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AMERICAN NATIONAL STANDARD

Methods for the Measurement of Insertion Loss of Hearing Protection Devices in Continuous or Impulsive Noise Using Microphone-in-Real-Ear or Acoustic Test Fixture Procedures

ANSI/ASA S12.42-2010

Accredited Standards Committee S12, Noise

Standards Secretariat
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**Methods for the Measurement of Insertion Loss of
Hearing Protection Devices in Continuous or Impulsive
Noise Using Microphone-in-Real-Ear or Acoustic Test
Fixture Procedures**

Secretariat:

Acoustical Society of America

Approved January 11, 2010 by:

American National Standards Institute, Inc.

Abstract

This standard specifies microphone-in-real-ear (MIRE) methods for the measurement of the insertion loss of active and passive circumaural earmuffs, helmets, and communications headsets, and specifies acoustic test fixture (ATF) methods for the measurement of the insertion loss of active and passive earplugs, earmuffs, helmets, and communications headsets. The MIRE methods are appropriate for use with continuous noise whereas the ATF methods may be used with both continuous noise and high-level impulsive noise test signals. The standard contains information on instrumentation, calibration, and electroacoustic requirements, procedures for determining sound pressure levels in the ear with and without the hearing protection devices in place, and procedures for calculating the corresponding insertion loss values. The standard also describes how to combine the active contribution of insertion loss for active devices measured using the MIRE method with the passive real-ear attenuation measured in accordance with ANSI/ASA S12.6 to obtain an attenuation value for use in estimating sound pressure levels for active protectors in accordance with ANSI/ASA S12.68. Requirements for reporting of the data are also described.

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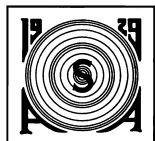
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Foreword

[This Foreword is for information only and is not a part of the American National Standard ANSI/ASA S12.42-2010 American National Standard Methods for the Measurement of Insertion Loss of Hearing Protection Devices in Continuous or Impulsive Noise Using Microphone-in-Real-Ear or Acoustic Test Fixture Procedures.]

This standard comprises a part of a group of definitions, standards, and specifications for use in noise. It was developed and approved by Accredited Standards Committee S12, Noise, under its approved operating procedures. Those procedures have been accredited by the American National Standards Institute (ANSI). The Scope of Accredited Standards Committee S12 is as follows:

Standards, specifications, and terminology in the field of acoustical noise pertaining to methods of measurement, evaluation, and control, including biological safety, tolerance, and comfort, and physical acoustics as related to environmental and occupational noise.

This standard is a revision of ANSI S12.42-1995 (R2004). This revision adds procedures for determining the insertion loss of active earmuffs on real heads and of active earmuffs and earplugs on an acoustic test fixture. This revision also adds methods for determining the insertion loss of earmuffs, earplugs, and helmets in impulsive noise.

This standard is in part comparable to ISO Standard 4869-3:2007 *Acoustics – Hearing protectors – Part 3: Measurement of insertion loss of earmuff type protectors using an acoustic test fixture*. The ISO standard only addresses passive hearing protectors and only on a simplified acoustic test fixture, while this standard addresses active and passive hearing protectors on both human subjects and on an acoustic test fixture that includes an occluded ear simulator, flesh simulation, and pinna. Two other related ISO Standards are ISO 4869-1:1990 *Acoustics – Hearing protectors – Part 1: Subjective method for the measurement of sound attenuation* and ISO/TR 4869-4:1998 *Acoustics – Hearing protectors – Part 4: Measurement of effective sound pressure levels for level-dependent sound-restoration ear-muffs*

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Introduction

This standard contains two objective procedures, a microphone-in-real-ear (MIRE) method and an acoustic test fixture (ATF) method, for the measurement of the insertion loss of hearing protection devices. Insertion loss, when measured using microphone-based techniques, is an objective estimate of the attenuation of noise by a hearing protection device. Both methods may be used to measure insertion loss as a function of frequency with specified continuous noise test signals, and the ATF method can also be used to measure the peak insertion loss of hearing protection devices when exposed to specified impulsive test signals. The two procedures are similar except for the location of the protector (human head or test fixture) and the sequence in which measurements are made. The MIRE method utilizes human subjects who serve as test fixtures with microphones positioned in their ears; it is the preferred method for continuous noise since it captures the performance and variability of the hearing protection device on human subjects/users. The ATF method utilizes an acoustical test fixture with a measurement microphone embedded at each ear position.

