International Standard 2671

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Environmental tests for aircraft equipment — Part 3.4 : Acoustic vibration

Essais en environnement pour les équipements aéronautiques — Partie 3.4 : Vibrations acoustiques

First edition — 1982-10-15

UDC 629.7.05/.06 : 534.831 : 620.178.5 **Ref. No. ISO 2671-1982 (E)**

Descriptors : aircraft industry, aircraft equipment, tests, environmental tests, acoustic tests, vibration tests, performance tests, sound pressure.

Price based on 9 pages

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 2671 was developed by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, and was circulated to the member bodies in March 1979.

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

Austria	Italy	Spain
Belgium	Korea, Rep. of	United Kingdom
Canada	Libyan Arab Jamahiriya	USA
Czechoslovakia	Poland	USSR
France	Romania	
India	South Africa, Rep. of	

No member body expressed disapproval of the document.

This International Standard is part of a composite standard, specifying environmental tests for aircraft equipment, details of which are given in ISO 7137, *Aircraft — Environmental conditions and test procedures for airborne equipment*.

Environmental tests for aircraft equipment — Part 3.4 : Acoustic vibration

1 Scope and field of application

1.1 This International Standard specifies laboratory conditions for testing the ability of equipment for subsonic and supersonic civil aircraft to withstand the effects of acoustic vibration. Two types of tests are specified : tests for the functioning of the equipment, and tests for its acoustic endurance. The tests for the functioning of the equipment are carried out both during equipment development and for certification. The tests for acoustic endurance are usually carried out in order to find structural defects during equipment development.

1.1.1 The tests for the functioning of the equipment may be carried out in accordance with one of the two alternative methods.

— wide band noise test

— harmonic sound test.

The tests for acoustic endurance are carried out using the wide band noise method.

1.1.2 The selection of the test severity grade is made by the user in accordance with one of the following two procedures :

a) If measurements of sound pressure levels at the location where the equipment is to be installed are available for in-flight conditions or can be calculated, they can be used to determine test sound pressure levels by a method proposed in this International Standard. This is referred to as procedure "A" (see 4.4.1, 5.2.1, and the annex).

b) If such measurements are not available or the user does not wish to use method A, the test levels may be obtained from this International Standard on the basis of the type of aircraft in which the equipment is to be installed and the location of the equipment in the aircraft with respect to the noise sources. In this method, which will be referred to as procedure "B", the test sound pressure level can be determined by means of the tables and formulae given in this International Standard (see 4.4.2; 5.2.2, and the annex).

1.2 The tests are intended to be applied to equipment sensitive to acoustic vibration. The necessity for functioning and endurance tests, the use of the wide band noise method or harmonic sound method, and the applicable test sound pressure level shall be specified in the relevant equipment specifications.

1.2.1 The equipment located in aircraft, regions where overall sound pressure levels are less than 125 dB will not normally require testing in acoustic vibration environments.

2 Definitions

For the purposes of this International Standard, the following definitions apply :

2.1 control points : Locations of microphones in the test chamber.

2.2 maximum non-uniformity of sound pressure field : The maximum difference between overall sound pressure levels at any two control points when testing in accordance with the wide band noise method.

2.3 mean value of sound pressure levels at the control points : The value determined from the formula :

$$L_m = \left(\left[10 \lg \sum_{j=i}^{k} 10^{L_j/10} \right] - \left[10 \lg k \right] \right), \text{ dB}$$

where

L_j is an overall sound pressure level at the j-th control point relative to 20 µPa, in decibels;

k is the number of control points;

or, when the sound pressure level difference does not exceed 5 dB, from the following formula :

$$L_m = \frac{1}{k} \sum_{j=i}^{k} L_j, \text{ dB}$$

2.4 maximum overall sound pressure level at the equipment location in the aircraft, L_{max} : The maximum r.m.s. level of sound pressure in areas of the equipment location in the aircraft during typical flight.

