
**Packaging — Complete, filled
transport packages — General rules
for the compilation of performance
test schedules**

*Emballages — Emballages d'expédition complets et pleins —
Règles générales pour l'établissement de programmes d'essais de
performance*

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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).

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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 122, *Packaging*, Subcommittee SC 3, *Performance requirements and tests for means of packaging, packages and unit loads (as required by ISO/TC 122)*.

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.

This second edition cancels and replaces the first edition (ISO 4180:2009) which has been technically revised. The main changes compared to the previous edition are as follows:

- the test item in the test schedule can now be selected by agreement of the stakeholders depending on the expected or existing transportation process and hazards;
- in 6.4, the test conditions have been reviewed and revised by the distance and condition of transportation;
- in 6.5, a new Level-4 has been added for well controlled handling;
- in 6.6, the test conditions have been reviewed and revised; they can be changed or selected depending on the storage conditions by the agreement of stakeholders.

Packaging — Complete, filled transport packages — General rules for the compilation of performance test schedules

1 Scope

This document establishes general rules for the compilation of performance test schedules for complete, filled transport packages intended for use within any distribution system except for the packages used for dangerous goods.

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 2206, *Packaging — Complete, filled transport packages — Identification of parts when testing*

ISO 2233, *Packaging — Complete, filled transport packages and unit loads — Conditioning for testing*

ISO 2244, *Packaging — Complete, filled transport packages and unit loads — Horizontal impact tests*

ISO 2873, *Packaging — Complete, filled transport packages and unit loads — Low pressure test*

ISO 8318, *Packaging — Complete, filled transport packages and unit loads — Sinusoidal vibration tests using a variable frequency*

ISO 13355:2016, *Packaging — Complete, filled transport packages and unit loads — Vertical random vibration test*

ISO 21067-1, *Packaging — Vocabulary — Part 1: General terms*

IEC 60068-1:2013, *Environmental testing — Part 1: General and guidance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21067-1 and the following apply.

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 <http://www.electropedia.org/>

3.1

performance test schedule

single laboratory test, or series of tests, intended to ascertain the performance, under working conditions, of the subject under test

3.2

hazard

factor which brings a possibility of damage or deterioration of the value to the packaged freight or product

3.3
power spectral density
acceleration power spectral density
PSD

degree of variation in energy for each frequency to the acceleration signal in a specific frequency range as a function of frequency

3.4
sweep cycle

scanning through the specified frequency band once in each direction, e.g. 10 Hz to 150 Hz to 10 Hz

[SOURCE: IEC 60068-2-6:2008, 3.4, modified — The Note has been deleted.]

4 Hazard

Typical hazards in the logistics process, and the related international standards, are shown in [Table 1](#).

Table 1 — Expected hazard during logistics process, and related international standards

Basic factor in logistics	Hazard	Related international standards	
Transport	— Vibration during transportation	Vertical random vibration test	ISO 13355
	— Repetitive impact by bouncing	Sinusoidal vibration tests using a variable frequency	ISO 8318
		Vibration tests at fixed low frequency	ISO 2247
	Horizontal impact by sudden stop or start	Horizontal impact test	ISO 2244
	Horizontal impact by linking work of railway freight car		
	Stacking stress during transportation	Random vibration test	ISO 13355
		Sinusoidal vibration tests using a variable frequency	ISO 8318
Low pressure by high altitude	Low pressure test	ISO 2873	
Handling	Drop impact by manual handling	Vertical impact test by dropping	ISO 2248
	Drop impact by mechanical handling		EN 14149
	Horizontal impact during handling by forklift or crane as such	Horizontal impact test	ISO 2244
	Rough handling by rolling	Rolling test	ISO 2876
	Topple	Toppling test	ISO 8768
	Handling of unit load	Stability testing of unit loads	ISO 10531
Storage	Compression load in stacking storage in warehouse	Stacking tests using a static load	ISO 2234
		Compression and stacking tests using a compression tester	ISO 12048
Climate	Temperature and humidity	High temperature test	ISO 2233 IEC 60068-1
		High temperature/High humidity test	
		Low temperature test	
	Wet, dewing	Water-spray test	ISO 2875

5 Preparation of the test schedule

5.1 The test item shall be selected from [Table 2](#) depending on the expected or existing hazard and considering logistics-related elements which affect the specimen.

