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Textile machinery acoustics — Determination of sound pressure levels and sound power levels emitted by textile machines — Engineering and survey methods

Acoustique du matériel pour l'industrie textile — Détermination des niveaux de pression acoustique et des niveaux de puissance acoustique émis par les machines textiles — Méthodes d'expertise et de contrôle

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Annexes

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9902 was prepared by Technical Committee ISO/TC 72, *Textile machinery and allied machinery and accessories.*

Annexes A, B, C, D and E form an integral part of this International Standard. Annex F is for information only.

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Textile machinery acoustics — Determination of sound pressure levels and sound power levels emitted by textile machines — Engineering and survey methods

1 Scope

This International Standard specifies engineering and survey methods applied to textile machinery with reference to ISO 3744 and ISO 3746 for measuring the sound pressure levels on a measurement surface enveloping the source and for calculating the sound power produced by the source. It specifies the test environment and instrumentation as well as techniques for obtaining the surface sound pressure level from which the A-weighted sound power level of the source and octave band sound pressure levels, if required, are calculated.

This International Standard provides specifications for measuring the noise emitted by textile machines into the ambient air (noise emission) according to uniform methods so that the results are comparable. It contains requirements for carrying out airborne sound measurements in the vicinity of textile machines, including at the operator position, under given operating conditions.

The term "textile machines" as used in this International Standard includes all machinery used in the textile industry for the production and processing of textile fibres, yarns and fabrics and other fibre-based textile materials, but does not include machines designed for the manufacture of clothing and other sewn or similarly assembled products.

This International Standard also specifies the measurement of sound pressure levels at the operator position for specified typical conditions, with reference to ISO 6081.

As the working parameters for many textile machines are variable, the operating conditions must be clearly defined for the specific machinery. Specifications for operating conditions for various types of machines are given in the annexes.

NOTE 1 The operating conditions specified in the annexes may also be used if the reverberation method (see ISO 3741 and ISO 3742) is used to determine the sound power of textile machines instead of the enveloping surface method.

Many textile machines are multiposition machines. As most multiposition machines are built in sections, it is possible, under certain circumstances, to make acoustic measurements on a machine part instead of on the complete machine.

2 Normative references

The following standards 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 standards 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 standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3744:1993[1], *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane.*

1) To be published.

ISO 3745:1977, *Acoustics — Determination of sound power levels of noise sources — Precision methods for anechoic and semi-anechoic rooms.*

ISO 3746:1979, *Acoustics — Determination of sound power levels of noise sources — Survey method.*

ISO 6081:1986, *Acoustics — Noise emitted by machinery and equipment — Guidelines for the preparation of test codes of engineering grade requiring noise measurements at the operator's or bystander's position.*

IEC 651:1979, *Sound level meters.*

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

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 3744, ISO 3745 and ISO 3746 apply, some of which are repeated here for the user's convenience.

3.1 free field over a reflecting plane: A sound field in a homogeneous, isotropic medium in the half-space above an infinite, rigid plane surface on which the source is located.

[ISO 3744:1993, 3.8]

3.2 semi-anechoic room: Test room with a hard, reflecting floor whose other surfaces absorb essentially all the incident sound energy over the frequency range of interest, thereby affording free-field conditions above a reflecting plane.

[ISO 3745:1977, 3.4]

3.3 sound pressure level, L_p: Ten times the logarithm to the base 10 of the ratio of the square of the sound pressure radiated by the sound source under test to the square of the reference sound pressure. Sound pressure levels are expressed in decibels.

The frequency weighting or the width of the frequency band used, and the time weighting (S, F or I, see IEC 651), shall be indicated. The reference sound pressure is 20 μPa (2×10^{-5} Pa).

NOTE 2 For example, the A-weighted sound pressure level with time weighting S is L_{pAS}.

[ISO 3744:1993, 3.2]

3.4 surface sound pressure level, $\overline{L_{pf}}$: The energy-average of the time-averaged sound pressure levels at all the microphone positions on the measurement surface, with the background noise correction, K_1, and the environmental correction, K_2, applied. It is expressed in decibels.

[ISO 3744:1993, 3.4]

3.5 sound power level, L_W: Ten times the logarithm to the base 10 of the ratio of the sound power radiated by the sound source under test to the reference sound power. It is expressed in decibels.

