International Standard 6487

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Road vehicles — Techniques of measurement in impact tests — Instrumentation

Véhicules routiers — Techniques de mesurage lors des essais de chocs — Instrumentation

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 6487 was developed by Technical Committee ISO/TC 22, *Road vehicles*, and was circulated to the member bodies in June 1979.

It has been approved by the member bodies of the following countries :

Australia	Italy	South Africa, Rep. of
Austria	Korea, Dem. P. Rep. of	Spain
Belgium	Korea, Rep. of	Sweden
Canada	Libyan Arab Jamahiriya	United Kingdom
Chile	Netherlands	USA
Czechoslovakia	New Zealand	USSR
France	Poland	
Germany, F. R.	Romania	

No member body expressed disapproval of the document.

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Road vehicles — Techniques of measurement in impact tests — Instrumentation

1 Scope

The purpose of this International Standard is to give requirements and recommendations for the techniques of measurement used in impact tests. The requirements are to facilitate comparisons between results obtained by different laboratories and the recommendations are to assist such laboratories in meeting the requirements.

Photographic methods are excluded from the present International Standard.

2 Field of application

The instrumentation as defined in this International Standard applies in particular to impact tests for road vehicles, including tests on their sub-assemblies.

3 Definitions

3.1 data channel : All of the instrumentation from and including a single transducer (or multiple transducers whose outputs are combined in some specified way) up to and including any analysis procedures that may alter the frequency content or the amplitude content of data.

3.2 transducer : The first device in a data channel used to convert a physical quantity to be measured into a second quantity (such as an electrical voltage) which can be processed by the remainder of the channel.

3.3 channel amplitude class, CAC : The designation for a data channel that meets certain amplitude characteristics as specified by this International Standard.

The CAC number is numerically equal to the upper limit of the measurement range.

3.4 characteristic frequencies, F_H, F_L, F_N : These frequencies are defined in the figure.

3.5 channel frequency class, CFC : The channel frequency class is designated by a number indicating that the channel frequency response lies within limits specified by the figure.

This number and the value of the frequency F_H in hertz are numerically equal.

3.6 sensitivity coefficient : The slope of the straight line representing the best fit to the calibration values determined by the method of least squares within the channel amplitude class.

3.7 calibration factor of a data channel : The mean value of the sensitivity coefficients evaluated over frequencies which are evenly spaced on a logarithmic scale between F_L and $\frac{F_H}{2,5}$.

3.8 linearity error : The ratio, in percent, of the maximum difference between the calibration value and the corresponding value read on the straight line defined in 3.6 at the upper limit of the channel amplitude class.

3.9 cross sensitivity : The ratio of the output signal to the input signal, when an excitation is applied to the transducer perpendicular to the measurement axis. It is expressed as a percentage of the sensitivity along the measurement axis.

3.10 phase delay time : The phase delay time of a data channel is equal to the phase delay (in radians) of a sinusoidal signal, divided by the angular frequency of that signal (in radians per second).

3.11 environment : The aggregate, at a given moment, of all external conditions and influences to which the data channel is subjected.

4 Performance requirements

4.1 Linearity error

The absolute value of the linearity error of a data channel at any frequency in the CFC, shall be less than or equal to 2,5 % of the value of the CAC, on the whole measurement range.

4.2 Amplitude against frequency[1)]

The frequency response of a data channel shall lie within the limiting curves given in the figure. The zero dB line is defined by the calibration factor.

4.3 Phase delay time

The phase delay time between the input and the output of a data channel shall be determined, and shall not vary more than $\frac{1}{10\,F_H}$ s between 0,03 F_H and F_H.

4.4 Time

4.4.1 Time base

A time base shall be recorded and shall give at least 1/100 s with an accuracy of 1 %.

4.4.2 Relative time delay

The relative time delay between the signals of two or more data channels regardless of their frequency class, must not exceed 1 ms excluding phase delay caused by phase shift. Two or more data channels of which the signals are combined shall have the same frequency class and shall not have a relative time delay greater than $\frac{1}{10\,F_H}$ s.

This requirement applies to analogue signals as well as synchronization pulses and digital signals.

4.5 Transducer cross sensitivity

The transducer cross sensitivity shall be less than 5 % in any direction.

4.6 Calibration

4.6.1 General

A data channel shall be calibrated at least once a year against reference equipment traceable to known standards. The methods used to carry out a comparison with reference equipment shall not introduce an error greater than 1 % of the CAC. The use of the reference equipment is limited to the range of frequencies for which they have been calibrated.

Subsystems of a data channel may be evaluated individually and the results factored into the accuracy of the total data channel. This can be made for example by an electrical signal of known amplitude simulating the output signal of the transducer which allows a check to be made on the gain factor of the data channel, except the transducer.

4.6.2 Accuracy of reference equipment for calibration

The accuracy of this reference equipment shall be certified or endorsed by an approved metrology service.

4.6.2.1 Static calibration

4.6.2.1.1 Accelerations

The error shall be less than 1,5 % of the channel amplitude class.

