INTERNATIONAL STANDARD

ISO 10819

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Mechanical vibration and shock — Hand-arm vibration — Method for the measurement and evaluation of the vibration transmissibility of gloves at the palm of the hand

Vibrations et chocs mécaniques — Vibrations main-bras — Méthode pour mesurer et évaluer le facteur de transmission des vibrations par les gants à la paume de la main

Reference number
ISO 10819:1996(E)

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.

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.

International Standard ISO 10819 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee TC 108, *Mechanical vibration and shock* Subcommittee SC 4, *Human exposure to mechanical vibration and shock* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Annex A forms an integral part of this International Standard. Annexes B, C, D and ZA are for information only.

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Foreword

The text of EN ISO 10819:1996 has been prepared by Technical Committee CEN/TC 162 "Protective clothing including hand and arm protection and lifejackets",the secretariat of which is held by DIN, in collaboration with Technical Committees ISO/TC 108 "Mechanical vibration and shock" and CEN/TC 231 "Mechanical vibration and shock".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 1996, and conflicting national standards shall be withdrawn at the latest by December 1996.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

There are five annexes to this standard whereof annex A is normative and annexes B, C, D and ZA are for information only.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This European Standard was developed in response to the growing demand to protect people from the risks of vibration damage caused by exposure to hand-transmitted vibration.

In the field of personal protective equipment (PPE), gloves are being marketed which are intended to reduce the magnitude of vibration exposure.

On present evidence, there have been no circumstances in which gloves have been shown to provide adequate attenuation of vibration to prevent vibration injuries.

Within the current state of knowledge, gloves do not provide significant attenuation in the frequency range below 150 Hz. Some gloves may provide amplification in this frequency range. Also, the use of gloves might alter the gripping force which would alter the transmission of vibration into the arms thus increasing the risk of damage. However, it must be emphasized that an important purpose of gloves is to keep the hands warm and dry, as this may help to limit some vibration-induced effects.

This standard describes a method of measuring the vibration transmissibility of gloves in the laboratory, but as far as possible under conditions typical of use at actual working places. The measurement is performed at the palm of the hand and so does not give the transmission of vibration to the fingers. However, when evaluating the protective effects of a glove, it must be remembered that in many work situations vibration is transmitted not only to the palm but also to the fingers. A different measurement procedure will be required to establish the vibration transmissibility of gloves at the fingers.

This standard describes a method of measuring the vibration transmissibility of gloves worn by a test subject. For the measurement of the vibration transmissibility of resilient materials which are used to cover handles of tools or make gloves, EN ISO 13753 should be consulted.

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1 Scope

This European Standard specifies a method for the laboratory measurement, the data analysis and reporting of the vibration transmissibility of gloves in terms of vibration transmission from a handle to the palm of the hand in the frequency range from 31,5 Hz to 1250 Hz.

The standard is intended to define a screening test for the vibration transmission through gloves. It is recognised that many factors influence the transmission of vibration through gloves. Therefore the transmissibility value according to this standard is not sufficient to assess the health risk due to vibration.

The transmissibility of vibration is measured and reported for two input spectra, which are representative of the vibration of some tools, and may be reported as a function of frequency.

2 Normative References

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

EN 420	General requirements for gloves
ENV 25349	Mechanical vibration – Guidelines for the measurement and the assessment of human exposure to hand-transmitted vibration (ISO 5349:1986)
ENV 28041	Human response to vibration – Measuring instrumentation (ISO 8041:1990)
EN 61260	Electroacoustics - Octave-band and fractional-octave-band filters (IEC 1260:1995)
ISO 2041	Vibration and shock – Vocabulary
ISO 5805	Mechanical vibration and shock affecting man – Vocabulary

3 Definitions

The terminology used in this standard is in accordance with ISO 2041, ISO 5805 and ENV 25349. Additionally for the purposes of this standard, the following definition applies:

Transmissibility: the ratio of the accelerations measured at the surface of the hand and at the reference point. Transmissibility values greater than 1 indicate that the glove amplifies the vibration. Values lower than 1 indicate that the glove attenuates the vibration.

4 Symbols and abbreviations

The following symbols and abbreviations are used:

a_w r.m.s. frequency-weighted acceleration, measured by means of a weighting filter or calculated from acceleration spectrum (see ENV 28041 and ENV 25349)

a_{ws} r.m.s. frequency-weighted acceleration for vibration spectrum s (s = M or H, see clause 6.2)

R subscript used to denote measurements taken at the reference point, i. e. at the handle

P subscript used to denote measurements taken at the palm of the hand

b subscript used to denote measurements taken with "bare hand", i. e. without glove

g subscript used to denote measurements taken with "gloved hand", i. e. between glove and hand.

