NATIONAL ASSOCIATION OF SPECIAL EQUIPMENT DISTRIBUTORS

http://www.nased.com

Technical Reference Handbook
Rev. 1.2, 2012

Last update 26/4/2012

Mission statement:

N.A.S.E.D. IS THE TRADE ASSOCIATION DEDICATED TO ESTABLISHING, MAINTAINING, AND MONITORING THE PROFESSIONAL AND ETHICAL STANDARDS OF OUR GROUP MEMBERS. THE PROCEDURES OF OUR GROUP MEMBERS WILL BE REPORTED IN A UNIFORM MANNER AND MEET THE HIGHEST STANDARDS FOR MEASUREMENT, DOCUMENTATION, AND REPORTING OF SERVICE AND CALIBRATION INFORMATION AND THUS ESTABLISH A GOLD STANDARD FOR OUR INDUSTRY.

NASED CALIBRATION STANDARDS

Foreword

This handbook describes the requirements for technical compliance with the National Association of Special Equipment Distributors. It should be used and understood in conjunction with the association's by-laws. This document is a dynamic paper and will change to meet the requirements of the by-laws, future standards, methods and instrumentation needs. Members will be notified of changes and updates to this document. Members are required to keep a current copy of this document on file at all times.

The standards adopted in this handbook were taken from existing industry standards

ANSI S3.6 – 2004 Specification for Audiometers

ANSI S3.6 – 2010 Specification for Audiometers (Not adopted in Technician test)

ANSI S3.1-1999 (R 2003) Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms

ANSI S3.39-1987 (R 2007) Specifications for Instruments to Measure Aural Acoustic Impedance and Admittance (Aural Acoustic Immittance)

ANSI S3.7- 1995 (R2008) Methods for Coupler Calibration of Earphones

ANSI S3.13-1987 (R 2007) Mechanical Coupler for Measurement of Bone Vibrators

ANSI S3.1-1999 (Rev 2008)

Recommendations by Special Instrumentation Manufacturers

NASED By-laws

Best practice recommendations by industry leaders

Any member concerns regarding this document maybe addressed to any current board member or the Chair of NASED technical standards.

Acknowledgements:

The writing of this reference manual could not have been completed without the support of the people involved in our industry. Many people offered their time and technical expertise. Special acknowledgements and the appreciation of the NASED board of Directors to:

Steve Wood - President NASED Board (2008-2010) Gordon Stowe
Bruce Waring - Technical Standards NASED Board (2008-2011) Audiometrics Ca.
Travis McColly - Maico Diagnostics (Diagnostic Group)
Randy Veillette - Tele-Acoustics
Chick Clemen – Gordon Stowe
Tom Fuerstenberg – Midwest Special Instruments
Bob Johnson – MSR West
Eric Melton – Northeastern Technologies
Angelo Restivo – Northeastern Technologies
Phil Algaier – Electro Medical
Chris Previte – Audio Technology Specialty
Julie Renshaw Public Relations NASED Board (2006-2010)
Rick LeCuyer - Grason Stadler Inc. (Diagnostic Group)

Rational for exhaustive field calibration intervals

Because there is no Federal or National standards specified for calibration intervals, except those stipulated by Federal OSHA (Occupational Safety and Health Administration) (1983) NASED has adopted the guidelines & requirements set forth by

AAA (American Academy of Audiology)
ASHA (American Speech-language & Hearing Association) (2001 revised)
JCAHO* (Joint Commission on Accreditation of Healthcare Organizations) (2002)
OSHA** (Occupational Safety and Health Administration) (1983)
OSHA requires:
Daily biological listening checks
Annual acoustic calibration (Output at 70dBHL, Linearity check from 70dBHL to 10dBHL) per ANSI S3.6-1969
Every two (2) years an exhaustive calibration per ANSI S3.6-1969

OWCP (Office of Workers Compensation Programs) (U.S. department of labor, 1988-revised)

*JCAHO and OWCP both refer to the ASHA manual for calibration requirements

And Manufacturers of Audiology instrumentation

**Although OSHA does not require an exhaustive calibration annually, NASED recommends but does not require a NASED field calibration, which exceeds the OSHA requirement. (See appendix B, general part e) of this handbook

.

In summary NASED recommends the following requirements for an EXHAUSTIVE FIELD CALIBRATION interval.

1) Maximum calibration interval of a 12 month period after manufactures initial calibration. This applies to all Audiometric test instrumentation

2) Recalibration should be performed after any of the following instances occur:
   a) A specified time period has elapsed (Annually, 12 month period maximum time period between calibrations)
   b) When a specified usage (operating hours) has elapsed. This is based on usage and environment, typically requested by instrument owner. Typical intervals of quarterly, or every six month period
   c) When an instrument has had an event which potentially may have put it out of calibration, (such as drop, shock, vibration, or other environmental condition),
   d) Whenever the function of the instrument is in question
   e) After a major repair or part replacement has been performed

INDEX page

TECHNICIAN AND MEMBER ORGANIZATION REQUIREMENTS

Technicians will:

a) Have a minimum education level of high school graduate or equivalent

b) Have on the job training with a minimum of six months hands on experience, under the supervision of a certified NASED technician

c) Attend the NASED school for technicians prior to taking the certification exam (2012)

d) Pass the certification examination:
The examination consists of two written and one practical test.
Testing only applies to

ANSI S3.6 -2004 **

ANSI S.39 -1987 (R2007)

ANSI S3.1 -1999 (R 2008)

**NASED understands and recognizes the necessity that not all instrumentation meets the ANSI S3.6- 2004 standard. However NASED certified technicians should endeavor to calibrate to the latest standard where possible and should instrumentation not meet the standard, calibrate to the manufacturers specified standard.

e) Obtain necessary credits needed to sustain certification requirements as set forth by the board of directors and association by-laws. All certified NASED technicians are required to obtain a minimum of 16 CEU's every two years. If you fail to obtain your 16 CEU's you will need to retest to regain your certification. NASED will provide adequate opportunities for technicians to maintain their CEU's, as well as provide information regarding other ways to maintain credits, either through service schools provided by manufacturers or other approved courses

f) Conduct business in a professional manner by suitable dress and conduct

Member organizations will:

a) Have all service technicians NASED certified (refer to Association by –laws)

b) Maintain membership with annual dues

c) Willingly assist technicians in obtaining continuing education credits and endeavor to keep up to date on latest instrumentation and standards policies

d) Maintain calibration requirements of all test instruments

e) Keep on file all current relevant ANSI standards for technician training and reference purposes

f) Have on file a current copy of the NASED hand book for members

g) Conduct business in a professional manner

h) Abide to the by-laws stipulated by NASED

NASED AUDIOMETER EXHAUSTIVE FIELD CALIBRATION REQUIREMENTS

The following are the minimum requirements for field calibration of audiometer instruments. The procedures listed are not in order of test preference. Technicians may perform the required measurements in the order best suited for the specific instrument

Equipment needed to perform exhaustive Audiometer field calibrations:

a) Type 1 Sound Level Meter – Reading in SPL (Linear & "C" weighting)
   Octave Band Filter Set (1/3 Octave, range of minimum 125 Hz to 16000 Hz) must meet Type 1 sound level meter (ANSI S1.4-1983(R2001))
b) Mechanical Coupler (used for bone conduction calibration) – B&K 4930 Artificial Mastoid – or other suitable mechanical coupler. Must meet ANSI S3.13.-1987(R2002)
c) System to measure:
   Frequency
   Rise Time
   Fall Time
   Duration (Pulse width)
   Over Shoot
   THD (Total Harmonic Distortion)
e) Piston phone or tone generator calibrator (Commercially available, preferably from the sound level meter manufacturer)
f) Artificial Ear & Couplers – NBS–9A (6cc), IEC 318, IEC 318 - 2 Flat plate coupler, HA-1 or 2 or 711 Ear simulator (ANSI S3.7-1995(R1999) Artificial Ear, (ANSI S3.25-1989(R1999) Ear Simulator
g) Specification/ calibration sheet for all microphones, filters, SLM and couplers showing needed corrections to the standard (If necessary)
h) Manufacturer specified couplers and adapters as stated by manufacturer
i) Calibration reports/sheets that meet the requirements stipulated by NASED standards committee to show minimum measurement results of the instrumentation calibrated

Calibration of Test Equipment:

All test equipment is to be calibrated annually. **
Calibration is to be performed by an outside lab which is traceable to the National Institute of Standards and Technology (NIST)
Documents are to be kept on file permanently
Sound Level Meters (SLM) to be checked daily before use, with a calibrator approved by the SLM manufacturer and their (manufacturer) method.

** The NASED Standards Committee performs an audit annually for membership compliance of test instrumentation. See by-laws for more specific information regarding audits.

Measurements to be performed:

All air conduction transducer measurements:

(ANSI S3.6-2004, section 9.1.2 Air conduction, supra-aural earphones)
"During calibration the earphone shall be applied to the coupler or artificial ear with a static force of 4.5 N"

All instruments to be calibrated should be visually checked and tested prior to performing calibration. (Connections, transducer outputs' etc)

(ANSI S3.6-2004, section 6.1.4 Frequency accuracy)
Frequency (Hz) - To be performed on all transducers, recorded as actual reading (Hz)
Tolerances - ±1% type 1&2 audiometers and for audiometers that provide extended high frequency capabilities
- ±2% type 3&4 audiometers

(ANSI S3.6-2004, section 6.2.9 overall distortion)
Distortion (%) -To be performed on all transducers, recorded as actual total harmonic distortion reading (THD %) or dB Down
-. The minimum Distortion measurements taken shall include at a minimum of 4 frequencies in the range of 250Hz to 4Khz', for each transducer (excluding extended high frequency).

Tolerances - Less than 2.5 % on all, frequencies from 125 Hz to 16000 Hz all air conduction
- Less than 2.5% for speech signals (Earphones)
- 3% for loudspeakers
- Test levels 90 dB@ 250Hz, 110 dB @ 500 Hz through 4 kHz,
(For Insert Phones and HDA200 the levels are 10dB less then above)

Output Levels - Recorded as a deviation from standard, to be performed on all transducers, all frequencies
Tolerances - ±3dB from 125 to 4000 Hz
- ±5dB 6 KHz & Higher frequencies

- Speech measurements on all transducers, performed acoustically through microphones for live voice, and through external source if available, using 1 KHz calibration tone, VU meter at zero

Tolerances - ±3dB, ** (background noise cannot exceed 45dBHL)

(ANSI S3.6-2004, section 6.3 Masking sounds)

-Masking stimuli:

- White noise: within 5dB of the level a 1000Hz at frequencies from 250 to 5000 Hz (level to be determined by manufacturer) *(ANSI S3.6-2004, section 6.3.2 White noise)*

- Speech Noise: within 5dB of the RETSPLs for speech for that transducer, (Speech/White Noise Output measured and recorded as actual level using linear *(ANSI S3.6-2004, section 6.3.3 Weighted random noise)*
Tolerances - +5 to -3dB Flat from 100-1000Hz then -12db per octave from 1000-6000Hz

- Narrowband Noise: +5dB to minus -3dB for each frequency (unfiltered) *(ANSI S3.6-2004, section 7.4.2 Accuracy of masking level)*

(ANSI S3.6-2004, section 7.3.3 Hearing level control)

-Linearity – To be performed on all channels, at a selected frequency of 1, 2, or 4 KHz in 5dB steps, recorded as a deviation from standard, Measurement to be made acoustically from Maximum hearing level to a minimum 50dBHL and electrically from 50dBHL

Tolerances - for every 5dB step the difference cannot be more than 3/10 of 5dB or max of 1dB. The maximum deviation at any level cannot be more than 2dB. The total error determined must include the output error at the selected frequency. (ANSI S3.6 2004)

- Example: from 70dBHL to 75dBHL the difference cannot be more than 1dB i.e. at 75dBHL the level cannot be more than 76dBSPL or less than 74dBSPL if 70dBSPL was read at 70dB HL, including the error for output recorded at that frequency.