2.5 nominal sound pressure level : The constant overall sound pressure level specified in a frequency range of 250 to 2 000 Hz for each severity grade, when testing in accordance with the harmonic sound method.

2.6 equivalent sound pressure level, L_{eqv} : The sound pressure level which, if applied constantly for a duration equal to that of an aircraft's typical flight, would result in overall damage of the aircraft's equipment equal to the damage in the aircraft during a typical flight. The formula for evaluation of the equivalent sound pressure level is given in the annex.

2.7 accelerated sound pressure level : The sound pressure level for accelerated acoustic endurance tests, in decibels.

It is determined from the formula :

$$L_{acc.t.} = L_{eqv} + \frac{20}{\gamma} \lg \frac{T_{s.l.}}{T_{acc.t}}, \text{ dB}^{1)}$$

where

$T_{s.l.}$ is the required service life of the aircraft equipment, in hours;

$T_{acc.t.}$ is the acoustic endurance test duration, in hours;

γ is the index of the rate of fatigue damage accumulation law for the equipment.

3 Test facility requirements

3.1 The acoustic vibration test facility shall consist of the following :

— test chamber;

— equipment to produce a sound field in the test chamber;

— instrumentation for monitoring the sound field parameters.

3.2 The test chamber, the equipment to produce the sound field in the test chamber and the instrumentation for monitoring the sound field parameters shall satisfy the requirements for sound pressure levels, non-uniformity of the sound pressure field, the sound pressure spectrum shape and the test duration (see 3.2.1 to 3.2.3, 3.3 to 3.7, 4.1.1 to 4.1.5, 4.2.1 to 4.2.4, 4.3, 5.2.1, 5.2.2 and the annex).

3.2.1 The test chamber shall be of such shape and construction to produce as closely as possible a diffuse sound field.

3.2.2 For the wide band noise tests, the sound pressure applied to the test chamber is preferred to be of a random nature approximating to a normal (Gaussian) distribution, with amplitudes up to a peak value not less than three times the root mean square (r.m.s.) value.

3.2.3 The chamber shall be provided with a system for supporting the test equipment, the first resonance frequency shall not exceed 25 Hz.

3.3 The monitoring instrumentation shall be capable of measuring overall sound pressure levels in the frequency range from 90 to 11 200 Hz and octave band levels at central frequencies from 125 to 8 000 Hz at each of the control points.

The monitoring instrumentation shall have a flat frequency response with the following tolerances :

Frequency range Hz	Tolerance dB
90 to 125	± 3,0
125 to 2 500	± 2,0
2 500 to 11 200	± 3,0

3.4 The monitoring instrumentation shall be capable of measuring sound pressure levels at least 10 dB higher than the specified test level.

3.5 The microphones shall be calibrated for random incidence measurement.

3.6 The intensive sound pressure used in the tests is dangerous and appropriate measures should be taken for the protection of personnel.

3.7 If the test is carried out in test chambers which do not satisfy the requirements of this International Standard the test conditions shall be discussed between the purchaser and the supplier of the equipment.

4 Functioning tests

4.1 Functioning test conditions; wide band noise method

4.1.1 The functioning test conditions in the test chamber, when using the wide band noise method, are specified by the mean value of the overall sound pressure levels at the control points, the maximum permissible non-uniformity of the sound pressure field, the sound pressure spectrum shape and the test duration.

1) This formula is derived from the equation :

$$\frac{T_{s.l.}}{T_{acc.t.}} = \left(\frac{P^2_{acc.t.}}{P^2_{eqv}} \right)^{\gamma/2}$$

where

$P^2_{acc.t.}$ is the mean value of the square of the accelerated sound pressure, in pascals squared;

P^2_{eqv} is the mean value of the square of the equivalent sound pressure, in pascals squared;

4.1.2 Four test severity grades for the functioning tests are specified in accordance with table 1. The standardized parameter is the mean value of sound pressure levels at the control points (see 2.3). The maximum permissible non-uniformity of the sound pressure field, spectrum shape and test duration are specified to be constant for all the severity grades.

Table 1 — Severity grades for the functioning test

Severity grade	Standardized sound pressure level at control points, dB
I	130
II	140
III	150
IV	160

4.1.3 The maximum permissible non-uniformity of the sound pressure field defined by the difference between the overall sound pressure levels at the control points is 6 dB. The overall sound pressure levels at the control points should be within the limits of − 2, + 4 dB with respect to the sound pressure level at the specified test severity grade.

4.1.4 The spectrum shape is specified in frequency octave bands with central frequencies from 125 to 8 000 Hz at any control point relative to the mean value of sound pressure levels at the control points. The levels in frequency octave bands shall be within the limits given in figure 1.

4.1.5 The tests may be carried out in test chambers in which the non-uniformity of the sound pressure field exceeds 6 dB. In this case, the levels at the control points should be within the limits of − 2, + 10 dB with respect to the sound pressure level at the specified test severity grade. The upper limits of the sound pressure spectrum are allowed to be 6 dB higher than they are in figure 1. The lower limits are not changed.

4.2 Functioning test conditions, harmonic sound method

4.2.1 The functioning test conditions in the test chamber, when using the harmonic sound method, are specified by the frequency distribution of sound pressure levels at the control points, the rate of the fundamental harmonic frequency change and the test duration.

4.2.2 Four test severity grades for the functioning tests are specified in accordance with table 1. The standardized parameter is the nominal sound pressure level (see 2.5).

The sound pressure levels in the specified frequency range shall be within the limits given in figure 2.

4.2.3 The fundamental harmonic level shall be at least 3 dB higher than the levels of the upper harmonics.

4.2.4 The change in the fundamental harmonic frequency shall be smooth at a rate not exceeding one octave/minute. The whole frequency range is covered twice.

4.3 The duration of the functioning test under wide band noise or harmonic sound conditions shall be sufficient to determine the functioning characteristics of the equipment, but shall not be less than 15 min.

4.4 Selection of test severity grade

4.4.1 Procedure A

The selection of the test severity grade for the functioning test in accordance with the known, measured or calculated operational conditions for the equipment is made as follows :

The equipment is to be tested according to the severity grade which satisfies the following requirement :

The difference between the maximum measured or calculated overall sound pressure level at the equipment location in the aircraft and the standardized sound pressure level of one of the severity grades (see table 1) is within the limits of − 6, + 3 dB. The selected test severity grade is specified for both the wide band noise test and harmonic sound test.

4.4.2 Procedure B

The selection of the test severity grade under unknown equipment operational conditions is made in accordance with table 2. The mean value of the overall sound pressure levels at the control points, and the nominal sound pressure level appropriate to the severity grade is obtained from table 1.

Table 2 — Selection of severity grade

Characteristics of location of aircraft equipment	Severity grade
Bays not close to engine zones	I
Bays close to engine zones	II
Bays in the zone of jet exhausts	III
The most noisy locations	IV

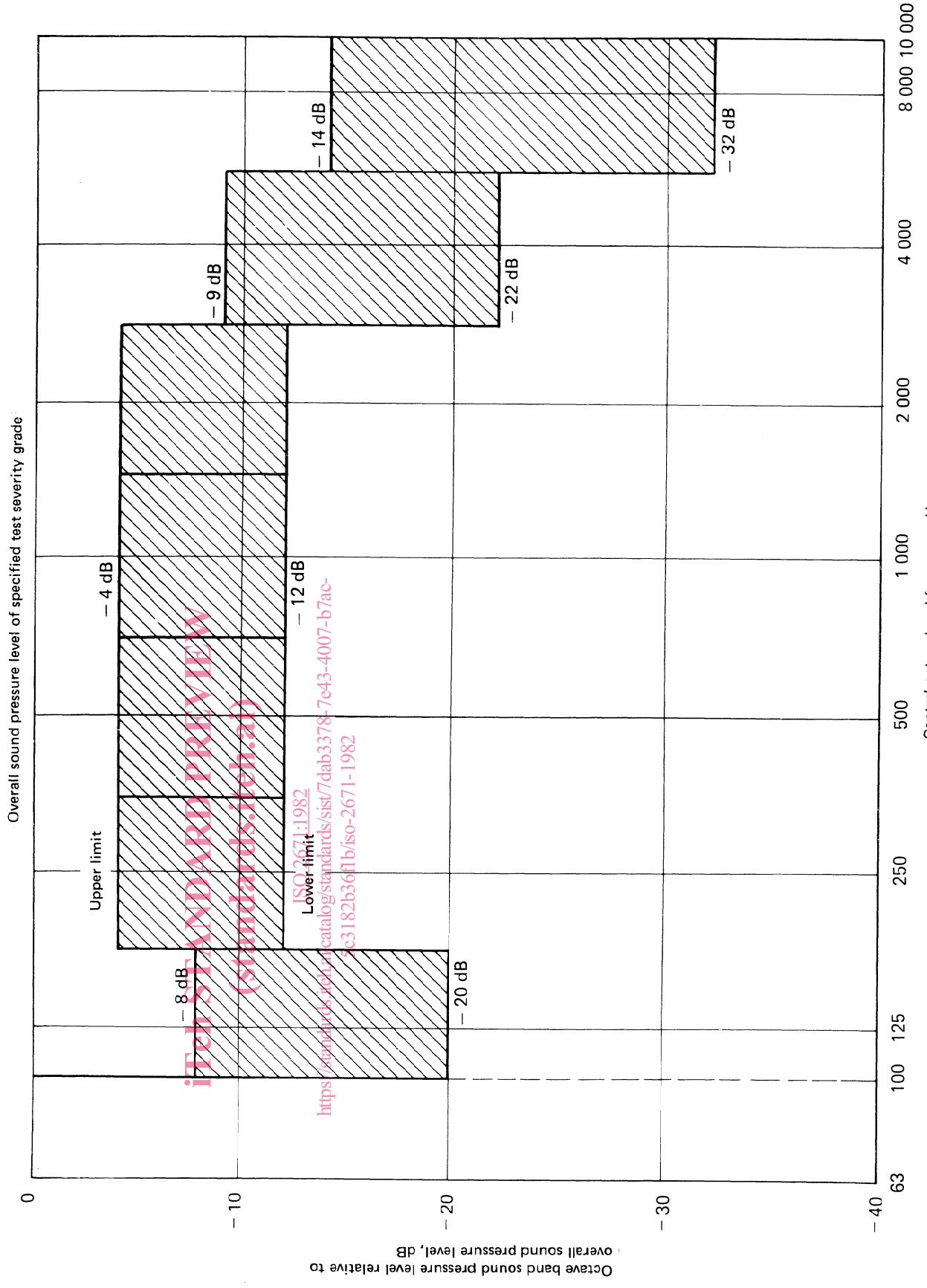

Figure 1 — Sound pressure spectrum shape in frequency octave bands; wide band noise test method

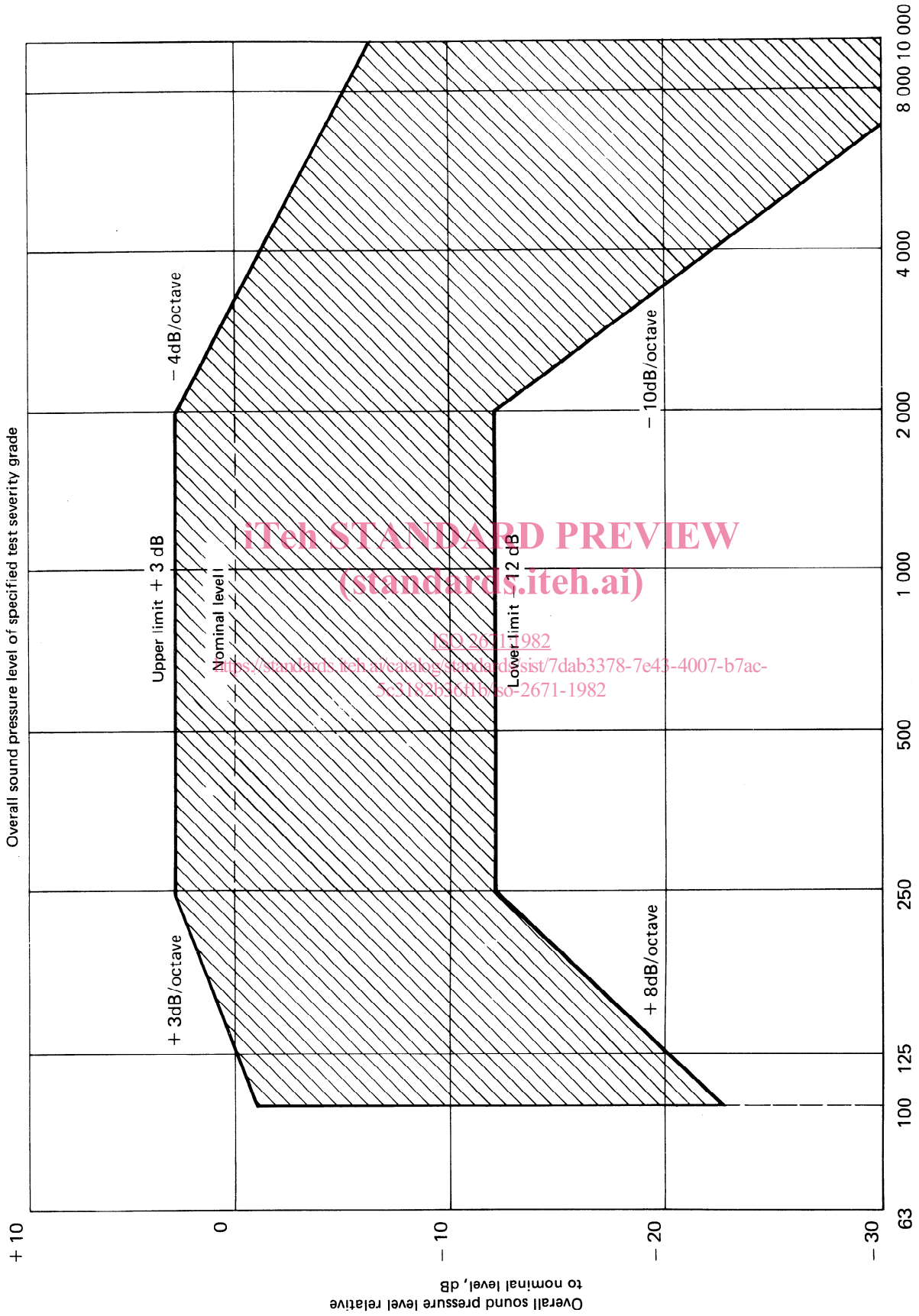

Figure 2 — Sound pressure levels; harmonic sound test method

5 Acoustic endurance tests

5.1 The acoustic endurance test conditions are specified in the same manner as for the functioning tests (see 4.1.1, 4.1.3, 4.1.4, 4.1.5 and figure 1).

5.2 Selection of test sound pressure level

5.2.1 Procedure A

The mean sound pressure level in the test chamber is defined by the formula from clause 2.7 if operating conditions are known or can be calculated. The required equipment service life $T_{s.l.}$ is usually given in the relevant equipment specification, the recommended test duration to be specified is not less than 5 h. The equivalent sound pressure level can be obtained from the formula given in the annex.

5.2.2 Procedure B

The mean sound pressure level in the test chamber, when operating conditions are unknown, is determined as follows : the test severity grade is found from table 2, the equivalent sound pressure level is determined from table 3 given in the annex and the mean sound pressure level, which is accelerated sound pressure level, is obtained from the formula given in 2.7 and in the annex. The mean sound pressure level for endurance tests can be also obtained from table 3 where

$\gamma = 6$;

the difference $L_{max} - L_{eqv} = 5$ dB, and

$T_{s.l.} = 200; 5\,000; 30\,000$ h.

6 Testing procedure

6.1 Prior to testing, the equipment shall be visually inspected and its functioning characteristics monitored. The equipment shall have no mechanical damage. The equipment functioning characteristics shall comply with the relevant specifications. The octave band and harmonic sound levels of the specified test severity grade are calculated in accordance with the requirements given in clauses 4 and 5.

6.2 The equipment under test shall be suspended in the centre of the test chamber so that its main surfaces are not parallel or perpendicular to the chamber walls. All the electrical connections shall be attached in the same manner as required by the operating conditions.

6.3 The adjustment of sound pressure levels

6.3.1 When preparing the wide band noise test, the mean value of sound pressure levels at the control points shall be adjusted to the specified test severity grade, the octave band levels are adjusted at one of the control points and the non-uniformity of the sound pressure field is checked. The sound pressure level adjustment in the frequency octave bands may be performed without the test specimen. The sound pressure mean level shall be adjusted with the specimen in position.

6.3.2 When preparing the harmonic sound test, the overall sound pressure levels of the specified severity grade are adjusted at any control point over the whole frequency range in accordance with figure 2 and the difference between the levels of the fundamental and upper harmonics checked. The rate of the fundamental frequency change shall satisfy the requirements of this International Standard (see 4.2.4).

6.4 Six microphones shall be placed uniformly around the equipment at a distance of 0,1 to 0,2 m from its surfaces if the dimensions of the main surfaces of the equipment exceed 0,35 m. If the dimensions of the main surfaces do not exceed 0,35 m, the operator may place less than six microphones but not less than two must be at a distance of 0,1 to 0,2 m from the surfaces of the equipment.

6.5 Recommended test procedure

6.5.1 If only the functioning test is specified in the relevant equipment specification, the functioning characteristics are monitored during acoustic environmental testing under the test conditions appropriate to the specified functioning severity grade.

6.5.2 If the acoustic endurance test is specified in the relevant equipment specifications, then first the functioning characteristics of the equipment are monitored under the test conditions of the appropriate severity grade for the functioning test. The endurance test is then carried out under the endurance test conditions. When the testing is completed, the functioning characteristics are monitored again under the functioning test conditions.

6.6 The acoustic endurance test may be carried out with the equipment non-operational if this does not change the mechanical properties of the equipment or its components.

6.7 The equipment is considered to satisfy the functioning requirements in the acoustic environment if, whilst under test, its functioning characteristics are within the limits specified by the relevant equipment specification.

6.8 The equipment is considered to satisfy the requirements of the acoustic endurance test if, after testing, its functioning characteristics under the appropriate functioning test conditions are within the limits specified by the relevant equipment specification and it has no mechanical damage.

7 Information to be stated in the relevant equipment specification

7.1 When an acoustic vibration test is specified in the relevant equipment specification, the following information shall be stated :

— need to test for functioning;

— need to test for acoustic endurance;

— mounting method;

— the test severity grade (test sound pressure level);

— acoustic endurance test duration;

— required service life of the equipment;

— index of the rate of fatigue damage accumulation law for the equipment;

— list of the monitored functioning characteristics prior to, during and after testing;

— number of specimens for the test.

7.2 In addition to the information listed in 7.1, the test facility characteristics and the deviations of functioning characteristics during the test shall also be noted in the test report.