AUDIOLOGISTS AND ANSI STANDARDS

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Audiologists generally are familiar with the American National Standards Institute (ANSI) standard ANSI S3.6 *American National Standard Specification for Audiometers* that defines the characteristics of audiometers and includes threshold values for air-conduction and bone-conduction. However, there are many other ANSI standards that are also important for audiologists. These standards describe the characteristics of a piece of equipment; describe how that equipment should be used; or provide normative values to be used with the equipment.

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Among the standards used in audiology are standards for audiometric test rooms, audiometers, acoustic immittance devices, the procedures for obtaining pure-tone thresholds, and for the "0" threshold values for various transducers. All of these standards have been developed by volunteers who are either expert in the specific areas or certainly quite knowledgeable about them. Although these standards are not of themselves laws many of them are referred to in laws and regulations and must be used when complying with the requirements of those legal documents. Standards are designed to specify what aspects of a particular piece of equipment should be measured and the required performance characteristics within specified tolerances. In all cases, they serve as a base for checking equipment or for carrying out a test procedure.

Generally, standards are used because they provide a baseline for the manufacturers and users. One then is confident that an individual was tested in the same way, using the same normative values on comparable equipment in other settings that use the same standards. Thus, results can be compared over time with more certainty. Sometimes standards are used because their use is mandated by state or federal legislation. For example, the Occupational Safety and Health Administration (OSHA) requires the use of test rooms that meet specific ambient noise standards and requires the use of ANSI S3.6-1969. A state licensing law may require that audiometers used in testing conform to specific standards. Sometimes standards are mandated by certifying bodies such as the American Speech-Language-Hearing Association (ASHA), the American Board of Audiology (ABA), the Joint Commission on Accreditation of Health Care Organizations (JCAHO), or the Council for Accreditation of Rehabilitative Facilities (CARF).

Although there is no specific federal legislation that states that audiometers must be calibrated to meet the specifications in ANSI 3.6-2004 there may be a state law or Federal regulation that specifies that, in order to test hearing and comply with the regular, an audiometer must meet those requirements.

Most of the standards used in our field are developed under voluntary, consensus standard procedures promulgated by ANSI. It is important to understand first of all, that ANSI is not a Federal agency. It is a federation of organizations interested in establishing voluntary standards for use in industry and elsewhere. It was founded in 1918 as the American Engineering Standards Committee to "ensure that U.S. voluntary standards would be produced in a manner which eliminated or minimized waste, duplication of efforts, and conflicting standards." Around 1928 the American Standards Association was founded. In 1966 its name was changed to the United States of America Standards Institute. Finally, in 1969, it became the American National Standards Institute (ANSI)[1,4]

It is important to understand that ANSI does not develop standards. It uses various committees composed of volunteers to write the standards. ANSI then reviews the process under which the standard was developed and gives its final approval, allowing the standard to be designated an "American National Standard."[2] The American Speech-Language-Hearing Association (ASHA) and the Acoustical Society of America (ASA) are both organizational members of ANSI, although only the ASA is an accredited standards developer. ANSI currently recognizes over 260 standards developing organizations.[3] Most "ANSI standards" that deal with acoustics or aspects of sound—including hearing—are actually developed by the ANSI-Accredited Standards Committee S3, Bioacoustics, which is sponsored by the ASA. That organization has as part of its mission the overseeing of standards dealing with acoustics. It administers the secretariat for standards related to acoustics.

There are currently four Accredited Standards Committees (ASCs) in the Acoustical Society's Standards Program: Accredited Standards Committee ASC S1, Acoustics; ASC S2, Mechanical Vibration and Shock; ASC S3, Bioacoustics; and ASC S12, Noise. Notice that in each case the letter and first numbers of a standard's designation (for example, ANSI S1.1-1994 (R2004)) refer to the committee

Table 1. Selected current ANSI standards for acoustics and acoustical measurement

Designation	Title	Description
ANSI S1.1-1994 (R2004)	American National Standard Acoustical Terminology	Defines terms and symbols used in acoustics, acoustical measurement and electro-acoustics
*ANSI S1.4-1983 (R2006)	American National Standard Specifications for Sound Level Meters.	Describes the characteristics and tolerances of sound level meters
ANSI S1.8-1989 (R2006)	American National Standard Reference Quantities for Acoustical Levels	Provides reference level quantities for acoustical measurements using the International System of Units (SI)
ANSI S1.9-1996 (R2006)	American National Standard Instruments for the Measurement of Sound Intensity	Describes the two microphone method for measuring intensity of sound
ANSI S1.13-2005	American National Standard Measurement of Sound Pressure Levels in Air	Describes the method for measuring sound pressure levels either indoors or outdoors in air.
*ANSI S1.25-1991 (R2007)	American National Standard Specification for Personal Noise Dosimeters	Describes the characteristics of personal dosimeter used for determining noise exposure

