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BASIC SAFETY PUBLICATION
PUBLICATION FONDAMENTALE DE SÉCURITÉ

Environmental testing –
Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens

Essais d'environnement –
Partie 2-31: Essais – Essai Ec: Choc lié à des manutentions brutales, essai destiné en premier lieu aux matériels

IEC 60068-2-31:2008

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FOREWORD

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International Standard IEC 60068-2-31 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 1969 and constitutes a technical revision.

The major changes with regard to the previous edition concern the introduction of soft packaging tests, where appropriate. This new edition of IEC 60068-2-31 now incorporates the second edition of IEC 60068-2-32 (1975).

IEC 60068-2-32 will be withdrawn once this standard has been issued.

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

FDIS	Report on voting
104/458/FDIS	104/462/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.

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 maintenance result 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- withdrawn,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.

ENVIRONMENTAL TESTING –

Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens

1 Scope

This part of IEC 60068 deals with a test procedure for simulating the effects of rough handling shocks, primarily in equipment-type specimens, the effects of knocks, jolts and falls which may be received during repair work or rough handling in operational use.

This procedure does not simulate the effects of impacts received during transportation as loosely constrained cargo. Where the effects of loose cargo transportation are to be assessed, test Ee: Bounce should be used. Also this procedure does not simulate the effects of shock applied to installed equipments. Where this effect is to be assessed refer to test Ea: Shock.

Testing should only be specified for equipment likely to receive such rough handling, for example those of small to medium size and mass, and should only be applied to those faces and corners where there is a risk of such treatment being encountered.

In general, equipment which is frequently handled and serviced (for example field equipment and unit spares) can be considered at risk, whereas equipment forming an integral part of a permanent installation would not normally be considered at risk and need not be tested.

Testing may not be applicable to fragile unprotected equipment of irregular shape (for example aircraft nose radar) which, when removed from the installation would be contained in a handling frame or jig. It may however be applicable to these items of equipment when they are in their transit case or in their handling frame or jig.

For equipment which stands only on one face (for example the normal base) the test is generally only applied to that face.

Shock tests are performed on the specimen when fixed to the test machine. Drop and topple, free fall, repeated free fall and bounce tests are performed with the specimen free.

2 Normative references

The following referenced documents are indispensable for the application 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.

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

IEC 60068-2-55:1987, *Environmental testing – Part 2-55: Tests – Test Ee and guidance: Bounce*

IEC Guide 104,*The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO 48:2007, *Rubber, vulcanized or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)*

ISO 4180-2:1980, *Complete, filled transport packages – General rules for the compilation of performance test schedules – Part 2: Quantitative data*

3 General description of test

Rough handling shocks can be simulated by one or more of the following tests:

a) Drop and topple

A simple test intended to assess the effects of knocks or jolts likely to be received primarily by equipment-type specimens during repair work or rough handling on a table or bench.

b) Free fall – Procedure 1

A simple test to assess the effects of falls likely to be experienced due to rough handling. It is also suitable to demonstrate a degree of robustness.

c) Free fall – Procedure 2

A test that additionally simulates repetitive shocks likely to be received by certain component-type specimens, for example connectors in service.

The topple test need not be applied to specimens which have dimensions which make them stable whilst being handled. Reference to points 1) and 2) below should be made for information on the "*c – g* ratio" and "height ratio" to establish if the test is necessary.

The falling or topple actions produced by the test procedures given in 5.1.3.1, 5.1.3.2 and 5.1.3.3 are illustrated by Figures 1, 2 and 3.

The drop and topple test includes three distinct procedures:

i) dropping on to a face (5.1.3.1);

ii) dropping on to an edge or a corner (5.1.3.2);

iii) toppling (or pushover) (5.1.3.3).

The purpose of each of these procedures is basically the same, but they represent different kinds of handling.

The test is not intended to be a precise test and a tolerance of ±10 % is allowed on the heights and angles prescribed in 5.1.2.

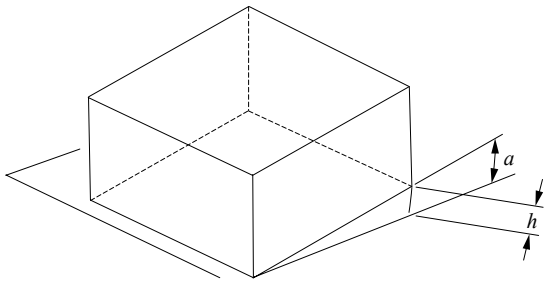
NOTE For a more precise shock test, test Ea: Shock (IEC 60068-2-27) should be used.

