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Environmental testing –
Part 2-55: Tests – Test Ee and guidance – Loose cargo testing including bounce

Essais d'environnement –
Partie 2-55: Essais – Essai Ee et guide – Essais de chargement sans arrimage y compris l'essai de rebondissement

IEC 60068-2-55:2013

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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ENVIRONMENTAL TESTING –

Part 2-55: Tests – Test Ee and guidance – Loose cargo testing including bounce

FOREWORD

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International Standard IEC 60068-2-55 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

This second edition cancels and replaces the first edition, published in 1987, and constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

This new edition allows for loose cargo testing in a more general sense. The test is no longer aligned with a special testing machine but allows for use of any suitable equipment such as electrodynamic or servo-hydraulic shaker tables. Moreover, sinusoidal and random vibration can be used. The previous rotation table motions are included in Annex A as historical methods.

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The text of this standard is based on the following documents:

FDIS	Report on voting
104/592/FDIS	104/598/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

It has the status of a basic safety publication in accordance with IEC Guide 104.

This standard should be used in conjunction with IEC 60068-1.

A list of all the parts in the IEC 60068 series, under the general title *Environmental testing*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This test is applicable to specimens which, during transportation on the load-carrying platform of wheeled vehicles either not fastened down or with some degree of freedom, may be subjected to dynamic stresses resulting from random shock conditions (bounce). The test may also be used as a simple means of assessing the satisfactory design of a specimen so far as its structural integrity is concerned.

NOTE In practice, this test is primarily applicable to equipment-type specimens and packages.

Although the test is performed using a vibrating platform, it is not considered as a vibration test, but as an impact test. Vibration tests should be conducted according to the appropriate standards from IEC 60068-2.

In Clause 11, specification writers will find a list of details to be considered for inclusion in specifications and, in Annex A, the necessary accompanying guidance.

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ENVIRONMENTAL TESTING –

Part 2-55: Tests – Test Ee and guidance – Loose cargo testing including bounce

1 Scope

This part of IEC 60068 provides a standard procedure for determining the ability of a specimen to withstand specified severities of bounce, e. g. when transported as loose cargo on wheeled vehicles.

This test is primarily intended for specimens prepared for transportation, including specimens in their transport case when the latter may be considered as part of the specimen itself or packages. This test should not be used as a low-frequency vibration test.

Although primarily intended for electrotechnical products, this standard is not restricted to them and may be used in other fields where desired.

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.

IEC 60068-1, *Environmental testing – Part 1: General and guidance*[1]

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

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

IEC 60068-2-80, *Environmental testing – Part 2-80: Tests – Test Fi: Vibration – Mixed mode*

ISO 13355, *Packaging – Complete, filled transport packages and unit loads – Vertical random vibration test*

ASTM D4169-09, *Standard Practice for Performance Testing of Shipping Containers and Systems*

3 Terms and definitions

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

3.1
bounce testing machine
testing machine with a vibrating platform driven by rotating shafts and eccentrics

Note 1 to entry: Bounce testing machines typically have a fixed displacement amplitude and a variable frequency.

[1] A new edition of IEC 60068-1 is currently under consideration.

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3.2
checkpoint
point located on the vibration table

Note 1 to entry: For the purpose of this standard, the checkpoints have to be located on the vibration table, regardless of the position of the specimen.

3.3
reference point
point, chosen from amongst the checkpoints, whose signal is used to control the test, such that the requirements of this standard are satisfied

3.4
g_n
standard acceleration due to the earth's gravity, which itself varies with altitude and geographical latitude

Note 1 to entry: For the purposes of this standard, the value of g_n is rounded up to the nearest whole number, that is 10 m/s^2.

4 Requirements for the test apparatus

4.1 General test description

The specimen is installed on a vibrating platform without a fixture and occasionally bounces, according to the mass and stiffness of the platform and the specimen, and the prescribed motion. No direct control is imposed on the specimen motion. Wherever possible, the test severity applied to the specimen shall be related to the operational environment to which the specimen will be subjected during transportation.

The relevant specification shall state the criteria upon which the acceptance or rejection of the specimen is to be based. Normally, for this test the specimen is not functioning and it is sufficient that it should survive the testing.

4.2 Characteristics of the testing machine

The testing machine shall consist of a horizontal platform coupled to a shaker or a similar drive mechanism. If prescribed by the relevant specification, special bounce testing machines may be used (see Clause A.3).

The platform shall be of at least 24 mm and not to exceed 32 mm plywood firmly attached to a suitable stiff frame, if required, with appropriate barriers (see 4.7). It shall be of sufficient size to support the specimen. Furthermore, the characteristics of the testing machine shall allow for the prescribed motion of the platform, see 4.3.

