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Optics and photonics — Environmental test methods —

Part 3: Mechanical stress

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

Partie 3: Contraintes mécaniques

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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).

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 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 fourth edition cancels and replaces the third edition (ISO 9022-3:2015) which has been technically revised. It also incorporates the Amendment 1 (ISO 9022-3:2015/Amd 1:2020).

The main changes are as follows:

— Footnotes in Tables 11, 12, 13 were adapted.

A list of all parts in the ISO 9022 series can be found on the ISO website.

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 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, the ISO 9022 series 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 the ISO 9022 series 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 the ISO 9022 series and other appropriate International Standards will be necessary.

Optics and photonics — Environmental test methods —

Part 3:
Mechanical stress

1 Scope

This document 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 mechanical stress.

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. 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*

IEC 60068-2-6:2007, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60068-2-7, *Environmental testing — Part 2-7: Tests — Test Ga and guidance: Acceleration, steady state*

IEC 60068-2-27, *Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock*

IEC 60068-2-31, *Environmental testing — Part 2-31: Tests — Test Ec: Rough handling shocks, primarily for equipment type specimens*

IEC 60068-2-47, *Environmental testing — Part 2-47: Tests — Mounting of specimens for vibration, impact and similar dynamic tests*

IEC 60068-2-55, *Environmental testing — Part 2-55: Tests — Test Ee and guidance: Loose cargo testing including bounce*

IEC 60068-2-64, *Environmental testing — Part 2-64: Test methods — Test Fh: Vibration, broadband random and guidance*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological 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/

4 General information and test condition

The test shall be carried out at ambient atmospheric conditions and in accordance with ISO 9022-1 and with the International Standards listed in Table 1. The specimens shall be mounted on the test apparatus (shock machine, acceleration facility, or electrodynamic shaker) in accordance with IEC 60068-2-47.

g_n is the standard acceleration due to the earth's gravity, which itself varies with altitude and geographical latitude.

NOTE For the purposes of this document, the value of g_n is rounded up to the nearest whole number which is 10 m/s^2.

Table 1 — Conditioning methods and applicable International Standards for testing

Subclause	Conditioning methods	International Standard
4.1	30: Shock	IEC 60068-2-27
4.2	31: Bump	IEC 60068-2-27
4.3	32: Drop and topple	IEC 60068-2-31
4.4	33: Free fall	IEC 60068-2-31
4.5	34: Bounce	IEC 60068-2-55
4.6	35: Steady-state acceleration	IEC 60068-2-7
4.7	36: Sinusoidal vibration	IEC 60068-2-6
4.8	37: Random vibration (wide-band), digital control	IEC 60068-2-64

5 Conditioning

5.1 Conditioning method 30: Shock

See Table 2.

When testing optical instruments, a half-sine shock pulse shall be applied. The specimen shall be subjected to three shocks in each direction along each axis.

Table 2 — Degrees of severity for conditioning method 30: Shock

Degree of severity[a]		01	02	03	04	05	06	07	08[b]
Acceleration amplitude	m s^{-2}	100	150	300	300	500	500	1 000	5 000
	g_n multiples	10	15	30	30	50	50	100	500
Duration of nominal shock ms		6	11	6	18	3	11	6	1
State of operation		0 or 1 or 2							

[a] Degrees of severity 02, 03 and 05 are to be given preference.

[b] Applicable to testing of components and assemblies. Complete optical instruments should be subjected to 500 g_n acceleration and shocks of 0,5 ms duration.

5.2 Conditioning method 31: Bump

See Table 3.

Table 3 — Degrees of severity for conditioning method 31: Bump

Degree of severity		01	02	03	04	05	06	07	08
Acceleration amplitude	m s^{-2}	100	100	100	100	250	250	400	400
	g_n multiples	10	10	10	10	25	25	40	40

Table 3 *(continued)*

Degree of severity		01	02	03	04	05	06	07	08
Duration of nominal shock	ms	6	6	16	16	6	6	6	6
Number of shocks in each direction along each axis ±10		1 000	4 000	1 000	4 000	1 000	4 000	1 000	4 000
State of operation		0 or 1 or 2							

5.3 Conditioning method 32: Drop and topple

See Table 4.

Table 4 — Degrees of severity for conditioning method 32: Drop and topple

Degree of severity			01[a]	02[a]	03[a]	04[b]
Height of overturn		mm	25	50	100	Toppling over
	Acceptable deviation	mm	±5			—
State of operation			0 or 1			

[a] The specimen shall be subjected to one drop on each bottom corner and along each bottom edge.

[b] The specimen shall be subjected to one topple about each bottom edge.

5.4 Conditioning method 33: Free fall

See Table 5.

Table 5 — Degrees of severity for conditioning method 33: Free fall

Degree of severity			01	02	03	04	05	06
Height of fall		mm	25	50	100	250	500	1 000
	Acceptable deviation	mm	±5			±10		
State of operation			0 or 1					
Mass of specimen including packing[ab]		kg	>500	≤ 500	≤ 200	≤ 100	≤ 50	≤ 20

[a] Storage containers are not to be considered as packing.

[b] Recommendation for selection of degrees of severity.

Unpackaged optical instruments shall not be tested unless they are especially designed, constructed, and armoured (e.g. rubber armouring) for free fall. The degrees of severity are applicable to normal transport handling. Unless otherwise prescribed in the relevant specification, the specimen shall be subjected to two falls. If another number of falls is taken, the total number of falls shall be preferably taken from the following series: 10, 20, 50.

5.5 Conditioning method 34: Bounce

See Table 6.

The test shall be carried out according to IEC 60068-2-55. All degrees of severity in Table 6 refer to testing with either a bounce table, or an electrodynamic/servo-hydraulic testing facility.

When using a bounce table, use a double amplitude of 25,5 mm ± 0,5 mm and a frequency of 4,75 Hz ± 0,05 Hz.

When using an electrodynamic/servo-hydraulic testing facility, excite with a digitally controlled mixed mode vibration spectrum. This spectrum is a sine over random with 1,1 g_n acceleration at a sweeping

frequency from 8 Hz to 12 Hz with 3 octaves per minute and 0,04 g_n^2/Hz[1)] acceleration power spectral density from 5 Hz to 20 Hz.

Table 6 — Degrees of severity for conditioning method 34: Bounce

Degree of severity[a]		01	02	03
Exposure time	min	15	60	180
	Acceptable deviation	±10 %		
State of operation		0 or 1		
[a] The degree of severity 02 is to be given preference. The period of exposure shall be allocated in equal portions to each of the surfaces to be exposed.				

5.6 Conditioning method 35: Steady-state acceleration, centrifugal

See Table 7.

Table 7 — Degrees if severity for conditioning method 35: Steady-state acceleration, centrifugal

Degree of severity		01	02	03	04	05	06
Acceleration	m s^{-2}	50	100	200	500	1 000	2 000
	g_n multiples	5	10	20	50	100	200
Exposure time along each axis and in each direction	s	>10[a]					
State of operation		0 or 1 or 2					
[a] The exposure time begins after reaching the rated number of revolutions.							

5.7 Conditioning method 36: Sinusoidal vibration

5.7.1 General

The degrees of severity specified in Table 8 are relevant to optical instruments because the low frequencies combined with large displacement amplitudes do not stress optical instruments.

In special cases, refer to IEC 60068-2-6:2007, Figure 1.

5.7.2 Vibration testing using sweep frequencies

See Table 8 and Table 9.

1) The acceleration power spectral density was determined experimentally with different test samples.