

ANSI S3.46-1997

AMERICAN NATIONAL STANDARD
**METHODS OF MEASUREMENT
OF REAL-EAR PERFORMANCE
CHARACTERISTICS OF HEARING AIDS**

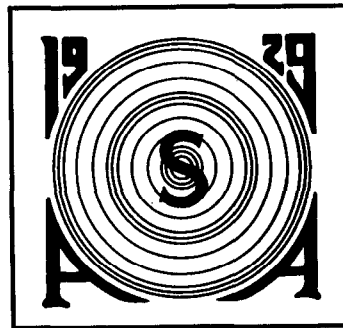
ANSI S3.46-1997

Accredited Standards Committee S3, Bioacoustics

Standards Secretariat
Acoustical Society of America
120 Wall Street, 32nd Floor
New York, New York 10005-3993

The American National Standards Institute, Inc. (ANSI) is the national coordinator of voluntary standards development and the clearing house in the U.S. for information on national and international standards.

The Acoustical Society of America (ASA) is an organization of scientists and engineers formed in 1929 to increase and diffuse the knowledge of acoustics and to promote its practical applications.



ANSI S3.46-1997

American National Standard

**Methods of Measurement of Real-Ear Performance
Characteristics of Hearing Aids**

Secretariat

Acoustical Society of America

Approved 22 July 1997

American National Standards Institute, Inc.

Abstract

This Standard provides definitions for terms used in the measurement of real-ear performance characteristics of hearing aids, provides procedural and reporting guidelines and identifies essential characteristics to be reported by the manufacturer of equipment used for this purpose. Acceptable tolerances for the control and measurement of sound pressure levels are indicated. Where possible, sources of error have been identified and suggestions provided for their management.

AMERICAN NATIONAL STANDARDS ON ACOUSTICS

The Acoustical Society of America (ASA) provides the Secretariat for Accredited Standards Committees S1 on Acoustics, S2 on Mechanical Vibration and Shock, S3 on Bioacoustics, and S12 on Noise. These committees have wide representation from the technical community (manufacturers, consumers, and general-interest representatives). The standards are published by the Acoustical Society of America through the American Institute of Physics as American National Standards after approval by their respective standards committees and the American National Standards Institute.

These standards are developed and published as a public service to provide standards useful to the public, industry, and consumers, and to Federal, State, and local governments.

Each of the Accredited Standards Committees [operating in accordance with procedures approved by American National Standards Institute (ANSI)] is responsible for developing, voting upon, and maintaining or revising its own standards. The ASA Standards Secretariat administers committee organization and activity and provides liaison between the Accredited Standards Committees and ANSI. After the standards have been produced and adopted by the Accredited Standards Committees, and approved as American National Standards by ANSI, the ASA Standards Secretariat arranges for their publication and distribution.

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered and that a concerted effort be made towards their resolution.

The use of American National Standards is completely voluntary. Their existence does not in any respect preclude anyone, whether he or she has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

NOTICE: This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this Standard.



Standards Secretariat
Acoustical Society of America
120 Wall Street, 32nd Floor
New York, New York 10005-3993

Telephone: +1 212 248 0373
Telefax: +1 212 248 0146
E-mail: asastds@aip.org

© 1998 by the Acoustical Society of America. This Standard may not be reproduced in whole or in part in any form for sale, promotion, or any commercial purpose, or any purpose not falling within the provisions of the Copyright Act of 1976, without prior written permission of the publisher. For permission, address a request to the Standards Secretariat of the Acoustical Society of America.

