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**Optics and optical instruments —
Environmental test methods —**

Part 4:
Salt mist

*Optique et instruments d'optique — Méthodes d'essais
d'environnement —*

Partie 4: Brouillard salin



Reference number
ISO 9022-4:1994(E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9022-4 was prepared by Technical Committee ISO/TC 172, *Optics and optical instruments*, Subcommittee SC 1, *Fundamental standards*.

ISO 9022 consists of the following parts, under the general title *Optics and optical instruments — Environmental test methods*:

- Part 1: *Definitions, extent of testing*
- Part 2: *Cold, heat, humidity*
- Part 3: *Mechanical stress*
- Part 4: *Salt mist*
- Part 5: *Combined cold, low air pressure*
- Part 6: *Dust*
- Part 7: *Drip, rain*
- Part 8: *High pressure, low pressure, immersion*
- Part 9: *Solar radiation*
- Part 10: *Combined sinusoidal vibration, dry heat or cold*

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- *Part 11: Mould growth*
- *Part 12: Contamination*
- *Part 13: Combined shock, bump or free fall, dry heat or cold*
- *Part 14: Dew, hoarfrost, ice*
- *Part 15: Combined random vibration wide band: reproducibility medium, in dry heat or cold*
- *Part 16: Combined bounce or steady-state acceleration, in dry heat or cold*
- *Part 17: Combined contamination, solar radiation*
- *Part 18: Combined damp heat and low internal pressure*
- *Part 19: Temperature cycles combined with sinusoidal or random vibration*
- *Part 20: Humid atmosphere containing sulfur dioxide or hydrogen sulfide*

Annex A of this part of ISO 9022 is for information only.

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Introduction

Optical instruments are affected during their use by a number of different environmental parameters which they are required to resist without significant reduction in performance.

The type and severity of these parameters depend on the conditions of use of the instrument (for example, in the laboratory or workshop) and on its geographical location. The environmental effects on optical instrument performance in the tropics and subtropics are totally different from those found when they are used in the arctic regions. Individual parameters cause a variety of different and overlapping effects on instrument performance.

The manufacturer attempts to ensure, and the user naturally expects, that instruments will resist the likely rigours of their environment throughout their life. This expectation can be assessed by exposure of the instrument to a range of simulated environmental parameters under controlled laboratory conditions. The severity of these conditions is often increased to obtain meaningful results in a relatively short period of time.

In order to allow assessment and comparison of the response of optical instruments to appropriate environmental conditions, ISO 9022 contains details of a number of laboratory tests which reliably simulate a variety of different environments. The tests are based largely on IEC standards, modified where necessary to take into account features special to optical instruments.

It should be noted that, as a result of continuous progress in all fields, optical instruments are no longer only precision-engineered optical products, but, depending on their range of application, also contain additional assemblies from other fields. For this reason, the principal function of the instrument must be assessed to determine which International Standard should be used for testing. If the optical function is of primary importance, then ISO 9022 is applicable, but if other functions take precedence then the appropriate International Standard in the field concerned should be applied. Cases may arise where application of both ISO 9022 and other appropriate International Standards will be necessary.

Optics and optical instruments — Environmental test methods —

Part 4: Salt mist

1 Scope

This part of ISO 9022 specifies methods for the testing of optical instruments and instruments containing optical components, under equivalent conditions, for their ability to resist salt mist.

Normally, representative samples or complete small units are used for testing. Complete large instruments or assemblies are only tested as specified in this part of ISO 9022 in exceptional cases.

The purpose of testing is to assess as early as possible the ability of the instrument, and particularly of the surfaces and protective coatings of the instrument, to resist the effects of a salt atmosphere.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 9022. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9022 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 9022-1:1994¹⁾, *Optics and optical instruments — Environmental test methods — Part 1: Definitions, extent of testing.*

1) To be published.

3 General information and test conditions

Exposure to salt mist mainly results in the corrosion of metals; effects may also occur by way of clogging or binding of moving parts.

The aim of salt mist testing is, however, unlikely to be achieved unless the deficiencies and limitations of such testing as detailed in 3.1 and 3.2 are fully recognized.