The characteristics of the specimen, test equipment and past damage experience should be considered when selecting the test item.

[Table 3](#) shows an example of hazards and corresponding test items.

5.2 The test schedule shall be chosen by accumulation of selected hazards. Follow [Clause 6](#) for the selection of test level.

However, the test level can be modified by agreement of the stakeholders.

[Table 4](#) shows an example of performance test schedule based on the hazards listed in [Table 3](#).

5.3 The test sequence should be decided by agreement of the stakeholders taking into consideration the logistics process. Where the logistics process is unknown, the following test sequence may be carried out:

- a) compression test;
- b) vibration test;
- c) free-fall test.

The test sequence may comprise one, two or three of the tests given in a), b) and c), in any order.

5.4 Refer to ISO 10531 for the handling and stability test of the unit load.

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Table 2 — Selection guide for test item and correspondent test method

Basic factor in logistics	Test item	Guide for selection of test		Test method
		Type of hazard	Examples of the related product or failure	
Transport	Vertical random vibration test in general transportation	Vertical vibration or stacking load in general transportation ^a	— Electric, electronics or mechanical products — High precision surfaced products — Powder or granular products	6.4.2
	Sinusoidal vibration test in general transportation			6.4.3
	Random vibration test in rough road transportation			6.4.4
	Sinusoidal vibration test in rough road transportation	Repetitive shock by poor road		6.4.5
	Vibration tests at fixed low frequency			ISO 2247
	Stacked vibration test	Stacking stress during transportation		6.4.6
	Low pressure test	Low pressure	— Burst, deformation — Leak of the contents	6.8
	Free-fall test	Manual handling	— Electronic component or product which has mechanical structure	6.5.2
	Rotational drop test	Machinery handling		6.5.3
	Handling	Horizontal impact test	Horizontal impact during handling or transportation	— Liquid or semi-liquid product
Toppling test		Toppling during handling	— Liquid, semi-liquid, powder or granular products which are weak to sharp item	ISO 8768
Rolling test		Rough handling by rolling	— Pressure sensitive product, powder or granular products	ISO 2786
Storage	Compression test	Stacking compression in warehouse	Container for warehouse storage and products	6.6
	Temperature and humidity environmental test	High temperature with low humidity	Deformation or cracking by the high temperature	6.7
Climate	Temperature and humidity environmental test	High temperature/high humidity	— Sensitive to corrosion	6.7
			— Hygroscopic product	
			— Mold, spoil, degrade	
Water spray test	Low temperature		Degradation by contraction or embrittlement	6.7
	Rain		Wet damage	ISO 2875 ^b

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^a Random vibration has priority.
^b Test condition may be specified by the agreement of the stakeholders.

Table 3 — Example of hazard and correspondent test item

No.	Activity	Hazard	Test item	Test method
1	Unitization at factory	Mechanical handling	Rotational drop test	6.5.3
2	Container loading by forklift	Mechanical handling	Rotational drop test Horizontal impact test	6.5.3 6.5.4
3	Transport to port	150 km, paved road, by trailer	Vertical random vibration test	6.4.2
4	Storage at port	Maximum stack height: 2,4 m Temperature/humidity	Compression test Temperature and humidity environmental test	6.6 6.7
5	Load to container ship	Mechanical handling	Rotational drop test	6.5.3
6	Transport by ship	Vibration	Horizontal impact test	6.5.4
7	Unload from container ship	Maximum stack height: 2,4 m	Vertical random vibration test Compression test	6.4.2 6.6
8	Transport container to warehouse	Mechanical handling	Rotational drop test	6.5.3
9	Storage operation by forklift	3 000 km, paved road, by trailer	Vertical random vibration test	6.4.2
10	Storage at warehouse	Mechanical handling	Horizontal impact test	6.5.4
11	De-vanning at warehouse Reload to local distribution truck	Maximum stack height: 5 m Temperature/humidity	Rotational drop test Horizontal impact test Compression test Temperature and humidity environmental test	6.5.3 6.5.4 6.6 6.7
12	Transport to final destination	Manually handling	Free-fall test	6.5.2
13	Unloading at final destination	Partially rough road transport	Random vibration	6.4.2
14		Partly air cargo	Random vibration test in rough road transportation	6.4.4
15		Manual handling	Low pressure test	6.8
16			Free-fall test	6.5.2

