
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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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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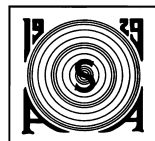
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Foreword

[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.

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*.

ANSI/ASA S3.25, *American National Standard for an Occluded Ear Simulator*.

ANSI S3.36-1985 (R2006), *American National Standard Specification for a Manikin for Simulated in-situ Airborne Acoustic Measurements*.

ANSI/ASA S12.6-2008, *American National Standard Methods for Measuring the Real-Ear Attenuation of Hearing Protectors*.

ANSI/ASA S12.68-2007, *American National Standard Methods of Estimating Effective A-Weighted Sound Pressure Level When Hearing Protectors are Worn*.

ASTM D2240-05, *Standard Test Method for Rubber Property—Durometer Hardness*.

IEC 61094-4, *Measurement microphones - Part 4: Specifications for working standard microphones*.

3 Terms and definitions

For the purposes of this standard, the terms and definitions given in ANSI S1.1, ANSI S3.20 and the following apply.

3.1 A-duration. The duration of an impulsive sound from the time of its initial sharp increase in positive sound pressure to the time when the sound pressure becomes negative.

3.2 acoustic test fixture (ATF). An inanimate device that approximates certain physical characteristics and dimensions of a representative human head, pinnae, and ear canal and is used for measuring the insertion loss of a hearing protection device.

3.3 active hearing protection device. A hearing protection device that contains electronic components including transducers (i.e., speakers and microphones) to increase or decrease the transmission of sound into the ear canal.

3.4 active insertion loss (AIL). The insertion loss determined during a single fitting of an active noise reduction hearing protection device, comparing the sound pressure levels with and without the device's electronics operating. This is equivalent to the arithmetic difference in decibels between the total insertion loss and the passive insertion loss.

3.5 active noise reduction (ANR) hearing protection device. A hearing protection device that reduces acoustic energy using wave interference.

3.6 attenuation. The reduction of sound pressure by a hearing protection device using a combination of structural elements, acoustic pathways, electronic means and/or mechanical means.

3.7 bone conduction (including tissue conduction). Transmission of acoustic energy to the cochlea (inner ear) via pathways other than the ear canal.

3.8 communications headset. A device designed for voice communication that may also provide or be used for hearing protection.

3.9 continuous noise. Noise with a duration exceeding 1 s with a consistent spectrum and level with respect to time.

3.10 custom earplug. An earplug that is fabricated in a shape that closely matches a specific individual's earcanal, and may also include portions of the concha and pinna.

3.11 earmuff. A hearing protection device usually comprised of a headband and earcups with a soft cushion to seal against the head, intended to fit against the pinna (supra-aural) or the sides of the head enclosing the pinna (circumaural). The earcups may also be held in position by attachment arms mounted on a hard hat or hard cap.

3.12 earplug. A hearing protection device that is inserted into or that caps the earcanal.

3.13 fitting noise. A noise used to assist the subject in adjusting the fit of a hearing protection device.

3.14 hearing protection device (HPD). A device, also called a hearing protector, worn to reduce the sound level in the earcanal.

3.15 helmet. A device that usually provides impact protection to the head or skull and that may be designed also to reduce noise in the ear.

3.16 impulsive peak insertion loss (IPIL). The reduction of the peak sound pressure level of an impulsive noise provided by an HPD determined from noise reduction measurements corrected using the free-field to open-ear transfer function.

3.17 impulsive noise. An acoustic event characterized by a rise time of less than 1 ms and a duration of less than 1 s.

3.18 insertion loss (IL). The arithmetic difference in decibels between the sound pressure levels measured at a fixed position in the ear, measured under two different conditions (e.g., with and without the HPD in place or with ANR on and off in a single fitting).

3.19 level-dependent hearing protection device. A device, also called an amplitude sensitive hearing protector, designed to produce a change in attenuation as a function of the external sound level.

3.20 noise reduction. The arithmetic difference in decibels between sound pressure levels measured simultaneously external to and under the hearing protector.

3.21 passive hearing protection device. A device that relies solely on mechanical elements to block or otherwise control the transmission of sound to the auditory system.

3.22 passive insertion loss (PIL). The insertion loss determined from the difference between the sound pressure levels with and without the HPD in place on the head or fixture, measured for a passive HPD or an active HPD with the electronics turned off.

3.23 random incidence field. Sound field in which the arrival of sound at a given point is random in time and angle.

3.24 real-ear attenuation at threshold (REAT). At a specific frequency, the value in decibels of the occluded threshold of hearing minus the open threshold of hearing under otherwise identical test conditions.

