
ANSI TECHNICAL REPORT

Evaluating the Effectiveness of Hearing Conservation Programs through Audiometric Data Base Analysis

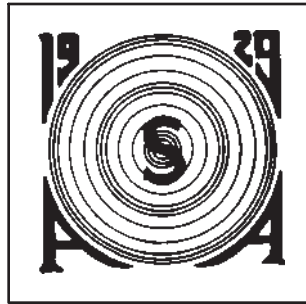
ANSI S12.13 TR-2002

Accredited Standards Committee S12, Noise

Acoustical Society of America
Standards Secretariat
1305 Walt Whitman Road, Suite 300
Melville, New York 11747

The American National Standards Institute, Inc. (ANSI) is the national coordinator of voluntary standards development and the clearinghouse in the U.S.A. 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 Technical Report

Evaluating the Effectiveness of Hearing Conservation Programs through Audiometric Data Base Analysis

Secretariat

Acoustical Society of America

ANSI Technical Report Registered: 26 August 2002

American National Standards Institute, Inc.

ABSTRACT

This ANSI Technical Report describes methods for evaluating the effectiveness of hearing conservation programs in preventing occupational noise-induced hearing loss by using techniques for audiometric data base analysis. The rationale is given for using the variability of threshold measurements in annual monitoring audiograms as the basis for judging effectiveness. Guidelines are discussed concerning how to select a restricted data base to which the analysis procedures will be applied. Specific procedures for data analysis are defined, and criterion ranges are given for classifying program effectiveness as acceptable, marginal, or unacceptable. Sample results for industrial audiometric data bases contributed to Working Group S12/WG12 are included as an annex for reference and illustration.

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, trade associations, general-interest and government 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 toward their resolution.

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

NOTICE: This Technical Report 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 a standard.



Standards Secretariat
Acoustical Society of America
35 Pinelawn Road, Suite 114E
Melville, New York 11747-3177
Telephone 631-390-0215
FAX 631-390-0217
E-mail asastds@aip.org

© 2002 by the Acoustical Society of America. This technical report 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	iv
0 Introduction	1
0.1 Need	1
0.2 Rationale	1
0.3 Alternative Approaches	1
0.4 Brief Historical Review	2
0.5 Report Development Process	2
0.6 Benefits of ADBA	2
0.6.1 Enhancing Prevention of Noise-Induced Hearing Loss	2
0.6.2 Providing Cost-Effective Data for Regulatory Compliance	3
0.6.3 Guiding Internal Management Decisions	3
0.6.4 Motivating Workers and Supervisors	4
1 Scope, purpose and applications	4
1.1 Scope	4
1.2 Purpose	4
1.3 Applications	4
1.3.1 Assumptions	4
1.3.1.1 Effective Hearing Conservation Program	4
1.3.1.2 Audiometric Variability as an Indicator	4
1.3.1.3 Analysis of a Restricted Data Base	5
1.3.1.4 Reliance on ADBA Results	5
1.3.1.5 Interpretation of Undesirable Results	5
1.3.2 Data Requirements	5
1.3.2.1 Annual Audiometry	5
1.3.2.2 Constant Restricted Population	5
1.3.2.3 Minimum Number of Audiograms	5
1.3.2.4 Representative Restricted Population	5
1.3.2.5 Minimum Size of Restricted Population	5
1.3.2.6 Identification of Obvious Contaminants in the Data	5
1.3.2.7 Audiometric Testing During Workshifts	6
2 References	6
3 Definitions	7
4 Recommended ADBA Statistics	7
4.1 Procedures	7
4.2 Criterion Ranges	7
5 Implementing the Procedures	7
5.1 Selecting the Restricted Data Base	7
5.1.1 Early Tests	8
5.1.2 Later Tests	8
5.2 Examining the Data for Contamination	8
5.3 Applying the ADBA Procedures	8
5.3.1 Percent Worse Sequential (%W_s)	8
5.3.2 Percent Better or Worse Sequential (%BW_s)	8
6 Interpreting the Results	9
6.1 Classifying HCP Effectiveness	9
6.2 Identifying Sources of High Variability	9