(ANSI S3.6-2004, section 7.5.3 Rise/fall times for audiometers)

Rise Time (m/sec) - At a selected frequency of 1, 2, or 4 KHz test frequency on all channels Actual measurement recorded (ms)
Tolerances - Rise time within 20-50 ms

Fall Time (m/sec) - At a selected frequency of 1, 2, or 4 KHz test frequency on all channels, actual measurement recorded (ms)

Tolerances - Fall time within 20-50 ms

Duration (m/sec) - At a selected frequency of 1, 2, or 4 KHz test frequency on all channels Actual measurement recorded (ms)
Tolerances - < 500ms

Over Shoot (dB) - Actual measurement recorded at 1, 2 or 4 KHz (dB)
Tolerances - not more than +1dB

(ANSI S3.6-2004, section 7.5.2 on/off ratio for audiometers)

On/ off Ratio -At a selected frequency of either 1, 2, or 4 KHz test frequency on all channels, and recorded as dB down
Tolerances - greater than -70 dB

Cross talk - At a selected frequency of 1, 2, or 4 KHz test frequency on all channels, and recorded as dB down
Tolerances - greater than -70 dB

(ANSI S3.6-2004, section 7.5.4 Pulse tones for audiometers)

Pulse tones - At a selected frequency of 1, 2, or 4 KHz test frequency on all channels, and recorded as pulse width (m/sec.) down
Tolerances - The plateau of the signal shall be no less than 150 ms in duration. On/Off Times: shall each have values of 225 ± 35 ms. * OSHA on/off times at least 200 ms

(ANSI S3.6-2004, section 6.1.3 Frequency modulated signals)

Warble/ FM - To be performed on the primary air conduction transducer
Tolerances -FM rate to be within ±10% for the stated frequency
- Frequency to be within ±10% of its stated value

Bone masking measurements:

Per ANSI S3.43-1992 *(ANSI S3.6-2004, section 9.4.3 RETFLS)*
"During calibration the vibrator shall be applied to the coupler with a static force of 5.4 +/- 0.5 N"

All bone conduction components of the calibration sequence will be the same as prescribed previously for air conduction**.** A static force of 5.4 Newton's (540 grams) will be applied to the bone oscillator.

Frequency (Hz) - Actual measurement recorded (all frequencies)

Distortion (%) - To be performed at 4frequencies between 250Hz and 4000 Hz
Tolerances - <5.5%

Output Levels - Recorded as a deviation from standard, to be performed at all frequencies
Tolerances - ±3dB

(ANSI S3.6-2004, section 6.3.1 Narrow-band Noise)
Narrow Band
Noise - Output measured and recorded as actual level all frequencies. Measurement to be unfiltered
Tolerances - +5 to -3dB

(ANSI S3.6-2004, section 6.3.2 White noise)
White Noise - Output measured and recorded as actual level using linear filter settings
Tolerances - +5 to -3dB SPL

(ANSI S3.6-2004, section 6.2.4 loudspeaker output level)
Sound Field measurements:
Speakers should be a minimum of 1m from patient position; the loudspeaker shall be arranged at the head-height of a seated listener. If a free field microphone is utilized then the face of the microphone should be positioned so as to face the sound source. A pressure microphone should be placed such that the face of the microphone is 90 degrees to the sound source

Output levels – (Warble/ FM) - Actual measurement recorded (all frequencies) with deviation from standard
Tolerances - Warble/FM rate to be within ±10% for the stated frequency

- Frequency to be within ± 3% of its stated value

(ANSI S3.6-2004, section 6.2.12 RETSPL for speech)

Speech in Sound field – Speech output level
- 1 KHz signal applied to the live voice input acoustically through a microphone. VU meter at zero
Tolerances - ±3dB SPL

Speech through external inputs - CD / TAPE/ Phono
1 KHz signal applied to the external input. VU meter at zero
Tolerances - ±3dB SPL

Speech/White Noise - Output measured and recorded as actual level using linear
Tolerances - +5 to -3dB Flat from 100-1000Hz then -12dB per octave from 1000-6000Hz for speech noise

(ANSI S3.6-2004, section 6.2.9 Overall distortion)

Distortion - The total harmonic distortion for the loudspeaker output shall not exceed ±3% at frequencies 250Hz, 500Hz and 1000 Hz at an output sound pressure level of 80 dBSPL. The THD at 100 dBSPL less than ±10%

SISI - Using peak hold function test at 1 & 5 dB steps. Indicate pass or fail on Calibration sheet

Hi- Frequency audiometer measurements:

(ANSI S3.6-2004, Annex C section C.2 Calibration of circumaural earphones for extended high frequency testing)

"Calibration shall be performed using an IEC 60318-2 artificial ear and appropriate flat plate adaptor. During calibration the earphone shall be applied to the adaptor with a static force between 9 and 10 N."

Frequency (Hz) - To be performed on all transducers, recorded as actual reading (Hz)
Tolerances - ±1%

Distortion (%) -To be performed on all transducers, recorded as actual total harmonic distortion reading (THD %)

	-To be performed electrically on minimum 8 KHz, maximum 16 KHz Tolerances - Less than ±2.5 % on all frequencies - Test levels 80 dB at 8 kHz and 16 kHz
Output Levels	- Recorded as a deviation from standard, to be performed on all transducers, all frequencies Tolerances - ±3dB
Linearity	– To be performed on all channels, at a selected frequency above 10 KHz in 5dB steps, recorded as a deviation from standard, from maximum hearing level to -10dB or minimum hearing level. Measurement to be made Acoustically from Maximum hearing level to a minimum 50dBHL and electrically from 50dBHL Tolerances - for every 5dB step the difference cannot be more than 3/10 of 5dB or max of 1dB. The maximum deviation at any level cannot be more than 2dB. The output deviation at the frequency tested must be included in this error calculation - Example: from 70dBHL to 75dBHL the difference cannot be more than 1dB i.e. at 75dBHL the level cannot be more than 76dBSPL or less than 74dBSPL if 70dBSPL was read at 70dB HL

General inspection: (Subjective tests)

Visual inspection/ Safety	- Physical condition of instrument
Unwanted noise Check	- pass or fail Interrupter switch Hum Pure tone emissions Switch sounds Mechanical sounds
Visual and Physical Inspection	- Pass /fail - General inspection of all accessories.
Functional checks	- To be recorded with a check mark indicating pass or fail

Operation of instrument must be checked pre/post calibration

*NOTE: Pre and post numbers: In the comments section it should be noted that the instrument was in calibration, if no adjustments out side of the standards were made. Any adjustment of more than+/- 3dB should be noted.

*NOTE: when servicing an Occupational or Urgent care customer who comes under the OSHA law, NASED recommends that technicians provide a new annual baseline from the Bio-acoustic simulator being used by the customer. Bio-acoustic simulators should be serviced annually according to the manufactures specification.

NASED MIDDLE EAR/ SCREENING / IMMITANCE EXHAUSTIVE FIELD CALIBRATION REQUIREMENTS

The following are the requirements for field calibration of Immittance instruments.

i) Equipment needed to perform exhaustive Immittance field calibrations:

a) Type 1 Sound Level Meter – Readings in SPL (Linear & "C" Weighting) Octave Band Filter Set (Prefer 1/3 Octave, range of minimum 125 Hz to16000 Hz) must meet Type 1 sound level meter (ANSI S1.4-1983(R2006)

b) Manometer (refer to ANSI 3.39) that meets or exceeds the tolerances of the system measured

c) Cavity (0.5 ml, 2 ml, 5ml or Cavity specified by manufacturer) Coupler (appropriate IPSI probe coupler) (HA-1 or 2 or 711 Ear Simulator, manufacturer supplied or recommended)

d) Device to measure:
Frequency
Distortion (THD)
Rise & Decay time

e) Calibration sheet that meets the requirements stipulated by NASED Standards Committee to show minimum measurement results of instrumentation calibrated (See page 22 of this handbook)

ii) Calibration of Test Equipment

All test equipment is to be calibrated annually.
Calibration is to be performed by an outside lab which is traceable to the National Institute of Standards and Technology (NIST).
Documents are to be kept on file permanently.
Sound Level Meters (SLM) will need to be checked daily before use with a calibrator approved by the SLM manufacturer and their (manufacturer) check method. Manometers will be calibrated by an approved laboratory a minimum of once per year. A traceable document for at least one manometer will be kept per member organization

iii) Measurements to be performed:

Per ANSI S3.9 1987(Rev 2002) and manufacturers specifications

Reflex stimulus: - Frequency Verification (+/-3%)

- Intensity:
Tolerance - Contra +/-3dB of manufacturer's specifications
If insert, +/-3dB of manufacturer's specs.
IPSI +/-3dB of manufacturer's specifications
Probe tone +/- 3dB manufactures specifications
Noise stimuli to be measured unfiltered

- Distortion (THD)
Probe tones,
Contra & IPSI (<5%) Measured at 100 dB level

- Linearity
The same as the audiometer specifications

- Rise, Decay & Duration Times
The same as the audiometer specifications

- Noise Intensity
Tolerance - Contra & IPSI, +5/-3 dB of manufacturer's Specifications, unfiltered

- Overshoot <1dB

- On/Off Ratio >70dB

Probe Tone: - Frequency verification, all frequencies per manufacturer's specifications
Tolerance - +/- 3%

- Intensity 85dBSPL or as specified by manufacturer
Tolerance - +/- 3 dB

- Distortion (THD) as per manufacturer's specifications (3%)

Pressure tests: **at pressure ranges from at least 400 to -400 dpa
Tolerance - Clinical +/- 10%
Screeners+/- 15%
Using a manometer that meets ANSI 339

Volume compliance: - Per manufacturer's specification, all volumes on test cavities provided by manufacturer to be tested (See ANSI S3.9-1987)

Tolerance - +/- 5% or +/- .1ml
(0.5ml +/- .1)
(2.0ml +/- .1)
(5.0ml +/- .3)

NASED CERTIFICATION STANDARDS OF AUDIOLOGY SOUND ROOMS

NASED recommends testing to ANSI S3.1-1999 (R2008), American National Standard Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms.

Method to certify audiometric sound rooms

The NASED Standards Committee recommends all sound rooms for audiometric testing be certified using the following method:

Equipment needed to perform Audiometric room calibrations:

1) Type 1 Sound Level Meter – Readings in SPL (Linear & "C" weighting)
Octave Band Filter Set (1/3 Octave, range of minimum 125 Hz to16000 Hz) must meet Type 1 sound level meter (ANSI S1.4-1983(R2001))

Basic procedure:

This test determines the ambient background levels in the sound room. The audiometer is not used in this test. However the test should be conducted under normal working conditions. i.e. With Room lights, fan working.

The data is recorded in 1/3 octave bands as well as Flat (Unweighted) and "A" weighted wideband levels.

The test microphone should be placed at the patient's position at head height. A reading in 1/3 octaves in SPL (Unweighted) from 125Hz to 8000Hz, and an "A" weighted unfiltered reading recorded. These should be compared to the ANSI S3.1-1999 (R2003) maximum permitted ambient noise levels for Audiometric Test Rooms. A certificate showing the levels recorded should be presented to the owner. A sticker should be place on the booth in plain sight.
Recommend, although not required, is the measurement of the ambient noise outside of the booth.

Maximum Permissible Ambient noise level (ANSI S3.1-1999 re-afirmed 2008)

Frequency	Testing range (Hz)		125	250	500	1000	2000	4000	8000
Insert	125	8000	59	53	50	47	49	50	56
Insert	250	8000	67	53	50	47	49	50	56
Insert	500	8000	78	64	50	47	49	50	56
Supra aural	125	8000	35	25	21	26	34	37	37
Supra aural	250	8000	39	25	21	26	34	37	37
Supra aural	500	8000	49	35	21	26	34	37	37
Not covered	125	8000	29	21	16	13	14	11	14
Not covered	250	8000	35	21`	16	13	14	11	14
Not covered	500	8000	44	30	16	13	14	11	14
OSHA	500	8000	n/a	n/a	40	40	47	57	62

(Taken from ANSI S3.6 1999 rev 2004)

*These permissible levels allow sound field testing to a minimum of 0dBHL

This measurement should be conducted every year. This is required annually for certain organizations such as JCAHO, ASHA etc.

Audiometric test rooms used for **OSHA Hearing Conservation Programs** shall not have background sound pressure levels exceeding those in Table C-1 (OSHA hearing conservation regulations) when measured by equipment conforming at least to the Type 2 requirements of ANSI S1.4-1971 (R1976), and to the Class II requirements of ANSI S1.11-1971 (R1976). (See page 41 of this handbook Appendix B)

Note: NASED requires Type 1 equipment for this purpose, which exceed OSHA requirements.

Note: Booths will be certified if the booth or test area which the booth is in, is changed, moved or modified in any manner.