The topple test need not be applied to specimens which have dimensions which make them stable while being handled. When considering the applicability of the topple test, two dimensional ratios are important:

1) the ratio of the height of the centre of gravity from the base, to the smaller dimension of the base, hereinafter referred to as the *c – g* ratio;

2) the ratio of the height of the specimen to the smaller dimension of the base, hereinafter referred to as the height ratio.

If the *c – g* ratio is small, for example less than 0,25, the specimen is unlikely to fall over due to sudden sideways displacements. If the height ratio is small, for example less than 0,5, the specimen is unlikely to topple over due to a sudden sideways force or blow at the top. In such cases the writer of the relevant specification should consider whether the topple test is applicable.



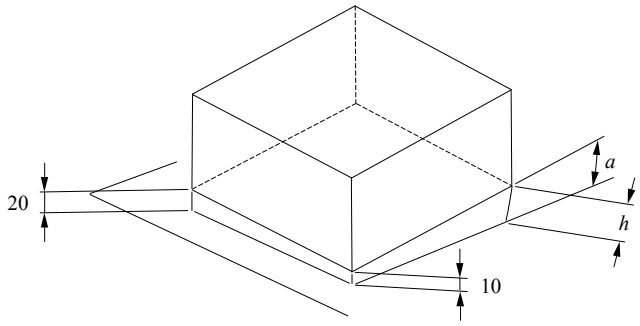
IEC 782/08

h = distance between edge of specimen and test surface

a = angle between bottom face of specimen and test surface

Figure 1 – Dropping on to a face

Dimensions in millimetres



IEC 783/08

h = distance between edge of specimen and test surface

a = angle between bottom face of specimen and test surface

Figure 2 – Dropping on to a corner

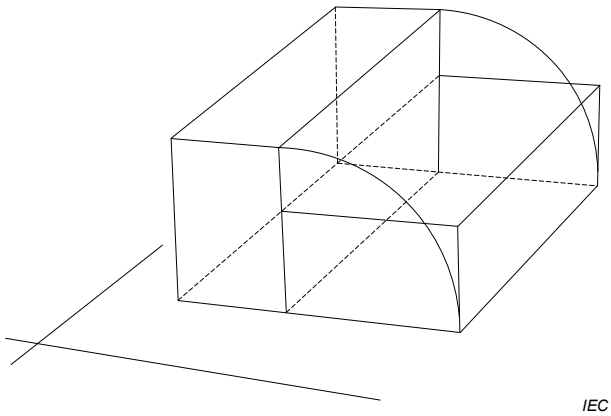


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Figure 3 – Topple (or push over)

4 Initial measurements

Before commencement of the test, the specimen shall be visually examined and electrically and mechanically checked as required by the relevant specification.

5 Testing

5.1 Drop and topple

5.1.1 Description

Having taken into account the manner in which the specimen will be handled in use and during repair, the relevant specification shall state the test procedure to be used and whether covers, cables, etc., are to be in position or not. The relevant specification shall also state whether the specimen is, or is not, operational during the test.

In the test procedure where the specimen is dropped on to a face or corner, it is possible for the specimen to topple onto a different face instead of falling back onto the test face as intended. This shall be avoided by a suitable method.

In any of the test procedures, the specimen shall not be allowed to continue rolling about the next edge.

Where the number of bottom edges exceeds four, the number of drops or topples shall be limited to four and the relevant specification shall prescribe the edges to be used for the test.

5.1.2 Test facility

The test facility surface shall be smooth, hard, rigid, unyielding, horizontal and, for example, made of concrete or steel. The steel plate shall be wet floated, that is, installed while the concrete is still wet in order to remove voids, or bonded to the concrete. The seismic reaction mass of the facility shall be at least 20 times the mass of the specimen under test. The thickness of the steel plate shall be a minimum of 25 mm. With a specimen in excess of 500 kg, the steel plate shall be at least 40 mm thick, level within two degrees to the horizontal and with a Brinell hardness of 90 – 300.

5.1.3 Testing procedures

5.1.3.1 Dropping onto a face

The specimen, standing in its normal position of use, is tilted along one bottom edge so that the distance between the opposite edge and the test surface is 25 mm, 50 mm or 100 mm, as prescribed by the relevant specification, or so that the angle made by the bottom and the test surface is 30°, whichever condition is less severe.

It is then allowed to fall freely onto the test surface.

The specimen shall be subjected to one drop along each of four bottom edges (see also Figure 1).