Table 4 — Example of performance test schedule based on Table 3

Test schedule	Example of test order			
	1	2	3	4
A: Sequential test using one specimen	Conditioning [6.3 Method B]	Compression test [6.6.2.2, Table 22, Classification level 2]	Vertical random vibration test [6.4.2 Table 6, Level 1]	Free-fall test [6.5.2 Table 17]
B: Parallel test using multiple specimens (in case of four specimens)	Conditioning [6.3 Method A]	Vertical random vibration test [6.4.2 Table 6, Level 1]	Random vibration test in rough road transportation [6.4.4 Table 12, Level 2]	Free-fall test [6.5.2 Table 17]
	Conditioning [6.3 Method B]	Compression test [6.6.2.2, Table 22, Classification level 2]		
	Conditioning [6.3 Method B]	Temperature and humidity environmental test [6.7, table 26, High temperature test]		
	Conditioning [6.3 Method B]	Low pressure test [6.8, Table 27, Level 2]		

NOTE Table 4 shows an example of a performance test schedule based on Table 3.

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6 Test method

6.1 The laboratory atmosphere

The laboratory shall be in the standard atmospheric conditions specified in IEC 60068-1:2013, Table 2:

- temperature: 15 °C to 35 °C;
- relative humidity: 25 %RH to 75 %RH;
- air pressure: 86 kPa to 106 kPa.

NOTE IEC 60068-1 is referred in this situation due to the difference of environment between pre-conditioning and laboratory atmosphere.

6.2 Specimens

6.2.1 Content of specimens

Each test specimen shall be filled with its intended content. However, simulated or substituted content can be used, provided that the dimensions and physical properties of such content are as close as possible to those of the intended content. The specimen shall be packaged (closed, sealed, bundled as such) under shipment conditions.

6.2.2 Number of specimens

The preparation of several specimens is recommended for high reliability of test result. The number of specimens may be decided by the standard user or by agreement of the stakeholders.

6.2.3 Degradation of specimen

Unless the performance of aged specimen materials is known, the effects of aged specimen on transportation should be considered.

6.2.4 Identification of specimen

The identification of specimens shall be in accordance with ISO 2206.

6.3 Conditioning

Conditioning shall be applied in accordance with [Table 5](#), depending on the characteristics of the packaged product. For the compression test, Method B should be applied, except when a user specifies, a specially controlled environment to be applied (Method C).

Table 5 — Conditioning method for specimen

Method	Case	Conditioning ^a
A	The specimen is brought from a temperature or humidity atmosphere that is different from the laboratory atmosphere.	Condition for not less than 24 hours, or until the content reaches equilibrium with the laboratory environment.
B	The characteristic of specimen is sensitive to temperature or humidity.	Condition for not less than 24 h, or until the content reaches equilibrium at 23 °C, 50 %RH.
C	The specimen requires other test conditions.	Condition for not less than 24 h, or until the content reaches equilibrium, with the condition specified in ISO 2233 or as specified by the standard user ^b .

^a If the test cannot be carried out with the necessary conditioning, the test shall be carried out as soon as possible after removing the specimen from the environmental conditioning apparatus. Re-conditioning should be applied if needed.

^b Depending on the region of the test, more specific conditions are applicable when available^{[13][14]}.

6.4 Vibration test

6.4.1 General

Sinusoidal vibration test (see 6.4.3 and 6.4.5) shall be carried out only where the random vibration (see 6.4.2 and 6.4.4) test is not available.

NOTE The distance of transportation by boat and aircraft are not included in the distance of transportation of Tables 6, 7, 10, and 11 because the vibration level of those transportation modes is considered very low.

6.4.2 Vertical random vibration test in general transportation

6.4.2.1 Place the specimen on the vibration table which simulates the restraint method and loading method during transportation.

6.4.2.2 Carry out the test using the apparatus and the method for vertical random vibration test specified in ISO 13355 under the test conditions in 6.4.2.3, 6.4.2.4, and 6.4.2.5.

6.4.2.3 When the shipping orientation during transportation is known, carry out the test specified in Table 6. The specimen shall be placed by known shipping orientation. The test shall be carried out from PSD profile A and then from PSD profile B.

6.4.2.4 When the shipping orientation during transportation cannot be predicted, carry out the test along three axes specified in Table 7. The test shall be carried out from PSD profile A and then from PSD profile B.