AUDITORY BRAINSTEM REPONSE (ABR)

Currently no standards exist for calibrations of ABR equipment. It is NASED's position to follow the manufacturer's specifications and recommendations for calibrations with the recommended instrumentation. It should be noted that NASED is currently working with ANSI and other associations and committees (Joint Committee on Infant Hearing JCIH) on a national standard for ABR equipment. Meanwhile NASED will work with the manufacturers to provide the proper methods of coupling to the transducers, which will permit measurements and adjustments if necessary, to meet the manufacturer's specifications.

NASED highly recommends members attend service schools from manufacturers to be trained in the correct procedures for their specific instruments, many of the manufacturer service schools provided offer NASED certification credits for attending their schools.

Instrumentation used in the calibration process of the above instrumentation must meet the requirements stipulated per NASED, ANSI and manufacturers as discussed previously under field calibration instrumentation minimum requirements

OTOACOUTIC EMMISSIONS (OAE)

Currently no standards exist for calibrations of OAE equipment. It is NASED's position to follow the manufacturer's specifications and recommendations for calibrations with the recommended instrumentation. It should be noted that NASED is currently working with ANSI and other associations and committees on a national standard for OAE equipment. Meanwhile NASED will work with the manufacturers to provide the proper methods of coupling to the transducers, which will permit measurements and adjustments if necessary, to meet the manufacturer's specifications.

NASED highly recommends members attend service schools from manufacturers to be trained in the correct procedures for their specific instruments, many of the manufacturer service schools provided offer NASED certification credits for attending their schools.

Instrumentation used in the calibration process of the above instrumentation must meet the requirements stipulated per NASED/ ANSI as discussed previously under field calibration instrumentation minimum requirements

AUDITORY STEADY STATE RESPONSE (ASSR)

Currently no standards exist for calibrations of ASSR equipment. It is NASED's position to follow the manufacturer's specifications and recommendations for calibrations with the recommended instrumentation. Meanwhile NASED will work with the manufacturers to provide the proper methods of coupling to the transducers, which will permit measurements and adjustments if necessary, to meet the manufacturer's specifications

NASED highly recommends members attend service schools from manufacturers to be trained in the correct procedures for their specific instruments, many of the manufacturer service schools provided offer NASED certification credits for attending their schools

Instrumentation used in the calibration process of the above instrumentation must meet the requirements stipulated per NASED/ ANSI as discussed previously under field calibration instrumentation minimum requirements

HEARING AID ANALYZERS AND PROBE MEASUREMENT INSTRUMENTS

Currently no standards exist for calibrations of Hearing aid analyzers and probe measurement equipment. It is NASED's position to follow the manufacturer's specifications and recommendations for calibrations with the recommended instrumentation. Meanwhile NASED will work with the manufacturers to provide you with the proper methods of coupling to the transducers, which will permit measurements and adjustments if necessary, to meet the manufacturer's specifications

NASED highly recommends members attend service schools from manufacturers to be trained in the correct procedures for their specific instruments, many of the manufacturer service schools provided offer NASED certification credits for attending their schools

Instrumentation used in the calibration process of the above instrumentation must meet the requirements stipulated per NASED/ ANSI as discussed previously under field calibration instrumentation minimum requirements

ENG/VNG AND BALANCE SYSTEMS

Although there is no "calibration" on this type of audiology instrumentation NASED recommends manufacturers specifications and recommended instrumentation for the above audiometric instrumentation.

NASED highly recommends members attend service schools from manufacturers to be trained in the correct procedures for service and annual maintenance on their specific instruments, many of the manufacturer service schools provided, offer NASED certification credits for attending their schools

NASED CERTIFICATE OF CALIBRATION

The Standards Committee for NASED recommends that a Certificate of Calibration be produced and presented to the instrument owner
A calibration sticker which should be placed on the instrument
A copy of the certificate should be kept on file for a minimum of 7 years

The calibration certificate should show the following minimum information:

1) Calibration company name, address and contact information
2) Instrument owner name
3) Date of calibration
4) Instrument manufacturer make, model and serial numbers
5) Calibration standard's used; some instruments may meet various standards. All standards should be listed
6) All transducers make, model, and serial numbers
7) Results of tests for frequency
8) Deviation from standard for results of outputs for all transducers listed
9) Distortion for transducers tested
10) Deviation from standard for linearity, transducers/channels tested
11) Electrical & acoustic test results for rise, fall times and pulse width
12) Pass/fail check boxes for functional checks
13) Name of technician who performed calibration
14) Calibration test instrumentation used, including model, serial numbers and Date of last calibration
15) Notes section for corrections or problems observed or repaired. It should be Recorded if the instrument was with in specification or not, prior to the actual Calibration*

*Pre and Post recording: NASED recommends recording pre and post readings whenever an adjustment of greater than 3dB is made.

For middle Ear/Immittance instruments the certificate should include all of the previous as well as the 3 listed below

1) Probe tone frequencies and output
2) Pressure test results (Manometer)
3) Compliance results (Cavity tests in CC's)

Calibration stickers must show the minimum information below

1) Instrument Model
2) Instrument serial number
3) Date of calibration (due date optional)
4) Calibration Company name/ contact (i.e. phone or website etc.)
5) Technicians name/ initials

FIELD NOTES

This sections contains information and recourses to help NASED technicians in the field

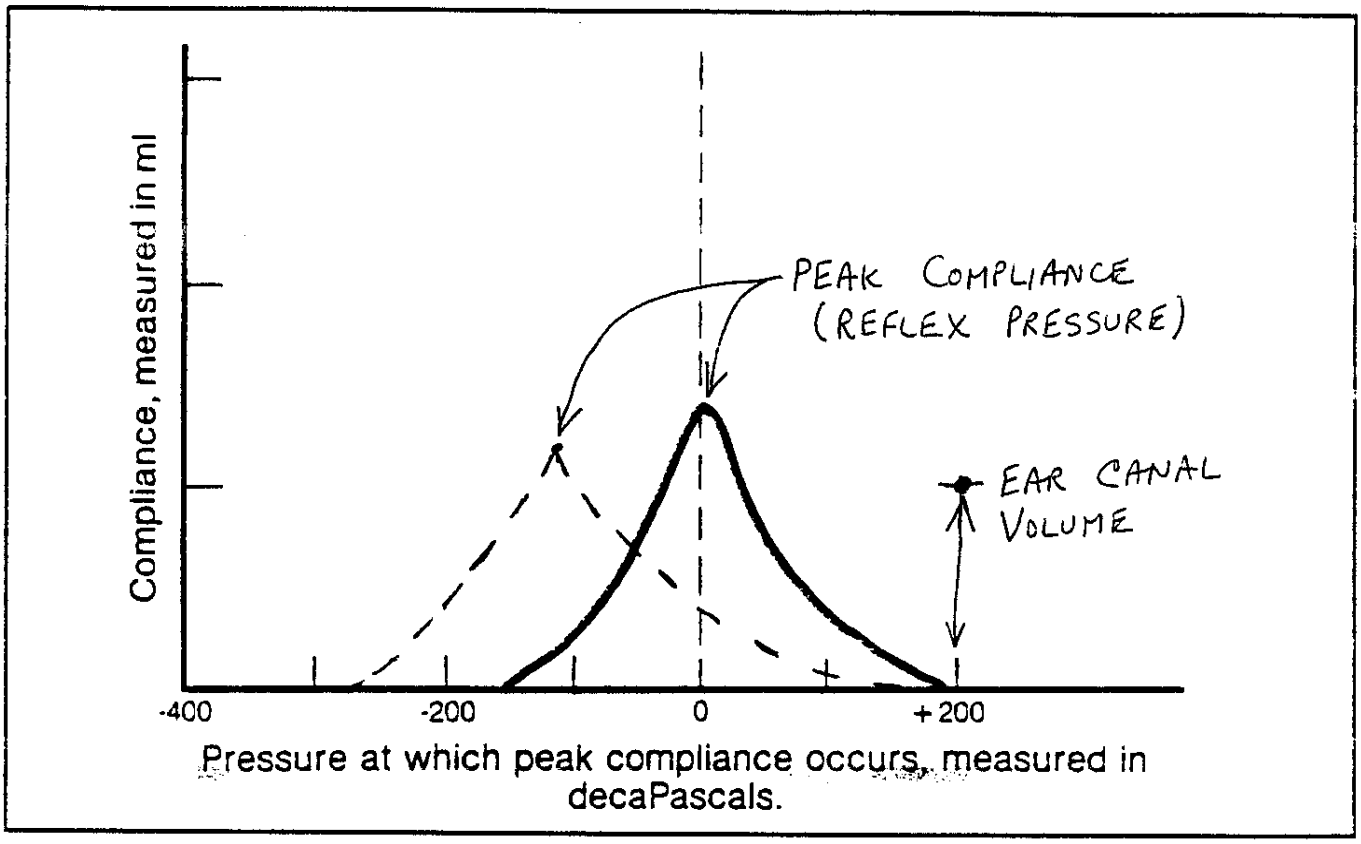
ANSI Standards reference material (ANSI S3.6 2004)
Technicians should be familiar with the following chapters and subsections in this ANSI standard.

Audiometry instrumentation
3.5 Air conduction
3.6 Bone conduction
3.9 Reference equivalent threshold sound pressure level: RETSPL
3.10 Reference equivalent threshold force level: RETFL
3.11 Occlusion effect
3.12 Hearing threshold
3.15 Hearing level for pure tones
3.16 Speech recognition threshold level
NOTE – Speech recognition threshold was previously called speech reception threshold.
3.19 Free-field equivalent earphone sensitivity
3.20 Free-field equivalent bone vibrator sensitivity
5.4.4 Unwanted sound from an audiometer
5.5 Subject's response system
5.6 Monitor earphone or loudspeaker
5.7 Talk back system (Patient Monitor)
6.1.4 Frequency accuracy.
6.1.5 Harmonic distortion.
6.2.9 Overall distortion.
6.2.12 Standard reference sound pressure level for speech
6.3.2 White Noise.
6.3.3 Weighted random noise for the masking of speech.
7.2 Accuracy of sound pressure and vibratory force level
7.3.3 Hearing level control linearity.
7.4.2 Accuracy of masking sound level.
7.5.2 on/off ratio for audiometers.
7.5.3 Rise/fall times for audiometers.
7.5.4 Pulsed tones for audiometers.
9 Transducers (specifications, RETSPLs and RETFLs)
9.1 Air conduction, "supra-aural earphones"
9.1.2 Calibration.
9.2 Air Conduction, circumaura earphones (high frequency)
9.3 Air conduction, insert earphones
9.3.3 Reference levels in an HA-1 acoustic coupler.
9.4.1 Bone vibrators.
9.4.2 Headband.
9.4.3 Reference equivalent threshold force levels **(**RETFLs).

9.4.4Sound field produced via loudspeakers
9.5.1 Sound field characteristics (Patient Location & Head Height)
Recordings of speech test material
Calibration of circumaural earphones for extended high frequency testing
Annex F supra-aural cushions for telephonic earphones

ANSI standard reference material (ANSI S3.9 1987- (R2003))
Technicians should be familiar with the following chapters and subsections in this ANSI standard.

Immittance / tympanometery specifications
Cavity Tolerance
7.1.5 Accuracy of Acoustic-Immittance Measurements
7.3.2 Frequency
7.4.6.1 Clinical Units: Type 1 and Type 2 Instruments
7.4.6.2 Screeners: Type 3 Instruments and Type 4 Instruments equipped with a pneumatic system
7.5 The acoustic-reflex activating (stimulus) system
7.5.1 General
7.5.2.3 Harmonic Distortion
7.5.7 Rise Time and Fall Time
10.2 Cavities for Calibration of Acoustic Immittance and Air Pressure



A Normal Tympanogram

Provided courtesy Grason Stadler Inc.

