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**ISO/TC 122 / SC 3**

Title

**Packaging — Complete, filled transport packages and unit loads — Vertical random vibration test**

Secretariat **BSI - GB**

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*English title*

**Packaging — Complete, filled transport packages and unit loads — Vertical random vibration test**

*French title*

**Emballages — Emballages d'expédition complets et leins et charges unitaires — Essai de vibration verticale aléatoire**

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Introductory note

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# Packaging — Complete, filled transport packages and unit loads — Vertical random vibration test

*Emballages — Emballages d'expédition complets et leins et charges unitaires — Essai de vibration verticale aléatoire*



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# Contents

# Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 13355 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)*.

# Introduction

A random vibration test is the most realistic way to reproduce environmental vibration during transportation. For this reason, if suitable laboratory facilities are available, this kind of test should be preferred to any fixed or swept frequency sinusoidal vibration tests similar to those given in ISO 2247[1] and ISO 8318[2].

# Packaging — Complete, filled transport packages and unit loads — Vertical random vibration test

## 1 Scope

This international standard specifies a method to carry out a vertical random vibration test on a complete, filled transport package(s) and unit loads using a random excitation[1].

This test may be used to assess the performance of a package in terms of its strength or the protection that it offers to its contents when it is subjected to vertical vibration. It may be performed either as a single test to investigate the effects of vertical vibration or as a part of a sequence of tests designed to measure the ability of a test specimen to withstand a distribution system that includes a vibration hazard.

NOTE In the following text a package or unit load is called a test specimen.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

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

ISO 2234, *Packaging — Complete, filled transport packages and unit loads — Stacking test using a static load*

## 3 Principle

The test specimen is placed on a vibration table and made to vibrate using a random excitation with effective frequency range for the test specimen. The atmospheric conditions, the duration of the test, the acceleration power spectral density, the attitude of the test specimen and its method of restraint are predetermined.

NOTE 1 When required, a load may be superimposed on the test specimen to simulate conditions at the bottom of a stack.

NOTE 2 Specific requirements for the mounting of the test specimen on the vibrating platform is given in ISO 4180:2009[4] 10.7.1.

[1] The treatment of random vibration theory can be found in IEC 60068-2-64[3].

# 4 Apparatus

**4.1 Vibration table**, of sufficient size and performance (in terms of power, displacement, frequency range) capable of being stiff (its lower resonant frequency shall be higher than the higher test frequency) and remaining horizontal during the test.

The table may be equipped with the following components:

**4.1.1 Low fences**, restricting sideways and endways movements during testing;

**4.1.2 High fences**, or other means of maintaining a superimposed load in position on the test specimen during testing:

Furthermore, the apparatus shall meet the requirements and tolerances of clause 6.

**4.2 Vibration measurement, data storage and control system** comprising accelerometers, signal conditioners and a computer, capable of:

a) generating vibration with the required power spectral density;

b) controlling the motion of the vibration table by feeding back the signal from the control accelerometer which monitors the table acceleration;

c) performing the analysis with at least 120 statistical degrees of freedom;

d) having data acquisition and control channels with a response accurate to 5% over the frequency range specified for the test.

# 5 Sampling

## 5.1 Test specimen preparation

The test specimen shall normally be filled with its intended contents. However, simulated or substituted contents may be used, provided that the dimensions and physical properties of such contents are as close as possible to those of the intended contents.

Ensure that the test specimen is closed normally, as if ready for distribution. If simulated or substituted contents are used, ensure that the normal method of closure is still employed.

## 5.2 Conditioning

Condition the test specimen in accordance with ISO 2233.

# 6 Procedure

Carry out the test in the same atmospheric conditions as used for conditioning where this is critical to the performance of the test specimen.

In other circumstances, the test shall be carried out in atmospheric conditions which are as near as practicable to those used for conditioning.

Place the test specimen in the predetermined attitude on the vibration table (see 4.1), with the centre of gravity placed as near as practicable to the centre of the table; if the test specimen is not secured to the table it may be fenced. If a superimposed load is required, the loading procedure shall comply with ISO 2234.

Measure the imposed acceleration as closely as possible to the test specimen. Protect the accelerometer suitably to avoid damage.

