INTERNATIONAL STANDARD

ISO 9022-9

Second edition
2016-05-01

Optics and photonics — Environmental test methods —

Part 9: Solar radiation and weathering

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

Partie 9: Rayonnement solaire et désagrégation

Reference number
ISO 9022-9:2016(E)

Contents

Page

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).

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).

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 World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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 9022-9:1994), of which Clause 4 has been technically revised.

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*

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 a 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 may arise where application of both ISO 9022 and other appropriate International Standards will be necessary.

Optics and photonics — Environmental test methods —

Part 9:
Solar radiation and weathering

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 effects of simulated solar radiation or laboratory weathering, which is a combination of simulated solar radiation, heat, and moisture. It is applicable to instruments that may be exposed to sunlight during operation or unsheltered storage on the earth's surface, or in the lower atmosphere.

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 solar radiation or weathering (solar radiation, heat, and moisture).

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 4892-1:1999, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance*

ISO 4892-2:2013, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 9022-1, *Optics and photonics — Environmental test methods — Part 1: Definitions, extent of testing*

ISO 9370, *Plastics — Instrumental determination of radiant exposure in weathering tests — General guidance and basic test method*

IEC 60068-2-5:2010, *Environmental testing — Part 2-5: Tests — Test Sa: Simulated solar radiation at ground level and guidance for solar radiation testing*

3 General information and test conditions

A radiation source capable of generating irradiance as specified in Table 1 on the specimen surface or in a plane specified in the relevant specification is installed in a heated test chamber. The data shall include any radiation reflected from the test chamber walls but not infrared radiation emitted from the chamber walls on account of the wall temperature.

Ozone generated during exposure shall be removed from the test chamber.

The position and mounting of the specimen, the characteristics of its support and the location of the test points for measuring the radiation and the temperature within the exposure zone shall be specified in the relevant specification.

In addition to the requirements specified above, IEC 60068-2-5 applies.

4 Conditioning methods

4.1 Conditioning method 20: Solar radiation

See Table 2.

NOTE 1 Wavelengths in the atmospheric window below 280 nm are not covered by this part of ISO 9022. However, wavelengths below 280 nm can increase long-term degradation of optics, surfaces and other materials. In outdoor conditions, material degradation can therefore occur even when passing the test according to this part of ISO 9022.

NOTE 2 An irradiance of 1 kW/m^2 corresponds to the intensity of global radiation. The latter is the total radiation incident upon a horizontal area of the earth's surface and is, with the sun being at the zenith, composed of direct solar radiation and solar radiation diffusely reflected from the atmosphere. The global radiation is not constant and has therefore been determined by the International Commission on Illumination (CIE) on the basis of solar constant I_0 = 1,35 kW/m^2 (see CIE No. 20/1972).

NOTE 3 Degree of severity 01 represents extreme natural stress and is preferably used to determine thermal influences. Degree of severity 02 represents medium-degree natural stress over a long period and is preferably used to determine thermal, photomechanical and ageing influences. Degrees of severity 03 and 04 do not represent true influences but are preferably used to determine photochemical influences and to achieve artificial ageing. In addition, heating effects on specimens of low thermal capacity may be determined.

Table 1 — Spectral energy distribution of the radiation source

Spectral range		**Ultraviolet**		**Visible**			**Infrared**
Wavelength band	nm	280 to 320	beyond 320 to 400	beyond 400 to 520	beyond 520 to 640	beyond 640 to 780	beyond 780 to 3 000
Irradiance	W/m^2	5 ± 2	63 ± 15	200 ± 20	186 ± 20	174 ± 20	492 ± 100

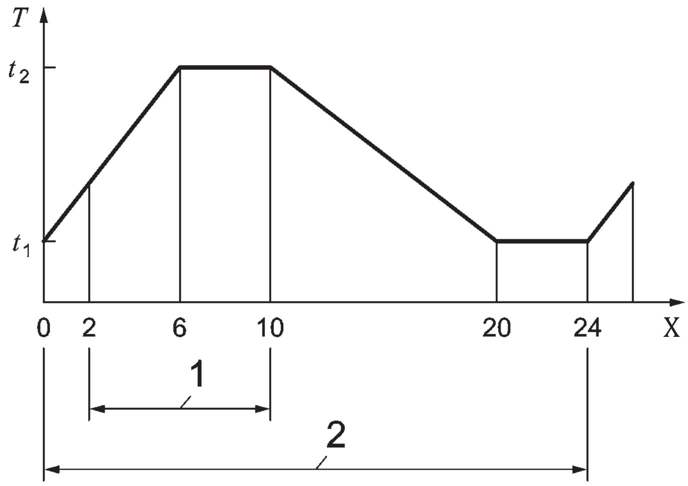
Table 2 — Degrees of severity for conditioning method 20: Solar radiation