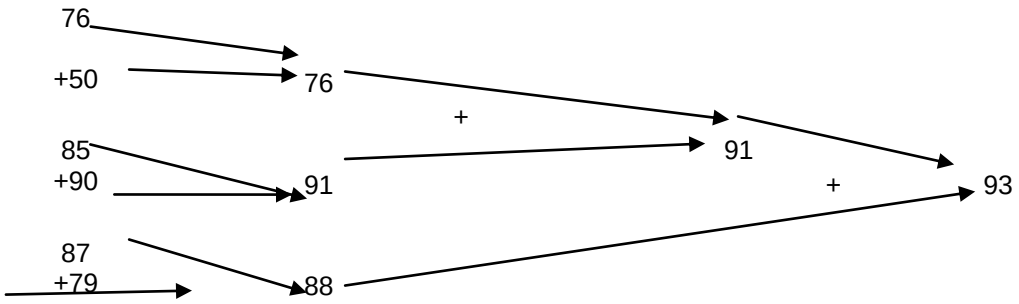
DECIBEL ADDITION OF TWO NOISE SOURSES

When adding two decibel sources, the following “rule’ applies

When the two dB values differ by the following

Difference in dB of two values			Amount to be added to higher value	
dB		dB	add	dB
0	to	1	add	3
2	to	3	add	2
4	to	8	add	1
8	or	more	add	0

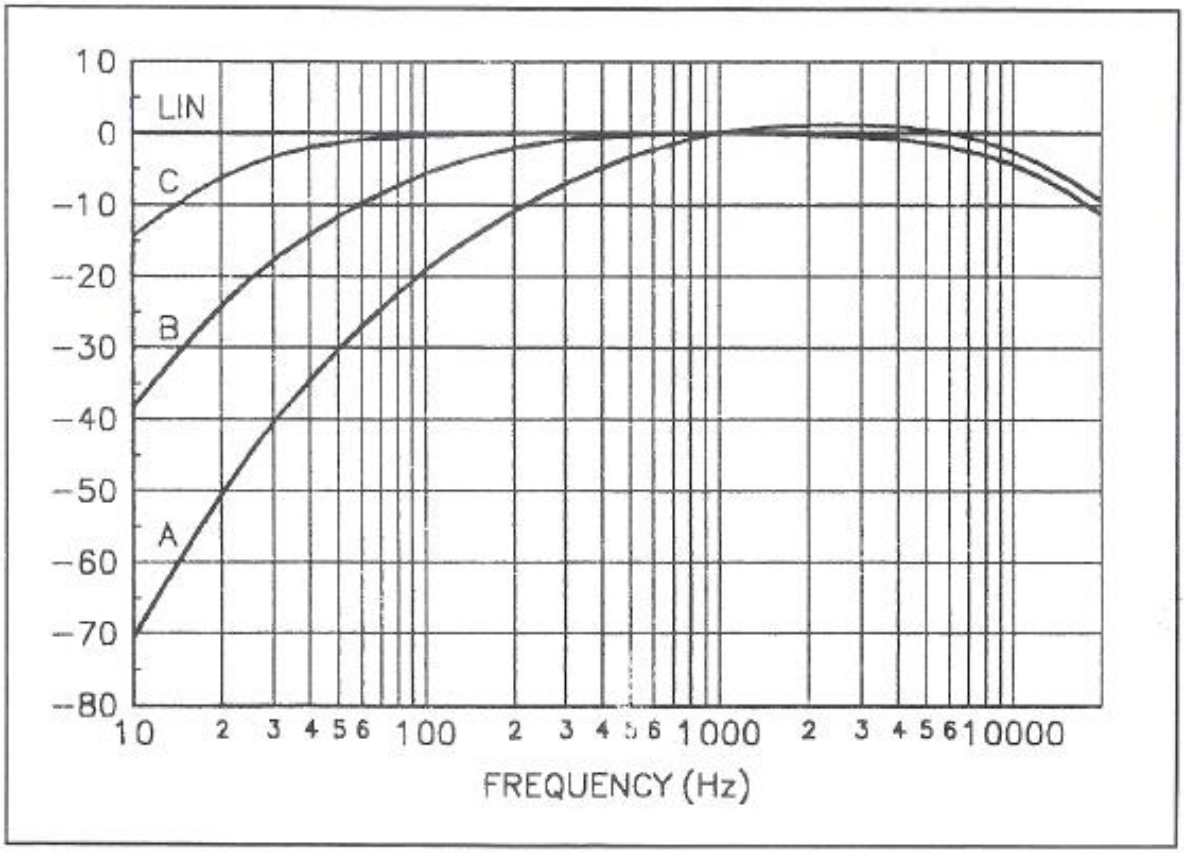
Example



Decibel Table

dB	Power Ratio	Voltage or Current ratio	dB	Power Ratio	Voltage Current ratio
0.00	1.00	1.00	10	10	3.20
0.50	1,12	1.06	15	31.6	5.60
1.00	1.26	1.12	20	100	10.00
1.50	1.41	1.19	25	316	18.00
2.00	1.58	1.26	30	1000	32.00
3.00	2.00	1.41	40	10000	100.00
4.00	2,51	1.58	50	1.E+05	316.00
5.00	3.16	1.78	60	1.E+06	1.00
6.00	3.98	2.00	70	1.E+07	3.16
7.00	5.01	2.24	80	1.E+08	10.00
8.00	6.31	2.51	90	1.E+09	31.62
9.00	7.94	2.82	100	1.E+10	1.00E+05

Graph showing weighted response curves



Graph provided courtesy Quest technologies- Noise dosimetry with common terms

Weighting of the signal analyzed is used by certain agencies to determine noise compliance. For example OSHA uses “A” weighted measurements to determine noise exposure of employees in work places.

REFERENCES

Selected ANSI Standards Relating to Audiology:

ANSI S1.4-1983 (R 2001), "American National Standard Specification for Sound Level Meters"

ANSI S1.15-1997/Part 1 (R 2001), "American National Standard Measurement Microphones, Part 1: Specification for Laboratory Standard Microphones"

ANSI S1.40-1984 (R 2001), "American National Standard Specification for Acoustical Calibrators"

ANSI S3.1-1999 (R 2003), "American National Standard Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms"

ANSI S3.6-1996 "American National Standard Specification for Audiometers"

ANSI S3.6 1996 (R 2004) "American national standard specifications for audiometers"

ANSI S3.7-1995 (R 2003), "American National Standard Method for Coupler Calibration of Earphones"

ANSI S3.13-1987 (R 2002), "American National Standard Mechanical Coupler for Measurement of Bone Vibrators"

ANSI S3.20-1995 (R 2003), "American National Standard Bioacoustical Terminology"

ANSI S3.21-1978 (R 1997), "American National Standard Method for Manual Pure-Tone Threshold Audiometry"

ANSI S3.22-1996 (R 2003), "American National Standard Specification of Hearing Aid Characteristics"

ANSI S3.35-1985 (R 1997), "American National Standard Methods of Measurement of Performance Characteristics of Hearing Aids under in situ Working Conditions"

ANSI S3.39-1987 (R 2002), "American National Standard Specifications for Instruments to Measure Aural Acoustic Impedance and Admittance (Aural Acoustic Immittance)"

ANSI S3.42-1992 (R 2002), "American National Standard Testing Hearing Aids with a Broad-Band Noise Signal"

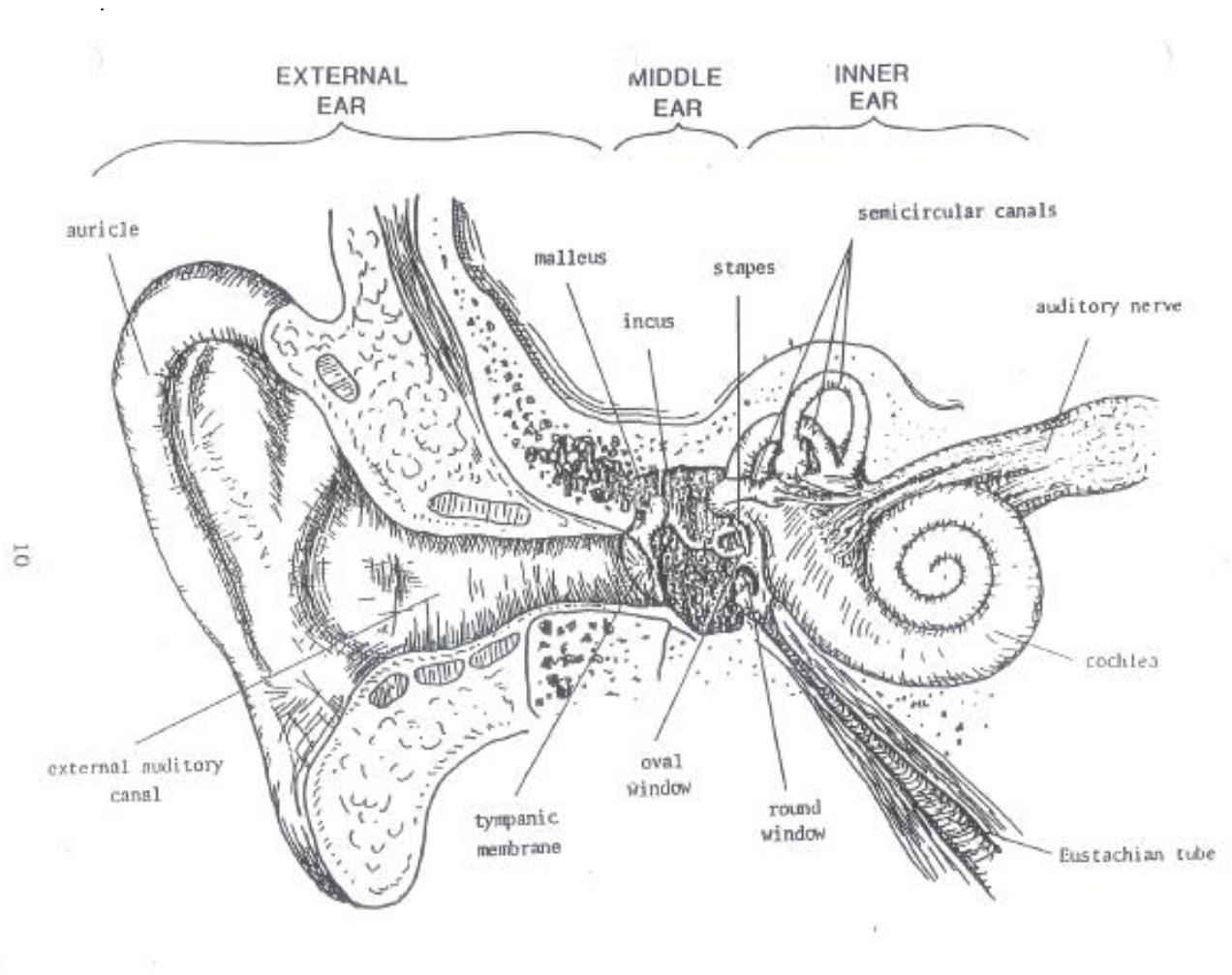
ANSI S3.45-1999, "American National Standard Procedures for Testing Basic Vestibular Function"

ANSI S12.60-2002, "American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools"

BASIC ANATOMY OF THE EAR

THE EXTERNAL EAR

The external ear consists of the auricle (pinna) and the external auditory canal. The external auditory canal is slightly curved. The canal carries sound to the ear drum. In the external canal are hair follicles, sweat and oil glands. The wax (cerumen) produced by these glands protect the ear drum from foreign objects.



Provided courtesy of Grason Stadler Inc

THE MIDDLE EAR

The middle ear is an air filled cavity. The outer wall contains the tympanic membrane. The inner ear also contains the opening to the Eustachian tube, which extends from the middle ear to the back wall of the mouth. The inner wall of the cavity of the middle ear contains the Oval and round windows.

The primary function of the middle ear is to transfer sound from the outer ear to the inner ear. This is done through the ossicular chain which is composed of three small bones commonly called the hammer, anvil and stirrup. The malleus is attached to the eardrum and transfers sound through the incus which is attached to the stapes which is attached to the oval window

INNER EAR

The inner ear consists of two sensory organs, the organ for balance and the organ for hearing.

The organ for balance (Semi circular canals) maintains a person's balance.

The organ for hearing (Cochlea) consists of 3 fluid filled chambers similar to the shell of a snail, and run the whole length of the coil. The opening to these is called the Oval window. Microscopic hairs in the cochlea detect fluid movement resulting from the movement of the stapes against the window. The bending of these hairs causes nerve impulses to the auditory nerve.

THE AUDITORY NERVOUS SYSTEM

The nervous system is made up of the auditory nerve (VIII cranial nerve) and its pathway to the brain. This enters the lower portion of the brain, then finally to the auditory portion of the temporal lobe.

