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REDLINE VERSION

INTERNATIONAL STANDARD

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inside

Environmental testing –
Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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International Standard IEC 60068-2-52 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

This third edition cancels and replaces the second edition published in 1996. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the entire content has been harmonized with ISO 9227 as far as possible;
b) an introduction has been added;
c) the scope has been simplified;
d) normative references have been updated;
e) the general description of the test has been changed;
f) a dry chamber has been added to the test apparatus;
g) severities have been changed to test methods;
h) test methods 7 and 8 have been added;
i) information on the test report has been added;
j) Figure 1 has been changed to Table 1;
k) a typical test apparatus example has been added in a new Annex A;
l) a description of each test method has been added in a new Annex B;
m) bibliographical references have been added.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
104/751/FDIS	104/761/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60068 series, published under the general title *Environmental testing*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

The mechanism of ~~salt~~ corrosion on metallic materials in a chloride-containing atmosphere is electrochemical, whereas the degradation effects experienced on non-metallic materials are caused by complex chemical reactions of the salts with the materials involved. The rate at which corrosive action takes place is dependent, to a large extent, on the supply of oxygenated salt solution to the surface of the test specimen(s), the temperature of the test specimen(s) and the temperature and humidity of the environment.

Apart from the corrosive effects, this cyclic salt mist test may be used to indicate deterioration of some non-metallic materials by assimilation of salts. In the various test methods described in this document, the period of spraying with the relevant salt solution is sufficient to wet the test specimen(s) thoroughly. Because this wetting is repeated after intervals of storage under humid conditions ~~(severities (1) and (2)) and in some cases severities ((3) to (6)) –~~ supplemented by storage under a standard atmosphere ~~for testing~~, it goes some way to reproducing the effects of natural environments.

Furthermore, considering natural environments for corrosion on metallic materials, neutral or acidified salt solution spray, humid, and dry conditions are also important factors as a cyclic corrosion test. Each condition is repeated after intervals of other conditions in different combinations to achieve corrosion on metallic materials and to get acceleration of corrosion.

The tests described in this document are accelerated compared with most expected conditions of use. As a result, it may be difficult to establish an overall acceleration factor for all kinds of test specimens. This also means that it is often not possible to use results gained from these tests as a comparative guide to the long-term behaviour of different coating systems since the corrosion stress during these tests differs significantly from the corrosion stresses encountered during use. Nevertheless, the method described gives a means of checking that the comparative quality of a metallic material is maintained.

This document may involve hazardous materials, operations and equipment. This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

ENVIRONMENTAL TESTING –

Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)

1 Scope

~~This test is intended for application to components or equipment designed to withstand a salt-laden atmosphere, depending on the chosen severity. Salt can degrade the performance of parts manufactured using metallic and/or non-metallic materials.~~

~~Severities (1) and (2) are intended to be used for testing products which are used in a marine environment, or in close proximity to the sea. Severity (1) should be used to test products which are exposed to the environment for much of their operational life (e.g. ship radar, deck equipment). Severity (2) should be used to test products which may be exposed to the marine environment from time to time but will normally be protected by an enclosure (e.g. navigational equipment which will normally be used on the bridge or in a control room).~~

~~Additionally, severities (1) and (2) are commonly used as a general corrosion test in component quality assurance procedures.~~

~~Severities (3) to (6) are intended for products where, under normal use, there is a frequent change between salt-laden and dry atmosphere, e.g. automobiles and their parts.~~

~~Severities (3) to (6), compared to severities (1) and (2), therefore include an additional storage under a standard atmosphere for testing.~~

~~The period of dry atmosphere may happen, in practice, during breaks of operation, e.g. during the weekend. This inclusion of such a dry period in severities (3) to (6) leads to corrosion mechanism which can be quite different from those under constant humid conditions.~~

~~The test is accelerated compared with most service conditions. However, it is not possible to establish an overall acceleration factor for all kinds of specimens (see IEC 60355).~~

This part of IEC 60068-2 specifies the application of the cyclic salt mist test to components or equipment designed to withstand a salt-laden atmosphere as salt can degrade the performance of parts manufactured using metallic and/or non-metallic materials.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-1~~: 1988~~, *Environmental testing – Part 1: General and guidance*

~~IEC 60068-2-3: 1969, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*~~

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

~~IEC 60355: 1971, *An appraisal of the problems of accelerated testing for atmospheric corrosion*~~

ISO 9227, *Corrosion tests in artificial atmospheres – Salt spray tests*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 General description of the test

~~For severities (1) and (2), the test procedure is separated into a specified number of periods of spraying by a salt mist at a temperature between 15 °C and 35 °C, each followed by a storage period under humid conditions at 40 °C ± 2 °C, (93^{+2}_{-3}) % relative humidity.~~

~~For severities (3), (4), (5) and (6) the test procedure is separated into a specified number of test cycles. Each test cycle consists of four periods of spraying by a salt mist at a temperature between 15 °C and 35 °C, each followed by a storage period under humid conditions at 40 °C ± 2 °C, (93^{+2}_{-3}) % relative humidity, and of one storage period under a standard atmosphere for testing at 23 °C ± 2 °C and 45 % to 55 % relative humidity after these four periods of spraying and storage under humid conditions.~~

~~If the spray period and storage period are carried out in different chambers, care should be taken to avoid loss of salt solution deposits on the specimen and to avoid any damage to the specimen due to handling.~~

~~The specimen is never energized during the spray period, and not normally during the storage period.~~

4.1 Description of each test condition

4.1.1 General

This document consists of the cyclic test conditions of salt mist, dry condition, humid condition and standard atmosphere. The effect of each test condition is as follows.

NOTE Salt mist is also called salt spray.

The test specimen(s) is typically not energized during the test.

4.1.2 Salt mist

The test specimen is corroded by an electrochemical or complex chemical reaction with neutral or acidified salt solution. Salt solution forms a thin electrolytic film on the test specimen surface. This can initiate corrosion and can allow it to proceed.

4.1.3 Dry condition

Heated air in the chamber may cause evaporation of water from the test specimen surface from decreasing relative humidity and increased specimen temperature. This causes the concentration of the solution to increase and speeds up chemical reactions, accelerating the corrosion process. Salt precipitates out of the solution onto the test specimen surface during this condition. Evaporation and heating rates may vary based on the test chamber and test specimen.

4.1.4 Humid condition

4.1.4.1 Dry condition to humid condition

As the relative humidity increases, precipitated salt crystals on the specimen surface absorb water vapour until a liquid electrolytic solution forms, reinitializing the corrosion process.

4.1.4.2 Salt mist to humid condition

The humid condition maintains the existing wetness on the test specimen surface at the end of the salt mist period, without excessive dilution of the solution that may result from condensing humidity.

4.1.5 Standard atmosphere

The test specimen is allowed to equilibrate with standard laboratory conditions, which results in gradual drying and relaxation from most corrosion reactions. The period of dry atmosphere may occur, in practice, during breaks of operation, for example during the weekend. The inclusion of such a dry period may lead to corrosion mechanisms which can be quite different from those under constant wet conditions. The test schedule shall be chosen in order to respect the timelines given in 9.4. Additional dry periods (e.g. during a weekend) shall be avoided.

5 Test apparatus

5.1 General

Each test method includes two or more environmental conditions, which may be achieved by the use of multiple chambers or a single chamber that automatically transitions from one condition to the next. In either case, transitions are not assumed to be instantaneous. Care shall be taken to minimize any adverse effects associated with handling of specimens during transfer between chambers.

5.2 Salt mist chamber

The chamber ~~for this test shall be constructed of such materials that will not influence the corrosive effects of the salt mist~~ shall conform to the requirements of ISO 9227. It shall maintain a temperature of 35 °C ± 2 K.

NOTE A schematic diagram of one possible design of spray cabinet is shown in Annex A.

~~The detailed construction of the chamber, including the method of producing the salt mist is optional, provided that:~~

~~a) the conditions in the chamber are within the limits specified;~~

~~b) a sufficiently large volume with constant, homogeneous conditions (not affected by turbulence) is available; these conditions should not be influenced by the specimen under test;~~

~~c) no direct spray impinges upon the specimen under test;~~

~~d) drops of liquid accumulating on the ceiling, the walls, or other parts cannot drip on the specimen;~~

~~e) the chamber shall be properly vented to prevent pressure build-up and allow uniform distribution of the salt mist. The discharge end of the vent shall be protected from strong draughts which can cause strong air currents in the chamber.~~

~~4.1.1 Atomizer(s)~~

~~The atomizer(s) shall be of such a design and construction as to produce a finely divided, wet, dense mist. The atomizer(s) shall be made of material that is non-reactive to the salt solution.~~

~~4.1.2 The sprayed solution shall not be re-used.~~

~~4.1.3 Air supply~~

~~If use is made of compressed air, that air shall, when entering the atomizer(s), be essentially free from all impurities, such as oil and dust.~~

~~Means shall be provided to humidify the compressed air as required to meet the operating conditions. The air pressure shall be suitable to produce a finely divided dense mist with the atomizer(s) used.~~

~~To ensure against clogging of the atomizer(s) by salt deposition, the air is recommended to have a relative humidity of at least 85 % at the point of release from the nozzle. A satisfactory method is to pass the air in very fine bubbles through a tower containing water, which should be automatically maintained at a constant level. The temperature of this water shall be not less than that of the chamber.~~

~~The air pressure shall be capable of adjustment so that the collection rate as specified in 9.2 can be maintained.~~

5.3 Humidity chamber

The chamber shall conform to the requirements of ~~IEC 60068-2-3, i.e.~~ IEC 60068-2-78. It shall maintain a relative humidity of ~~(93 $^{+2}_{-3}$) % at a temperature of 40 °C ± 2 °C~~ 93 % ± 3 % at a temperature of 40 °C ± 2 K or a relative humidity of over 95 % at a temperature of 50 °C ± 2 K.

5.4 Standard atmosphere chamber

The chamber shall conform to the requirements ~~of 5.2~~ of IEC 60068-1~~, (table second line, wide range), i.e.~~ It shall maintain a relative humidity of ~~45 % to 55 % at a temperature of 23 °C ± 2 °C~~ 50 % ± 5 % at a temperature of 23 °C ± 2 K.

5.5 Dry chamber

The chamber shall maintain a relative humidity of less than 30 % at a temperature of 60 °C ± 2 K.

6 Salt solution

~~5.1 5 % sodium chloride (NaCl) solution~~

~~5.1.1 The salt used for the test shall be high-quality sodium chloride (NaCl) containing, when dry, not more than 0,1 % sodium iodide and not more than 0,3 % of total impurities.~~

~~The salt solution concentration shall be 5 % ± 1 % by weight.~~

~~The solution shall be prepared by dissolving 5 ± 1 parts by weight of salt in 95 parts by weight of distilled or demineralized water.~~

~~NOTE – The relevant specification may call for other salt solutions, the composition and characteristics (density, pH value, etc.) of which should be stated clearly in the specification, e.g. to simulate the special effects of a marine environment.~~

~~5.1.2 The pH value of the solution shall be between 6,5 and 7,2 at a temperature of 20 °C ± 2 °C. The pH value shall be maintained within this range during conditioning; for this purpose, diluted hydrochloric acid or sodium hydroxide may be used to adjust the pH value, provided that the concentration of NaCl remains within the prescribed limits. The pH value shall be measured when preparing each new batch of solution.~~

6.1 Preparation of the sodium chloride solution

The solution shall conform to the requirements of ISO 9227.

NOTE The sodium chloride concentration of the sprayed solution collected is 50 g/l ± 5 g/l.

6.2 pH adjustment

6.2.1 Neutral salt solution

The pH adjustment shall conform to the requirements of ISO 9227 for the neutral salt solution test.

6.2.2 Acidified salt solution

Add the following reagents to 10 litres of the prepared neutral 5 % sodium chloride solution as follows: 12 ml of nitric acid (HNO_3, ρ = 1,42 g/ml), 17,3 ml of sulfuric acid (H_2SO_4, ρ = 1,84 g/ml) and sufficient quantity of 10 % mass fraction of sodium hydroxide (NaOH) solution to adjust the pH of the solution to 3,5 ± 0,1 (about 300 ml will be required). The pH of the sprayed solution collected within the chamber is 3,4 to 3,6 at 25 °C ± 2 K.

6.3 Filtration

If necessary, filter the solution before placing it in the reservoir of the apparatus to remove any solid matter which might block the apertures of the spraying device.

~~6 Severities~~

~~6.1 The severity of the test is defined as follows.~~

~~For severities (1) and (2):~~

~~by the combination of the number of spray periods and the duration of the storage under humid conditions following each spray period.~~

~~For severities (3) to (6):~~

~~by the number of test cycles consisting of four spraying periods with storage under humid conditions after each one, and one additional storage period under a standard atmosphere for testing after these four periods of spraying and storage under humid conditions.~~

~~6.2 The relevant specification shall indicate which of the six following severities shall be used.~~

~~Severity (1): four spray periods, each of 2 h, with a humidity storage period of seven days after each.~~

~~NOTE – The humidity storage period should be suitably reduced so that the spray period plus storage period is seven days.~~

~~Severity (2): three spray periods, each of 2 h, with a humidity storage period between 20 h and 22 h after each.~~

~~Severity (3): one test cycle consisting of:~~
~~four spray periods, each of 2 h, with a humidity storage period between 20 h and 22 h after each; afterwards one storage period of three days under a standard atmosphere for testing at 23 °C ± 2 °C and 45 % to 55 % humidity.~~

~~Severity (4): two test cycles as specified in severity (3).~~

~~Severity (5): four test cycles as specified in severity (3).~~

~~Severity (6): eight test cycles as specified in severity (3).~~

~~6.3 A schematic survey of time-scale of all the test severities is given in figure 1.~~

7 Initial measurements

The test specimen(s) shall be visually inspected and, if necessary, electrically and mechanically checked as required by the relevant specification.

8 Preconditioning

The relevant specification shall ~~prescribe~~ specify the cleaning procedure to be applied immediately before the test; it shall also state whether temporary protective coatings shall be removed.

NOTE ~~–~~ The cleaning method used should not interfere with the effect of the salt mist on the test specimen(s), nor introduce any secondary corrosion. Touching of the test surfaces by hand should be avoided as far as possible before the test.

9 Testing

~~9.1 The specimen shall be placed in the salt mist chamber, and sprayed with the salt solution, for a period of 2 h at a temperature between 15 °C and 35 °C.~~

~~9.2 The salt mist conditions shall be maintained in all parts of the exposure zone, that a clean collecting receptacle with a horizontal collecting area of 80 cm², placed at any point in the exposure zone, shall collect between 1,0 ml and 2,0 ml of solution per hour, averaged over the collecting period. A minimum of two receptacles shall be used. The receptacles shall be placed such that they are not shielded by the specimen and so that no condensate from any source shall be collected.~~

~~NOTE – When calibrating the spray rate of the chamber, a minimum spray period of 8 h should be used, for accurate measurement purposes.~~

~~9.3 Severities (1) and (2)~~

~~At the end of the spray period, the specimen shall be transferred to the humidity chamber and stored at a temperature of 40 °C ± 2 °C and a relative humidity of~~ ~~(93^{+2}_{-3}) % in accordance with IEC 60068-2-3.~~

~~The spraying with salt solution as in 9.1 and the storage as in this subclause constitutes one cycle.~~

~~The required severity for the number of cycles and the duration of storage shall be in accordance with 6.2.~~

~~9.4 Severities (3) to (6)~~

~~At the end of the spray period, the specimen shall be transferred to the humidity chamber and stored at a temperature of 40 °C ± 2 °C and a relative humidity of~~ (93^{+2}_{-3}) ~~% in accordance with IEC 60068-2-3 for a period of 20 h to 22 h. This shall be repeated a further three times.~~

~~The specimen shall then be stored under a standard atmosphere for testing at 23 °C ± 2 °C and 45 % to 55 % relative humidity for a period of three days.~~

~~The four spray periods (see 9.1) and storage periods of this subclause followed by three days under a standard atmosphere for testing constitutes one test cycle.~~

~~The required severity for the number of test cycles shall be in accordance with 6.2.~~

~~9.5 The removal of the specimen from the salt mist chamber to the humidity chamber shall be carried out so as to minimize the loss of salt solution from the specimen(s).~~

~~NOTE – If the salt mist chamber can maintain the humidity and temperature conditions of IEC 60068-2-3, the specimen may remain in it for the humidity storage period.~~

~~9.6 If the specimen consists of more than one item they shall not be in contact with each other or with other metal parts and shall be so arranged as to exclude any influence of one part upon another.~~

9.1 Test chamber

For test methods 1 and 2, a salt mist chamber and humidity chamber are used.

For test methods 3 to 6, a salt mist chamber, humidity chamber and standard atmosphere chamber are used.

For test methods 7 and 8, a salt mist chamber, dry chamber and humidity chamber are used.

All test methods may be performed in a single chamber provided it is capable of maintaining the required conditions. If not, care should be taken to avoid loss of salt solution deposits on the test specimen(s) and to avoid any damage to the test specimen(s) due to manual handling. For test methods 7 and 8, each condition should be carried out in the same chamber due to the difficulty in achieving the rapid drying and re-wetting intended if specimens are manually moved from one chamber to another.

It is recommended to use a specific chamber for testing test method 8 exclusively. Cross effects of remaining acidified salt solution when consequently using test method 1 to 7 cannot be ignored.

9.2 Arrangement of the test specimen(s)

The arrangement shall conform to the requirements of ISO 9227.

9.3 Conditions during salt mist

The test conditions shall conform to the requirements of ISO 9227.

9.4 Test methods

9.4.1 General

The relevant specification shall indicate which of the eight following test methods shall be used. A description of each test method is given in Annex B. When not specified, the test method shall be agreed by the interested parties.

The user should be aware of mass loss for each test condition.

9.4.2 Test method 1

One cycle is seven days. One cycle shall consist of spraying the specimen with a salt solution at 35 °C ± 2 K for 2 h, followed by the humid condition at 40 °C ± 2 K, 93 % ± 3 % RH for six days and 22 h. The required number of cycles is four (28 days).

In the case of manual handling, the transition time (maximum 2 h) should be included in the humid condition period of six days and 22 h.

9.4.3 Test method 2

One cycle is one day. One cycle shall consist of spraying the specimen with a salt solution at 35 °C ± 2 K for 2 h, followed by the humid condition at 40 °C ± 2 K, 93 % ± 3 % RH for 22 h. The required number of cycles is three (three days).

In the case of manual handling, the transition time (maximum 2 h) should be included in the humid condition period of 22 h.

9.4.4 Test method 3

One cycle is seven days. One cycle shall consist of spraying the specimen with a salt solution at 35 °C ± 2 .K for 2 h, followed by the humid condition at 40 °C ± 2 K, 93 % ± 3 % RH for 22 h. This shall be repeated four times. The test specimens shall then be stored under standard atmosphere at 23 °C ± 2 K and 50 % ± 5 % RH for three days. The required number of cycle is one (seven days).

In the case of manual handling, the transition time (maximum 2 h) should be included in the humid condition period of 22 h and standard atmosphere period of three days.

9.4.5 Test method 4

The required number of cycles as specified in test method 3 shall be two (14 days).

9.4.6 Test method 5

The required number of cycles as specified in test method 3 shall be four (28 days).

9.4.7 Test method 6

The required number of cycles as specified in test method 3 shall be eight (56 days).

9.4.8 Test method 7

One cycle is 8 h. One cycle shall consist of spraying the specimen with a salt solution at 35 °C ± 2 K for 2 h, followed by the dry condition at 60 °C ± 2 K, under 30 % RH for 4 h and then the humid condition at 50 °C ± 2 K, over 95 % RH for 2 h.

The transition times (time allowed to reach the temperature and relative humidity specified for a condition after changing to that condition) for temperature and humidity shall be specified between the following choices and reported:

- salt mist to dry condition: within 30 min or between 30 min and 60 min;
- dry condition to humid condition: within 15 min or between 15 min and 30 min;
- humid condition to salt mist: within 30 min.

Those transition times shall be included in the next condition period of the pair, for example the salt mist to dry condition transition time is included in the period of the dry condition. Spraying the specimen with a salt solution begins instantaneously once the salt mist is started.

The recommended number of cycles are 3 (1 day), 6 (2 days), 12 (4 days), 30 (10 days), 45 (15 days), 60 (20 days), 90 (30 days), 150 (50 days) and 180 (60 days).

9.4.9 Test method 8

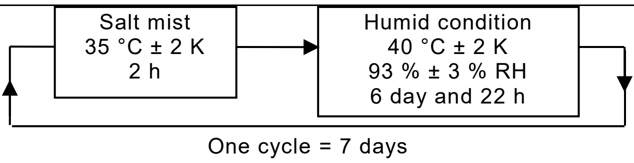
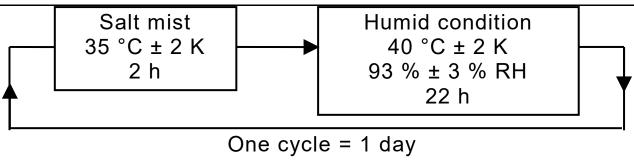
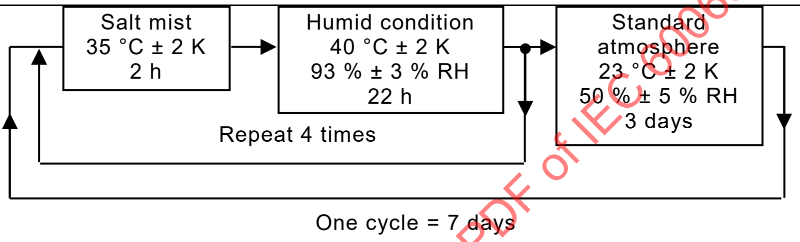
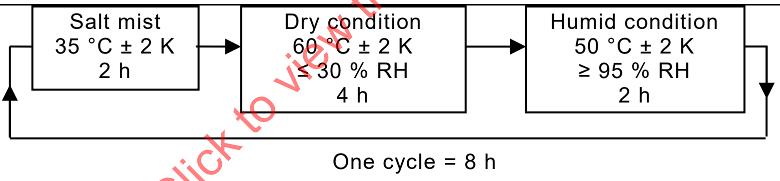
One cycle is 8 h, as specified in test method 7 using acidified salt solution instead of neutral salt solution.

The recommended number of cycles is the same as in test method 7.

9.5 Test cycles for test methods 1 to 8

The test cycles for test methods 1 to 8 shall be in accordance with Table 1.

Table 1 – Test cycles for test methods 1 to 8

Test methods	Details of the cycle	Recommended number of cycles
Test method 1	 In the case of manual handling, the transition time (max. 2 h) should be included in the humid condition period of 6 days and 22 h.	4 cycles (28 days)
Test method 2	 In the case of manual handling, the transition time (max. 2 h) should be included in the humid condition period of 22 h.	3 cycles (3 days)
Test method 3	 In the case of manual handling, the transition time (max. 2 h) should be included in the humid condition period of 22 h and standard atmosphere period of 3 days.	1 cycle (7 days)
Test method 4		2 cycles (14 days)
Test method 5		4 cycles (28 days)
Test method 6		8 cycles (56 days)
Test method 7	 The transition times (time allowed to reach the temperature and relative humidity specified for a condition after changing to that condition) are within 30 min or between 30 min and 60 min from salt mist to dry condition, within 15 min or between 15 min and 30 min from dry condition to humid condition and within 30 min from humid condition to salt mist. Those transition times shall be included in next condition period.	3, 6, 12, 30, 45, 60, 90, 150, 180 cycles (1, 2, 4, 10, 15, 20, 30, 50, 60 days)
Test method 8		
NOTE The ± tolerances given for temperature and relative humidity are the allowable fluctuations which are defined as the positive and negative deviations from the setting of the sensor at the operational control set point during equilibrium conditions. This does not mean that the set value can vary by plus/minus the amount indicated from the given value.		

9.6 Removal of the test specimen(s)

The test is recommended to be carried out in the same chamber (see Figure A.1). If not, care should be taken to avoid loss of salt solution deposits on the test specimen(s) and to avoid any damage to the test specimen(s) due to handling.

10 Recovery (at the end of testing)

The relevant specification shall state whether or not the test specimen(s) shall be washed. If the test specimen(s) is to be washed, it shall be washed using running tap water for 5 min, rinsed in distilled or ~~demineralized~~ deionized water, shaken by hand or subjected to air blast to remove droplets of water, then dried for 1 h at 55 °C ± 2 K and allowed to cool under controlled recovery conditions (IEC 60068-1) for not less than 1 h and not more than 2 h.

The relevant specification shall ~~specify~~ provide, if needed, other methods ~~to be used~~ for washing and drying the test specimen(s). The specimen shall be stored under controlled recovery conditions (IEC 60068-1) for not less than 1 h and not more than 2 h. The temperature of the water used for washing shall not exceed 35 °C.

11 Final measurements

The test specimen(s) shall be ~~submitted~~ subjected to visual, dimensional and functional checks ~~prescribed~~ specified by the relevant specification.

The relevant specification shall provide the criteria upon which the acceptance or rejection of the test specimen(s) is to be based.

12 Information to be given in the relevant specification

~~When this test is included in a relevant specification, the following details shall be given, in so far as they are applicable. The relevant specification shall supply information as required in the clauses listed below~~The following details shall be given, in so far as they are applicable in the relevant specification, paying particular attention to the items marked with an asterisk (*), as this information is always required.

a) salt solution, if different from that specified in 6.1 (see Clause 6);

~~b) The appropriate severity*(6)~~

b) initial measurements* (see Clause 7);

c) preconditioning (see Clause 8);

d) appropriate test method* (see Clause 9);

e) recovery conditions (see Clause 10);

f) final measurements* (see Clause 11).

13 Information to be given in the test report

The following details shall be given in the test report, where applicable:

a) test standard (IEC 60068-2-52:2017);

b) test dates (dates when test was run);

c) testing test method, one of 1 to 8;

d) preconditioning;

e) method and results of initial measurement;

f) conditions and duration of test;

g) operation and loading during test;

h) recovery conditions and duration;

i) method and results of final measurement (see Clause 11);

j) any deviation from this document;

k) any unusual features observed.

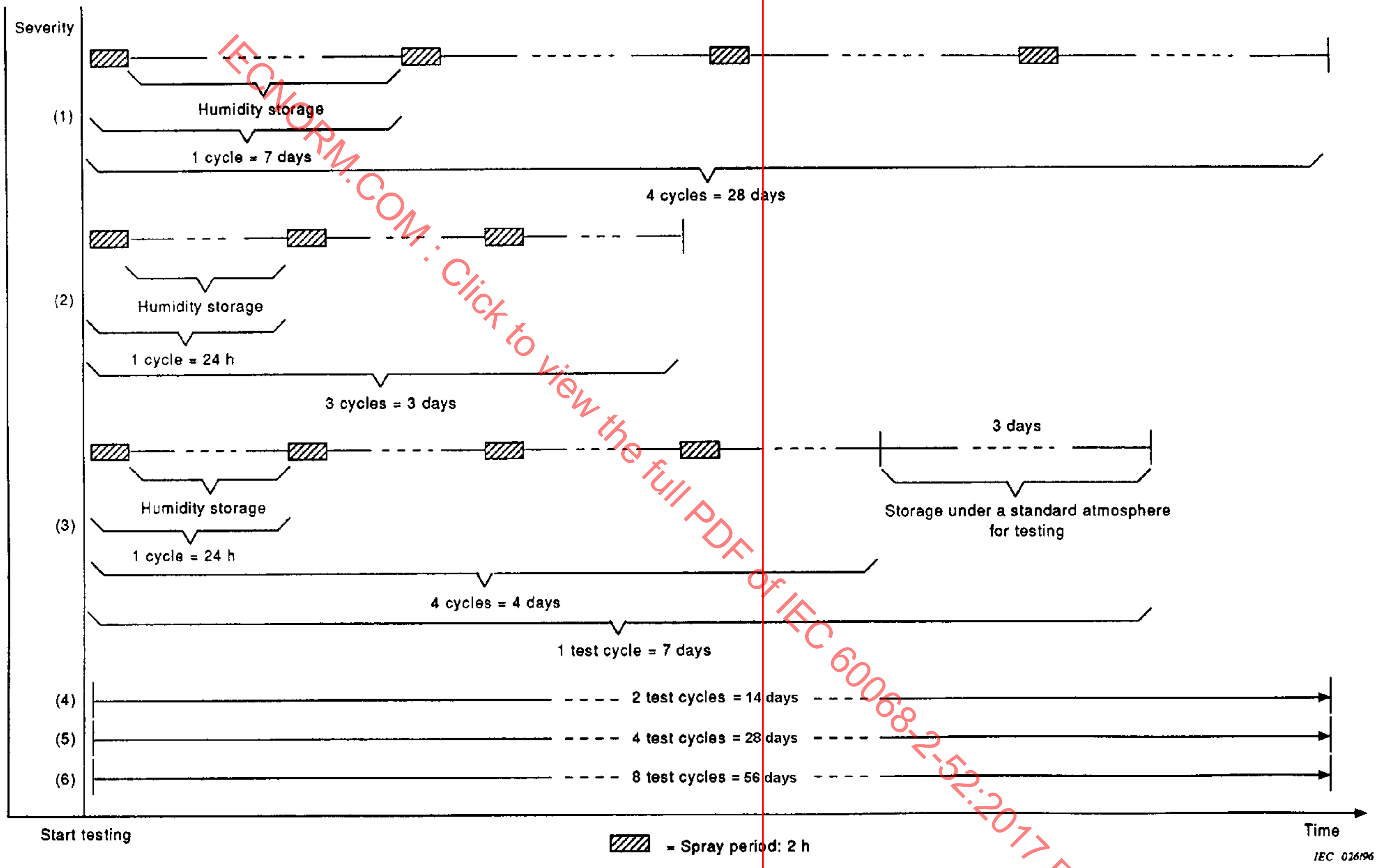
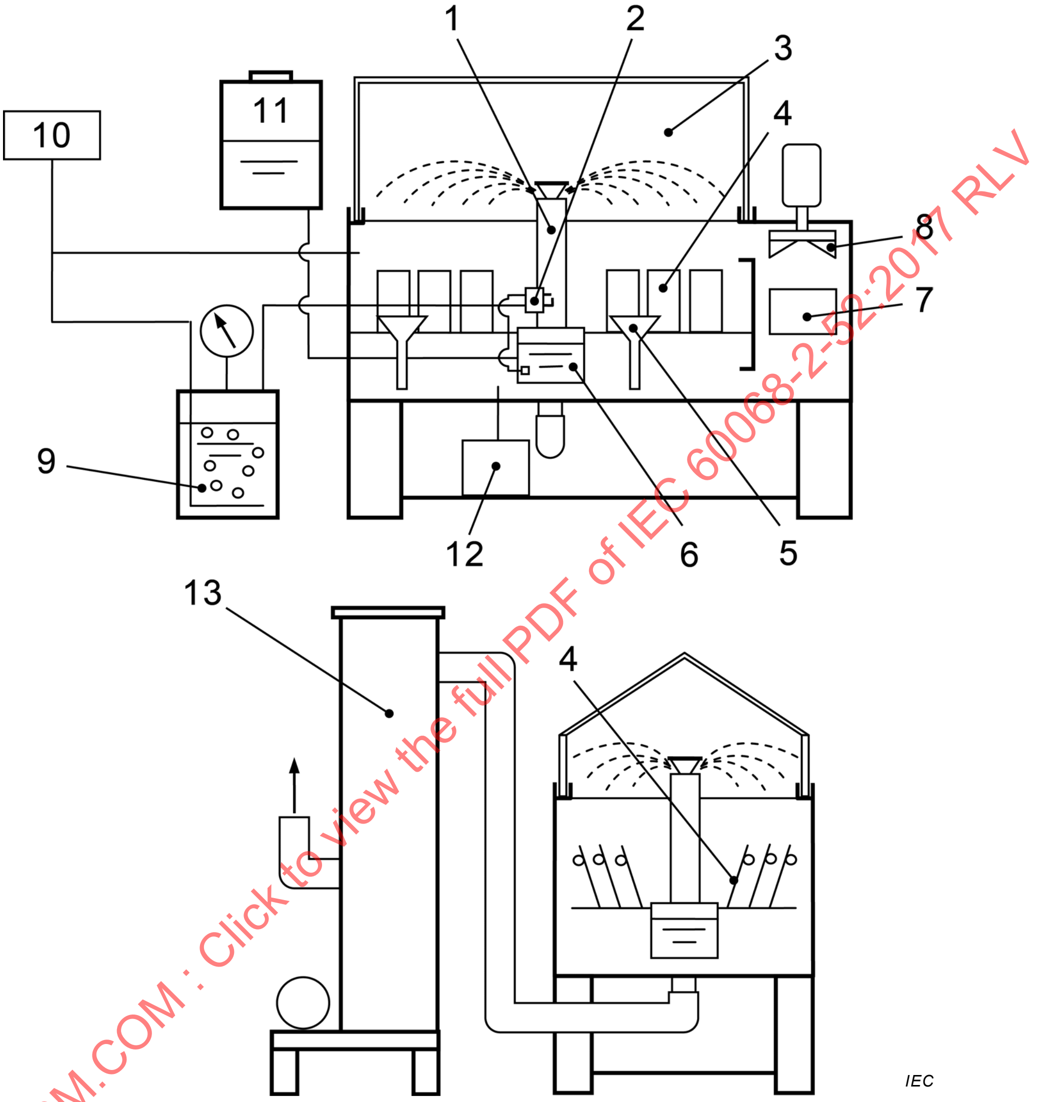


Figure 1 - Time-scale of the different test severities (1) to (6)

Annex A
(informative)

Typical apparatus for cyclic salt mist, humid condition, dry condition and standard atmosphere corrosion tests



Key

1	Mist dispersion tower	6	Solution reservoir	11	Solution tank
2	Atomizer	7	Heater	12	Humidifier
3	Test chamber	8	Agitating fan	13	Exhaust air treatment unit
4	Test specimen	9	Saturation tower		
5	Collecting device	10	Compressed air		

Figure A.1 – Example of test apparatus

Annex B
(informative)

Description of each test method

B.1 Test methods 1 and 2

Test methods 1 and 2 are commonly used as a general corrosion test in component quality assurance procedures.

Test methods 1 and 2 can be used for testing products which are used in a marine environment, or in close proximity to the sea. Test method 1 should be used to test products which are exposed to the environment for much of their operational life (e.g. ship radar, deck equipment). Test method 2 should be used to test products which may be exposed to the marine environment from time to time but will normally be protected by an enclosure (e.g. navigational equipment which will normally be used on the bridge or in a control room).

For test methods 1 and 2, the test procedure is separated into a specified number of periods of spraying with a salt solution each followed by a storage period under humid conditions.

B.2 Test methods 3 to 6

Test methods 3 to 6 can be used for products where, under normal use, there is a frequent change between salt-laden and dry atmosphere, for example automobiles and their parts.

Test methods 3 to 6, compared to test methods 1 and 2, include an additional storage exposure under a standard atmosphere.

For test methods 3 to 6, the test procedure is separated into a specified number of test cycles. Each test cycle consists of four periods of spraying with a salt solution each followed by a storage period under humid conditions, and of one storage period under standard atmosphere after these four periods of spraying and storage under humid conditions.

B.3 Test methods 7 and 8

Test method 7 defines a specific number of test cycles that include spraying salt mist, followed by dry conditions and humid conditions. The process can be used as a general corrosion test for many materials including automobiles and their parts.

Test method 8 contains the same cyclic exposure as test method 7, but utilizes an acidified salt solution instead of a neutral salt solution to induce a corrosion that occurs in acidified salt environment.

Test methods 7 and 8, dry conditions provide a correlation with real-world corrosion for metals and their alloys, as well as plating and coatings. It can be used as a quality control test or for material qualification, where test repeatability is very important.

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[3] Townsend H. E., Davidson D. D. and Ostermiller M. R., *Development of laboratory corrosion tests by the automotive and steel industries of north america*, The 4th International Conference on Zinc and Zinc Alloy Coated Steel Sheet (GALVATECH'98), Chiba, Japan, 1998, pp. 659-666

[4] Shigeru Suga and Shigeo Suga, *Report on the results from the ISO/TC 156/WG 7 International Round Robin Test Programme on ISO 9227 Salt spray tests*; J. Surface Finish. Soc. Japan; Vol. 56, p. 28 (2005)

[5] Shigeru Suga and Shigeo Suga, *Development of Simulated Acid Rain Test Using CCT Method; Accelerated and Outdoor Durability Testing of Organic Materials*; ASTM STP 1202, (1994)

IEC 60068-2-52

Edition 3.0 2017-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Environmental testing –
Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)

Essais d'environnement –
Partie 2-52: Essais – Essai Kb: Brouillard salin, essai cyclique (solution de chlorure de sodium)

IEC 60068-2-52:2017-11(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL TESTING –

Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60068-2-52 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

This bilingual version (2019-07) corresponds to the monolingual English version, published in 2017-11.

This third edition cancels and replaces the second edition published in 1996. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) the entire content has been harmonized with ISO 9227 as far as possible;
b) an introduction has been added;

c) the scope has been simplified;
d) normative references have been updated;
e) the general description of the test has been changed;
f) a dry chamber has been added to the test apparatus;
g) severities have been changed to test methods;
h) test methods 7 and 8 have been added;
i) information on the test report has been added;
j) Figure 1 has been changed to Table 1;
k) a typical test apparatus example has been added in a new Annex A;
l) a description of each test method has been added in a new Annex B;
m) bibliographical references have been added.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
104/751/FDIS	104/761/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60068 series, published under the general title *Environmental testing*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

The mechanism of corrosion on metallic materials in a chloride-containing atmosphere is electrochemical, whereas the degradation effects experienced on non-metallic materials are caused by complex chemical reactions of the salts with the materials involved. The rate at which corrosive action takes place is dependent, to a large extent, on the supply of oxygenated salt solution to the surface of the test specimen(s), the temperature of the test specimen(s) and the temperature and humidity of the environment.

Apart from the corrosive effects, this cyclic salt mist test may be used to indicate deterioration of some non-metallic materials by assimilation of salts. In the various test methods described in this document, the period of spraying with the relevant salt solution is sufficient to wet the test specimen(s) thoroughly. Because this wetting is repeated after intervals of storage under humid conditions supplemented by storage under a standard atmosphere, it goes some way to reproducing the effects of natural environments.

Furthermore, considering natural environments for corrosion on metallic materials, neutral or acidified salt solution spray, humid, and dry conditions are also important factors as a cyclic corrosion test. Each condition is repeated after intervals of other conditions in different combinations to achieve corrosion on metallic materials and to get acceleration of corrosion.

The tests described in this document are accelerated compared with most expected conditions of use. As a result, it may be difficult to establish an overall acceleration factor for all kinds of test specimens. This also means that it is often not possible to use results gained from these tests as a comparative guide to the long-term behaviour of different coating systems since the corrosion stress during these tests differs significantly from the corrosion stresses encountered during use. Nevertheless, the method described gives a means of checking that the comparative quality of a metallic material is maintained.

This document may involve hazardous materials, operations and equipment. This document does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

ENVIRONMENTAL TESTING –

Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)

1 Scope

This part of IEC 60068-2 specifies the application of the cyclic salt mist test to components or equipment designed to withstand a salt-laden atmosphere as salt can degrade the performance of parts manufactured using metallic and/or non-metallic materials.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

ISO 9227, *Corrosion tests in artificial atmospheres – Salt spray tests*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 General description of the test

4.1 Description of each test condition

4.1.1 General

This document consists of the cyclic test conditions of salt mist, dry condition, humid condition and standard atmosphere. The effect of each test condition is as follows.

NOTE Salt mist is also called salt spray.

The test specimen(s) is typically not energized during the test.

4.1.2 Salt mist

The test specimen is corroded by an electrochemical or complex chemical reaction with neutral or acidified salt solution. Salt solution forms a thin electrolytic film on the test specimen surface. This can initiate corrosion and can allow it to proceed.

4.1.3 Dry condition

Heated air in the chamber may cause evaporation of water from the test specimen surface from decreasing relative humidity and increased specimen temperature. This causes the concentration of the solution to increase and speeds up chemical reactions, accelerating the corrosion process. Salt precipitates out of the solution onto the test specimen surface during this condition. Evaporation and heating rates may vary based on the test chamber and test specimen.

4.1.4 Humid condition

4.1.4.1 Dry condition to humid condition

As the relative humidity increases, precipitated salt crystals on the specimen surface absorb water vapour until a liquid electrolytic solution forms, reinitializing the corrosion process.

4.1.4.2 Salt mist to humid condition

The humid condition maintains the existing wetness on the test specimen surface at the end of the salt mist period, without excessive dilution of the solution that may result from condensing humidity.

4.1.5 Standard atmosphere

The test specimen is allowed to equilibrate with standard laboratory conditions, which results in gradual drying and relaxation from most corrosion reactions. The period of dry atmosphere may occur, in practice, during breaks of operation, for example during the weekend. The inclusion of such a dry period may lead to corrosion mechanisms which can be quite different from those under constant wet conditions. The test schedule shall be chosen in order to respect the timelines given in 9.4. Additional dry periods (e.g. during a weekend) shall be avoided.

5 Test apparatus

5.1 General

Each test method includes two or more environmental conditions, which may be achieved by the use of multiple chambers or a single chamber that automatically transitions from one condition to the next. In either case, transitions are not assumed to be instantaneous. Care shall be taken to minimize any adverse effects associated with handling of specimens during transfer between chambers.

5.2 Salt mist chamber

The chamber shall conform to the requirements of ISO 9227. It shall maintain a temperature of 35 °C ± 2 K.

NOTE A schematic diagram of one possible design of spray cabinet is shown in Annex A.

5.3 Humidity chamber

The chamber shall conform to the requirements of IEC 60068-2-78. It shall maintain a relative humidity of 93 % ± 3 % at a temperature of 40 °C ± 2 K or a relative humidity of over 95 % at a temperature of 50 °C ± 2 K.

5.4 Standard atmosphere chamber

The chamber shall conform to the requirements of IEC 60068-1. It shall maintain a relative humidity of 50 % ± 5 % at a temperature of 23 °C ± 2 K.

5.5 Dry chamber

The chamber shall maintain a relative humidity of less than 30 % at a temperature of 60 °C ± 2 K.

6 Salt solution

6.1 Preparation of the sodium chloride solution

The solution shall conform to the requirements of ISO 9227.

NOTE The sodium chloride concentration of the sprayed solution collected is 50 g/l ± 5 g/l.

6.2 pH adjustment

6.2.1 Neutral salt solution

The pH adjustment shall conform to the requirements of ISO 9227 for the neutral salt solution test.

6.2.2 Acidified salt solution

Add the following reagents to 10 litres of the prepared neutral 5 % sodium chloride solution as follows: 12 ml of nitric acid (HNO_3, ρ = 1,42 g/ml), 17,3 ml of sulfuric acid (H_2SO_4, ρ = 1,84 g/ml) and sufficient quantity of 10 % mass fraction of sodium hydroxide (NaOH) solution to adjust the pH of the solution to 3,5 ± 0,1 (about 300 ml will be required). The pH of the sprayed solution collected within the chamber is 3,4 to 3,6 at 25 °C ± 2 K.

6.3 Filtration

If necessary, filter the solution before placing it in the reservoir of the apparatus to remove any solid matter which might block the apertures of the spraying device.

7 Initial measurements

The test specimen(s) shall be visually inspected and, if necessary, electrically and mechanically checked as required by the relevant specification.

8 Preconditioning

The relevant specification shall specify the cleaning procedure to be applied immediately before the test; it shall also state whether temporary protective coatings shall be removed.

The cleaning method used should not interfere with the effect of the salt mist on the test specimen(s), nor introduce any secondary corrosion. Touching of the test surfaces by hand should be avoided as far as possible before the test.

9 Testing

9.1 Test chamber

For test methods 1 and 2, a salt mist chamber and humidity chamber are used.

For test methods 3 to 6, a salt mist chamber, humidity chamber and standard atmosphere chamber are used.

For test methods 7 and 8, a salt mist chamber, dry chamber and humidity chamber are used.

All test methods may be performed in a single chamber provided it is capable of maintaining the required conditions. If not, care should be taken to avoid loss of salt solution deposits on the test specimen(s) and to avoid any damage to the test specimen(s) due to manual handling. For test methods 7 and 8, each condition should be carried out in the same chamber due to the difficulty in achieving the rapid drying and re-wetting intended if specimens are manually moved from one chamber to another.

It is recommended to use a specific chamber for testing test method 8 exclusively. Cross effects of remaining acidified salt solution when consequently using test method 1 to 7 cannot be ignored.

9.2 Arrangement of the test specimen(s)

The arrangement shall conform to the requirements of ISO 9227.

9.3 Conditions during salt mist

The test conditions shall conform to the requirements of ISO 9227.

9.4 Test methods

9.4.1 General

The relevant specification shall indicate which of the eight following test methods shall be used. A description of each test method is given in Annex B. When not specified, the test method shall be agreed by the interested parties.

The user should be aware of mass loss for each test condition.

9.4.2 Test method 1

One cycle is seven days. One cycle shall consist of spraying the specimen with a salt solution at 35 °C ± 2 K for 2 h, followed by the humid condition at 40 °C ± 2 K, 93 % ± 3 % RH for six days and 22 h. The required number of cycles is four (28 days).

In the case of manual handling, the transition time (maximum 2 h) should be included in the humid condition period of six days and 22 h.

9.4.3 Test method 2

One cycle is one day. One cycle shall consist of spraying the specimen with a salt solution at 35 °C ± 2 K for 2 h, followed by the humid condition at 40 °C ± 2 K, 93 % ± 3 % RH for 22 h. The required number of cycles is three (three days).

In the case of manual handling, the transition time (maximum 2 h) should be included in the humid condition period of 22 h.

9.4.4 Test method 3

One cycle is seven days. One cycle shall consist of spraying the specimen with a salt solution at 35 °C ± 2 .K for 2 h, followed by the humid condition at 40 °C ± 2 K, 93 % ± 3 % RH for 22 h. This shall be repeated four times. The test specimens shall then be stored under standard atmosphere at 23 °C ± 2 K and 50 % ± 5 % RH for three days. The required number of cycle is one (seven days).

In the case of manual handling, the transition time (maximum 2 h) should be included in the humid condition period of 22 h and standard atmosphere period of three days.

9.4.5 Test method 4

The required number of cycles as specified in test method 3 shall be two (14 days).

9.4.6 Test method 5

The required number of cycles as specified in test method 3 shall be four (28 days).

9.4.7 Test method 6

The required number of cycles as specified in test method 3 shall be eight (56 days).

9.4.8 Test method 7

One cycle is 8 h. One cycle shall consist of spraying the specimen with a salt solution at 35 °C ± 2 K for 2 h, followed by the dry condition at 60 °C ± 2 K, under 30 % RH for 4 h and then the humid condition at 50 °C ± 2 K, over 95 % RH for 2 h.

The transition times (time allowed to reach the temperature and relative humidity specified for a condition after changing to that condition) for temperature and humidity shall be specified between the following choices and reported:

- salt mist to dry condition: within 30 min or between 30 min and 60 min;
- dry condition to humid condition: within 15 min or between 15 min and 30 min;
- humid condition to salt mist: within 30 min.

Those transition times shall be included in the next condition period of the pair, for example the salt mist to dry condition transition time is included in the period of the dry condition. Spraying the specimen with a salt solution begins instantaneously once the salt mist is started.

The recommended number of cycles are 3 (1 day), 6 (2 days), 12 (4 days), 30 (10 days), 45 (15 days), 60 (20 days), 90 (30 days), 150 (50 days) and 180 (60 days).

9.4.9 Test method 8

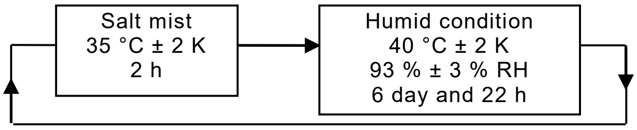
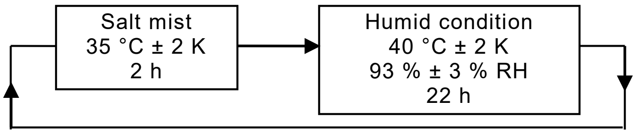
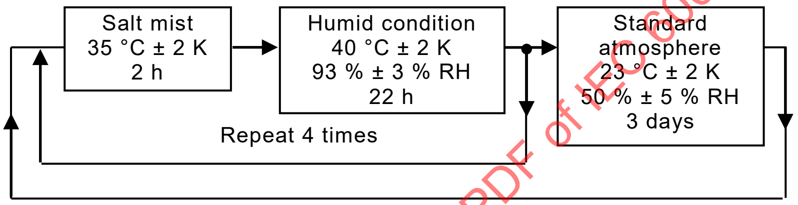
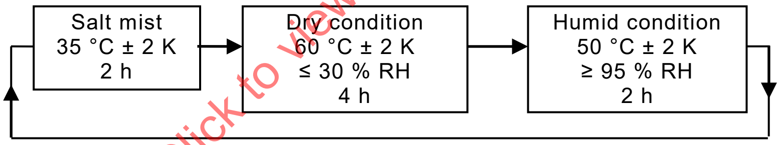
One cycle is 8 h, as specified in test method 7 using acidified salt solution instead of neutral salt solution.

The recommended number of cycles is the same as in test method 7.

9.5 Test cycles for test methods 1 to 8

The test cycles for test methods 1 to 8 shall be in accordance with Table 1.

Table 1 – Test cycles for test methods 1 to 8

Test methods	Details of the cycle	Recommended number of cycles
Test method 1	 One cycle = 7 days In the case of manual handling, the transition time (max. 2 h) should be included in the humid condition period of 6 days and 22 h.	4 cycles (28 days)
Test method 2	 One cycle = 1 day In the case of manual handling, the transition time (max. 2 h) should be included in the humid condition period of 22 h.	3 cycles (3 days)
Test method 3	 One cycle = 7 days In the case of manual handling, the transition time (max. 2 h) should be included in the humid condition period of 22 h and standard atmosphere period of 3 days.	1 cycle (7 days)
Test method 4		2 cycles (14 days)
Test method 5		4 cycles (28 days)
Test method 6		8 cycles (56 days)
Test method 7	 One cycle = 8 h The transition times (time allowed to reach the temperature and relative humidity specified for a condition after changing to that condition) are within 30 min or between 30 min and 60 min from salt mist to dry condition, within 15 min or between 15 min and 30 min from dry condition to humid condition and within 30 min from humid condition to salt mist. Those transition times shall be included in next condition period.	3, 6, 12, 30, 45, 60, 90, 150, 180 cycles (1, 2, 4, 10, 15, 20, 30, 50, 60 days)
Test method 8		
NOTE The ± tolerances given for temperature and relative humidity are the allowable fluctuations which are defined as the positive and negative deviations from the setting of the sensor at the operational control set point during equilibrium conditions. This does not mean that the set value can vary by plus/minus the amount indicated from the given value.		

9.6 Removal of the test specimen(s)

The test is recommended to be carried out in the same chamber (see Figure A.1). If not, care should be taken to avoid loss of salt solution deposits on the test specimen(s) and to avoid any damage to the test specimen(s) due to handling.

10 Recovery (at the end of testing)

The relevant specification shall state whether or not the test specimen(s) shall be washed. If the test specimen(s) is to be washed, it shall be washed using running tap water for 5 min, rinsed in distilled or deionized water, shaken by hand or subjected to air blast to remove droplets of water, then dried for 1 h at 55 °C ± 2 K and allowed to cool under controlled recovery conditions (IEC 60068-1) for not less than 1 h and not more than 2 h.

The relevant specification shall provide, if needed, other methods for washing and drying the test specimen(s). The specimen shall be stored under controlled recovery conditions (IEC 60068-1) for not less than 1 h and not more than 2 h. The temperature of the water used for washing shall not exceed 35 °C.

11 Final measurements

The test specimen(s) shall be subjected to visual, dimensional and functional checks specified by the relevant specification.

The relevant specification shall provide the criteria upon which the acceptance or rejection of the test specimen(s) is to be based.

12 Information to be given in the relevant specification

The following details shall be given, in so far as they are applicable in the relevant specification, paying particular attention to the items marked with an asterisk (*), as this information is always required.

a) salt solution, if different from that specified in 6.1 (see Clause 6);
b) initial measurements* (see Clause 7);
c) preconditioning (see Clause 8);
d) appropriate test method* (see Clause 9);
e) recovery conditions (see Clause 10);
f) final measurements* (see Clause 11).

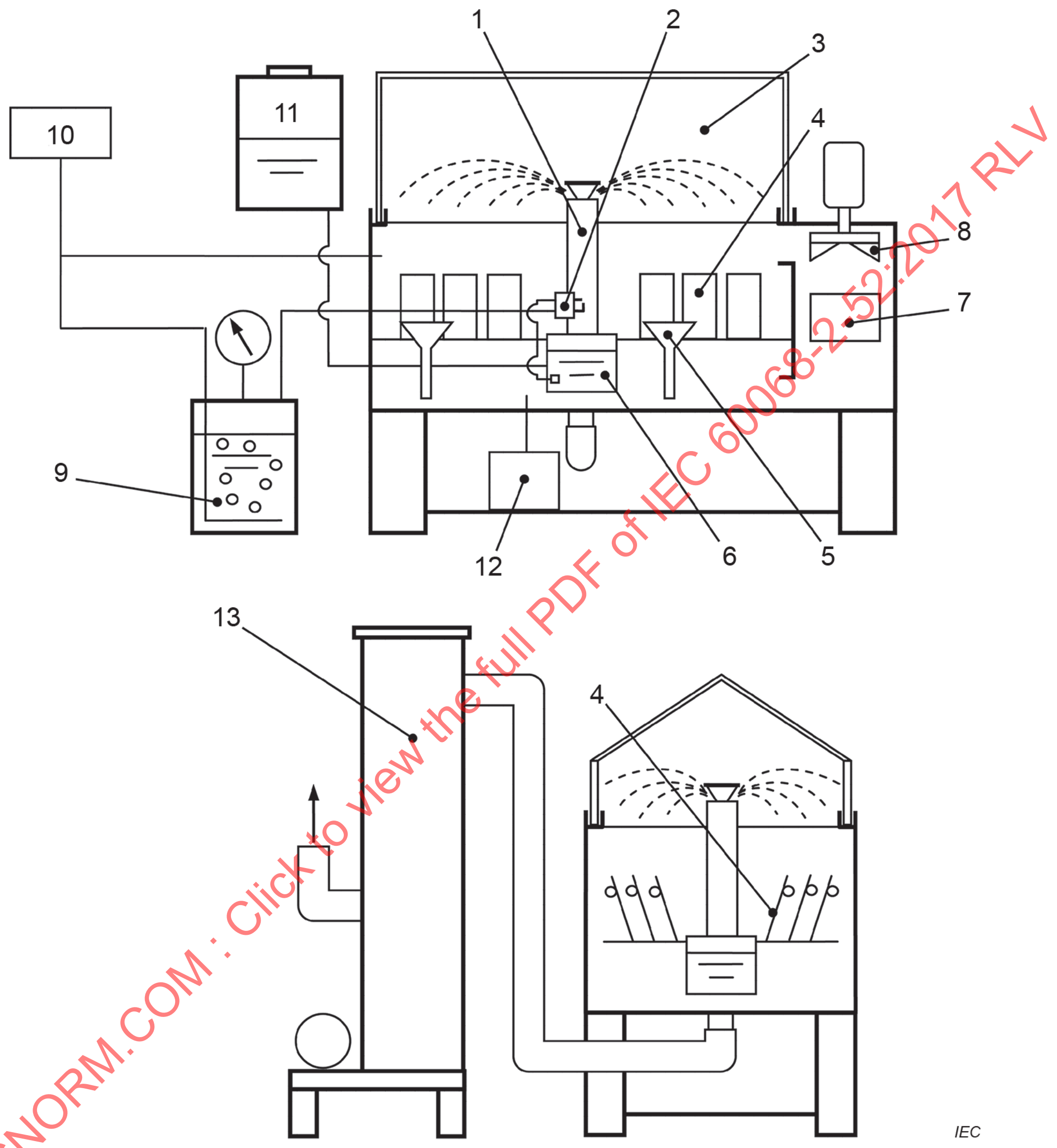
13 Information to be given in the test report

The following details shall be given in the test report, where applicable:

a) test standard (IEC 60068-2-52:2017);
b) test dates (dates when test was run);
c) testing test method, one of 1 to 8;
d) preconditioning;
e) method and results of initial measurement;
f) conditions and duration of test;
g) operation and loading during test;
h) recovery conditions and duration;
i) method and results of final measurement (see Clause 11);
j) any deviation from this document;
k) any unusual features observed.

Annex A
(informative)

Typical apparatus for cyclic salt mist, humid condition, dry condition and standard atmosphere corrosion tests



Key

1 Mist dispersion tower
2 Atomizer
3 Test chamber
4 Test specimen
5 Collecting device
6 Solution reservoir
7 Heater
8 Agitating fan
9 Saturation tower
10 Compressed air
11 Solution tank
12 Humidifier
13 Exhaust air treatment unit

Figure A.1 – Example of test apparatus

Annex B

(informative)

Description of each test method

B.1 Test methods 1 and 2

Test methods 1 and 2 are commonly used as a general corrosion test in component quality assurance procedures.

Test methods 1 and 2 can be used for testing products which are used in a marine environment, or in close proximity to the sea. Test method 1 should be used to test products which are exposed to the environment for much of their operational life (e.g. ship radar, deck equipment). Test method 2 should be used to test products which may be exposed to the marine environment from time to time but will normally be protected by an enclosure (e.g. navigational equipment which will normally be used on the bridge or in a control room).

For test methods 1 and 2, the test procedure is separated into a specified number of periods of spraying with a salt solution each followed by a storage period under humid conditions.

B.2 Test methods 3 to 6

Test methods 3 to 6 can be used for products where, under normal use, there is a frequent change between salt-laden and dry atmosphere, for example automobiles and their parts.

Test methods 3 to 6, compared to test methods 1 and 2, include an additional storage exposure under a standard atmosphere.

For test methods 3 to 6, the test procedure is separated into a specified number of test cycles. Each test cycle consists of four periods of spraying with a salt solution each followed by a storage period under humid conditions, and of one storage period under standard atmosphere after these four periods of spraying and storage under humid conditions.

B.3 Test methods 7 and 8

Test method 7 defines a specific number of test cycles that include spraying salt mist, followed by dry conditions and humid conditions. The process can be used as a general corrosion test for many materials including automobiles and their parts.

Test method 8 contains the same cyclic exposure as test method 7, but utilizes an acidified salt solution instead of a neutral salt solution to induce a corrosion that occurs in acidified salt environment.

Test methods 7 and 8, dry conditions provide a correlation with real-world corrosion for metals and their alloys, as well as plating and coatings. It can be used as a quality control test or for material qualification, where test repeatability is very important.

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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ESSAIS D'ENVIRONNEMENT –

Partie 2-52: Essais –
Essai Kb: Brouillard salin, essai cyclique (solution de chlorure de sodium)

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La Norme internationale IEC 60068-2-52 a été établie par le comité d'études 104 de l'IEC: Conditions, classification et essais d'environnement.

La présente version bilingue (2019-07) correspond à la version anglaise monolingue publiée en 2017-11.

Cette troisième édition annule et remplace la deuxième édition parue en 1996. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) le contenu a été harmonisé autant que possible avec l'ISO 9227;
b) une introduction a été ajoutée;
c) le domaine d'application a été simplifié;
d) les références normatives ont été mises à jour;
e) la description générale de l'essai a été modifiée;
f) une chambre sèche a été ajoutée à l'appareillage d'essai;
g) les sévérités ont été remplacées par les méthodes d'essai;
h) les méthodes d'essai 7 et 8 ont été ajoutées;
i) des informations sur le rapport d'essai ont été ajoutées;
j) la Figure 1 a été remplacée par le Tableau 1;
k) un exemple d'appareillage d'essai type a été ajouté à la nouvelle Annexe A;
l) une description de chaque méthode d'essai a été ajoutée à la nouvelle Annexe B;
m) des références bibliographiques ont été ajoutées.

Le texte anglais de cette norme est issu des documents 104/751/FDIS et 104/761/RVD.

Le rapport de vote 104/761/RVD donne toute information sur le vote ayant abouti à l'approbation de cette norme.

La version française de cette norme n'a pas été soumise au vote.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 60068, publiées sous le titre général *Essais d'environnement*, peut être consultée sur le site web de l'IEC.

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INTRODUCTION

Le processus de corrosion s'appliquant aux matériaux métalliques dans une atmosphère contenant du chlorure est de nature électrochimique, alors que les effets de dégradation relevés sur les matériaux non métalliques sont dus à des réactions chimiques complexes des sels avec les matériaux en présence. La vitesse de l'action de la corrosion dépend dans une large mesure de la quantité de solution saline oxygénée à la surface du ou des spécimens d'essai, de la température du ou des spécimens d'essai, et de la température et de l'humidité de l'environnement.

Outre la mise en évidence des effets dus à la corrosion, cet essai cyclique au brouillard salin peut être utilisé pour signaler la détérioration de certains matériaux non métalliques, par absorption de sels. Dans les diverses méthodes d'essai décrites dans le présent document, la durée de vaporisation avec la solution saline appropriée est suffisante pour humidifier complètement le ou les spécimens d'essai. Puisque cette humidification est répétée après des périodes de stockage dans des conditions d'humidité complétées par un stockage dans des conditions atmosphériques normales, elle tend à reproduire en quelque sorte les effets d'un environnement naturel.

En outre, compte tenu de l'environnement naturel corrosif sur les matériaux métalliques, la vaporisation de solution saline neutre ou acide et les conditions humides et sèches sont aussi des facteurs importants pour un essai de corrosion cyclique. Chaque condition est répétée après des périodes où d'autres conditions sont appliquées dans différentes combinaisons, pour obtenir une corrosion sur les matériaux métalliques et pour accélérer cette corrosion.

Les essais décrits dans le présent document sont accélérés comparativement à la plupart des conditions d'utilisation attendues. Par conséquent, il peut être difficile d'établir un facteur d'accélération global pour tous les types de spécimens d'essai. Cela signifie également qu'il est souvent impossible d'utiliser les résultats de ces essais comme un guide comparatif du comportement à long terme des différents systèmes de revêtement, étant donné que la contrainte de corrosion au cours de ces essais diffère considérablement des contraintes de corrosion rencontrées pendant l'utilisation. Néanmoins, la méthode décrite permet de vérifier le maintien de la qualité comparative d'un matériau métallique.

Le présent document peut impliquer des matériaux, un fonctionnement et du matériel dangereux. Le présent document n'a pas pour but de traiter tous les problèmes de sécurité qui sont, le cas échéant, liés à son utilisation. Il incombe à l'utilisateur du présent document d'établir, avant de l'utiliser, des pratiques d'hygiène et de sécurité appropriées et de déterminer l'applicabilité des restrictions réglementaires.

ESSAIS D'ENVIRONNEMENT –

Partie 2-52: Essais –
Essai Kb: Brouillard salin, essai cyclique
(solution de chlorure de sodium)

1 Domaine d'application

La présente partie de l'IEC 60068-2 spécifie l'application de l'essai cyclique au brouillard salin aux composants ou équipements conçus pour résister à une atmosphère chargée en sel, car le sel peut détériorer le fonctionnement des parties fabriquées à partir de matériaux métalliques et/ou non métalliques.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60068-1, *Essais d'environnement – Partie 1: Généralités et lignes directrices*

IEC 60068-2-78, *Essais d'environnement – Partie 2-78: Essais – Essai Cab: Chaleur humide, essai continu*

ISO 9227, *Essais de corrosion en atmosphères artificielles – Essais aux brouillards salins*

3 Termes et définitions

Aucun terme n'est défini dans le présent document.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse http://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse http://www.iso.org/obp

4 Description générale de l'essai

4.1 Description de chaque condition d'essai

4.1.1 Généralités

Le présent document décrit les conditions d'essai cyclique au brouillard salin, les conditions sèches et humides, ainsi que les conditions atmosphériques normales. L'effet de chaque condition d'essai est décrit ci-après.

NOTE Le brouillard salin est aussi appelé vaporisation saline.

Le ou les spécimens d'essai ne sont généralement pas sous tension pendant l'essai.

4.1.2 Brouillard salin

Le spécimen d'essai est corrodé par une réaction chimique complexe ou électrochimique avec une solution saline neutre ou acide. La solution saline forme un mince film électrolytique à la surface du spécimen d'essai. Ce film peut déclencher le processus de corrosion et lui permettre de se poursuivre.

4.1.3 Condition sèche

L'air chauffé de la chambre peut provoquer l'évaporation de l'eau à la surface du spécimen d'essai par la diminution de l'humidité relative et par l'augmentation de la température du spécimen. Cela provoque l'augmentation de la concentration de la solution et accélère les réactions chimiques et le processus de corrosion. Le sel précipite dans la solution à la surface du spécimen d'essai dans cette condition. Les taux d'évaporation et de chaleur peuvent varier selon la chambre d'essai et le spécimen d'essai.

4.1.4 Condition humide

4.1.4.1 De la condition sèche à la condition humide

A mesure que l'humidité relative augmente, les cristaux de sel précipités à la surface du spécimen absorbent la vapeur d'eau jusqu'à ce qu'une solution électrolytique liquide se forme, réinitialisant le processus de corrosion.

4.1.4.2 Du brouillard salin à la condition humide

La condition humide maintient l'humidité existante à la surface du spécimen d'essai à la fin de la période de brouillard salin, sans dilution excessive de la solution qui peut résulter de la condensation.

4.1.5 Conditions atmosphériques normales

Le spécimen d'essai est autorisé à s'équilibrer avec les conditions de laboratoire normalisées, ce qui entraîne un assèchement et un relâchement progressifs de la plupart des réactions de corrosion. La période d'atmosphère sèche peut avoir lieu, dans la pratique, pendant les pauses d'exploitation, par exemple pendant le week-end. L'inclusion d'une telle période sèche peut conduire à des mécanismes de corrosion qui peuvent être très différents de ceux trouvés dans des conditions humides constantes. Le calendrier d'essai doit être établi dans le respect des délais donnés en 9.4. D'autres périodes sèches (par exemple pendant le week-end) doivent être évitées.

5 Appareillage d'essai

5.1 Généralités

Chaque méthode d'essai comprend deux conditions d'environnement ou plus, qui peuvent être obtenues par l'utilisation de plusieurs chambres ou par l'utilisation d'une seule chambre qui passe automatiquement d'une condition à l'autre. Dans les deux cas, il est admis par hypothèse que les transitions ne sont pas instantanées. Des précautions doivent être prises pour réduire le plus possible les effets néfastes associés à la manipulation des spécimens lors du transfert entre les chambres.

5.2 Chambre de brouillard salin

La chambre doit être conforme aux exigences de l'ISO 9227. Elle doit maintenir une température de 35 °C ± 2 K.

NOTE Un schéma d'une conception possible d'armoire de vaporisation est donné dans l'Annexe A.