Examples of combined subscripts:

a_{wMPg} weighted acceleration for vibration spectrum M, measured at the palm of the hand with glove

TR_{sb} transmissibility for vibration spectrum s measured with bare hand ($TR_{sb} = a_{wsPb} / a_{wsRb}$)

TR_{sg} transmissibility for vibration spectrum s measured with gloved hand ($TR_{sg} = a_{wsPg} / a_{wsRg}$)

TR_s corrected vibration transmissibility of glove for vibration spectrum s ($TR_s = TR_{sg} / TR_{sb}$)

$\overline{TR}_s$ mean corrected transmissibility of glove for vibration spectrum s (see clause 7.1).

5 Measuring principle and equipment

5.1 General principle and setup

The method uses a vibration excitation system ("shaker") equipped with a special handle (see annex B) to measure the gripping force and a device for measuring the feed force. The vibration in the direction of the excitation is measured at two points simultaneously: at the surface of the handle and – by means of an adaptor containing an accelerometer – between hand and glove, i. e. inside the glove. In order to compensate for the frequency response of the adaptor, the vibration transmissibility of the glove is calculated as the difference in vibration transmissibility from handle to hand with and without glove.

The measuring setup is shown in figure 1. The acceleration at the reference point (at the handle) and the vibration at the hand shall be measured simultaneously.

The values of the gripping force and the feed force have to be displayed continuously, to enable the operator to adjust them to the required values.

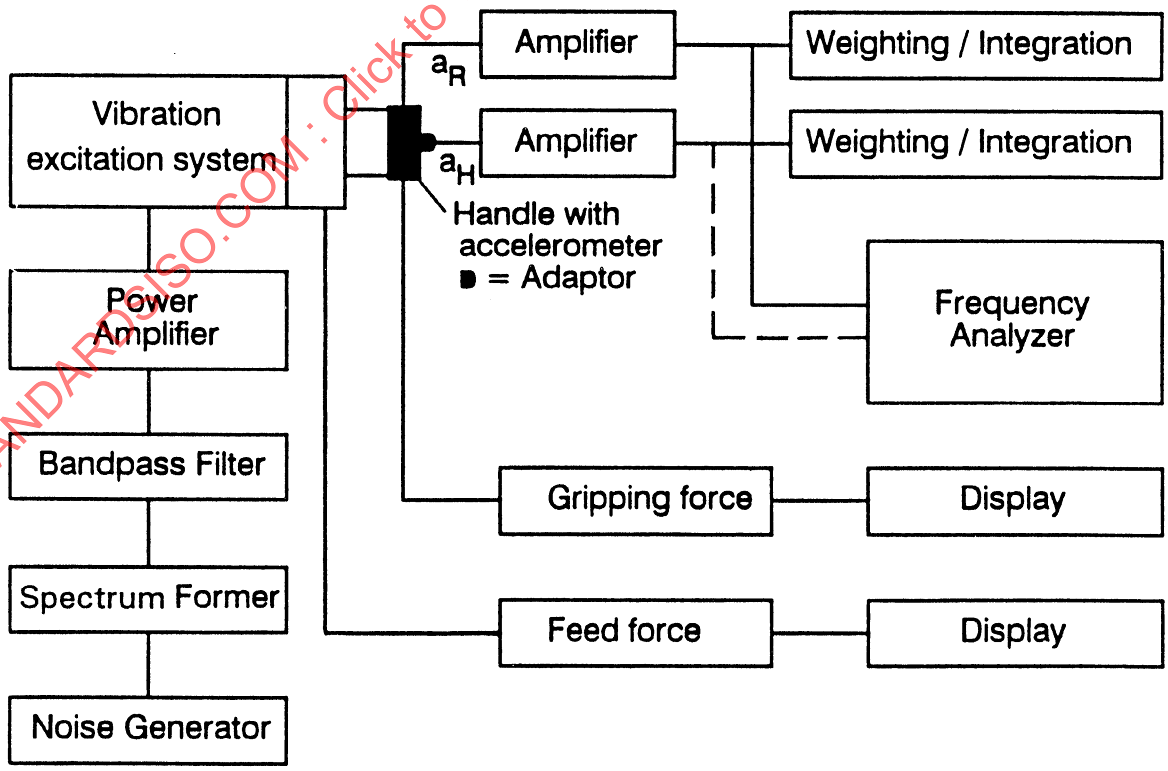


Figure 1: Schematic diagram for measurement of vibration transmissibility

5.2 Measuring equipment

5.2.1 General requirements

A frequency analyzer (narrow band or one-third octave band, preferably twin channel), two transducers and two channels of measuring equipment (including signal conditioning and weighting) are required.

The elements of the measuring chain shall fulfill the requirements for type 1 instrumentation according to ENV 28041.

An overload indication for the input signals shall be provided. The dynamic range shall be at least 60 dB.

5.2.2 Transducer mounting

5.2.2.1 Mounting at the reference point in the handle

The transducer shall be rigidly mounted into the handle, close and in parallel to the excitation axis. The exact location of the transducer shall be marked on the surface of the handle.

5.2.2.2 Mounting for measurement at the hand

The transducer shall be held in the palm of the hand. Therefore, an adaptor according to the drawing in figure 2 shall be used which contains the transducer. Its mass shall not exceed 15 g including transducer.