3.1 Suitability

Salt mist testing is considered suitable for

- a) assessing the anticorrosion effect of metallic and nonmetallic coatings;
- b) comparing the anticorrosion effect of identical products manufactured by different methods;
- c) comparing the anticorrosion effect of similar coatings employed by different manufacturers;
- d) comparing or, where standard specimens have been agreed, assessing configurations, materials or parts which are similar to each other and designed to serve the same purpose;
- e) early detection of the unacceptability of metal combinations on account of the increased occurrence of electrochemical corrosion.

3.2 Unsuitability

Salt mist tests as specified by this part of ISO 9022 shall not be performed

- as a general corrosion test, as no verified data are available showing that there is a direct relationship between salt mist corrosion and corrosion caused by other attacking corrosive media or environments;
- on separate components or assemblies that are used only in assembled or any other configurations protected from corrosion;
- as a true duplication of a natural marine environment.

NOTE 1 Generally the salt mist test is unreliable for comparing the corrosion resistance of different materials, or the anticorrosive effect of coatings, exposed to varying climatic conditions; neither is it suitable for predicting the service life of such materials or coatings. Some idea of the service life of different specimens of identical or closely related metals, or of different specimens of identical or comparable protective coating combinations, can be gained by the salt mist test provided that, by correlating field service test data with laboratory tests, such relationships can be demonstrated as exist in the case of aluminium alloys. Such correlation tests are essential if data are required on the accelerating effect (if any) of laboratory testing as compared to performance under natural service conditions.

3.3 Specimens

Specimens shall be made of the basic materials used for the instrument under test; coatings (finishing coatings, protective coatings, thin films on optical parts), if any, shall be of the same structure as those used for the instrument components and surfaces to be assessed.

Specimens for testing metallic and nonmetallic coatings shall preferably be metal sheets (sample sheets) as shown in figure 1.

Where the instruments or instrument components to be assessed are made of cast material, the use of specimens originating from the same batch shall be agreed upon and documented in the test report.

The coating under test shall completely cover the sample sheet, especially the outer edges and edges of holes. Where this is not feasible, exposed metal edges shall be protected by a means that does not affect the coating under test. Marking of the sample sheets shall not damage the coating to be tested (e.g. punch-marking shall be carried out prior to applying the coating).