Ensure the horizontal components of the acceleration are no greater than 20% of the value of the vertical component.

Start the test 6 dB below the test level to allow the system to equalize the power spectral density profile, then carefully adjust the level to reach full test level and continue the test for the predetermined duration.

The test duration and the power spectral density of the vibration table, in absence of experimental data concerning the effects of transportation to be reproduced, should be chosen as indicated in annex A.

When distribution system and intensity of vibration acceleration is partly known, the test duration and the power spectral density of the vibration table may be chosen from annex B1 or B2 as indicated.

NOTE Vibration spectra depend very much on the transportation conditions selected. Therefore, whenever possible, perform tests with spectra obtained from measured data of the particular transportation conditions.

The test schedule may be changed as agreed by the involved stakeholders. In this case, the change and the reason should be added to the test report.

The tolerance on root mean square acceleration shall not exceed 15%; the obtained acceleration power spectral density of the test control signal shall not deviate by more than $\pm 3$ dB over the entire test frequency range.

Tests may be interrupted at any time to allow visual inspection of the test specimen, or for any other purpose.

## 7 Test report

The test report shall include the following information:

a) reference to this International Standard, i.e. ISO 13355;

b) the name and address of testing laboratory and name and address of the customer;

c) the unique identification of report;

d) the date of receipt of the test specimens and the date(s) of performance of test;

e) the name, the title and the signature of persons accepting responsibility for the test report;

f) a statement to the effect that the test results relate only to the specimens tested;

g) a statement that the report shall not be reproduced except in full without the written approval of the testing laboratory;

h) the number of replicate test specimens tested;

i) a full description, including dimensions, mass, structural and material specifications of the test specimen and its fittings, cushioning, blocking, closure or reinforcing arrangements, in accordance with ISO 2206;

j) a description of the contents, i.e. if simulated or substituted contents were used, full details shall be given;

k) the gross mass of the test specimen;

l) the relative humidity, the temperature and the time of conditioning; the temperature and the relative humidity of the test area at the time of test; whether these values comply with the requirements of ISO 2233;

m) the duration of the test, the frequency range, the applied acceleration power spectral density and the obtained root mean square acceleration value;

n) whether a superimposed load was used; if so, the mass, in kilograms, of the superimposed load and the period of time during which the test specimen was under load;

o) the method of restraint, and whether low or high fences were used;

p) any deviations from the test method described in this International Standard:

q) the recorded acceleration power spectral densities, with any observations which may assist in correct interpretation;

r) the attitude(s) in which the package was tested, using the method of identification as given in ISO 2206;

s) a list of the equipment and the serial numbers.

# Annex A
(normative)

# Indicative power spectral densities

## A.1 Generic transportation

Table A.1-1 and Figure A.1-1 give the indicative power spectral density which can be used to simulate generic (mainly road) transportation, when experimental recordings are not available.

**Table A.1-1 — Spectral density**

| **Frequency**<br>Hz | **Level**<br>$g^2$/Hz | **Slope**<br>dB/oct. |
|---|---|---|
| ~~3~~ 2 Hz. | 0,0005 | — |
| ~~3~~ 2 to ~~6~~ 4 Hz. | — | +13,75 |
| ~~6~~ 4 to 18 Hz. | 0,012 | — |
| 18 to 40 Hz. | | -9,34 |
| 40 Hz. | 0,001 | — |
| 40 to 200 Hz. | — | -1,29 |
| 200 Hz. | 0,0005 | — |