5.1.3.2 Dropping onto an edge or a corner

The specimen, standing in its normal position of use, is raised above the test surface by placing a wooden stud 10 mm high under one corner, and a 20 mm wooden stud under the other adjacent corner of one of the bottom edges. The specimen is then lifted above the test surface by rotating it about the edge on the two studs, until the other corner adjacent to the 10 mm stud is raised 25 mm, 50 mm or 100 mm, as prescribed in the relevant specification, or

so that the angle made by the specimen and the test surface is 30°, whichever condition is less severe.

It is then allowed to fall freely on the test surface.

The specimen shall be subjected to one drop on each of the four bottom corners by applying the test along the four bottom edges in turn (see Figure 2).

5.1.3.3 Topple or push-over

The specimen, standing in its normal position of use, is tilted about one bottom edge until it reaches a position of instability. It is then allowed to fall over freely from this position on to an adjacent face.

The specimen shall be subjected to one topple about each of four bottom edges (see also Figure 3).

5.2 Free fall – Procedure 1

5.2.1 Description

The specimen shall be allowed to fall freely in its normal attitudes of transport or use, as prescribed in the relevant specification.

Unless otherwise prescribed in the relevant specification, the specimen shall be subjected to two falls from each prescribed attitude.

5.2.2 Test facility

The test facility used for free fall, procedure 1, is identical to that described in 5.1.2.

5.2.3 Test severity

Test severity is defined by the height of fall which shall be taken from the following series, taking into account the mass of the specimen, unless real usage conditions are known or as otherwise specified:

Table 1 – Fall heights versus mass

25 mm				Mass < 50 kg
50 mm,	**100** mm,	250 mm,	**500** mm	Mass < 10 kg
750 mm,	**1 000** mm	1500 mm		Mass < 1 kg

[a] The values in bold type are preferred values.

[b] For specimens in their transit case or for packed specimens, use the fall heights given in ISO 4180-2.

5.2.4 Testing procedures

The specimen shall be dropped onto the surface of the test facility, see 5.2.2, from a height selected from values in 5.2.3 and as prescribed in the relevant specification.

The height shall be measured from the part of the specimen nearest to the test surface, when the specimen is suspended prior to letting it fall.

The method of releasing the specimen shall allow free fall from the position of suspension with a minimum of disturbance at the moment of release.

Where justified, other impact surfaces and hitting angle of the specimen may be prescribed in the relevant specification.

5.3 Free fall repeated – Procedure 2

5.3.1 Description

The specimen shall be placed in the test apparatus and subjected to the prescribed number of falls. If the specimen is normally attached to a cable, the relevant specification shall state the type of cable to be used. When the specimen is normally attached to a cable, a free length of 100 mm of cable shall remain connected to the specimen during the test, unless otherwise prescribed in the relevant specification.

5.3.2 Test facility

A suitable apparatus for use as the test facility is described in Annex A.

The specimen shall fall onto a smooth, hard, rigid test surface which, unless otherwise prescribed by the relevant specification, shall be of steel of 3 mm thickness, backed by hardwood of between 10 mm and 19 mm thickness.

NOTE 1 The tumbling barrel may not be appropriate for heavy specimens or if the shape of specimen prevents repeated free fall.

5.3.3 Test severity

The total number of falls shall be as prescribed in the relevant specification and shall be taken from the following series:

50, 100, 200, 500, 1 000

The height of the fall shall be 500 mm or 1000 mm.

NOTE The height of the fall should be related to the intended usage of the specimen.

5.3.4 Testing procedure

Each specimen is tested individually, and to simulate practical conditions, a length of cable (see 5.3.1) is normally attached to the specimen during the test, which consists of subjecting the specimen to a prescribed number of falls from a specified height onto a hard surface. The effect of the test is checked in relation to the changes, if any, in the mechanical and electrical parameters of the specimen.

The test apparatus shall be such that the prescribed number of falls from the specified height selected from values given in 5.3.3 and stated in the relevant specification may be applied to individual specimens. The number of falls selected from the list given below should be related to the intended usage of the item.

Annex A describes one suitable form of apparatus employing a rotating barrel.

6 Final measurements

The specimen shall be visually examined and electrically and mechanically checked, as required by the criteria prescribed in the relevant specification.

The rate of fall shall be approximately ten falls per minute.

