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**Table of content**

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## Contents

Foreword .....	vi
Introduction.....	viii
1 Scope .....	1
2 Normative references .....	1
3 Terms and definitions.....	1
4 Symbols .....	4
5 Instrumentation.....	6
5.1 Sound level meters and personal sound exposure meters.....	6
5.2 Calibrator .....	7
5.3 Periodic verification.....	7
6 Methodology – Chronological steps .....	7
6.1 Step 1: Work analysis.....	7
6.2 Step 2: Selection of the measurement strategy.....	7
6.3 Step 3: Measurements.....	7
6.4 Step 4: Error handling and uncertainties .....	7
6.5 Step 5: Calculation and presentation of results and uncertainty.....	8
7 Work analysis .....	8
7.1 General .....	8
7.2 Defining homogeneous noise exposure groups (HEG).....	8
7.3 Determination of a nominal day .....	9
8 Selection of measurement strategies .....	9
8.1 General .....	9
8.2 Measurement strategies.....	9
9 Strategy 1 – Task-based measurement.....	10
9.1 Dividing the nominal day into tasks .....	10
9.2 Duration of tasks.....	10
9.3 Measurement of $L_{p,A}$ , $e_{qTm}$ for tasks.....	11
9.3.1 General.....	11
9.3.2 Number of measurements.....	11
9.3.3 Time and duration of measurements .....	12
9.3.4 Calculation of the A-weighted equivalent continuous sound pressure level .....	12
9.4 Calculation of contribution from each task to daily noise exposure level.....	12
9.5 Determination of daily noise exposure level.....	13
10 Strategy 2 – Job based measurement .....	14
10.1 General .....	14

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**10.2 Measurement plan – Number, duration and distribution of measurements.....14**

**10.3 Measurements .....15**

**10.4 Determination of daily noise exposure levels for workers in a homogenous exposure group .....15**

**11 Strategy 3 — Full-day measurement .....16**

**11.1 General .....16**

**11.2 Observing work activities and monitoring measurements.....16**

**11.3 Measurements .....16**

**11.4 Determination of daily noise exposure level.....17**

**12 Measurements .....17**

**12.1 Selection of instrumentation.....17**

**12.2 Field calibration.....18**

**12.3 Instrument worn by the worker .....18**

**12.4 Integrating-averaging sound level meter .....18**

**13 Sources of uncertainty and errors.....19**

**13.1 General .....19**

**13.2 Mechanical impacts on microphone .....20**

**13.3 Wind and airflows .....20**

**13.4 Relevance of sound contributions .....21**

**14 Calculation of measurement uncertainties and presentation of the final results .....21**

**15 Information to be reported.....21**

**Annex A (informative) Example of a checklist to ensure that significant noise events are detected during the work analysis .....24**

**Annex B (informative) Guidance to the selection of measurement strategy.....25**

**Annex C (normative) Evaluation of measurement uncertainties .....28**

**Annex D (informative) Example showing calculation of daily noise exposure level using task-based measurements .....38**

**Annex E (informative) Example showing calculation of daily noise exposure level using job-based measurements .....43**

**Annex F (informative) Sample calculation of daily noise exposure level using full-day measurements .....46**

**Annex G (informative) Example calculation of daily noise exposure level for flexible workers..50**

**Annex H (normative) Uncertainty calculation for peak levels.....54**

**Bibliography.....59**

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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.

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part-1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part-2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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This document was prepared by Technical Committee ISO/TC 43, Acoustics, Subcommittee SC 1, Noise, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 211, Acoustics, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement). This second edition cancels and replaces the first edition (ISO 9612:2009), which has been technically revised.

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The main changes are as follows:

- A reshaping of the guidance on measurement of  ~~$L_{p,A,eqT_m}$~~   $L_{p,A,eqT_m}$  for the task based strategy (9.3)-(9.3).
- A revision of the measurement plan for the job-based strategy (10.2)-(10.2).
- The addition of Homogenous noise Exposure Groups (HEG) sampling requirements for the full day measurement strategy and the addition of criteria to validate sampling (11.3)-(11.3).
- Some precisions and clarifications on the instrumentation section.
- Some additions to the test report section: number of peak events,  ~~$L_{EX,8h,95\%}$~~   $L_{EX,8h,95\%}$ .

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- The addition of **C.7.C.7** in **Annex C, Annex C**, which gives the formulae to calculate the measurement uncertainty when multiple nominal days are used. **An Annex H** **An Annex H** is also introduced to clarify uncertainty of peak measurements.
- The introduction of a new **informative Annex G: Example calculation of daily noise exposure level for flexible workers**. **Annex G**.
- The introduction of a new **informative Annex H: Uncertainty calculation for peak levels**. **Annex H**.
- A full revision of the Excel calculation file attached to this document.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html) [www.iso.org/members.html](http://www.iso.org/members.html).

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## Introduction

This document provides a stepwise approach to the determination of occupational noise exposure from noise level measurements. The procedure contains the following major steps: work analysis, selection of measurement strategy, measurements, error handling and uncertainty evaluations, calculations, and presentation of results. This document specifies three different measurement strategies: task-based measurement; job-based measurement; and full-day measurement. This document gives guidance on selecting an appropriate measurement strategy for a particular work situation and purpose of investigation. This document also provides an informative spreadsheet to allow calculation of measurement results and uncertainties. ISO is not responsible for errors that shall arise or occur with the use of this spreadsheet.

This document recognizes the use of hand-held sound level meters as well as personal sound exposure meters. The methods specified optimize the effort required for obtaining a given accuracy.

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# Acoustics — Determination of occupational noise exposure methodology — Methodology

## 1 Scope

This document specifies a method for measuring workers' exposure to noise in a working environment and calculating the noise exposure level. This document deals with A-weighted levels but is applicable also to C-weighted levels. Three different strategies for measurement are specified. The method is applicable for detailed noise exposure studies or epidemiological studies of hearing damage or other adverse effects.