The frequency weighting or the width of the frequency band used shall be indicated; for example, A-weighted sound power level (L_{WA}). The reference sound power is 1 pW (10^{-12} W).

[ISO 3744:1993, 3.6]

3.6 frequency range of interest: For general purposes, the frequency range of interest includes the octave bands with centre frequencies from 125 Hz to 8 000 Hz.

[ISO 3744:1993, 3.9]

3.7 measurement surface: A hypothetical surface of area S, enveloping the source, on which the measuring points are located. The measurement surface terminates on one or more reflecting planes.

[ISO 3744:1993, 3.3]

3.8 reference box: A hypothetical surface which is the smallest rectangular parallelepiped that just encloses the source and terminates on the reflecting plane or planes.

[ISO 3744:1993, 3.10]

3.9 measurement distance, d: The distance from the reference box to a box-shaped measurement surface.

[ISO 3744:1993, 3.11]

3.10 time-averaged sound pressure level, $L_{p,\,\mathrm{eq},T}$: Sound pressure level of a continuous steady sound that, within a measurement time interval T, has the same mean-square sound pressure as a sound under consideration which varies with time.

Time-averaged sound pressure levels are expressed in decibels and shall be measured with an instrument which complies with the requirements of IEC 804.

[ISO 3744:1993, 3.2.1]

4 Acoustic environment

4.1 General

Test environments suitable for measurements according to this International Standard include:

a) a laboratory room which provides a free field over a reflecting plane;

b) a flat outdoor area that meets the requirements of 4.2 and annex A of ISO 3744:1993 or annex A of ISO 3746:1979;

c) a room in which the contributions of the reverberant field to the sound pressures on the measurement surface are small compared with those of the direct field of the source.

4.2 Criteria for adequacy of the test environment

Ideally, the test environment should be free from reflecting objets other than a reflecting plane, so that the source radiates into a free field over a reflecting plane.

Test environments which are suitable for engineering or survey measurements shall permit the sound power level to be determined with an uncertainty that does not exceed the values given in 7.2.3.1.

NOTE 3 Annex A of ISO 3744:1993 and annex A of ISO 3746:1979 describe procedures for determining the magnitude of the environmental correction (if any) to account for departures of the test environment from the ideal condition.

The environmental correction K_2 (designated K in annex A of ISO 3746:1979) shall not exceed 2 dB for the engineering method and 7 dB for the survey method.

4.3 Criterion for background noise

At the microphone position, the sound pressure levels of the background noise shall be at least 3 dB for the survey method or at least 6 dB and preferably more than 10 dB for the engineering method below the sound pressure level to be measured in each frequency band of the frequency range of interest.

Care shall be taken to minimize the effects of wind, which may increase the apparent background noise. The appropriate instructions provided by the microphone manufacturer shall be followed.

5 Instrumentation

For the engineering method, instrumentation systems in accordance with ISO 3744 and, for the survey method, systems in accordance with ISO 3746 shall be used. Details of sound level meters for use in these systems are available from IEC 651 and IEC 804.

6 Installation and operation of the source

6.1 Test object

The test object is the fully operational textile machine. It is to be accurately determined which equipment belongs to the machine to be tested. All units that operate exclusively as part of the machine are considered to be part of the "textile machine". Suction systems which are in an integral part of the textile machine are to be considered as part of the test object. The test report shall contain accurate details describing the test object. A sketch of the machine with the principal dimensions is useful. Casing and/or means of soundproofing shall be especially mentioned.

From the determined sound power level of a multiposition machine, the sound power level of another machine equipped with a different number of operating positions can be calculated if the following conditions are met:

a) operating conditions and technical construction of both multiposition machines are the same;

b) the dimensions of both multiposition machines fulfil the requirement necessary for a multiposition machine:

$$l_1 > 5l_2;\ l_1 > 5l_3$$

(see figure 4);

c) the lengths of the headstock l_T and the lengths of the end support l_E are equal for both machines:

$$l_{T1} = l_{T2} = l_T;\ l_{E1} = l_{E2} = l_E$$

(see figure 1);

d) the average sound pressure level of the machine as measured at points 1 and 5 should be a maximum of 1 dB above the average sound pressure level measured at points 3 and 7 (see figure 4);

e) the dimensional ratio $l_{i1}/(l_T + l_E)$ of the measured multiposition machine and the quotient i_1/i_2 of the number of operating positions of machine 1 and

machine 2 are within the permissible range shown in figure 1.