Annexes

A	Population Comparison ADBA Techniques	9
A.1	Comparisons at One Point in Time	9
A.2	Comparisons of Longitudinal Hearing Level Trends	10
A.3	References	10
B	Rates of OSHA STS as an Indicator	10
B.1	Common Use of STS Rates	10
B.2	Reasons for Excluding STS Rates from this Report	10
B.3	References	10
C	Research Performed by S12/WG12	11
C.1	Data Tape Availability	11
C.2	Procedures Evaluated	11
C.3	Recommended Procedures	12
C.4	Data Base Comparisons Used to Define Criterion Ranges	12
C.5	Defining the Criterion Ranges	13
C.6	Conclusions and Recommendations	13
C.7	References	13
D	Analysis Example	17

Tables

Table 1	Criterion ranges (in percent) for rating HCP performance using the values of the statistics Percent Worse Sequential (%W _s) and Percent Better or Worse Sequential (%BW _s)	7
Table D1	Steps in implementing ADBA	17
Table D2	Example of determining whether an individual employee will be included in the Percent Worse sequential (%W _s) and Percent Better or Worse sequential (%BW _s) statistics in each of three sequential test comparisons	17

Figures

Fig. 1	Sequence of events in a worker's noise exposure history showing how ADBA indicates an inadequate degree of employee protection before a confirmed OSHA STS develops	3
Fig. C1	Distribution of %W _s values in sequential comparisons of tests 1-4	14
Fig. C2	Distribution of %W _s values in sequential comparisons of tests 5-8	14
Fig. C3	Distribution of %BW _s values in sequential comparisons of tests 5-8	14
Fig. C4	Distribution of percent AAO-HNS shifts in sequential comparisons of tests 1-4	14
Fig. C5	Distribution of percent AAO-HNS shifts in sequential comparisons of tests 5-8	14
Fig. C6	Distribution of standard deviations of differences in HTLs at single audiometric test frequencies in sequential comparisons of tests 1-4 for control data bases	14
Fig. C7	Distribution of standard deviations of differences in HTLs at single audiometric test frequencies in sequential comparisons of tests 5-8 for control data bases	15
Fig. C8	Distribution of standard deviations of differences in HTLs at single audiometric test frequencies in sequential comparisons of tests 1-4 for non-control data bases	15
Fig. C9	Distribution of standard deviations of differences in HTLs at single audiometric test frequencies in sequential comparisons of tests 5-8 for non-control data bases	15
Fig. C10	Distribution of standard deviations of differences in HTLs at averaged audiometric test frequencies in sequential comparisons of tests 1-4 for control data bases	15
Fig. C11	Distribution of standard deviations of differences in HTLs at averaged audiometric test frequencies in sequential comparisons of tests 5-8 for control data bases	16
Fig. C12	Distribution of standard deviations of differences in HTLs at averaged audiometric test frequencies in sequential comparisons of tests 1-4 for non-control data bases	16
Fig. C13	Distribution of standard deviations of differences in HTLs at averaged audiometric test frequencies in sequential comparisons of tests 5-8 for non-control data bases	16
Fig. D1	Mean hearing levels on the latest audiogram for noise exposure groups subdivided by race	18
Fig. D2	Mean hearing levels at 2-6 kHz on the most recent five approximately annual audiograms for noise-exposed subjects, as a function of mean age at the time of each test	19
Fig. D3	Mean hearing levels at 2-6 kHz on the most recent five approximately annual audiograms for non-noise-exposed subjects, as a function of mean age at the time of each test	19
Fig. D4	Percent Worse sequential results over the most recent four test comparisons for noise-exposed and non-noise-exposed groups	20
Fig. D5	Percent Better or Worse sequential results over the most recent four test comparisons for noise-exposed and non-noise-exposed groups	20

FOREWORD

[This foreword is for information only and is not an integral part of ANSI S12.13 TR - 2002 *ANSI Technical Report Evaluating the Effectiveness of Hearing Conservation Programs through Audiometric Data Base Analysis*]

This ANSI Technical Report is a revision of Draft American National Standard S12.13-1991, which was published for a period of trial use and comment regarding the validity and usefulness of the recommended procedures for evaluating the effectiveness of hearing conservation programs (HCPs) through audiometric data base analysis (ADBA), and later unsuccessfully balloted for approval as a full standard. The ADBA procedures described are those recommended by the members of S12 Working Group 12 (S12/WG12) based on the results from their original research in applying suggested procedures to actual audiometric data bases (see Annex C), as well as the additional experience and feedback obtained from S12/WG12 members and other interested users following publication of the draft standard.