The MIRE method employs miniature microphones in the ear to measure the insertion loss of hearing protection devices such as active and passive earmuffs or helmets. Insertion loss is the difference between sound pressure levels measured with the test microphones uncovered and with the microphones covered by the hearing protection device under evaluation. The MIRE procedure is objective rather than psychophysical and is not limited to passive linear attenuation hearing protection devices; it may be used to evaluate amplitude-sensitive and active noise reduction circumaural and supra-aural devices. This standard also specifies how to combine the active contribution to insertion loss with the passive contribution measured using the methods in ANSI/ASA S12.6 in order to determine the total attenuation of active earmuffs or helmets. These data may be used in accordance with ANSI/ASA S12.68 to estimate sound pressure levels when hearing protectors are worn. The MIRE procedure is suitable only for use with continuous noises. Clauses 5, 7, 8, and 9 describe the requirements to be met to conduct MIRE tests.

The ATF method is used to evaluate the insertion loss of hearing protection devices in continuous noise but is also applicable in measuring the reduction of peak sound pressure levels of impulsive test signals. The latter is accomplished using a noise-reduction procedure that simultaneously samples microphone signals external to and under the hearing protector. The resulting external signal is then transformed using the results of a calibration procedure to estimate the equivalent open-ear impulsive signals at each ear in order to compute the hearing protector's insertion loss.

The ATF method requires that a manikin with a representative head size and earcanals be utilized. The need for an ATF arises from the instrumentation challenge of conducting measurements under an earplug without compromising its seal, as well as the necessity to use high-level signals during impulsive-noise testing without endangering human subjects. The ATF shall have sufficient acoustic isolation and dynamic range to permit testing the hearing protection device over a wide range of noise levels. The ATF method is suitable for use with active noise reduction and level-dependent earplugs in continuous noise and for active and passive earmuffs, earplugs, and helmets in high-level impulsive sound field environments. Clauses 5, 6, 10, and 11 describe the requirements to be met to conduct impulsive noise tests. Clauses 5, 6, 8, and 9 describe the requirements to be met to conduct continuous noise insertion loss tests using an ATF.

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American National Standard

Methods for the Measurement of Insertion Loss of Hearing Protection Devices in Continuous or Impulsive Noise Using Microphone-in-Real-Ear or Acoustic Test Fixture Procedures

1 Scope

This standard provides methods for the measurement of the insertion loss of hearing protection devices in specified continuous and impulsive noise environments. The microphone-in-real-ear (MIRE) method utilizes human test subjects and may be used for hearing protectors that enclose the ears and make supra-aural or circumaural contact with the head, whereas the acoustical test fixture (ATF) method employs an inanimate fixture and can be used for any hearing protection device. The standard contains information on instrumentation, calibration, and electroacoustic requirements including details regarding the sound field of test facilities, the acoustical characteristics of ATFs, and subject selection and training and location of ear-mounted microphones for MIRE testing. Methods for measuring or determining sound pressure levels in the ear are also specified as well as methods for reporting the calculated insertion loss.

This standard establishes uniform instrumentation requirements and procedures for the measurement of insertion loss at supra-threshold levels of continuous noise using the MIRE method with human subjects, and at supra-threshold levels with continuous or impulsive noise using the ATF method. These procedures utilize signals at sound levels representative of applications in which hearing protection devices are worn. The methods are intended to provide quick, economical, and repeatable objective (not psychophysical) measurement techniques that can be used as additions or complements to the real-ear attenuation at threshold (REAT) measurement method specified in ANSI/ASA S12.6.

This standard is intended for use in design, quality assurance, and verification of compliance with specifications for hearing protection devices. The MIRE subject selection and fitting procedures described herein correspond to Method A (trained-subject fit) of ANSI/ASA S12.6. An inexperienced subject fit MIRE method, corresponding to Method B of ANSI/ASA S12.6, is not provided because of the degree of subject/experimenter interaction required to ensure proper fitting of the MIRE microphones in the ear.

2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI S1.1, *American National Standard Acoustical Terminology*.

ANSI/ASA S1.11-2004 (R2009), *American National Standard Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters*.

ANSI/ASA S3.20, *American National Standard Bioacoustical Terminology*.