4.6.2.1.2 Forces

The error shall be less than 1 % of the channel amplitude class.

4.6.2.1.3 Displacements

The error shall be less than 1 % of the channel amplitude class.

4.6.2.2 Dynamic calibration

4.6.2.2.1 Accelerations

The error in the reference accelerations expressed as a percentage of the channel amplitude class shall be less than 1,5 % below 400 Hz, less than 2 % between 400 and 900 Hz, and less than 2,5 % above 900 Hz.

4.6.2.2.2 Forces and displacements[1)]

See note.

4.6.2.3 Time

The relative error in the reference time shall be less than 10^{-5}.

4.6.3 Sensitivity coefficient and linearity error

The sensitivity coefficient and the linearity error shall be determined by measuring the output signal of the data channel against a known input signal, for various values of this signal.

The calibration of the data channel shall cover the whole range of the amplitude class.

For bi-directional channels, both the positive and negative values shall be used.

If the calibration equipment cannot produce the required input, due to excessively high values of the quantity to be measured, calibrations shall be carried out within the limits of these calibration standards and these limits shall be recorded in the report.

1) No method for the evaluation of the dynamic response during calibration of data channels for forces and displacements is included in this International Standard since no satisfactory method is known at present. This problem shall be reconsidered later.

A total data channel shall be calibrated at a frequency or at a spectrum of frequencies with its significant value comprised between F_L and $\frac{F_H}{2,5}$.

4.6.4 Calibration of the frequency response

The response curves of phase and amplitude against frequency shall be determined by measuring the output signals of the data channel in terms of phase and amplitude against a known input signal, for various values of this signal varying between F_L and 10 times the CFC or 3 000 Hz whichever is the lower value.

4.7 Environmental effects

The existence or not of an influence of environmental effects shall be regularly checked (i.e. electric or magnetic flux, cable velocity, etc.). This can be done for instance by recording the output of spare channels equipped with dummy transducers.

If significant output signals are obtained, corrective action shall be taken, for instance re-allocation or replacement of cables.

4.8 Choice and designation of the data channel

The CAC and CFC define a data channel.[1]

The CAC shall be 1, 2 or 5 multiplied by a power of ten.

A data channel consistent with the specifications of this International Standard shall be designated according to the following codes :

ISO 6487 — (number of this International Standard)
CAC . . . — (channel amplitude class)
CFC . . . — (channel frequency class)

If the calibration of the amplitude response does not cover the complete CAC owing to limited properties of the calibration equipment, then the CAC shall be marked with an asterisk.

Example, ISO 6487
CAC* 200 m/s^2
CFC 1 000 Hz

means that :

— this measurement has been carried out according to this International Standard;

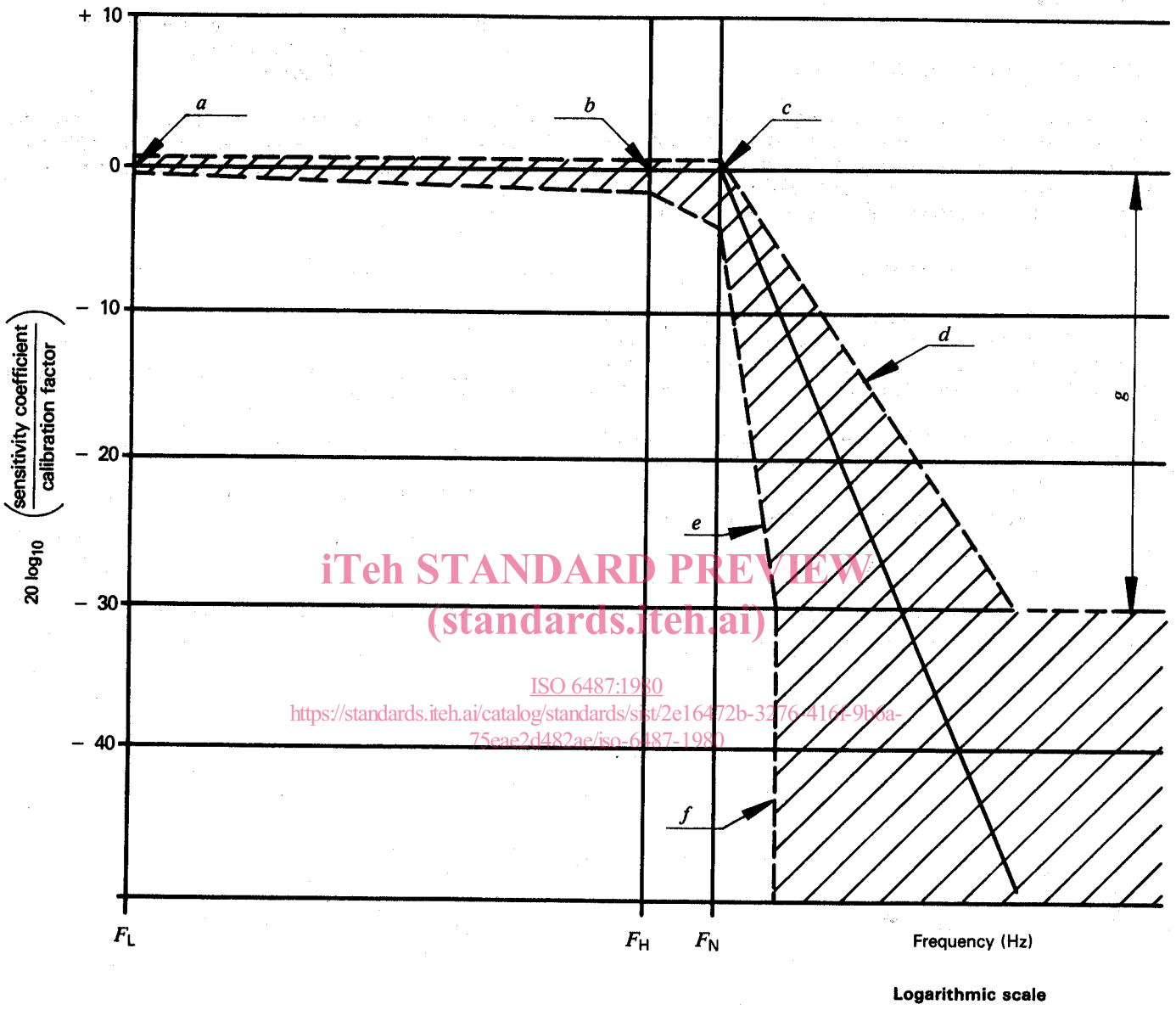
— the channel amplitude class was 200 m/s^2;