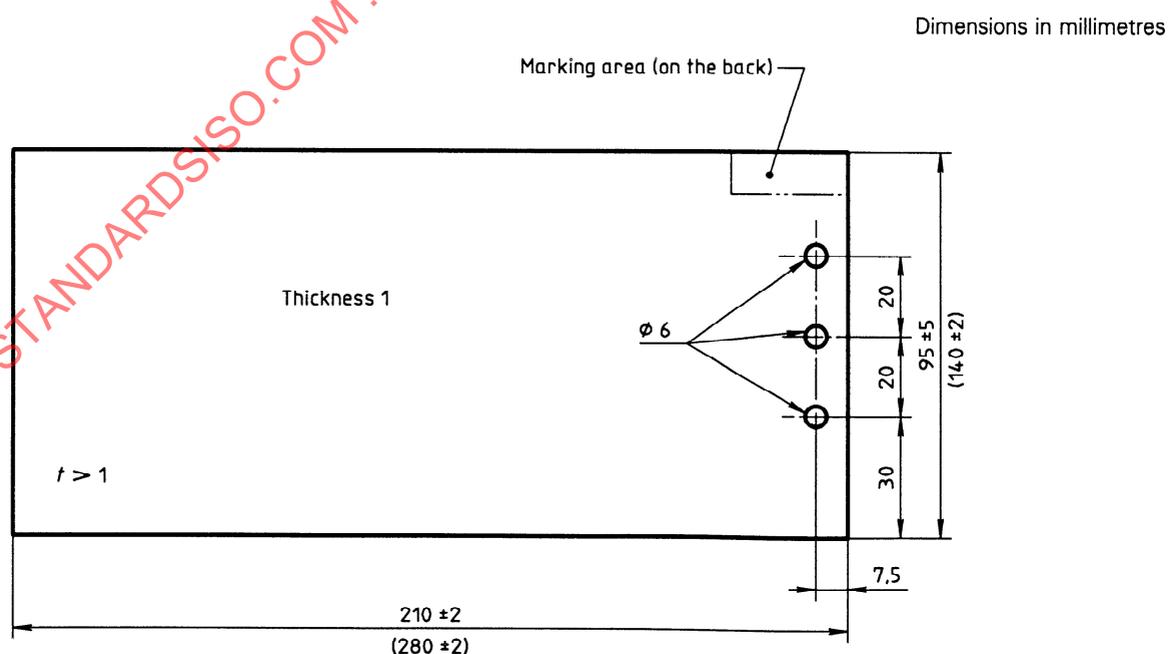


Figure 1 — Sample sheet

Complete large instruments and assemblies, or separate components that are used in assembled configurations only, shall not be tested in accordance with this part of ISO 9022 unless as an exception. If necessary, essential areas of such specimens and of specimens other than sample sheets (e.g. electrically insulated components, open assemblies) may be used for assessment by agreement between the parties concerned.

NOTE 2 Sample sheets of $140 \text{ mm} \pm 2 \text{ mm}$ and $280 \text{ mm} \pm 2 \text{ mm}$ in length may also be specified in the relevant specification.

3.4 Apparatus

The test apparatus (see figure 2) essentially comprises the components described below. All parts of the test apparatus that come into contact with the salt mist or the test solution shall be made of a material that will not affect the corrosiveness of the test solution or the salt mist.

3.4.1 Test chamber

The apparatus used for salt mist tests shall include a heated exposure chamber providing pressure balance and measuring/controlling means to adjust and maintain the test temperature to $35 \text{ °C} \pm 2 \text{ °C}$ within the closed chamber. The test chamber shall have a volume of not less than 400 litres; it shall be constructed so as to prevent condensate dripping from overhead, and from the sidewalls, onto the specimens. The dripping of condensate from overhead can be avoided by inclining the exposure chamber at least 30° to the horizontal.

Test solution once atomized shall not return into the salt solution reservoir.

The exposure zone is that part of the test chamber which is not covered by the cone-shaped spray, and where uniform distribution of the mist can be demonstrated in accordance with 3.7.2.

3.4.2 Atomizing nozzles

Salt mist has proved to be best produced by self-priming compressed-air nozzles without a regulating

or quick-cleaning needle. The nozzles are made of polymethylmethacrylate or polyvinylchloride and have an orifice of 1 mm diameter; their dispersion angle is approximately 30° and they are operated at a positive pressure of between 70 kPa and 140 kPa, and a suction level of 200 mm to 500 mm. It is useful to provide a means for measuring and controlling the flow of fluid (see figure 2), serving to adjust and control the amount of salt solution to be atomized so that the condensate collected per hour in the exposure chamber is kept within the acceptable tolerances specified in 3.7.2.

The spray shall not impinge upon the specimens. It may therefore be necessary to direct the spray against one of the chamber walls (see figure 2, example 1) or, if the nozzle is installed at the bottom of the chamber, to provide a guide tube (see figure 2, example 2).

The number and location of the atomizing nozzles shall be selected so that the requirements for the available exposure space as specified in 3.7.2 are met.

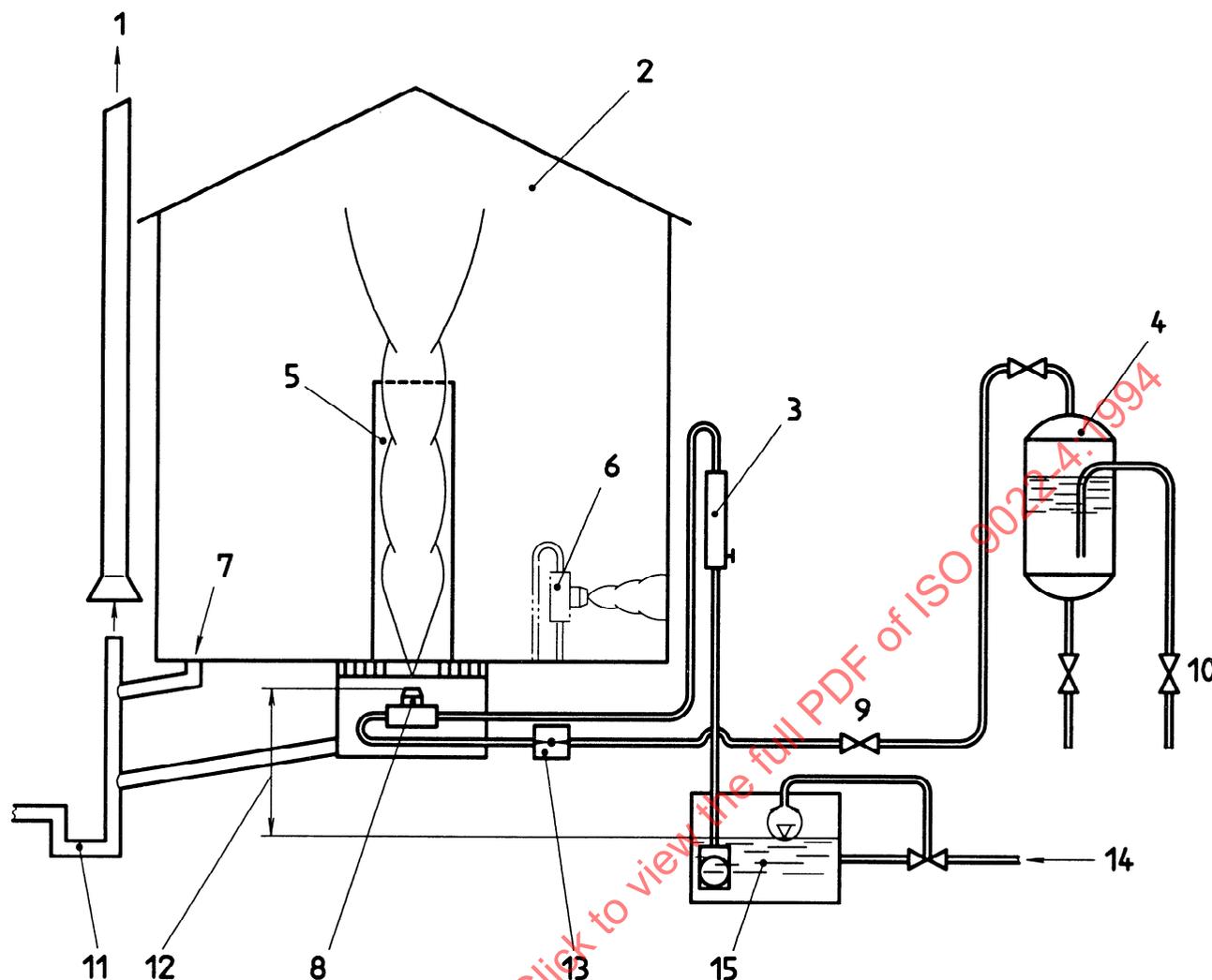
Other types of nozzles may be used provided that the materials of which they are made do not affect the corrosiveness of the salt mist, and that the salt mist produced by such nozzles meets the requirements specified in 3.7.2.

3.4.3 Levelling receptacle and supply line

The levelling receptacle for the salt solution to be atomized shall be designated and constructed so that the suction level remains constant throughout the duration of the test.

3.4.4 Airline including oil and solid matter trap, and humidifier

The humidifier shall be designed and constructed so that the compressed air remains saturated with water at the required temperature throughout the duration of the test. A pressure gauge for measuring the air pressure at the nozzle shall be installed in the airline running from the humidifier to the exposure chamber.



Key

- 1 Chamber ventilation
- 2 Exposure chamber
- 3 Fluid flow measuring and controlling device
- 4 Humidifier
- 5 Example 1: guide tube around atomizing nozzle
- 6 Example 2: atomizing nozzle directed against chamber wall
- 7 Pressure balance
- 8 Atomizing nozzle
- 9 Air inlet control valve
- 10 Compressed air, free from oil and solid matter
- 11 Siphon
- 12 Suction level 200 mm to 500 mm
- 13 Pressure gauge
- 14 Filtered sodium chloride solution
- 15 Sodium chloride solution reservoir and liquid-level controller

Figure 2 — Schematic representation of test apparatus, showing two different locations of atomizing nozzle

3.4.5 Racks for specimen arrangement

Racks shall permit the arrangement of the specimens within the available exposure space so that they do not come into contact with each other.

Major surfaces of representative samples and, if possible, of assemblies shall be inclined at least 60° to the horizontal.

Sample sheets shall be placed on edge at an angle of 60° to 75° to the horizontal. Unless otherwise specified in the relevant specification, instruments and, if required, assemblies shall be installed in the exposure chamber in their operating position.

The specimens shall be arranged in the exposure chamber in such a manner that they do not overlap or come into contact with each other and that condensate cannot drip down upon them. Care shall be taken to prevent contact corrosion (e.g. electrolytic action or crevice corrosion) where the specimens come into contact with the supporting racks.

The supporting racks for the specimens shall be made of one of the following materials: glass, polypropylene, non-plasticized PVC (polyvinyl chloride), PA 66 (polyamide), PA 6, etc.

Supporting devices that are likely to cut into surface coatings, or materials that release agents which tend to change the surface of the specimen, shall not be used.

3.5 Test solution

The water used to prepare the test solution shall be distilled or demineralized (completely softened); its electrical conductivity at a temperature of 25 °C ± 2 °C shall not exceed 20 µS/cm and the proportion of solid matter shall not be more than 100 ppm.

The test solution is a 5 % (*m/m*) aqueous solution of sodium chloride obtained by dissolving 50 g ± 10 g of sodium chloride (NaCl), containing not more than 1 % total impurities, in 950 g of water at ambient temperature. The pH of the sodium chloride solution shall be adjusted so that the pH of the collected condensate will be in the range 6,5 to 7,2, measured at a temperature of 25 °C ± 2 °C. Only chemically pure dilute hydrochloric acid or sodium hydroxide solution shall be used to adjust the pH. The pH shall be measured either electrometrically using a glass electrode at a temperature of 25 °C ± 2 °C, or colorimetrically using bromothymol blue as indicator (see annex A). The concentration of sodium chloride in the collected condensate shall be 50 g/l ± 10 g/l.

The test solution shall be filtered before use to remove any solid matter which might block the aperture of the spraying device.

The sprayed solution shall not be able to return to the sodium chloride solution reservoir; neither shall it be reused.

3.6 Compressed air

The compressed air used for atomizing the test solution, at a positive pressure of 70 kPa to 140 kPa, shall be free from dirt, oil and other impurities. It shall therefore be passed through standard oil and liquid separators, followed by a ceramic compressed-air cleaner, so that at least 99,5 % of the impurities are removed.

1 m³ of purified air shall contain less than 0,2 mg of oil and dust particles of less than 5 µm in size.

The purified air shall then be saturated with water (using a humidifier operating on demineralized water) at such a temperature that the air reaches approximately 35 °C after expansion (see annex A).

NOTE 3 It is necessary to saturate the compressed air with water in order to prevent an increase of the sodium chloride concentration in the atomized solution.

3.7 Salt spray test conditions

3.7.1 Temperature

During testing, the temperature in the exposure zone of the closed test chamber shall be 35 °C ± 2 °C. If it becomes necessary to open the test chamber, the temperature may be allowed to fall by a few degrees. It shall be measured sufficiently in order to record all temperature changes, if possible.

NOTE 4 It is recommended to record the temperature curve by means of the thermograph and to ensure a uniform temperature distribution by providing adequate thermal insulation of the test chamber.

3.7.2 Salt mist

The amount of salt solution to be atomized per unit of time within the exposure chamber shall be such that over a period of not less than 16 h a mean of 1,5 ml ± 9,5 ml of solution per hour for each 80 cm² of horizontal collecting area is collected in a receptacle placed in the bottom of the test chamber.

As regards the atomizing nozzles (3.4.2), it has proved useful to adjust only by means of the external flow measuring and controlling device the amount of salt

solution to be atomized at a given constant positive pressure of the compressed air and a constant suction level.

Other methods of adjusting the amount of salt solution to be atomized are acceptable provided that they ensure uniform distribution of the salt mist within the exposure zone and do not impair the deposition characteristics of the salt mist. In order to permit verification of the uniformity of salt mist distribution within the exposure zone, a minimum of two collecting receptacles shall be placed in the bottom of the chamber near the racks supporting the specimens, one near a nozzle and one distant from the nozzles. The receptacles shall be arranged in such a manner that they cannot collect condensate dripping down from the chamber ceiling or walls, or from the racks or specimens. Receptacles suitable for collecting the atomized solution are, for instance, glass or plastics funnels of 10 cm diameter (corresponding to a collecting area of approximately 78,5 cm²), fitted into a glass or plastics measuring cylinder by means of a plug.

3.8 Test interruption and opening of test chamber

Salt mist tests shall be conducted as uninterrupted trials. The salt solution shall be continuously atomized throughout the exposure period. Atomizing shall not be interrupted during the exposure period unless it is necessary to open the test chamber for the purpose of removing specimens for assessment or to replace them.

If intermediate inspections are required, care shall be taken to prevent the specimens from becoming dry; wet them, if appropriate, using test solution (3.5) at room temperature. Under no circumstances shall intermediate inspections take more than 30 min for each 24 h of test duration.

4 Conditioning method 40: Salt mist

See table 1.

Table 1 — Degrees of severity for conditioning method 40: Salt mist

Degree of severity	01	02	03	04	05	06	07
Exposure time	2 h	4 h	8 h	16 h	2 d	4 d	8 d
State of operation	1 or 2						

5 Procedure

5.1 General

The test shall be conducted in accordance with the requirements of the relevant specification and with ISO 9022-1.

5.2 Preconditioning (specimen preparation)

Sample sheets shall be properly cleaned immediately before exposure.

NOTE 5 The following is recommended for sample sheets protected by organic coatings: wash in a tepid soap solution or a neutral to weakly alkaline solution, using a soft brush, where appropriate; then rinse in demineralized water and air-dry, using an electric hair-dryer or oil-free compressed air.

If sample sheets protected by organic coatings (such as paints or similar coatings) are to be tested, a straight line shall be scratched into the coating after cleaning to approximately 5 mm from the inside of, and running parallel to, the lateral and bottom edges of the lower front half to the sample sheet. The scratch shall be deep enough to penetrate to the metal substrate.

If desirable, there may be several such scratched lines, the distance between them being not less than 30 mm. The means used for scratching the lines shall be such as to ensure that the scratch penetrates to the metal substrate and is of a given width; a knife shall not be used. The lines shall be scratched immediately before the sample sheets are exposed to the salt mist.

Metal or varnish chips shall be dry-removed by means of a soft brush or oil-free compressed air.

In the event that the behaviour of an undamaged coating of sample sheets, especially of ferrous material, is of interest in order to detect film or coating deficiencies or weak points, the sample sheets shall be exposed to the salt mist in their unscratched condition subject to prior agreement.

Representative samples shall not be scratched.

The surfaces of specimens such as instruments and assemblies, including optical components, shall be properly cleaned immediately before exposure. The cleaning methods shall not include the use of corrosive solvents or solvents which deposit either corrosive or protective films, or of abrasives other than a paste of pure magnesium oxide (do not use for optical surfaces).

Other types of specimens, such as electrically insulated or open components, shall be prepared in a similar manner, subject to prior agreement and to documentation in the relevant specification, where appropriate.

5.3 Recovery

After exposure the specimen shall be gently washed, first under running water, using a soft brush where appropriate, and then in demineralized water, to remove salt deposits. The water used shall not be warmer than 38 °C. After having been allowed to drain, the specimens shall be conditioned for 1 h at a temperature of 40 °C ± 3 °C in a heating cabinet provided with air circulation.

