A DRAFT FOR ISI SPECIFICATION FOR ELECTRO – ACOUSTIC IMPEDANCE AUDIOMETER

Ashok Kumar Sinha

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CERTIFICATE

This is to certify that the project entitled "A DRAFT FOR ISI SPECIFICATION FOR ELECTRONACKOUSTIC IMLPEDANCE AUDIOMETER" is the bona fide work in part fulfillment for the degree of M.Sc., III Semester M.Sc., (SPEECH AND HEARING) of the student with Register N0. 03

Director

All India Institute of speech and hearing

Mysore.

CERTIFICATE

This is to certify that this independent project work has been prepared under my Supervision and guidance.

Dr. (Miss) Shailaja Nikam

Guide.

DECLARATION

This independent project work is the result of my own study undertaken under the guidance Of Dr. (Miss) SHAILAJA NIKAM, professor and Head of Dept, Of Audiology. All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier at any University for any other Diploma or Degree.

Mysore:

Dated : Reg. No. 03

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CHAPTER --1

INTRODUCTION

The determinat6ikoknk of acoustic impedance is an important aspect of the clinical audio logical test battery. Acoustic impedance measurements are particularly useful to audiologists because the objective results often substantiate or classify behavioral audiometric findings. Some audiologists use impedance audiometry initially with each patient to predict audiometric results, thereby increasing efficiency and accuracy in the clinic routine; other audiologists use impedance measures to confirm behavioral audiometric observations with difficult-to-test patients. In the past few years acoustic impedance test procedures have had an important part in every type of hearing evaluation (Jerry L. Northern, and Alison M. Grimes, 1978).

The measurement of acoustic impedance is by no means a new technique. Oto Metz of Denmark, in 1946, using an early mechanical impedance bridge, reported many of the applications of impedance audiometry currently in the use today. The Scandinavians were quick to appreciate the clinical use of impedance measurements for testing the acoustic reflex and Eustachian tube function (Jepson, 1963; Kristensen and Jepsen, 1952, Thomsen, 1955a, 1955b).

An Impedance Audiometre was developed in Denmark by Terkildsen and Scott-Nielser (1960). These authors described their new as an "exact electronic counterpart of the bridge employed by Metz."Recurrent applications of impedance audiometry continue to emphasize its broad impact on the field of hearing evaluation.

Acoustic Impedance measurements in the clinical evaluation of auditory problems have now been applied, in one o4r another form, For 3 decades. Over this period, there have been dramatic changes in instrumentation and measurements approaches. Some of these changes are the direct result of the accumulation of data from basic and applied research, while other grew out of clinical experience (Metz. 1946, Terkildsen and Nielson, 1960; zwislocki, 1963).

While there can be no question that we have yet to reach the ultimate level of sophistication with this form of measurement of the auditory system, its present stage of development is such that it can provide a major contribution to the differential diagnosis of auditory problems. The acoustic impedance battery can provide us with a variety of both direct and indirect objective measures of functions of the various components of the auditory system and, further can help localize wherein the system abnormality can exist. This localization can extend from the ear canal itself, to the central auditory network. At the same time, it is worth noting that this battery, as is true for most other tests, is not infalliable, and one must not be tempted to view the result in isolation.

BRIDGES Vs. METERS.

There are two types of instruments involved in measurement of acoustic impedance. They are acoustic impedance bridge and acoustic impedance meters.

The procedure by which the probe tone is maintained at a constant level in the ear canal determines whether the instrument is an electro-acoustic bridge or electroacoustic meter. Electro-acoustic bridges have an attenuator that is

Variously referred to as a “compliance” or “intensity” control. Its function is to increase or decrease the level of the probe tone generated into the ear canal. When the signal is at a specified level, example 85dB, the instrument balance meter will read at mid-point. Then, as the air pressure in the ear canal is varied, the changing transducer drive current will cause the balance meter to deflect. The bridge is then manually rebalanced at the point of peak change by readjusting the attenuator control to bring the balance meter back to its midpoint. These adjustments of the attenuator control also provide the settings for the values of compliance at maximally stiff tympanic membrane (c1) and compliance at middle ear pressure (c2).