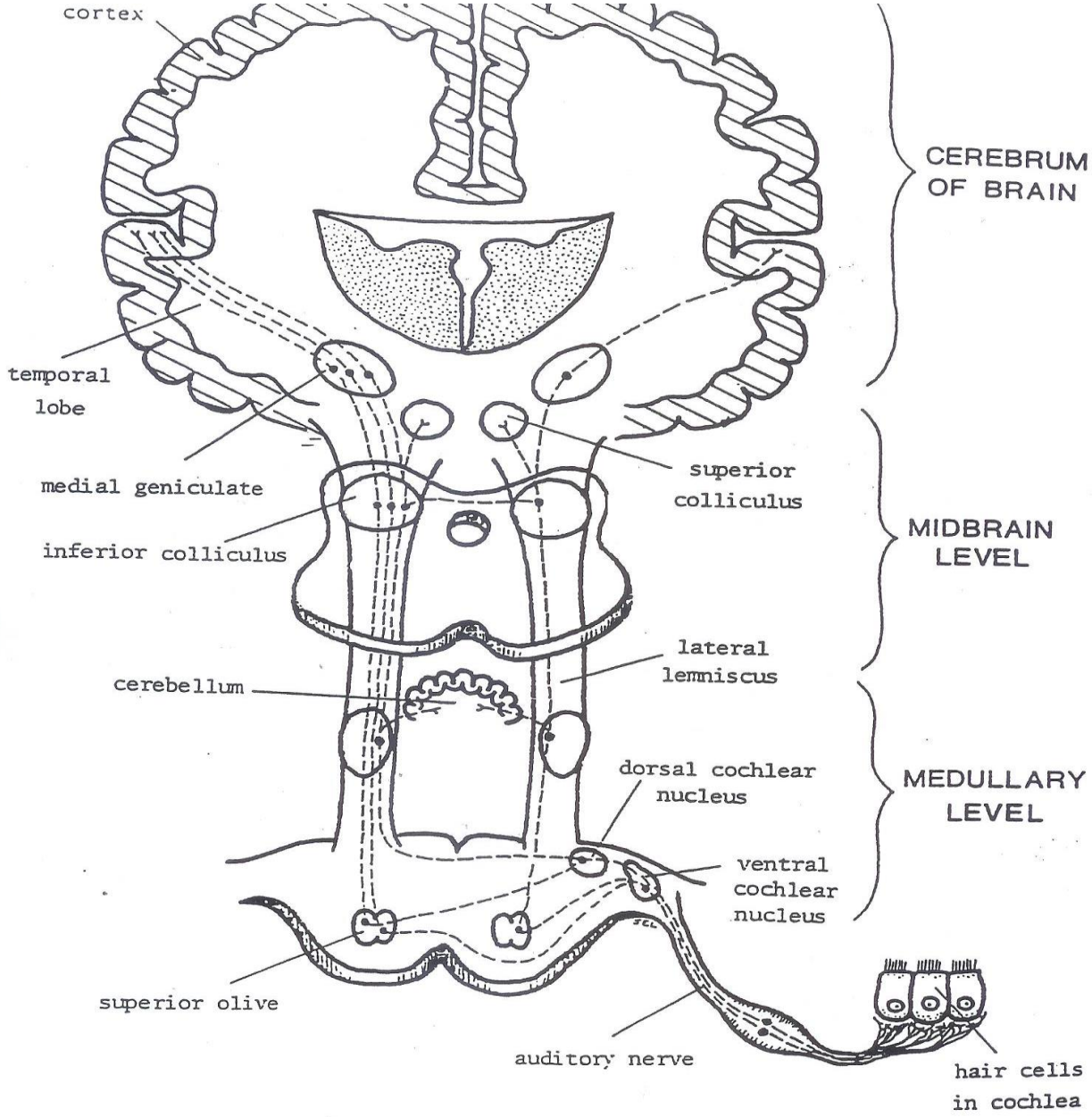
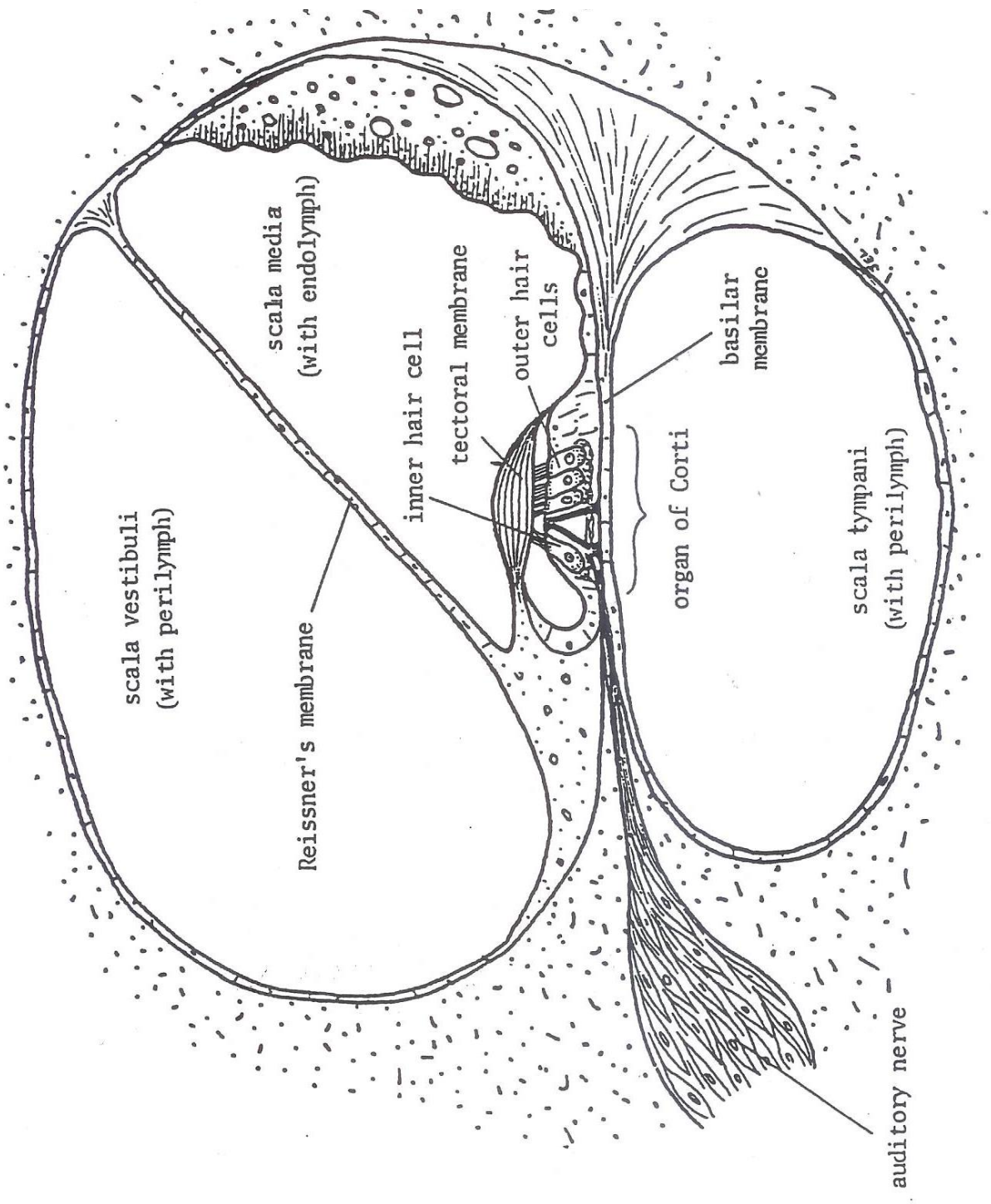


Fig. 3 AUDITORY PATHWAY OF THE CENTRAL NERVOUS SYSTEM



CROSS-SECTION OF COCHLEA

GLOSSSARY OF TERMS

Air conduction
Transmission of sound through the outer and middle ear to the inner ear

Artificial ear / ear simulator
For use in calibration, an acoustic impedance equivalent to that of the average human ear. The artificial ear or ear simulator incorporates a calibrated microphone to measure the sound pressure level that an earphone develops within the cavity. Example is an IEC 318 coupler

Audiogram: A chart, graph, or table resulting from an audiometric test showing an individual's hearing threshold levels as a function of frequency.

A **free-field microphone** is designed to measure the sound pressure in a sound field and compensate for the influence of its presence in the sound field. A free-field microphone measures the sound pressure as it existed before the microphone was introduced into the sound field; in effect, maintaining free-field conditions**.** A free-field microphone should be pointed towards the sound source, i.e. at an angle of 0º incidence to the source.

A **pressure microphone** is designed to measure the sound pressure that actually exists in front of its diaphragm. This means that the microphone also measures any changes in the sound field brought about by the presence of the microphone. A pressure microphone is used, typically, in coupler measurements and, when flush-mounted on a wall for example, for sound-pressure measurements on the surface of the wall. In such applications, the effect of the microphone's presence in the sound field is intended.

Bone conduction
Transmission of sound to the inner ear primarily by means of mechanical vibration of the cranial bones

Calibration: The act of checking or adjusting (by comparison with a standard) the accuracy of a measuring instrument. (WordNet® 3.0, © 2006 by Princeton University)

"The calibration process begins with the design of the measuring instrument that needs to be calibrated. The design has to be able to "hold a calibration" through its calibration interval. In other words, the design has to be capable of measurements that are "within engineering tolerance" when used within the stated environmental conditions over some reasonable period of time. Having a design with these characteristics increases the likelihood of the actual measuring instruments performing as expected."

Computer-controlled audiometer
An audiometer in which the test procedure is controlled by a microprocessor or computer

Decibel (dB): Unit of measurement of sound level.

dBA: (Decibels-A-Weighted). A unit of measurement of sound level corrected to the A-weighted scale, as defined in ANSI S1.4-1971 (R1976), using a reference level of 20 micropascals (0.00002 Newton per square meter).

Equivalent threshold sound pressure level (ETSPL)
The sound pressure level (SPL) generated by the earphone in a specified
Acoustic coupler, artificial ear, or ear

Equivalent threshold force level (ETFL)
The vibratory force level generated by the bone vibrator on a
Specific mechanical applied to the mastoid prominence or to the forehead *****provided the non-test ear is adequately masked

Extended high frequency audiometer
An instrument used for the measurement of hearing sensitivity, an audiometer providing test frequencies in the 8000 to 16000 Hz range.

Frequency: The number of vibrations or cycles per second (Hz)

Hertz (Hz): Unit of measurement of frequency, numerically equal to cycles per second.

The "**IEC 318"** coupler is an example of a standardized human ear, having the same acoustic input impedance as an average human ear.

Mechanical coupler
Device that presents specified mechanical impedance to a vibrator applied with a specified static force

Masking
The process by which the threshold of hearing for one sound is raised by the presence of another (masking) sound

Occlusion effect
Increase in loudness of bone-conducted signals, at frequencies below 2000 Hz when the external ear(s) are covered.

Pure-tone audiometer
Instrument used to measure hearing sensitivity, specifically hearing level for pure tones, as a function of frequency.

Reference equivalent threshold sound pressure level (RETSPL)
Equivalent threshold sound pressure level at a specified frequency, as measured in a specified acoustic coupler, artificial ear, or ear simulator based upon hearing threshold data from a sufficiently large number of otologically normal individuals of both genders ranging in age from 18 to 30 years.

Reference equivalent threshold force level (RETFL)
Equivalent threshold force level at a specified frequency as measured on a specified mechanical coupler based upon hearing threshold data from a sufficiently large number of otologically normal individuals of both genders, from 18 to 30 years of age.

Sound Pressure Level, SPL,
Is sound pressure expressed in dB referenced to 20 micro Pascal's (20µPa), the "threshold of hearing" ?
Sound Pressure Level, dB ref 20µPa ($dB_{20\mu Pa)}$ = $20.\log_{10}$ (Sound Pressure/20µPa). Or add 20dB for every 10-fold increase in sound pressure.

Speech audiometer
An audiometer which uses either live or recorded speech signals for measurement of hearing.

Speech level
The sound pressure level or the vibratory force level of a speech signal as measured in an appropriate coupler, artificial ear, ear simulator, or in a sound field.

Speech recognition threshold level (SRT)
The lowest hearing level at which the speech signal is recognized 50% of the time.

