

BS 5647 : 1979

IEC 561 : 1976

UDC 656.7.091.4 : 351.814 : 351.759.4 :
628.517.2 : 534.836.2 : 621.317.39

Specification for Electro-acoustical measuring equipment for aircraft noise certification

Spécification pour équipements électroacoustiques de mesure
pour la certification acoustique des aéronefs

Spezifikation für elektroakustische Meßgeräte für die
akustische Bescheinigung von Luftfahrzeugen

CONTENTS

	Page		Page
National foreword	Inside front cover	6. Attenuators	3
Cooperating organizations	Back cover	7. Performance of the analyzer	3
Clause		8. Data acquisition	4
1. Object	1	9. Resolution	4
2. Definitions and explanation of terms	1	10. Calibration and checking of system	5
3. Microphone system	2	APPENDIX A	6
4. Tape recorder	2	FIGURES	9
5. Filters	3		

National foreword

This British Standard has been prepared under the direction of the Electronic Equipment Standards Committee and is identical with Publication 561 : 1976 ‘Electro-acoustical measuring equipment for aircraft noise certification’ published by the International Electrotechnical Commission (IEC).

Terminology and conventions. The text of the IEC Publication has been approved as suitable for publication, without deviation, as a British Standard. Some terminology and certain conventions are not identical with those used in British Standards; attention is especially drawn to the following.

The comma has been used as a decimal marker. In British Standards it is current practice to use a full point on the baseline as the decimal marker.

Wherever the words ‘Recommendations’ or ‘Publication’ appear, relating to this standard, they should be interpreted as ‘British Standard’.

References in the text to page numbers relate to IEC page numbers which are given in brackets at the bottom of each page. IEC Publication 561 does not contain a ‘Scope’ clause. However, for the purposes of this British Standard the first eight words of clause 1 should be interpreted to read ‘This standard specifies’ and consequently the title of clause 1 should be interpreted as ‘Scope’.

Cross-references

International standard	Corresponding British Standard
IEC 179 : 1973	BS 4197 : 1967 Precision sound level meter* (Technically equivalent)
IEC 225 : 1966	BS 2475 : 1964 Octave and one-third octave band-pass filters (Related)
ISO 3891-1978	BS 5727 Acoustics – Procedure for describing aircraft noise heard on the ground† (Identical)

* A revision of BS 4197 is, at present, in course of preparation.
† In course of preparation.

British Standard Specification for

Electro-acoustical measuring equipment for aircraft noise certification

1. Object

The object of this standard is to specify the performance requirements for sound measurement and analysis equipment to be used for aircraft noise certification using the procedure described in the International Standard ISO 3891 for measurements requiring spectral analysis as a function of time. It is intended to ensure that results obtained by various noise certification authorities using different sets of equipment are mutually comparable.

2. Definitions and explanation of terms

2.1 *Effective bandwidth and reference attenuation*

The effective bandwidth of a filter is equal to the bandwidth of an ideal filter, with rectangular frequency response and reference bandpass attenuation, that passes the same amount of energy from a white noise signal source.

The reference bandpass attenuation is often specified as the minimum attenuation of the filter within its bandwidth; here, however, it is specified as the attenuation at the exact geometric centre frequency of the filter (see Table 1, page 20, and Figure 1, page 21).

2.2 *Averaging properties*

The averaging time of an averaging system which is not a true integrator is often taken as the integration time of a true integrator which has the same low-pass effective bandwidth as the system considered. When defined in this way, the averaging time is equal to one-half of the reciprocal of the effective bandwidth.

Note. — The low-pass effective bandwidth of an integrator is not related to the effective bandwidth of the signal filter referred to in Sub-clause 2.1.

Aircraft noise measurements require the determination of a large number of values at relatively short intervals of time, each representing an average over a period of time sufficiently short to preserve the rise-and-fall pattern of the noise during overflight. With such short-time averaging, the measurements will be subject to some uncertainty due to the random fluctuations in the noise.

For this reason, a different way of specifying the averaging properties of the measuring system is adopted here, by which different systems are required to meet a specified value in respect of the standard deviation σ of the measurements of the level of an electrical test noise signal having defined statistical fluctuations.

The averaging time of an integrator also determines the rate of rise and decay of the output signal when a constant-amplitude signal is suddenly applied or terminated at the input (transient response). For true integrators and RC integrators having equal values of averaging time, and hence equal values of standard deviation σ , the transient response is different. Since correct recording of the rise and fall of aircraft noise level is needed in order to determine the tone correction and duration allowance in the calculation of effective perceived noise level, it is necessary to specify a tolerance range for the transient response in this standard.

Tolerances are therefore stated both for the standard deviation of test noise measurements and for transient response, which together will ensure that all integrators, including those which are neither of the true or RC types, will yield equivalent results.

Note. — The specified values with their permitted tolerances correspond to averaging times of 1396 ms to 1581 ms for a true integrator, and to time constants of 719 ms to 1154 ms for an RC integrator (see Clause A3).

3. Microphone system

The microphone system shall consist of a microphone cartridge fitted with a windshield and attached to a preamplifier, and shall meet the requirements of Sub-clauses 3.1, 3.2, 3.3 and 3.4.

