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**Optics and photonics —  
Environmental test methods —**

**Part 12:  
Contamination**

*Optique et photonique — Méthodes d'essais d'environnement —  
Partie 12: Contamination*

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## 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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

This second edition cancels and replaces the first edition (ISO 9022-12:1994), of which it constitutes a minor revision.

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

- Part 1: *Definitions, extent of testing*
- Part 2: *Cold, heat and humidity*
- Part 3: *Mechanical stress*
- Part 4: *Salt mist*
- Part 6: *Dust*
- Part 7: *Resistance to drip or rain*
- Part 8: *High internal pressure, low internal pressure, immersion*
- Part 9: *Solar radiation and weathering*
- Part 11: *Mould growth*
- Part 12: *Contamination*
- Part 14: *Dew, hoarfrost, ice*
- Part 17: *Combined contamination, solar radiation*
- Part 20: *Humid atmosphere containing sulfur dioxide or hydrogen sulfide*

- *Part 22: Combined cold, dry heat or temperature change with bump or random vibration*
- *Part 23: Low pressure combined with cold, ambient temperature and dry and damp heat*

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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 and to remain within defined specifications.

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 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.

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 is to 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 can arise where application of both ISO 9022 and other appropriate International Standards will be necessary.

# Optics and photonics — Environmental test methods —

## Part 12: Contamination

### 1 Scope

This part of ISO 9022 specifies the methods relating to the environmental tests of optical instruments including additional assemblies from other fields (e.g. mechanical, chemical, and electronic devices), under equivalent conditions, for their ability to resist the influence of 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 in this part of ISO 9022 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 references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9022-1, *Optics and photonics — 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.

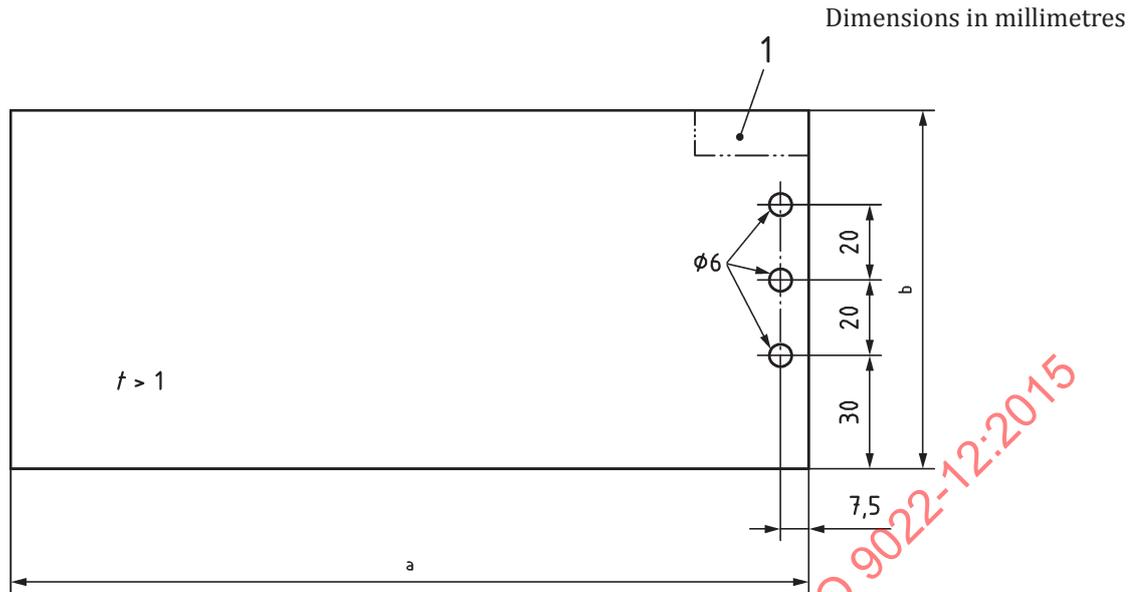
The test agents listed from each conditioning method (Clause 4) represent different chemical groups.

#### 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 sample sheets 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.

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

1) Another possible source of service contamination to which optical instruments can 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.



**Key**

- 1 marking area (on the back)
- a 210 ± 2 (280 ± 2)
- b 95 ± 5 (140 ± 2)

**Figure 1 — Sample sheet**

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 sample sheet in the same manner as required for the original instrument. The coating shall completely surround the sample sheet 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 sample sheets as shown in [Figure 1](#) are not available, as level a surface as possible of representative instrument 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:

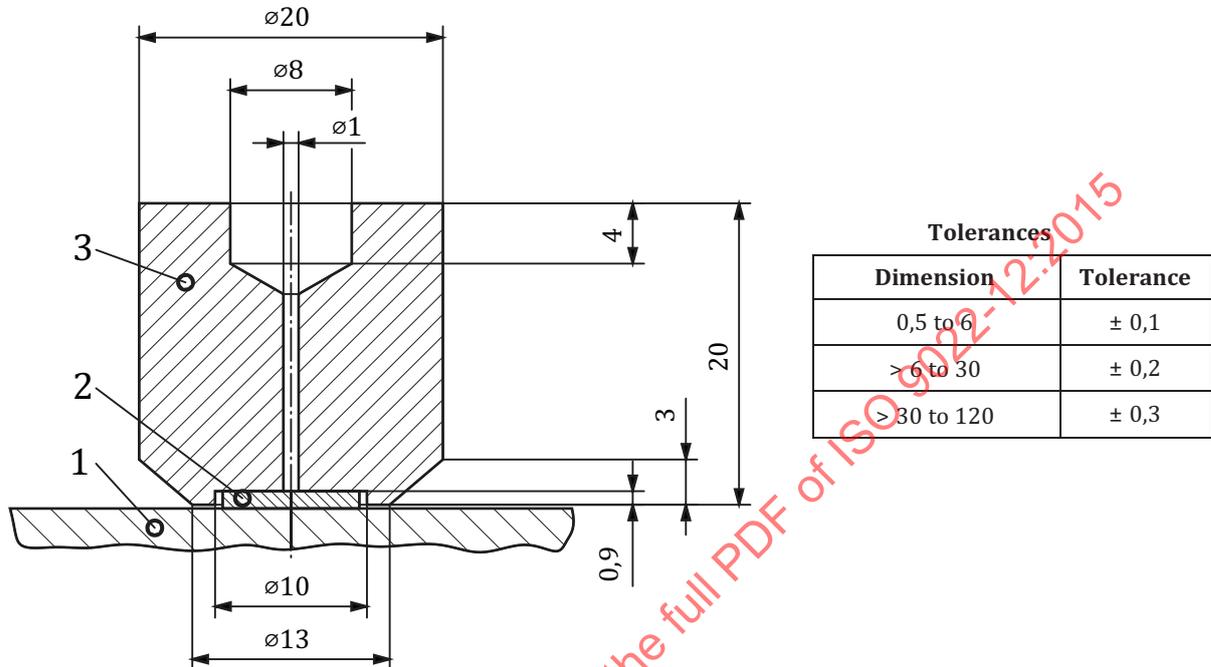
- colour: white
- mass density: 0,25 g/cm<sup>3</sup> to 0,30 g/cm<sup>3</sup>
- pH: 5 to 8 (for measurement, see [Annex A](#))
- thickness: 1 mm
- diameter 9 mm

The felt pads shall be used only once.

### 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](#).

Dimensions in millimetres



#### Key

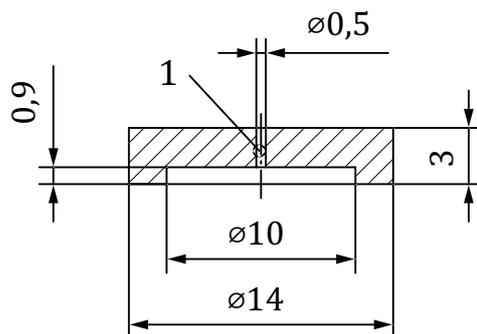
- 1 specimen
- 2 drenched felt pad
- 3 weight approx. 43 g

**Figure 2 — Weight and test arrangement**

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.

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.

Dimensions in millimetres  
Tolerances as shown in [Figure 2](#)



#### Key

1 ventilation capillary

Figure 3 — Capsule

## 4 Conditioning

### 4.1 General

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.

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

See [Table 1](#).

### 4.3 Conditioning method 87: Laboratory agents

See [Table 2](#).

### 4.4 Conditioning method 88: Production plant resources

See [Table 3](#).

### 4.5 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
Test agents	Paraffin oil, high purity Glycerine, high purity Vaseline, white <sup>a</sup> Lanoline (unguentum molle) <sup>a</sup> Cold cream (unguentum leniens) <sup>a</sup> Artificial hand sweat <sup>b</sup>		
Exposure time, days	1	7	30
State of operation	1 or 2		
<sup>a</sup> Felt pad drenched in melted test agent. <sup>b</sup> 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
Test agents	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)			high purity
Mixture ratio of test agent/distilled water (m/m)	1:20	1:10	1:1	1:0
Exposure time min	120			10
Test agents	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> ]			high purity
Exposure time min	5	15	30	60
State of operation	1 or 2			

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

Degree of severity	01	02	03
Test agents <sup>a</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>b</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 Trichloroethylene Ethanol, mass fraction <i>w</i> (ethanol) = 0,96 (denaturated by means of methylethylketone)		
Exposure time h	2	6	16
State of operation	1 or 2		
<sup>a</sup> The relevant specification specifies the commercial type, if not indicated in this Table. <sup>b</sup> 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
Test agents <sup>a</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>b</sup>		
Exposure time      h	2	6	16
State of operation	1 or 2		
<sup>a</sup> The relevant specification specifies the commercial type, if not indicated in this Table. <sup>b</sup> Composition: liquid paraffin, mass fraction $w_1 = 0,65$ dioctylphthalate, mass fraction $w_2 = 0,20$ tricresilophosphate, 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 with 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 test 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 might 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 the 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.