Contents

	Page
Foreword	iii
0 Introduction	1
1 Scope, purpose, and applications	1
1.1 Scope	1
1.2 Purpose	1
1.3 Applications	1
2 References	1
2.1 Normative references	1
2.2 Informative references	2
3 Definition of terms	2
3.1 Definition of terms relating to the sound field	2
3.2 Definition of terms relating to the subject	3
3.3 Definition of terms relating to the stimulus	3
3.4 Definition of terms relating to measurement and analysis	4
4 Test equipment	5
4.1 Test space	5
4.2 Sound source	5
4.3 Equipment for the measurement of SPL or BSPL	6
5 Test conditions	7
5.1 Reporting of test parameters	7
5.2 Ambient conditions	7
5.3 Choice of test point	7
5.4 Location of the operator	7
5.5 Location of the subject	7
5.6 Location of the hearing aid	7
5.7 Operating conditions for the hearing aid	7
6 Recommended measurement procedures	8
6.1 Calibration	8
6.2 Inspection of the ear canal	8
6.3 Equalization	8
6.4 Choice of stimulus level	8
6.5 Choice of measurement point	8
6.6 Real-ear unaided response (REUR) or real-ear unaided gain (REUG)	8
6.7 Real-ear occluded response (REOR) or real-ear occluded gain (REOG)	9
6.8 Real-ear aided response (REAR) or real-ear aided gain (REAG)	9
6.9 Real-ear insertion gain (REIG)	9
Figure	
1 Subject and sound source references	2
Annexes	
A Characteristics of acoustic stimuli	10
A1 Introduction	10

	Page
A2 Narrow-band stimuli	10
A3 Broad-band stimuli	10
B Locating the probe microphone sound inlet at the measurement point	12
B1 Introduction	12
B2 Visually-assisted positioning	12
B3 Acoustically-assisted positioning	12
B4 Acoustical positioning	12
B5 Geometrical positioning	13

Foreword

[This Foreword is for information only and is not an integral part of *American National Standard*, ANSI S3.46-1997.]

This Standard was developed under the jurisdiction of Accredited Standards Committee S3, Bioacoustics, which has the following scope:

Standards, specifications, methods of measurement and test, and terminology, in the fields of psychological and physiological acoustics, including aspects of general acoustics, shock and vibration which pertain to biological safety, tolerance, and comfort.

At the time this standard was submitted to Accredited Standards Committee S3, Bioacoustics, for final approval, the membership was as follows:

T. Frank, *Chair*
R. F. Burkard, *Vice Chair*
A. Brenig, *Secretary*

Acoustical Society of America	T. Frank R. F. Burkard (<i>Alt.</i>)
American Academy of Otolaryngology, Head and Neck Surgery, Inc	G. Gates L. A. Michael (<i>Alt.</i>)
American Association of Speech-Language Pathology and Audiology	J. D. Royster M. E. Thompson (<i>Alt.</i>)
American College of Occupational and Environmental Medicine	P. J. Brownson J. Sataloff (<i>Alt.</i>)
American Industrial Hygiene Association	L. H. Royster J. F. Meagher (<i>Alt.</i>)
American Otological Society, Inc.	R. F. Naunton
AT&T	R. M. Sachs M. S. Mayer (<i>Alt.</i>)
Audio Engineering Society	R. H. Campbell M. R. Chial (<i>Alt.</i>)
Hearing Industries Association (HIA)	S. Armstrong C. Rogin (<i>Alt.</i>)
Industrial Safety Equipment Association (ISEA)	D. K. Shipp
International Hearing Society	P. Mercola
National Institute of Standards and Technology	E. D. Burnett V. Nedzelnitsky (<i>Alt.</i>)
Power Tool Institute, Inc	G. Rescigno M. Brown (<i>Alt.</i>)
U.S. Air Force	R. McKinley
U.S. Army Aeromedical Research Laboratory	B. Mozo
U.S. Army Human Research & Engineering Directorate	G. Garinther G. R. Price (<i>Alt.</i>)
U.S. Army Audiology and Speech Center	R. Danielson
U.S. Navy Environmental Health Center	J. Page L. Marshall (<i>Alt.</i>)

Individual experts of Accredited Standards Committee S3, Bioacoustics, were:

J. R. Bareham	R. S. Gales	J. D. Royster
S. J. Barry	W. J. Galloway	L. H. Royster
R. W. Benson	R. M. Guernsey	H. E. von Gierke
A. J. Brammer	D. L. Johnson	D. E. Wasserman
D. D. Dirks	K. D. Kryter	L. A. Wilber
K. M. Eldred	H. Levitt	W. A. Yost
L. S. Finegold	R. L. McKinley	R. W. Young
J. L. Fletcher		