5.4 Evaluation

5.4.1 Sample sheets

The specimens shall not show any corrosion of the substrate as compared to its condition prior to exposure. Slight changes in colour and/or brightness as well as corrosion of the protective coating are acceptable. In the case of scratched sample sheets protected, for instance, by organic coatings, slight deterioration (such as subsurface corrosion, blistering, or delamination) of not more than 2 mm in width on each side of the scratch may be tolerated.

5.4.2 Instruments and assemblies

The test is considered successful if the tolerances for function and physical appearance as specified in the relevant specification are met; slight changes in colour and/or brightness and corrosion of protective coatings are acceptable. Corrosion of the substrate is not acceptable.

6 Environmental test code

The environmental test code shall be as defined in ISO 9022-1.

EXAMPLE

The environmental test of optical instruments for resistance to salt mist, conditioning method 40, degree of severity 02, state of operation 1, shall be identified as:

Environmental test ISO 9022-40-02-1

7 Specification

The relevant specification shall contain the following details:

- a) environmental test code;
- b) number of specimens;
- c) type and dimensions of the specimens or sample sheets;
- d) arrangement and position of the specimens in the exposure chamber if other than specified in 3.4;
- e) preconditioning of specimen if other than specified in 5.2;
- f) type and scope of initial test;
- g) determination of the period of operation for state of operation 2;
- h) type and scope of intermediate test for state of operation 2 and information as detailed in 3.4;
- i) recovery if other than specified in 5.3;
- j) type and scope of final test;
- k) criteria for evaluation (see 5.4);
- l) type and scope of test report.

Annex A (informative)

Explanatory notes

A.1 Self-priming compressed-air nozzles (see 3.4.2)

The operating method given for the self-priming compressed-air nozzles requires a reduction of the nozzle flow on the liquid side, with the result that only a part of the nozzle spray flow possible at constant air pressure and at the constant suction level prescribed will be possible.

When using composite atomizing nozzles it has proved useful to have the nozzle set at maximum suction flow at an air pressure of approximately 100 kPa by the supplier, or alternatively to perform the setting one self and then to mark and fix this position before mounting. This facilitates the re-setting of the movable nozzle caps to maximum suction power if the nozzles have to be removed and taken apart for cleaning.

Experience has shown that, for a test chamber with a volume of up to approximately 10 m³ and a surface area of approximately 5 m² (in rectangular surface area with an aspect ratio of between 1 : 1 and 1 : 5), one atomizing nozzle as described in 3.4.2 will suffice.

A.2 pH of sodium chloride solution (see 3.5)

When using water containing carbon dioxide for preparing the sodium chloride solution, care is to be taken when setting the pH value, as carbon dioxide escapes when atomizing the solution at 35 °C, and the re-collected solution therefore has a higher pH value than the solution prior to atomizing. For this reason a sodium chloride solution made with water containing carbon dioxide is to be set to a pH value

under 6,5 at a temperature of 25 °C ± 2 °C so that the re-collected solution will have a pH between 6,5 and 7,2. To test if the pH of the solution before atomizing has been correctly set, remove 50 ml, boil lightly for approximately 30 s and cool to 25 °C ± 2 °C. Then measure the pH value immediately. If the pH value measured lies between 6,5 and 7,2 experience has shown that the pH value of the re-collected spray will also lie in this range.

A.3 Air humidifier temperature (see 3.6)

On leaving the atomizing nozzle the pressure of the compressed air decreases to the pressure of the surrounding atmosphere and cools down in the process. To ensure a spray temperature of 35 °C, the temperature of the compressed air saturated with water is to be greater than 35 °C. Table A.1 shows empirical temperature values (air humidifier temperature) which the compressed air saturated with water is to have in relation to the positive pressure in order to have a temperature of approximately 35 °C after meeting the atmosphere.

Table A.1 — Empirical values of air humidifier temperature

Compressed air positive pressure kPa	Air humidifier temperature throughout salt mist test °C
70	45
84	46
98	47
112	48
126	49
140	50