AMERICAN NATIONAL STANDARD

Methods for Measuring the Real-Ear Attenuation of Hearing Protectors

ANSI/ASA S12.6-2016

Accredited Standards Committee S12, Noise

Standards Secretariat
Acoustical Society of America
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ANSI/ASA S12.6-2016
(Revision of ANSI/ASA S12.6-2008)

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Methods for Measuring the Real-Ear Attenuation of Hearing Protectors

Secretariat:
Acoustical Society of America

Approved on June 16, 2016 by:
American National Standards Institute, Inc.

Abstract
This standard specifies laboratory-based procedures for measuring, analyzing, and reporting the passive noise-reducing capabilities of hearing protectors. The procedures consist of psychophysical tests conducted on human subjects to determine the real-ear attenuation measured at hearing threshold. Two fitting procedures are provided: Method A) trained-subject fit, intended to describe the capabilities of the devices fitted by carefully trained users, and Method B) inexperienced-subject fit, utilizes subjects with little or no experience with respect to the use of hearing protection, in order to approximate the attenuation that can be attained by groups of users as reported in real-world occupational studies. Regardless of test method, the attenuation data will be valid only to the extent that the users wear the devices in the same manner as during the tests. This standard does not address issues pertaining to computational schemes or rating systems for applying hearing protector attenuation values (see ANSI/ASA S12.68), nor does it specify minimum performance values for hearing protectors, or address comfort or wearability features. Method A of this standard corresponds to ISO 4869-1:1990, *Acoustics – Hearing protectors – Part 1: Subjective method for the measurement of sound attenuation*, and Method B corresponds to ISO/TS 4869-5:2006, *Acoustics – Hearing protectors – Part 5: Method for estimation of noise reduction using fitting by inexperienced test subjects*.

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Foreword

[*This Foreword is for information only and is not a part of the American National Standard ANSI/ASA S12.6-2016 American National Standard Methods for Measuring the Real-Ear Attenuation of Hearing Protectors* (revision of ANSI/ASA S12.6-2008). *As such, this Foreword may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the standard*.]

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/ASA S12.6-2008. The principal changes in this update pertain to the definition of the filters used in signal generation, room ambient noise requirements and various other items regarding the test site as described in Clause 4, retention of subjects during Method-B testing, a completely revised annex on the computation of uncertainty in close harmonization with the related specifications in ISO 4869-1, and inclusion of requirements on laboratory procedures for purposes of accreditation for laboratories choosing to become accredited.

This standard is comparable to two existing ISO standards. Method A corresponds to ISO 4869-1:1990, *Acoustics – Hearing protectors – Part 1: Subjective method for the measurement of sound attenuation*, with the principal differences being in the number of test subjects and replications, the fitting instructions, and certain details of the electroacoustic test specifications, especially the room ambient noise. Method B corresponds to ISO/TS 4869-5:2006, *Acoustics – Hearing protectors – Part 5: Method for estimation of noise reduction using fitting by inexperienced test subjects*, again with similar differences as between Method A and 4869-1.

This standard does not include performance requirements for hearing protectors, nor does it specify how to use the attenuation values derived from testing via the methods of this standard for the prediction of protected noise exposures; computational methods and attenuation ratings are described in ANSI/ASA S12.68-2008 (R2012). This standard also does not pertain to physical attenuation measurements using acoustical test fixtures or microphones mounted in human earcanals; those procedures are covered in ANSI/ASA S12.42-2010. And finally, with respect to attenuation obtained by individual users, a standard is under development that will provide specifications for field attenuation estimation systems (FAES) intended to estimate the personal attenuation ratings of hearing protection devices obtained by individual wearers in actual practice (BSR/ASA S12.71-201X).

At the time this standard was submitted to Accredited Standards Committee S12, Noise for approval, the membership was as follows:

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Working Group S12/WG 11, Hearing Protector Attenuation and Performance, which assisted Accredited Standards Committee S12, Noise, in the development of this standard, had the following membership.

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Suggestions for improvements of this standard will be welcomed. They should be sent to Accredited Standards Committee S12, Noise, in care of the Standards Secretariat of the Acoustical Society of America, 1305 Walt Whitman Road, Suite 300, Melville, New York 11747-4300. Telephone: 631-390-0215; Fax: 631-923-2875; E-mail: asastds@acousticalsociety.org.

Introduction

This standard describes real-ear attenuation at threshold (REAT) methods for the measurement of the noise attenuation of hearing protection devices (HPDs). Variations of this approach have been in wide use since the development of ASA Z24.22-1957. REAT data have generally been recognized as yielding the best measure of the noise attenuation provided by passive hearing protection devices and include the effects of sound transmission from flanking pathways, such as those arising from tissue and bone conduction (Berger, 1986).

Key factors influencing the measured attenuation values are the selection, training, and fitting of the hearing protector test subjects. For that reason this standard includes two methods with distinctly differing approaches for dealing with these issues.

