GUIDELINES FOR THE PURCHASE OF INSTRUMENTS FOR THE SPEECH AND HEARING CENTRES

Reg. NO M 9119

An independent project submitted as part fulfilment for the first year

M.Sc. (Speech and Hearing) to the University of Mysore

All India Institute of Speech and Hearing
MYSORE - 570 006
MAY 1992

TO

BAI and KAKAJI

CERTIFICATE

This is to certify that the Independent Project entitled. **"GUIDELINES FOR THE PURCHASE OF INSTRUMENTS FOR THE SPEECH AND HEARING CENTRES'** *has been prepared under my supervision and guidance.*

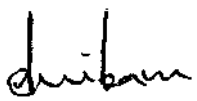
MYSORE
MAY 1992

Dr.(MISS).S.NIKAM
GUIDE

C ERTIFICATE

This is to certify that the independent Project entitled; **'GUIDELINES FOR THE PURCHASE OF INSTRUMENTS FOR THE SPEECH AND HEARING CENTRES"** *is a bonafide work, done in part fulfilment for the First Year Degree of Master of Science (Speech and Hearing), of the student with*

Reg No M 9119



Dr.(Miss). S.NIKAM
DIRECTOR
All IndiaInstitute of Speech and Hearing
MYSORE - 6

MYSORE
MAY 1992

DECLARATION

I hereby declare that this Independent Project entitled: **"GUIDELINES FOR THE PURCHASE OF INSTRUMENTS FOR THE SPEECH AND HEARING CENTRES"** *is the result of my own study under the guidance of* **Dr (MISS) S.NIKAM,** *Professor and Head of the Department 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 **Reg.No. M.9119**
MAY 1992

ACKNOWLEDGEMENT

I WOULD LIKE TO EXTEND MY SINCERE GRATITUDES TO:

My Guide Dr (Miss) S NIKAM, Professor and HOD of Audiology, AIISH, Mysore, for her suggestion, criticisms and concern without which the work could not have been accomplished.

Dr.S.NIKAM, Director, AIISH, Mysore, for permitting me to take up the work.

Mrs.VANAJA, Mr.ANIMESH, Mrs ASHA YETHIRAJ, for providing me their precious suggestions and informations.

MrsROOPA.N., MrsRAJALAKSHMI, Miss.MANJULA, for helping me at various stages of this project.

Mr.VENKATESH,C.S. Lecturer, Speech Science Department, AIISH, Mysore, for his valuable guidance, advices and suggestions.

Mrs.MANJULA, Mrs.GEETHA, Mrs.SUCHITRA, Mrs.SAVITRI, for their timely helps.

Mr BALASUBRAMANYAN, for his kindly helps and firing for not being punctual.

Mr RAMACHANDRA RAO & RAJLAKSHMI AKKA, for their helping hands

AIISH Library Staffs, especially, **RAMESH BABU** whose helping nature made it very convenient for me in preparing the write up.

PATHAKJI, BALA & **REGHU,** for their timely helps and they were the turning points of this project.

JYOTHI BALGI & **SUCHITRA,** for their valuable cooperation and timely helps.

Thanks to all my classmates, specially, **CHOTU, GANESH, SWATHI, RAJA AND RAVA, BALARAJU, NIRMAL, PATRA, ZAVER, PITU.**

Thanks a lot to the NSS **(NISHU, SUNIL & SHASHI)** for their help

Thanks to **SAI & SOMYA NARAYANAN,** for their constant encouragement.

Last but not least **Mr RAVI SHANKAR**, for his neat typing.

C O N T E N T S

INTRODUCTION

Welcome to the field of Speech Pathology and Audiology. Most simply, audiology refers to the science of hearing and the study of the auditory process. The audiologist is concerned with the development, anatomy, physiology and pathology of the auditory system. Audiologist deals with the evaluation of hearing and rehabilitation of hearing disordered person. Whereas, speech pathology, the study and treatment of all aspect of functional and organic speech defects and disorders (Wood k.S, 1971). One who carries out these functions is known as speech pathologist.

This field is newly developed and rapidly developing in all the areas like clinical, training and research. In clinical work, to arrive at diagnosis one has to use 2 types of testing methods. (1) Subjective and (2) Objective. Speech pathologist and audiologist have relied heavily almost exclusively on their trained ears for judgements. Based upon careful listening, clinicians often would make inferences. But auditory processing often does not leave the listener with a conscious awareness of the acoustic details that have combined to generate a given perception. We may not know what actually giving rise to these conditions. Ex. Perceived hypernasality may be the result of abnormal velar timing, rather than inadequate velopharyngeal closure.

Objective test excludes subjective factors. Observation and measurement made by objective method has significant advantage over unaided perceptual judgement. The advantages are:

1) Increased precision of diagnosis with more valid specification of abnormal function that require modification.
2) More positive identification and documentation of therapeutic efficacy both for short term assessment and long term monitoring.
3) Expansion of options for therapy modalities. Most measurement techniques offer a means of demonstrating to the patient exactly what is wrong and they can usually provide feedback on the degree of his success in modifying the fault.

Nowadays, speech and hearing centres are equipped with sophisticated and highly versatile indigenous and imported instruments. Such as clinical audiometer, impedance audiometer, brain-stem evoked response audlometry for audiological evaluation and instruments such as spectrograph, vlsipitch, PM pitch analyzer, high frequency resolution analyzer, expirograph, vocal-II, electroglottography for the purpose of diagnosis and treatment to individuals having speech disorder.

In all the newly developing centres for speech and hearing, apart from conduction indepth training programs, a

comprehensive diagnostic and therapeutic services to the speech and hearing handicapped are being provided. With the professionals of an inter-disciplinary team consisting of speech pathologists, audiologists, psychologists, ear nose and throat specialists, paediatrician, neurologist etc. Apart from these training centres, there are various speech and hearing centres as a separate unit or as a part of ENT department in various medical college and hospitals, where facilities are provided to speech and hearing impaired individual. Many private centres are also coming up. For the services in rural areas - many speech and hearing centres are seen in district rehabilitation centre (DRC), and regional rehabilitation training centre. So, there is increased awareness in different profession and layman, give rise to more and more speech and hearing centres in India.

According to Ashish Kumar Purwar (1981) done survey and found that 37.8% (N=42) of the total number of hospitals made speech and hearing services available. Out of 42 hospitals, 36 were located in teaching and only 6 in non-teaching hospitals. Speech and hearing services were found more in number in the state government hospitals (52.4%, N=22) next in order were private hospitals, central government and Quasi-government hospitals.

Many professions requires help of speech and hearing profession for their diagnosis and further treatment

procedure. Like an otologist need to have preoperative audiological evaluation to know whether the patient can undergo operation and postoperative evaluation to find out is there any improvement after operation. Criteria of cure for otitis media is the return of hearing to normal level and it can only be known by audiological evaluation.

Many screening programs are done in schools, rural areas to know whether the people have any problems concerned to speech and hearing. To do this, one requires different types of equipment.

There are many places where, no speech and hearing centre is present and now one wants to establish speech and hearing centre. Those people do not have much of experience regarding what, how and where to buy the equipment to set up speech and hearing centre. So, there is a need of such handout to help such people for the purchase of diagnostic and rehabilitative equipment for the purpose of objective evaluation and diagnosis and treatment for those with speech and hearing Impaired. And the research oriented centre needs more sophisticated equipments.

This project serves as a guideline for the administrator. The administrator may be of other profession or a layman. Ashish Kumar Parwar (1981) 65.7% of speech pathologists and audiologists were involved in administrative work. 60% in evaluation and further referrals. 45.7% planning

and ordering for purchases of equipment. 20% in preparation of budge. They may not know what to buy and what not to buy. They may not know what are the formalities to be done in a newly setup centre. One may not know the procedure of procuring the equipment.

This project serves as a guideline and gives information regarding :

1) The Importances of instruments in speech and hearing centre.
2) What to buy? and what not to buy?
3) What information one should have prior to purchase of an instrument?
4) How to buy (procedure of buying the equipment both indigenous and imported one).
5) Guideline for the purchase of equipment.
6) What accessories should be bought along with instrument?
7) Where to buy the equipment?
8) What is the estimated cost of the equipment?

HISTORY OF THE SPEECH AND HEARING INSTRUMENTS: HOW TIME HAS MOVED FROM PAST TO PRESENT IN SPEECH AND HEARING

In the family of science, audiology and speech pathology are young. In India born about two and half decades ago. As the infant grows up you can find lots of changes in him/her sameway, lots of changes from old to modern can be seen in this field. Almost every one is aware of the technological revolution of the last 2 or 3 decades. It has changed our homes, our ways of conducting business, our preferred recreations. It has revolutionized research laboratories and advanced medical practice inquantum leaps. The development of technology has also had its effect on our ability to observe speech and hearing behavior. Early clinicians and researchers commonly had to spend hours obtaining data about speech and hearing system function and their primitive (by today's standards) instruments were often incapable of giving them a clear picture of the variable being evaluated. In many instances this is no longer the case. Instrumentation today tends to be more reliable, more valid, much easier to use, less esoteric and more readily available.

In the 1920s it took several hours of work to produce a record of fundamental frequency characteristics of just a few seconds speech. The process involved is generating a record of the "speech waveform on moving film, developing the film, projecting it and measuring the wavelengths by hand, tabulating the results and deriving the summary means, wave

to wave variations and other measures of interest. Today, with several instrument, measuring fundamental frequency and obtaining a record of its changes during speech production can be done while the patient is speaking.

In audiology various tests has been developed ranging from the crude watch-tick and coin-click tests to the extensive quantitative measurements made possible by the development of puretone, speech audiometers. Impedance audiometry, BSERA etc. Between these extremes fall such time-honored tests as the spoken - and whispered - voice test and the various tuning fork tests. The development of the audiometer, like many other scientific advancements, cannot be wholly attributed to any one man of genius. It has been said that inventions seems to invent themselves when the culture is ripe for them and the audiometer and other instruments are not exceptions. It could only have been developed when all the pieces of an acoustic and electronic jig-saw puzzle fell together at a point of time when medical needs demanded such as instruments.

