ANSI/ASA S3.45-2009
(Revision of ANSI S3.45-1999)
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AMERICAN NATIONAL STANDARD

Procedures for Testing Basic Vestibular Function

ANSI/ASA S3.45-2009

Accredited Standards Committee S3, Bioacoustics

Standards Secretariat
Acoustical Society of America
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Procedures for Testing Basic Vestibular Function

Secretariat:

Acoustical Society of America

Approved January 8, 2009:

American National Standards Institute, Inc.

Abstract

This Standard defines procedures for performing and reporting a battery of tests for the evaluation of human vestibular function. Six different tests are specified. Stimuli are presented to evoke eye movement by a subject whose response is determined either by measurement of electrical signals generated by the eye movements or by image processing methods applied to video eye movements. The Standard specifies test procedures, measurements, data analysis, and data reporting requirements. These tests, including the data analysis and reporting procedures, are called the Basic Vestibular Function Test Battery. Test interpretation is not a part of this Standard.

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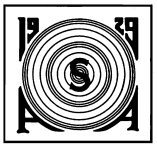

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Foreword

[*This Foreword is for information only, and is not a part of the American National Standard ANSI/ASA S3.45-2009 American National Standard Procedures for Testing Basic Vestibular Function.*]

This standard comprises a part of a group of definitions, standards, and specifications for use in bioacoustics. It was developed and approved by Accredited Standards Committee S3, Bioacoustics, under its approved operating procedures. Those procedures have been accredited by the American National Standards Institute (ANSI). The Scope of Accredited Standards Committee S3 is as follows:

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

This standard is a revision of ANSI S3.45-1999, which has been technically revised. An alternate means for the measurement of eye movements using video-oculography (VOG) has been added, since this method has advantages of being less invasive, and can be used to display and measure torsional eye movements that are not possible with electro-oculography.

A 5-year exception to the standard, which permitted use of older computerized equipment which sampled ENG signals at 50 samples per second, was eliminated since current technology is capable of supporting the 100-sample-per-second rate specified in the standard.

The issues that needed to be addressed before the use of air as a medium for caloric irrigations could be incorporated into the standard have been added in an informative annex.

One normative reference was added in Clause 2, and additional informative resources were added to the bibliography, primarily regarding the use of video-oculography.

This standard is not comparable to any existing ISO Standard.

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

C.A. Champlin, *Chair*

R.F. Burkard, *Vice-Chair*

S.B. Blaeser, *Secretary*

Acoustical Society of America ..... C.A. Champlin
..... R.F. Burkard (Alt.)

American Academy of Audiology ..... .Y. Szymko-Bennett
.....D.A. Fabry (Alt.)

American Academy of Otolaryngology, Head and Neck Surgery, Inc.…… .....R.A. Dobie
.....L.A. Michael (Alt.)

American Industrial Hygiene Association ..... T.K. Madison
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..... R. Scicluna (Alt.)

Frye Electronics, Inc. ..... G.J. Frye
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National Hearing Conservation Association ..... T. Schulz

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..... W.J. Murphy (Alt.)

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Quest Technologies, Inc. ..... M. Wurm
..... P. Battenberg (Alt.)

Starkey Laboratories ..... D.A. Preves
..... T. Burns (Alt.)

U.S. Air Force ..... R. McKinley

U.S. Army Aeromedical Research Lab ..... W. Ahroon
..... Vacant (Alt.)

U.S. Army CERL ..... L. Pater
..... D. Delaney (Alt.)

U.S. Army Research Laboratory, Human Research and Engineering Directorate ..... T.R. Letowski
..... P. Henry (Alt.)

Individual Experts of the Accredited Standards Committee S3, Bioacoustics, were:

J.R. Bareham	T. Frank	P.D. Schomer
A.J. Brammer	K.D. Kryter	L.A. Wilber
A.J. Campanella	R. McKinley	W.A. Yost

Working Group S3/WG 82, Basic Vestibular Function Test Battery, which assisted Accredited Standards Committee S3, Bioacoustics, in the development of this standard, had the following membership.