Degree of severity			**01**	**02**	**03**[a]	**04**[a]
Temperature limits within test chamber	°C	t_2	55 ± 2	55 ± 2	40 ± 2	55 ± 2
		t_1	25 ± 2			
Relative humidity	%		≤25			
Recirculating air speed	m/s		1,5 to 3			
Total irradiance	kW/m^2		1,0 ± 0,1	0 to 1,0[b]	1,0 ± 0,1	1,0 ± 0,1
Total exposure time[c]	d		3	5	4	10
Total radiant exposure[c]	kWh/m^2		24	45	96	240
Test sequence[c]			See Figure 1	See Figure 2	See Figure 3	
Number of cycles			3	5	1	
State of operation			1 or 2		1	

a For testing representative specimens only.

b Cyclic. Tolerance for intermediate irradiance levels and upper limit: ± 0,1 kW/m^2.

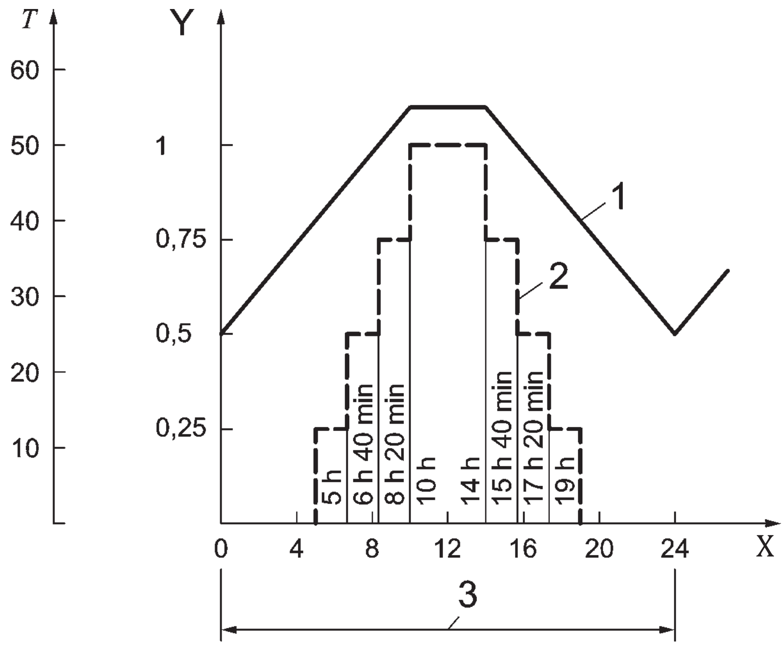
c See Figures 1 to 3.



Key

1	radiation exposure
2	1 cycle
X	duration, h
T	temperature, °C

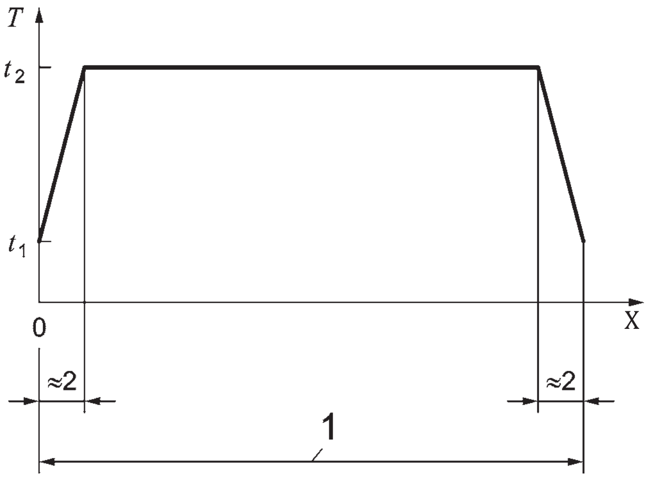
Figure 1 — Test sequence of controlled test chamber temperature and period of radiation exposure for degree of severity 01 (one of three cycles required)