INFORMATION PRIOR TO PROCURE AN INSTRUMENT

The task of buying an equipment or for that matter any speech and hearing equipment often evokes apprehension and sometimes anxiety in prospective purchasers. In most cases, the buyer has to live with the instruments chosen for many years, and no one wants to be responsible for a poor choice, but in a new set up the buyer has to make purchase decision taking into consideration a number of factors.

A good purchase is a result of planning and multidimensional business decision. The four cirtical elements that should be included in purchase decision making are:

1) Technology: This defines the testing capabilities, applications and life expectancy of the equipment.
2) Capital budgeting: Equipment purchases are an investment and the conomic consequences of investing in the equipment must be closely evaluated.
3) Competitive advantage: Equipment purchase can provide the hearing health professionals with significant competitive advantages. Equipment can reinforce or help build a professional or high technical image. A client gets imporessed by the use of computers and computer based test equipment, video monitor that displays test results and computer print outs of test measurement allow the client to become more involved in their own health care and facilitate customer education.

4) Resource Requirement: The acquisition of new equipment often had unexpected costs, time, fund change. These costs may be associated with the installation or actual use of the equipment. One should plan for these costs.

The person asking for equipment should have an up-to-date knowledge in that field. As the person asking Instrument in thi3 field should have knowledge about audiology and speech pathology one must know where do you get the instrument. Whether it is indigenous or imported . This can be done by going through the advertisements in the leading magazines, journals of this field. Usually the new equipment that is put into the market will be advertised in such a manner that the person purchasing the instrument should write to the concerned firm and asks for more detail of that equipment called as catalogs or manual of the equipment. Best time to get information regarding new-new equipment or products is in the beginning of the year i.e., January.

Before buying any instrument one must know about the cost of that instrument. So, one must collect invoice of that instrument. Such information is collected before requisition for budget is made. One should get information regarding the technical details of that instrument. Whether, we can calibrate if or not. If not, where we have to send it for calibration. Details about the accessories required with the instrument. How often w have change it. Estimated cost of the

accessories is also collected. One should know about the procedure of buying the equipment both indigenous and imported one.

It is wise not to risk buying an equipment from manufacturers who are new comers in the field as one never knows if they will survive. Select well established companies and priority may be given to those from whom some other equipment is already purchased and in working to ones satisfaction.

It is often advantagenous to try to define the longterm goals of the facility. If expansions of a facility's service is a serious possibility, equipment to be purchased should have broad enough capabilities to meet further needs and to be able to interface effectively with any future purchases. A close examination of a facility will help identify its strengths and weaknesses and enable planning for future growth. It is important to define needs, goals, patient population, physical plan and staff capabilities before hand, to avoid costly mistakes that can result from hasty decisions.

Preferably obtain information about a particular piece of equipment which you wish to buy from other professionals who have worked on it and learn about their experiences regarding reliability of generated data, ease of use, service history, availability of inservice and support from the

manufacturer and/or special instrument distributor who sold it. One place to start such an inqury is with former instructors, employers or classmates. These are often individuals who will provide a candid assessment of their experiences. However, one should not permit a single assessment to guide a purchase, an individual may have had a bad experience with a piece of equipment, that generally, has a good track record. Seek out more than one opinion to avoid getting biased.

Shop around: After speaking to a variety of instrument users, it may be advisable to see the various pieces of equipment. One may get an opportunity to handle these equipments during exhibits in conferences, seminars etc. This not only gives a first hand opportunity to watch the working of the equipment, it also enables one to obtain necessary literature and technical specifications for later study.

After making a check list and arriving at a tentative decision **regarding** the purchase of the equipment **in** consultation with other professionals, the next step would be to contact the **special instrument distributors (SID).** Besides the manufacturer, the role of the SID is equally important in decision making process . It therefore becomes essential to choose a SID whose reputation and work is well known and respected. The manufacturers provide information on who distributes the specific instrument of interest.

Functions/Role of **SID:**

1) The SID not only sells instruments but also installs and usually warrantes the equipment for the manufacturer.

2) They tend to repairs of equipment when necessary. As most of the ERA equipments are purchased from foreign countries, it is not feasible to ship them to the manufacturers in case of repair. It is here that the SID comes to the rescue.

3) The SIDs provide ongoing support during the time of first working with the new instrument.

4) The SID generally goes through the needs list prepared by the prospective buyers and suggests the specific piece of equipment best suited to meet the individual requirement.

5) Besides technical specifications the SID also keeps the customers budget in mind. If there is a fixed amount to spend, certain prices of equipment may be outside the budget. In short, a SID and specifically, the instrumentation consultants should be able to help define, refine and target the equipment needs. They should advice on financing the equipment and arrange for its installation and inservice.

BUYING A USED EQUIPMENT

When considering the purchase of used equipment, the following questions should be asked:

- Is the product still is production?
- Can you get parts for it?
- Was it manufactured by a reputable supplier?
- Is the manufacturer still around?
- Does your local SID service that product?
- How old is the equipment?

Examine the service record, consider why this equipment was traded in? why is it being sold?

One of the main advantages of purchasing used equipment is the cost factor. If used equipment is purchased through a local SID, there are chances of the equipment being reconditioned and depending on the condition will carry a limited warranty. If the equipment is to be purchased from a private party, it is recommended that the product be shipped to a reputable dealer/distributor for evaluation. Without an electronics background, thorough examination of a product to determine if it is in good condition or not is difficult. Normally, a distributor will evaluate used equipment for a nominal fee.

Even if the piece of equipment that is running smoothly is purchase, consideration should be given to who can be called when service is required.

The effective life of used equipment is less. As a buyer, determination must be made as to whether the loss of those yars will be worth the savings in lost.

HOW TO BOY OR PROCEDURE OF BUYIHG AN INSTRUMENT

Before buying any equipment one must have detailed information regarding that instrument as mentioned in previous chapter. Such information is collected before making budget. In some of the institutes the budget proposals are made annually or quarterly.

The person should be ready with the list of instruments with he/she wants to buy in that department. The need of the department or institute depends upon the type of function carried out in that institute. It can vary from clinical, training to research need. The equipment asked for should be suitable to meet all these needs. For ex: In the clinical setup one requires instrument both for assessment and treatment. As in audiology the professional needs audiometers suitable for the diagnosis and in speech pathology needs speech trainer for training. If clinical, training and research all the functions are carried out in the institute one need more sophisticated equipment. This again depends upon area of research or current interest that develops in that department. The equipment is listed on priority of use. What should bring first and what should bring next. Urgent needed instrument are listed first in the list. Once the list is prepared, following type of detailed information regarding the instrument is made;

1) Name of the instrument as given by the company.
2) Estimated cost of the instrument.

3) Accessories that might be required along with this instrument.
4) Accessories that may have to be replaced frequently once the instrument put into the use.
5) Justification of the use or need of that instrument in that department.
6) Invoice should be collected before requisition is made to the higher authorities for the acquisition of that instrument.

Invoices are supplied by manufacture or company with gives the cost of the instrument and accessories including sales tax and mail charges depending upon the type of delivery mode of this equipment. The cost mentioned in the invoice is only an estimated, need not be same as the equipment is actually delivered in the institute. This is because there may be variation in the price of that equipment over the time and hence, if there is gap between the period of asking for equipment and finally receiving the equipment there may be some price differences.

As the next step the equipment list is referred to the committee concerned which either approve it or rejects it depending upon the sanctioned budget from the ministry or sanctioning authority. Also, the committee approves only equipment which are needed urgently depending upon the budget.

Quotation: If the equipment is approved quotation are called from the firm with manufacture that particular equipment.

Quotation can be called for non proprietory equipment (redimate), not for proprietry one. For proprietory equipment. One has to make one proforma regarding what actually you wants and send it to the concerned company. Company will send invoice and catalogs regarding that equipment. If it is approved then buy it.

Quotation need not be called for proprietory equipments (i.e., not ready made). If the equipment is manufactured by only one company, then one need not call for quotation, one can directly buy it. If the same equipment is manufactured by 3 or 4 companies with slight difference in quality quotations have to be called. A specific date will be given in the advertisement for quotation or directly informed to the firm concerned and the firm will have to send invoices and detailed information to the institute before the last date given in quotation. The information will be sent in a scaled cover.

Opening of the Quotation: Once the last date for receiving quotation expires, the office persenate of the institute opens the quotation i.e, scaled cover of quotation in the presence of people from the respective company and head of the institute. This is done to avoid cheating in the process.

The lowest quoted figure or cost of the equipment given by the firm is accepted and the equipment is ordered from this particular firm. In a government setup there are formalities to be performed. In the official procedure it is required that at least 3 quotations be called for a purchase of an equipment. Sometimes high cost equipment also can be purchased depending upon quality. The reason has to be mentioned why low cost equipment is not purchased.

Spot Quotation: Some time one cannot call quotation due to emergency, urgent need of instrument. One has to buy the instrument directly from the firm with out quotation.

Payment: As the equipment is delivered from the manufacturing company, payment is done either through bank or paying directly from the organization to the manufacturing company. Usually in Government setup 90% of equipment cost is paid soon after the delivery of the equipment and 10% paid later after assessing the performance of the equipment over a period of time. This is a precautionary measures taken by the organization to see if the equipment is right within the guarantee period promised by company. Along with equipment accessories are also purchased and sometime extra number of accessories are purchased in order to avoid delays that might occur if the equipment goes out of order and there is delay in purchasing the accessories. When the equipment is delivered through the organization the technical person who

requested for this equipment approve the bill and equipment only after checking the functions of equipment thoroughly.