** Probably most important for audiologists involved in clinical testing*

Table 2. Selected current ANSI standards related to noise and noise measurement

Designation	Title	Description
AN S12.2-1995 (R1999)	American National Standard Criteria for Evaluating Room Noise	Defines four different sets of criterion curves and gives rules for using them to evaluate room noise.
ANSI S12.3-1985 (R2006)	American National Standard Statistical Methods for Determining and Verifying Stated Noise Emission Values of Machinery and Equipment	Defines the preferred methods for determining and verifying noise emission values for machinery and equipment.
ANSI S12.6-1997 (R2002)	American National Standard Methods for Measuring the Real-Ear Attenuation of Hearing Protectors	Specifies laboratory-based procedures for measuring, analyzing, and reporting the noise-reducing capabilities of conventional passive hearing protection devices. These are psychophysical tests conducted on human subjects to determine the real-ear attenuation measured at hearing threshold.
ANSI S12.7-1986 (R2006)	American National Standard Methods for Measurement of Impulse Noise	Describes methods for measurement of impulse noise and presentation of data. This includes all kinds of impulse noise such as quarry and mining explosions or sonic booms, or from multiple event sources such as pile drivers, riveting, or machine-gun firing.
ANSI S12.13 TR 2002	ANSI Technical Report Evaluating the Effectiveness of Hearing Conservation Programs through Audiometric Data Base Analysis	Provides a procedure for determining how effective a specific hearing conservation program is – using data from audiometric thresholds
ANSI S12.60-2002	American National Standard Acoustical Performance Criteria, Design Requirements and Guidelines for Schools	Gives criteria for ambient noise and reverberation characteristics for various sized classrooms
ANSI S12.65-2006	American National Standard for Rating Noise with Respect to Speech Interference	This standard defines a simple numerical method for rating the expected speech-interfering aspects of noise It uses a single-valued index known as the speech-interference level.
ANSI S12.19-1996 (R2006)	American National Standard Measurement of Occupational Noise Exposure	Presents methods that can be used to measure a individual person's noise exposure received in a work place.
ANSI S12.42-1995 (R2004)	American National Standard Microphone-in-Real-Ear and Acoustic Test Fixture Methods for the Measurement of Insertion Loss of Circumaural Hearing Protection Devices	Describes the microphone-in-real-ear and the acoustic test fixture methods for the measurement of the insertion loss of circumaural earmuffs, helmets, and communications headsets.

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Table 3. Selected current ANSI bioacoustics standards (for audiometric equipment and audiometric testing)

Designation	Title	Description
*ANSI S3.1-1999 (R2003)	American National Standard Maximum Permissible Ambient Noise for Audiometric Test Rooms	Gives levels of ambient sound that will allow testing with or without ears covered to "0" HL.
ANSI S3.2-1989 (R1999)	American National Standard Method for Measuring the Intelligibility of Speech over Communication Systems	Gives word lists that can be used to assess communication systems (might be used to test clients as well)
ANSI S3.4- 2005	American National Standard Procedure for the Computation of Loudness of Steady Sound	Allows for determination of loudness of octave or third octave noise – provides formula and tables of equal loudness. Accompanying software may be used to perform the calculation.
ANSI S3.5-1997 (R2007)	American National Standard Methods for Calculation of the Speech Intelligibility Index	A method for computing a number that correlates well with speech intelligibility testing by normal hearing persons – uses spectrum and noise
*ANSI S3.6-2004	American National Standard Specification for Audiometers	Presents all aspects of the standards for audiometers including distortion, allowable frequencies, and values for "0"HL for various transducers, etc.
ANSI S3.7-1995 (R2003)	American National Standard Method for Coupler Calibration of Earphones	This describes various 6.0 cm^3 and 2.0 cm^3 couplers and how to use them with various earphones
*ANSI S3.13-1987 (R2002)	American National Standard Mechanical Coupler for Measurement of Bone Vibrators	This gives the requirements for mechanical couplers (sometimes called artificial mastoids) used in calibrating bone vibrators
ANSI S3.20-1995 (R2003)	American National Standard Bioacoustical Terminology	A dictionary for bioacoustical terminology
*ANSI S3.21- 2004	American National Standard Methods for Manual Pure-Tone Threshold Audiometry	Describes the preferred procedure for pure-tone threshold testing (ascending)
*ANSI S3.22- 2003	American National Standard Specification of Hearing Aid Characteristics	Describes basic procedures for checking air conduction hearing aids – including distortion measures and battery life
ANSI S3.25-1989 (R2003)	American National Standard American National Standard for an Occluded Ear Simulator	This is essentially a description of a device designed to simulate the acoustical behavior of the ear canal (Including impedance)
*ANSI S3.35- 2004	American National Standard Method of Measurement of Performance Characteristics of Hearing Aids Under Simulated Real-Ear Working Conditions	Describes techniques for measuring hearing aids in simulated conditions of use – that is when the aid is actually worn
ANSI S3.36-1985 (R2006)	American National Standard Specification for a Manikin for Simulated *in-situ* Airborne Acoustic Measurements	Describes the head and torso of a manikin that can be used to measure hearing aids
ANSI S3.37-1987 (R2007)	American National Standard Preferred Earhook Nozzle Thread for Postauricular Hearing Aids	An attempt to bring uniformity to the earhooks used with postauricular hearing aids
*ANSI S3.39-1987 (R2007)	American National Standard Specifications for Instruments to Measure Aural Acoustic Impedance and Admittance (Aural Acoustic Immittance)	Describes the instrument used for measurement of acoustic immittance – classifies 4 types of instruments
*ANSI S3.42-1992 (R2007)	American National Standard Testing Hearing Aids with a Broad-Band Noise Signal	Describes characteristics of a broad band noise used for assessing hearing aids and how it can be used
ANSI S3.44-1996 (R2006)	American National Standard Determination of Occupational Noise Exposure and Estimation of Noise-Induced Hearing Impairment	Gives procedures other than the ISO recommended 3 dB doubling rule – also may be applied to calculation of risk of incurring a hearing handicap following daily noise exposure
*ANSI S3.45-1999	American National Standard Procedures for Testing Basic Vestibular Function	Describes 6 different tests for evaluating vestibular function
*ANSI S3.46-1997 (R2002)	American National Standard Methods of Measurement of Real-Ear Performance Characteristics of Hearing Aids	Defines the terms and procedures used for real-ear measurement of hearing aids

