IEC 60068-2-65

Edition 2.0 2013-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Environmental testing –
Part 2-65: Tests – Test Fg: Vibration – Acoustically induced method

Essais d'environnement –
Partie 2-65: Essais – Essai Fg: Vibrations – Méthode induite acoustiquement

IEC 60068-2-65:2013

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you to find IEC publications by a variety of criteria (reference number, text, technical committee,…).
It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available on-line and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Liens utiles:

Recherche de publications CEI - www.iec.ch/searchpub

La recherche avancée vous permet de trouver des publications CEI en utilisant différents critères (numéro de référence, texte, comité d'études,…).
Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

Just Published CEI - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications de la CEI. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

IEC 60068-2-65

Edition 2.0 2013-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Environmental testing –
Part 2-65: Tests – Test Fg: Vibration – Acoustically induced method

Essais d'environnement –
Partie 2-65: Essais – Essai Fg: Vibrations – Méthode induite acoustiquement

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX V

ICS 19.040; 29.020 ISBN 978-2-83220-641-6

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL TESTING –

Part 2-65: Tests –
Test Fg: Vibration –
Acoustically induced method

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60068-2-65 has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

This second edition cancels and replaces the second edition, published in 1993, and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

– minor technical and editorial changes were made throughout the document as originally requested by the DE National Committee;

– following comments at the CD stage, particularly from the UK National Committee, significant technical and editorial additions were made to the standard for acoustic testing employing the progressive wave tube technique.

The text of this standard is based on the following documents:

FDIS	Report on voting
104/591/FDIS	104/597/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 60068 series, published under the general title *Environmental testing*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Acoustic noise may produce significant vibration in components and equipment. In the acoustic noise field, sound pressure fluctuations impinge directly on the specimen and the response may be different to that produced by mechanical excitation.

Items particularly sensitive to acoustic noise include relatively lightweight items whose dimensions are comparable to an acoustic wavelength in the frequency range of interest and whose mass per unit area is low, such as dish antennas and solar panels, electronic devices, printed circuit boards, optical elements, etc.

Acoustic testing is applicable to components, equipment, functional units and other products, hereinafter referred to as “specimens”, which are liable to be exposed to and/or are required to function in conditions of high sound pressure levels. It should be noted that, under service conditions, the specimen may be subjected to simultaneous mechanical and acoustical excitation.

High sound pressure levels may be generated by jet engines and other aircraft propulsion systems, rocket motors, high-powered gas circulators, turbulent gas flow around aircraft or launchers, etc. This part of IEC 60068 deals with acoustic testing in compressible gases and can also be used to simulate the excitation response caused by turbulence resulting from high-velocity separated gas flows.

The intent of the test procedure contained in this standard is to produce a high intensity acoustic noise field by either reverberant methods (known as reverberant chamber testing) or by progressive wave methods (known as progressive wave tube testing).

Testing for the effects of vibration caused by acoustic noise demands a certain degree of engineering judgement and this should be recognized both by the manufacturer/supplier and the purchaser of the specimen. Based on the guidance provided in this standard, the writer of the relevant specification is expected to select the most appropriate method of test and values of severity, taking account of the nature of the specimen and its intended use.

Since the acoustic levels occurring during testing are high enough to be damaging to human hearing, appropriate protective measures need to be taken to reduce the noise exposure of operators performing the test to a level regarded as permissible from the standpoint of hearing conservation.

ENVIRONMENTAL TESTING –

Part 2-65: Tests –
Test Fg: Vibration –
Acoustically induced method

1 Scope

This part of IEC 60068 provides standard procedures and guidance for conducting acoustic tests in order to determine the ability of a specimen to withstand vibration caused by a specified sound-pressure level environment to which it is, or is liable to be, subjected.

For sound pressure level environments of less than 120 dB acoustic tests are not normally required.

This standard determines the mechanical weakness and/or degradation in the performance of specimens and to use this information, in conjunction with the relevant specification, to decide on their acceptability for use. The methods of test may also be used as a means of establishing the mechanical robustness or fatigue resistance of specimens.

Two procedures are described for conducting tests and for measurement of the sound pressure levels within the acoustic noise field and considers the need for measurement of the vibration responses at specified points on the specimen. It also gives guidance for the selection of the acoustic noise environment, spectrum, sound pressure level and duration of exposure.

The progressive wave tube method is relevant to material where aerodynamic turbulence will excite part, or all, of the total external surface. Such applications include aircraft panel assemblies where the excitation exists on one side only. The reverberant chamber method is relevant where it is preferable to induce vibration onto the entire external surface of equipment by distributed excitation rather than fixed points by means of electro-dynamic shakers.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61672-1, *Electroacoustics – Sound level meters – Part 1: Specifications*

ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
acoustic horn
tube with increasing cross-section of generally exponential envelope, used to couple an acoustic source to the test volume, for example the inside of a reverberation room, thus achieving the maximum transfer of sound energy

Note 1 to entry: Each acoustic horn has individual transfer characteristics which affect the sound spectrum.

3.1.2
analysis integration time
time duration over which a signal is averaged

Note 1 to entry: See Clause A.8.

3.1.3
bandwidth
difference between the nominal upper and lower cut-off frequencies

Note 1 to entry: It may be expressed

a) in hertz,

b) as a percentage of the pass-band centre frequency, or

c) as the interval between the upper and lower nominal cut-off frequencies in octaves.

3.1.4
overall sound pressure level
OASPL
value computed from the third-octave or octave band sound pressure levels L_i

$$L_G = 10 \log_{10} \sum_{i=1}^{m} 10^{L_i/10}$$

where

L_G is the overall sound pressure level in dB;

L_i is the sound pressure level in the ith third-octave or octave band;

m is the number of third-octave or octave bands.

3.1.5
centre frequency
geometric mean of the nominal cut-off frequencies of a pass-band

Note 1 to entry: The nominal upper and lower cut-off frequencies of a filter pass-band are defined as those frequencies above and below the frequency of maximum response of a filter at which the response to a sinusoidal signal is 3 dB below the maximum response.

Note 2 to entry: The geometric mean is equal to $(f_1 \times f_2)^{½}$, where f_1 and f_2 are the cut-off frequencies.

3.1.6
constant-bandwidth filter
filter which has a bandwidth of constant value when expressed in hertz; it is independent of the centre frequency of the filter

3.1.7
cut-off frequency (of acoustic horn)
frequency below which an acoustic horn becomes increasingly ineffective

Note 1 to entry: This cut-off frequency is a main characteristic of an acoustic horn.

3.1.8
diffuse sound field
sound field which, in a given region, has statistically uniform energy density, for which the directions of propagation at any point are randomly distributed

Note 1 to entry: In a diffuse sound field, the sound pressure level measured with a directional microphone would give the same results whatever its orientation.

[SOURCE: IEC 60050-801:1994 [1][1], definition 801-23-31, modified – Addition of the Note 1 to entry]

3.1.9
electro-pneumatic transducer
hydraulic-pneumatic transducer
most generally employed laboratory source of acoustic noise to simulate sound pressure levels encountered in a high operational ambient acoustic noise environment

Note 1 to entry: This transducer consists of a pneumatic transducer supplied with pressurized gas modulated by an electromagnetic or hydraulic valve.

Note 2 to entry: This type of transducer provides a continuous spectrum of energy over a wide frequency band with random amplitude distribution and is capable of providing a shaped sound spectrum to meet the specifications in acoustic testing (see Clause A.5).

3.1.10
grazing incidence
angle between the direction of the acoustic wave and either the surface of the specimen and/or the sensing surface of the acoustic transducer, 0 ° being parallel and 90 ° normal to the surface

3.1.11
frequency interval
ratio of two frequencies

[SOURCE: IEC 60050-801:1994, definition 801-30-07]

3.1.11.1
octave
interval between two frequencies which have a ratio of 2

3.1.11.2
one-third octave
1/3
interval between two frequencies which have a ratio equal to $2^{1/3}$

Note 1 to entry: Octave and third-octave frequency bands are defined by their geometric centre frequencies in ISO 266 [2].

3.1.11.3
one-twelfth octave
1/12
interval between two frequencies which have a ratio equal to $2^{1/12}$

3.1.12
measuring points
specific points in the sound field at which sound pressure is measured for the conduct of the test

[1] Figures in square brackets refer to the bibliography.

Note 1 to entry: Measurements may be made at points within the specimen in order to assess its behaviour but these are not considered as measuring points in the sense of this standard.

3.1.12.1
checkpoints
points located on a fictitious surface surrounding the specimen and at a fixed distance from it

3.1.12.2
reference points
points chosen from the checkpoints, whose signals are used to control the test so that the requirements of this standard are satisfied

3.1.13
multipoint control
control achieved by using the average of the signals at the reference points

Note 1 to entry: When using multipoint control, each microphone signal relates to the sound pressure level at one position. The average sound pressure level L_{AV} can be computed as given in IEC 60050-801:1994, definition 801-31-36, when

$$L_{AV} = 10 \log_{10} \frac{1}{n}\sum_{1}^{n} 10^{L_i/10}$$

where

n is the number of reference points;

L_i is the sound pressure level in the ith third-octave or octave band.

3.1.14
narrowband frequency filter
band-pass filter for which the pass-band is generally smaller than third-octave

3.1.15
broadband frequency
wide band filter
band-pass filter for which the pass-band is relatively wide or broad, in general larger than an octave

3.1.16
progressive wave tube
tube along which sound waves propagate from the acoustic source, which is coupled to a suitable test section by an acoustic horn

Note 1 to entry: The tube is terminated by an acoustically absorptive termination placed at the end of the test section to minimize reflection of the progressive acoustic waves in the frequency range of interest (see Clause A.2).

3.1.17
proportional-bandwidth filter
filter which has a bandwidth that is proportional to the frequency

Note 1 to entry: Octave bandwidth, third-octave bandwidth, etc. are typical bandwidths for proportional-bandwidth filters.

3.1.18
reverberation chamber (or room)
chamber or room which has hard, highly reflective surfaces such that the sound field therein becomes diffuse

Note 1 to entry: The geometry of the chamber or room may influence the test. Information on reverberant chambers is given in Clause A.1.

3.1.19
sound absorption coefficient
fraction of incident sound power not reflected from the surface of a material at a given frequency and under specified conditions

Note 1 to entry: Sound absorption is the property possessed by materials and objects for converting sound energy to heat.

[SOURCE: IEC 60050-801:1994, definition 801-31-02, modified – word order of definition reversed, Note 1 to entry replaces previous NOTE and bears no relation]

3.1.20
sound pressure
p
root mean-square of instantaneous sound pressures over a given time interval, unless specified otherwise

Note 1 to entry: Sound pressure characterizes the variation of pressure about the static pressure, produced by acoustic waves, which are variations of pressure caused by disturbances in a gaseous medium.

[SOURCE: IEC 60050-801:1994, definition 801-21-20, modified – addition of Note 1 to entry]

3.1.21
sound pressure level L_p

$$L_p = 20 \log_{10} \frac{p}{p_o} \text{ dB}$$

3.2 Symbols and abbreviations

NOTE Where appropriate, a cross-reference to the definition is given.

OASPL	overall sound pressure level in dB (derived from 801-22-07), see 3.1.4;
L_G	overall sound pressure level in dB (see 3.1.4);
L_i	sound pressure level in third-octave or octave band in dB (see 3.1.4);
L_p	sound pressure level in dB (see 3.1.21);
L_{AV}	average sound pressure level in dB (see 3.1.13);
p	r.m.s. sound pressure in N/m^2 or Pa (see 3.1.20);
p_o	international reference sound pressure, standardized as 2 x 10^{-5} Pa or 20 μPa in air (IEC 61672-1), 1 μPa in other media;
DOF	statistical degrees of freedom, given by:

$$N_d = 2B_e \times T_a$$

where

B_e is the frequency resolution;

T_a is the effective averaging time.

4 Acoustic environments and requirements for testing

4.1 Acoustic environment for testing

4.1.1 General

An acoustic test is conducted in order to determine the ability of a specimen to operate or survive in a specified high-intensity acoustic noise field. In practice, the fluctuating pressure environment exerted on a specimen under consideration may be a complex combination of progressive waves and reverberant acoustic fields. Standing waves, formed within structures and cavities exposed to noise may resonate and produce very high local sound pressure levels. It is, therefore, necessary to select the most appropriate type of acoustic test for the specimen.

The selection may be based upon real measured data from field tests or flight trials or be obtained from general levels specified for particular equipment applications, for example as in Figures 1, 2 and 3. The applied test spectrum may contain energy above and below the frequencies given in the figures.

NOTE For further information on sound pressure levels associated with aircraft environments, see ISO 2671 [3].

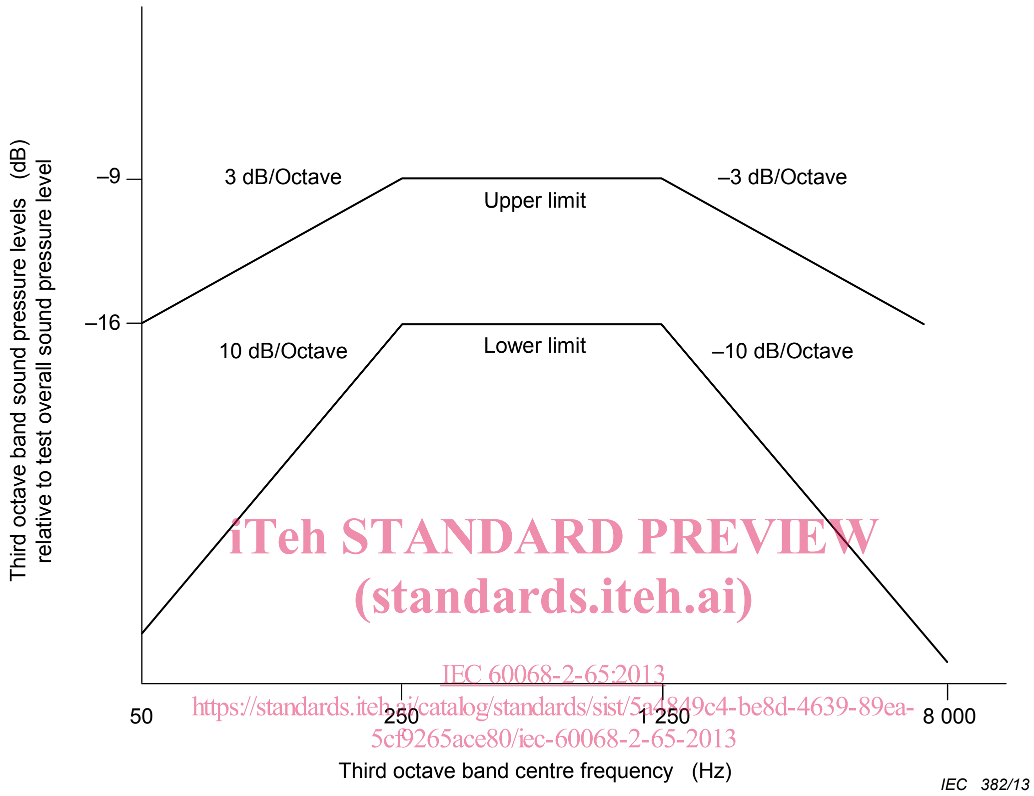

Figure 1 – Third-octave band spectrum for aeronautical applications

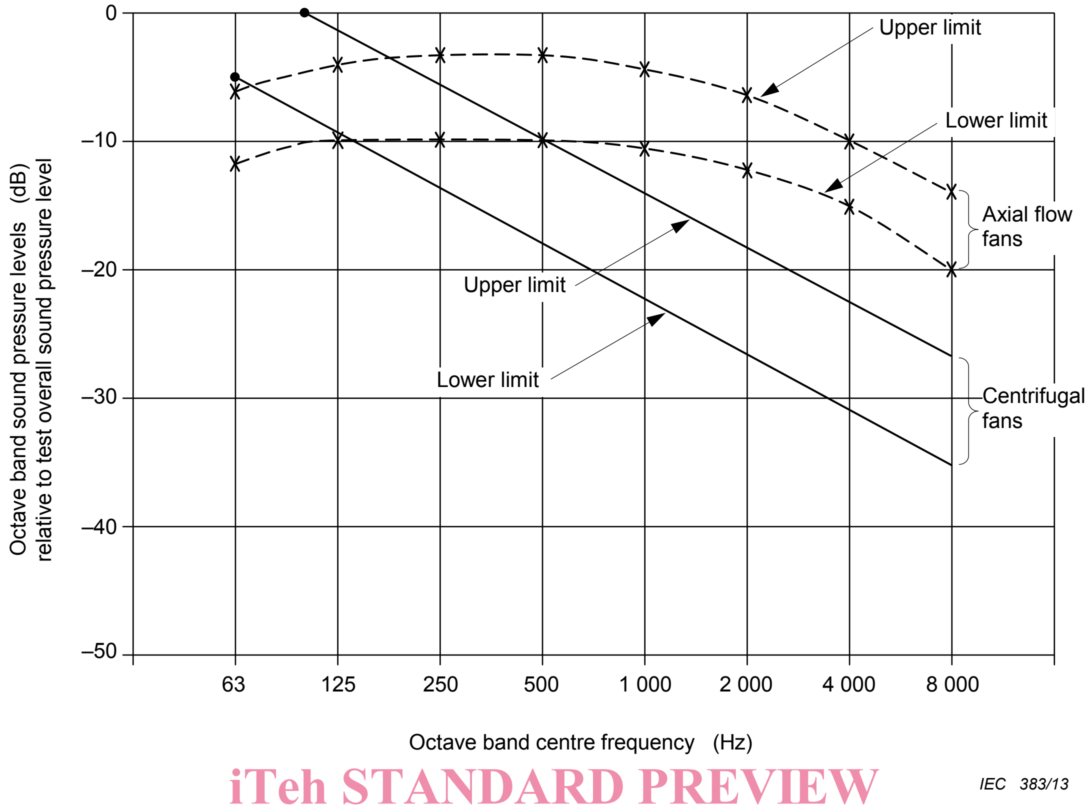

Figure 2 – Octave band spectra for fans derived from [4]

