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STANDARD

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

**Part 12:**  
Contamination

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

*Partie 12: Contamination*



Reference number  
ISO 9022-12:1994(E)

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 9022-12 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 forms an integral part of this part of ISO 9022.

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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 12: Contamination

### 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 contamination, i.e. contact with corrosive chemical substances (hereafter called test agents).<sup>1)</sup>

However, complete instruments or assemblies are only tested as specified in this part of ISO 9022 in exceptional cases (see 5.3). Normally, representative samples such as material items or surface coatings on representative substrates are used for testing.

The tests described are designed for the selection of materials and components for instruments likely to suffer contamination during service life, rather than for regular production control.

The purpose of testing is to investigate the resistance of an instrument and, in particular, of instrument surfaces, coatings or synthetic materials, to a short exposure to the test agents.

### 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 9022-1:1994<sup>2)</sup>, *Optics and optical instruments — Environmental test methods — Part 1: Definitions, extent of testing.*

### 3 General information and test conditions

The test shall be conducted under ambient atmospheric conditions in accordance with ISO 9022-1.

The test agents listed from each conditioning method (clause 4) represent different chemical groups.

#### 3.1 Specimen

Unless the testing of complete instruments or assemblies is required in the relevant specification, representative samples shall be used for testing. Representative materials of at least 1 mm thickness and having dimensions as shown in figure 1 shall be used as substrates for the testing of non-metallic coatings.

1) Another possible source of service contamination to which optical instruments may be exposed is radioactive elements and isotopes, and hazardous chemical substances (e.g. 2:2-dichlorodiethylsulfide). However, as these materials may only be handled, used for testing, and stored by special, officially approved laboratories, they were not used as test reagents.

2) To be published.

NOTE 1 Sample sheets of 140 mm ± 2 mm or 280 mm ± 2 mm in length may also be specified in the relevant specification.

Coatings to be tested shall be of the same structure as the coating intended for the instrument or for parts of the instrument.

Prior to applying the coating, prepare the surface of the specimen in the same manner as required for the original instrument. The coating shall completely surround the specimen so as to cover particularly edges, corners and edges of holes. The coating shall not be degraded by identification marking; numbers, etc. shall be punched prior to applying the coating.

Particular care shall be taken to apply the coating in such a manner that the dry film will meet the thickness required for the instrument with a tolerance of ± 5 µm. The specimens shall be protected from contamination until commencement of the tests.

If specimens as shown in figure 1 are not available, as level a surface as possible of representative in-

strument parts shall be used as test areas for testing synthetic materials. Where such surfaces are not sufficient in size to support the test pad (3.2), the specimen shall be half immersed in the test agent in order to permit testing under the required conditions.

### 3.2 Test pad

Felt pads having the following characteristics and drenched with test agent shall be used as test media:

colour: white

mass density: 0,25 g/cm<sup>3</sup> to 0,30 g/cm<sup>3</sup>

pH: 5 to 8 (for measurement, see annex A)

thickness: 1 mm

diameter: 9 mm

The felt pads shall be used only once.