The sound power level L_{W2} should be calculated from the sound power level L_{W1} of the machine, determined in accordance with 7.2, according to the formula

$$L_{W2} = L_{W1} - 10 \lg \frac{i_1}{i_2} \text{ dB}$$

For the shaded area in figure 1, the error in the calculated sound power level L_{W2} is 1 dB max.

6.2 Operating conditions of the textile machine

As the development of noise from textile machines depends upon the operating conditions, these shall be fully recorded in the test report. Annexes A to E give specific information with regard to particular machines, including description of the test objects, operating conditions and additional information to be recorded.

Additional points which should be taken into account:

a) For machines for which the idling noise alone is stated and this exceeds the working noise, this fact shall be indicated in the test report. For machines for which the operating noise is greater, but cannot be clearly measured and therefore only the idling noise, for example, is measured, it shall be noted in the test report that the operating noise is greater.

b) If characteristic operating values are quoted for the measurement of the noise, it shall be noted to what extent deviations from them affect the uncertainty of the noise-measuring value. The operating conditions to be selected for noise measurements on particular types of machines are given in annexes A to E.

c) Revolution counters installed on the machines do not always have the accuracy required to determine the exact number of revolutions. The number of revolutions thus shall be determined by other means.

6.3 Installation of the machine

The installation of the machine should correspond to that used in practice. Should this not be known or should there be more than one way to install the machine, the chosen method shall be mentioned in the test report.

7 Sound pressure levels on the measurement surface

7.1 Measurement surface and microphone positions

7.1.1 Reference surface

To facilitate the location of the microphone positions, a hypothetical reference surface, or reference box, is defined (see 3.8). When defining the dimensions of this reference box, elements protruding from the source which are not significant radiators of sound energy may be disregarded.

7.1.2 Measurement surface

The measurement surface is defined in 3.7.

7.1.3 Measurement distance (see 3.9)

The preferred measurement distance d between the measurement surface and the reference parallelepiped is 1 m. A distance $d < 1$ m may be taken if the measurement surface sound pressure level cannot be ascertained with certainty because the background noise is too high. Measurements made at very small distances (0,25 m min.) still allow a comparison of machines of the same type with similar dimensions. A measuring distance $d > 1$ m may be used when necessary to ensure safety during the measurement. Deviations from a measurement distance of 1 m shall be mentioned in the test report.

7.1.4 Microphone positions on the measurement surface

The microphones are positioned on the measurement surface in one of the following arrangements:

7.1.4.1 Complete measurement point arrangement

The measurement points shall be taken from figures 2, 3 and 4 according to the size of the reference parallelepiped for floor-mounted machines. The number of measurement points shall be increased if the horizontal distance between adjacent points exceeds 2 m or if the difference between the highest and the lowest values of the A-weighted sound pressure level is larger than the number of measurement points. Care shall be taken that the measurement points are proportionately distributed.

In the vicinity of intake openings and exhaust openings, the measurement points shall be positioned such that the microphones do not lie in the air current. The number and the arrangement of measurement points depend on the size of the reference parallelepiped, the uniformity of the sound field and the position of the machine.

7.1.4.2 Simplified measurement point arrangement

An even simpler basic arrangement of the measurement points may be adequate for larger machines, if, for that type of machine, it can be shown with the help of test measurements that the sound field is adequately uniform and that measurements lead to values of sound power level equal to those determined with a complete arrangement of measurement points.

For sources that produce a symmetrical radiation pattern, it may be sufficient to distribute the measurement points over only a portion of the measurement surface. This is permissible if preliminary investigation shows that the surface sound pressure levels in this portion do not deviate by more than 1 dB from those determined from measurements over the entire measurement surface.

7.1.5 Calculation of the measurement surface (see ISO 3744:1993, 7.3.1)

The area S of the measurement surface is given by the formula

$$S = 4(ab + bc + ca)$$

where

$$a = 0{,}5l_1 + d$$

$$b = 0{,}5l_2 + d$$

$$c = l_3 + d$$

(see figures 2 to 4).