3.25 reference point. A fixed spatial location within the test chamber at which the midpoint of a line connecting the test subject's or ATF's earcanal openings is located for MIRE or ATF measurements, and likewise the point to which all objective measurements of the sound field characteristics are referenced.

3.26 requester. The party submitting a hearing protection device and fitting instructions for testing.

NOTE When the investigator is evaluating hearing protectors other than for an entity external to the laboratory, the requester is considered to be the investigator conducting the research.

3.27 total attenuation (TA). The combination, as specified in 9.6.3, of passive attenuation as measured in accordance with ANSI/ASA S12.6 with active insertion loss as measured in accordance with this standard for an active noise reduction HPD.

3.28 total insertion loss (TIL). The insertion loss determined from the difference between the sound pressure levels with and without the HPD in place on the head or fixture, measured for an active HPD with its electronics turned on.

4 Applicability of the test methods

This standard describes several procedures that are appropriate for testing different types of HPDs depending upon the noise environment and the performance issues being assessed. Table 1 provides guidance on which procedures in this standard are appropriate to specific combinations of HPD type and performance issue.

This standard defines how to combine the active component of an active noise reduction (ANR) device's insertion loss with the passive attenuation measured using the REAT method to obtain a total attenuation value appropriate for estimating the effective sound pressure level to which a workplace population may be exposed in accordance with ANSI/ASA S12.68. The only data to be used to estimate the active component for the above computation are those derived from the MIRE method, except in the case of most ANR earplugs when ATF data may be applied. The ATF method may only be used to infer performance on human subjects in two cases: estimating effective peak impulsive insertion loss for all types of HPDs, and estimating the active insertion loss for deep-insert custom-molded active noise reduction earplugs.

MIRE insertion loss values approximate real-ear attenuation values except for test signals at or below 250 Hz, where REAT values often exceed MIRE values due to physiological noise masking (Berger and Kerivan 1983). Since hearing conservation programs typically use REAT attenuation values to assess hearing protector effectiveness, the total attenuation of active devices is determined by combining passive REAT performance (rather than passive MIRE performance) with active insertion loss. ATF measurements are intended to quantify the active insertion loss of active noise reduction or level-dependent earplugs and earmuffs, the peak insertion loss of all hearing protectors in high-level impulsive noise, and as a repeatable test of passive attenuation for quality assurance and certain aspects of product development work. The passive insertion loss values from an ATF should not be used as a substitute for REAT attenuation values in a hearing conservation program (Nixon et al., 1992).

Table 1 — Applicability of test methods to different hearing protection device types

Preferred = method to be used to estimate hearing protector attenuation (Note 1).
 Applicable = method may be used, but only for quality assurance or research purposes.
 Not advised = this method not recommended.

HPD Type	Continuous Noise		Impulsive Noise
	MIRE (Clauses 5, 7, 8, 9)	ATF (Clauses 5, 6, 8, 9)	ATF (Clauses 5, 6, 10, 11)
Passive earmuff	Applicable	Applicable	Preferred (Note 1)
Passive earplug	Not advised	Applicable	Preferred (Note 1)
Passive level-dependent earmuff	Applicable	Applicable	Preferred
Passive level-dependent earplug	Not advised	Applicable	
Active level-dependent earmuff	Preferred (electronics on only)	Applicable (electronics on only)	
Active level-dependent earplug	Not advised	Preferred (electronics on or off)	
ANR earmuff	Preferred (Note 2)	Applicable	
ANR earplug (non-custom)	Not advised	Preferred (Note 2)	
ANR earplug (deep custom fit)	Preferred (Note 3)	Applicable	
NOTE 1 When choosing between REAT conducted according to ANSI/ASA S12.6 and the tests in this standard, REAT is preferred for all measurements in continuous noise of passive HPDs, of passive level-dependent HPDs at levels below which their level-dependency is operational, and for electronic products turned off. REAT is also an acceptable measurement method for passive earmuffs and earplugs in impulsive noise for peak levels up to 170 dB SPL, although at this time there is no standardized method of estimating IPIL from REAT values.			
NOTE 2 REAT is to be used to measure passive attenuation and the indicated continuous noise method is to be used to measure active insertion loss. The two should be combined as described in 9.6.3 to determine the total attenuation.			
NOTE 3 This is applicable only to devices that meet the requirements specified in Annex E. The MIRE active insertion loss measurement shall be made using the ANR system's in-canal sensing microphone. That data shall be combined with the REAT passive data as described in 9.6.3 to determine the total attenuation.			

