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Third edition

Optics and photonics — Guidance for the selection of environmental tests

Optiques et photonique — Directives relatives au choix des essais environnementaux

PROOF/ÉPREUVE

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 172, *Optics and photonics*, Subcommittee SC 1, *Fundamental standards*.

This third edition cancels and replaces the second edition ISO 10109:2015 which has been technically revised.

The main changes are as follows:

— standard environments were revised and new standard environments were added.

— example of selection of standard environmental tests were added as Annex B.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Optical and photonic instruments including additional assemblies from other fields (e.g. mechanical, chemical, and electronic devices) are affected during their use by a number of different environmental and handling parameters, which they are required to resist without significant reduction in performance and to remain within defined specifications. This is what the manufacturer attempts to ensure and the user expects to receive.

This expectation can be assessed by exposure of the instrument to a range of simulated environmental parameters under controlled laboratory conditions. The cumulative combination, degree of severity, and sequence of these conditions can be selected to obtain meaningful results in a relatively short period of time.

Technical requirements as given in the tables of this document are abbreviated and the reader has to consult the referenced standards (i.e. the relevant part of ISO 9022) for the full specification of the technical requirement.

For the purposes of this document, nominal values for properties or performance characteristics are understood to be the manufacturer's internal technical data and do not directly reflect manufacturer's product specifications.

Optics and photonics — Guidance for the selection of environmental tests

1 Scope

This document contains tables for environmental tests and test parameters which can be used as a guideline for the selection of environmental tests. These include the selection of standardized tests according to ISO 9022 as well as additional parameters not described in ISO 9022 and necessary for the optical or photonic instruments. Ultimately, these tables specify the requirements to be met with regard to the reliability of the optical, mechanical, chemical, and electrical properties or performance characteristics of the instruments when exposed to environmental influences.

Environmental test methods, as specified in ISO 9022 (all parts), can be assigned to the various areas of application for the purpose of ascertaining the suitability of the instruments in the respective area of application.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
environmental requirement
specific natural and technical environmental influences between the limiting values of which optical instruments and instruments with optical, mechanical, chemical, and electrical components are to be operable

3.2
technical requirement
defined limiting value for the natural and technical environmental influences occurring in the envisaged area of application

Note 1 to entry: In order to verify whether an instrument fulfils a technical requirement, conditioning methods can be stipulated with degrees of severity whose limiting values are either higher or lower than those specified.

3.3
extent of testing
sum of all required tests to ascertain operability as well as product performance within the intended use and time of life

Note 1 to entry: The extent of design verification/testing is subdivided into

— design verification and production process controlling (not addressed by this International Standard), and

— testing of functional models, prototypes, and production series products.

3.4
area of application
classification of the operability of an instrument within a defined environment and intended application

Note 1 to entry: The manufacturer defines the environment parameters. This can be done, e.g. by using pre-defined 'standardized areas of application' such as in Table 3 to Table 12 in full or in part.

EXAMPLE General application in an office environment with air conditioning; or an outdoor application, non-weather protected in arctic climate.

3.5
conditioning method
individual or combined environmental influence(s) to which the specimen is submitted during the test, e.g. shock or damp heat

3.6
degree of severity
parameter containing all the individual quantities required for the test

Note 1 to entry: See also ISO 9022-2 to ISO 9022-23.

EXAMPLE Temperature, humidity, conditioning time, and others have to be defined for the intended area of application.

3.7
state of operation
code that designates the state of operation of a specimen

Note 1 to entry: Table 1 gives states of operation in accordance with ISO 9022 (all parts).

Table 1 — States of operation

State of operation	Comment
0	Specimen in its normal transport and/or storage container as provided by the manufacturer (transport container, shipping package).
1	Specimen is unprotected, ready for operation, power supply not connected.
2	Specimen is in operation during conditioning for a period to be specified in the relevant specification. The mode of the operating status is specified in the relevant specification. During operation, a check is performed to establish if the specimen is functioning as required.

3.8
status after test
code that designates the outcome of the test

Note 1 to entry: Table 2 gives the status after test.

Table 2 — Status after test

Status after test	Comment
A	All performance criteria are satisfied.
B	All performance criteria are satisfied. Damage to parts not needed for function or reduced life are possible.
C	Not all performance criteria are satisfied. Damage to parts not needed for function or reduced life are possible.
D	Device may not operate anymore; damage is expected.

4 Environmental influences

4.1 General

Table 3 to Table 13 classify and describe standardized environment areas, which constitute a summary of the various environmental requirements with major influences to products during shipping, transport, storage, and operation.

The values for standard environments 1, 2, 7, 8, 9, 10, and 11 have been compiled from excerpts of IEC 60721-2-1, IEC 60721-3-4, MIL-STD-810H, and MIL-HDBK-310.

Standard environment 5 and 13 are defined for use in weather-protected locations.

Standard environment 2 and 6 are both defined as an open-air climate. The temperature range for standard environment 2 applies for states of operation 0 and 1. The restricted temperature range for standard environment 6 applies for state of operation 2. The restricted limiting values of standard environment 6 are for optical precision measurements and for the use of optical consumer products in the open air.