Electroacoustic meters differ from bridges in that the probe tone level is maintained constant by means of an automatic volume control circuit. In these instruments the appropriate meter simply displays the instantaneous value of the parameter being measured. Another distinction between the electro-acoustic bridge and meter on the tympanogram itself. Because the probe tone is not constantly maintained at a prescribed level, the tympanogram designed with an electro-acoustic bridge is based on a relative (uncaibrated) scale. Tympanograms obtained with electro-acoustic meters are calibrated at all points on the curve and can directly provide the static admittance values.

SCOPE:

Here, specifications required for diagnostic electro-acoustic impedance audiometer are discussed.

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CHAPTER:

TERMINOLOGY.

Acoustic Admittance: an expression of the case of sound flow measured at the surface of the eardrum. A complex expression that is composed of acoustic susceptance and acoustic conductance. The reciprocal of acoustic impedance.

Acoustic compliance: an expression of the case or magnitude of movement of the eardrum and middle ear system. Equivalent to a acoustic susceptance at 220 Hz. At sea level and standard barometric pressure and temperature. The unit of measurement is the centimeter.

Acoustic conductance : an expression of the real flow of energy through a resistance. A reciprocal of acoustic resistance.

Acoustic Impedance: an expression of the difficulty of flow of energy measured at the surface of the eardrum. The reciprocal of acoustic admittance. A complex that is composed of acoustic reactance and acoustic resistance.

Acoustic mho: the unit of measurement of sound flow. The value is generally so small that is expressed as millimho or 1/1000 of a mho. The reciprocal of acoustic ohm.

Acoustic ohm: the unit of measurement of resistivity of flow of sound pressure through a medium.

Acoustic reactance: the imaginary component of the acoustic impedance. It is the result of the stiffness and mass of the system and is the component that expresses the storage and return of energy; when the system is stiffness controlled the acoustic reactance is negative.

Acoustic resistance: the real component of the acoustic impedence which is responsible for the dissipation of energy.

Acoustic susceptance: an expression of the storage of energy as on the reciprocal feature of acoustic reactance. It relates to the compliance and the imaginary component of acoustic impedance.

Acoustic Reflex: is a reflex contraction of the stapedius muscle induced by sound stimulation.

Acoustic Reflex Threshold (ART): the lowest signal intensity capable of eliciting the acoustic reflex is recorded as the acoustic reflex threshold for the stimulated ear.

Admittance: an expression of the case of energy flow encountered at the ear drum.

Complex parameter: the portion of the complex acoustic impedance or admittance: eg., reactance and susceptance or conductance.

Contralateral reflex: the acoustic reflex monitored in one ear and stimulated in the contralateral ear. It is also called as crossed reflex….

Dynamic: refers to the change in a steady state condition: eg., dynamic reflex measurement is a change in steady state impedance as a result of acoustic reflex. Also the changing flow in energy through the middle ear induced by modigying the stiffness of the ear drum with air pressure in the ear canal.

Eliciting Stimulus: Stimulus used to elicit the intra-aural muscle reflex.

Equivalent volume: an expression of the compliance of the ear drum and middle ear in terms of a volume of air having an equicompliance. Expressed in cubic centimeter (cm) and equal to susceptance at 229 Hz.

Electro-Acoustic Impedance Audiometer: is an instrument used for evaluating functional integrity of hearing system using pure tones, noise and absolute and relative impedance measurements.

Fundamental Frequency: The principal component of a complex wave form or the component having the lowest frequency. Using the physical definitions the fundamental frequency is called the first harmonic, F1.

Impedance: an expression of the difficulty of energy flow encountered at the eardrum.

Immitance: the term used to express impedance and / or admittance

Intra aural muscle reflex: contraction of one or both of the middle ear muscles – usually monitored by measuring dynamic change in some aspect of the middle ear impedance.

Ipsilateral Reflex: the acoustic reflex monitored on the same side as the reflex inducing stimulus is presented.

Noise: is a mixture of sound, consisting of the numerous harmonics of a fundamental tone close to each other.

Narrow Band noise (NBN) : is a sound in which energy is concentrated within a small frequency interval.

Probe: is tube inserted and sealed in the ear canal that caries the incident and reflected acoustic signal and the variable air pressure from the immitance device.

<u>Probe tone:</u> the acoustic signal introduced into the ear canal whose properties are compared with the signal resulting as a consequence of reflection off the ear drum.

<u>Resonance:</u> is that frequence at which mass and stiffness of the middle ear are equally influential in their response to acoustic stimulation.

<u>Static Measurement:</u> a measure of the steady state of impedance or one of its components or their reciprocals usually accomplished with electroacoustic instruments by comparing the flow measured with the ear drum stiffened by air pressure introduced into the ear canal and flow measured with the ear drum relaxed.

<u>Tone:</u> A sound wave capable of exciting an auditory sensation and having pitch.

<u>Tympanometry:</u> the measurement of the changing flow through the middle ear as a function of pressure in external auditory metres.

<u>Wide Band Noise:</u> Wide Band noise is a sound in w hich energy over a wide range of frequencies, those frequencies close to the specific one being tested cause masking interference.

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CHAPTER ----- 3

REQUIREMENT FOR TYMPANOKMETRY

INTRODUCTION:

Tympanometry as we know today is a direct refinement of the electro-acoustic measurements first described by terkildsen and Thomson (1959) and Terkildsen (1962) who used the prototype of what was to become the first clinical electro-acoustic impedance bridge The actual term tympanometry was applied by terkildsen " to designate impedance measurements which require systematic pressure variations in the external acoustic meters (Feldman 1978).

Tympanometry is an audio logical test based on impedance principles. It is used for the simultaneous assessment of the mobility of the tympanic membrane and ossicular chain, the determination of the air pressure in the middle ear and evaluation of the air cushion of the tympanic cavity. It is of great value in clinical diagnosis of different middle ear lesions. Tympanometry is performed by generating a probe tone in the external ear canal and recording the change in the sound pressure level of the reflected probe tone while altering automatically or manually the air pressure in the ear canal. The recorded change of the sound pressure level indicates the relative change of impedance of the ear drum and the middle ear. Tympanometry was based on and developed from the principles of impedance measurements reported by metz (1946).

EQUIPMENT USED:

The basic equipment used in a tympanometry consists of an electro-acoustic bridge, a headset with earphone and probe unit, and a graphic recorder or balance meter for manual recording, variable electronic monometer.

PROBE TONE FREQUENCY:

Probe tone frequency selection in tympanometry is of no importance in the determination of pressure status of the middle ear. All probe tone frequencies provide the identical information for this aspect of tympanometry. Optimal delineation of pathology incluenced changing stiffness / mass relationships in the ear are best disclosed with high frequency probe tones and component analysis systems. The low frequency probe tones complex measurement system tends to limit the tympanometric capabilities to a pressure analysis-reflex system.

Among the variety of probe tones available to the clinician with commercial instruments are 220 Hz., 275 HJz., and 660 Hz. Laboratory studies have employed additional probe tones, such as 520, 625 and 800 Hz., among others. Regardless of instrument type, the probe tone is introduced into a sealed canal. Some of the acoustic energy is transmitted through the middle ear and some of it is reflected off the ear drum. The phase and amplitude of the reflected signal are a consequence of the interaction between the stiffness, mass and resistance of the middle-ear system. It is the analysis of the combined incident and reflected sound waves under varying states of air pressure simultaneously introduced into the ear canal that results in the tympanogram. The mechanical transmission properties of the ear drum and the middle ear act to influence the flow of the acoustic energy through the middle ear to the cochlea.

Most of the time probe tone frequency of 220 Hz is used and itis

Quite significant diagnostically. Researches have shown importance of high frequency probe tone also (Feldman 1974, Newman 1976).

In regard to stiffness-mass properties the use of higher frequency probe tones serves a very valuable role by helping to validate or invalidate static measurements made with low-frequency probe tone.

Tympankometry utilizing higher frequencies probe tone provides a better ability to analyse this stiffness / mass relationship of the ear. The changing relationship between stiffness and mass control of the middle ear transmission system is a normal phenomenon that occurs with increasing frequency and is revealed in tympanometry by increasing amplitude of the tympanogram and notching when sudden changes occur or there is reversal of stiffness / mass control at is passes through its natural resonance point. It should be no mystery then, why interruption of the ossicular chain results in broad and deep notched high frequency tympanograms. In such conditions, as the artificially induced stiffness imposed by varying amounts of air pressure in the ear canal is released, and the middle ear system is allowed to vibrate in its natural state, the tympanogram curve changes direction. This is nothing more than a shift from artificially induced stiffness to a state of decrease stiffness and greater stiffness influence. This increased mass control is then overridden by the return of air pressure induced stiffness and the direction of the tympanogram again changes.

It is this feature of tympanometry that is most influenced by probe-tone frequency. The lowered resonance of the system that

Occurs as a consequence of ossicular discontinuity or ear drum abnormality is revealed by amplitude changes with low frequency probe tones and peaking or notching with middle and higher frequency probe tones. Notching with low frequency probe tones is extremely rare. When only amplitude changes are available as in the case with low-frequency probe tone, it is impossible to establish their basis.

Ear drum abnormality is a far more common occurrence, than most people are aware. It is frequency undetectable by visual typanometry is highly sensitive to its presence. While this abnormality itself is of little or no clinical significance, its presence must be stablished in order to validate the static measurements. This critical validation is not possible with a system that is confined to low- frequency probe tones. Fortunately the notching patterns associated with ear drum abnormality tend to be different from those accruing because of ossicular interruption.

Based on above literature Acoustic Impedance audiometer shall be capable of generating or 0producing at least 220 Hz . and 660Hz. Probe tone frequency.

Impedance audiometer shall also provide a selector switch to selector either pro either probe tone freauency of 220Hz. Or 660Hz.

Probe tone :

Accoustic impedence audiometer shall be capable of generating or producing at least 220Hz and 660Hz probe tone frequency.

Impedance audiometer shall also provide a selector switch to

Select either probe tone frequency of 220 Hz or 60 Hz.

Accuracy of Probe tone frequency :

Total harmonic distortion of each probe tone shall not increase more than 1%. These distortion values shall be measured acoustically on an acoustic on an acoustic coupler or artificial ear.

Air Pressure pump:

Acoustic Impedance Audiometer shall be capable of producing wide range of air pressure with the help of electronic or manually driven air pressure pump. It should have safeguard stop at maximum pressure values as well as pressure range limiter.

Pump shall be solid state pressure transducer for long life reliability complemented by the self-adjusting zeroing (Auto zero) circuit, providing drift-free pressure measurements.

Different pressure produced by the manometric shall be displaced on manometer, indicating maximum and minimum air pressure with 20mmH2O subdivisions. For automatic recording pressure limiter shall be provided at intermediate value for negative and positive sweep.

Rate of pressure change shall belinear impedence audiometer shall provide air pressure ranged +300mmH2O to -700H2O with accuracy of ±5% full scale deflection.

PROBE TIP:

For tympanometry pressure has to be raised in the external anditory meters. Thus external auditory meters shall be scaled to ensure no pressure. The manufacture shall prove suitable

Probe tips along with the instruments. The probe tips shall satisfy the following requirements.

1. It shall be made of such kind of material which is not of a type known to cause irritation, and shall be resistant to skin oil. Hair oil and ear wax. The material shall be moisture-proof, hear resistant and cold-proof.
2. The material to be used to make probe tip shall not be damaged readily under normal handling and it's strength, hardness and elasticity shall be suitable for the purpose it is to serve.
3. The probe tips shall be made of materials that are capable of being cleaned and sterilized.
4. It shall be so constructed that no changes occur between -25^{0}C and 55^{0}C.
5. It shall not absorb or amplify frequency so that it affects measurements.
6. It shall be easy to insert and remove without causing any harm to external auditory meatusa. It shall be elastic to the ear canal, and shall be designed so as not to give uncomfortable feeling to the wearer and not to fall off easily from the ear.
7. It shall be provided in different sizes so that all age population can be covered. The probe tip shall be provided in following sizes.
   a) Very small
   b) Small
   c) Large
   d) Very Large
   e) Extra large

The size difference between any two consequence size shall be constant.

8. Different probe tips may be color coded for easy identification.

9. Spring headbands with adjustment provisions shall be provided to hold tip in convenient position .

10. All probe tips shall have fixed diameter for proper insertion in probe.

11. The probe tips shall pass the clean ability test, test air pressure test, damp heat test.

12. The Manufacturer shall provided instruction for cleaning the probe tips.

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CHAPTER – 4

REQUIREMENT FOR REFLEXOMETRY

INTRODUCTION:

The stapedial muscle contracts reflesively when the ear is stimulated with a sufficiently loud sound. This condition occurs bilaterally, even when only one ear is stimulated. Researchers have consistently documented that the necessary loudness range is 70dB to 100dB hearing threshold level(HTz.). The medium threshold value for the stapedial reflex to pure tone signal is approximately 85dB HTL and approximately 65dB HTL for white noise (Metz, 1952, Jepson, 1963).

The acoustic reflex has been found to be considerable value. The reflex threshold is used in

1. In gross estimation of threshold of audibility (Moller, 1962a, Lamb et al., 1968).
2. In identification of nonoraganic hearing loss (Rintelman and Harford, 1963, Lamb and Petersen, 1961).
3. As an aid in the diagnoisis of certain middle ear pathologies (Dujupesland, 1959; Klockhoff, 1961).
4. As an index of recruitment (Metz, 1952)
5. In identification of brain stem lesions (Steniberg and Louhardt, 1972; Greisen and Rasmossen, 1970)
6. The perstimulatory decay of the reflex at different frequencies has been implicated as a sign of VIII nerve pathology (Andersen et al. 1970).
7. In patients with lesions of cortical association areas, the reflex growth with intensity may show a truncated input-output function (Petersen and Liden, 1972).

In the demonstration of the acoustic reflex, the electroacoustic impedance technique measure the sudden change in sound pressure caused by the change in compliance of the middle ear system as the muscle contracts. The acoustics signal is introduced through an earphone attached to be the impedance audiometer headset. If the signal is sufficiently loud to the earphone ear to elicit the bilateral acoustic reflex, the contraction of stapedial muscle in the ear containing the probe tip will suddenly decrease the compliance of that ear drum (creating a sudden increase in the cavity sound pressure level) synchronously with the presentation of the stimulating ear phone signal. The lowest signal intensity capable of eliciting the acoustic reflex is recorded on the acoustic reflex threshold for the stimulated ear. This is called crossed reflex or contralateral reflex. For ipsilateral or uncrossed reflex stimulating tone is fed through probe only and threshold measured.

Requirement for Impedance Audiometer for reflexometer contralateral Reflex and Insilateral Reflex.

The impedance audiometer shall be capable of generating or producing at least 8 tones of frequencies of 250, 500, 1000, 2000, 3000, 4000,6000, 8000 Hz.

Impedance audiometer shall provide minimum upper limit of intensities as listed as in Table I for different frequencies.

Hearing Level Control (Attenuator):

The sound pressure level of each tone shall be adjustable in steps of 5dB or less throughout the full range of the instrument. One of the settings shall correspond to the hearing threshold level given in

Table - I

Frequency	Minimum upper limit Contralateral reflex	Hearing T.L. Ipsilateral Reflex
250 Hz.	110dbHTL	100dBHTL
500 Hz	125dBHTL	115dbHTL
1000 Hz		
2000 Hz		
4000 Hz		
6000 Hz	110dBHTL	
8000 Hz.		

Given in 301 of is.4555-1968 for the tone in question. This corresponds to an audiometric hearing loss of 0dB for this tone. The hearing level dial shall have a fixed index point and only one scale. The maximum levels for different frequencies shall be indicated on the hearing level dial.

Attenuator Linearity:

Attenuator linearity shall be within one dB over entire range.

Accuracy of tone Frequencies:

The frequency of each tone shall be constant and accurate to within ±3% throughout the presentation. Present controls to readjust the frequency when deviated from their specified value may also be provided.

Harmonic Distortion:

For the frequencies and hearing level settings listed in Table I the maximum level of the harmonics relative to the fundamental or the test tone shall not exceed the values given in Table II distortion shall be measured at the hearing level listed.

For air conduction distortion shall be measured acoustically or an acoustic compler or artificial ear.

Table II: Maximum Permissible Harmonic Distortion.

Frequency. Hz.	Air conduction	
	250-8000Hz	500-6000Hz
Hearing Harmonic	90	119
Second Harmonic	2%	2%
Third Harmonic	2%	2%
Fourth and each higher Harmonic	0.3%	0.3%
A11 sub-harmonic	0.3%	0.3%
Total Harmonic	03%	03%

Noise Requirement for Reflexometry:

Acoustic impedance audiometer shall be capable of production following type of the minimum upper limit of sound pressure level. Manufacturer shall also provide the value for per dB octave cutoff.

	Minimum upper limit in SPL	
	CR	IB
White Band noise (WBN)	125dBSPL	110dBSPL
Low pass noise with cut off Frequency 2600Hz.	125dBSPL	110dBSPL
High pass noise with cut off Frequency 2600 Hz.	125dBSPL	110dBSPL
Narrow Band Noise		

250	Hz	110dBSPL	110dBSPL
500	Hz	125oBSPL	110dBSPL
1000	Hz	125oBSPL	110dBSPL
2000	Hz	125oBSPL	110dBSPL
4000	Hz.	110oBSPL	110dBSP

Accuracy of Noise Level:

The level of the noise produced by on ear phone shall not differ from the indicated value by more than 5. -3dB the measured difference in output between any two successive designations of the noise level shall not differ from indicated or 1 dB. Which ever is smaller. Measurement for conformity with this requirement may be made acoustically or electrically at the input to the trasducer with the transducer attaced to a coupler. Alternatively the transducer may be replaced by a dummy load which simulates the transducer impedance at that test frequency.

Selector Switch :

1. Acoustic impedance audiometer shall provide a selector switch for different stimuli used to eleiciting reflex like pure tone, high pass noise, low pass noise, narrow band noise. It shell be easily operable with clear indicated stimuli.
2. Acoustic impedance audiometer shall be provided with an interrupter switch for the presentation of the test tone to the subject by the operator and its operation shall be such as to establish and eliminate the tone without production audible transients or extraneous frequencies. Switch shall be easily

Rise and Decay Time:

Rise and decay time of stimulus used for reflex measurement shall not exceed 50msec. during of stimulus presentation way be manually controlled or automatic controlled at two fixed timings that is for reflex measurement 1.5 sec. And for reflex decay test (Anersen, 1974) 10 sec.

Stimulus Indicator:

The manufacture shall provide a means of indicating, in impedance audiometer, whether stimulus is active or not may be by using lamp which glows as stimulus is on and puts off a stimulus is stopped .

Sensitivity Switch:

Acoustic impedance audiometer shall be provided with a sensitivity switch which may be also to increase of or decrease the efficiency of measuring acoustic reflex.

Recording of Reflex:

Impedance audiometer shall be provided with mechanism for detecting presence or absence of acoustic reflex as by means of deflection of needle or by means of electric lamp or graphical recording.

Manufacturer shall clearly define criteria for presence of reflex for both contra lateral and ipsilateral stimulus presentation.

If it is graphical recording then the speed of paper shall be constant and paper shall be calibrated in order to measure onset. During and decay time of acoustic reflex.

CHAPTER - 5

REQUIREMETN FOR COMPLIANCE MEASUREMENT

Static compliance is also a measure of middle ear mobility. The factors of compliance include mass, friction and stiffness which work together in a complex manner to facilitate or impede motion of the middle ear system. Historically, this test procedure is referred to as acoustic impedance. Currently, however, compliance seems to be a more appropriate the clinical contribution. Unfortunately, because a wide range of compliance values exist for various otologic pathologies that overlap with normal middle ear mechanisms, diagnosis of ear pathology based only on the static compliance measure must be considered with extreme caution.

Static compliance is measured in terms of equivalent volume in cubic centimeters based on two volume measurements. The first volume measurement (C_1) is made with the tympanic membrane clamped in a position of poor compliance with +200mmH_2O air pressure in the external ear canal. The second volume measurement (C_2) is made with the tympanic membrane at maximum compliance pressure. Since sound is more easily transmitted by the tympanic membrane (C_2), the probe-sound pressure in the enclosed cavity of the external canal is lower than noted in the first volume measurement (C_1), and a larger “Equivalent volume” will be indicated.

The static compliance measure is contaminated by the compliance of the air in the external canal itself. Static compliance is calculated by subtracting (C_1) from (C_2), which cancles out the external ear canal compliance and leaves a final compliance value

That is the amount of compliance of the middle ear mechanism. Thus (C_2) - (C_1) equals the static compliance of the ear in units of equivalent air volume in cubic centimeters.

Requirement for compliance Measurement:

The manufacture shall provide a compliance scale calibrated both in cubic centimeters and acoustic ohm. Ranging 0.2 to 5 cc and 200 to 5000 acoustic ohm. Scale shall be equally divided with one division equal to 100 acoustic ohm.

A Rotating switch shall be provided for moving the needle on compliance scale to indicate different compliant compliant values at different pressures.

Compliance scale shall not deviate more than five percent of the indicated compliance value and actual value.

CHAPTER - 6

REQUIREMENT FOR CALIBRATION OF ELECTROACOUSTIC IMPEDANCE BRIDGE

INTRODUCTION:

Calibration of any instrument is of greatest importance. Calibration can be defined on checking the output levels of any function and making them with specified value. As already mentioned electroacoustic impedance bridge used in conjunction with either a built in or an independent audiometer, which is used to elicit the acoustic reflex. It should be expected that those audiometer meet the Indian standard specification for pure tone Audiometers: IS:9098:1979.

In electro-acoustic impedance bridge the following parameters shall be calibrated.

1. Air pressure which is emitted from the air pressure probe on any of the electroacoustics bridges which use this parameter.
2. Probe tone frequency.
3. Probe tone intensity.
4. Reflex onset, duration and decay time.

Requirement for air Pressure Calibration:

The manufactures shall provide a standard manometer. By using either a direct connection or a piece of rubber tubing the probe from the impedance bridge may be connected to a manometer or "U" tube. One may then read directly the output in millimeter of water pressure (WP). At +200 the guage should read 200; at 0 it should read 0 and at -200.

It is recommended if pressure variation exceeds 25mm/wp the impedance bridge shall be adjusted. Variations from listed values will affect the absolute acoustic impedance measurement and

To a lesser extent the tympanogram (Wirber, 1978).

The manufacture shall provide an easy means to calibrate the air pressure precisely.

Requirement for Probe tone Intensity Calibration:

The probe tone intensity shall be measured in the decibal output. The manufacture shall indicated in the manual the output which should be expected at a given (usually 2 cc) volume setting. The specified output shall not vary beyond limits of ± 3dB.

Probe is attached to a 2 c.c comupler or Hearing Aid type I or II compler and attaching that comupler to a sound level meter, one can directly read the output from the impedance audiometer IA should be set to the appropriate volume and then read the output on the sound level meter.

Manufacture shall provide an means of adjusting the probe tone output.

Requirement for probe tone frequency calibration:

Frequency of probe tone shall also be calibrated and manufacture shall provide a means of adjusting the probe tone frequency. The probe tone frequency shall be with in 5% of the stated test frequency.

The frequency of the probe tone may be checked in the standard manner by either reading directly from the electronic frequency counter or by attaching the probe to the coupler thence to a sound level meter and finally to an electronic counter.

Requirement for calibration of reflex measurements:

The built-in acoustic reflex stimulator shall be calibrated in the same manner as described earlier for pure tone audiometer in IS specification for pure tone audiometer.

Attention shall be paid to the frequency intensity and rise fall time of the reflex stimulus.

The manufacture shall provide a system to check acoustic reflex system by affixing the probe to a standard closed 2 cc coupler to make sure that there is no apparent reflex elicited in the cavity. In some instances when there is electronic crossoner one will see a deflection on the meter which might suggest the presence of a reflex. Clearly a closed metal cavity cannot have an acoustic reflex. This false detecting indicates a problem within the machine which must be corrected.

CHAPTER - 7

GENERAL REQUIREMENTS FOR ACOUSTIC IMPREDANCE AUDIOMETER

WARM-UP-TIME: The maximum warm-up time shall be specified by the manufacturers and shall not exceed ten minutes when the unit has been stored at room temperature. The performance requirements of this standard shall be met after the stated-warm-up time has leapsed and after any setting-up adjustments have been carried out in the manner prescribed by the manufacturers.

Stability with Respect to Variations in the Environmental conditions:

The impedance audiometer shall be capable of operating with the specified requirement at all temperature within the range of +15 to +35^{0}C when the relative humidity is within the range from 30 to 90 present.

Power Indicator:

A suitable indicator shall be provided to ensure that the instrument is on when the switch is put in the ‘on’ position.

Housing: Housing shall be an integral part of the Impedance audiometer. The protector cover shall be provided with suitable windows where necessary.

Carrying Means: A suitable carrying means shall be provided Facilities for carrying accessories shall be provided. Where a separate carrying case is provided, it shall also have facilities for storing the normal accessories.

Unwanted Acoustic Radiation:

General : Objective acoustical measurements may be impracticable

For testing certain characteristics of impedance audiometric performance. In such cases, subjective tests described in appendix may be performed using a test crew consisting of an adequate number of selected ontologically normal subjects whose hearing threshold levels shall not exceed 10dB for the test frequencies 250, 500, 1000, 2000, 4000 Hz. And not exceed 20 dB for the frequencies 125, 6000 and 8000 Hz.

Extraneous sound of Electrical origin from the Earphone:

Extraneous sounds from any cause shall be of such a magnitude that the sound pressure level in any one third octave band us at least 10 dB below the signal from the 'ON' ear phone (suggested subjective test procedures to supplement these measurements are described in Appendix of IS:9098-1979).

Unwanted sound from an Impedance Audiometer:

Any sound due to the operation of impedance audiometer controls during the actual listening test, or to impedance audiometer, shall be inaudible at each setting of the hearing level dial ups and including 50dB. The test for this requirement shall be made by an ontologically normal subject wearing a disconnected earphone and located at the recommended test position, the electrical output of the impedance audiometer being absorbed in a resistive load equal to the impedance of the ear phone at 1000 Hz.

Power Supply:

The impedance audiometer shall be capable of operating with the specified requirements either from AC mains or battery or both within the limits or voltages as specified below.

Battery Operations: The impedance audiometer shall operate from suitable batteries as specified by the manufacturer. The number and type of cells shall be indicated. The batter shall be housed inside the audiometer itself. The limits of the battery voltages with which the impedance audiometer shall operate shall be specified by the manufacturer.

Mains Operation: The impedance shall operate from 240V ± percent, 50 Hz. AC power source. If any change in voltage is needed manufacture shall provide with built in or external eliminator.

Marking:

The impedance audiometer shall be clearly and indelibly marked with the following.

a) Manufacture's name and trade mark.
b) Type or model No. and Serial Number.
c) Supply Voltage, and
d) Country of manufacture.

The impedance audiometer may also be marked with the ISI certification mark.

Safety Requirements:

In so far as mains operation is concerned, it shell conform to the relevant requirements specified in IS:616-1957.

Workmanship and Finish:

Different knows and switches shall be of such shape and size so that they are easily operable and accessible to tester. Knobs which are used maximally shall be placed on right side so that they

Are operated by right hand easily. Manufacturers shall give good finishing or the impedance audiometer. The balance meter and manometer shall be placed in a position where one can read the scale easily.

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