7.1.6 Measurement point at the operator position (see ISO 6081)

If there is a fixed operator position near the machine, an additional measurement point should be provided in line with ISO 6081. In this case the microphone shall be located 0,2 m $\pm$ 0,02 m sideways from that ear (left or right) in which the higher noise level is observed, unless otherwise stipulated in the annexes to this International Standard. A description of the normal working position(s) of the operator(s) should be provided. The measurement should be taken in the absence of the operator, in order to avoid any spurious influences.

If the operator position cannot be fixed, either the surface sound pressure level shall be determined or the sound pressure level shall be measured at a distance of 0,5 m from the machine and at a height of 1,5 m $\pm$ 0,025 m above the floor. The type of measurement chosen shall be recorded.

In all cases, the sound pressure level at the operator position should be determined under the same machine operating conditions used to determine the sound power level.

7.2 Conditions of measurement

7.2.1 General (see ISO 3744:1993, 7.5.1)

The microphone shall be placed at the measurement point and directed towards the machine tested during the measurement. Between the microphone and the machine tested, neither persons nor objects should be present which could distort the sound field. The distance between the microphone and the observer should not be less than 0,5 m.

7.2.2 Measurement with sound level meter (see ISO 3744:1993, 7.5.2).

7.2.3 Measurement uncertainty

7.2.3.1 Uncertainty of noise measurement

The specifications of this International Standard for the acoustic measurement method correspond to the requirements of the engineering method, if the correction K_1 for considering background noise does not exceed 1 dB and the correction K_2 for considering the environmental effect does not exceed 2 dB. The engineering method (ISO 3744) of the enveloping surface method used is associated with a maximum standard deviation for the A-weighted sound power level of $\sigma_b = 2$ dB. If one of the corrections K_1 or K_2 exceeds the values given above, the entire measurement is classified as survey method (ISO 3746), which is associated with a maximum standard deviation of the A-weighted sound power level equal to 4 dB. The given standard deviations represent maximum values with reference to the true value of the noise output. As regards repeatability and reproducibility of the sound power level, which are of particular interest, the values for the standard deviation are smaller. If sufficient test experience and sufficient material are available, appropriate precise details concerning the uncertainty of the noise measurement can be given.

7.2.3.2 Uncertainty in ascertaining the operating conditions

In addition to the uncertainties of the noise measurement stated in 7.2.3.1, uncertainties regarding the ascertainment of the operating conditions may increase the overall uncertainty of the measurement; for details see normative annexes A, B, C, D and E.

7.2.4 Corrections for background noise (K_1)

The measured sound pressure levels shall be corrected for background noise (7.2.3.1) according to table 1. The correction shall not exceed 1 dB for the engineering method and 3 dB for the survey method (see ISO 3746:1979, table 4).

8 Calculation of surface sound pressure level and sound power level

8.1 Calculation of sound pressure level averaged over the measurement surface

See ISO 3744:1993, 8.1, however take into consideration 3.4 of this International Standard.

8.2 Calculation of surface sound pressure level

See ISO 3744:1993, 8.4, however take into consideration 3.4 of this International Standard.

8.3 Calculation of sound power level

See ISO 3744:1993, 8.6.

8.4 Calculation of sound pressure level at the operator position

The sound pressure level measured at the operator position shall be corrected by the background noise correction K_1 (see ISO 3744).

9 Information to be recorded (see annexes A to E)

The following information, when applicable, shall be compiled and recorded for all measurements made according to the requirements of this International Standard.

Table 1 — Correction K_1 for background noise

Difference between sound pressure levels measured with sound source operating and background sound pressure level alone dB	Correction K_1 to be subtracted from sound pressure level measured with sound source operating to obtain sound pressure level due to sound source alone dB		
< 3	measurements invalid		
3	3		^
4	2		|
5	2		|
6	1,0	<— Engineering method —>	|
7	1,0		|
8	1,0		|
9	0,5		|
10	0,5		|
> 10	0		v Survey method

9.1 Sound source under test

The following information shall be recorded:

a) description of the sound source under test (including its dimensions and the dimensions of the reference box);

b) operating conditions (see 6.2 and annexes A to E) and the respective test values to indicate the operating conditions;

c) mounting conditions (see annexes A to E);

d) location of sound source in the test environment;

e) if the test object has multiple noise sources, a description of the source(s) in operation during the measurements.

