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Optics and photonics — Environmental test methods —

Part 14: Dew, hoarfrost, ice

Optique et photonique — Méthodes d'essais d'environnement —

Partie 14: Rosée, givre, glace

Reference number
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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).

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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 9022-14:1994), 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 sulphide*

— *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*

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 14:
Dew, hoarfrost, ice

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 dew, hoarfrost or ice.

The purpose of testing is to investigate to what extent the optical, climatic, mechanical, chemical, and electrical (including electrostatic) performance characteristics of the specimen are affected by dew, hoarfrost, or ice.

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*

ISO 9022-4, *Optics and photonics — Environmental test methods — Part 4: Salt mist*

3 General information and test conditions

Exposure to dew, hoarfrost, or ice is effected by rapid change of the environmental conditions in a chamber or by transferring the specimen from a cold chamber to a conditioned room. Instrument parts not exposed to hoarfrost or icing conditions during normal use should be protected from exposure to such conditions during test.

4 Conditioning

Table 1 shows the conditioning methods 75 (dew), 76 (hoarfrost followed by the process of thawing), and 77 (ice covering followed by the process of thawing). Conditioning method 77 (ice covering followed by the process of thawing) includes two types of ice formation (see Annex A for details):

— rime ice: degree of severity 01 applies;

— glazed ice: degrees of severity 02 to 04 apply.

Table 1 — Degrees of severity for conditioning methods 75, 76, and 77

Conditioning method			75	76			77			
Step 1	Degree of severity		01	01	02	03	01	02	03[a]	04[a]
	Test chamber temperature	°C	10 ± 2	−10 ± 2	−25 ± 3		−15 ± 3		−25 ± 3	
	Exposure time		Until specimen has reached a temperature within 3 °C of the test chamber temperature[b].							
Step 2	Test chamber temperature	°C	Not applicable			−5 ± 2			−15 ± 3	−25 ± 3
	Hoarfrost, rime ice, or glazed ice build-up on test surfaces[c]	mm				0,5 to 2	2 to 4	5 to 7	20 to 30	≥75
	Exposure time					Until the specimen has reached a temperature within 3 °C of the test chamber temperature[b].				
Step 3	Test chamber temperature	°C	30 ± 2							
	Relative humidity	%	80 to 95							
	Exposure time		Until specimen has reached a temperature within 3 °C of the test chamber temperature[b].							
State of operation			1 or 2							

[a] Only applicable for outside-mounted naval equipment.

[b] Where heat-dissipating specimens are involved, temperature soaking shall be deemed to be satisfactory if, at stabilized test chamber temperature, the temperature of the specimen does not change by more than 3 °C within one hour.

[c] Test surfaces as specified by the relevant specification.

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

Unless otherwise specified in the relevant specification, the surface of the specimen shall be properly cleaned using nonresidue neutral cleaning agents only. After cleaning, the specimen shall be restored to service condition (as, for instance, by applying protecting grease, etc.).

5.3 Test sequence

5.3.1 Conditioning method 75, degree of severity 01; conditioning method 76, degrees of severity 01 and 02

After temperature stabilization in step 1, immediately expose the specimen to the environmental conditions of step 3. This can be done by transferring the specimen to a conditioned room or changing the test chamber conditions.

5.3.2 Conditioning method 76, degree of severity 03

After temperature stabilization of the specimen in step 1, proceed to step 2 and heat the test chamber to −5 °C. Produce hoarfrost by directing water vapour or atomized spray against the specimen, using a fine nozzle spray gun arranged at a distance of 0,5 m from the specimen.

If state of operation 2 is required, perform an intermediate test after completion of step 2, immediately proceed to step 3, and perform another intermediate test during the process of thawing.

5.3.3 Conditioning method 77

5.3.3.1 Degree of severity 01

After temperature stabilization of the specimen during step 1, proceed to step 2 and heat the test chamber to −5 °C. Produce a build-up of opaque rime ice, as thick as required, on the specimen by directing a spray of atomized-water, pre-cooled to 5 °C, against the specimen (using a coarse nozzled spray gun arranged at a distance of 0,2 m to 0,3 m from the specimen).

Continue as specified in 5.3.2.

5.3.3.2 Degrees of severity 02 to 04

After temperature stabilization of the specimen in step 1, proceed to step 2 and procedure a build-up of glazed ice on the specimen as required. This can be achieved by sprinkling or pouring freezing water on the specimen (in several layers, if necessary).