C. Wall, III, Chair

R. Burkard
J.M. Furman
R. Miles
E.M. Monsell
N.T. Shepard

Suggestions for improvements of this standard will be welcomed. They should be sent to Accredited Standards Committee S3, Bioacoustics, in care of the Standards Secretariat of the 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.

Introduction

The vestibular system provides information related to a person's orientation in space using information from five organs in each inner ear. Three of these organs sense angular acceleration in approximately orthogonal planes, while two sense linear acceleration and gravity. This peripheral information is integrated with that of other senses, including vision and proprioception, to give information about the orientation of the individual in space and to allow for appropriate compensatory reflexive movements. These reflexes can adapt in ways that enhance a person's ability to cope with changing conditions.

Two major reflexes involved are the vestibulo-ocular reflex and the vestibulo-spinal reflex. The former allows one to keep visual objects of interest stable on the retina while the person is in motion. The latter allows one to maintain postural stability when subjected to motion. These reflexive movements can be used to evaluate the response to vestibular stimuli. This Standard utilizes the vestibulo-ocular reflex as its basis for test procedures.

A variety of test methods has been used in clinical and research evaluations of vestibular function. Some require relatively modest test equipment; others require relatively complex and expensive mechanical equipment. Lack of standardization in test protocols and data reporting often makes comparison of data between facilities and test conductors difficult. The goal of this Standard is to specify a battery of tests that use defined stimuli, data collection and recording methods, data analysis procedures, and data reporting requirements.

Depending on the system used to measure the movement in the eyes, the test battery is commonly known as "Electronystagmography" or "Videonystagmography." Electronystagmography (ENG) measures eye movements using the method of electro-oculography (EOG). In this method, skin-mounted electrodes measure changes in potentials across the eyeball due to movement of the eye in its socket. The corneal retinal potential is the source of the measured voltage. Videonystagmography (VNG) measures eye movements using video-oculography (VOG). In this method images of the eyes from video cameras are processed to give two dimensional (2D) or three dimensional (3D) eye position estimates. For VNG, 2D (horizontal and vertical) eye movements are typically provided, although some systems can also provide torsional eye movement estimates.

Use of the Standard will greatly facilitate comparison of data among different clinical settings as well as between these data and the data from research laboratories.

American National Standard

Procedures for Testing Basic Vestibular Function

1 Scope, purpose, and applications

1.1 Scope

1.1.1 General

This Standard specifies procedures for conducting six separate tests, which, together with the data analysis and reporting requirements specified in this Standard, constitute the Basic Vestibular Function Test Battery. The six tests cover:

(a) spontaneous nystagmus (see 5.2);

(b) gaze-evoked nystagmus (see 5.3);

(c) saccade test (see 6);

(d) pursuit testing (see 7);

(e) positioning and positional nystagmus (see 8); and

(f) caloric testing (see 9).

Each of these tests evaluates a response of the vestibular system by the vestibulo-ocular reflex through the measurement of electrical signals generated by eye movements recorded by electro-oculography.

1.1.2 Subjects

This Standard may be used to evaluate basic vestibular function in any human subject without restriction on age or sex.

NOTE Children under the age of about 4 may not be able to participate in all tests for various reasons, e.g., inability to follow verbal instructions.

Test subjects, however, must have functional retinas in both eyes and be able to see light through each eye separately to determine conjugacy of eye movements (i.e., ability to move both eyes synchronously or together).

Applicability of this Standard to some subjects may be limited by two variables. The test utilizing caloric stimulation depends upon heat transfer to the vestibular end organ, and is highly variable among individuals. The electro-oculogram, one method of measuring eye movement used in this Standard, depends on the existence of a corneoretinal potential which may be absent in certain cases of visual pathology. The use of video methods to measure eye movements requires that the eye can be visualized by video cameras well enough so that image processing methodology (e.g., tracking the iris-pupil limbus) can be effectively applied.