

Electroacoustics — Specifications for personal sound exposure meters

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Electronic Equipment Standards Policy Committee (EEL/-) to Technical Committee EEL/24, upon which the following bodies were represented:

British Association of Otolaryngologists
British Hearing Aid Industry Association
British Hearing Aid Manufacturers' Association
British Medical Association
British Society of Audiology
British Telecommunications plc
Confederation of British Industry
Department of Health
Department of Trade and Industry (National Physical Laboratory)
Health and Safety Executive
Institute of Acoustics
Institute of Sound and Vibration Research
Institution of Electrical Engineers
Medical Research Council
Ministry of Defence
National Health Services
Royal Aeronautical Society
Royal National Institute for Deaf People
Society of Environmental Engineers
University of Exeter

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National foreword

This British Standard has been prepared under the direction of the Electronic Equipment Standards Policy Committee. It is identical with IEC 1252 : 1993 *Electroacoustics — Specifications for personal sound exposure meters*, published by the International Electrotechnical Commission (IEC).

BS 6402 : 1994 supersedes BS 6402 : 1983, which is withdrawn.

Specifications in this standard for personal sound exposure meters are consistent, insofar as is practical, with comparable specifications in BS 6698 : 1986 for integrating-averaging sound level meters. The four principle technical differences from the specifications in BS 6698 : 1986 are as follows.

- a) Sound exposure is measured and displayed rather than equivalent-continuous frequency-weighted sound pressure level or sound exposure level.
- b) Accuracy of squaring and integrating short-duration signals is specified by measurement of the sound exposure of a sequence of repeated constant-amplitude, 1 ms and 10 ms duration, 4 kHz tonebursts rather than by measurement of the response to single 4 kHz tonebursts of varying amplitudes with durations ranging from 1 ms to 1 s, each single toneburst being accompanied by a continuous, in-phase, low-level, 4 kHz background signal.
- c) Specifications for a personal sound exposure meter include a limitation on the difference between the sound exposure indicated in response to positive-going and negative-going unipolar pulses.
- d) Requirements are not specified for the directional response of the microphone of a personal sound exposure meter intended to be worn on a person.

This standard includes two informative annexes. Annex A provides a table of selected sound exposures and corresponding normalized 8-h-average sound levels. Annex B describes recommendations for tests to verify the performance of a personal sound exposure meter.

Cross-references

International standard	Corresponding British Standard
IEC 50 (801) : 1984	BS 4727 <i>Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms</i> Part 3 : Group 08 : 1985 <i>Acoustics and electroacoustics terminology</i> (Technically equivalent)
IEC 651 : 1979	BS 5969 : 1981 <i>Specification for sound level meters</i> (Identical)
IEC 801-3 : 1984	BS 6667 <i>Electromagnetic compatibility for industrial-process measurement and control equipment</i> Part 3 : 1985 <i>Method of evaluating susceptibility to radiated electromagnetic energy</i> (Identical)
IEC 804 : 1985	BS 6698 : 1986 <i>Specification for integrating-averaging sound level meters</i> (Identical)
IEC 942 : 1988	BS 7189 : 1989 <i>Specification for sound calibrators</i> (Identical)
ISO 266 : 1975	BS 3593 : 1963 <i>Recommendation on preferred frequencies for acoustical instruments</i> (Technically equivalent)

The Technical Committee has reviewed the provisions of ISO 1999 : 1990, to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. A related British Standard to ISO 1999 : 1990 is BS 5330 : 1976.

IEC 801-2 : 1984 has been superseded by IEC 801-2 : 1993 which is identical with BS EN 60801-2 : 1993.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

INTRODUCTION

According to this International Standard, a personal sound exposure meter is intended to measure sound exposure as the time integral of the square of the instantaneous A-frequency-weighted sound pressure. This operating principle underlies the measurement of sound exposure level according to IEC 804. It is the "equal-energy exchange rate" whereby a doubling (or halving) of the integration time of a constant sound level yields a two-fold increase (or decrease) of sound exposure. Similarly, an increase (or decrease) of 3 dB in a constant input sound level for a constant integration time yields a doubling (or halving) of the sound exposure.