Key

1	temperature
2	irradiance
3	1 cycle
X	duration, h
T	temperature, °C
Y	irradiance, kW/m^2

Figure 2 — Test sequence of irradiance and controlled test chamber temperature for degree of severity 02 (one of five cycles required)



Key

1	radiation exposure
X	duration, h (96 or 240)
T	temperature, °C

Figure 3 — Test sequence of controlled test chamber temperature and period of radiation exposure for degrees of severity 03 and 04

4.2 Conditioning method 21: Laboratory weathering

The purpose of the laboratory weathering test is to determine the effect of combined simulated solar radiation, heat and moisture, acting simultaneously on the test specimens, and causing chemical and physical degradation processes.

General guidance and specific instructions on how to perform an accelerated weathering test using an appropriately filtered xenon-arc light source are provided in ISO 4892-1 and ISO 4892-2.

The laboratory light source shall be appropriately filtered xenon-arc lamp(s) meeting the specifications of ISO 4892-1 and ISO 4892-2.

Exposure parameters according to ISO 4892-2:2013, Table 3 and Table 4, Cycle A-1 and Cycle A-4 are commonly used for the simulation of outdoor exposures, while Cycle B-2 and Cycle B-5 are for interior exposures behind window glass and Cycle B-3 and Cycle B-6 are for hot light fastness, e.g. for automotive interior devices.

See Table 3 for laboratory weathering with temperature control using a black-standard thermometer and Table 4 for laboratory weathering with temperature control using a black-panel thermometer. Any changes to the test parameters described in Tables 3 and 4 shall be given in the relevant specification.

For the test, an apparatus in accordance with ISO 4892-2 shall be used, which is capable of measuring and controlling irradiance, chamber air temperature, black-standard or black-panel temperature, and relative humidity, as well as providing cyclic water spray.

All sensors for measurement of irradiance, temperature, or humidity shall be operated and calibrated according to ISO 4892-1, ISO 4892-2, and ISO 9370.

Table 3 — Degrees of severity for conditioning method 21: Laboratory weathering with temperature control using a black-standard thermometer

Degree of severity		01		02		03	04	05	06
Cycle No. acc. to ISO 4892-2[a]		A-1[b]		A-1[b]		B-2[c]	B-2[c]	B-3[c]	B-3[c]
Exposure period		102 min dry	18 min water spray	102 min dry	18 min water spray	continuously dry			
Irradiance, broadband UV (300 nm to 400 nm)	W/m^2	60 ± 2				50 ± 2			
Irradiance, narrowband	$W/(m^2 \cdot nm)$	(0,51 ± 0,02)[b]				(1,10 ± 0,02)[c]			
Black-standard temperature	°C	65 ± 3	—	65 ± 3	—	65 ± 3		100 ± 3	
Chamber temperature	°C	38 ± 3	—	38 ± 3	—	38 ± 3		65 ± 3	
Relative humidity	%	50 ± 10	—	50 ± 10	—	50 ± 10		20 ± 10	
Exposure time[d]	h	2 000		5 000		2 000	5 000	2 000	5 000
UV radiant exposure[e] (300 nm to 400 nm)	MJ/m^2	432		1 080		360	900	360	900
State of operation		1 or 2							

[a] Exposure parameters according to ISO 4892-2:2013, Table 3.

[b] The xenon-arc lamp(s) shall be filtered using daylight filter systems according to ISO 4892-2:2013, Table 1 (method A); narrowband control at 340 nm.

[c] The xenon-arc lamp(s) shall be filtered using window glass filter systems according to ISO 4892-2:2013, Table 2 (method B); narrowband control at 420 nm.

[d] The exposure times can be reduced if higher irradiance values are used than stated in this table, e.g. by a factor of three if xenon-arc lamps with daylight filters are operated at 180 W/m^2 (300 nm to 400 nm) or if xenon-arc lamps with window glass filters are operated at 162 W/m^2 (300 nm to 400 nm).