7 Information to be included in the relevant specification

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

7.1 Drop and topple test	**Clause**
a) Initial measurements	4
b) Testing	5.1.1
c) Fitting of cables, covers, etc.	5.1.1
d) Whether the specimen is operational or not during the test	5.1.1
e) Edges to be used in the test, where there are more than four bottom edges	5.1.1
f) Height of drop onto a face	5.1.3.1
g) Height of drop onto a corner	5.1.3.2
h) Final measurements	6
7.2 Free fall and free fall repeated tests	
a) Initial measurements	4
b) Test surface if other than concrete or steel	5.1.2
c) Height of fall	Table 1, 5.3.4
d) Attitude from which the specimen is dropped	5.2.1
e) Number of falls, if other than two	5.2.1
f) Final measurements	6
g) Type of cable to be attached	5.3.1

8 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.	Type of test	(free fall or drop and topple)
6.	Purpose of the test	(development test, qualification, etc.)
7.	Test standard, edition	(relevant test procedure)
8.	Test specimen description	(unique identity, drawing, photo, quantity, etc.)
9.	Mounting of test specimen	(test apparatus used, if applicable)
10.	Performance of test apparatus	(description and mass of test surface)
11.	Initial and final measurements	
12.	Required severities	(from test specification)
13.	Test severities with documentation	
14.	Test results	(comment on status of test specimen)
15.	Observations during testing and actions taken	
16.	Summary of test	

17. Test manager (name and signature)

18. Distribution (list of those receiving report)

NOTE A test log should be written in which the test is documented, e.g. with a chronological list of test runs that includes test parameters, observations during testing and actions taken as well as data sheets on measurements made. The test log can be attached to the test report.

Annex A
(normative)

Test apparatus for repeated free fall test – Procedure 2

One suitable form of apparatus for the repeated free fall test (see 5.3.4) is based on a barrel which rotates and causes a free fall combined with a tumbling motion of the specimen. Where a large number of specimens have to be tested, the barrel may contain a number of sections, one specimen being placed in each section, so that simultaneous testing may be carried out.

The width of each section, *W*, is not specified but shall preferably be between 200 mm and 300 mm, depending on the size of the specimen.

The dimensions of the barrel, and/or its sections shall be as shown in Figure A.1. The smooth, rigid, steel test surface at each end, 3 mm in thickness, is backed by wood of between 10 mm and 19 mm thickness (see also 5.1.2).

Each compartment in which the specimen rests between falls is backed by a wedge-shaped piece made of chip-resistant rubber with a hardness of 80 ± 20 IRHD[1], as defined in ISO 48, and the sliding surfaces of that same compartment are made of smooth, hard plastics laminated sheet.

The rotating barrel is designed so that the shaft does not protrude into the interior.

The rotating barrel is provided with an aperture with a lid which may be made of transparent acrylic material.