Working Group S3/WG80, Probe-Tube Measurements of Hearing Aid Performance, which assisted Accredited Standards Committee S3, Bioacoustics, in the preparation of this Standard, had the following membership:

W. A. Cole, *Chair*

J. Agnew	D. Hotvet	V. Nedzelnitsky
R. Brander	B. Kruger	D. A. Preves
L. B. Beck	F. M. Kruger	L. J. Revit
E. D. Burnett	I. Leonard	C. Schweitzer
G. J. Frye	P. Mercola	R. F. Sullivan

Suggestions for improvement will be welcomed. Send suggestions for improvement to Accredited Standards Committee S3, Bioacoustics, in care of the ASA Standards Secretariat, 120 Wall Street, 32nd floor, New York, New York 10005-3993, USA, Telephone: + 1 212 248 0373, FAX: + 1 212 248 0146, E-mail: asastds@aip.org.

American National Standard

Methods of Measurement of Real-Ear Performance Characteristics of Hearing Aids

0 Introduction

The performance characteristics of hearing aids in real ears can differ significantly from those determined in accordance with standards such as ANSI S3.22-1996 [1] and ANSI S3.35-1985 (R 1997) [5], because of differing acoustic input and loading conditions presented by individual real ears. [Numbers within brackets refer to references in 2.1]. Measuring methods that take into account the acoustic coupling and the influence of the individual wearer on the acoustic signal and the performance of hearing aids are therefore important in the fitting of these devices. Such measurement methods have come to be known as "real-ear measurements" and are sometimes performed clinically in less than ideal acoustic environments. The accuracy and repeatability of measurements made under such conditions are complex functions of sound-field uniformity, the nature of the stimulus and background noise, the hearing aid under evaluation, the method of stimulus control, the location of the sound source, the nature of the data acquisition, analysis and presentation and the degree of subject movement permitted. This standard addresses these issues by providing terminology for procedures and equipment, by recommending measurement methods and reporting requirements and by identifying key equipment parameters and acceptable tolerances.

NOTE - Throughout this standard, the term "real ear" is used to emphasize the fact that these measurements are made in the ear canal of a human subject.

1 Scope, purpose, and applications

1.1 Scope

This standard covers the terminology, procedures and essential equipment characteristics for the measurement of the acoustic output and acoustic

gain of hearing aids with integral microphones, coupled to human ears, in a variety of acoustic environments. These measurements may be divided into two classes: (a) direct measures of sound pressure level (SPL) and (b) insertion measurements. Direct measures (previously called *in situ* measurements) report SPL developed in an ear canal, with or without a hearing aid in place and may also be expressed as dB gain relative to the SPL at a field reference point. Insertion measurements report ear canal SPL with a hearing aid in place relative to the ear canal SPL without the hearing aid.

The insertion measurement method recommended in this standard yields a Real-Ear Insertion Gain (REIG) (previously called Real-Ear Insertion Response). The direct measurement methods recommended in this standard yield the following characteristics: (1) Real-Ear Unaided Response (REUR), (2) Real-Ear Unaided Gain (REUG), (3) Real-Ear Occluded Response (REOR), (4) Real-Ear Occluded Gain (REOG), (5) Real-Ear Aided Response (REAR), and (6) Real-Ear Aided Gain (REAG).

1.2 Purpose

The purpose of this Standard is to assist those making or interpreting the results of real-ear performance measurements of hearing aids by promoting consistency in terminology, procedures and equipment specification.

1.3 Applications

Applications of this Standard include the selection, ordering and fitting of hearing aids, the collection and reporting of research data, and the selection of equipment used for the measurement of real-ear performance characteristics of hearing aids. Unless otherwise stated, the measurements and requirements in this Standard apply to a minimum frequency range of 200–6000 Hz.

2 References

2.1 Normative references

The following Standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National