This checkup is sometime done by electronic engineer. In this period the manual supplied the company is referred to make thorough checkup. The payment is done only after this approval is given by the technician.

Purchase of the equipment can be done with in the country or outside the country.

1) Indigenous equipment - above all the steps can be followed for the purchase of indigenous equipment.

2) **Non-**Indigenous equipment - for the import of equipment some additional step have to be followed along with steps followed in the purchase of indigenous equipment. Before purchase of equipment from foreign manufacturers one has to get NOC (No objection Certificate) from DGTD (Directing General of Technical Development) and NMIC (Not manufactured in India Certificate) has to be taken from department of commerce. This is a directory this keep information about all the manufacture companies in India regarding all the technical equipments that there companies manufacture. The DGTD sees that the requisition made by the Institute is for an equipment which is not really available with in the country and only then if gives approval. Another approval, CCP (custom clearance certificate) is obtained from CCE&I (Chief Controller of Export and Import). This is done to make

way for equipment without any problem at the custom (Ex: AIISH has issued a pass book for imports of equipment (from Address. No.40).

This pass book will be valid for particular time interval, then we have to issue fresh one. Wherever we need to buy any equipment we have to write in this pass book a brief description of item to be imported, CIF value in Rupees and whether consumable or other items. This pass books is given only to Government Institute not in private one.

GUIDE LINE FOR THE PURCHASE OF ACCESSORIES

Accessories are something subordinate or additional but contributing to the principal cause of producing general result. For example ear mold is an accessory of the hearing aid. Each instrument have some accessories. Standard accessories are those which are compulsory, where as optional accessories are those which depends upon once needs. It is not compulsory to have these optional accessories.

Purchase of accessories are as important as purchase of instrument following points should be taken into consideration while purchasing the accessories.

1) While purchasing the instrument are should check whether the instrument has accessories or not. If it has then whether it is standard or optional one.
2) If the accessories are indigenously available, then it is better to purchase indigenously than importing it because it is cost efficient.
3) One should find out how often the accessories are needed to be replaced for a particular instrument. If it has to be replaced frequently, then one should have stock of such accessories so one need not wait till it comes from the company. Owing to frequent hike in price one may purchase these accessories in bulk.
4) While purchasing it, one should see whether it is according to the standard specified.
5) Better to get the accessories along with equipment it self and from the same manufacture.

DIAGNOSTIC INSTRUMENTS

AUDIOMETER

Def: An Instrument for the Measurement of hearing acuity (IS: 1979)

Audiometer can be divided into two types:

1) Manual Audiometer: A pure tone audiometer in which the signal presentations, frequency and hearing level selection and recording of the results are performed manually (IS-1979). This is most often used audiometer for the screening, diagnostic and clinical purpose.

2) Automatic recording audiometer: A pure tone audiometer in which signal presentations, hearing level variation, frequency selection or (for Bekesy type) frequency variation and recording of subject responses are implemented automatically (IS: 1979).

The purchase of audiometer not only depends upon the budget but it also depends upon the setup.

If it is a paediatric setup, one may give importance to the BOA (Behavioral Observation Audiometer). Therefore only screening may become important. Test battery contains reflex inhibition audiometry, visual reinforcement audiometry (VRA), peep show audiometry, TROCA etc.

In an otological setting, one may need to know the type and degree of hearing loss, whether it is conductive, SN-Cochlear/Retrocochlear. For that one needs to have a diagnostic audiometer with speech audiometer and some of the

special test facilities like TDT, STAT, ABLB, MLB, SISI etc. Immittance audiometry may also be required.

In a neurological setup, audiologist work for evaluating the hearing of the patients with neurological symptoms as well as to differentially diagnose the case based on the site of the lesion. For this one may need to have BSERA, immittance audiometry along with a diagnostic audiometer.

In an industrial setup, diagnostic audiometer is sufficient, but chances of pseudohypacusis cases are more in industrial area when compared to other areas. So, one should have facilities for the tests of pseudohypacysis in the audiometer like stenger, DAF etc.

In a research oriented setup, one may require more sophisticated instruments like clinical audiometer having all most all the facilities for testing. For ex: Amplaid 455, Madsen OB822, GSI-10 etc. One may also have a dual channel FM tape recorder as an accessory to the audiometer for presenting stimulus, depending on the need. Other instruments like immittance audiometer (Madsen 20741), instrument for measuring ABR, MLR, LLR etc (like Nicolet).

All these instruments have standard specification as given by different standards like IS, ANSI, ISO, IEC etc. The specification for puretone audiometer by IS Standards is given in Appendix-A.

POINTS FOR CONSIDERATION

1) If a battery operated audiometer is purchased, sufficient funds must be available to meet the recurring expenditure.
2) If you intend to import the audiometer, it is a time consuming process. In order to get the customs duty exemption, you have to get the import licence, NMIC etc otherwise customs duty will be heavy.
3) One can buy amplifiers and loudspeakers separately for use with audiometers that have facilities for free field testing (Speakers: 5,9,23,11-16,30).

Note: To know the addresses of the manufacturers refer to Appendix-L.

4) A 2-room situation is required to carryout speech audiometry using monitored live voice and for free field testing.
5) Calibration or repair of imported audiometer is difficult. It has to send to the manufacturer concerned or to the Indian dealer for the manufacturer.
6) Purchasing audiometer for testing older people or drug induced hearing loss patients one needs to have high frequency range like 6K to 12KHz or one can purchase **"High frequency audiometry".**
7) **Automatic audiometry** - Ex Bekesy audiometry. Audiometers that utilize an oscillator with a range from 100 to lO.OOOHz may be used. The tone may be either automatically pulsed or presented continuously. One should look at the frequency, intensity range, attenuation rate, chart speed, masking noise etc.

8) Computerized audiometers - A computer may be programmed to control all aspects of administering pure tone air and bone conduction stimuli, speech stimuli, masking, analyse the subject's responses in terms of threshold determination criteria, and present the obtained threshold values in an audiogram format at the conclusion of the test. The instrument should be microprocessor controlled which allows it to be remotely operated by a computer.

10) Insert Earphones - A modern alternative to conventional headphones called as **Tubephones.** the pocket-sized covered by foam material (to fit snugly into ear canal) electronic device is connected to audiometer just like typical head phones. One can test threshold in noisy area also, AC masking is needed less frequently and it is comfortable.

11) In the digital system audiometer if display facilities are available one needs to have AC room (It is necessary for indigenous audiometers than imported).

12) One should see whether the audiometer has built in calibrator or not.

13) Some of the audiometer have option for the connection to the computers. So that one can record results (audiogram) into it.

14) For children's testing following facilities are available:

Peep-show audiometry - can used along with the audiometry. One should look at the specifications like digital selection of frequency, attenuation, light stimulation, frequency, tone and light stimulation, sound source, (loudspeaker) etc. It is available indigenously.

Visual reinforcement audiometry - It uses visual representation of pictures while testing hearing threshold. It can be connected directly to the patient response connector of the audiometer. One should look at the specifications like audiometer interface, video output, monitor type, power supply, operating environment, accessories etc. Other facilities are also available like puppet in the window illumination test, conditioned oriented audiometry (COR) etc.

Infants hearing test unit - available at 5, 49, 108.

Cost of the Audiometer (Indigenous audiometer):

Screening - 4000 to 10,000

Diagnostic - 15,000 to 40,000

Clinical - 40,000 to 70,000

Technical specifications for the different types of audiometers are given in Appendix-B. Manufacturer **1,** 2, 3, 5, 7, 9, 11, 12, 13, **14,** 15, 16, 23, 26, 33, **49, 54,** 60, 77, 78, 80, 82, 101, 108, 125 and 138.

Calibration of the Audiometer:

Use of calibrated equipment is a pre-requisite. for an accurate audiological evaluation. Failure to calibrate the

instrument at appropriate intervals may be a major cause of unreliable test results.

Three parameters need calibration in puretone audiometry:

i) Intensity,

ii) Frequency, and

iii) Time.

Summary of the equipments used for the calibration of audiometer are given in Appendix-C.

The purchase of the equipments used for the calibration of audiometer depends upon (i) type of audiometer - for ex: Calibration of the screening audiometer requires less instruments than diagnostic or clinical. If one has a portable audiometer with only AC facilities, then it is better to send it to the manufacturer or place concerned for the calibration, because it is not economical to purchase instrument for the calibration. Instrument required depends upon facilities available in the audiometer as given in Appendix-c. Some of the audiometers have in built calibrator, so one need not have any instruments for calibration. (ii) Type of earphone and ear cushion - different types of audiometers may have different types of earphones like TDH 39, TDH 49 etc and different types of ear cushions like circumaural and supraural. Artificial ear cannot be connected directly to the all the types of earphones and ear

cushions. Some of them have to be connected with the help of the adapter For ex: Circumaural ear cushion needs adapter for connecting it with the artificial ear.

ARTIFICIAL MASTOID

A device that simulates the mechanical impedance of the human mastoid process. It is used with a SLM in calibrating the level produced by bone vibrator.

Replication of the mechanical impedance of the human head is difficult with an artificial mastoid. No commercially available mastoid meets the mechanical impedance requirements of the ANSI (1972) or IEC (1971) standards. However, both standards are being revised to conform more closely to an artificial mastoid which is available. While purchasing the artificial mastoid one should look at the specifications like frequency range, charge and voltage sensitivity to acceleration and force, adjustable static force, calibration surface area, inertial mass etc. It costs around 80,000.

ARTIFICIAL EAR

A device consisting of a 6 c.c. coupler and a microphone for the measurement of sound levels produced by an earphone. The microphone, coupler, weight and cathode follower may be purchased collectively as an "artificial ear".

The 6 c.c. coupler was originally chosen because it was thought that the enclosed volume under an earphone for a

human ear (Corliss, 1933). But the 6 c.c. coupler doesnot replicate the impedance of the human ear, it cannot be considered a true artificial ear.