4.3 Motion of the platform

The motion of the platform shall be vertical linear, also when loaded by the specimen and any other devices necessary for conducting the test. A rotary motion of the platform is not possible when connected to a shaker table. The relevant specification can prescribe sinusoidal or random vibration of the platform.

The deflections of the platform resulting from the bouncing specimen shall be negligible. This can be achieved by sufficient strength and stiffness of the supporting stiff frame.

If prescribed by the relevant specification, other kinds of motion can be used that require special bounce testing machines, such as circulating (see A.3.1) or non-synchronous (A.3.2) motion of the platform.

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4.4 Tolerances on the horizontal accuracy of platform

The testing machine shall be installed so that at its lowest point (bottom dead centre of the motion), the platform is horizontal within the following tolerance:

– ±0,5° in the longitudinal and lateral axes (respectively pitching and rolling angles).

Any allowances for play of the drive mechanism are included in this value.

4.5 Control

The motion of the platform is controlled. Acceleration or displacement control is permissible. If the platform is driven mechanically by eccentrics, actual eccentricity and control of the shaft speed may be used. It is not necessary to measure the response of the specimen.

The impacts of the specimen on the platform are very likely to influence the actual motion of the platform. The occurrence of high-frequency oscillations resulting from these impacts shall be considered, as this may lead to signal distortion without appropriate filtering. In the case of the reference point being influenced by the impacting, and the stated tolerances not being able to be met, the achieved result shall be stated in the test report.

4.6 Mounting

For the purpose of this test, the specimen is never fastened or otherwise fixed to the platform during testing.

4.7 Horizontal motion of specimen

The horizontal motion of the specimen shall be limited by suitable barriers of sufficient strength and stiffness.

The maximum horizontal clearance shall be small compared to the size of the specimen but large enough to allow for free vertical movement. Normally, this is achieved by a clearance of approximately 10 mm on each side.

A suitable barrier arrangement is described in Clause A.2 and shown in Figure A.1.

5 Severities

NOTE Severity is described by the motion of the platform and the testing duration.

5.1 Severity for sinusoidal motion of the platform

If sinusoidal vibration is required, the relevant specification should refer to IEC 60068-2-6 and prescribe the amplitude and frequency of the motion together with the testing duration.

The duration of testing shall be selected from the severities given below. These severities represent the nominal duration of testing, exclusive of recovery periods (see Clause 8), to be applied. The test duration depends on the specimen and the purpose of the test:

– 180 min;
– 90 min;
– 60 min;
– 15 min;
– 5 min.

The duration of testing shall be divided equally between the specified attitudes or as required by the relevant specification, see Clause 8.

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The following values are often applied:

Sinusoidal motion of the platform according to IEC 60068-2-6, peak displacement amplitude of 12,75 mm ±0,5 mm at a frequency of 4,75 Hz ±0,05 Hz. This is equivalent to a peak acceleration amplitude of approximately 1,1 g_n. A typical test duration for robustness testing of shipping containers is 60 min.

NOTE The test severity given here corresponds to widely used test procedures. However, it is considered as very conservative and not related to the operational or transportation environment.

5.2 Severity for random motion of the platform

If random vibration is required, the relevant specification should refer to IEC 60068-2-64 and prescribe the ASD spectrum of the motion together with the test duration.

The duration of testing shall be divided equally between the specified attitudes or as required by the relevant specification, see Clause 8.

5.3 Severity for mixed mode motion of the platform

If mixed mode vibration is required, the relevant specification should refer to IEC 60068-2-80 and prescribe the mixed mode spectrum of the motion together with the test duration.

NOTE 1 Mixed mode produces a stochastic bouncing of packaged specimens. Digital vibration control systems require long loop times at these low frequencies and it may be some time before the test starts and equalization is achieved.

NOTE 2 Bouncing motion generated with a pure random or pure sine vibration is unsuitable for reproducing the motion required for unfixed packaged specimens.

5.4 Severity for use of special bounce testing machines

If the relevant specification requires use of a special bounce testing machine (see Clause A.3), the kind of motion and the testing duration shall be specified.

6 Preconditioning

If the relevant specification calls for preconditioning it shall then prescribe the conditions.

7 Initial measurements and functional performance test

The specimen shall be submitted to visual, dimensional, functional and any other checks as prescribed by the relevant specification.

8 Testing

The specimen, with or without its transport case or packaging as required by the relevant specification, is placed in the middle of the platform without being fixed.

A vibration test is carried out with an excitation as prescribed by the test severity (see Clause 5).