4.2 Standard environment 1

Table 3 — Non-weather-protected locations with extremely cold climates (Arctic or Antarctic climate)

Environmental influence	Value	Comment
Temperature	−55 °C to +30 °C	This range applies for commonly experienced conditions. In extreme geographical conditions, temperatures as low as −65 °C and as high as 45 °C can occur in the location of use. With temporary or permanent storage in enclosed vehicles, sheds, hangars, or attics, temperatures of over 45 °C can be experienced in strong sunshine, and over 70 °C in extreme cases. The specification does not address these conditions.
Relative humidity	up to 100 %	
Air pressure	70 kPa to 106 kPa	50 kPa to 110 kPa in unfavourable conditions.
Total solar irradiance	up to 1,1 kW/m^2	Intensity of global radiation on earth's surface, depending on the latitude.
Amount of precipitation (rain, snow, or hail)	≤15 mm/min	
Dew or ice build-up	yes	

4.3 Standard environment 2

Table 4 — Global locations, non-weather-protected locations in basic regional type[a]

Environmental influence	Value	Comment
Temperature[b]	−33 °C to +50 °C	This range applies for commonly experienced conditions. In extreme geographical conditions, temperatures as low as −45 °C and over 50 °C can be experienced in the location of use. With temporary or permanent storage in enclosed vehicles, sheds, hangars, or attics, temperatures of over 65 °C can occur in strong sunshine, and over 70 °C in extreme cases. The specification does not address these conditions.
Relative humidity	up to 100 %	
Air pressure	70 kPa to 106 kPa	50 kPa to 110 kPa in unfavourable conditions.
Total solar irradiance	up to 1,1 kW/m^2	Intensity of global radiation on earth's surface, depending on the latitude.
Amount of precipitation (rain, snow or hail)	≤5 mm/min	
Dew or ice build-up	yes	

[a] Standard environment 8 and 9 have a temperature range up to +55 °C.

[b] Testing for temperature range +50 °C is not currently a severity condition in ISO 9022-2.

4.4 Standard environment 3

Table 5 — Global locations, non-weather-protected, with maritime and/or coastal climate

Environmental influence	Value	Comment
Temperature	−20 °C to +35 °C	This range applies for commonly experienced conditions. Along coasts with icing, temperatures below −20 °C can be experienced, and above 35 °C along tropical coasts. With temporary or permanent storage in enclosed vehicles, sheds, hangars, or attics, temperatures over 50 °C can be experienced in strong sunshine, and over 70 °C in extreme cases. The specification does not address these conditions.
Relative humidity	up to 100 %	
Air pressure	90 kPa to 106 kPa	50 kPa to 110 kPa in unfavourable conditions.
Total solar irradiance	up to 1,1 kW/m^2	Intensity of global radiation on earth's surface, depending on the latitude.
Amount of precipitation (rain, snow or hail)	≤15 mm/min	
Dew or ice build-up	yes	

4.5 Standard environment 4

Table 6 — High altitudes of up to 30 000 m

Environmental influence	Value	Comment
Temperature	−65 °C to +55 °C	This range applies for commonly experienced conditions. Above polar zones, temperatures below −65 °C have to be expected. With temporary or permanent storage in enclosed vehicles, sheds, hangars, or attics, temperatures over 55 °C can be experienced in strong sunshine, and over 85 °C in extreme cases. The specification does not address these conditions.
Relative humidity	up to 100 %	
Air pressure	1 kPa to 106 kPa	
Total solar irradiance	up to 1,4 kW/m^2	Intensity of radiation at altitude of 30 000 m.
Amount of precipitation (rain, snow or hail)	≤15 mm/min	
Dew or ice build-up	yes	

4.6 Standard environment 5

Table 7 — Technical climate in weather-protected locations

Environmental influence	Value	Comment
Temperature	+10 °C to +35 °C	This range applies for commonly experienced conditions. In unfavourable conditions, temperatures below 10 °C and over 35 °C may occur. The specification does not address these conditions.
Relative humidity	up to 85 %	
Air pressure	70 kPa to 106 kPa	50 kPa to 110 kPa in unfavourable conditions.
Total solar irradiance	up to 0,9 kW/m^2	Without protection from sunshine, depending on the latitude.

4.7 Standard environment 6

Table 8 — Non-weather-protected locations with restricted limiting values

Environmental influence	Value	Comment
Temperature	−20 °C to +50 °C	The restricted temperature range applies for state of operation 2. The values of standard environment 2 apply for the states of operation 0 and 1.
Relative humidity	up to 100 %	
Air pressure	70 kPa to 106 kPa	50 kPa to 110 kPa in unfavourable conditions.
Total solar irradiance	up to 1,1 kW/m^2	The total solar irradiance depends on the latitude. Beware of critical values in and on the instruments when combining heat and solar irradiance.
Amount of precipitation (rain, snow or hail)	≤5 mm/min	
Dew or ice build-up	yes	