IEC uses the IES 318 coupler. But even of this couplers impedance characteristics are also not exactly those of the real human ear.

But ANSI standard currently accepts only the NBS 9-A coupler (NBS-National Bureau of Standards).

Despite these difficulties the 6 cc coupler has been accepted as a standard device for measuring acoustic output from the audiometer through an earphone.

It is important to make sure that the condensor microphone fits snugly into the coupler. This is rarely a problem if components are purchased from the 3ame manufacturer. While purchasing the artificial ear one should look at the specifications like microphone (1" or 1/2"), preamplifier, coupler, maximum force applied to the top of acoustic coupler etc. Costs around 80,000. Manufacturers 2, 11,16, 29, 30, 85, **94,** 106, 108.

Distortion meter: Used for accurate distortion measurement for frequency. While purchasing one should look at the specifications like range, filter characteristics, accuracy, distortion introduced, meter indication etc. Manufacturer - 10, 45, 47.

Other instruments required like mic, SLM, OFS, Piston phone, frequency counter, oscilloscope, AF analyser and GLR have been discussed in the chapter Noise Measurement.

2) Calibration of the loudspeakers: Should be checked in an anechoic chamber so that precise frequency response characteristics can be obtained. Ideally, sweep frequency oscillator, condensor microphone and GLR are used to check the frequency response curve of a loudspeaker. Harmonic distortion measurements can be done with a distortion meter or other device, as discussed in conjunction with earphone calibration, should be used.

3) Calibration of the automatic audiometer (Bekesy): Begins with frequency, intensity, cross-talk and other aspect described for manual puretone audiometry.

The attenuation rate can be measured with a stop watch. To measure pulsed stimulus duration one can use electronic counter i.e. frequency counter speed of interruption can be measures with the help of oscilloscope.

Some of the above mentioned instruments may be purchased as a single package, as well as by individual components, for ex: one can purchase an "artificial ear" which will include a mic, a coupler and a SLM which may be used with the "artificial ear". But other equipments like oscilloscope, GLR, frequency counter, AF analyser etc are more costly and less used one. So it becomes difficult for a single person

to purchase all the equipments. These equipment can be shared with other audiologist in the area. Otherwise one can send the instrument it self for the calibration to the manufacturer or place concerned. Sometime one can call a representative from the manufacturer or place concerned with equipment for the calibration.

OTOACOUSTIC EMISSION (OAE)

This is one of the objective noninvasive technique to screen for hearing loss even before the age of 8 months when the ability to localize sound is used.

OAE is separated into 2 categories

OAE	Notation	Stimulus used	Response Measured by
1) Spontaneous emission	SOAE	None	Mic
2) Evoked emission			
a) Transiently evoked	TEOAE	Clicks/+one brust	Mic
b) Stimulus frequency	SFOAE	Continuous pure tone	Mic
c) Distortion product	DPOAE	2 continuous pure tones	Mic

TEOAE is clinically established one for neonatal screening. DPOAE has potential of getting threshold of hearing but still it is in the experimental stage.

The whole instrument is programmed in microcomputer and a probe is used to stimulate and measure the response (ear phone and mic). For this testing one need not get air tight seal, but sound proof room is must. Most of the OAE measuring instruments are in experimental stage.

Manufacturer: Indigenously not available. Commercially available ILO-88 developed by Otodynamics limited.

IMMITTANCE AODIOMETRY

Today, there are more impedance instrument manufacturers then ever before. In addition, the impedance instruments availability are quit€ diversified.

Armed with a list of general impedance instrument requirements, the hearing care professional next should consider measurement (diagnostic) needs and output (reporting) needs. For example: If the majority of a hearing care professionals referrals is from a local paediatrician whose primary interest is whether or not fluid is present in the ME sapce, that person's diagnostic priority may be quite different (screening) from a hearing care professional whose referrals come largely from an otologist seeking detailed site-of-lesion diagnosis and appropriate treatment of more complex pathologies.

In evaluating output needs, one may have to look at a variety of factors.

- Is a hardcopy printout of test results necessary?
  If so, what formate should it take.
  Strip chart or 8 l/2"x 11" standard paper?
  Will it be desirable to save the data to computer?
  Will it be useful to integrate impedance findings with other test results in a combined reports?
  Will it be necessary to review and analyzer the data in ways other than it was obtained and recorded after the patient left?

The important step is to learn about the technology used in impedance instruments because all impedance instrument have some common capabilities. For ex: inorder to perform tympanametry all impedance instruments have the ability to change air pressure. How they do this can be important.

When selecting an impedance instrument, it is beneficial to organize the information, so a purchase selection can be made easily. With in the category of impedance testing, the instruments can be divided into categories according to the market segments they service:

A) Screening instruments

B) Clinical instruments

C) Research instruments for advanced research applications.

A) Screening impedance instrument:

The primary goal of screening tympanometry is to provide early identification of ME conditions that may be provided as a result of identification.

- Screening impedance instruments incorporate the basic function of tympanometry often with pass/fail approach of the testing.

- Some screening impedance instrument also include the capability to test acoustic reflex responses normally, occuring with in 85 to 95dBHL.

- Certain immittance screening devices also include screening audiometry capabilities. Ex GSI 28A.

- Some screening instruments have display but some may not have display of the tympanogram at all (Ex. GSI37). They may be manually operated. The measuring instrument must be sensitive and artifact free enough to reliably detect the response.

B) CLINICAL IMPEDANCE INSTRUMENTS

Clinical middle ear analysis is complete, highly accurate and sophisticated middle ear analysis may be performed with clinical instruments today. While they often contain screening like capabilities (since it is a subset of their total capability), their emphasis is upon full manipulation of the test configuration, more types of testing, more thorough testings and much more flexibility with the display and manipulation of the data after it is acquired. Within the category of clinical instruments, a further division can be made into instruments that are analog and instruments that are computerized or digital.

1) Analog Impedance Instruments - are those that do not store the data as it is recorded. They record the wave form results in real time on paper. The recorder tradionally used has been a plotter. These instruments are simple to use and understand and **give** a straight forward approach to testing. Ex: Virtual model 201.

2) Computerized Impedance instruments - can be separated into 2 categories;

a) Those with a computer designed into them (Computer Integrated), and

b) Those which use an external computer to control the testing (stand alone computers).

Impedance instruments in both of these categories can offer high flexibility of measurement parameters, extensive data manipulation and formatting and at the same time short test procedures. Measurements are made under the direction of the computer in chip form or stand-alone wave forms and other measured values are digitized and shown on a display, rather than being recorded in real time on paper. By doing this, more data can be recorded and then selective parts of it can be printed for a hard copy record. After acquiring the data and storing it in the computer memory, the data can be manipulated, which perhaps is one of the most powerful features of the computer-based instrument.

A clinical middle ear analyzer, should contain all of the capabilities necessary for performing a standard middle ear test battery. Generally test capabilities of clinical impedance instruments include:

- Diagnostic tympanometry
- Reflex threshold
- Reflex Decay
- Eustachian tube function for intact and perforated eardrum,
- Screening tympanoraetry and reflex for fast middle ear analysis of difficult to test patients.

Testing may be performed (a) Automatically - or (b) manually whereby the operator has full control of the test situation. Some impedance instruments may be operated only manually for ex: Amplaid 720, Madson ZS331 and some may be operated automatically for ex: Madsen ZS331, GSI 28A Auto Tymp.770 and some may be able to operate both automatically and manually. For ex: GSI-33 ME analyzer, Massen ZS77MB.

CONTENT AND REQUIREMENTS FOR TYMPANOMETRY

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

i) Probe tone frequency:

It has been observed that most of the impedance audiometer use low probe tone. But tympanometry can also be performed using high probe tones.

Probe tone frequency selection in tympanometry is important in determining stiffness/mass relationship. Acoustic impedance audiometer shall be capable of generating or producing at least 220Hz and 660Hz. Most of the time probe tone frequency of 220Hz is used and it is quite significant diagnostically. But low frequency probe tone alone may not be optimal for the differential diagnosis of some ME pathologies.

Acoustic reflex testing using a probe tone of 1KHz also has been shown to be highly effective in eliciting acoustic reflexes in infants.

Impedance audiometer should also have a selector switch to select different probe tone frequency.

Accuracy of probe tone frequency: The accuracy of probe tone frequency shall not increase more than *±5%.*

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

(ii) Air pressure pump:

Acoustic impedance audiometer should 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 limits.

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

Different degree of pressure produced by the manometric shall be displaced on manometer, indicating max and mim air

pressure with 20m H2O subdivisions. Rate of pressure change should be linear. Impedance audiometer shall provide air pressure ranged +300mm H2O to -700mm H2O with accuracy of ±.5% full scale deflection. Some impedance audiometers provides choice of sweep rates including fast (600/200 dapa/sec) or a very slow rate (of 12.5 dapa/sec) which allows more accurate definition of flaccid tymps is available. Start pressure (positive or negative) and normal or wide pressure ranges also are selectable.

(iii) Probe Tip:

For tympanometry pressure has to be raised in the external audiotory meatus. There should not be any pressure leakage. The manufacturer should prove suitable probe tips along with the instruments. The probe tips should satisfy the following requirements.

- The probe tips should not be made of materials which may cause irritation, and shall be resistance to skin oil, hair oil and ear wax. The material shall be moisture-proof, heat resistance and cold-proof.

- The material to be used to make probe tip shall not be damaged readily under normal handling and its strength, hardness and elasticity should be suitable for the purpose it is to serve.

- The probe tips shall be made of materials that are capable of being cleaned and sterilized.

- It shall not absorb or amplify frequency so that it affects measurements.

- It shall be easy to insert and remove without causing any harm to external audlotory meatus. 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.

