one face of the reference specimens with a removable coating, for example an adhesive plastic film. The edges of the reference test specimens may be protected by the adhesive tape as well.

6.3.2 Arrangement and test of reference specimens

The arrangement and test of reference specimens used for evaluation of cabinet reproducibility related to corrosivity shall be as follows.

- a) Position four steel reference specimens in four quadrants (if six specimens are available, place them in six different positions including the four quadrants) in the zone of the spray cabinet where the test specimens are placed, with the unprotected face upwards and at an angle of $20^\circ \pm 5^\circ$ from the vertical.
- b) The support for the reference specimens shall be made of, or coated with, inert materials such as plastics. The lower edge of the reference specimens shall be level with the top of the fog collector.
- c) The parts of the test specimen support where the reference specimens are not placed shall be filled with dummy specimens of inert materials such as plastics or glass during the verification procedure.
- d) If agreed between the interested parties, test specimens may be placed on the supports in the spray cabinet instead of the dummy specimens of inert materials like plastics or glass, and the test may be performed on both specimens simultaneously. Where this has been the case, it shall be reflected in the test report.

NOTE : Care shall be taken so that the reference specimens and test specimens do not affect the test results of their counterparts.

- e) Perform the test for 24 h under the test conditions shown in table 2.

6.3.3 Determination of mass loss

The determination of mass loss in the evaluation of cabinet reproducibility related to corrosivity shall be as follows.

- a) At the end of the test, immediately take the reference specimens out of the spray cabinet and remove the protective coating. Remove the corrosion products with running water at 40 °C or lower by light brushing or other mechanical or chemical cleaning method. The chemical cleaning shall be performed by immersing the reference specimen in the solution prepared by adding distilled water to 200 mg of diammonium hydrogen citrate $[(\text{NH}_4)_2\text{HC}_6\text{H}_5\text{O}_7]$ specified in **JIS K 8284** to make 1 L, at 23 °C $\pm$ 2 °C for 10 min.

The solution used for chemical cleaning may be that prepared by mixing 500 ml of hydrochloric acid specified in **JIS K 8180** and 500 ml of water in 4.1 b) and adding as a corrosion inhibitor 3.5 g of hexamethylene tetramine ($\text{C}_6\text{H}_{12}\text{N}_4$) specified in **JIS K 8847** per litre of the solution.

- b) After each stripping, clean the reference specimens with running water at 40 °C or lower, brush lightly and rinse with an organic solvent such as ethanol, followed by drying.
- c) Weigh the reference specimens to the nearest 1 mg. Divide the determined mass loss by the area of the exposed surface area of the reference specimen in order to assess the metal mass loss per square metre (g/m^2) of the reference specimen. Perform this removal procedure several more times until variation in the mass loss is hardly observed, and determine the mass loss.

NOTE : It is recommended to use freshly prepared solution during every procedure for removal of corrosion products.

6.3.4 Checking of apparatus operation

The operation of the test apparatus is satisfactory if the mass loss of each reference specimen is $40 \text{ g/m}^2 \pm 10 \text{ g/m}^2$ for 24 h of operation.

6.4 CASS test

6.4.1 Reference specimens

The reference specimens used for evaluation of cabinet reproducibility related to corrosivity shall be as follows.

- a) Use four or six reference specimens, depending on the size of the spray cabinet, that are of $1 \text{ mm} \pm 0.2 \text{ mm}$ thickness and $150 \text{ mm} \times 70 \text{ mm}$ size, cut from SPCE-grade cold rolled sheets or strips in accordance with **JIS G 3141** with an essentially faultless surface and a matt finish (arithmetical mean deviation of the profile $Ra = 0.8 \text{ } \mu\text{m} \pm 0.3 \text{ } \mu\text{m}$).
- b) Clean the reference specimens carefully to eliminate all traces of dirt, oil or other foreign matter that could influence the test results with an organic solvent such as ethanol by means of a clean soft brush or an ultrasonic bath. Carry out the cleaning in a vessel full of organic solvent such as ethanol. After cleaning, rinse the reference specimens with fresh organic solvent such as ethanol, and then dry them.

- c) Determine the mass of the reference specimens to ± 1 mg.
- d) Protect one face of the reference specimens with a removable coating, for example an adhesive plastic film. The edges of the reference test specimens may be protected by the adhesive tape as well.

6.4.2 Arrangement and test of reference specimens

The arrangement and test of reference specimens used for evaluation of cabinet reproducibility related to corrosivity shall be as follows.

- a) Position four steel reference specimens in four quadrants (if six specimens are available, place them in six different positions including the four quadrants) in the zone of the spray cabinet where the test specimens are placed, with the unprotected face upwards and at an angle of $20^\circ \pm 5^\circ$ from the vertical.
- b) The support for the reference specimens shall be made of, or coated with, inert materials such as plastics. The lower edge of the reference specimens shall be level with the top of the fog collector.
- c) The parts of the test specimen support where the reference specimens are not placed shall be filled with dummy specimens of inert materials such as plastics or glass during the verification procedure.
- d) If agreed upon between the interested parties, test specimens may be placed on the supports in the spray cabinet instead of the dummy specimens of inert materials like plastics or glass, and the test may be performed on both specimens simultaneously. Where this has been the case, it shall be reflected in the test report.

NOTE : Care shall be taken so that the reference specimens and test specimens do not affect the test results of their counterparts.

- e) Perform the test for 24 h under the test conditions shown in table 2.