6.4.2.5 The direction of vibration table motion shall be vertical. If needed, horizontal vibration can be performed with the agreement of the stakeholders.

Table 6 — Distance of transportation and test period when shipping orientation is known

Vibration classification	Level 1		Level 2		Level 3	
Transport distance	4 000 km		2 000 km		1 000 km	
PSD profile	A	B	A	B	A	B
Test period	100 min	20 min	50 min	10 min	25 min	5 min

NOTE Refer to Table 8 and Table 9 for the details of PSD profile “A” and “B”.

Table 7 — Distance of transportation and test period when the shipping orientation cannot be predicted

Vibration classification		Level 1		Level 2		Level 3	
Transport distance		4 000 km		2 000 km		1 000 km	
PSD profile		A	B	A	B	A	B
Test period	Normal placement	50 min	10 min	25 min	5 min	10 min	5 min
	Vertical placement	25 min	5 min	10 min	5 min	5 min	5 min
	Horizontal placement	25 min	5 min	10 min	5 min	5 min	5 min

NOTE Refer to [Table 8](#) and [Table 9](#) for the details of PSD profile “A” and “B”.

Table 8 — PSD profile A

Frequency Hz	PSD (m/s ²) ² /Hz	PSD G ² /Hz
2	0,012	0,000 125
4	0,288	0,003
18	0,288	0,003
40	0,024	0,000 25
200	0,012	0,000 125

NOTE The root mean square (rms) acceleration value is 2,97 m/s² [0,303 G].

Table 9 — PSD profile B (ISO 13355:2016, Annex A)

Frequency Hz	PSD (m/s ²) ² /Hz	PSD G ² /Hz
2	0,048	0,000 5
4	1,154	0,012
18	1,154	0,012
40	0,096	0,001
200	0,048	0,000 5

NOTE The root mean square (rms) acceleration value is 5,926 m/s² [0,604 G].

6.4.3 Sinusoidal vibration test in general transportation

6.4.3.1 Place the specimen on the vibration table which simulates the restraint method and loading method during transportation.

6.4.3.2 Carry out the test using the apparatus and the method 1 specified in ISO 8318 under the test conditions for sweep sinusoidal vibration test specified in [Table 10](#).

6.4.3.3 When the shipping orientation during transportation cannot be predicted, carry out the test along three axes specified in [Table 11](#).

6.4.3.4 The direction of vibration table motion shall be vertical. If needed, horizontal vibration can be applied with the agreement of the stakeholders.

Table 10 — Distance of transportation and sweep cycle when shipping orientation is known

Vibration classification	Level 1	Level 2	Level 3
Transport distance	4 000 km	2 000 km	1 000 km
Frequency range	3 Hz - 100 Hz		
Acceleration	7,0 m/s ²		
Sweep rate	0,5 Oct./min		
Sweep cycle (Test period)	6 cycles (about 120 min)	3 cycles (about 60 min)	1,5 cycles (about 30 min)

Table 11 — Distance of transportation and sweep cycle when the shipping orientation cannot be predicted

Vibration classification	Level 1	Level 2	Level 3
Transport distance	4 000 km	2 000 km	1 000 km
Sweep cycle (Test period)	Normal placement	1,5 cycles (about 30 min)	1 cycle (about 20 min)
	Vertical placement	1 cycle (about 20 min)	0,5 cycle (about 10 min)
	Horizontal placement	1 cycle (about 20 min)	0,5 cycle (about 10 min)

6.4.4 Random vibration test in rough road transportation

6.4.4.1 The random vibration test in rough road transportation should be carried out in addition to other vibration tests, when rough road transportation is expected.

6.4.4.2 Place the specimen on the vibration table without fixing.

6.4.4.3 Carry out the test using the apparatus and method for vertical random vibration test specified in ISO 13355 under the test conditions specified in 6.4.4.4 and 6.4.4.5.

6.4.4.4 When the shipping orientation during transportation is known, carry out the test specified in Table 12. The specimen shall be placed in known shipping orientation.

6.4.4.5 When the shipping orientation during transportation cannot be predicted, carry out the test along three axes as specified in Table 13.

Table 12 — Test period in rough road transportation when shipping orientation is known by random vibration

Vibration classification	Level 1	Level 2	Level 3
Rough road transport distance	Long	Middle	Short
Test period	15 min	10 min	5 min
PSD profile	C		

NOTE Refer to Table 14 for the details of "PSD profile C".