— the channel frequency class was 1 000 Hz;

— the calibration of the amplitude response did not cover the complete CAC.

The test report shall indicate the calibration limits.

1) Their values are chosen for a given application by the party requiring this application.



CFC	F_L Hz	F_H Hz	F_N Hz
1 000	< 0,1	1 000	1 650
600	< 0,1	600	1 000
180	< 0,1	180	300
60	< 0,1	60	100

a ± 0,5 dB
b + 0,5; − 1 dB
c + 0,5; − 4 dB
d − 9 dB/octave
e − 24 dB/octave
f ∞
g − 30 dB

Figure — Frequency response limits

Annex

Recommendations

(The recommendations made in this annex are intended to provide advice on how the requirements of this International Standard might be met.)

A.1 Mounting of transducers

Transducers should be solidly mounted so that their recordings are affected as little as possible by vibration. Any mounting having a lowest resonance frequency equal to at least five times the frequency F_H of the given data channel should be considered valid.

Acceleration transducers, in particular, should be mounted in such a way that the initial angle of the actual measurement axis to the corresponding axis of the reference axis system is not greater than 5° unless analytical or experimental assessment of the effect of the mounting on the collected data is made. When multi-axial accelerations at a point are to be measured, each acceleration transducer axis should pass within 10 mm of that point, and the centre of seismic mass of each accelerometer should be within 30 mm of that point.

Transducers should be mounted on the dummies using a support specially provided for this purpose.[1)]

A.2 Recording

A.2.1 Analogue magnetic recorder

Tape speed should be stable to within less than 0,5 % of the tape speed used. The signal-to-noise ratio of the recorder should not be less than 42 dB at the maximum tape speed.

The total harmonic distortion should be less than 3 % and the linearity error should be less than 1 % of the measurement range.

A.2.2 Digital magnetic recorder

Tape speed should be stable to within less than 10 % of the tape speed used.

A.2.3 Paper tape recorder

In the case of direct data recording, the paper speed in millimetres per second should be at least 1,5 times the number expressing F_H in hertz.

In other cases, the paper speed should be such that an equivalent resolution should be obtained.

A.3 Data processing

A.3.1 Filtering

Filtering corresponding to the frequencies of the data channel class may be carried out either during recording or processing of data.

However, before recording, analogical filtering at a higher level than CFC should take place in order to use at least 50 % of the dynamic range of the recorder and to reduce the risk of high frequencies saturating the recorder or aliasing error in the digitising process.

A.3.2 Digitising

A.3.2.1 Sampling frequencies

The sampling frequency should be equal to at least eight times F_H.

In the case of analogue recording, when the recording and reading speeds are different, the sampling frequency can be divided by the speed ratio.

A.3.2.2 Amplitude resolution

The length of digital words should be at least seven bits and a sign.

A.4 Presentation of results

The results should be presented on A4 size paper (ISO 216).

Accelerations on the vehicle can be recorded at various locations on the vehicle. These locations shall be stated in the test report.

Results presented as diagrams should have axes scaled with one measurement unit corresponding to a suitable multiple of the chosen unit (for example 1, 2, 5, 10, 20 millimetres). SI units shall be used, except for vehicle velocity where kilometres per hour may be used and for accelerations due to an impact where g may be used (with $g = 9{,}81\ m/s^2$).

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1) The support is to be defined in a future International Standard in preparation by SC 12.