6.4.3 Determination of mass loss

The determination of mass loss in the evaluation of cabinet reproducibility related to corrosivity shall be as follows.

- a) At the end of the test, immediately take the reference specimens out of the spray cabinet and remove the protective coating. Remove the corrosion products with running water at 40°C or lower by light brushing or other mechanical or chemical cleaning method. The chemical cleaning shall be performed by immersing the reference specimen in the solution prepared by adding distilled water to 200 mg of diammonium hydrogen citrate $[(\text{NH}_4)_2\text{HC}_6\text{H}_5\text{O}_7]$ specified in **JIS K 8284** to make 1 L, at $23^\circ\text{C} \pm 2^\circ\text{C}$ for 10 min.

The solution used for chemical cleaning may be that prepared by mixing 500 ml of hydrochloric acid specified in **JIS K 8180** and 500 ml of water in **4.1 b)** and adding as a corrosion inhibitor 3.5 g of hexamethylene tetramine ($\text{C}_6\text{H}_{12}\text{N}_4$) specified in **JIS K 8847** per litre of the solution.

- b) After each stripping, clean the reference specimens with running water at 40°C or lower, lightly brush, and rinse with an organic solvent such as ethanol, followed by drying.

- c) Weigh the reference specimens to the nearest 1 mg. Divide the determined mass loss by the area of the exposed surface area of the reference specimen in order to assess the metal mass loss per square metre (g/m^2) of the reference specimen. Perform this removal procedure several more times until variation in the mass loss is hardly observed, and determine the mass loss.

NOTE : It is recommended to use freshly prepared solution during every procedure for removal of corrosion products.

6.4.4 Checking of apparatus operation

The operation of the test apparatus is satisfactory if the mass loss of each reference specimen is $55 \text{ g/m}^2 \pm 15 \text{ g/m}^2$ for 24 h of operation.

7 Test specimens

7.1 Handling of test specimens

Test specimens shall be always handled with the use of gloves and shall not be handled with bare hands.

7.2 Size of test specimens

The test specimens should be flat panels 150 mm × 70 mm × 1 mm in size. If agreed upon between the interested parties, they may be of other dimensions or they may be products or components cut from a product.

NOTE : Test specimens made of different metals which may affect the corrosivity should not be tested at the same time.

7.3 Preparation of test specimens

The test specimens shall be free from stains or flaws. Preparation of test specimen shall be as follows.

- a) If the test specimens are cut from a product with inorganic film or organic coating, cutting shall be carried out in such a way that the film or coating is not damaged in the area adjacent to the cut. Unless otherwise agreed between the interested parties, the cut edges shall be adequately protected by coating them with a suitable material, which remains stable under the conditions of the test, such as paint, wax or adhesive tape.
- b) The test specimens shall be thoroughly cleaned before testing, by a method selected suitably depending on the surface and the contaminants. Use of any abrasives or solvents which may attack the surface of the specimens shall be avoided. However, abrasives composed of pasty precipitated calcium carbonate, aluminium oxide and magnesium oxide may be applied to metallic and metallic coated specimens. Care shall be taken that specimens are not recontaminated after cleaning by careless handling.
- c) Test specimens with inorganic film or organic coating shall not be cleaned or subjected to other treatments before testing. However, removal of finger prints, oil and other adhering matters, so that they do not affect the test, is permissible.

- d) Where assessment of progress of corrosion from damaged areas is required, artificial flaws such as scribe marks that expose the metallic substrate shall be made on the film or coating prior to test. In this case, the method of making scribe marks shall be subjected to the agreement between the interested parties.
- e) In the case of using test specimens with organic coating such as painted coat, unless otherwise agreed between the interested parties, preparation of test specimens shall be in accordance with Annex C.

8 Arrangement of test specimens

The angle and position of the test specimens in the spray cabinet shall meet the following conditions during the test. If the specimens are components cut from a product, however, the conditions agreed between the interested parties shall be used.

- a) The specimens shall be placed in the cabinet facing upwards at an angle as close as possible to 20° to the vertical, this angle, in all cases, being within the limits of 15° to 25°. However, in the case of components cut from a product, they shall be placed with the exposed surfaces adhering to these limits as closely as possible.

If agreed upon between the interested parties, other angle may be used.

- b) The specimens shall be placed in the cabinet so that the surfaces to be tested are exposed to free circulation of sprayed solution, and so that they are not in the direct line of travel of the spray from the mist dispersion tower or atomizer nozzle.
- c) The specimens shall be placed so that they do not come into contact with anything other than test specimens supports.
- d) The positions of and intervals between specimens shall be such that no specimen blocks free circulation of sprayed solution on other test specimens.
- e) The sprayed solution on specimens shall not drip on other specimens.
- f) For tests with a total duration exceeding 96 h, location permutation of specimens is permitted. Where this has been performed, it shall be reflected in the test report.

If agreed upon between the interested parties, instead of location permutation of specimens, a device which rotates specimens around the mist dispersion tower may be used.

NOTE : See Annex JA for the arrangement and positions of the test specimens.

9 Test conditions

The test conditions shall be as follows.

- a) Prior to the test, check the test conditions given in table 2 by filling the test specimen supports in the spray cabinet with dummy specimens made of inert materials such as plastics or glass.
- b) After it has been confirmed that the test conditions are within a specified range, stop spraying the salt solution, remove the inert dummy test specimens from the test specimen supports, mount the test specimens on the supports and start the test.