Table 13 — Test period in rough road transportation when the shipping orientation cannot be predicted by random vibration

Vibration classification		Level 1	Level 2	Level 3
Rough road transport distance		Long	Middle	Short
Test period	Normal placement	15 min	10 min	5 min
	Vertical placement	10 min	5 min	5 min
	Horizontal placement	10 min	5 min	5 min
PSD profile		C		
NOTE Refer to Table 14 for the details of "PSD profile C".				

Table 14 — PSD profile C

Frequency (Hz)	PSD [(m/s ²) ² /Hz]	PSD (G ² /Hz)
2	0,048	0,000 5
4	1,154	0,012
70	1,154	0,012
200	0,048	0,000 5
NOTE The root mean square (rms) acceleration value is 10,59 m/s ² [1,08 G].		

6.4.5 Sinusoidal vibration test in rough road transportation

6.4.5.1 Carry out the test according to ISO 8318, method 2 using the test conditions specified in [Table 15](#) and [Table 16](#). The test frequency shall be the resonance frequency measured at the maximum detected response acceleration.

6.4.5.2 Place the specimen on the vibration table without fixing.

6.4.5.3 When the shipping orientation during transportation is known, carry out the test specified in [Table 15](#).

6.4.5.4 When the shipping orientation during transportation cannot be predicted, carry out the test along three axes specified in [Table 16](#).

Table 15 — Test period in rough road transportation when shipping orientation is known by sinusoidal vibration

Vibration classification		Level 1	Level 2	Level 3
Rough road transport distance		Long	Middle	Short
Frequency (Hz)		The test frequency shall be the resonance frequency measured at the maximum detected response acceleration.		
Acceleration		7,0 m/s ²		
Test period		15 min	10 min	5 min

Table 16 — Test period in rough road transportation when the shipping orientation cannot be predicted by sinusoidal vibration

Vibration classification		Level 1	Level 2	Level 3
Rough road transport distance		Long	Middle	Short
Test period	Normal placement	15 min	10 min	5 min
	Vertical placement	10 min	5 min	5 min
	Horizontal placement	10 min	5 min	5 min

6.4.6 Stacked vibration test

6.4.6.1 Carry out the test in accordance with 6.4.2 or 6.4.3.

6.4.6.2 Apply stacking as loading factor, K , equal to 1 in Formula (1) and select the appropriate transport distance.

6.5 Drop test

6.5.1 Testing classification (common for free-fall test and rotational edge drop test)

Carry out the free-fall test specified in 6.5.2 for manual handling, and the rotational drop test specified in 6.5.3 for mechanical handling, using the following classification levels.

- Level 1: The number of transshipment is high, with a possibility of very large force.
- Level 2: The number of transshipment is high, with a possibility of comparatively large force.
- Level 3: The number of transshipment and level of external force are considered to be general.
- Level 4: The number of transshipment is low, and there is no possibility of large external force.

6.5.2 Free-fall test (applies to manual handling)

Carry out the free-fall test using the drop heights and directions given in Table 17 and Table 18. Refer to ISO 2206 for parallelepipedal and cylindrical package, ISO 2248 for test procedure.

Table 17 — Drop height and directions for mass of packaged product 30 kg or less

Mass of packaged product, m kg	Drop height mm			
	Level 1	Level 2	Level 3	Level 4
$0 < m \leq 10$	1 000	800	600	400
$10 < m \leq 20$	800	600	450	350
$20 < m \leq 30$	600	450	300	200
Drop direction/ Number of drops	— For parallelepipedal package: 1 corner, 3 edges, 6 faces — For cylindrical package: 4 bottom corners and 4 upper corners			

Table 18 — Drop height and directions for mass of packaged product exceeding 30 kg

Mass of packaged product, m kg	Drop height mm			
	Level 1	Level 2	Level 3	Level 4
$30 < m \leq 40$	400	350	250	150
$40 < m \leq 50$	400	300	200	100
$50 < m \leq 100$	250	200	150	100
Drop direction/ Number of drops	— For parallelepipedal package: 1 corner, 3 edges, 5 faces (except face No.1) — For cylindrical package: 4 bottom corners and 4 upper corners			