In spite of the unsuccessful ballot to convert the draft standard to a full standard, S12 deemed the contents of the document of substantial value for the hearing conservation community, and hence decided to publish them for guidance as an ANSI Technical Report. The substantive negative comments during the balloting involved the following issues:

- a) the possibility that gradual hearing loss in excess of that due to aging may occur in subgroups of the population evaluated in spite of acceptable ADBA criteria results on a year-to-year basis,
- b) objections to the year-to-year nature of ADBA evaluations, which intentionally provide a set of indicators with values that vary annually to reflect current HCP status changes to alert personnel to incipient problems (in contrast to a single overall indicator across a long period of time),
- c) concern that an inadequate selection of restricted groups for analysis by the evaluator might lead to failure to detect that different subgroups of the HCP population may show lesser degrees of protection from noise than the group selected for analysis,
- d) the derivation of the numerical ranges for the criteria,
- e) the fact that this results-oriented method does not address failures of omission by the HCP (such as failure to identify and include all noise-exposed individuals in the program) or failures of implementation by the HCP (such as failure to provide annual educational programs).

The Working Group chair did not elect to pursue reversal of the negative votes because the scope of changes desired by negative voters would have fundamentally altered the nature of the document. The ADBA method was developed as a tool for evaluating HCP effectiveness in terms of audiometric data variability from year to year. Other types of methods that reflect cumulative hearing loss over time are briefly described in Annexes A and B, but the intent of this document was to describe only the ADBA method.

Publication of this ANSI Technical Report has been approved by the Acoustical Society of America. This document is registered as a Technical Report in a series of publications according to the Procedures for the Registration of ANSI Technical Reports. This document is not an American National Standard and the material contained herein is not normative in nature. Comments on the content of this document should be sent to the following address:

Acoustical Society of America
Standards Secretariat
35 Pinelawn Road, Suite 114E
Melville, New York 11747-3177
Tel: 631-390-0215
Fax: 631-390-0217
E-Mail: asastds@aip.org

This ANSI Technical Report was developed under the jurisdiction of Accredited Standards Committee S12, Noise, which has the following scope:

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.

At the time this ANSI Technical Report was submitted to Accredited Standards Committee S12, Noise, for final approval, the membership was as follows:

P.D. Schomer, *Chair*
R.D. Hellweg, *Vice Chair*
S. Blaeser, *Secretary*

Abbott Labs	.D. Walton, B.Muto (Alt.)
Acoustical Society of America (ASA)	.B.M. Brooks, W.J. Galloway (Alt.)
Air-conditioning & Refrigeration Institute	.R. Seel, M. Darbeau (Alt.)
Aluminum Company of America (ALCOA)	.W.D. Gallagher
American Academy of Otolaryngology–Head & Neck Surgery, Inc. (AAO–HNS)	.R.A. Dobie, L.A. Michael (Alt.)
American Industrial Hygiene Association (AIHA)	.D. Driscoll, J. Banach (Alt.)
American Otological Society (AOS)	.R.F. Naunton
American Speech-Language-Hearing Assoc. (ASHA)	.G. Linn, R. Levinson (Alt.)
Audio Engineering Society, Inc. (AES)	.M.R. Chial, D. Queen (Alt.)
Brüel & Kjaer Instruments, Inc.	.M. Alexander, J. Chou (Alt.)
Caterpillar, Inc.	.K.G. Meitl, D. Roley (Alt.)
Compressed Air and Gas Institute	.J.H. Addington, D.R. Bookshar (Alt.)
Council for Accreditation in Occupational Hearing Conservation (CAOHC)	.R.D. Bruce, E.H. Berger (Alt.)
E-A-R/Aearo Company	.E.H. Berger
Howard Leight Industries	.V. Larson, E. Woo (Alt.)
Information Technology Industry Council (ITI)	.R.D. Hellweg, W.H. Johnson (Alt.)
Institute of Noise Control Engineering (INCE)	.B. Tinianov, M. Lucas (Alt.)
International Safety Equipment Association (ISEA)	.J. Birkner, J.C. Bradley (Alt.)
James, Anderson & Associates (JAA)	.L.D. Hager, R.R. Anderson (Alt.)
Larson-Davis, Inc.	.L. Davis, L. Harbaugh (Alt.)
National Council of Acoustical Consultants (NCAC)	.J. Erdreich
National Hearing Conservation Association (NHCA)	.K. Michael
Noise Pollution Clearinghouse	.L. Blomberg
North American Insulation Manufacturers Association	.R. Godfrey, R. Moulder (Alt.)
Power Tool Institute, Inc.	.S. Broadbent, J. Nosko (Alt.)