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**Acoustics — Determination of sound  
immission from sound sources placed  
close to the ear —**

**Part 2:  
Technique using a manikin**

*Acoustique — Détermination de l'exposition sonore due à des sources  
placées à proximité de l'oreille —*

*Partie 2: Technique utilisant un mannequin*



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Published in Switzerland

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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.

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)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 43, *Acoustics* 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 11904-2:2004), of which it constitutes a minor revision. The changes compared to the previous edition are editorial.

A list of all parts in the ISO 11904 series can be found on the ISO website.

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).

## Introduction

ISO 11904 is a series of standards which specify methods for the determination of sound immissions from sources located close to the ear in which situations the sound pressure level measured at the position of the exposed person (but with the person absent) does not adequately represent the sound exposure.

In order to make it possible to assess the exposure by means of well-established criteria, the exposure of the ear is measured and subsequently converted into a corresponding free-field or diffuse-field level. The result is given as a free-field related or diffuse-field related equivalent continuous A-weighted sound pressure level,  $L_{FF,H,Aeq}$  or  $L_{DF,H,Aeq}$  when ISO 11904-1 is used, or  $L_{FF,M,Aeq}$  or  $L_{DF,M,Aeq}$  when ISO 11904-2 is used.

ISO 11904-1 describes measurements carried out using miniature or probe microphones inserted in the ears of human subjects (microphones in real ear, MIRE technique). ISO 11904-2 describes measurements carried out using a manikin equipped with ear simulators including microphones (manikin technique).

ISO 11904 may, for instance, be applied to equipment tests and the determination of noise exposure at the workplace where, in the case of exposure from sources close to the ears, the sound pressure level measured at the position of the exposed person (but with the person absent) does not adequately represent the sound exposure. Examples of applications are head- and earphones used to reproduce music or speech, whether at the workplace or during leisure, nail guns used close to the head, and combined exposure from a close-to-ear sound source and an external sound field.

When specific types of equipment are to be tested (e.g. portable cassette players or hearing protectors provided with radio receivers), test signals suitable for this particular type of equipment have to be used. Neither such test signals nor the operating conditions of the equipment are included in ISO 11904 but might be specified in other standards.

When workplace situations are measured, the various noise sources contributing to the immission should be identified. Operating conditions for machinery and equipment used might be specified in other standards.

Both parts of ISO 11904 strive for the same result: a mean value for a population of the free-field or the diffuse-field related level. ISO 11904-1 does this by specifying the mean of measurements on a number of human subjects; ISO 11904-2 does this by using a manikin, which aims at reproducing the acoustical effects on an average human adult. However, the two methods yield different measurement uncertainties which can influence the choice of method. Only the method described in ISO 11904-1 gives results which indicate the variance in a human population. Information on the uncertainties is given in [Annexes A](#) and [B](#).

When using the MIRE technique for measurement of sound from earphones of insert and stethoscopic types, practical problems can occur with the positioning of microphones in the ear canal. When using the manikin technique, the headphone or earphone is coupled to the pinna simulator and ear canal extension as closely as possible to the way it is coupled to the human ear. In cases where headphones, earphones, or other objects touch the pinna, a possible deviation in stiffness or shape of the artificial pinna from human pinnae has a significant impact on the result and can even make the results invalid.

An overview of the differences between the two parts of ISO 11904 is given in [Table 0.1](#).

**Table 0.1 — Overview of differences between MIRE and manikin techniques**

Parameter	ISO 11904-1	ISO 11904-2
Type of method	Microphone in real ear technique	Manikin technique
Limitation of the method	With earphones of insert and stethoscopic type, practical problems can occur with positioning of microphones in the ear canal.	Proper coupling may not always be obtained if the artificial pinna deviates from human pinnae in stiffness or shape.  In some cases the exposed person cannot be replaced by a manikin, e.g., if the person has to operate equipment.
Main issues affecting accuracy	<p>Number of subjects</p> <p>When tabulated values are used for <math>\Delta L_{FF,H}</math> or <math>\Delta L_{DF,H}</math>:</p> <ul style="list-style-type: none"> <li>— calibration of ear canal microphone</li> <li>— accuracy in positioning of microphones in the ear canal</li> </ul> <p>When individual values are used for <math>\Delta L_{FF,H}</math> or <math>\Delta L_{DF,H}</math>:</p> <ul style="list-style-type: none"> <li>— quality of reference sound field</li> <li>— stability of sensitivity and frequency response as well as position of ear canal microphone</li> </ul>	<p>Similarity of manikin to humans</p> <p>Calibration of manikin</p>
Frequency range	20 Hz to 16 kHz	20 Hz to 10 kHz

# Acoustics — Determination of sound immission from sound sources placed close to the ear —

## Part 2: Technique using a manikin

### 1 Scope

This document specifies basic framework measurement methods for sound immission from sound sources placed close to the ear. These measurements are carried out with a manikin, equipped with ear simulators including microphones. The measured values are subsequently converted into corresponding free-field or diffuse-field levels. The results are given as free-field related or diffuse-field related equivalent continuous A-weighted sound pressure levels. The technique is denoted the manikin technique.

This document is applicable to exposure to sound from sources close to the ear, for example during equipment tests or at the workplace to sound from earphones or hearing protectors with audio communication facilities.

This document is applicable in the frequency range from 20 Hz to 10 kHz. For frequencies above 10 kHz, ISO 11904-1 can be used.

### 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.

IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

ITU-T P.58:2013, *Head and torso simulator for telephonometry*

### 3 Terms and definitions

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

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

#### 3.1

#### manikin sound pressure level

$L_{M,exp,f}$   
equivalent continuous sound pressure level in one-third-octave frequency bands with nominal midband frequency  $f$ , measured with the microphone of an ear simulator integrated in a manikin when the manikin is exposed to the sound under test