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Optics and photonics — Guidance for the selection of environmental tests

Optiques et photonique — Directives relatives au choix des essais environnementaux

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Foreword

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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*, SC 1, *Fundamental standards*.

This second edition cancels and replaces the first edition (ISO 10109:2014), of which it constitutes a minor revision.

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 International Standard are abbreviated and the reader has to consult the referenced standards (i.e. the relevant ISO 9022 part) for the full specification of the technical requirement.

For the purposes of ISO 10109, 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 International Standard 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 Terms and definitions

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

2.1
environmental requirements
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

2.2
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.

2.3
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.

2.4
severity of testing
number of specimens per production batch/series or sample production to be subjected to a specific test

Note 1 to entry: The severity of testing is stipulated in the relevant specification or in the instrument standard.

2.5
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 predefined 'standardized areas of application' such as in Table 3 to Table 8 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.

2.6
conditioning method
individual or combined environmental influence(s) to which the specimen is submitted during the test, e.g. shock or damp heat

2.7
degree of severity
parameter containing all the individual quantities required for the test

Note 1 to entry: See also the specific parts of ISO 9022.

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

2.8
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.

2.9
status after test
code that designates the outcome of the test as given in Table 2

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.

3 Environmental influences

3.1 General

Table 3 to Table 8 classify and describe standardized environment areas, which constitute a summary of the various environmental parameters with major influences to products during shipping, transport, storage, and operation.

The values for standard environments 1 and 2 have been compiled from excerpts of IEC 60721-2-1 and IEC 60721-3-4.

Standard environment 5 is defined for use in weather-protected locations.

Standard environment 6 is defined as an open-air climate with restricted limiting values for optical precision measurements and for the use of optical consumer products in the open air.

3.2 Standard environment 1

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

Environmental influence	Value	Comment
Temperature	−65 °C to +35 °C	This range applies for commonly experienced conditions. In extreme geographical conditions, temperatures as low as −75 °C and as high as 40 °C can occur in the location of use. With temporary or permanent storage in enclosed vehicles, sheds, hangars, or attics, temperatures of over 35 °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	

3.3 Standard environment 2

Table 4 — Global locations, non-weather-protected, with the exception of cold and extremely cold climates

Environmental influence	Value	Comment
Temperature	−33 °C to +55 C	This range applies for commonly experienced conditions. In extreme geographical conditions, temperatures as low as −45 °C and over 60 °C can be experienced in the location of use. With temporary or permanent storage in enclosed vehicles, sheds, hangars, or attics, temperatures of over 55 °C can occur in strong sunshine, and over 85 °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.

Table 4 *(continued)*

Environmental influence	Value	Comment
Amount of precipitation (rain, snow or hail)	≤15 mm/min	
Dew or ice build-up	yes	

3.4 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 35 °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	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	

3.5 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 1,4kW/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	

3.6 Standard environment 5

Table 7 — Technical climate in weather-protected locations

Environmental influence	Value	Comment
Temperature	+15 °C to +35 °C	This range applies for commonly experienced conditions. In unfavourable conditions, temperatures below 15 °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.

3.7 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)	≤6 mm/min	
Dew or ice build-up	yes	

4 Table for environmental tests and test parameters

The wide range of technologies applied in complex instruments often requires specific and individually selected test parameters, test sequences, and combined tests. Table 9 is a collection of mainly climatic and mechanical tests.

The user of this International Standard, e.g. a manufacturer, selects the tests and adapts the parameters to his specific equipment. A specific area of application has to be defined for every item of equipment and both the tests and the degree of severity also have to be adapted to the intended climatic and operating environment and to the customer expectations. It is up to the manufacturer to carefully select the appropriate tests, the combination of the tests, the required technical parameters, the degree of severity, the status of operation and other parameters. An example is given in Annex A.

As a general test result, the status after the test can be shown in the table for each specific test-run.

Note that in Table 9, the combination of the three columns “Conditioning method”, “Degree of severity”, and “State of operation” provide the full specification using the coded format as defined in ISO 9022-1. The column labelled “Technical requirement” is only a short description and does not reproduce the full requirement. For a full description, it is necessary to consult the referenced standards.