If the test solution (salt water) specified in ISO 9022-4 is to be used for producing the build-up of glazed ice when testing to degrees of severity 03 and 04, the relevant specification shall include an appropriate note.

Continue as specified in 5.3.2.

5.4 Recovery

Unless otherwise specified in the relevant specification, superficially dry the specimen after removal from the test chamber. Do not use compressed air for drying. Restore specimen to ambient temperature.

5.5 Final test

Condensed moisture visible on optical surfaces within the specimen shall be acceptable provided that such films vanish within the time interval specified in the relevant specification. Unless penetrated water can be detected by visual inspection, the relevant specification shall specify an appropriate method of verification.

6 Environmental test code

The environmental test code shall be as defined in ISO 9022-1, giving a reference to ISO 9022 and the codes for the conditioning method chosen, the degree of severity and the state of operation.

EXAMPLE The environmental test of optical instruments for resistance to hoarfrost, conditioning method 76, degree of severity 03, state of operation 1, is identified as:

Environmental test ISO 9022-76-03-01

7 Specification

The relevant specification shall contain the following details:

a) environmental test code;

b) number of specimens;

c) number, location, and method of installation of temperature sensors;

d) position and mounting of specimen in the test chamber (e.g. on a turntable);

e) size and position of the test surfaces on the specimen;

f) method of producing hoarfrost or ice build-up, if other than described in 5.3.2 and 5.3.3;

g) preconditioning if other than described in 5.2;

h) type and scope of initial test;

i) if state of operation 2 is required: time of operation;

j) if state of operation 2 is required: type and scope of intermediate test;

k) recovery, if other than described in 5.4;

l) type and scope of final test if other than described in 5.5;

m) criteria for evaluation, e.g. potential amount of water allowed to penetrate, time within which moisture film shall vanish;

n) type and scope of test report.

Annex A
(informative)

Explanatory notes

A.1 General

Dew, hoarfrost, or ice degrade or impede visibility through optical instruments or front windows. Ice build-up binds moving parts together and is much more difficult to remove than dew or hoarfrost. The operation and service life of optical instruments can be degraded as the necessity of employing manual, mechanical, or chemical ice removal measures entails an increased hazard of damage to the instrument. One of the objectives of testing, therefore, is to evaluate gentle methods of removing ice build-up, hoarfrost, and dew from the instrument.

A.2 Dew

The formation of dew is caused by water vapour condensing from the surrounding air on the surface of instruments the temperature of which is above 0 °C but below the dew point of the surrounding relative humidity. Dew can also occur on an instrument that is removed from a cold open air condition to a warm indoor environment.

A.3 Hoarfrost

Hoarfrost is a light, mostly thin and relatively easy-to-remove deposit of crystalline ice which normally occurs in the shape of scales, feathers, fans, or needles, formed by water vapour condensing, from the surrounding clear air on surfaces the temperature of which is below 0 °C. Thick build-up of hoarfrost can be produced by blowing water vapour or water fog against the cold instrument.

A.4 Ice build-up

A.4.1 General

There are two ways of compact natural ice build-up on instruments: non-transparent rime ice and more or less transparent glazed ice, the grade of transparency being dependent upon the thickness of the build-up. Being saturated with air, rime ice is about a quarter the mass by volume of glazed ice, whereas the latter is nearly as dense as pure ice.

A.4.2 Rime ice formation

Rime ice is a deposit of caking granular particles. The colour ranges from haze grey to white, depending upon the density of build-up. Rime ice is much denser and more compact than hoarfrost and therefore much less easy to remove.

It will occur wherever fog or drizzle falls on surfaces that are colder than 0 °C. The deposited precipitation can accumulate to a considerable thickness and can form large upwind plumes.

A.4.3 Glazed ice build-up

Glazed ice will build up wherever air or supercooled rain falls on surfaces that are colder than 0 °C. Supercooled rain can also lead to glazed ice build-up on surfaces the temperature of which is slightly above 0 °C.

Thick glazed ice build-up can occur on ships from rain, sea spray, or seawater, coating the instrument when the temperatures are below freezing. When testing to degrees of severity 03 and 04, salt water can be required to produce glazed ice because the lower freezing point of salt water can degrade the process of thawing where ice removal measures are employed.

Corrosion behaviour as a result of the use of seawater is not an object of testing as understood by this part of ISO 9022.

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