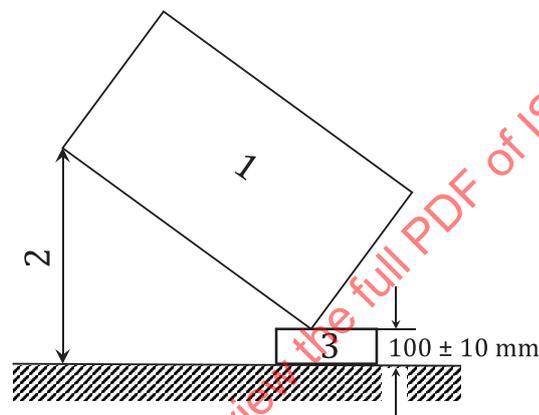
NOTE For the drop test of the packaged products by the paper bag and the plastic film bag, refer to ISO 7965-1 and ISO 7965-2.

6.5.3 Rotational drop test (applies to mechanical handling)

Carry out the rotational drop test using the drop height and directions applicable to the following methods given in [Table 19](#). Refer to EN 14149 for the test procedure.

- Method A: Rotational edge drop test ([Figure 1](#)) should be applied for mechanically-handled packages.
- Method B: Rotational flat drop test ([Figure 2](#)) can be applied instead of Method-A in following cases:
 - where the risk of danger is expected in the test, e.g. topple-down because of tall or long length specimen; and
 - where sufficient impact cannot be applied to the target edge.

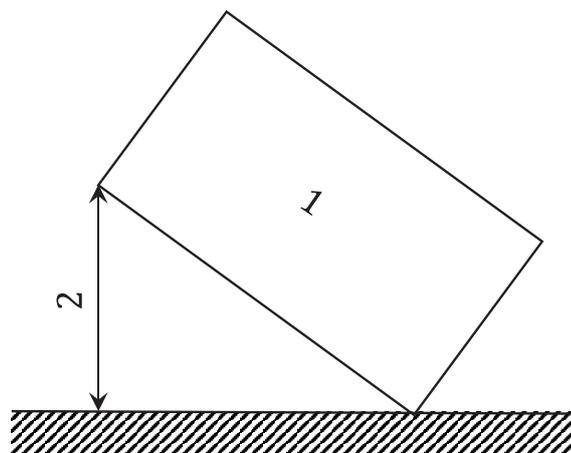
In both methods, drop height or height of the block (method A) may be changed depending on the shape or the position of the centre of gravity of the specimen with the agreement of the stakeholders.



Key

- 1 specimen
- 2 drop height (mm)
- 3 block

Figure 1 — Method A



Key

- 1 specimen
- 2 drop height (mm)

Figure 2 — Method B

Table 19 — Drop height and direction for rotational drop test

Mass of packaged product, <i>m</i> kg	Drop height mm		
	Level 1	Level 2	Level 3 and 4
$m \leq 200$	400	300	200
$200 < m \leq 500$	300	200	150
$500 < m$	300	200	100
Drop direction/ Number of drops	Method A: For two arbitrary sides of four sides in contact with the bottom surface, test 2 times with placement of a block on the opposite side of the dropping edge. The height of block: (100 ± 10) mm. Method B: For the edge which selected Method A without block, test 2 times.		

6.5.4 Horizontal impact test

Using the test apparatus and the test method set out in ISO 2244, apply an impact once at the applicable speed at impact or velocity change given in Tables 20 and 21 to each of the side faces of the specimen.

Where using the programmable horizontal impact test system, use a half-sine programmer which produces less than 20 ms duration and apply the velocity change specified in Table 21, assuming the coefficient of restitution is 0,0 and the total velocity change is equivalent to the specified velocity at impact.

Table 20 — Speed at impact for horizontal impact test

Classification	Level 1	Level 2	Level 3 and 4
Speed at impact (m/s)	2	1,5	1

Table 21 — Velocity change for horizontal impact test using programmable horizontal impact test system

Classification	Level 1	Level 2	Level 3 and 4
Velocity change (m/s)	2	1,5	1

6.6 Compression test

NOTE The compression test specified in this clause is for testing paper boxes, such as corrugated card board boxes.

6.6.1 Test apparatus and test method

The test should be carried out by using a compression tester in accordance with ISO 12048, and the static load test specified in ISO 2234 may be applied if required.

6.6.2 Compression test using a compression tester

6.6.2.1 Calculate the test load using Formula (1), with a relative compression speed of 10 mm/min \pm 3 mm/min, and release at once.

$$F = 9,8 \times K \times M \times n \quad (1)$$

where

F is the test load in Newton (N);

K is the loading factor (see [Table 22](#));
 $K = A \times B \times C$ in each classification level of [Table 22](#)

M is the total mass of specimen in kilograms (kg);

n is the maximum stacking number of packages or load units on the bottom one during storage.

NOTE Maximum stacking number “*n*” does not include bottom package.

6.6.2.2 The four classifications are given in [Table 22](#) depending on the storage conditions. The detailed loading factor consideration is given in [Table 23](#).

6.6.2.3 The specimen shall be filled with the content or the dummy load. However, the test can be carried out without content when the package receives 100 % of applied load, and the packaged content does not affect the test result.

6.6.2.4 The loading factor may be changed with the combination of weighting factors when storage conditions are known, with the agreement of the stakeholders.

6.6.2.5 The loading factor for the container for which strength is not affected by the storage period or humidity may be specified, with the agreement of the involved stakeholders.

Table 22 — Loading factor, *K*, for compression test

Classification level	1			2			3			4		
	A	B	C	A	B	C	A	B	C	A	B	C
Storage condition	Bad	12	90	Bad	6	90	Good	3	80	Quite good	1	50
Weighting factor	2,0	2,1	1,9	2,0	1,9	1,9	1,5	1,8	1,4	1,4	1,7	1,0
Loading factor, <i>K</i>	8,0			7,2			3,8			2,4		

^a A: Storage condition (the environment or behaviour which affects the stacking strength of the container, such as stowage condition, the number of transshipment), B: Storage period (Month), C: Humidity (% RH).

NOTE

— The loading factor, *K*, is given by the product of the weighting factor of each storage conditions. For example, Classification 1 shows $K = 2,0 \times 2,1 \times 1,9 = 8,0$.

— The loading factor takes paper containers such as corrugated cardboard into consideration because their strength is affected by the storage period or humidity.

Table 23 — Detailed loading factor “K” values for compression test

Weighting factor by storage conditions				Loading factor <i>K</i>		Level			
Storage condition, A	Storage period, B		Humidity, C						
Quite good	1,4	1 month	1,7	50 % RH	1,0	2,4	4		
				80 % RH	1,4	3,3			
				90 % RH	1,9	4,5			
		3 months	1,8			50 % RH	1,0	2,5	
						80 % RH	1,4	3,5	
						90 % RH	1,9	4,8	
		6 months	1,9			50 % RH	1,0	2,7	
						80 % RH	1,4	3,7	
						90 % RH	1,9	5,1	
		12 months	2,1			50 % RH	1,0	2,9	
						80 % RH	1,4	4,1	
						90 % RH	1,9	5,6	
Good	1,5	1 month	1,7	50 % RH	1,0	2,6			
				80 % RH	1,4	3,6			
				90 % RH	1,9	4,8			
		3 months	1,8			50 % RH	1,0	2,7	
						80 % RH	1,4	3,8	3
						90 % RH	1,9	5,1	
		6 months	1,9			50 % RH	1,0	2,9	
						80 % RH	1,4	4,0	
						90 % RH	1,9	5,4	
		12 months	2,1			50 % RH	1,0	3,2	
						80 % RH	1,4	4,4	
						90 % RH	1,9	6,0	
Bad	2,0	1 month	1,7	50 % RH	1,0	3,4			
				80 % RH	1,4	4,8			
				90 % RH	1,9	6,5			
		3 months	1,8			50 % RH	1,0	3,6	
						80 % RH	1,4	5,0	
						90 % RH	1,9	6,8	
		6 months	1,9			50 % RH	1,0	3,8	
						80 % RH	1,4	5,3	
						90 % RH	1,9	7,2	2
		12 months	2,1			50 % RH	1,0	4,2	
						80 % RH	1,4	5,9	
						90 % RH	1,9	8,0	1

6.6.3 Stacking load tests using a static load

6.6.3.1 Apply the test load, *F*, calculated from [Formula \(1\)](#) specified in [6.6.2.1](#) for 24 h on the bottom package. Refer to ISO 2234 for test procedure.

The loading factor, *K*, shall be selected from [Table 24](#).