The measuring process requires observation and analysis of the noise exposure conditions so that the quality of the measurements can be controlled. This document provides methods for estimating the uncertainty of the results.

This document is not intended for assessment of masking of oral communication or assessment of infrasound, ultrasound and non-auditory effects of noise. It does not apply to the measurement of the noise exposure of the ear when hearing protectors are worn.

Results of the measurements performed in accordance with this document can provide useful information when defining priorities for noise control measures.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

~~<std>ISO 1999, Acoustics — Estimation of noise-induced hearing loss</std>~~

~~<std>ISO/IEC Guide 98-3, Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)</std>~~

ISO/IEC Guide 98-3, Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)

~~<std>IEC 60942, Electroacoustics — Sound calibrators</std>~~

~~<std>IEC 60942, Electroacoustics — Sound calibrators~~

IEC 61252, Electroacoustics — Specifications for personal sound exposure meters

~~<std>IEC 61672-1, Electroacoustics — Sound level meters — Part 1: Specifications</std>~~

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain **terminological terminology** databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp> <https://www.iso.org/obp>

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— IEC Electropedia: available at <https://www.electropedia.org/https://www.electropedia.org/>

3.1 A-weighted equivalent continuous sound pressure level

$L_{p,A,eqT}$

$L_{p,A,eqT}$

ten times the logarithm to the base 10 of the ratio of the time average of the square of the A-weighted sound pressure,  $p_A$ , during a stated time interval of duration  $T$  (starting at  $t_1$  and ending at  $t_2$ ), to the square of a reference value,  $p_0$ , expressed in decibels

$$L_{p,A,eqT} = 10 \lg \left[ \frac{\frac{1}{T} \int_{t_1}^{t_2} p_A^2(t) dt}{p_0^2} \right] \text{ dB} \quad (1)$$

$$L_{p,A,eqT} = 10 \lg \left[ \frac{\frac{1}{T} \int_{t_1}^{t_2} p_A^2(t) dt}{p_0^2} \right] \text{ dB}$$

where the reference sound pressure,  $p_0$ , is 20  $\mu\text{Pa}$

Note 1-to entry: Adapted from ISO/TR 25417:2007<sup>[9], [9]</sup>

3.2 A-weighted noise exposure level normalized to an 8 h work day <daily noise exposure level>

$L_{EX,8h}$

$L_{EX,8h}$

daily noise exposure level, in decibels, given by the formula:

$$L_{EX,8h} = L_{p,A,eqT_e} + 10 \lg \left[ \frac{T_e}{T_0} \right] \text{ dB} \quad (2)$$

$$L_{EX,8h} = L_{p,A,eqT_e} + 10 \lg \left[ \frac{T_e}{T_0} \right] \text{ dB}$$

where

$L_{p,A,eqT}$  is the A-weighted equivalent continuous sound pressure level for  $T_e$ ;  $L_{p,A,eqT}$

$T_e$  is the effective duration, in hours, of the working day;

$T_0$  is the reference duration,  $T_0 = 8$  h.

Note 1-to entry: -to entry: If the effective duration of the working day,  $T_e$ , is equal to 8 h, then  $L_{EX,8h} = L_{p,A,eq8h}$  equals

$$L_{p,A,eq8h} = L_{p,A,eq8h}$$

Note 2-to entry: -If the average or normalized exposure over a number of days is desired, Formula (3) the following formula can be used;

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$$\bar{L}_{EX,8h} = 10 \lg \left[ \frac{1}{X} \sum_{x=1}^X 10^{0,1 \cdot L_{EX,8h,x}} \right] \text{ dB} \quad (3)$$

$$\bar{L}_{EX,8h} = 10 \lg \left[ \frac{1}{X} \sum_{x=1}^X 10^{0,1 \cdot L_{EX,8h,x}} \right] \text{ dB}$$

where  $L_{EX,8h,x}$  is the daily noise exposure level for day  $x$ .

The value of  $X$  is chosen according to the purpose of the averaging process. For example,  $X = 5$  leads to a daily noise exposure level normalized to a nominal week of five 8 h working days.

Note 3\_to entry: This definition differs from that given in ISO/TR 25417:2007<sup>[9]</sup>.

### 3.3 nominal day

working day over which it is chosen to determine the noise exposure

Note 1\_to entry: The nominal day is determined from the work analysis and depends on the purpose of the measurements. See also 7.3.7.3.

Note 2\_to entry: The noise exposure level is normally calculated on a daily basis, but there can be circumstances where the use of weekly or longer noise exposure periods is considered appropriate.

Note 3\_to entry: The nominal day can be a synthesized working day that includes fragments of different real working days of a week or of several consecutive weeks.

### 3.4 C-weighted peak sound pressure level

$L_{p,Cpeak}$  ten times the logarithm to the base 10 of the ratio of the square of the C-weighted peak sound pressure,  $p_{Cpeak}$ , to the square of a reference value,  $p_0$ , expressed in decibels

$$L_{p,Cpeak} = 10 \lg \frac{p_{Cpeak}^2}{p_0^2} \text{ dB} \quad (4)$$

$$L_{p,Cpeak} = 10 \lg \frac{p_{Cpeak}^2}{p_0^2} \text{ dB}$$

where the reference sound pressure,  $p_0$  is 20  $\mu$ Pa

### 3.5 task

distinct part of a worker's occupational activity

Note 1\_to entry: Figure 1 illustrates the hierarchy of jobs and tasks.

### 3.6 job

overall occupational activity that is carried out by a worker, consisting of all the tasks performed by the worker during the entire working day or shift

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