Appendix A

TIPS FOR TECHNICIANS IN THE FIELD:

A GOOD TECHNICIAN WILL TAKE CARE OF A CUSTOMER'S INSTRUMENTATION
A GREAT TECHNICIAN WILL TAKE CARE OF THE CUSTOMER!

It should be noted that technicians, prior to going on site for calibration and repair; should be aware of the correct way to conduct business. You are required by the membership to conduct yourself in a professional manner. Be prepared, be professional and dress appropriately.

It should be noted that calibration ideally should be performed outside of the instrument calibration mode. Once completed any adjustments needed, would be made in the calibration mode, then changes made re-checked out of the calibration mode. This may seem odd; consider that most instruments when in the calibration mode do not always make it possible to perform certain calibration sequences. For example distortion, and linearity tests, the user does not conduct testing in the calibration mode but in the normal or user mode.

NOTE: Technicians who service customers who come under the "OSHA" regulations should consider becoming CAOHC certified. The Council for Accreditation in Occupational Hearing Conservation offers a certification course to "audiology technicians". NASED offers a one time 8 CEU credit to technicians who become CAOHC certified. A copy of your certification should be sent to NASED for the CEU's to be credited.

The information referenced below is taken from the current ANSI standard for Audiometers (ANSI S3.6 2004)

Reference equivalent threshold sound pressure level (RETSPL) (ANSI 1996 rev2004)
Reference equivalent threshold force level (RETFL) (ANSI 1992)

Trans.	Supra-aural			Circumaural	(Flat plate)	Insert			Bone		
	TDH type*	TDH 39	TDH 49/50	HDA200	HV/1A	IEC-711 OES	HA-2	HA-1	Mastoid	Forehead	F-M
Coupler	IEC 318-3	NBS 9A	NBS 9A	IEC-318-2	IEC318-2	IEC-711	rigid				
Frequency											
125	45	45	47.5	30.5		28	26	26.5			
250	27	25.5	26.5	18		17.5	14	14.5	67	79	12
500	13.5	11.5	13.5	11		9.5	5.5	6	58	72	14
750	9	8	8.5	6		6	2	2	48	61	13
1000	7.5	7	7.5	5.5	16	5.5	0	0	42.5	51	8.5
1500	7.5	6.5	7.5	5.5		9.5	2	0	36.5	47.5	11
2000	9	9	11	4.5		11.5	3	2.5	31	42.5	11.5
3000	11.5	10	9.5	2.5		13	3.5	2.5	30	42	12
4000	12	9.5	10.5	9.5	8	15	5.5	0	35.5	43.5	8
6000	16	15.5	13.5	17		16	2	-2.5	40	51	11
8000	15.5	13	13	17.5	16.5	15.5	0	-3.5	40	50	10
9000				18.5	21						
10000				22	25.5						
11200				23	24.5						
12500				28	26						
14000				36	33						
16000				56	51						
Speech	20	19.5	20	19	28.5	18	12.5	12.5	55	63.5	8.5

Note: The IEC-711 OES can be used for all insert/button phone measurements
Bone numbers are for B-71 Bone oscillators
*IEC 318 RETSPLs can be applied to all TDH headphones. Flat plate required for HDA200/HV/1A circumaural headphones (IEC318-2)

A. ANSI RETSPL table values are based on a sound level meter reference of 20micro Pascal's for headphone reference(20 µPa)
B. Bone conduction speech RETFL is derived from 12.5dB above the pure tone value at 1 KHz

Reference equivalent threshold sound pressure levels (RETSPLs) for sound field (ANSI 1996)

	Monaural Sound field			Binaural	
coupler	0 Deg.	45 Deg.	90 Deg.	0 deg	
Frequency					
125	24	23.5	23	22	
250	13	12	11	11	
500	6	3	1.5	4	
750	4	0.5	-1	2	
1000	4	0	-1.5	2	
1500	2.5	-1	-2.5	0.5	
2000	0.5	-2.5	-1.5	-1.5	
3000	-4	-9	-6.5	-6	
4000	-4.5	-8.5	-4	-6.5	
6000	4.5	-3	-5	2.5	
8000	13.5	8	5.5	11.5	
9000	15.5	10.5	8.5	13.5	
10000	15.5	11	9.5	13.5	
11200	14	10	7	12	
12500	13	11.5	5	11	
14000	18			16	
16000	44.5			43.5	
Speech	16.5	12.5	11	14.5	

Maximum Permissible Ambient noise levels (ANSI S3.1-1999 (R2003)

Frequency	Testing range (Hz)		125	250	500	1000	2000	4000	8000
Insert	125	8000	59	53	50	47	49	50	56
Insert	250	8000	67	53	50	47	49	50	56
Insert	500	8000	78	64	50	47	49	50	56
Supra aural	125	8000	35	25	21	26	34	37	37
Supra aural	250	8000	39	25	21	26	34	37	37
Supra aural	500	8000	49	35	21	26	34	37	37
Not covered	125	8000	29	21	16	13	14	11	14
Not covered	250	8000	35	21`	16	13	14	11	14
Not covered	500	8000	44	30	16	13	14	11	14
OSHA	500	8000	n/a	n/a	40	40	47	57	62

ANSI S3.6 TORERANCES COMPARISON

Measurment		1969	1989	1996	2004
Frequency accuracy		3%	3%	Type 1=1% Type 2=2% Type 3,4&5=3%	Type1&2=1% Type 3&4=2% Hi-Freq=1%

	Comment	1969	1989	1996	2004
SPL output	125Hz	5dB to -5dB	3dB to -3dB	3dB to -3dB	3dB to -3dB
all transducers	250Hz-3KHz	3dB to -3dB	3dB to -3dB	3dB to -3dB	3dB to -3dB
	4KHz	4dB to -4dB	3dB to -3dB	3dB to -3dB	3dB to -3dB
	6KHz and above	5dB to -5dB	5dB to -5dB	5dB to -5dB	5dB to -5dB

		1969	1989	1996	2004
Masking SPL output		none	5 to -3 dB	5 to -3 dB	5 to -3 dB
from pure tone					

	Comment	1969	1989	1996	2004
Distortion (THD) %	Air	3% (-30dB)	3%(-30dB)	2.5%(-32dB)	2.5%(-32dB)
dB down	Bone		5%(-26dB)	5.5%(-25dB)	5.5%(-25dB)
	Speech		3%(-30dB)	2.5%(-32dB)	2.5%(-32dB)
	Inserts- use air levels with		3%(-30dB)	2.5%(-32dB)	2.5%(-32dB)
	HL 10dBHL below air level				

	Comment	1969	1989	1996	2004
Linearity/5dB step		1.5dB to -1.5dB	1dB to -1dB	1dB to -1dB	1dB to -1dB
max. total error	(accumulated error)				2dB

		1969	1989	1996	2004
Off level,		-10	-10	-10	-10
dB down		50dB down	70dB down	70dB down	70dB down

		1969	1989	1996	2004
Cross level,		-10	-10	-10	-10
dB down		70dB down	70dB down	70dB down	70dB down

		1969	1989	1996	2004
Fall time		5 to 100ms	20 to 50 ms	20 to 50 ms	20 to 50 ms

		1969	1989	1996	2004
Rise time		20 to 100ms	20 to 50 ms	20 to 50 ms	20 to 50 ms

	Comment	1969	1989	1996	2004
Overshoot	equal to or less	1dB	1dB	1dB	1dB

	Comment	1969	1989	1996	2004
Channel Mix. Error		1dB to -1dB	1dB to -1dB	1dB to -1dB	1dB to -1dB

	Comment	1969	1989	1996	2004
Background noise			-10	-10	-10
in speech circuit(dB down)	down	50dB	40dB down	45dB down	45dB down

		1969	1989	1996	2004
Unwanted sound		50dB HL	50dB HL	50dB HL	50dB HL

		1969	1989	1996	2004
Pulse width				190 -260ms	190 -260ms

Appendix B

OSHA RULE HEARING CONSERVATION
Relevant sections for technicians, from the OSHA Federal website

Subchapter 7 General Industry Safety Orders
Group 15 Occupational Noise.
Article 105. Control of Noise Exposure

§5095. General.

(a) Scope and Application. Article 105 establishes requirements for controlling occupational exposures to noise. Agriculture, construction, and oil and gas well drilling and servicing operations are exempt from the provisions of Sections 5097 through 5100.

(b) Definitions.

Action Level: An 8-hour time-weighted average of 85 decibels measured on the A-scale, slow response, or equivalently, a dose of fifty percent.

Audiogram: A chart, graph, or table resulting from an audiometric test showing an individual's hearing threshold levels as a function of frequency.

Audiologist: A professional, specializing in the study and rehabilitation of hearing, who is certified by the American Speech, Hearing and Language Association or licensed by a state board of examiners.

Baseline Audiogram: the audiogram against which future audiograms is compared

Criterion Sound Level: a sound level of 90 decibels.

Decibel (dB): Unit of measurement of sound level.

dBA: (Decibels-A-Weighted). A unit of measurement of sound level corrected to the A-weighted scale, as defined in ANSI S1.4-1971 (R1976), using a reference level of 20 micropascals (0.00002 Newton per square meter).

Hertz (Hz): Unit of measurement of frequency, numerically equal to cycles per second.

Medical Pathology: A disorder or disease, a condition or disease affecting the ear, which should be treated by a physician specialist.

Otolaryngologist: A physician specializing in diagnosis and treatment of disorders of the ear, nose and throat.

Representative Exposure: Measurements of an employee's noise dose or 8-hour time-weighted average sound level that the employer deems to be representative of exposures of other employees in the workplace.

Sound Level: Ten times the common logarithm of the ratio of the square of the measured A-weighted sound pressure to the square of the standard reference pressure of 20 micropascals. Unit: decibels (dB). For use with this regulation, SLOW time response, in accordance with ANSI S1.4-1971 (R1976), is required.

Sound Level Meter: An instrument for the measurement of sound level.

- **§5096. Exposure Limits for Noise.**

(a) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table N-1 of this section when measured on the A-scale of a standard sound level meter at slow response.

(b) When employees are subjected to sound levels exceeding those listed in Table N-1 of this section, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of the table, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

Table N-1 Permissible Noise Exposure[1]

Sound Level (dBA)	Permitted Duration per Workday (hours-minutes)	hours	Sound Level (dBA)	Permitted Duration per Workday (hours-minutes)	hours
90	8-0	8.00	103	1-19	1.32
91	6-58	6.96	104	1-9	1.15
92	6-4	6.06	105	1-0	1.00
93	5-17	5.28	106	0-52	0.86
94	4-36	4.60	107	0-46	0.76
95	4-0	4.00	108	0-40	0.66
96	3-29	3.48	109	0-34	0.56
97	3-2	3.03	110	0-30	0.50
98	2-38	2.63	111	0-26	0.43
99	2-18	2.30	112	0-23	0.38
100	2-0	2.00	113	0-20	0.33
101	1-44	1.73	114	0-17	0.28
102	1-31	1.52	115	0-15	0.25

[1] When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: C1/T1 + C2/T2 . . . Cn/Tn exceeds unity, then, the mixed exposure should be considered to exceed the limit value. Cn indicates the total time of exposure at a specified noise level, and Tn indicates the total time of exposure permitted at that level.

(c) If the variations in noise level involve maxima at intervals of 1 second or less, the noise is to be considered continuous.

- (d) Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

§5097. Hearing Conservation Program

§5097. Hearing Conservation Program

a) **General**.

The employer shall administer a continuing, effective hearing conservation program, as described in this section, whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels measured on the A-scale (slow response) or, equivalently, a dose of fifty percent. For purposes of the hearing conservation program, employee noise exposures shall be computed in accordance with Appendix A and Table A-1 and without regard to any attenuation provided by the use of personal protective equipment.

(c) **Audiometric Testing Program**.

(1) The employer shall establish and maintain an audiometric testing program as provided in this section by making audiometric testing available to all employees whose exposures equal or exceed the action level.

(2) The program shall be provided at no cost to employees.

(3) Audiometric tests shall be performed by a licensed or certified audiologist, Otolaryngologist, or other physician, or by a technician who is certified by the Council of Accreditation in Occupational Hearing Conservation, or who has satisfactorily demonstrated competence in administering audiometric examinations, obtaining valid audiograms, and properly using, maintaining and checking calibration and proper functioning of the audiometers being used. A technician who performs audiometric tests must be responsible to an audiologist, Otolaryngologist or physician.