[e] For comparison only: the average annual total UV radiant exposure is:

397 MJ/m^2 in Miami, Florida, USA (tilt angle of 26° facing south),

448 MJ/m^2 in Phoenix, Arizona, USA (tilt angle of 34° facing south), and

312 MJ/m^2 in Sanary-sur-Mer, France (tilt angle of 45° facing south)

for direct exposures;

and

260 MJ/m^2 in Miami, Florida, USA (tilt angle of 26° facing south), and

300 MJ/m^2 in Phoenix, Arizona, USA (tilt angle of 34° facing south)

for exposures behind a window glass filter system.

Table 4 — Degrees of severity for conditioning method 21: Laboratory weathering with temperature control using a black-panel thermometer

Degree of severity		01		02		03	04	05	06
Cycle No. acc. to ISO 4892-2[a]		A-4[b]		A-4[b]		B-5[c]	B-5[c]	B-6[c]	B-6[c]
Exposure period		102 min dry	18 min water spray	102 min dry	18 min water spray	continuously dry			
Irradiance, broad-band UV (300 nm to 400 nm)	W/m^2	60 ± 2				50 ± 2			
Irradiance, narrow-band	$W/(m^2 \cdot nm)$	(0,51 ± 0,02)[b]				(1,10 ± 0,02)[c]			
Black-panel temperature	°C	63 ± 3	—	63 ± 3	—	63 ± 3		89 ± 3	
Chamber temperature	°C	38 ± 3	—	38 ± 3	—	38 ± 3		65 ± 3	
Relative humidity	%	50 ± 10	—	50 ± 10	—	50 ± 10		20 ± 10	
Exposure time[d]	h	2 000		5 000		2 000	5 000	2 000	5 000
UV radiant exposure[e] (300 nm to 400 nm)	MJ/m^2	432		1 080		360	900	360	900
State of operation		1 or 2							

[a] Exposure parameters according to ISO 4892-2:2013, Table 4.

[b] The xenon-arc lamp(s) shall be filtered using daylight filter systems according to ISO 4892-2:2013, Table 1 (method A); narrowband control at 340 nm.

[c] The xenon-arc lamp(s) shall be filtered using window glass filter systems according to ISO 4892-2:2013, Table 2 (method B); narrowband control at 420 nm.

[d] The exposure times can be reduced if higher irradiance values are used than stated in this Table, e.g. by a factor of three if xenon-arc lamps with daylight filters are operated at 180 W/m^2 (300 nm to 400 nm) or if xenon-arc lamps with window glass filters are operated at 162 W/m^2 (300 nm to 400 nm).

[e] For comparison only: the average annual total UV radiant exposure is

397 MJ/m^2 in Miami, Florida, USA (tilt angle of 26° facing south),

448 MJ/m^2 in Phoenix, Arizona, USA (tilt angle of 34° facing south), and

312 MJ/m^2 in Sanary-sur-Mer, France (tilt angle of 45° facing south)

for direct exposures;

and

260 MJ/m^2 in Miami, Florida, USA (tilt angle of 26° facing south),

300 MJ/m^2 in Phoenix, Arizona, USA (tilt angle of 34° facing south)

for exposures behind a window glass filter system.

5 Procedure

5.1 General

The test shall be conducted in accordance with the requirements of the relevant specification and with ISO 9022-1 and IEC 60068-2-5.

5.2 Preconditioning

Unless otherwise specified in the relevant specification, the surface of the specimen shall be properly cleaned prior to exposure. No cleaning agents shall be used for this purpose, other than non-residual neutral agents which do not attack the surface of the specimen.

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 solar radiation, conditioning method 20, degree of severity 02, state of operation 1, is identified as:

Environmental test ISO 9022-20-02-1

7 Specification

The relevant specification shall contain the following details:

a) environmental test code;

b) number of specimens;

c) specimen surface to be irradiated;

d) position of the irradiation measuring plane;

e) mounting and support of specimen;

f) location of the test points for measuring irradiance and test chamber temperature;

g) preconditioning if other than specified in 5.2;

h) type and scope of initial test;

i) state of operation 2: period of operation;

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

k) recovery;

l) type and scope of final test;

m) criteria for evaluation;

n) type and scope of test report.

Bibliography

[1] CIE Publication No. 20-1972, *Recommendations for the integrated spectral irradiance and the spectral distribution of simulated solar radiation for testing purposes*

ICS 37.020

Price based on 8 pages