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that developed it (S1, S2, S3, or S12). The number after the decimal is the number of the standard itself, the next number is the year in which the standard was developed or last revised. The number following the letter R is the year in which the standard was reaffirmed. Standards are reviewed on a regular basis but not always changed. For example, the indication (R 2004) allows us to know that the standard was reviewed by the committee responsible for it in 2004 and found to be suitable for continued use as of that date.

It is beyond the purview of this article to describe *all* the ANSI standards related to acoustics and hearing that have been developed. However, the annotated tables list the standards that are most likely to be of interest to audiologists. Table 1 lists those related to equipment used to measure or test equipment that might be used in hearing testing. Table 2 lists those standards related to hearing conservation that might be used by audiologists and Table 3 lists the standards that are most likely to be used by audiologists in clinical settings.

These tables do **not** list all of the standards but a complete listing can be found on the ASA web page at (http://asa.aip.org). After accessing the ASA home page, use the link to the "ASA Store." This site lists all of the standards in each area, provides a brief description, and allows one to purchase the standards online for immediate downloading. (Printed copies of documents may be ordered from the Standards Office.) This site also lists International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) standards that may be purchased through the Acoustical Society. For further information about other applicable standards (such as ISO and IEC) see Wilber, 2004.**AT**

References for further reading

1 W. Melnick, "What is the American National Standards Institute," ASHA **10**, 418–421 (1973).

2 American National Standards Institute (ANSI), "Purpose," http://www.ansi.org/about_ansi/overview/overview.aspx?menuid=1 (retrieved June 25, 2007).

3 American National Standards Institute, List of Member Organizations, https://eseries.ansi.org/Source/directory/ (retrieved June 25, 2007).

4 Laura Ann Wilber, "What are standards–and Why do I care?," in *Seminars in Hearing–Current Topics in Audiology: A Tribute to Tom Tillman* (Thieme, New York, 2004) pp 81-92.

Laura Ann Wilber received a Bachelor's degree from the University of Southern Mississippi in Speech Correction; a Master's from Gallaudet in Deaf Education; and a doctorate in audiology under Raymond Carhart from Northwestern University. After completing her doctorate she moved to the University of California, Los Angeles (UCLA), to do research with Victor Goodhill. Later she moved to New York to serve as the Director of the Speech and Hearing Clinic at Albert Einstein College of Medicine. Dr. Wilber was professor of Audiology at Northwestern University from 1978 until she retired in 2002. She served on the environmental control board in New York City as the "Noise Expert," and has represented the United States on various International Organization for Standardization (ISO) working groups related to bioacoustics since 1977. She has been a member of several American National Standards Institute (ANSI) working groups and served as chair of Standards Committee S3. Dr. Wilbur also served as president of the American Speech-Language-Hearing Association (ASHA). She is currently professor emeritus at Northwestern University.