5 Requirements for product samples and band force

5.1 Required number of HPD samples

A minimum of five samples of the HPD under evaluation shall be used in each test. They shall be distributed (for example, among subjects in the case of a MIRE test) so as to achieve equal proportional representation of the samples in the measurements. For sized HPDs, at least one sample of each size shall be provided for the test, though not all sizes will necessarily be used depending upon the subject population. Each sample shall be marked with a unique identifier to be associated with all measurements made on that sample.

For estimates of the total attenuation of active earmuffs and earplugs per 9.6.3, the same samples shall be used for both the REAT and MIRE or the REAT and ATF tests.

5.2 Measurement of band force

The band force shall be measured on all samples of earmuff and semi-insert devices prior to insertion loss testing. This requirement does not apply to helmets. Band force shall be measured two minutes ± 5 seconds after the hearing protector has been positioned on the test fixture, and the values shall be reported in newtons (N). The temperature and relative humidity at which the band force is measured shall be recorded.

The band force exerted by earmuffs shall be measured on a suitable fixture with hard flat plates against which the earmuff cushions are pressed. The plate separation shall be 145 mm ± 1 mm [median head width (bitracion width)], with a distance of 130 mm ± 1 mm between the underside of the apex of the headband and an imaginary line through the pivot points of the attachments of the headband to the earcups (median head height). The headband shall remain free of contact with the test fixture during the measurement. For some types of products, such as those with headbands situated behind the neck or under the chin, other head-height dimensions may be more appropriate and the actual head-height shall be reported.

To test the band force of earmuffs that are attached to hard hats, the support webbing shall be removed from the inside of the hard hat and a hole drilled through its vertex so that the hat can be positioned on a stud affixed to the test fixture in a reproducible manner. The test fixture head height and earcup separation shall be adjusted as for standard earmuff assemblies.

The band force exerted by semi-insert devices shall be measured on a suitable fixture having flexible pinnae, the dimensions of which are specified in Annex A. The bitracion width shall be 145 mm ± 1 mm. The head/neck band shall remain free of contact with the test fixture during the measurement. For semi-inserts with adjustable bands, the band shall be set for a head height of 130 mm ± 1 mm, or its minimum setting, whichever is greater. For devices with asymmetric pods, the devices shall be properly oriented to fit the concha and earcanal entrance.

NOTE The laboratory may devise its own band force measuring device or may purchase a suitable unit. Suitable devices are available from Michael and Associates, Inc., State College, PA, or INSPEC Laboratories, Ltd., Salford, UK. Equivalent devices from other sources may be used.

5.3 Devices with adjustable band force

Unless otherwise designated by the requester, devices that include adjustment mechanisms that allow the band force to be varied shall be initially set to the minimum force adjustment prior to being provided to each subject for MIRE testing. When tests are conducted on the ATF, devices shall be set to the visually determined midpoint of their adjustment range.

6 Acoustic test fixture(s) – continuous and impulsive noise methods

6.1 Introduction

An acoustic test fixture or artificial head (ATF) meeting the requirements in this subclause may be used with either the continuous noise or impulsive noise tests described in this standard. One ATF may satisfy the requirements for both methods. However, two differently instrumented ATFs may be required for continuous noise and impulsive noise testing because of the dynamic-range requirements of the impulsive noise method. The ATF shall have two symmetrical simulated ears that include representative pinnae, conchae, and earcanals, with earcanal and circumaural flesh simulations, and two instrumented earcanal couplers. The ATF shall be anthropometrically representative overall with approximately flat surfaces surrounding the pinnae and shall be maintained during fitting and testing at a temperature of 37 ± 2 °C. Annex B contains additional informative materials on ATFs.

6.2 Critical dimensions

The ATF shall have a bitrignon width greater than or equal to 13 cm and less than or equal to 18 cm. It shall have a head height greater than or equal to 12 cm and less than or equal to 15 cm.

6.3 Self insertion loss

The ATF shall have a minimum self insertion loss of 60 dB from 80 Hz to 12.5 kHz when measured using a suitable isolation cup or plug with the flesh simulation of 6.7 absent.

NOTE Self insertion loss is the PIL of the ATF when measured with a simulator of a near-ideal HPD, normally a metal plug or cup that is machined to seal the earcanal. It represents the acoustic leakage through the flanking pathways of the ATF.

6.4 Microphone and preamplifier requirements

6.4.1 Microphone and preamplifier sensitivity and dynamic range

The microphone and preamplifier sensitivity and dynamic range shall be sufficient to meet the signal-to-noise ratio/noise floor, and peak signal measurement handling requirements pertinent to the test in which it is to be used: 8.6.3 and 8.6.4 for continuous noise tests, and 10.2.3 and 10.2.4 for impulsive noise tests. Special attention shall be given to ensure the absence of peak clipping in high-level impulsive noise tests.