(4) All audiograms obtained pursuant to this section shall meet the requirements of Appendix B: Audiometric Measuring Instruments.

(5) The employer shall establish for each employee exposed at or above the action level a valid baseline audiogram against which subsequent audiograms can be compared.

(6) Testing to establish a baseline audiogram shall be preceded by at least 14 hours without exposure to workplace noise. This requirement may be met by wearing hearing protectors which will reduce the employee's exposure to a sound level of 80 dBA or below.

(7) The employer shall notify employees of the need to avoid high levels of non-occupational noise exposure during the 14-hour period immediately preceding the audiometric examination.

(8) Audiometric tests shall be made available to employees by June 1, 1983 or within 6 months of an employee's first exposure at or above the action level, except that where a mobile test van is used to conduct the audiometric test, the test shall be made available within one year of an employee's first exposure at or above the action level provided that all such employees are given an opportunity for testing.

NOTE: This requirement may be met by an audiogram available to the employer upon the effective date of this section provided the conditions under which the audiometric test was performed were the same as prescribed by this section.

(9) Where an employer chooses to have audiometric tests performed by a mobile test van in accordance with Section 5097(c)(8) and an employee's baseline audiogram has not been obtained within 6 months of the employee's first exposure at or above the action level, the employer shall make hearing protectors available to the employee in accordance with Section 5098 and require that the hearing protectors are worn by the employee until the baseline audiogram is obtained.

(10) At least annually after obtaining the baseline audiogram, the employer shall obtain a new audiogram for each employee exposed at or above the action level.

(e) **Audiometric Test Requirements**.

(1) Audiometric tests shall be pure tone, air conduction, hearing threshold examinations, with test frequencies including as a minimum 500, 1000, 2000, 3000, 4000 and 6000 Hz. Tests at each frequency shall be taken separately for each ear.

(2) Audiometric tests shall be conducted with audiometers (including microprocessor audiometers) that meet the specifications of, and are maintained and used in accordance with, ANSI S3.6-1969.

(3) Pulsed-tone and self-recording audiometers, if used, shall meet the requirements specified in Appendix B, Audiometric Measuring Instruments.

(4) Audiometric examinations shall be administered in a room meeting the requirements listed in Appendix C, Audiometric Test Rooms.

(f) **Audiometer Calibration.**

(1) The functional operation of the audiometer shall be checked before each day's use by testing a person with known, stable hearing thresholds, and by listening to the audiometer's output to make sure that the output is free from distorted or unwanted sounds. Deviations of 10 dB or greater shall require an acoustic calibration.

(2) Audiometer calibration shall be checked acoustically at least annually in accordance with Appendix D, Acoustic Calibration of Audiometers. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this check. Deviations of 15 dB or greater necessitate an exhaustive calibration.

(3) An exhaustive calibration shall be performed at least every two years in accordance with Sections 4.1.2, 4.1.3, 4.1.4.3, 4.2, 4.4.1, 4.4.2, 4.4.3, and 4.5 of ANSI S3.6-1969. Test frequencies below 500 Hz and above 6000 Hz may be omitted from this calibration.

(c) **Audiometric Test Rooms.**

The employer shall maintain accurate records of the measurements required by Appendix C, Audiometric Test Rooms, of the background sound pressure levels in audiometric test rooms.

Appendix B

Obsolete as modern audiometers and microprocessor based audiometers are now utilized. This appendix covers the methods used in older model audiometers using chart recorders.

Appendix C

Audiometric Test Rooms

Rooms used for audiometric testing shall not have background sound pressure levels exceeding those in Table C-1 when measured by equipment conforming at least to the Type 2 requirements of ANSI S1.4-1971 (R1976), and to the Class II requirements of ANSI S1.11-1971 (R1976).

Table C-1

Maximum Allowable Octave-Band Sound Pressure Levels for Audiometric Test Rooms

Octave-band center frequency (Hz)	500	1000	2000	4000	8000
Sound pressure level (dB)	40	40	47	57	62

NOTE: Authority and reference cited: Section 142.3, Labor Code.

HISTORY

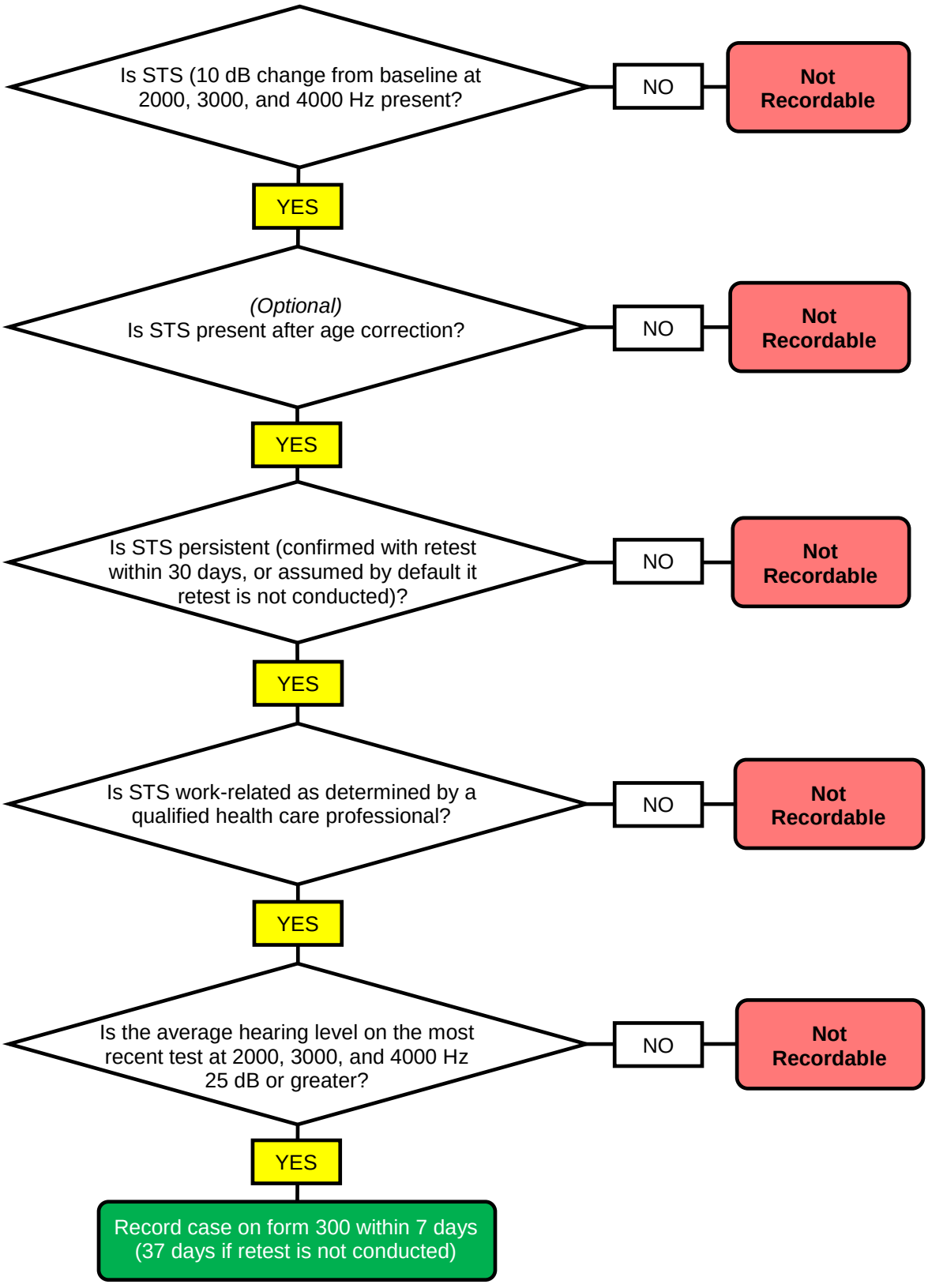
1. Amendment filed 10-3-83; effective thirtieth day thereafter (Register 83, No. 41).

Appendix D

Acoustic Calibration of Audiometers

I. Audiometer calibration shall be checked acoustically, at least annually, according to the procedures described in this Appendix. The equipment necessary to perform these measurements is a sound level meter, octave-band filter set, and a National Bureau of Standards 9A coupler. In making these measurements, the accuracy of the calibrating equipment shall be sufficient to determine that the audiometer is within the tolerances permitted by ANSI S3.6-1969.

Hearing Loss Recordkeeping Flowchart



Appendix C

Although NASED does not require a specific manufacturer for calibration instrumentation, we do require that the instrumentation meet the requirements of ANSI as set forth in their standards for Type1 meters (ANSI S1.4-1983(R2001), microphones and specified couplers.

The listings below are simply a guide to some of the systems available on the market for your convenience.

Pictures and information are provided courtesy of the manufacturers:

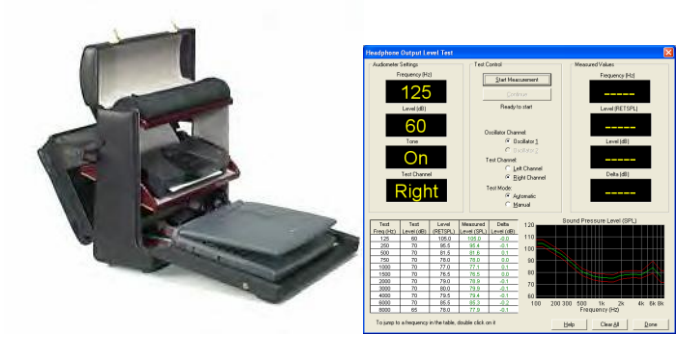
CALIBRATION SYSTEMS

Type 1 Sound Level Meter (ANSI S1.4-1983(R2001)

i) Larson Davis 824 with audiology calibration module

It should be noted that both the Larson Davis and Aussco systems come with built in analyzers and appropriate filters for calibration systems for high frequency measurement. Misc. couplers microphones and accessories are sold separately

ii)Aussco ACS 100



ACS-100 comes with all software, pre amp, filters etc. Does not include PC Printer couplers and microphones are sold separately

iii) Quest 1800 / 1900

Quest technologies 1800 or 1900 type on sound level meters used in conjunction with analyzers and couplers from Quest

Couplers (ANSI S3.7-1995(R1999) Artificial Ear
(ANSI S3.25-1989(R1999) Ear Simulator

i) Gras IEC 711 occluded ear simulator, includes ½ inch microphone used for Insert phone (3/5A) and contra insert phone, probe measurements

Shown attached to test jig

ii) Gras IEC 318 coupler with ½ inch microphone (Part number RA0039), Flat plate for High frequency. Used for all supra and circumaural headphones

Shown not attached to test jig

Shown with flat plate and mounted on test jig

iii) Larson Davis 9NBS 6 cc coupler (ANC493 mechanical coupler shown on mastoid)

Mechanical coupler (Bone) (ANSI S3.13.-1987(R2002)

B&K Artificial Mastoid — Type 4930

Manometer

Dwyer Series 475 Mk III Handheld Digital Manometer or equivalent

Cavities (Manufacturer supplied for specific instrumentation)

NASED recommends having in your calibration kit all the supplied test volume cavities from the manufactures you represent. The specific cavity should always be used with the manufactures instrument and recommended ear tip to couple.

Miscellaneous tools and supplies

Hand held digital multimeter, NASED technicians should have appropriate tools in their kits. Extension cables necessary for sound suite calibrations. Screw drivers and cutters necessary to perform on-site repairs. Solder iron and miscellaneous replacement parts most commonly needed to perform service and repair. Patch cables, headset, insert and bone cords. Headset cushions, cleaning supplies such as wipes and contact cleaner

CALIBRATION SYSTEMS AND COUPLERS

The listings below are simply a guide to some of the systems available on the market for your convenience.

Pictures and information are provided courtesy of the manufacturers:

Larson Davis Inc.

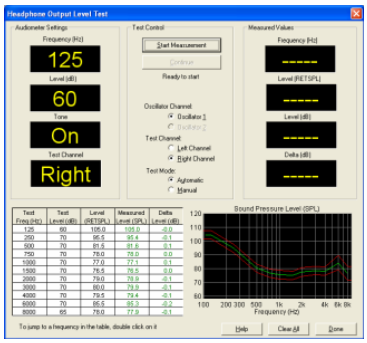
Larson Davis 824 Calibration system, showing the coupler and weight

Also available from Larson Davis is a mastoid for bone conduction calibration. Software packet is also available

Larson Davis offers the System 824; the system can be purchased with the Audiometry calibration module which allows specific measurements needed for calibration

Larson Davis Inc.
1681 West 820 North
Provo, Utah 84601 USA
Phone: 716-926-8243 (24 hour service)
Fax: 716-926-8215
Toll Free: 888-258-3222 (USA only)

AUSSCO Inc.



