

Australian Standard™

Environmental testing

Part 2.65: Tests—Test Fg: Vibration, acoustically induced

[IEC title: Environmental testing—Part 2-65: Methods of test—Test Fg:
Vibration, acoustically induced]



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This Standard was issued in draft form for comment as DR 02614.

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Part 2.65: Tests—Test Fg: Vibration, acoustically induced

First published as AS 60068.2.65—2003.

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Published by Standards Australia International Ltd
GPO Box 5420, Sydney, NSW 2001, Australia

ISBN 0 7337 5299 3

PREFACE

This Standard was prepared by the Standards Australia Committee EL-026, Protective Enclosures and Environmental Testing for Electrical/Electronic Equipment.

The objective of this Standard is to provide the electrotechnology industry with a complete set of environmental test procedures published as a series under AS 60068 *Environmental testing*. This Standard is Part 2.65 of that series.

This Standard is identical with, and has been reproduced from, IEC 60068-2-65:1993, *Environmental testing – Part 2-65: Methods of test—Test Fg: Vibration, acoustically induced*.

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In this Standard, the following print types are used:

- requirements proper: in arial type;
- *test specifications: in italic type;*
- explanatory matter: in smaller arial type.

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The terms ‘normative’ and ‘informative’ are used to define the application of the annex to which they apply. A normative annex is an integral part of a standard, whereas an informative annex is only for information and guidance.

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INTRODUCTION

Acoustic noise may produce significant vibration in components and equipment. In the acoustic noise field, 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, wiring, optical elements, etc.

This test is applicable to components, equipment and other products, hereinafter referred to as “specimens”, which are liable to be exposed to and/or 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, etc. This standard 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.

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 part of IEC 60068 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 potentially damaging to human hearing, appropriate measures need to be taken to reduce preparatory operation and the noise exposure of operators performing the test, to a level regarded as permissible from the standpoint of hearing conservation.

STANDARDS AUSTRALIA

Australian Standard
Environmental testing**Part 2.65: Tests—Test Fg: Vibration, acoustically induced**

1 Object

To provide 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.

To determine mechanical weakness and/or degradation in the performance of specimens and to use this information, in conjunction with the relevant specification, to decide their acceptability. In some cases, the methods of test may also be used as a means of establishing the mechanical robustness or fatigue resistance of specimens.

This part of IEC 60068 describes the procedures 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.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60068. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60068 are encouraged to investigate the possibility of applying the most recent editions of the normative documents listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(151): 1978, *International Electrotechnical Vocabulary (IEV) – Chapter 151: Electrical and magnetic devices*

IEC 60050(801): 1984, *International Electrotechnical Vocabulary (IEV) – Chapter 801: Acoustics and electro-acoustics*

IEC 60068-1: 1988, *Environmental testing – Part 1: General and guidance*

IEC 60651: 1979, *Sound level meters*

ISO 266: 1975, *Acoustics – Preferred frequencies for measurements*

ISO 2041: 1990, *Vibration and shock – Vocabulary*

ISO 2671: 1982, *Environmental tests for aircraft equipment – Part 3.4: Acoustic vibration*

3 Definitions, symbols and abbreviations

The terms used are generally defined in ISO 2041, IEC 60068-1 and IEC 60050(801). Where, for the convenience of the reader, a definition from one of those sources is included here, the derivation is indicated. Departures from the definitions in those sources are also indicated (see also 3.2). The additional terms and definitions that follow are applicable for the purposes of this standard.

3.1 Definitions

3.1.1 acoustic horn (not identical to 801-07-12): Tube of generally exponentially varying section, larger at one end than at the other, used to couple an acoustic source to the test volume, for example the inside of a reverberation room, thus achieving the maximum transfer of energy.

NOTE – 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 (see A.8).

3.1.3 bandwidth (identical to B.19 of ISO 2041): Difference between the nominal upper and lower cut-off frequencies.

NOTE – 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 i th third-octave or octave band and

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

3.1.5 centre frequency (identical to B.31 of ISO 2041): Geometric mean of the nominal cut-off frequencies of a pass-band.

NOTES

1 ISO 2041 defines the nominal upper and lower cut-off frequencies of a filter pass-band 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.

2 The geometric mean is equal to $(f_1 \cdot f_2)^{1/2}$, where f_1 and f_2 are the cut-off frequencies.

3.1.6 constant-bandwidth filter (identical to B.21 of ISO 2041): 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 progressively ineffective; it is a main characteristic of an acoustic horn.

3.1.8 diffuse sound field: (identical to 801-03-31). 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 – In a diffuse sound field, the sound pressure level measured with a directional microphone would give the same results whatever its orientation.

3.1.9 electro or hydraulic-pneumatic transducer: The most generally employed laboratory source of acoustic noise to simulate sound pressure levels encountered in a high operational ambient acoustic noise environment. It consists of a pneumatic transducer supplied with pressurized gas modulated by an electromagnetic or hydraulic valve.

NOTE – 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 A.5).

3.1.10 frequency interval (identical to 801-10-07): Ratio of two frequencies.

3.1.10.1 octave: Interval between two frequencies which have a ratio of two.

3.1.10.2 one-third octave (1/3): Interval between two frequencies which have a ratio equal to $2^{1/3}$.

NOTE – Octave and third-octave frequency bands are defined by their geometric centre frequencies in ISO 266.

3.1.10.3 one-twelfth octave (1/12): Interval between two frequencies which have a ratio equal to $2^{1/12}$.

3.1.11 measuring points: Specific points at which data are gathered for the conduct of the test. These points are of two main types which are defined below.

NOTE – 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.

3.1.11.1 checkpoints: Points located on a fictitious surface surrounding the specimen and at a fixed distance from it.

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

3.1.12 multipoint control: Control achieved by using the average of the signals at the reference points (see 3.1.11.2).

NOTE – 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), definition 801-11-36, when

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

where

n is the number of reference points

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

Alternatively, when differences in sound pressure levels are small, the average sound pressure level can be approximated by taking the arithmetically averaged value. For example, differences of 6 dB will result in an error of approximately 0,5 dB when averaged arithmetically.

3.1.13 narrowband frequency filter: Band-pass filter for which the pass-band is generally smaller than third-octave.

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

3.1.15 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 – An acoustically absorptive termination is placed at the end of the test section to minimize reflection of the progressive acoustic waves in the frequency range of interest (see A.2).

3.1.16 proportional-bandwidth filter (identical to B.22 of ISO 2041): Filter which has a bandwidth that is proportional to the frequency.

NOTE – Octave bandwidth, third-octave bandwidth, etc. are typical bandwidths for proportional-bandwidth filters.

3.1.17 reverberation room (not identical to 801-11-13): Room which has hard, highly reflective surfaces such that the sound field therein becomes diffuse.

3.1.18 sound absorption coefficient (not identical to 801-11-02): Fraction of incident sound power not reflected from the surface of a material at a given frequency and under specified conditions.

NOTE – Sound absorption is the property possessed by materials and objects for converting sound energy to heat.

3.1.19 sound pressure p (identical to 801-01-20 except for the note below): Root mean-square of instantaneous sound pressures over a given time interval, unless specified otherwise.

NOTE – 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.

3.1.19.1 sound pressure level L_p (identical to 801-02-07):

$$L_p = 20 \log_{10} \frac{p}{p_0} \text{ dB ref. } p_0 \text{ where } p_0 = 20 \text{ } \mu\text{Pa (see 3.2)}$$

3.1.20 standing wave tube: Tube in which a periodic sound wave is generated having a fixed distribution in space which is the result of the addition of directly propagated and reflected sound waves of the same frequency.

NOTE – Standing acoustic waves are characterized by the existence of complete or partial pressure nodes and anti-nodes that are fixed in space. The acoustic source is coupled to the standing wave tube by an acoustic horn and is terminated by an acoustically hard, axially adjustable, reflecting surface for tuning of the fundamental frequency. The standing wave tube provides an effective method of generating discrete frequencies with high sound pressure levels (see A.4).

3.2 Symbols and abbreviations

The following symbols and abbreviations are used. Where appropriate, a cross-reference to the definition is given.

OASPL	:	overall sound pressure level (derived from 801-02-07, see 3.1.14).
L_G	:	overall sound pressure level in dB (see 3.1.42);
L_i	:	sound pressure level in i th third-octave or octave band (see 3.1.14);
L_p	:	sound pressure level (see 3.1.19.1);
L_{AV}	:	average sound pressure level (see 3.1.12);
p	:	r.m.s. sound pressure in N/m^2 or Pa (see 3.1.19);
p_0	:	international reference sound pressure, standardized as 2×10^{-5} Pa or 20 μPa in air (IEC 60651), 1 μPa in other media.