9.2 Acoustic environment

The following information shall be recorded:

a) description of the test environment, including description of physical treatment of walls, ceiling and floor, and a sketch showing the location of source and room contents;

b) acoustical qualification of test environment according to 4.2 .

9.3 Instrumentation

The following information shall be recorded:

a) equipment used for measurements, including name, type, serial number and manufacturer;

b) bandwidth of frequency analyser;

c) frequency response of instrumentation system;

d) method used for checking the calibration of the microphones and other system components, as well as the date and place of calibration.

9.4 Acoustical data

The following information shall be recorded:

a) shape of the measurement surface, the measurement distance, the location and orientation of microphone positions;

b) area S of the measurement surface;

c) A-weighted sound pressure level L_{pA} at each measurement point;

d) A-weighted background noise level at each measurement point and correction K_1 (A-weighted);

e) environmental correction K_2 calculated according to 4.2;

f) surface sound pressure level L_{pf}, in decibels, expressed in terms of an A-weighted level (reference: 20 µPa) corrected using K_1 and K_2;

g) sound power level L_W, in decibels, calculated from the surface sound pressure level for A-weighting (reference: 1 pW);

h) remarks on subjective impression of noise (audible discrete tones, impulsive character, spectral content, temporal characteristics, etc.);

i) A-weighted sound pressure level at the operator position, where specified, or at the point of highest A-weighted sound pressure level corrected using K_1 and K_2;

j) date and time of measurements, as well as the name of the responsible person;

k) if required, uncorrected sound pressure spectra at the operator position, where specified, or at the point of highest A-weighted sound pressure level;

l) whether engineering or survey grade was reached.

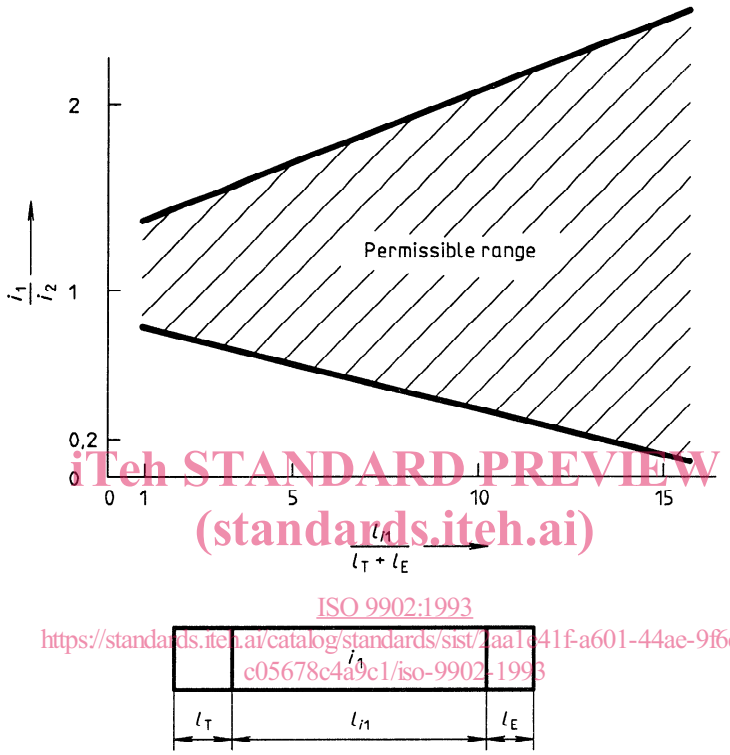
10 Test report

The test report shall contain the statement that the sound power levels have been obtained in full conformity with the procedures of this International Standard. The report shall state that these sound power levels are given in decibels with reference to 1 pW.

From the data recorded according to the requirements of clause 9, only those data shall be reported which are required for the purposes of the measurements.

Minimum requirements for the test report data are:

9.1 a), b), c); 9.2 b); 9.3 a); 9.4 f), g) i), k), m).



Horizontal view of the machine:

l_T is the length of the headstock;

l_E is the length of the end support;

l_i is the length of the working field;

i is the number of operating positions;

Subscript 1 indicates multiposition machine in operation;

Subscript 2 indicates multiposition machine for calculation.

Figure 1 — Length and permissible range for multiposition machines