Sensitivity of some polarized microphones can be decreased by using a lower polarization voltage (e.g., 28 V instead of 200 V) to effectively increase the maximum sound pressure levels that can be measured. The sensitivity and frequency response of the microphone shall be measured at the polarization voltage used for the test.

Some preamplifiers will have slew rate limitations, especially with long cables. Manufacturer's application notes shall be consulted regarding the effect of cable length, power supply, and peak pressure on the impulse response of the preamplifier and microphone.

6.4.2 Microphone and preamplifier distortion and linearity

The microphone and preamplifier shall demonstrate no more than 5% total distortion over the complete range of peak sound pressure levels up to the maximum level to be tested. For ATFs to be used in continuous noise tests the peak sound pressure level is considered to be 12 dB over the maximum rms sound pressure level to be tested. For ATFs to be used in impulsive noise tests, the requirement for no more than 5% total distortion shall be met at 170 dB SPL. If the maximum levels to be tested are above 170 dB, the microphones shall demonstrate a linear sound pressure to voltage input-output function ± 2 dB over the complete range of sound pressure levels expected in the test or have a calibrated correction to the required linear function.

NOTE This test may be difficult for a facility to conduct. However, the leading vendors of such microphones typically provide this type of calibration service at a reasonable cost.

6.4.3 Microphone calibration

The microphones shall have a calibrated sensitivity and frequency response from 80 Hz to 12.5 kHz. This calibration shall be verified in the 24 months prior to use for testing according to this standard.

6.5 Earcanal couplers

For continuous noise tests, the earcanal couplers shall be in accordance with ANSI/ASA S3.25 occluded ear simulator. For impulsive noise tests each coupler shall be modified to incorporate a 6.35 mm (0.25 in) pressure microphone to satisfy the required dynamic range of 130 dB SPL to 170 dB SPL.

The couplers and ATF shall be maintained at a temperature of 37 ± 2 °C during testing because of the influence of temperature on the dynamic characteristics of elastomeric materials used in earplugs and earmuff cushions.

NOTE The replacement of the 0.50 inch pressure microphone with the 0.25 inch pressure microphone in the ANSI/ASA S3.25 coupler slightly modifies its resonant frequency, but that is unimportant for the purposes of the tests in this standard.

6.6 Earcanal extension

The length of the earcanal extension (added to the ANSI/ASA S3.25 coupler) shall be 14 ± 1 mm, with an inside diameter of 7.5 to 8.0 mm including the flesh simulation in 6.7. The earcanal extension shall be lined with a material in accordance with 6.7, having a thickness of from 1.5 to 3.0 mm.

6.7 Flesh simulation

The ATF shall include flexible pinnae, flexible circumaural bases of sufficient diameter that can fully support earmuff cushions, and a resilient lining in each earcanal. The flesh simulations shall have a Shore 00 durometer reading between 30 and 60 when measured at 37 ± 2 °C (in accordance with the requirements of ASTM D2240). The circumaural material shall be between 5 and 8 mm thick and greater than 120 mm in diameter.

NOTE Due to wear that is experienced by pressure and friction on the earcanal flesh simulation it should be checked periodically for deterioration that might adversely affect insertion loss measurements. This may be accomplished by use of a 20-mm long rigid clear plastic cylindrical earplug whose diameter matches that of the earcanal with a 0.25-mm interference fit, and a reference mark corresponding to a standard insertion depth (8 to 10 mm). The ATF PIL of the clear plastic earplug, inserted to its reference mark, should be periodically measured in accordance with 9.4.3 and 9.5.5, and compared with previous measurements. If a changing insertion loss trend is observed from test to test, or if the earcanal flesh simulation appears degraded, it should be replaced.

7 Continuous noise methods – MIRE test subjects

7.1 Anatomical features

Subjects shall be selected without respect to size and shape of heads, pinnae and earcanals unless the requester indicates that the product is intended for use by specific populations such as children. However, subjects shall be excluded for features or physical disabilities adversely affecting the fitting of hearing protectors, such as might arise from birth defects, ear surgery, or personal adornments.

7.2 Otoscopic inspection

Prior to participation in testing according to this standard, an otoscopic inspection shall determine that subjects' ears are free from conditions that would affect the fit of the hearing protector or a plug used to mount a MIRE microphone, such as excessive cerumen, irritation, or infection. This requirement shall also apply to areas of the pinna and head that would be contacted by the hearing protector being tested.