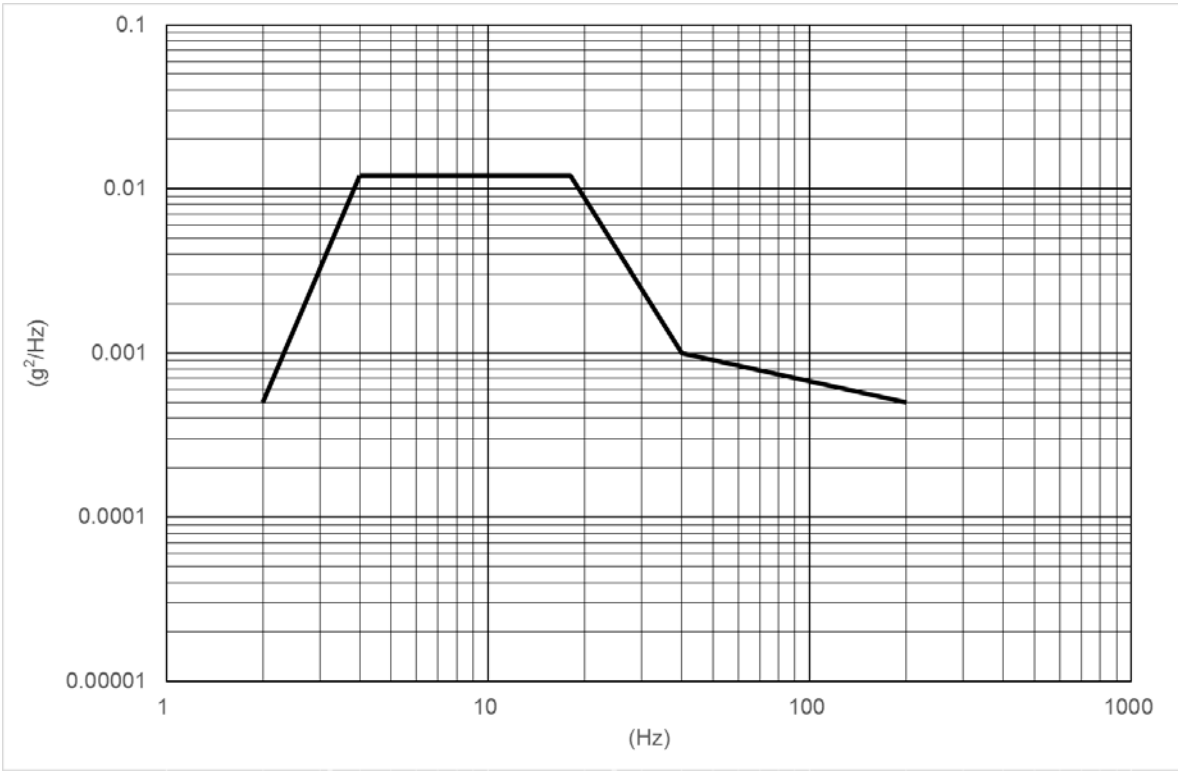


Figure A.1-1 — PSD Profile

The total root mean square acceleration value of the frequency range is: 0,60 g

The minimum recommended test duration is 30 min for each test specimen attitude to be tested. The correlation between transport distance and test time is not addressed in this International Standard.

# Annex B
(informative)

## B.1 PSD derived from recorded data (Europe)

The test in Table B.1-1 and Figure B.1-1 simulates 12 hours transport on the road; this is a multilevel test where all three levels are performed in sequence in any order. To reduce testing time the levels may be increased by multiplying the values of all power spectral densities with the factors given in Table B.1-2.

**Table B.1-1 —Vibration spectrum for road transport**

| | | Power Spectral Density | | |
|---|---|---|---|---|
| **Frequency Hz** | | **Level 1 g²/Hz** | **Level 2 g²/Hz** | **Level 3 g²/Hz** |
| 3 | | 0,001920 | 0,003780 | 0,006000 |
| 5 | | 0,003200 | 0,006300 | 0,010000 |
| 11 | | | | 0,010000 |
| 24 | | 0,000500 | 0,000960 | |
| 38 | | 0,000052 | 0,000100 | |
| 48 | | | | 0,000300 |
| 61 | | 0,000044 | 0,000087 | |
| 71 | | | | 0,000300 |
| 80 | | | | 0,000150 |
| 98 | | 0,000014 | 0,000028 | |
| 200 | | 0,000014 | 0,000028 | 0,000150 |
| time [h:min:s] | | 07:12:00 | 03:36:00 | 01:12:00 |
| ***Percent of test time*** | | ***60*** | ***30*** | ***10*** |
| *3-200 Hz $a_{RMS}$ / g* | | *0,181* | *0,253* | *0,415* |
| *5-200 Hz $a_{RMS}$ / g* | | *0,167* | *0,233* | *0,395* |

NOTE Peak to peak displacement may exceed 1 inch by testing with low frequencies.

A frequency range from 5 to 200 Hz may be sufficient for the testing of small specimens.

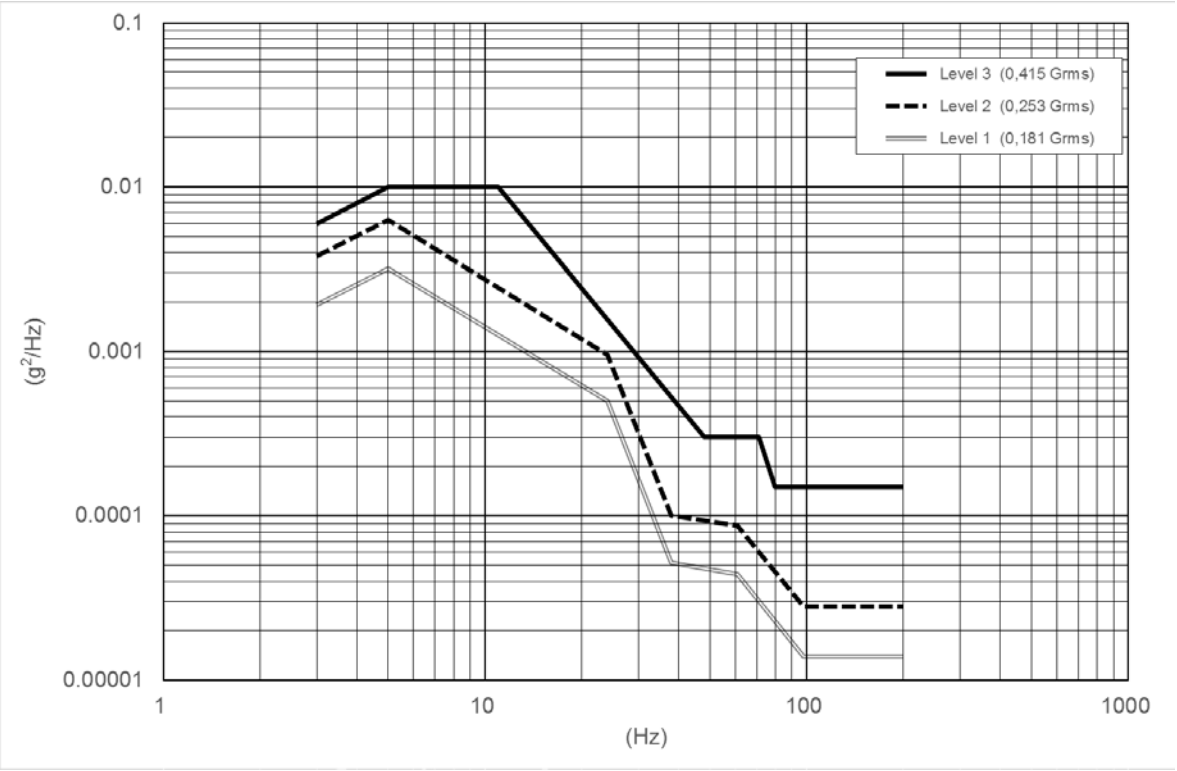


Figure B.1-1 — PSD Profile

**Table B.1-2 —Factors to increase the vibration level and reduce the test time, based on a 12 hour transport**

| Test time $T_2$ hours : minutes | Level increase factor $I$ |
|---|---|
| 0:30 | 1,89 |
| 1:00 | 1,64 |
| 2:00 | 1,43 |
| 3:00 | 1,32 |
| 4:00 | 1,25 |
| 6:00 | 1,15 |
| 9:00 | 1,06 |
| 12:00 | 1,00 |

The minimum recommended testing duration per relevant axis is 30 minutes.

## B.2 PSD derived from recorded data (Japan)

Table B.2-1 and Figure B.2-1 give a power spectral density derived from measured data from transport within Japan with 20 tons, half loaded, leaf spring truck. The test duration depends on the length of the journey it is wished to simulate and is given in Table B.2-2.

**Table B.2-1 — Random vibration test PSD**

| Frequency Hz | PSD $g^2$/Hz |
|---|---|
| 2 | 0,004 |
| 3 — 16 | 0,01 |
| 200 | 0,00001 |

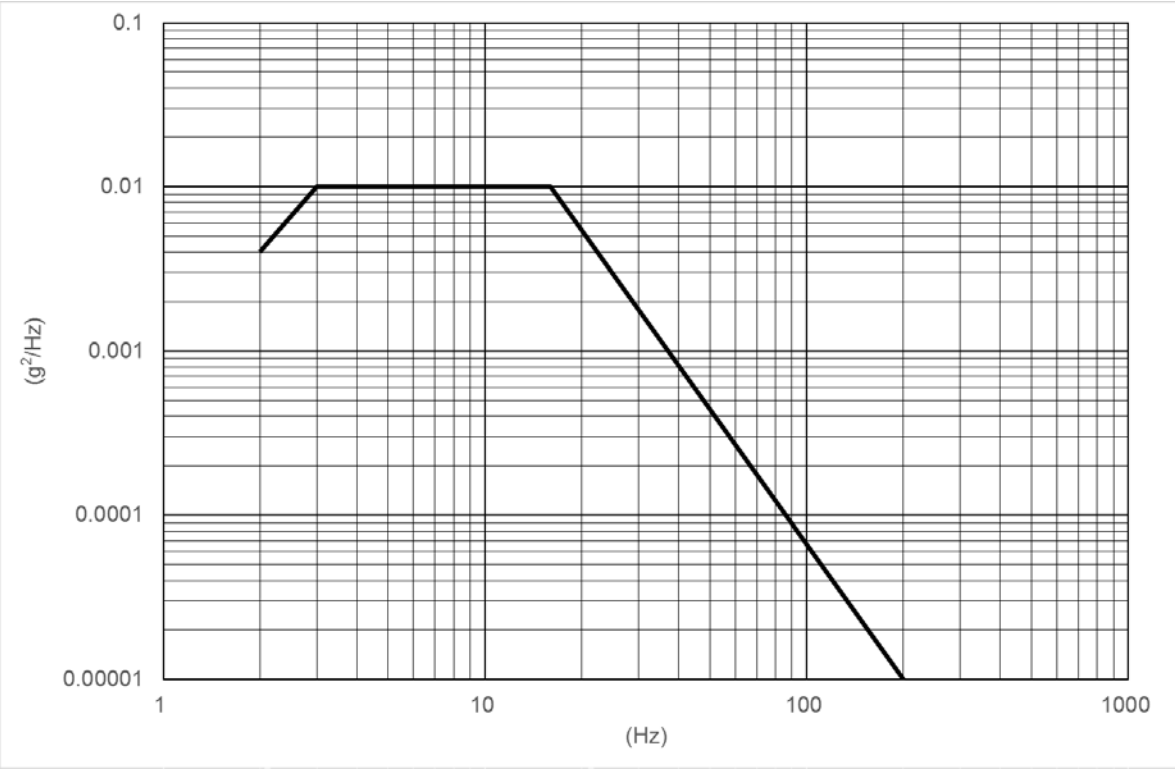


Figure B.2-1 — PSD Profile

The total root mean square acceleration value of the frequency range is: 0,48 g

**Table B.2-2 — Random vibration test duration**

| Journey length<br>km | Test duration<br>min |
|---|---|
| <200 | 15 |
| 200 — 500 | 30 |
| 500 — 1000 | 60 |
| 1000 — 1500 | 90 |
| 1500 — 2000 | 120 |
| 2000 — 2500 | 150 |
| >2500 | 180 |

# Bibliography

[1] ISO 2247, *Packaging — Complete, filled transport packages and unit loads — Vibration tests at fixed low frequency.*

[2] ISO 8318, *Packaging — Complete, filled transport packages —Sinusoidal vibration tests using a variable frequency.*

[3] IEC 60068-2-64, Environmental testing — *Part 2: Test methods — Test Fh: Vibration, broad-band random (digital control) and guidance.*

[4] ISO 4180, *Packaging — Complete, filled transport packages — General rules for the compilation of performance test schedules*