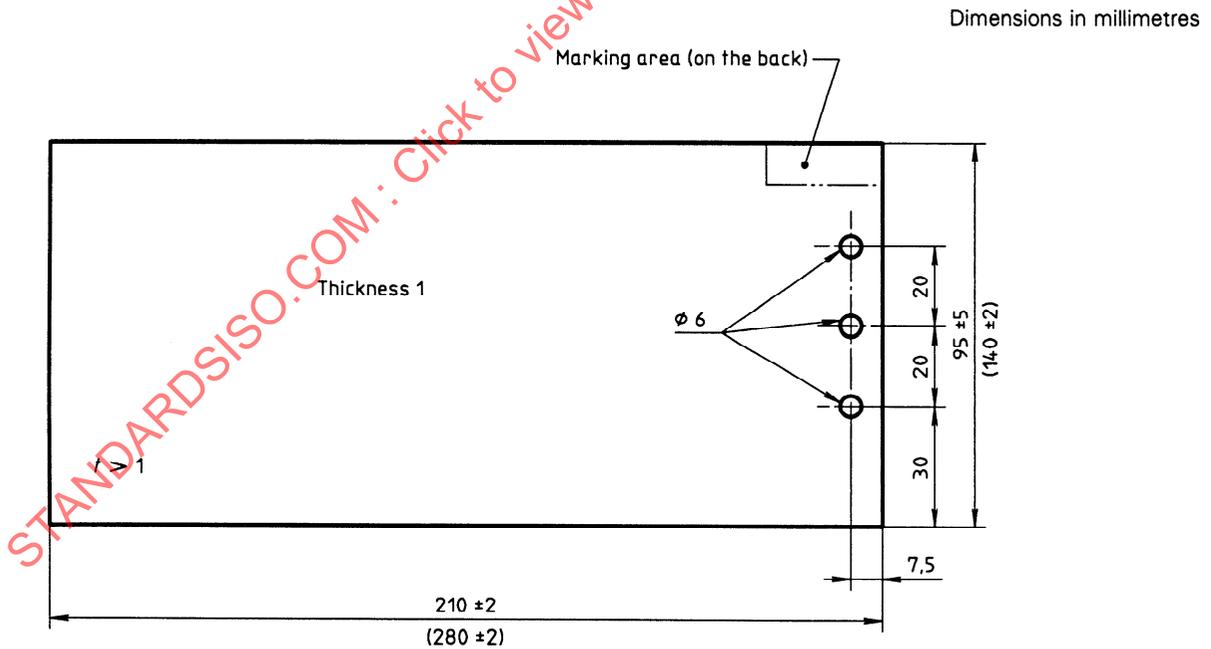


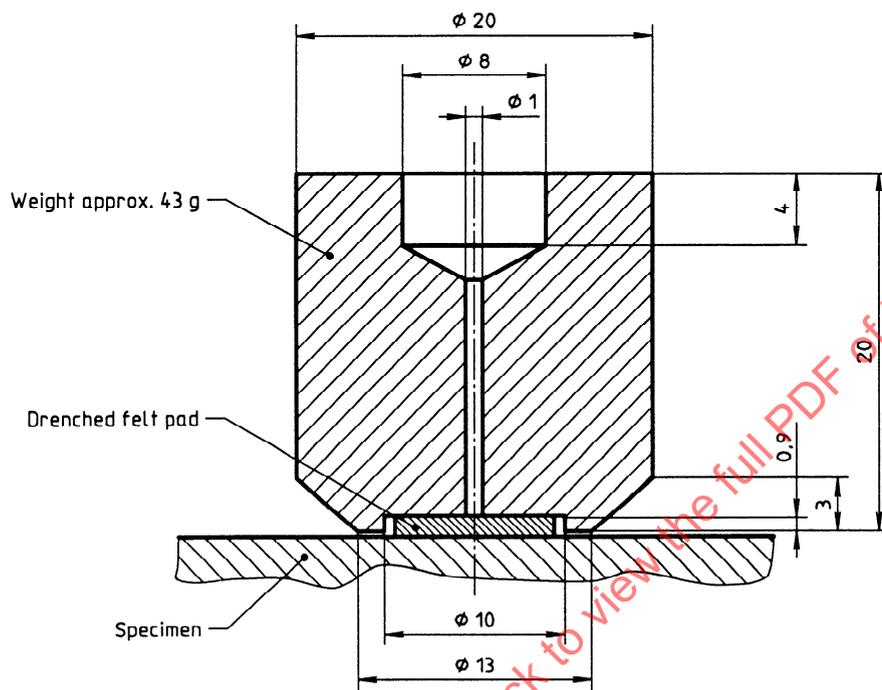
Figure 1 — Sample sheet

### 3.3 Test weight and arrangement of test pads

For the duration of the test, the felt pad, drenched in test agent, shall be weighted by means of a high-grade steel (e.g. X 5 CrNi 18 9 or X 5 CeNi 18 10) weight as shown in figure 2.

Where corrosive agents (such as concentrated acids or acids developing corrosive vapour) capable of attacking the weight are used for testing, the test pad shall be covered with a polytetrafluoroethylene (PTFE) capsule as shown in figure 3 before placing the weight on it.

Dimensions in millimetres



Tolerances

Dimension	Tolerance
0,5 to 6 inclusive	± 0,1
> 6 to 30 inclusive	± 0,2
> 30 to 120	± 0,3

Figure 2 — Weight and test arrangement

Dimensions in millimetres  
Tolerances as shown in figure 2

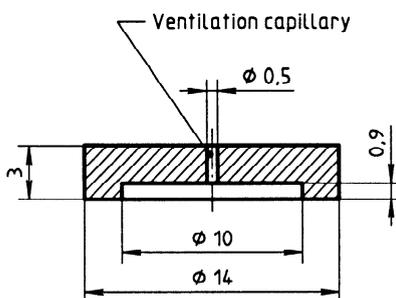


Figure 3 — Capsule

Normally, up to 21 test pads can be placed on a specimen with dimensions as shown in figure 1, provided that the pads are arranged in seven lines of three exposure areas each. Care shall however be taken to leave sufficient space between the exposure areas to prevent mutual contamination of the test agents. Each exposure area shall be appropriately identified by means of a pressure-sensitive label showing the test agent used and the degree of severity. Direct lettering in pencil or by similar means is unacceptable.

#### 4 Conditioning

Each of the test agents listed for a conditioning method shall be included in the test performed in accordance with that conditioning method.

The exposure time begins as soon as the drenched test pad is placed upon the specimen.

#### 4.1 Conditioning method 86: Basic cosmetic substances and artificial hand sweat

See table 1.

#### 4.2 Conditioning method 87: Laboratory agents

See table 2.

#### 4.3 Conditioning method 88: Production plant resources

See table 3.

#### 4.4 Conditioning method 89: Fuels and resources for aircraft, naval vessels and land vehicles

See table 4.

**Table 1 — Degrees of severity for conditioning method 86: Basic cosmetic substances and artificial hand sweat**

Degree of severity	01	02	03
<b>Test agents</b>	Paraffin oil, high purity Glycerine, high purity Vaseline, white <sup>1)</sup> Lanoline (unguentum molle) <sup>1)</sup> Cold cream (unguentum leniens) <sup>1)</sup> Artificial hand sweat <sup>2)</sup>		
<b>Exposure time, days</b>	1	7	30
<b>State of operation</b>	1 or 2		
1) Felt pad drenched in melted test agent. 2) Composition (high purity): 4,0 g sodium chloride (NaCl) 1,0 g urea [CO(NH <sub>2</sub> ) <sub>2</sub> ] 3,5 g ammonium chloride (NH <sub>4</sub> Cl) 3 ml lactic acid [CH <sub>3</sub> CH(OH)COOH] 0,5 ml acetic acid (CH <sub>3</sub> COOH) 0,5 ml pyruvic acid (CH <sub>3</sub> COCOOH) 1,7 ml butyric acid (C <sub>3</sub> H <sub>7</sub> COOH) Add sufficient distilled water to make 1 000 ml of solution.			

Table 2 — Degrees of severity for conditioning method 87: Laboratory agents

Degree of severity	01	02	03	04
<b>Test agents</b>	Sulfuric acid (H <sub>2</sub> SO <sub>4</sub> ), 95 % (m/m) to 97 % (m/m) Nitric acid (HNO <sub>3</sub> ), 65 % (m/m) Hydrochloric acid (HCl), 25 % (m/m) Acetic acid (CH <sub>3</sub> COOH), 96 % (m/m) Trichloroacetic acid (CCl <sub>3</sub> COOH), 40 % (m/m) Potassium hydroxide (KOH) solution, 50 % (m/m) <span style="float: right;">} high purity</span>			
<b>Mixture ratio of test agent/distilled water</b> (m/m)	1 : 20	1 : 10	1 : 1	1 : 0
<b>Exposure time</b> min	120			10
<b>Test agents</b>	Ethanol (C <sub>2</sub> H <sub>5</sub> OH) Acetone (CH <sub>3</sub> COCH <sub>3</sub> ) Acetic acid ethyl ester (CH <sub>3</sub> COOC <sub>2</sub> H <sub>5</sub> ) Dichloromethane (CH <sub>2</sub> Cl <sub>2</sub> ) Xylene [C <sub>6</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>2</sub> ] <span style="float: right;">} high purity</span>			
<b>Exposure time</b> min	5	15	30	60
<b>State of operation</b>	1 or 2			

Table 3 — Degrees of severity for conditioning method 88: Production plant resources

Degree of severity	01	02	03
<b>Test agents</b> <sup>1)</sup>	Hydraulic oil (H-LP), kinematic viscosity: 46 mm <sup>2</sup> /s at 40 °C Synthetic oil, ester-base (e.g. dioctylsebacate) Synthetic oil, polyglycol-base or polysilicone-base (e.g. dimethylpolysiloxane kinematic viscosity: 100 mm <sup>2</sup> /s at 25 °C) Synthetic oil, phosphate-ester base Cooling lubricating emulsion, for machining purposes (cooling lubrication essence <sup>2)</sup> in water), mass fraction <i>w</i> (essence) = 0,04 Cooling lubricating solution for grinding purposes (free of mineral oils). Synthetic additives mass fraction <i>w</i> = 0,05 General-purpose detergent Perchloroethylene Trichlorethane Trichlorethylene <span style="float: right;">} high purity</span> Ethanol, mass fraction <i>w</i> (ethanol) = 0,96 (denaturated by means of methylethylketone)		
<b>Exposure time</b> h	2	6	16
<b>State of operation</b>	1 or 2		

1) The relevant specification specifies the commercial type, if not indicated in this table.

2) Composition of essence:

mineral oil, mass fraction  $w_1 \leq 0,04$

EP additives, sulfur-, chlorine-, or phosphate-base, mass fraction  $w_2 \leq 0,20$

Emulsifying agent in water, mass fraction  $w_3 \geq 0,6$

**Table 4 — Degrees of severity for conditioning method 89: Fuels and resources for aircraft, naval vessels and land vehicles**

Degree of severity	01	02	03
<b>Test agents</b> <sup>1)</sup>	Petrol, super-grade Fuel oil (diesel-oil) Turbine fuel for aircraft Turbine lubricating oil, synthetic Combustion engine lubricating oil Lubricating grease for aircraft and instruments Hydraulic oil, mineral-base Hydraulic-fluid, phosphoric-ester-base Damping fluid, silicone-oil-base Brake fluid for motor vehicles De-icing and defrosting fluids Antifreeze agent Fire-extinguishing agent (bromochlorodifluoromethane) General-purpose detergent Potassium hydroxide (KOH) (alkaline battery electrolyte), mass fraction $w(\text{KOH}) = 0,35$ Sulfuric acid ( $\text{H}_2\text{SO}_4$ ) (acid battery electrolyte), mass fraction $w(\text{H}_2\text{SO}_4) = 0,34$ Diester mixture <sup>2)</sup>		
<b>Exposure time</b> h	2	6	16
<b>State of operation</b>	1 or 2		
1) The relevant specification specifies the commercial type, if not indicated in this table. 2) Composition: liquid paraffin, mass fraction $w_1 = 0,65$ dioctylphthalate, mass fraction $w_2 = 0,20$ tricresylphosphate, mass fraction $w_3 = 0,15$			

## 5 Procedure

### 5.1 General

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

### 5.2 Preconditioning

Prior to exposure, and unless otherwise specified in the relevant specification, specimens with a physically drying coat shall be conditioned at a temperature of  $23\text{ °C} \pm 2\text{ °C}$  and a relative humidity of  $(50 \pm 3)\%$  (hereafter called condition A) for 7 days. After this period, recondition the specimens by drying at  $70\text{ °C}$  for 3 h and again store in condition A for a further 24 h.

Specimens with heat-cured coatings shall be stored in condition A for 24 h before testing.

Varnishes cured at ambient temperature shall be stored successively in condition A for 24 h, at  $80\text{ °C}$  for drying for 24 h, and once more in condition A for 24 h.

Under no circumstances shall the specimens be cleaned using any liquid media prior to exposure. Dust may be removed by means of a soft brush or dry compressed air.

### 5.3 Test sequence

Thoroughly wet the test pads (3.2) by drenching them in the test agents. Without delay and as rapidly as possible, distribute the pads on the horizontal specimen at distances from one another that prevent mutual contamination, and weight them with the tests weights (see figure 2).

Care shall be taken to fit the test pads properly into the recesses provided for this purpose in the bottom of the test weight or capsule (see figure 3). If

necessary, carefully remove, using filter paper, any test agent leaking past the edge of the test weight or the air-venting capillary of the capsule after the pads have been weighted.

In the event of relatively long exposure times with solvents of high volatility, e.g. acetone, re-wet the pads using a pipette and funnel to drip the solvent through the capillary of the test weight. The test pads shall be kept thoroughly wet during the exposure time.

The relevant specification may require testing of a complete instrument or assembly if the instrument or assembly is likely to encounter, during its lifetime, complete flooding rather than partial contamination only. After having conditioned such specimens as described in 5.2, completely and copiously spray the surface, by means of an atomizer, with the test agent specified in the relevant specification. Test agent running off during exposure shall not be replaced.

#### 5.4 Recovery

Unless otherwise specified in the relevant specification, remove the test pads after exposure, rinse the specimens with demineralized water and dry them by means of compressed air. Using filter paper, a soft cloth, or cottonwool, pat dry test agents that are not soluble in water.

Evaluate the specimens immediately after having dried them. Store them for a further 24 h in condition A (5.2), and evaluate them once more.

#### 5.5 Evaluation

Immediately after recovery (5.4), evaluate the specimen with respect to each conditioning method and degree of severity in accordance with table 5.

- a) With the unaided eye and using appropriate illumination by varying the angle of incidence and view, evaluate the contamination caused by each test agent and determine the evaluation grade in conformity with table 5.
- b) At least three persons shall perform the evaluation and determination of the evaluation grade.
- c) Calculate the mean value of the evaluation for the test agent specified for one conditioning.
- d) This mean value shall represent the result of the test.

#### 5.6 General level for acceptance

Unless otherwise specified in the relevant specification, the test shall be accepted as successful if the mean value of the evaluation grade is less than or equal to 2,5.

**Table 5 — Evaluation grade**

Grade	Criteria
0	No visible degradation
1	Scarcely visible degradation of the brilliance and/or colour of the surface; no visible changes in the surface structure
2	Plainly visible moderate degradation of brilliance and/or colour, and/or just visible structural changes in the surface; first traces of cracking and blistering; no bared parts of the metallic substrate
3	Medium to severe changes in colour and brilliance, also extending beyond the contact area proper, and/or other obvious to severe degradation including also visible changes in the surface structure, such as blisters, cracks, ridging, flaking, etc.; destructive corrosion of not more than approximately 5 % to 7 % of the contact area, laying bare the metallic substrate
4	Heavy degradation, e.g. substantial discoloring and/or structural changes; and/or destructive corrosion of more than 7 % to 10 % of the contact area, laying bare the metallic substrate

## 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 contamination by laboratory agents, conditioning method 87, degree of severity 02, state of operation 1, shall be identified as:

**Environmental test ISO 9022-87-02-1**

## 7 Specification

The relevant specification shall contain the following details:

a) environmental test code;

b) type and number of specimens;

c) test agents not to be used and/or test agents to be used in addition;

d) Test agents to be used for testing complete instruments or assemblies; identification of the commercial type of the test agents specified for conditioning methods 88 and 89;

e) type and scope of initial test;

f) preconditioning if other than described in 5.2;

g) recovery if other than described in 5.4;

h) type and scope of final test;

i) criteria for evaluation taking account of 5.5;

j) type and scope of test report.

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