- It shall be provided in different sizes, so that all age population can be covered. The probe tip shall be provided in following sizes. Very small, Small, Large, very large, extra large. The size differences between any 2 consequclve size shall be constant.

- Different probe tips may be colour coded for easy identification.

- Spring head bands with adjustment provisions shall be provided to hold tips in convenient position.

- All probe tips should have fixed diameter for proper insertion in probe.

- The probe tips shall pass the cleanability test, air pressure test, damp heat test.

The manufacturer shall provide instruction for cleaning the probe tips.

For clinical accuracy, the probe should be light weight (for ease of obtaining and maintaining a 3eal) and should be self supporting to reduce movement artifact. Innovations have occurred in probe design and in the use of insert earphone transducers which offer benefits regarding collapsible ear canals and improved noise and interaural attenuation.

Recording: In manually operated the graph has to be plotted. On x-axis pressure and on y-axis compliance manually.

In automatic the tympanogram may be displayed on LCD. It is possible to display on a CRT a compensated (base line) tymp or uncompensated tymp.

COMPLIANCE MEASUREMENT

Static compliance is also a measure of ME mobility. The manufacturer shall provide a compliance scale calibrated both in cubic centimeters and acoustic ohm ranging 0.2 to 5cc 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 values at different pressures.

Compliance scale shall not deviate more than 5% of the indicated compliance value and actual value.

The impedance audiometry should also give information about physical volume and gradient (If it is automatic it should be displayed).

REQUIREMENT FOR IMPEDANCE AUDIOMETRE FOR REFLEXOMETER CONTRA AND IPSI 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 and 8OOOHz.

Important frequencies for reflexometry are 500, 1K, 2K and 4KHz. Impedance audiometer shall provide minimum upper limit of intensities as listed in Table-I for different frequencies.

Frequency	Minimum Upper Limit contra reflex	HTL Ipsi reflex
250HZ	110dBHTL	lOOdBHTL
500Hz	125dBHTL	115dBHTL
1KHz	125dBHTL	115dBHTL
2Kha	125dBHTL	115dBHTL
3KHa	125dBHTL	115dBHTL
4KHz	125dBHTL	115dBHTL
6Khz	110dBHTL	—
8KHa	110dBHTL	-

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. The maximum levels for different frequencies shall be indicated on the hearing level dial.

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. Preset 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 of 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 listed acoustically or an acoustic coupler or acoustic ear.

TABLE-II: Maximum permissible distortion

Frequencies	Air Conduction 250-8KHs	500-6KHZ
Hearing level (dB)	90	119
Second Harmonic	2%	2%
Third Harmonic	*2%*	2%
4th & each higher harmonic	0.3%	0.3%
All subharmonic	0.3%	0.3%
Total Harmonic	03%	03%

Noise required for reflexometry:

Acoustic impedance audiometer shall be capable of producing following type of and minimum upper limit of SPL. Manufacturer shall also provide the value for per dB Octave cutoff.

	Minimum upper limit in SPL CR	IR
White band noise	125dBSPL	110dBSPL
Low pass noise with cutoff frequency of 2600Hz	125dBSPL	110dBSPL
High Pass noise with cutoff frequency of 2600Hz	125dBSPL	110dBSPL
Narrow Band noise:		
250Hz	110dBSPL	110dBSPL
500Hz	125dBSPL	110dBSPL
1KHz	125dBSPL	110dBSPL
2KHz	125dBSPL	110dBSPL
4KHa	110dBSPL	110dBSPL

Accuracy of noise level: The level of the noise produced by an earphone shall not differ from the indicated value by more than 5, -3dB. The measured difference in output between any 2 successive designations of noise level shall not differ from the indicated or ldB. Whichever is smaller. Measurement for conformity with this requirement may be made acoustically or electrically at the input to the transducer with the transducer attracted to a coupler. Alternatively the transducer may be replaced by a dummy load with simulates the transducers impedance at that test frequency.

Selector **Switch:**

i) Acoustic impedance audiometer shall provide a selector switch for different stimuli used to eliciting reflex like pure tone, high pass noise, low pass noise, narrow band noise. It shall be easily operable with clear indicated stimuli.

ii) It shall also provide a selector switch for contra and ipsi reflex measurements.

Interrupter switch: It shall be provided with an interrupter switch for the presentation of the test tone to the subject by the operator and its operations shall be such as to establish and eliminate the tone without producing audible transients or extraneous frequencies. Switch shall be easily operable.

Rise **and** Decay time: Of stimulus used for reflex measured shall not exceed 50msec. Duration of stimulus presentation

may be manually or automatically controlled at 2 fixed timing that is for reflex measurement 1.5msec and for reflex decay test (Andersen, 1974) 10sec.

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

Sensitivity switch: It shall be provided with a sensitivity switch with may be able to increase or decrease the efficiency of measuring acoustic reflex.

Acoustic reflex testing using a probe tone of 1000Hz also has been shown to be highly effective in eliciting acoustic reflexes in infants. Non-acoustic reflex testing also may be accomplished for patients with ear canal abnormalities, where traditional test methods are inappropriate.

Recording of Reflexes:

It 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 and ipsi stimulus presentation. If it is graphical recording constant and paper shall be calibrated in order to measure onset, duration and decay time of acoustic reflex.

C) RESEARCH IMPEDANCE INSTRUMENTS

The market for research impedance instrument is small. For the most part, these instruments are constructed as one of a kind instruments used to support some particular investigation and are not commercially marketed. The user interface may not be polished, and the testing time required would not support use in a clinical environment. User documentation is often sparse and this contributes to the difficulty in working with the instruments. In specialised cases, however, when commercial instruments can be used to complete measurement and only some custom software is involved to control the instruments, investigator may share software and procedures. Rarely does this type of instrumentation become widely used or effective in the general market. Refer to the Appendix-D for the technical specification.

Manufacturers: 2,3,5,6,23,60,78,80,82,83,85,91,108 and 138.

CALIBRATION OF THE IMMITTANCE AUDIOMETER

Following parameters needs to be calibrated - (1) Air pressure, (2) Probe tone frequency (3) Probe tone intensity, and (4) Reflex onset, duration and decay time.

One should see whether immittance audiometer has in-built calibrator or not. If it is presents, one need not have any instrument if not then one may need 2.cc. cavity (most of the time supplied by the manufacturer along with the immittance audiometer) SLM, frequency counter and manometer.

ACOUSTIC REFLECTOMETRY (ACOUSTIC OTOSCOPE)

Use - Provides information about the ME pathology, which didnot require an ear seal and which could be used reliably even without patients cooperation. Can be used as a screenor along with screening audiometer.

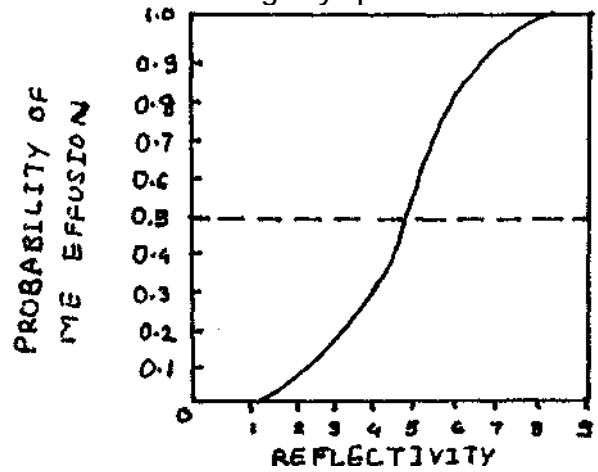
It is a hand held instrument which transmits, receives and analyzer sonar signals.

Principle - The sound wave in the ear canal will be reflected when it strikes the tympanic membrane. In a clear ME space (normal), the amplitude of reflected signals will be minimal, where as in fluid filled ME more signals will be reflected. Even a small amount of fluid can be detected.

Stimuli - Intensity of 80dB

Tone - Sweeps from 2KHz to 4KHz over a100Msec microphone is located in the probe tip.

Display: LED Display scale ranges from 0 to 9. Reflectively value over 5 are highly predictive of effusions.



HOW REFLECTIVITY PREDICTS MIDDLE EAR EFFUSION.

Bernard I Sohn, ENT medical 12 Kendrict Rd, Wareham, MA 02571

ERA

The task of buying an EAR equipment or for that matter any speech and hearing equipment often evokes apprehension and sometimes anxiety in prospective purchases. In most cases, the buyer has to live with the instruments chosen for many years, and no one wants to be responsible for a poor choice, but in a new set up the buyer has to make purchase decision taking into consideration a number of factors.

Since the advent of the first evoked potential system, more and more commercial response averagers are being introduced in the market and the clinician has a wide array of instruments from which to choose.

Some of the basic questions which need to be considered before procuring an EAR system are:

"What will be the present and future applications"?

The answer to this question will vary a lot from one clinic to the other, but it may be useful to extend the question in to the following detailed area:

a) Is the EAR equipment mainly for clinical or research purpose? In case of the former the clinician would be satisfied with facilities available for diagnosis and differential diagnosis of various otologic/neurologic disorders. On the other hand if research applications are to be taken in mind, it would be of help to have many other options which may not be essential in routine testing. For

ex: In certain clinical settings mass data storage of the information may not be essential, however it would be a pre-requisite for research purpose.

b) Who will be operating the EAR system?

The Clinician, an engineer, nurse, technician etc. In this case one may have to opt for an equipment which is easy to handle especially if it is to be operated by technicians or nurses. Also facility for data storage or print out for analysis of data at a later stage by the concerned specialist may be needed.

c) Where is the system to be installed?

In a shielded or non-shielded room, with or without a silent cabin installation, together with other audiological instruments or alone, in noisy or quite environment etc? For ex: in Case of noisy environment, an EAR with a high common mode rejection ratio would be preferable.

d) How is the engineering capacity?