One or several points on the platform not reached by the bouncing specimen is/are chosen as reference points. If necessary, multi-point control may be used, provided that this is stated in the test report. However, it is only expected to use multi-point control for very large, heavy equipment. In that case, the reference points shall be located on each side of the specimen on the platform. No additional check points are required.

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In case of sinusoidal motion of the platform, IEC 60068-2-6 applies, in case of random motion, IEC 60068-2-64 applies. The requirements of the respective standards shall be fulfilled for the reference points on the platform.

NOTE 1 The vibration testing standards IEC 60068-2-6 and IEC 60068-2-64 impose additional uniformity requirements on multiple check points that are not applicable for bounce tests according to this standard.

The test may be interrupted for inspection of the specimen, or to prevent excessive temperature rises, provided that the testing duration is properly achieved.

NOTE 2 Excessive temperature rises may occur in specimens which contain highly resilient structures or parts, except possibly for the severity of 5 min. In such cases it may be necessary, in order to prevent an excessive temperature rise within the specimen, to carry out the test in a series of phases (each of, say, 5 min bouncing followed by a recovery period of 5 min or longer) as required by the relevant specification.

If pre-tests are necessary for adjustment of the testing machine, this time shall not be deducted from the test duration.

Where the aspect ratio of the specimen (the ratio of its longest side to its shortest) does not exceed 3:1 and the mass does not exceed 50 kg, the specimen shall be subjected to bounce on each of its attitudes (for example the two bases and the lateral surface for a cylinder and six sides for a rectangular (parallelepipedal) object).

For specimens of greater mass or aspect ratio, or of a different form, the test shall be carried out as required by the relevant specification.

In this case, it can be necessary to further constrain the horizontal and overturning movement of the specimen. The vertical movement should not be restrained. The measures used for constraining movement should be stated in the test report.

Where there is only a limited number of faces on which the specimen would be transported, the relevant specification shall state the attitude(s) of the specimen for the test (see Clause A.5) and the test duration to be applied to each attitude.

If required by the relevant specification, specimens of any aspect ratio may be stacked, provided that the overall height does not exceed 600 mm. The relevant specification shall state what special arrangements, if any, are needed to constrain the movement of the topmost specimen.

Special bounce testing machines designed for circular or non-synchronous motion of the platform may be used for testing if prescribed by the relevant specification. Test procedures for these cases are described in Clause A.3.

9 Recovery

It is sometimes necessary to provide a period of time after testing and before final measurements in order to allow the specimen to attain the same conditions, for example of temperature, as existed for the initial measurements. The relevant specification shall then prescribe the conditions for recovery.

10 Final measurements

The specimen shall be submitted to visual, dimensional and functional checks and any others as prescribed by the relevant specification.

The relevant specification shall provide the criteria upon which the acceptance or rejection of the specimen shall be based.

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11 Information to be given in the relevant specification

When this test is included in a relevant specification, the following details shall be given as far as they are applicable:

		Clause and subclause
a)	Acceptance and rejection criteria (see Clause A.7)	2
b)	Test method, motion of the platform, (see Clause A.3)	4
c)	Severity (see Clause A.4)	5
d)	Preconditioning	6
e)	Initial measurements (see Clause A.7)	7
f)	Testing with or without transport case	8
g)	Attitude and orientation of specimen, distribution of test duration on different attitudes (see Clause A.5)	8
h)	Stacking requirements (see Clause A.6)	8
i)	Final measurements (see Clause A.7)	9

12 Information to be given in the test report

As a minimum, the test report shall show the following information:

1.	Customer	(name and address)
2.	Test laboratory	(name and address)
3.	Test report identification	(date of issue, unique number)
4.	Test dates	
5.	Purpose of the test	(development test, qualification)
6.	Test standard, edition	(relevant test procedure)
7.	Test specimen description	(unique identity, drawing, photo, quantity, comments on initial status of testspecimen, etc.)
8.	Test apparatus	(motion, description of the platform and barriers)
9.	Excitation axis	(testing attitude and testing axes)
10.	Measuring system, sensor location, filters	(description, drawing, photo)
11.	Uncertainties of measuring system	(calibration data, last and next date)
12.	Initial, intermediate or final measurements	
13.	Required severities	(from test specification)
14.	Test severities with documentation	(measurements at reference points, test durations for different attitudes)
15.	Test results	(comment on status of test specimen)
16.	Observations during testing and actions taken	
17.	Summary of test	
18.	Test manager	(name and signature)
19.	Distribution	(list of those receiving report)

NOTE 1 A test log should be written to document, for example, a chronological list of test runs with test parameters, observations during testing and actions taken and data sheets on measurements made. The test log can be attached to the test report.

NOTE 2 See also ISO/IEC 17025.

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