Method A, previously called “experimenter-supervised fit” and now designated “trained-subject fit,” describes something close to an optimum fitting scenario that can be accomplished by a motivated and proficient user. It allows full training and intervention by the experimenter prior to the attenuation measurement, but for the actual test the subject must don the hearing protector on his or her own without assistance. The rationale is that allowing intensive individualized training immediately prior to a subject fitting the device is a reasonable reflection of the best that can be obtained in practice. The reason to preclude the experimenter from actually fitting the device was the observation that experimenters, who vary in the ways they interpret the standard and perform HPD fitting, can increase interlaboratory variability (Murphy *et al*., 2009). To some extent, isolating the experimenters from the actual test reduces this problem. Furthermore, in actual use, whether trained or not, workers and others don hearing protectors without assistance.

Method B, previously called “subject fit” and currently designated “inexperienced-subject fit” to clearly indicate the key feature of the procedure, intends to approximate “achievable” results for *groups* of workers in hearing conservation programs. Because in an inexperienced-subject fit procedure the experimenter’s input is limited, much depends upon the subjects’ skill in reading and interpreting instructions, which in turn is substantially affected by their prior experience with HPDs and any previous training they may have received. Under such conditions it is important to select subjects with as little prior practice and training in HPD usage as possible; otherwise, their performance on the current tests will likely be influenced by their preconceptions and acquired level of skill (Berger, 1992).

Method B was developed by the Working Group responsible for this standard by evaluating various protocols via both a pilot and an initial full-scale interlaboratory comparison study (Berger *et al.*, 1998; Murphy *et al*., 2004; Royster *et al.*, 1996). Subsequently, an additional interlaboratory study evaluating six hearing protectors in six different laboratories was conducted, and the results led to refinements in the methods incorporated into the current standard (Murphy *et al.* 2009).

Sincerely interested and/or highly motivated *individuals* may obtain workplace attenuation values significantly exceeding Method-B, and even potentially exceeding Method-A results, but for most populations of occupational users, the inexperienced-subject-fit estimates will provide better predictors of group average data than will the Method-A results. The validity of the estimates has been assessed by comparing laboratory-measured values arrived at using procedures similar to the subject-fit protocol of this standard to values for groups of users derived from more than 20 available real-world studies (Berger *et al*., 1998).

Method A yields higher mean attenuation values and lower within-test standard deviation values than Method B, with the effect being substantially larger for earplugs than for earmuffs because of the greater difficulty in fitting insert devices. See Annex A for information on estimating the uncertainty of these procedures.

American National Standard

Methods for Measuring the Real-Ear Attenuation of Hearing Protectors

1 Scope

1.1 Scope

This standard specifies laboratory-based subjective-method for measuring, analyzing, and reporting the passive noise-reducing capacity of hearing protection devices. The methods consist of psychophysical tests conducted on groups of human subjects to determine real-ear attenuation at threshold.

Two methods are provided, differing in their subject selection, training, hearing protector fitting procedures, and experimenter involvement, but corresponding in all electroacoustic and psychophysical aspects. One method, designated *trained-subject fit*, is intended to describe the upper limits of hearing protector performance for devices fitted by groups of carefully trained users. The second method, designated *inexperienced-subject fit*, is conducted with persons with little or no experience with respect to the use of hearing protection. It approximates the attenuation that has been achieved by groups of users as reported in real-world occupational studies (Berger *et al*., 1998).

1.2 Applications

The selection of test method, trained-subject fit or inexperienced-subject fit, is based upon the intended application.

Method-A trained-subject fit values are useful to estimate performance for individually trained and well-motivated users, as well as in the design of hearing protectors, to provide a theoretical understanding of their performance limitations, and for routine testing for quality assurance purposes.

Method-B inexperienced-subject fit is intended to provide an approximation of the upper limits to the attenuation that can be expected on average for *groups* of occupational users. Properly trained and motivated *individuals* can potentially attain larger amounts of protection, in closer agreement with the trained-subject fit data, especially for earplugs, than the inexperienced-subject fit values found using this standard. However, inexperienced-subject fit values provide a closer correspondence to real-world performance for groups of users than do the trained-subject fit data.

Regardless of the test method that is selected, trained-subject fit or inexperienced-subject fit, the attenuation values will be applicable only to the extent that:

(a) the hearing protectors are worn in practice in the same manner as during the laboratory test;

(b) the hearing protectors are properly maintained; and

(c) the anatomical characteristics of the population of actual wearers are a reasonable match to the laboratory test subjects.

The methods of this standard apply to passive hearing protectors, as well as to active hearing protection devices when the electronics are turned off. For evaluation of active hearing protection devices with their electronics turned on, see ANSI/ASA S12.42. Hearing protectors can also take the form of communications headsets and earplugs, helmets, pressure suits, and other systems with sound-