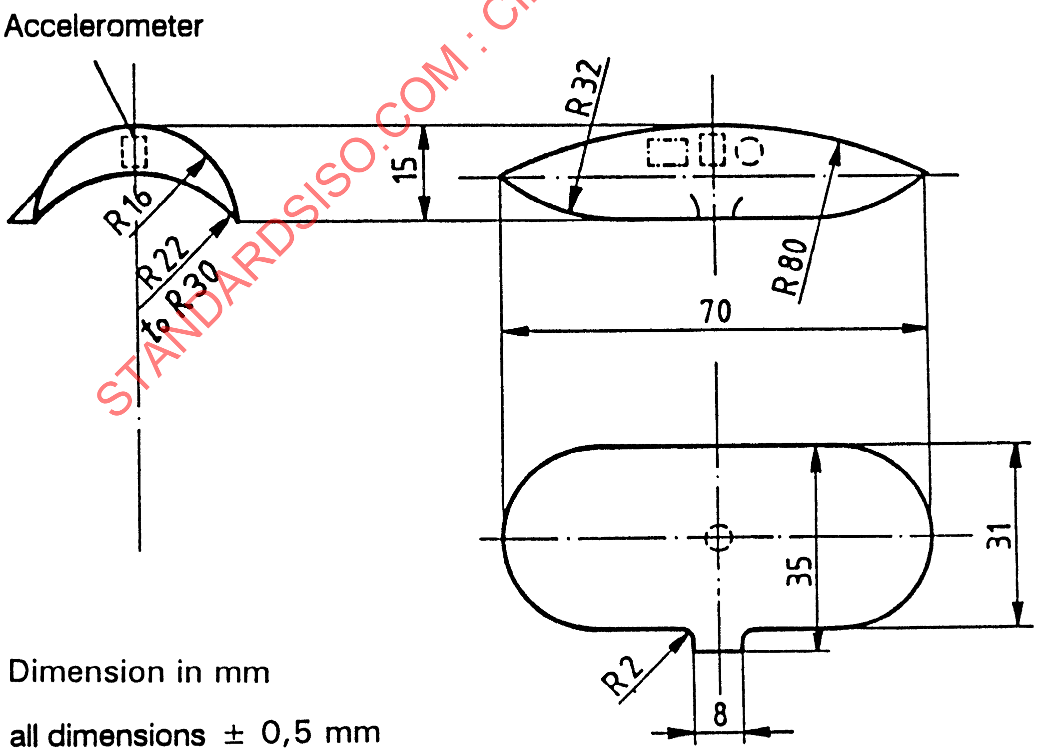


Figure 2: Adaptor for holding accelerometer in the palm of the hand

The exact value of R 22 to R 30 shall be chosen such as to apply a uniform pressure onto the glove material.

The frequency response is checked with the criterion indicated in clause 6.3.2.

5.2.3 Frequency analysis

If frequency analysis in third-octave bands is applied, the filters shall fulfill the requirements of EN 61260.

If constant bandwidth analysis is applied, the resolution for spectrum M shall be better than 1 Hz, for spectrum H better than 10 Hz.

5.2.4 Gripping force measuring system

In the context of this standard, gripping force means the force measured according to the principle shown in figure 3.

The gripping force measuring system shall fulfill the following requirements:
Dynamic range: 10 N to 50 N
Resolution: better than 2 N
Other measuring errors: less than 5 %
Integration time for display: 0,25 s

An example of a technical solution based on a strain gauge built into the handle is shown in annex B.

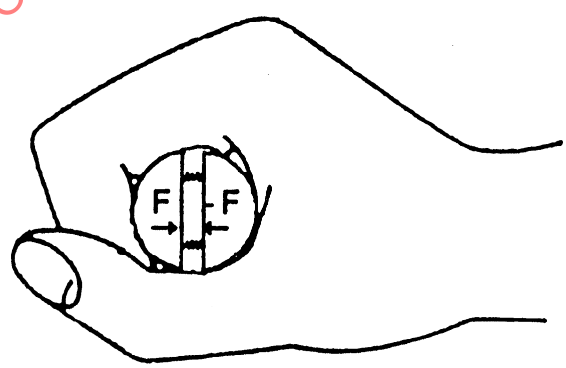


Figure 3: Definition of gripping force to be measured (top view)

5.2.5 Feed force measuring system

In the context of this standard, feed force means the horizontal force pushing towards the vibration excitation system.

The feed force measuring system shall fulfill the following requirements:
Dynamic range: 10 N to 80 N
Resolution: better than 2 N
Other measuring errors: less than 5 % of value
Integration time for display: 0,25 s

To measure the feed force, different technical solutions are possible:

- measuring the horizontal force applied to the platform by the operator (see figure 4);
- direct measurement of the feed force as a part of the vibration excitation system.

5.3 Vibration excitation system

5.3.1 Geometrical characteristics

5.3.1.1 Dimensions and direction of the handle

The handle shall have a circular section of 40 mm diameter and a length of 110 mm. The direction of the handle shall be vertical.

5.3.1.2 Position of the excitation system

The axis of vibration shall be horizontal and parallel to the forearm of the standing operator (see figure 4).

The excitation system or the platform the operator is standing on shall be adjusted so, that the requirements regarding the operator's posture as defined in clause 6.1.4 are fulfilled.

5.3.2 Performance

The excitation system shall be able to produce the vibration spectra specified in clause 6.2 when a feed force and a gripping force according to clause 6.1.3 are applied.

6 Measurement conditions and procedure

6.1 Measurement conditions

6.1.1 Test subjects

Three adults with hand sizes from 7 to 9 according to EN 420 shall serve as test subjets.

6.1.2 Test gloves

Three gloves shall be tested (one for each test subject).

6.1.3 Further conditions

For the measurements, the conditions specified hereafter shall be observed.

6.1.3.1 Gripping force

The gripping force shall be displayed continuously. The operator shall maintain the gripping force at 30 N ± 5 N throughout the test period.

6.1.3.2 Feed force

The feed force shall be displayed continuously. The operator shall maintain the feed force at 50 N ± 8 N throughout the test period.

6.1.3.3 Room temperature

The measurements shall take place at a room temperature of 20 °C ± 5 °C.

6.1.3.4 Humidity

The relative humidity shall be below 70 % and shall be reported.

6.1.3.5 Conditioning of gloves

The glove to be tested shall be stored at the specified temperature for at least 30 min and worn by a subject for at least 3 min before starting the test procedure.

6.1.3.6 Fitting of gloves

The size of the gloves shall be chosen according to EN 420.

6.1.3.7 Test period

Each test period to be evaluated shall be of at least 30 s duration for weighted measurements or third-octave band analysis, and shall allow averaging of at least 60 spectra if constant bandwidth analysis is applied.

6.1.4 Operator's posture

The operator is standing upright on a horizontal surface (floor or platform, see figure 4). The forearm is directed in the axis of vibration. The elbow forms an angle of approximately 90° ± 10°. The elbow shall not touch the body during the measurements. The wrist shall be bent from 0° (neutral) to 40° (dorsal bending) maximum (see figure 5).

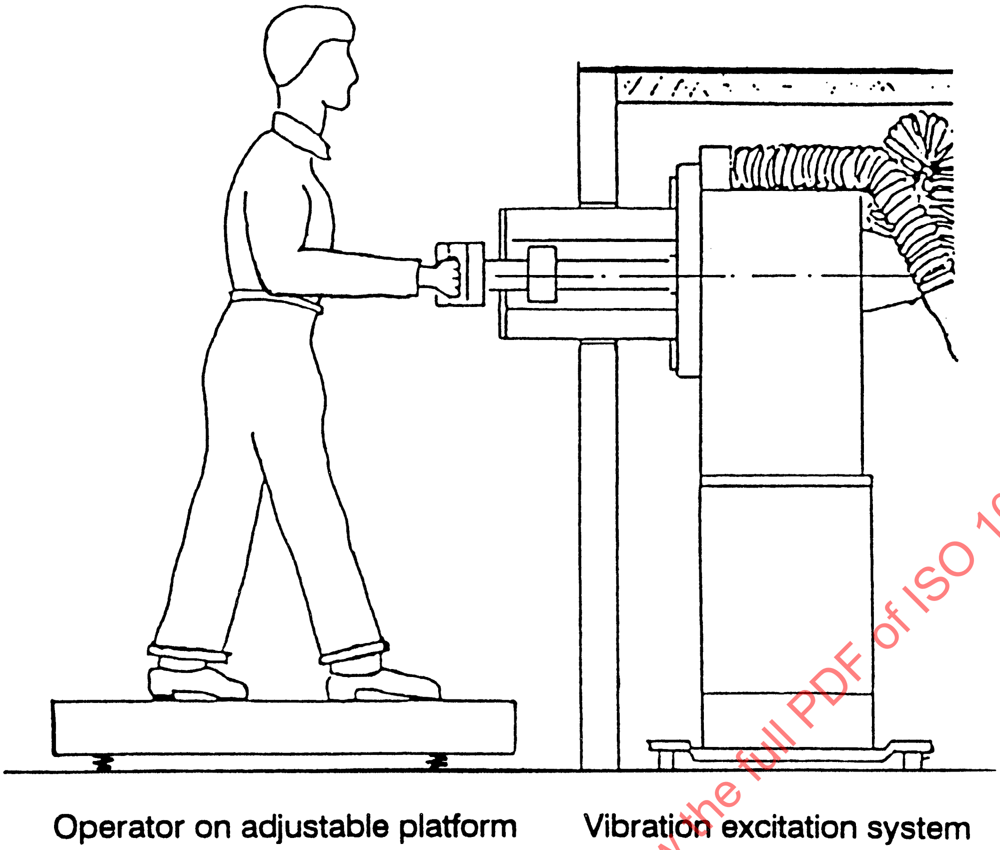


Figure 4: Posture of the operator during measurements

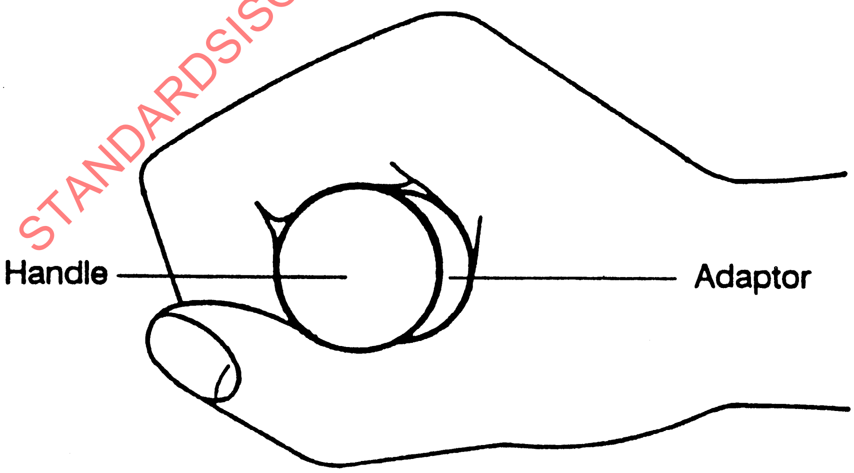


Figure 5: Position of hand with handle and adaptor (top view)

6.2 Vibration signal

The two vibration spectra (M and H) as measured at the handle consist of band-limited random noise and shall fulfill the requirements according to figure 6 and table 1. The power spectral density (PSD) is expressed as mean square acceleration per unit bandwidth in $(m/s^2)^2/Hz$. The mathematical definition of these signals is to be found in annex A.

The required PSD function can be generated for example by means of a white noise generator and a bandpass filter with slopes of 12 dB/octave. Depending on the excitation system, additional spectrum forming may be necessary.

Annex C gives third-octave band values of both spectra.

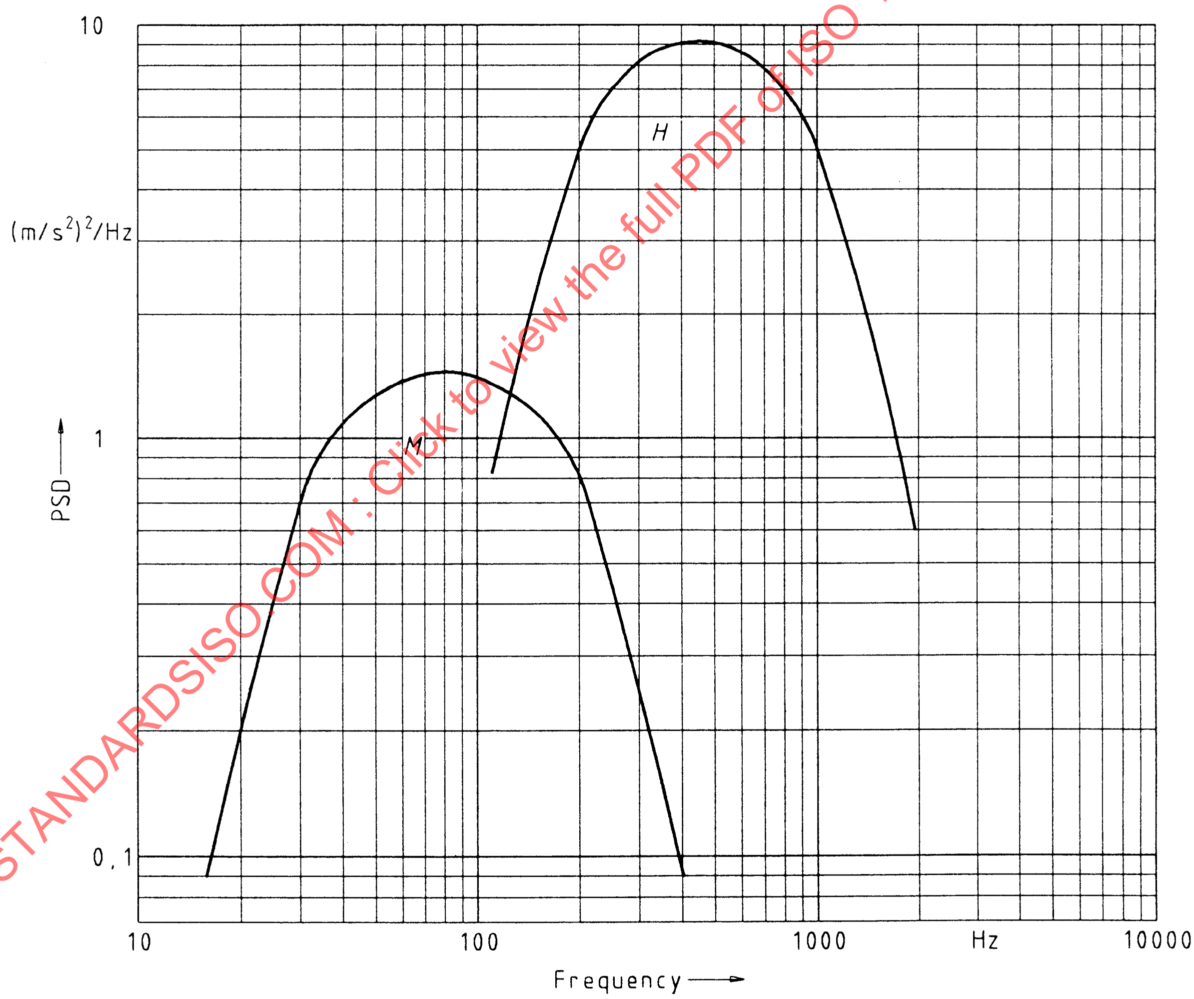


Figure 6: Spectra of the two vibration signals (M and H) measured on the handle

Table 1: Acceleration values and tolerances of vibration spectra M and H

Spectrum designation	Unweighted acceleration m/s²	Weighted acceleration rms-value m/s²	Weighted acceleration tolerance	Tolerances for frequency ranges (center frequencies)
M	16,7	3,4	± 10 %	± 1 dB from 31,5 Hz to 200 Hz ± 2 dB from 16,0 Hz to 400 Hz
H	92,2	3,3	± 10 %	± 1 dB from 200 Hz to 1000 Hz ± 2 dB from 100 Hz to 1500 Hz

6.3 Procedure

6.3.1 Preparation

The following steps shall be carried out before starting the measurements:

- calibration (see ENV 28041);
- conditioning of gloves;
- instruction to subjects and trials to learn control of the feed force and gripping force;
- checking (frequency analysis) and adjusting of the vibration signal.

6.3.2 Measurements with bare hand

First the measurements (spectra M and H) with bare (ungloved) hand shall be carried out with each of the test subjects. The weighted accelerations obtained at the handle (a_{wsRb}) and at the palm of the hand (a_{wsPb}) are measured simultaneously and used to calculate the weighted transmissibility (see clause 7.1).

If the transmissibility of the unweighted accelerations a_{sRb} and a_{sPb} for spectrum M or H is outside the range from 0,95 to 1,05, the measurements are to be considered not valid.

NOTE: The phase of the transfer function should also be calculated. If the phase exceeds ± 5° in the frequency range where spectra M and H are specified, the measurement should be considered not valid.

6.3.3 Measurements with gloved hand

Using the same adaptor as in clause 6.3.2, two sets of measurements (for spectra M and H) shall be carried out with each of the test subjects. From the weighted accelerations obtained at the handle (a_{wsRg}) and at the palm of the hand (a_{wsPg}) the weighted transmissibility is calculated (see clause 7.1).

NOTE: The coherence of the two unweighted signals a_{sRg} and a_{sPg} and the transfer function should also be calculated. If the coherence in the frequency range where spectra M and H are specified is lower than 0,95 or if the transfer function is not continuous, the validity of the measurement should be considered.

7 Evaluation of results

7.1 Calculation of transmissibility

The calculation of the mean corrected transmissibility consists of the following steps (see figure 7):

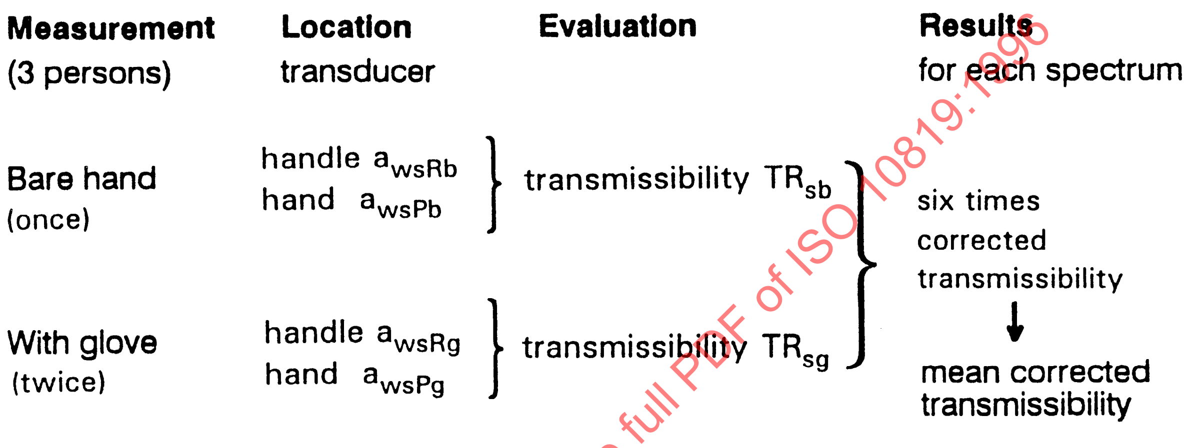


Figure 7: Principle of determination of mean corrected transmissibility

From the results obtained with bare hand, calculate the weighted transmissibility for each vibration spectrum: $TR_{sb} = a_{wsPb} / a_{wsRb}$

From the results obtained with gloved hand, calculate the weighted transmissibility (two values) for each vibration spectrum: $TR_{sg} = a_{wsPg} / a_{wsRg}$

The corrected transmissibilities of the glove are calculated for each vibration spectrum as follows: $TR_s = TR_{sg} / TR_{sb}$

The mean corrected transmissibility $\overline{TR}_s$ for each of the spectra (M and H) is equal to the arithmetic mean value of the six results (two measurements for each of the three subjects). Furthermore, the standard deviation and the coefficient of variation shall be calculated.

7.2 Criteria for antivibration gloves

A glove shall not be considered as "antivibration glove" according to this standard if it does not fulfill both of the following criteria:

$\overline{TR}_M < 1,0$ and $\overline{TR}_H < 0,6$

NOTE: The fulfilment of these criteria does not imply that the use of such gloves removes the hazard of vibration exposure.

Moreover, a glove shall only be considered as "antivibration glove" according to this standard if the fingers of the glove have the same properties (materials and thickness) as the part of the glove covering the palm of the hand.

NOTE: However, if such gloves fulfill the requirements regarding vibration transmissibility, they may have a beneficial effect when used in situations involving no contact between fingers and vibrating suface.

7.3 Transmissibility as a function of frequency

7.3.1 General

It is recommended to determine the transmissibility as a function of frequency. This will allow the effect of the glove on frequency-weighted vibration to be estimated, in situations where the vibration spectrum is known. The principle of calculation is identical to the one described in clause 7.1 for the weighted transmissibilities.

7.3.2 Transmissibility in third-octave bands

If transmissibility as a function of frequency is reported in third-octave bands, the results shall be given for third-octave bands with centre frequencies

from 31,5 Hz to 200 Hz: based on results obtained with vibration spectrum M
from 200 Hz to 1250 Hz: based on results obtained with vibration spectrum H.

7.3.3 Transmissibility in narrow band analysis

If transmissibility measured by means of narrow band analysis is reported, the results obtained with the two vibration spectra shall be used as follows:

from 32,0 Hz to 200 Hz: based on results obtained with vibration spectrum M
from 200 Hz to 1250 Hz: based on results obtained with vibration spectrum H.

8 Test report

The test report shall contain the following:

a) name and address of glove manufacturer;
b) model/type and state (new or used) of glove;
c) description of tested samples (size, weight, left/right, colour);
d) date of test;
e) description of testing equipment;
f) measuring conditions;
g) vibration attenuation results:
mean corrected transmissibility, standard deviation and coefficient of variation for vibration spectra M and H.
If possible: Transmissibility as a function of frequency (see clause 7.3);
h) test carried out by (institute, laboratory, responsible).

Annex A (normative)

Mathematical definition of vibration test signals

Equations for the power spectral densities (PSD):

