International Standard 131

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Acoustics — Expression of physical and subjective magnitudes of sound or noise in air

Acoustique — Expression des intensités physique et subjective d'un son ou d'un bruit aérien

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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 131 was developed by Technical Committee ISO/TC 43, *Acoustics*.

It was submitted directly to the ISO Council, in accordance with clause 6.13.1 of the Directives for the technical work of ISO. It cancels and replaces ISO Recommendation R 131-1959, which had been approved by the member bodies of the following countries :

Australia	India	Romania
Austria	Italy	Spain
Czechoslovakia	Japan	Sweden
Denmark	Mexico	Switzerland
Finland	Netherlands	United Kingdom
France	New Zealand	USA
Germany, F. R.	Poland	USSR
Hungary	Portugal	

No member body had expressed disapproval of the document.

It also cancels and replaces ISO Recommendation R 357-1963 which had been approved by the member bodies of the following countries :

Australia	Finland	Portugal
Austria	France	Sweden
Belgium	Germany, F. R.	Switzerland
Brazil	Hungary	United Kingdom
Burma	India	USA
Canada	Japan	USSR
Chile	Netherlands	Yugoslavia
Czechoslovakia	New Zealand	
Denmark	Poland	

No member body had expressed disapproval of the document.

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Acoustics — Expression of physical and subjective magnitudes of sound or noise in air

1 Scope and field of application

This International Standard expresses the physical and subjective magnitudes which are used in the description of acoustical sound or noise in air.

2 References

ISO 31/7, *Quantities and units of acoustics.*

ISO/R 226, *Normal equal-loudness contours for pure tones and normal threshold of hearing under free field listening conditions.*

ISO 1683, *Acoustics — Preferred reference quantities for acoustic levels.* [1)]

3 Physical magnitudes of sound or noise

3.1 General

It is recommended that data on the physical magnitude of sound or noise be expressed by a statement of the sound pressure level measured at a particular point (see 3.2) or in terms of the sound power level of a source (see 3.3). Reference quantities for acoustic levels used in this International Standard are in accordance with those of ISO 1683.

3.2 Sound pressure level

The sound pressure level, L_p, expressed in decibels, of a sound or noise is given by the formula :

$$20 \lg \frac{p}{p_0}$$

where

p is the root-mean-square value of sound pressure measured at a particular point;

p_0 is the reference sound pressure (= 20 μPa).

NOTE — A-weighting is frequently employed yielding a value of the A-weighted sound pressure level in decibels. Other weightings may also be used.

3.3 Sound power level

The sound power level, L_W [2)], expressed in decibels, of a source is given by the formula :

$$10 \lg \frac{P}{P_0}$$

where

P is the total sound power emitted by source of sound or noise;

P_0 is the reference sound power (= 1 pW).

NOTE — A-weighting is frequently employed yielding a value of the A-weighted sound power level in decibels. Other weightings may also be used.

3.4 Sound intensity level

The sound intensity level, L_I, expressed in decibels, of a sound or noise is given by the formula :

$$10 \lg \frac{I}{I_0}$$

where

I is the sound intensity of the sound field;

I_0 is the reference sound intensity (= 1 pW/m^2).

4 Subjective magnitudes of sound or noise

4.1 Loudness level — Phon

4.1.1 Loudness level

The loudness level, L_N, of a sound is expressed as n phon, when it is judged by normal observers to be equally loud to a pure tone of frequency 1 000 Hz consisting of a plane progressive sound wave, coming from directly in front of the observer, the sound pressure level of which is n dB.

NOTE — The measurement conditions should be described.

1) At present at the stage of draft.

2) The symbol L_P may also be used.

4.1.2 Phon

The phon is a unit with the dimension 1, used to express the loudness level of a given sound or noise.

4.2 Loudness scale — Sone

4.2.1 Loudness

The loudness level of any sound may be expressed uniquely in phons in accordance with the procedure defining the phon scale (see 4.1.1). Owing, however, to the arbitrary definition of this scale, loudness level values, in phons, do not immediately convey the magnitude of the loudness sensation, but have to be interpreted by the user on the basis of his experience of previously heard sounds to which phon values have been attached.

The purpose of the sone scale is to provide a numerical designation of the loudness of sounds or noises that is proportional to the subjective magnitude as estimated by normal observers (see ISO/R 226).

This International Standard specifies a function relating the loudness, in sones, of a steady sound or noise to its loudness level, in phons. The relation specified is an approximation of the laboratory data sufficiently accurate for expressing loudness in engineering applications. It does not necessarily represent the degree of accuracy required for research purposes.

4.2.2 Sone

The sone is a unit with the dimension 1, used to express the magnitude of loudness sensation of a given sound or noise.

The loudness, N, in sones, of any sound is given by the formula :

$$2^{0,1\,(L_N\,-\,40)}$$

where L_N is the loudness level, expressed in phons.

The relation between N and L_N is given in the table.

For the definition of sone and phon, see also ISO 31/7. For practical reasons these two "units" are used as dimensions for quantities with the dimension 1, and the following approximate relation is sometimes used :

$$\lg N = 0,03\,(L_N - 40)$$

NOTES

1 The specified relation defines the value of the sone (unit of loudness) as the loudness of a sound whose loudness level is 40 phons.

2 A twofold change in loudness corresponds to an interval of 10 phons.

3 Experimental confirmation of this relation exists over the range 40 to 105 phons, and its use outside this range should be recognized as an extrapolation.

Table — Relation between loudness level, L_N, in phons and loudness, N, in sones

L_N	N	L_N	N	L_N	N
phons	sones	phons	sones	phons	sones
		55	2,83	90	32,0
		56	3,03	91	34,3
		57	3,25	92	36,8
		58	3,48	93	39,4
		59	3,73	94	42,2
		60	4,00	95	45,3
		61	4,29	96	48,5
		62	4,59	97	52,0
		63	4,92	98	55,7
		64	5,28	99	59,7
		65	5,66	100	64,0
		66	6,06	101	68,6
		67	6,50	102	73,5
		68	6,96	103	78,8
		69	7,46	104	84,4
		70	8,00	105	90,5
		71	8,57		
		72	9,19		
		73	9,85		
		74	10,6		
40	1,00	75	11,3		
41	1,07	76	12,1		
42	1,15	77	13,0		
43	1,23	78	13,9		
44	1,32	79	14,9		
45	1,41	80	16,0		
46	1,52	81	17,1		
47	1,62	82	18,4		
48	1,74	83	19,7		
49	1,87	84	21,1		
50	2,00	85	22,6		
51	2,14	86	24,3		
52	2,30	87	26,0		
53	2,46	88	27,9		
54	2,64	89	29,9		

NOTE — Values in sones are given to three significant figures for purposes of interpolation only. For use, the values should be rounded to two significant figures.