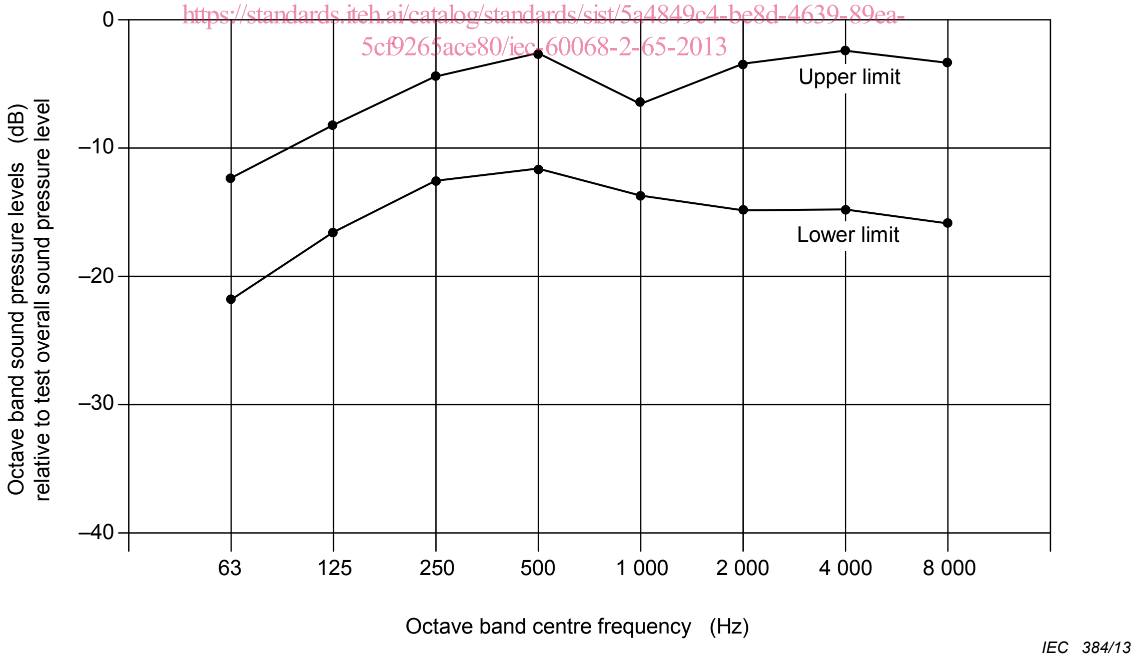

Figure 3 – Octave band spectrum for noisy industrial machinery derived from [4]

4.1.2 Reverberant field

A reverberant field is generally used for specimens intended to be located in enclosed spaces, when the pressure fluctuations seen by the specimens are evenly distributed. However, it may