$$PSD = c \cdot (HP_{12})^2 \cdot (LP_{12})^2$$

where

$$LP_{12} = \frac{1}{1 + 1{,}414\,s + s^2}$$

and

$$HP_{12} = \frac{s^2}{1 + 1{,}414\,s + s^2}$$

with

$$s = \frac{j\,f}{f_c}$$

$$j = \sqrt{-1}$$

f frequency, HZ

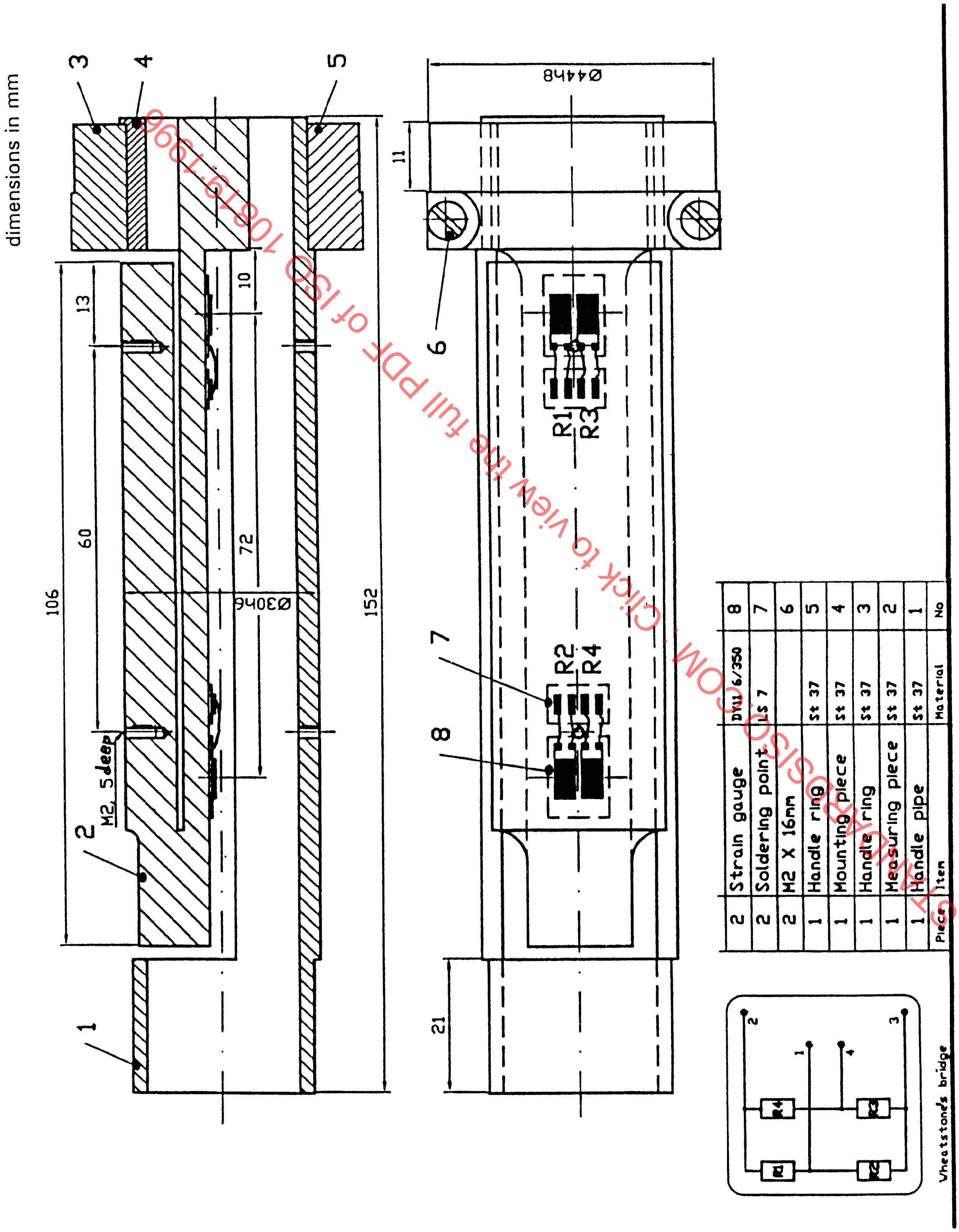
The filter cut-off frequencies f_c and the constant factors c are given in the table below.

Table A.1: Cut-off frequencies f_c and constant factors c for vibration spectra (filter slopes of 12 dB/octave, Butterworth characteristics)

Spectrum	f_c (HP_{12}) Hz	f_c (LP_{12}) Hz	c $(m/s^2)^2/Hz$	Comment
L	8	31,5	0,82	see note
M	31,5	200	1,52	—
H	200	1000	10,0	—
NOTE: According to the current state of knowledge gloves do not provide significant vibration attenuation below 150 Hz. If it is necessary to check the vibration transmissibility at low frequencies – e. g. for the testing of gloves purported to provide vibration attenuation in this frequency range – then spectrum L should be used in addition to M and H.				

Annex B (informative)

Example of handle with gripping force measuring system



Pieces	Item	Material	No
2	Strain gauge	DY11 6/350	8
2	Soldering point	LS 7	7
2	M2 X 16mm		6
1	Handle ring	St 37	5
1	Mounting piece	St 37	4
1	Handle ring	St 37	3
1	Measuring piece	St 37	2
1	Handle pipe	St 37	1

Figure B.1: Example of handle with gripping force measuring system

Annex C (informative)

Third-octave band spectra of vibration test signals

When analysed in third-octave bands, the vibration test signals M and H described in clause 6.2 and annex A give the acceleration values listed below.

Table C.1: Spectrum M

Band Hz	a_{rms} m/s²	Tolerance
16	0,18	± 2 dB
20	0,40	± 2 dB
25	0,90	± 2 dB
31,5	2,36	± 1 dB
40	3,18	± 1 dB
50	3,88	± 1 dB
63	4,54	± 1 dB
80	5,16	± 1 dB
100	5,71	± 1 dB
125	6,14	± 1 dB
160	6,28	± 1 dB
200	5,89	± 1 dB
250	5,04	± 2 dB
315	3,94	± 2 dB
400	2,89	± 2 dB

Table C.2: Spectrum H

Band Hz	a_{rms} m/s²	Tolerance
100	3,77	± 2 dB
125	6,29	± 2 dB
160	10,47	± 2 dB
200	15,24	± 1 dB
250	20,20	± 1 dB
315	24,86	± 1 dB
400	29,07	± 1 dB
500	32,48	± 1 dB
630	35,15	± 1 dB
800	35,95	± 1 dB
1000	33,79	± 1 dB
1250	28,91	± 2 dB
1600	22,40	± 2 dB