Noise dose meters usually have been designed to indicate noise dose as a percentage of a legal limit. The limit and its definition vary from country to country and are subject to change. To facilitate international comparison of sound exposure records with numerical values of convenient magnitude, this International Standard specifies an instrument that indicates sound exposure in pascal-squared hours. An indication of sound exposure with a unit other than pascal-squared hours is permitted provided the manufacturer specifies a procedure for converting the indication to pascal-squared hours, for example, a display of "dose" as a fraction or a percentage of a specified sound exposure in pascal-squared hours.

The principal application for a personal sound exposure meter is the measurement of sound exposure in the vicinity of a person's head; e.g., for assessment of potential hearing impairment according to Standards such as ISO 1999. The microphone of a personal sound exposure meter may be worn on the shoulder, collar, or other location close to one ear. For many practical situations, such as in a factory where the sound-incidence angle may vary widely during the course of workday, the sound exposure indicated by an instrument worn on a person is likely to be different from that which would be measured in the absence of the person. The influence of the person wearing a personal sound exposure meter should be considered when estimating the sound exposure that would have been measured with the person absent.

ELECTROACOUSTICS –

SPECIFICATIONS FOR PERSONAL SOUND EXPOSURE METERS

1 Scope

1.1 Sound exposure is a physical measure that accounts for both the sound pressure and its duration, at a given location, through an integral-over-time of the square of instantaneous frequency-weighted sound pressure.

1.2 This International Standard is applicable to instruments for measurement of A-frequency-weighted sound exposure resulting from steady, intermittent, fluctuating, irregular, or impulsive sounds. Instruments complying with the specifications of this International Standard are intended to be worn on a person to measure sound exposure. Measurements of sound exposure in the workplace may be useful for determinations of occupational noise exposure, in accordance with ISO 1999 and ISO 9612.

1.3 This International Standard specifies acoustical and electrical performance requirements for personal sound exposure meters of one accuracy grade. The accuracy grade corresponds to that for an integrating sound level meter which complies with the Type 2 requirements of IEC 804 for an A-weighted sound pressure level range from 80 dB to 130 dB and a nominal frequency range from 63 Hz to 8 kHz.

1.4 Tolerances on deviations of an instrument's performance from specified design goals represent the performance capabilities of practical instruments. Personal sound exposure meters are required to operate within the tolerances of this International Standard over specified ranges of environmental conditions.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard 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 normative documents.

IEC 50(801): 1984, *Advance edition of the International Electrotechnical Vocabulary, Chapter 801, Acoustics and electroacoustics*

IEC 651: 1979, *Sound level meters*

IEC 801-2: 1984, *Electromagnetic compatibility for industrial-process measurement and control equipment – Part 2: Electrostatic discharge requirements*

IEC 801-3: 1984, *Electromagnetic compatibility for industrial-process measurement and control equipment – Part 3: Radiated electromagnetic field requirements*

IEC 804: 1985, *Integrating-averaging sound level meters*

IEC 942: 1988, *Sound calibrators*

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

ISO 1683: 1983, *Acoustics – Preferred reference quantities for acoustic levels*

ISO 1999: 1990, *Acoustics – Determination of occupational noise exposure and estimation of noise-induced hearing impairment*

ISO 9612: 199X, *Acoustics – Guidelines for the measurement and assessment of exposure to noise in the working environment.**

3 Definitions

For the purposes of this International Standard, the following definitions apply. Definitions are consistent with corresponding definitions in IEC 50(801).

3.1 sound exposure: Time integral of squared, instantaneous A-frequency-weighted sound pressure over a specified event, for example, a working day.

NOTES

1 Although the primary SI unit for sound exposure is the pascal-squared second, for measurements of sound exposure in the workplace, the more-convenient derived unit, the pascal-squared hour, is used in this International Standard.

2 In symbols, (A-weighted) sound exposure is

$$E = \int_{t_1}^{t_2} p_A^2(t) dt \quad (1)$$

where $p_A^2(t)$ is the square of instantaneous A-frequency-weighted sound pressure as a function of time t for an integration time period starting at t_1 and ending at t_2 . The unit of sound exposure E is pascal-squared hours if A-weighted sound pressure p_A is in pascals and the running time t in hours.

3.2 equivalent-continuous A-weighted sound pressure level; time-average sound level: In decibels, ten times the logarithm to the base ten of the ratio of the time-mean-square, A-frequency-weighted sound pressure, during an averaging time period T , to the square of the standard reference sound pressure.

* At present, at the stage of draft.

NOTES

1 In symbols, equivalent-continuous A-weighted sound pressure level $L_{Aeq,T}$ or time-average sound level, is given by:

$$L_{Aeq,T} = 10 \lg \left\{ \left[(1/T) \int_0^T p_A^2(t) dt \right] / p_0^2 \right\} \quad (2)$$

where running time t and averaging time T are expressed in the same units, $p_A(t)$ is the instantaneous A-weighted sound pressure in pascals, and p_0 is the reference sound pressure of twenty micropascals (20 μ Pa) per ISO 1683.

2 Equivalent-continuous A-weighted sound pressure level during the averaging time period T is related to the total sound exposure occurring within that period by

$$E = (p_0^2 T) [10^{0,1 \times L_{Aeq,T}}] \quad (3)$$

or, alternatively, by

$$L_{Aeq,T} = 10 \lg [E / (p_0^2 T)] \quad (4)$$

where the unit of time is the same for both sound exposure and averaging time.

3.3 normalized 8-h-average sound level: In decibels, level of the time-mean-square, A-weighted sound pressure during a normalization time period T_n of 8 h such that the sound exposure therefrom is equal to that of a time-varying sound at a place where total sound exposure occurs within a time period not necessarily 8 h.

NOTES

1 In symbols, a normalized 8-h-average sound level (letter symbol $L_{Aeq,8hn}$), relative to the reference sound pressure p_0 and the 8 h normalization time period T_n , is given by:

$$L_{Aeq,8hn} = 10 \lg [E / (p_0^2 T_n)] \quad (5)$$

2 For computations, a simpler form of Eq.(5) for normalized 8-h-average sound level in decibels is obtained, for sound exposure E in pascal-squared hours, after substituting the values of 20 micropascals for p_0 and 8 h for T_n , as

$$L_{Aeq,8hn} = 10 \lg [(E \times 10^9) / 3,2] \quad (6)$$

3 When a total sound exposure is described indirectly by an equivalent-continuous A-weighted sound pressure level $L_{Aeq,T}$ for an averaging time T greater or less than the normalization time period of 8 h, normalized 8-h-average sound level may be determined from

$$L_{Aeq,8hn} = L_{Aeq,T} + 10 \lg (T/T_n) \quad (7)$$

4 Annex A provides a table of normalized 8-h-average sound levels and corresponding sound exposures. For example, a sound exposure of 1 Pa²h (irrespective of the period of time over which it is measured) corresponds to a normalized 8-h-average sound level of nearly 85 dB; a sound exposure of 3,2 Pa²h corresponds exactly to a normalized 8-h-average sound level of 90 dB.

5 Normalized 8-h-average sound level in Eq.(5) is identical to "daily personal noise exposure $L_{EP,d}$ in decibels" defined in Article 2 of the "European Communities Council Directive of 12 May 1986 on the protection of workers from the risks related to exposure to noise at work" (Directive 86/188/EEC).

6 Normalized 8-h-average sound level in Eq.(5) is also the same as "noise exposure level normalized to a nominal 8 h working day, $L_{EX,8h}$ " defined in ISO 1999.