Aussco offers the PC Based ACS 100 Audiometry calibration system. It includes a software package, couplers, microphones and all in one carry case. Includes pre set and user defined calibration protocols for specific instruments

AUSSCO, INC
800-755-8272, Fax: 773-427-4863, Chicago, Illinois

Quest technologies

Quest Technologies offer sound level meters, microphones and couplers for calibration systems. They also have the 188 analyzer for frequency and other electrical tests (NOTE: the AA175 analyzer from quest does not analyze above 8000 Hz)

Quest technologies
1060 Corporate Center drive.
Oconomowoc WI 53066
800 245-0779

Brüel & Kjær

BN& K offer a complete range of SLM and couplers for calibration needs. They also offer the B&K 4930 Artificial Mastoid

Brüel & Kjær
2815-A Colonnades Court
Norcross, Georgia 30071-1588
Phone: 770-209-6907
Toll Free: 800-332-2040
Fax: 770-448-3246
Toll Free Fax: 800-236-8351

Larson Davis 824 SLM

B& K SLM 2236

Quest 1800 SLM

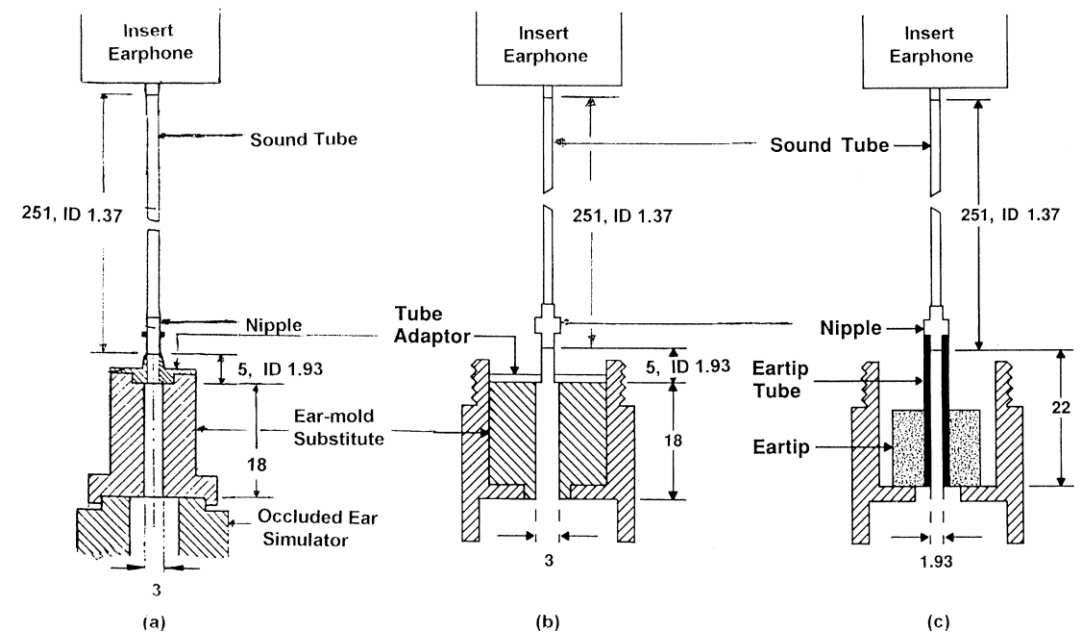
Misc. Calibrator / tone generators from manufacturers of sound testing systems

B&K 4930 Artificial Mastoid

Larson Davis headphone couplers and bone mastoid

IEC 318Couplers from Gras (Note flat plate for high frequency calibration on left and 711 ear simulator in center)

Misc. Microphones, pre amps and adapters



IEC 60711 **HA-2** **HA-1**

Insert phone couplers. Taken from the ANSI S3.6 1996 rev 2004

Appendix D:

NASED field calibration methods and procedures **06/16/2011**

AUDIOMETRY

1) Frequency measurements:

To be performed on all transducers, recorded as actual reading (Hz)
Tolerance : 1% type 1&2 audiometers (High Frequency)
2% type 3&4 audiometers

2) Distortion measurements:

To be performed on all transducers, recorded as actual total harmonic distortion reading (THD %)
a minimum of 4 frequencies chosen between 250Hz and 4Khz (excluding high frequency Audiometers)
Tolerance : less than 2.5 % on all, frequencies from 125 Hz to 16000 Hz all air conduction
less than 5.5% on all frequencies for bone conduction
less than 2.5% for speech signals
Test levels 90 dB@ 250Hz, 110 dB @ 500 Hz through 4 kHz, 90 dB @ 6 kHz through 16 kHz (Inserts and High freq. 10 dB less)

3) Output measurement levels:

To be performed on all transducers, all frequencies
Tolerance : 3dB from 125 to 4000hz
5dB 6 & higher
Speech measurements on all transducers, performed acoustically through microphones for live voice and through external source if available, using 1KHz calibration tone
Tolerance : 3dB

4) Linearity measurements:

To be performed on both primary air conduction transducers, and channels
at a selected frequency of either 1,2, or 4Khz test frequency in 5dB steps
from maximum hearing level to -10dB or minimum hearing level. Measurement to be made
Acoustically from Maximum hearing level to a minimum hearing level that is at least 20dB above the test room noise, and electrically from 20dB above the test room noise floor to the minimum hearing level

*NOTE both transducers are tested on channel 1 and only one transducer need be checked on channel two

Tolerances: for every 5dB step the difference cannot be more than 3/10 of 5dB or max of 1dB
The maximum deviation at any level cannot be more than 2dB
Example: from 70dBHL to 75dBHL the difference cannot be more than 1dB.
i.e. at 75dBHL the level cannot be more than 76dBSPL or less than 74dBSPL
if 70dBSPL was read at 70dB HL

5) Rise / fall and overshoot measurements:

At a selected frequency of either 1,2, or 4Khz test frequency on all channels
Tolerances: Rise time with in 20-50 ms
Fall time within 20-50 ms
Overshoot not more than 1dB

6) On/ Off ratio :

At a selected frequency of either 1,2, or 4Khz test frequency on all channels, and recorded as dB down
Tolerance: greater than -70 dB

7) Cross talk:

At a selected frequency of either 1,2, or 4Khz test frequency on all channels, and recorded as dB down
Tolerance: greater than -70 dB

8) FM / Warble tone measurements:

To be performed on the primary air conduction Headset
Tolerance: FM rate to be with in 10% for the stated frequency
Frequency to be with in 10% of its stated value

9) Pulsed tone measurements:

At a selected frequency of either 1,2, or 4Khz test frequency on all channels,
and recorded as pulse width (m/sec.)
Tolerance: The plateau of the signal shall be no less than 150 ms in duration.
On/Off Times: shall each have values of 225 ± 35 ms.
* OSHA on/off times at least 200 ms

10) Unwanted sounds check:

To be recorded with a check mark indicating pass or fail
Interrupter switches, Switch sounds , mechanical sounds and electrical hum

11) Functional check:

To be recorded with a check mark indicating pass or fail
Visual inspection of Headbands, cushions, and response button test.

12) Test room ambient noise measurements:

The Data is recorded in 1/3 Octave bands as well as Flat (Unweighted) and "A" wideband levels
Tolerance: See Handbook for ANSI allowable ambient noise levels for Headphones, inserts and Free field * Note OSHA levels

***Pre and post numbers : In the comments section it should be noted that the instrument was in calibration, if no adjustments out side of the standards were made.**
Any adjustment of more than+/- 3dB should be noted.

Bone masking measurements

Distortion (%) - To be performed at 4 frequencies between 250Hz and 4000Hz
Tolerances<5.5%

Output Level - Recorded as a deviation from standard, to be performed at all frequencies
Tolerances - ±3dB

Sound Field

Output Levels (Warble/ FM) - Actual measurement recorded (all frequencies) with deviation from standard

MIDDLE EAR / IMMITTANCE

1) IPSI/CONTRA reflex transducers

Same as Audiometers for air conduction transducers

Frequency measurements:
Distortion measurements:
Output measurement levels:
Linearity measurements:
Rise / fall and overshoot measurements:
On/ Off ratio :
Pulsed tone measurements:

2) Probe tone: all frequencies all outputs

Tolerance: 85dBSPL +/- 3dB
Distortion less than 3% of stated frequency

3) Pressure measurements:

**At pressure ranges from at least 400 to -400 dpa
Tolerance: Clinical +/- 10%
Screener +/- 15%

4) Volume measurement:

Tolerances +/- 5% or +/- .1 ml which ever is smaller
all volumes on test cavities provided by manufacturer to be tes

5) Unwanted sounds check:

To be recorded with a check mark indicating pass or fail
Interrupter switches, Switch sounds , mechanical sounds and electrical hum

6) Functional check:

To be recorded with a check mark indicating pass or fail
Visual inspection of Headbands, cushions and Probe cables.
**Note: where available safety vales for over pressure should be checked

***Pre and post numbers : In the comments section it should be noted that the instrument was in calibration, if no adjustments out side of the standards were made.**
Any adjustment of more than+/- 3dB should be noted.

retspl Work sheets

	TDH type 3 IEC 318	Mic. Correction	Dial HL	SLM SPL
Frequency				
125	45			
250	27			
500	13.5			
750	9			
1000	7.5			
1500	7.5			
2000	9			
3000	11.5			
4000	12			
6000	16			
8000	15.5			
9000				
10000				
11200				
12500				
14000				
16000				
Speech	20			

	TDH 39 NBS 9A	Mic. Correction	Dial HL	SLM SPL
Frequency				
125	45			
250	25.5			
500	11.5			
750	8			
1000	7			
1500	6.5			
2000	9			
3000	10			
4000	9.5			
6000	15.5			
8000	13			
9000				
10000				
11200				
12500				
14000				
16000				
Speech	19.5			

* Mic. Corrections from Calibration Chart

	TDH 49/50 NBS 9A	Mic. Correction	Dial HL	SLM SPL
Frequency				
125	47.5			
250	26.5			
500	13.5			
750	8.5			
1000	7.5			
1500	7.5			
2000	11			
3000	9.5			
4000	10.5			
6000	13.5			
8000	13			
9000				
10000				
11200				
12500				
14000				
16000				
Speech	20			

	HDA200 IEC-318-2	Mic. Correction	Dial HL	SLM SPL
Frequency				
125	30.5			
250	18			
500	11			
750	6			
1000	5.5			
1500	5.5			
2000	4.5			
3000	2.5			
4000	9.5			
6000	17			
8000	17.5			
9000	18.5			
10000	22			
11200	23			
12500	28			
14000	36			
16000	56			
Speech	19			

	HV/1A IEC318-2	Mic. Correction	Dial HL	SLM SPL
Frequency				
125				
250				
500				
750				
1000	16			
1500				
2000				
3000				
4000	8			
6000				
8000	16.5			
9000	21			
10000	25.5			
11200	24.5			
12500	26			
14000	33			
16000	51			
Speech	28.5			

	IEC-711 OES IEC-711	Mic. Correction	Dial HL	SLM SPL
Frequency				
125	28			
250	17.5			
500	9.5			
750	6			
1000	5.5			
1500	9.5			
2000	11.5			
3000	13			
4000	15			
6000	16			
8000	15.5			
9000				
10000				
11200				
12500				
14000				
16000				
Speech	18			

	HA-2 rigid	Mic. Correction	Dial HL	SLM SPL
Frequency				
125	26			
250	14			
500	5.5			
750	2			
1000	0			
1500	2			
2000	3			
3000	3.5			
4000	5.5			
6000	2			
8000	0			
9000				
10000				
11200				
12500				
14000				
16000				
Speech	12.5			

	HA-1	Mic. Correction	Dial HL	SLM SPL
Frequency				
125	26.5			
250	14.5			
500	6			
750	2			
1000	0			
1500	0			
2000	2.5			
3000	2.5			
4000	0			
6000	-2.5			
8000	-3.5			
9000				
10000				
11200				
12500				
14000				
16000				
Speech	12.5			

Notes:

Notes: