

# INTERNATIONAL STANDARD

# ISO 6954

Second edition  
2000-12-15

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## **Mechanical vibration — Guidelines for the measurement, reporting and evaluation of vibration with regard to habitability on passenger and merchant ships**

*Vibrations mécaniques — Lignes directrices pour le mesurage, l'établissement de rapports et l'évaluation des vibrations affectant l'habitabilité à bord des navires de commerce et des paquebots*



Reference number  
ISO 6954:2000(E)

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## Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6954 was prepared by Technical Committee ISO/TC 108, *Mechanical vibration and shock*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

This second edition cancels and replaces the first edition (ISO 6954:1984), which has been technically revised.

Annexes A, B and C of this International Standard are for information only.

## Introduction

Shipboard vibration that interferes with duties or reduces comfort is objectionable and often results in adverse comments from crew and passengers.

This International Standard gives the guidelines for evaluating the habitability of different areas on a ship. The habitability is evaluated by the overall frequency-weighted r.m.s. vibration values from 1 Hz to 80 Hz.

This International Standard also contains instrumentation requirements, measurement procedures, analysis specifications and assessment guidelines for the evaluation of ship vibration with respect to habitability.

Vibration data acquired in accordance with this International Standard are also useful for

- comparison with ship specifications,
- comparison with other vessels, and
- further development and improvement of vibration standards.

It is recommended that the classification to be applied to the various areas of a ship be agreed between the interested parties (e.g. shipbuilder and shipowner) prior to any assessment of the habitability.

ISO 6954:2000(E)

# Mechanical vibration — Guidelines for the measurement, reporting and evaluation of vibration with regard to habitability on passenger and merchant ships

## 1 Scope

This International Standard contains guidelines for the evaluation of vibration with regard to habitability on a passenger or merchant ship, as well as requirements for the instrumentation and the method of measurement in normally occupied spaces.

Assessment of low-frequency ship motion which may result in motion sickness is covered by other International Standards.

## 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 2631-1:1997, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements.*

ISO 2631-2, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 2: Vibration in buildings (1 Hz to 80 Hz).*

ISO 8041, *Human response to vibration — Measuring instrumentation.*

## 3 Instrumentation

### 3.1 General requirements

Measurements in accordance with this International Standard may be carried out using different types of measuring and recording equipment, e.g. instruments of analog, digital, spectral or time-based type. The measuring instrumentation shall meet the requirements of ISO 8041.

It is acceptable to use instruments manufactured in accordance with ISO 8041 that have frequency indications above 80 Hz provided that the filter characteristics comply with ISO 2631-2 (see annex A).

The compliance of the instrumentation system with the requirements of ISO 8041 shall be verified at least every second year. The date of the last verification shall be recorded.

### 3.2 Calibration

Each channel of the instrumentation shall be checked after installation to ensure proper functioning. Calibration of the instrumentation shall be checked before and after the measurements.

## 4 Measurement location and direction

### 4.1 Transducer locations

Transducer locations shall be selected on the decks of occupied spaces in sufficient quantity in order to characterize satisfactorily the vibration of the ship with respect to habitability.

### 4.2 Transducer orientation

The transducer orientation shall correspond to the three translational axes of the ship: longitudinal, transversal and vertical.

## 5 Measurement conditions

Measurement data shall be obtained, in the first instance, during the acceptance or performance trial of the ship. The collection of consistent and accurate vibration data requires the following uniform and favourable measurement conditions:

- a) free-route test on a straight course;<sup>1)</sup>
- b) constant representative engine output;
- c) sea state 3 or less;
- d) full immersion of the propeller;
- e) water depth not less than five times the draught of the ship.

Any deviation from the above measurement conditions shall be clearly stated in the test report.

## 6 Measurement procedure

Measurements are required in all three directions at a minimum of two locations on each deck. At other locations, measurements are only required in the vertical direction.

The combined frequency weighting curve according to ISO 2631-2 shall be applied to all measurements irrespective of their direction.

NOTE One-third-octave band values of the combined frequency weighting curve and a graphical presentation are given in annex A for information.

The frequency range to be evaluated is 1 Hz to 80 Hz.

The measurement duration shall be at least 1 min. If significant frequency components exist in the range below 2 Hz, a measurement duration of at least 2 min is required.

The result of each measurement shall be the overall frequency-weighted r.m.s. value as defined for acceleration in ISO 2631-1:1997, 6.4.2. A similar procedure is applicable for the frequency weighting of velocity spectra. The highest value in any direction shall be used for the evaluation of habitability, using the guidance given in clause 7.

If further data analysis is required following the measurement analysis as described above, the measurement data should be recorded with an electronic system which produces permanent records, e.g. on magnetic tape or computer disk.

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1) Free route is the condition maintained when the ship is proceeding at constant speed and course with rudder angles restricted to less than 2° port and 2° starboard.

## 7 Evaluation of habitability

It is recommended that the classification to be applied to the various areas of a ship be agreed between the interested parties (e.g. shipbuilder and shipowner) prior to any assessment of the habitability.

Table 1 contains guidelines for the values above which adverse comments are probable, and values below which adverse comments are not probable. The values are expressed in terms of the overall frequency-weighted r.m.s. acceleration ( $\text{mm/s}^2$ ) and overall frequency-weighted r.m.s. velocity ( $\text{mm/s}$ ) in the range 1 Hz to 80 Hz. The human sensitivity curve on which the frequency-weighting curves are based is shown for deeper understanding in annex B.

**Table 1 — Overall frequency-weighted r.m.s. values from 1 Hz to 80 Hz given as guidelines for the habitability of different areas on a ship**

|  | Area classification |               |                 |               |                 |               |
|--|---------------------|---------------|-----------------|---------------|-----------------|---------------|
|  | A                   |               | B               |               | C               |               |
|  | $\text{mm/s}^2$     | $\text{mm/s}$ | $\text{mm/s}^2$ | $\text{mm/s}$ | $\text{mm/s}^2$ | $\text{mm/s}$ |
| Values above which adverse comments are probable   | 143                 | 4             | 214             | 6             | 286             | 8             |
| Values below which adverse comments are not probable   | 71,5                | 2             | 107             | 3             | 143             | 4             |
| NOTE The zone between upper and lower values reflects the shipboard vibration environment commonly experienced and accepted. |                     |               |                 |               |                 |               |

Three different classification areas are presented:

- Classification A;
- Classification B;
- Classification C.

NOTE For guidance, Classification A can be passenger cabins, Classification B crew accommodation areas, and Classification C working areas.

## 8 Test report

The test report shall, as a minimum, contain the following information and data:

- a) reference to this International Standard;
- b) place and date of the test; identification of persons and organizations performing the test;
- c) principal ship design characteristics;
- d) actual conditions of ship and environment experienced during the test;
- e) locations and orientations of the transducers;
- f) recording equipment and calibration procedure;
- g) results of the measurements.

An example of a report is shown in annex C.

## Annex A (informative)

### Frequency-weighting curves

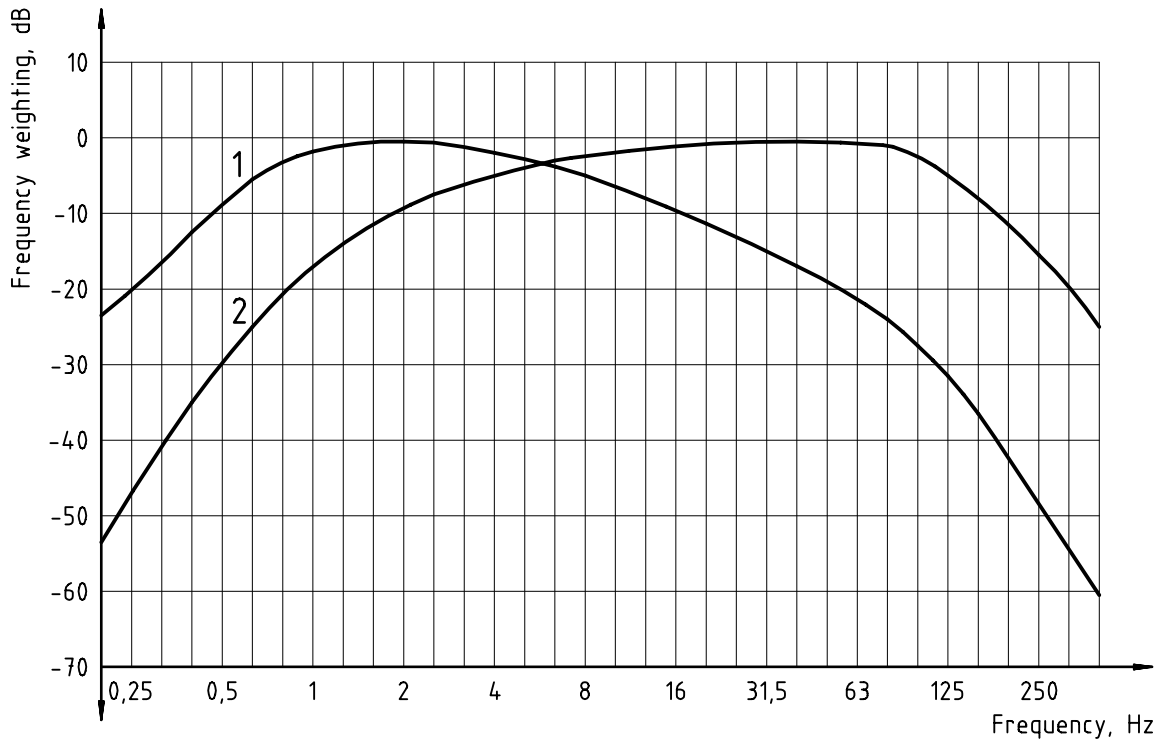
The frequency weighting to be used is the combined frequency weighting as defined in ISO 2631-2. It is given in Table A.1 and shown schematically in Figure A.1.

**Table A.1 — Combined frequency weighting, defined from 1 Hz to 80 Hz, in one-third-octave bands (calculated using the true mid-frequencies, band limitation included)**

| Frequency band number <sup>a</sup> | Frequency |        | Acceleration as input quantity |        | Velocity as input quantity |        |
|------------------------------------|-----------|--------|--------------------------------|--------|----------------------------|--------|
|                                    | Nominal   | True   | Factor $W_a$                   | dB     | Factor $W_v$               | dB     |
| $x$                                |           | Hz     |                                |        |                            |        |
| -7                                 | 0,2       | 0,1995 | 0,0629                         | -24,02 | 0,00221                    | -53,12 |
| -6                                 | 0,25      | 0,2512 | 0,0994                         | -20,05 | 0,00439                    | -47,14 |
| -5                                 | 0,315     | 0,3162 | 0,156                          | -16,12 | 0,00870                    | -41,21 |
| -4                                 | 0,4       | 0,3981 | 0,243                          | -12,29 | 0,0170                     | -35,38 |
| -3                                 | 0,5       | 0,5012 | 0,368                          | -8,67  | 0,0325                     | -29,77 |
| -2                                 | 0,63      | 0,6310 | 0,530                          | -5,51  | 0,0589                     | -24,60 |
| -1                                 | 0,8       | 0,7943 | 0,700                          | -3,09  | 0,0979                     | -20,19 |
| 0                                  | 1         | 1,000  | 0,833                          | -1,59  | 0,147                      | -16,68 |
| 1                                  | 1,25      | 1,259  | 0,907                          | -0,85  | 0,201                      | -13,94 |
| 2                                  | 1,6       | 1,585  | 0,934                          | -0,59  | 0,260                      | -11,68 |
| 3                                  | 2         | 1,995  | 0,932                          | -0,61  | 0,327                      | -9,71  |
| 4                                  | 2,5       | 2,512  | 0,910                          | -0,82  | 0,402                      | -7,91  |
| 5                                  | 3,15      | 3,162  | 0,872                          | -1,19  | 0,485                      | -6,28  |
| 6                                  | 4         | 3,981  | 0,818                          | -1,74  | 0,573                      | -4,83  |
| 7                                  | 5         | 5,012  | 0,750                          | -2,50  | 0,661                      | -3,59  |
| 8                                  | 6,3       | 6,310  | 0,669                          | -3,49  | 0,743                      | -2,58  |
| 9                                  | 8         | 7,943  | 0,582                          | -4,70  | 0,813                      | -1,80  |
| 10                                 | 10        | 10,00  | 0,494                          | -6,12  | 0,869                      | -1,22  |
| 11                                 | 12,5      | 12,59  | 0,411                          | -7,71  | 0,911                      | -0,81  |
| 12                                 | 16        | 15,85  | 0,337                          | -9,44  | 0,941                      | -0,53  |
| 13                                 | 20        | 19,95  | 0,274                          | -11,25 | 0,961                      | -0,35  |
| 14                                 | 25        | 25,12  | 0,220                          | -13,14 | 0,973                      | -0,23  |
| 15                                 | 31,5      | 31,62  | 0,176                          | -15,09 | 0,979                      | -0,18  |
| 16                                 | 40        | 39,81  | 0,140                          | -17,10 | 0,978                      | -0,20  |
| 17                                 | 50        | 50,12  | 0,109                          | -19,23 | 0,964                      | -0,32  |
| 18                                 | 63        | 63,10  | 0,0834                         | -21,58 | 0,925                      | -0,67  |
| 19                                 | 80        | 79,43  | 0,0604                         | -24,38 | 0,844                      | -1,48  |
| 20                                 | 100       | 100,0  | 0,0401                         | -27,93 | 0,706                      | -3,02  |
| 21                                 | 125       | 125,9  | 0,0241                         | -32,37 | 0,533                      | -5,46  |
| 22                                 | 160       | 158,5  | 0,0133                         | -37,55 | 0,370                      | -8,64  |
| 23                                 | 200       | 199,5  | 0,00694                        | -43,18 | 0,244                      | -12,27 |
| 24                                 | 250       | 251,2  | 0,00354                        | -49,02 | 0,156                      | -16,11 |
| 25                                 | 315       | 316,2  | 0,00179                        | -54,95 | 0,0995                     | -20,04 |
| 26                                 | 400       | 398,1  | 0,000899                       | -60,92 | 0,0630                     | -24,02 |

<sup>a</sup> Index  $x$  is the frequency band number according to IEC 61260.





**Key**

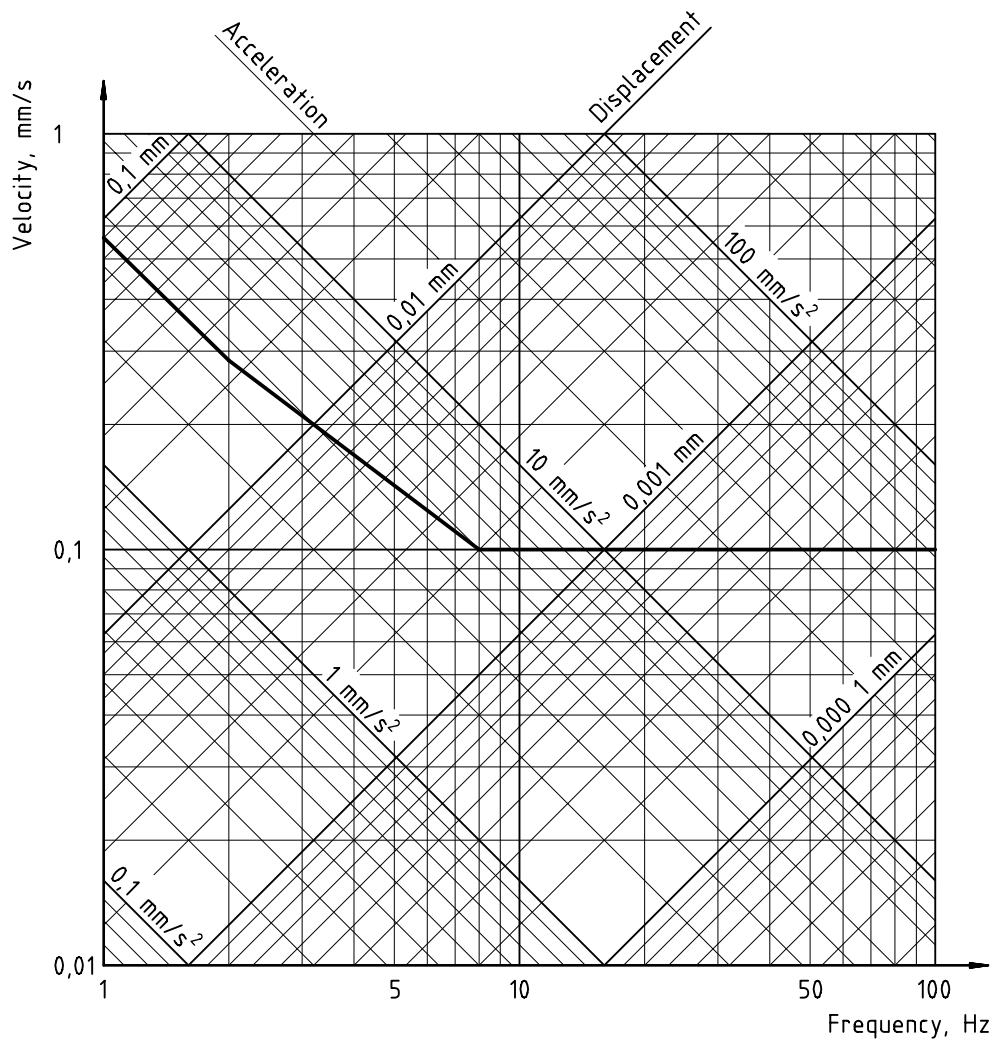
- 1 Based on acceleration as input quantity
- 2 Based on velocity as input quantity

**Figure A.1 — Combined frequency-weighting curves, band limitation included (schematic)**

## Annex B (informative)

### Human sensitivity curve

The human sensitivity curve on which the frequency-weighting curves are based is shown in Figure B.1.



**Figure B.1 — Human sensitivity curve**

## Annex C (informative)

### Example of report for evaluation of habitability of ships in accordance with ISO 6954

|  |           |                       |             |
|--|-----------|-----------------------|-------------|
| Place of test                                  |           | Date:                 |             |
| Name of organization responsible for the test: |           |                       |             |
| Name of person performing the test:            |           | Telephone:            | Fax:        |
| Name of ship:                                  |           | Owner:                |             |
| Type of ship:                                  | Location: | Yard and yard number: | Date built: |

#### Hull particulars

#### Main engine particulars

|                                   |                 |               |                      |
|-----------------------------------|-----------------|---------------|----------------------|
| Length between perpendiculars, m: |                 | Type:         | Number of cylinders: |
| Breadth moulded, m:               | Draught, m:     | Number:       | Power, kW:           |
| Depth, m:                         | Dead weight, t: | Speed, r/min: | Reduction ratio:     |

#### Propeller particulars

#### Measurement conditions

|                  |                   |                     |                           |
|------------------|-------------------|---------------------|---------------------------|
| Number and type: | Number of blades: | Sea state:          | Wind speed and direction: |
| Diameter, m:     | Skew in degrees:  | Draught forward, m: | Mean draught, m:          |
| Speed, r/min:    |                   | Draught aft, m:     | Depth of water, m:        |
| Remarks:         |                   |                     |                           |

#### Type and characteristics of measuring instrumentation

|                      |                           |                     |                  |
|----------------------|---------------------------|---------------------|------------------|
| Transducers, type:   | Frequency range:          | Sensitivity:        | Mounting method: |
| Data recorder, type: | Frequency range:          |                     |                  |
| Analyser, type:      | Analysis frequency range: | Sampling frequency: | Blocksizes:      |
| Sampling window:     | Anti-alias filter:        | Calibration check:  |                  |

#### Measurement results

| Transducer location | Direction | Overall frequency-weighted<br>r.m.s. values |                  |
|---------------------|-----------|---|------------------|
|                     |           | Acceleration<br>mm/s <sup>2</sup>           | Velocity<br>mm/s |
| 1.                  |           |   |                  |
| 2.                  |           |   |                  |
| 3.                  |           |   |                  |
| ....                |           |   |                  |
| ....                |           |   |                  |
| ....                |           |   |                  |

## Bibliography

- [1] ISO 2041, *Vibration and shock — Vocabulary*.
- [2] IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*.

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