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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 11904-2 was prepared by Technical Committee ISO/TC 43, *Acoustics*.

ISO 11904 consists of the following parts, under the general title *Acoustics — Determination of sound immersion from sound sources placed close to the ear*:

- *Part 1: Technique using a microphone in a real ear (MIRE technique)*
- *Part 2: Technique using a manikin*

## 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, nailguns 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 head- or earphone has to be coupled to the pinna simulator and ear canal extension as far as possible in the way it is coupled to the human ear. In cases where head- or 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 part of ISO 11904 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 part of ISO 11904 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 audiocommunication facilities.

This part of ISO 11904 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 referenced documents are indispensable for the application 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 60942:2003, *Electroacoustics — Sound calibrators*

IEC 61260:1995, *Electroacoustics — Octave-band and fractional-octave-band filters*

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

ITU-T P.58:1996, *Head and torso simulator for telephony*

GUM:1993<sup>1)</sup>, *Guide to the expression of uncertainty in measurement*. BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, 1995

1) Corrected and reprinted in 1995.