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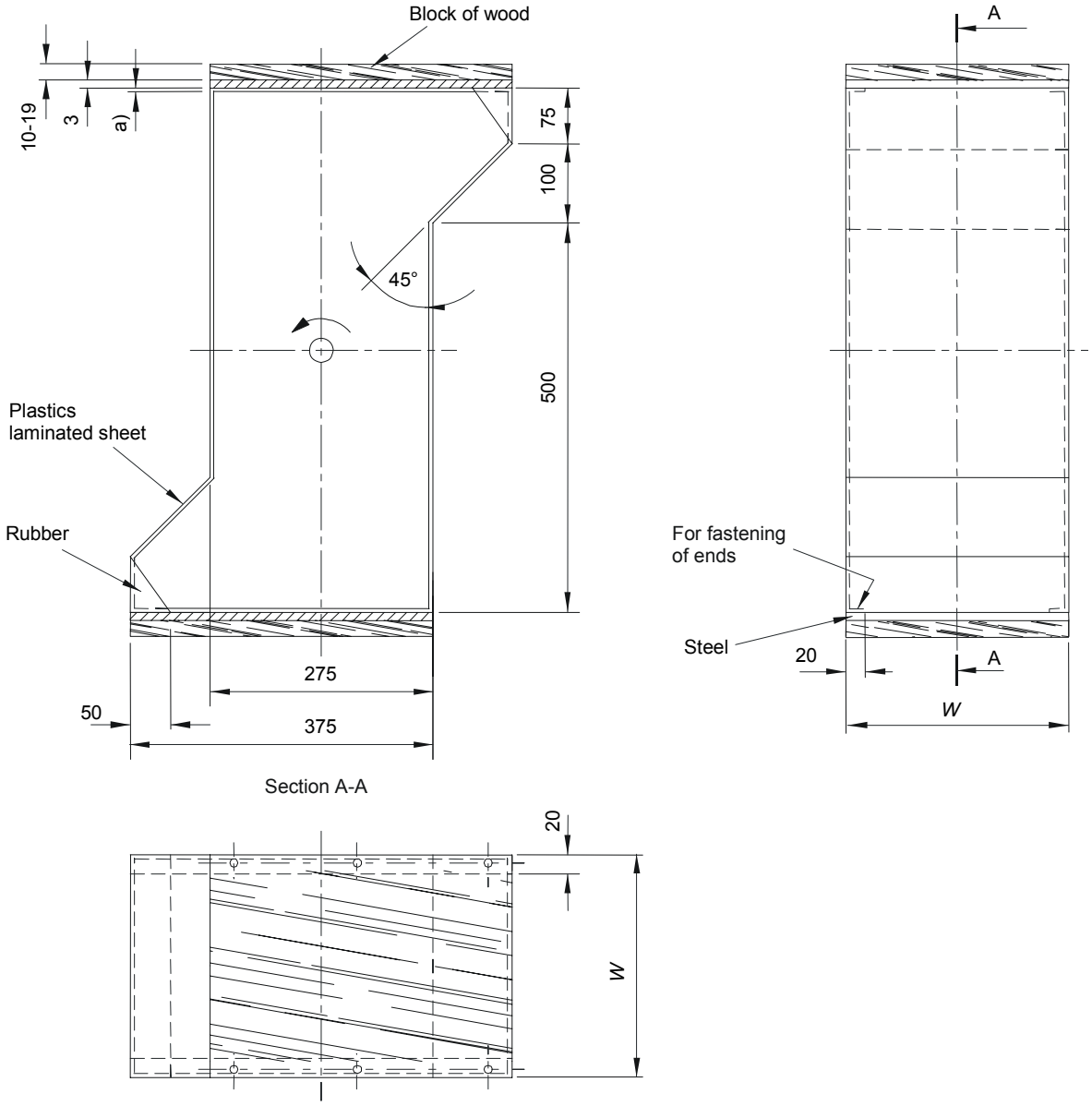
1 International rubber hardness degrees.

Dimensions in millimetres



a) The body of the rotating barrek is of sheet of 1,5 mm thickness

IEC 785/08

Figure A.1 – Rotating (or tumbling) barrel

Annex B
(informative)

Selection of test severities for free fall tests – Guidance

B.1 Object

The free fall test is applicable to specimens which during transportation, handling or repair work are liable to be dropped from their means of transport or from a work surface. The test is not applicable to very heavy specimens or to those with large dimensions, for example large power transformers.

B.2 Selection of test severities

The specification writer intending to prescribe this test should refer to Clause 7 of this standard to ensure that all such information is included in the relevant specification.

Where possible, the test severity applied to the specimen should be related to the expected handling and transport conditions to which the specimen will be subjected. However, it is neither realistic nor economical to expect all specimens to survive the most severe mis-handling which can be encountered in service, for example, dropping from an aircraft loading platform or from a crane. For tests on specimens where it is required to demonstrate serviceability, the height of the fall should be selected taking into account the risk of occurrence, the tolerable level of damage and the conditions of operational use, transportation and storage.

The appropriate severity, selected from 5.2.3, and 5.3.3 should be related to the mass of the specimen, the type of handling and transport, and whether the test is to be applied to unpacked specimens such as sub-assemblies, components, non-portable equipment, or transportable items which are housed in integral transport cases.

In the absence of precise information on these aspects, a suitable severity should be selected by the specification writer from Table B.1 which lists examples of severities appropriate to various transport or handling conditions.

This table is not mandatory, but lists severities which are typical. It should be borne in mind that there will be instances where the actual severities experienced in handling differ from those shown in the table.

Table B.1 – Examples of typical test severities

Height of fall mm	Specimen mass		Example of unpacked specimen	Type of handling
	Unpacked kg	In integral transport cases kg		
25	≥ 50	>500	Cubicles	Fork lift trucks[a]
50	>10 < 50	≤200	Cabinets	Fork lift trucks[a]
100	>10 < 50	≤100	Switchboards	Cranes[a]
250	>10 < 50	≤75	Portable cases	Storage, Stacking
500	<10	≤40	Small items	Fall from conveyor belts
1 000	≤1	≤15	Components, small assemblies	Fall from work benches or tailboard of truck

[a] This is limited to simulate the impact when lowered to the loading level by a fork lift truck or crane, not dropping from the platform of the truck or sling of the crane.

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