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

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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL TESTING –

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

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- withdrawn,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 $35\text{ °C} \pm 2\text{ K}$.

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 $20\text{ °C} \pm 2\text{ °C}$. 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 $50\text{ g/l} \pm 5\text{ g/l}$.

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 , $\rho = 1,42\text{ g/ml}$), 17,3 ml of sulfuric acid (H_2SO_4 , $\rho = 1,84\text{ g/ml}$) and sufficient quantity of 10 % mass fraction of sodium hydroxide (NaOH) solution to adjust the pH of the solution to $3,5 \pm 0,1$ (about 300 ml will be required). The pH of the sprayed solution collected within the chamber is 3,4 to 3,6 at $25\text{ °C} \pm 2\text{ K}$.

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 $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ 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 $15\text{ }^{\circ}\text{C}$ and $35\text{ }^{\circ}\text{C}$.~~

~~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 cm^2 , 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 $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and a relative humidity of $(93 \pm \frac{2}{3})\%$ 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.~~