Notes 1. — The microphone system will normally be mounted on a support (e.g. tripod) for aircraft noise measurements. Any acoustic effect of the support is considered here as part of the acoustical environment described in the International Standard ISO 3891.

2. — Where two or more similar microphone systems are used, at least one of these shall be fully calibrated in accordance with this clause, and the others may be compared with the fully calibrated system by means of any suitable technique covering the frequency range specified in this clause.

3.1 The microphone cartridge shall be of the pressure-sensitive capacitive type.

Note. — In order to obtain the best approximation to flat frequency response in the conditions of measurement described in the International Standard ISO 3891, it is recommended that the microphone cartridge should be of the “pressure-response” type instead of the more usual “free-field” type. This is because the former has a near-flat response to sound arriving at grazing incidence (see Figure 2, page 21).

3.2 The variation of sensitivity of the complete microphone system within an angle of $\pm 20^\circ$ of grazing incidence (70° to 110° from the normal through the diaphragm) shall not exceed ± 2 dB for any frequency over the range 40 Hz to 12 500 Hz. The variation of sensitivity of the microphone in the plane of the diaphragm shall not exceed ± 0.5 dB over this frequency range.

3.3 The overall free-field frequency response at 90° (grazing incidence) of the complete microphone system shall be determined using pure tones at each preferred $\frac{1}{3}$ -octave frequency from 40 Hz to 12 500 Hz. Within each $\frac{1}{3}$ -octave frequency band, the frequency response of the system shall be flat within the following tolerances:

Bands with centre frequencies from	50 Hz to	3 150 Hz	± 0.25 dB
Bands with centre frequencies from	4 000 Hz to	6 300 Hz	± 0.5 dB
Bands with centre frequencies	8 000 Hz and	10 000 Hz	± 1 dB

3.4 Specifications concerning sensitivity to environmental factors such as temperature, relative humidity and vibration shall be in accordance with the requirements of IEC Publication 179, Precision Sound Level Meters.

4. Tape recorder

When on-line analysis is not employed and a tape recorder is used to store data for subsequent analysis, the record/replay system (including magnetic tape) shall meet the requirements of Sub-clauses 4.1, 4.2 and 4.3.

Note. — With sharply falling spectra, appropriate pre-emphasis/de-emphasis networks may be needed. The de-emphasis should always have substantially the opposite effect of the pre-emphasis. An example of one possible pre-emphasis curve is shown in Figure 3, page 22.

4.1 At standard recording level (i.e. 10 dB below the 3 % harmonic distortion level), in each preferred $\frac{1}{3}$ -octave frequency range between 180 Hz and 11 200 Hz, the frequency response shall be flat within ± 0.25 dB, and in any $\frac{1}{3}$ -octave band between 45 Hz and 180 Hz, it shall be flat within ± 0.75 dB.

Note. — To meet these tolerances, the use of an f.m. tape recorder may be required.

4.2 The amplitude stability of a 1 kHz recorded sinusoidal signal at the standard recording level shall be within ± 0.5 dB throughout any reel of magnetic tape. Measurements to verify this shall be made using a device with averaging properties equal to those used in the measuring chain (see Clause 7).

4.3 The performance of the system must be such that the background noise in any $\frac{1}{3}$ -octave band is at least 35 dB below the standard recording level (see Sub-clause 4.1).

5. Filters

The $\frac{1}{3}$ -octave band filters shall satisfy the requirements of IEC Publication 225, Octave, Half-octave and Third-octave Band Filters Intended for the Analysis of Sounds and Vibrations, and additionally have less than 0.5 dB ripple. For each filter, the correction for effective bandwidth relative to the centre frequency response shall be determined by measuring the filter response to sinusoidal signals at a minimum of twenty frequencies equally spaced between the two adjacent preferred $\frac{1}{3}$ -octave frequencies.

6. Attenuators

Attenuators included in the measuring chain to permit range changing shall be scaled in equal integral decibel steps, and the error between any two settings required for operating the equipment during noise certification measurements or for associated calibrations shall not exceed 0.2 dB.

7. Performance of the analyzer

In principle, the output from any $\frac{1}{3}$ -octave band filter requires to be squared, averaged, converted to logarithmic form and finally digitized. However, in some systems, these operations may not be separable, and it is therefore convenient to specify the overall performance of these stages of the analyzer.

Note. — For the tests specified in Sub-clauses 7.1, 7.2 and 7.3, if the test signal cannot be easily fed separately to each detector, some other suitable method to ensure equivalent results should be used.

7.1 The detector or detectors shall operate over a minimum dynamic range of 60 dB and shall perform as true mean square devices for sinusoidal tone bursts having crest factors of up to 3 over the dynamic range extending from 0 dB to 30 dB below full-scale reading within an accuracy of ± 0.5 dB; the accuracy shall be within ± 1 dB between 30 dB and 40 dB below full-scale reading, and within ± 2.5 dB over the remaining 10 dB of range (see Figure 4, page 23).

Compliance with this requirement shall be tested by the method described in Appendix B of IEC Publication 179A, First supplement to Publication 179, using signals applied directly to the input of each detector in turn.