In certain setups who do not have an engineering section to deal with repairs or calibration problem, the necessity of help from local agents or service engineers is a must. Most of the EAR equipments are purchased from foreign countries and it is not feasible to ship it to the manufacturers during times of crisis, hence in case there is no engineering unit to take care of the problem, it is wise to chosen only those equipments who have the distributors or service engineers

located nearby. Also it Is essential that the spare parts of the equipment be easily obtained in case of damage.

In such cases one may need to enter into a service contracts or smooth maintenance of the equipment some of the aspects of a service contract could include are travel or shipping costs, service costs (parts and labor) preventive maintenance, annual certification emergency service.

Many organizations such as schools or clinics prefer to purchase service contracts because they can put the cost into the budget and not be forced with an unexpected expense.

Because of the care equipment receives under a service contract, longer product life can be expected. However, most of today's ERA equipment are of high quality and do not breakdown often enough to justify the contract cost.

e) How many investigations have to be performed each day?

In this case attention needs to be given for the display section. Most systems are able to display either the ongoing activity or the averaged results during the averaging procedure and some systems can display both simultaneously. It is important to be able to watch both the input and the results throughout the averaging simultaneously. Some system offer the feature of a display and print out section with its own memories, totally separated from the averager memory.

This feature saves a lot of time in the daily use of the system and would therefore be an assist in case of heavy patient load in the particular set up.

f) What are the financial resources?

It is certainly a heavy investment to procure an ERA system. The cost of the ERA equipment is about 10 to 20 times as much as a good clinical audiometer. The individual who wishes to buy the ERA equipment may therefore require to justify the need to purchase it especially in a government set up or private or semiprivate organizations.

Making a prior list of the facilities that are needed will aid the individual in arriving at an appropriate decision on the purchase of the equipment.

Only if one is completely satisfied with his/her buy will he/she be in a position to guide others as well in their choice of equipment.

This satisfaction stems from many things:

1) The equipment roust perform to specifications in a reliable and dependable manner.

2) Its capabilities should allows the user to perform all types of tests which the particular facility wants to offer.

3) The equipment should fit the physical constraints of a facility.

4) The instrument should be easy to master.

5) Adequate inservice 3hould be available during thelearing

6) The instrument users must feel comfortable with the equipment and must have absolute confidence in the results. Appendix-E gives information about the different ERAs manufacturers all over the world and their product capabilities.

Specification:

a) Stimulus frequency specificity:

The choice of stimulus depends primarily on the test objective and the AEP to be used. For any AEP a click stimulus might be used for obtaining average behaviour thresholds in the 1 to 4KH3 range. In testing slow cortical responses, the problem of frequency specificity does not arise. Here long tone bursts with gradual (10 to 20ms) rise time can be used. For carrying out MLR testing, frequency specificity using tone pips with relatively long rise time (5ms) would probably be adequate. For the ABR and ECochG where long stimulus rise times can degrade AEP development due to loss of neural synchrony, frequency specificity in a major issue.

b) Another factor of importance is **stimulus repetition rate.** The repetition rate has a major effect on the number of averaging runs which can be carried out in a given test run.

In ERA, the main objective is to demonstrate AEP presence or absence, so the rate should be chosen to make these decisions as efficiently as possible. Some equipments

may provide only 2-3 options in repetition rate change eg 11.4/s, 22.4/3 while others may provide a wider range where one can use a stimulus repetition rate as slow as 1/s to as fast as 90/s. This facility is probably considered in research oriented set ups where one would wish to find out the changes in latency, amplitude and waveform morphology with increasing repetition rate and aid is differentiating retrocochlear pathology from cochlear pathology.

c) **Calibration system:** Since one of the best way of achieving a proper and correct calibration is the subjective psychoacoustic method (plutchik) it should be possible for the ERA equipment user to calibrate the system himself in an easy way and preferably without any use of tools.

All existing ERA systems include a circuit for calibration of the auditory system. The relatively new ERA systems include a digital calibration with a memory back-up for storage for all the calibrations of the various types of stimuli. This calibration system offers the feature of being very easy to use by turning a key-locked calibration switch on the front panel.

Common Mode Rejection (CMR): The importance of CMR in ERA is that it suppresses ambient and unwanted electro-physiological noise. Ideally the CMR should not be less than 106dB (~ 2,00,000) which means that noise is suppressed with the factor 2,00,000. If the CMR is smaller, it will require too

many averagings to obtain the necessary sufficient noise free result and especially if the system must operate in a nonelectrically shielded room.

Number of data channels: One or multi-channel input depends on the type of investigation to be performed. In most cases one channel will do, but a feature of two channels may be convenient for certain latency measurements. Both ipsilateral and contralateral recordings can be obtained simultaneously with 2 channels instruments. Some systems offer 4 channels of input.

Besides the differences in technical details, all existing ERA systems may be divided in 3 main groups according to their general structure.

Group-I: Dedicated digital units with pushbutton controls and rotary switches but without any facility for connecting an external data system. This system is usually sufficient for use of ERA in daily clinical work and some limited research work.

Group-II: Computer based systems which are purely keyboard operated via menues on the monitor screen and having facility for an optional or built in data interface to be connected to an external data system. The "menues" offer a lot of facilities including fully automatic programs and storage of results via internal or external memory and data systems.

Such type of systems are excellent for research work but may appear rather complicated in daily clinical routine.

Group-Ill: The group III systems offer all the advantages of Group-I and II systems and enable the user to firstly invest in a limited group-I like system and then later extend the system with all the features of group-II, when required.

Manufacturers: 1,2,3,6,23,66,80,85;90,91,108.

REHABILITATION
HEARING AID

A hearing aid is an electroacoustic device which increases the intensity of sound energy and delivers to the ear with as little distortion as possible.

Types of Hearing aids: (1) Individual (2) Group

Individual:

a) Body level hearing aid (BLHA)
b) Behind-the-ear hearing aid (BTE)
c) In-the-ear hearing aid (ITE)
d) In-the-canal hearing aid (ITC)
e) Eye glass hearing aid

The different types of hearing aids for a patient is detemined by his/her needs, desires and factors of physical comforts such as the ease of adjustment. Despite the patients preference, clinical judgement may have to prevail. If the hearing loss is severe and satisfactory gain cannot be achieved by ITE hearing aid, then other hearing aid has to be choosen. Even though the patient would like the eye glass hearing aid, if he doesnot wear eyelass consistently throughout the days.

Appendix-F gives information regarding what are the different controls available in different types of hearing aids.

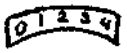
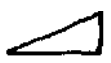
Hearing aids are also classified based on the output gain like mild, moderate and strong classes. It is prescribed depending upon the degree of hearing loss. But one should note that strong classes of hearing aid has more battery drainage, than moderate and mild classes. So, it requires

frequent replacement of batteries. Specification for the body level hearing aid for mild, moderate and strong categories of hearing aids is given in Appendix-G. Even there are other national (like ANSI) and international (like IEC) standards for the specifications of the different types of hearing aids.

While purchasing the hearing aids one should look at the technical specifications like max saturation SPL, full-on-gain, high frequency average full-on-gain, frequency range, earphone or receiver, current drain, AVC or Pc telephone coil sensitivity, distortion, dimensions etc.

MARKING OF CONTROL SETTINGS ON HEARING AIDS

The markings should preferably be in easily readable characters and aiming pn a ready identification for the various control settings.

SI. No.	Control	Function	Marking
1	Battery Switch	OFF	0
		ON	1
2	Input Selector	Microphone	M
		Pick-up coil	T
		Mic+Pickup coil	MT
3	Tone Selector	Normal or No emphasis	N
		High frequency emphasis	H
		Low frequency emphasis	L
4	Output limiting selector	No limiting	None
		Automatic volume control	Av/AVC
		Peak Clipping	PC
5	Gain Control	Indicated by number, higher No. indicate higher gain.	
		Increase height of △ Increasing volume	

Note: The martking of the "ON" position isused only when the hearing aid is provided with a separate battery switch.

Controls: ON/OFF swtich, gain and volume control, tone control etc.

ACCESSORIES

1) POWER SUPPLY:

Unless other wise specified by the manufacturer the hearing aid shall be so designed as to be capable of operating from a battery of nominal voltage 1.5V (IS 10775: 1984). Voltage drop and the life of each cell can be shown graphically as below:

Zink aircell is used commonly in almost all the hearing aids.

size:

Hearing aid	Cell
1) Body level Hearing aid	Pentorch cells or pencil cells.
2) BTE; ITE; ITC	Button cells.

Voltage: All the types of hearing aids needs 1.5 volts to works. When the cell voltage goes below 1.2 volts, the cell has to be replaced.

Rechargeble cells also can be used for hearing aid (Ni-cd-cell). It is recommended for both pentorch cells and button cells.

Cost:

Type of Cell	Cost of the Oridnary cell	Cost of the Rechargable cell	Cost of the Charger
Pentarch cell	6-7rupees/cell	25/-	200/-
Button cell	30-40/cell	100 to 180	200/-

- A cell should be recharged for 8-12 hours.
- It lasts for 12-18 hours depending on hearing aid user
- It can be recharged for approximately 500 times.

Manufacturers (Rechargeable and ordinary) 2, 5, 26, 45, 64, 82, 85, 100, 108, 110, 126.

2) Cord:

Three types of cords are used in hearing aids.

1) S-cord or single - for monoaural amplification.

2) Y-cord for pseudobinaural amplification.

3) V-cord for pseudobinaural amplification.

Length of the cord is 50cms and it has either 2 or 3 pins in which one is thicker and other is thinner. While purchasing cords should be checked for any breaks along its length and for its length. Cords are used for body level hearing aids.

Cost: S - Cord - 10 to 15/-; Y - Cord - 20 to 35/-;

V - Cord - 20 to 35/-

Manufacturer: 5, 9, 11-16, 26, 60, 85, 108, 119.

3) Tubing: is used for BTE, spectacle (AC) instead of cord. Plastic tubes are used.

4) Ear tips **and** ear molds: Generally ear tips are supplied with hearing aid. It is plastic made used to fit receiver into the ear. Earmold has to be purchased from an earmold lab.

Cost: Earmold: Varies from place to place. The ordinary mold rangs from 40 to 100/- (a pair of mold for both ears).

Ear tips: 1 to **4/-** per ear tip.

5) **Wax guard:** It prevents cerumen from migrating down the tubing and entering the receiver of the hearing instruments used in the ITE/ITC hearing aids. It contains no removable components to repair or replace and can be cleaned daily by using brush or soft tissue.

Manufacturer: 1, 54, 82, 83, 85, 108.

6) **Receiver:** Types: 1) Air conduction (2) Bone conduction (Bone vibrator).

- Some receiver should be purchased as recommended by the manufacturer i.e., the impedance should be matched between the receiver and hearing aids.

- Washer on the receiver should be intact to avoid leakage of sound energy.

Manufacturer: In India, No manufacturer makes receiver,all are imported. 1, 51, 54, 59, 73, 82, 85, 108, 122.

7) Volume control: - Smooth rotation of the volume control wheel should be there, - Numbers should be marked on the volume control wheel for easy adjustment of the volume control.

Manufacturers: 1, 54, 82, 85, 108.

8) Microphone: Mic shall be so mounted and housed as to minimize (a) mechanical transfer of housing noise to the mic (b) acoustic, magnetic or mechanical coupling between earphone and mic giving rise to the feedback.

Mic placement	Type of aid
Mic can be at the top or on the lateral sides.	BTE
Mic is either at top or bottom of the pinna. Top location gives better reception of sound.	BTE
Inside the pinna enhances sound of 1.5K to 4KHz by 5 to lOdB.	ITE, ITC

Some of the hearing aids have option for the connection of the external mic called direct input. It can be used as an audiotory trainer. This is availablein indigenously (Alps -Auditory trainer, Arphi - PPVT).

Manufacturers: 1, 30, 54, 82, 85, 108.

Cost of the hearing aids:

Types of Hearing aid3	Approximate Range
Body level hearing aid	600 to 2500
BTE	2500 to 6500
Spectacle	5500 to 11000
ITE	5000 to 10000 or more
ITC	5000 to 10000 or more

Accessories:

1) External Mic - 200 to 300
2) Bone conductor with head band - 600 to 1200

Manufacture (of the different types of the hearing aids): 2, 5, 9, 11-16, 26, 33, 49, 54, 59, 60, 67, 77, 81, 82, 83, 85, 96, 99, 101. 102, 103, 105, 107, 108, 121, 125.

ORDERING HEARING AIDS

After the evaluation of hearing threshold it becomes the job of the audiologist to provide the client with an appropriate hearing aid for the loss. This can be done by-placing order with a company for the purcahse of different kinds of hearing aids. There is an advantage to using only a small number of manufacturers, they will get to know you well and will be more helpful. In addition, you will be eligible for bulk purchasing, especially helpful if the program is a small one which will not be ordering a large number of aids. But a particular company may not have all varities required. For this audiologist has to ordr from different companies. The audiologist will have to evaluate patients population and determine which types of aids are needed and then investigate about their availability.

One should have choice of at least 2 to 3 manufacturers for any types of hearing aid purchase. One should investigate about delivery time of aids after ordering, time for repairs, if bulk purchases are done then concession are available, payment plans. If the company accepts the "trial period" use, it so for how long and it the aid is not useful then does it refund. It could be also helpful to contact other audiologist to get their view about different manufacturers.

The ordering of hearing aid can be done in different ways:

1) The different types of hearing aids can be purchased in bulk and stocked. Whenever dispensed they can be replaced from the stock.

2) Another method could be to stock only those that are used for hearing evaluation, once a hearing aid is recommended it can be ordered. However, the commonly used one can be kept in stock and dispensed when required.

3) One need not have any stock of aids, can select the aids for each client after hearing evaluation. Useful for small clinics.

In order to determine which ordering option is most appropriate, it is necessary to evaluate each clinic individually.

GENERAL GUIDELINES

1) Before purchase, the user must have a trial with different types/models of hearing aids to choose the one that gives him/her the optimum benefit.

2) Because of the cosmetic value or importance, it should not outweigh the consideration of amplification needs.

3) Purchase of the hearing aid, that is more powerful than the one actually required must be avoided.

4) It is always better to purchase indigenous hearing aids than imported one because (i) It is preferable to purchase an aid after a hearing aid trial. (ii) Hearing aid required periodical servicing and replacement of spares which may be more difficult to procure for the imported hearing aids. And, the spares of these hearing aids may not be available indigenously.

4) It is not wise to buy hearing aids by mail. Direct personal contact with the dealer is most desirable. Nearer the dealer, better for the inspection and trial of a hearing aid and also for the repair and replacement services.

5) Prior to purchase or after purchasing, all the hearing aids should be checked for structure and function to findout any defect. The electroacoustic characteristics of the hearing aids should be same as recommended by the manufacturer.

6) Many of the hearing aids like body level hearing aid, BTE have directional microphone facilities.

7) Even some of hearing aids have high frequency emphasis or low frequency emphasis facilities (High frequency extended hearing aids).

CROS:

General specification and control adjustments are same as for the BTE hearing aids. BTE hearing aid designed for use with an external receiver either air or bone conduction.

Type of air receiver or bone receiver, its impedance, gain, output, frequency range should be specified by the manufacturer.

Cords: Length should be specified.

Some of the BTE have CROS capability: Ex: Maico211 - Ultra cardiod directional hearing instrument.

Even they can be connected to virtually any type of auditory training system presently in use in the school.

Additional capability exists for direct hook-up to TV, radio, tape recorder etc.

Co3t: 10,000 to 15,000

SERVICE AND REPAIR:

If one has the equipments (including spare parts) and known to repair he can repair the hearing aid. Other wise it can be repaired by the manufacturer concerned. Requirements for the repair of hearing aids are:

- Signal injector - It is a oscillator produces 1KHz tone. Battery operated. Cost around 75 tolOO/-.

- Solding iron, cutter, watch screwdirver set, forceps of different sizes, battery holder, bruSh, cotton, spirit.

The whole set cost around 500/- or more. Hearing aids repair kits are available at 26, 85.

DIGITAL/PROGRMMABLE HEARING AIDS

Digital methods of signal processing offer substantial advantages over conventional analog techniques, and thus, it is not surprising that the recent development of a digital hearing instrument has met with considerable interest and high expections. Programmability in a hearing instrument can provide solutions for many practical problems in hearing instrument fitting. It provides the advantages of

1) Real ear measurement - It minimizes the fitting error. Because the fitter can make precise adjustments to the ' initial fitting, the hearoing instrument becomes a sophisticated ear-level master hearing aid; which the wearer can wear home.

2) Programmabllity - one can adjust a hearing instrument by programming, rather than using a mechanical adjustment (screw driver). The instrument also can be reprogrammed on-site to suit the clients changing needs.

3) Multiple memories - Conventional hearing instruments can be adjusted to one program at a time, the fitter and the wearer must compromise on the balance among several fitting goals; amplification to fit the hearing loss, listening comfort, intelligibility and reduction of back ground noise. Achieving thes goals simultaneously is difficult. But with the help of programable hearing aid one can achieve several different fittings, selectable by the wearer in the field. The instruments includes 8 memories, each of with acts as an independent hearing instrument.

4) Datalogging memory: Datalogging represents a new concept in hearing instrument fitting and adjustment. The hearing instrument is loaded in up to 8 memories, and the wearer selects among these memories, choosing the one with the best characteristics for the current listening condition. As the wearer switches memories, the hearing instrument records these selections tabulating the number of tiroes each memory is selected and the duration for which it is used. Based on this information, the fitter can tell whether the programming of the different memories is effective for that particular wearer, without having to make assumptions about the criteria which the werarer may value for hearing instrument

adjustment. Datalogging information helps determine how the programming should be redistributed to give the wearer the greatest value from the instrument.

Today, in the market programmable BTE and ITE hearing aids are available.

Manufacturer: 2,5,26,27,54,82,83,85,90,101,108,115.

AUDITORY SPEECH TRAINER

Used for the training of the deaf childrens while purchasing audiotory speech trainer one should consider following points.

1) Portability - whether it is portable or desk type?
2) Mode of working - Monophonic or storeophonic
3) Output power level - as given by the manufacturer. Generally it is upto 130dBSPL.
4) Volume control - 2 independent controls or one combined control.
5) Filters - Is these any option of high and low pass filter?
6) Whether connection facilities for external devices like tape recorder etc is available or not?
7) Power supply - Battery operated (how many batteries and voltage should be specified by the manufacturer) or mains supply.
8) Accessories - Headphone, set of batteries AC mains cord, Duster Cloth.

Costs Indigenously - 3500 to 10,000
Manufacturer - 5,11-16,33,77,121,125.

INSTRUMENTS USED FOR THE MEASUREMENTS OF ELECTROACOUSTIC CHARACTERISTICS (EAC) OF THE HEARING AIDS

EAC - It is the performance characteristics of hearing aid i.e., the changes effected in a signal as it is transduced from acoustic to electric to acoustic energy.

EAC can be measured in lab or fee field, in anechoid chamber or hearing aid test box. Instruments used to measure EAC specifies to one or more standards (ANSI, IEC, HAIC, IS etc). Fonix is the only instrument specifies to IS standard.

After purchasing the hearing aids, one should measure its EAC, to see whether it specifies to the specifications as per the manufacturers. Because, sometimes one may receive mild or moderate categories of hearing aids instead of strong. While purchasing the hearing aid analyzer one should look at the technical specifications like -test standards, acoustical device frequency, test level range, measurement range, battery current tests, total harmonic distortion, AGC test, video monitor types, built in plotter, power supply, environmental conditions.

Acessories - Standard - Recording papers, set of pens, dust cover and user's manual etc.

optional - hearing aid test box, color or monochrome monitor, foot switch, data interface, service manual etc.

Specifications for HAT box - frequency range, dynamic range, ambient noise insulation, measuring region, distortion, loud speaker, accessories like test mic, 2 cc coupler, adaptor etc.

It costs around 3,00,000 to 3,50,000

Manufacturers: 2,3,29,30,66,80,90,91,108,138.

ASSISTIVE LISTENING DEVICES

The terra ALD comprises of all systems which are meant to improve the communication ability of hearing impaired persons or to make them aware of the presence of the environmental sounds (Kaplan (1987).

ALD can be divided into:

A) System that uses auditory mode:

1) Hard wire system: Refers to an auditory trainer which has a mic and an amplifier attacted to the teachers desk and hard wires run from the teachers desk to the student desk, with has the volume control knob and head phones. This can be used in school situation.

2) Loop Induction system: This can be used in classroom situation. It consists of a mic for the teacher, an amplifier, one impedance matching device and loop made up of copper wire in the classroom for this system the child needs to have "T" or "MT" position in the hearing aid (matkin and Olsen, 1970). The acoustic gain varied between 30-65 db depending upon the loop induction device. It works on the principle of the electromagnetic induction.

Manufacturer: 2, 9, 23, 54, 60,66, 85, 91, and 108.

3) FM hearing Aids: Speech signal is superimposed on a carrier wave with has an ultra sound.

The FM system consists of 2 parts:
1) Transmitter and (2) Receiver.

The transmitter and receiver should be tuned to the same carrier wave. It should be noted that the licenced frequencies may differ in different nations. In America the FCC has admitted carrier wave bands 72-76 MHz should be used by schools for FM transmiter. At this carrier wave one can have as many as 32 bands. 32 different classes can be taught simultaneously in a school.

In FM receiver one can have monaural, binaural or pseudobinaural amplification depending upon ones need.

The FM receiver may also be hooked up directly to BTE audio input hearing aids.

Now days, Stero hearing aid with built-in FM receiver is also available.

Extended high frequency amplification is also possible in FM hearing aids personal FM systems are usually combined in teleloop or direct audio input coupling configuration for those who desire to combined FM system with BTE hearing instruments.

Technical Specification: Technical specifications for FM hearing aids - model, FM receiver section, receiving channels, receiving sensitivity, squelch, acoustic gain, max output, frequency range, noise level, AVC, tone control,

earphone, power supply, etc. For transmitters power supply, transmission channel, field strength, mic, oscillator etc.

Assessories - Antenna, earphone cord, earplug, screw dirver, wind screen, adaptor, carrying case etc.

Points to be considered:

General manufacturers advertise audio input capabilities, but not all companies clearly explain selection of FM-only or FM plus mic choices for the different coupling options. So, one should see that manufacturer are explained about different types of Fm-receptions.

- A greater input for FM system is required than ordinary hearing aids.

For example:

	Input	Gain	Output
Hearing instrument	60dB	40dB	100dBSPL
FM system	80dB	20dB	lOOdBSPL

_ It is important to have compatible cords and boots for each FM and hearing instrument configuration. Different cords and boots may cause signal transmission problems.

- One should see whether facilities are available to connect FM receivers to the tactoid, TV, radio, tape etc.

Manufacturer: 2, 3, 5, 23, 45, 54, 56, 60, 66, 85, 98, 99, 106, 108.

KOSTICLS APPARATUS

Used to train deaf childrens. It transmis signal through auditory, visual and tactile modes. It consists of 5 parts - SAFA, friction indicator, intensity indicator, nasality indicator, and vibrator. 8 children can be traived at a time. It has frequency from 105 to 9600Hz, divided into 26 channels.

INFRASED TRANSMISSION SYSTEM

Acoustic signal	Electrical signals	light signal	electric signal	acoustic signal

It is of 2 types: 1) Personal and (2) Group.

REQUIREMENT:

Sound transmission is based on semiconductor components. They posses optimum properties of transmission and reception in the range of intrared.

As intrared light speads inside the class-room without penetrating into adjacent rooms, each group can use the same frequency for intercommunication. Thus receivers are interchangeable.

1) Transmitter - Should have controls like level indicator and monitoring loudnspeakers connection socket for teachers mic, also it possible for external sound sources such as tape player, cassette recorder or radiotuner.

2) Infrared receiver: It can be BTE receiver. Receivers should have volume control and frequency control.

TECHNICAL DATA:

Max output SPL

Transmitted MF-band width

Harmonic dostortion factor in rated operation.

Infrased wave length

Modulation type FM Max. deviation.

Accessories: Microphone, floor stand, ceiling stand, head phone, rechargeble batteries and charger, overhead projector.

It can also be available in 2 channels.

Now days there is a new infrared remote control water resistant BTE hearing instrument. It can be used by moderate to severe hearing loss cases and also it has AGC-0 control.

Manufacturer: 2, 5, 23, 49, 54, 60, 66, 85.

One can look at the following advantages while purchasing:

System	Advantages		Comparison	
	FM	Loop	Infrared	Hardwire
1) Easy to use	+	+		+
2) Portable	+			
3) Flexible to type of loss	+			+
4) Indoors/outdoors	+			+
5) Installation easy	+	+		
6) Little interference	+			+
7) Cost efficient per individual		+		+
Overall	+			
8) Maintain S/N ratio	+		+	+
9) Use with other Av equipments	+		+*	+
10) Sounds stay within walls			+	+

Note: * Some systems only.

(B) VISUAL MODE

a) Oscillograph & Cathode Ray:

Speech wave form displayed on it screen. Useful in children with high frequency hearing loss and articulation difficulty (for detail of oscilloscope purchasing see page No.83)

b) Intensity Indicator

c) Frication indicator

d) N-Indicator

e) Laryngograph

f) Spectrogram

g) Vocal-2, PM 100, Visipitch.

h) Speech emphasis indicator

TV for the hard of hearing: Captioning in TVs under the picture inorder to teach deaf children.

Two types: (1) Close captioning - We required a special decoder in order to be able to see the captions, but in our country we donnot have close captions.

(ii) Open captioning - can be seen by any body.

Teletext: Deaf child can get indication in this about who is speaking, bigger letters for stressed words, different captions available for adults and children, also one can get background information about the program that is going on. One can get discription of unfamiliar words and also discription of the style in with a person is talking.

Manufacturer (Decoder, Sound amplifier and VCR with decoder) 20, 30, 85,98.

c) Tactile aids:

1) Vibrator - See Kostic's appraratus

2) Mini-phonator

3) BC-receiver

4) Nuvox sentinel - it alerts an individual to the ringing of a telephone or doorwell or other sounds. The electronic unit is activated by turn on a lamp or a chair or bed vibrator.

Cost: More than $ 135.00

Manufacturer: Hal-Hen Co.

6) Elctroalarm clock - Uses vibrator.

Cost: More than $ 90.00

Manufracturer: Hal-Hen co.

7) Smoke detector - Photoelectric or nonradioactive detector can be connected by which a deaf-blind person can be alert of the smoke or fire in the home.

Cost: More than $ 95.00

Vibrotactile devices are also available at: 5, 23, 30, 85, 104, 106.

TELECOMMUNICATION AIDS FOR THE DEAF

a) Telecoil - "T" position in the hearing aid.

b) Built in amplifier - Amplifier built into the telephone itself to amplify the speech. Mainly for severely and profoundly deaf individuals,

c) Portable amplifier: Battery operated, slips over the telephone headset.

Manufacturer: 2, 3, 20, 30,85.

Other devices which makes use of visual display are:

d) Teletype writter: Acoustic couplers are used. One person dials the number of another person, other person places the receiver in a special coupler and waits for other person to respond, and 1st one places the mic on a coupler and begins to type. Simultaneously the same words are printed out by other type writter.

e) Electronic Handwritter: Does not require typing skills. Electronic writing equipment is used to send/receive handwritten messages across distance.

Manufacturer (d&e): 2, 20, 30, 85.

(f) Acoustic couplers - 2, 30, 85, 99.

NOISE MEASUREMENT

Simply, noise can be defined as unwanted sound or not wanted by a recipient (the wrong sound in a wrong place at a wrong time). Noise has been identified as a major health hazard. The danger lies not only in accumulative damaging effects leading to temporary or permanent hearing loss, but also can produce signs of stress, physical fatigue and discomfort.

To control noise, one has to measure noise. This requires the use of appropriate instruments.) Hence, precise measurement of noise is a must which can be fulfilled by precise instruments. The sophistication of instruments varies rather crude portable SLM and octave band analysers to real time spectral analyzers coupled to digital computer. The portable ones are used for field measurement. The elaborate measuring system in conjunction with a tape recorder for field data are used exclusively for diagnostic purposes. The instrument which are used for noise measurements are listed below.

Microphone:

It is impractical to construct a mic with all characteristics. Thus we have different types of microphone that would fulfill certain requirement more.

***Types* of Microphone :**

Table-I: Indicates the type and classes of microphone and their characteristics in terms of the directivity

Type of Mic	Mic that belongs to the class	Type of response pattern
Pressure microphone	- Carbon microphone - Condensor microphone - Dynamic microphone - Piezo elecric microphone	Non directional
Velocity	Ribbon microphone	Directional
Pressure and velocity microphone	Not available	Directional

Though various types of microphone are available the most commonly used microphone is the pressure microphone, for reasons such as:

- They are used for calibration of the audiometer and the ear-phone.

- They have the most uniform frequency response when closely coupled to the source.

- They are used for noise measurement with a moving sound source.

The most commonly used microphones in noise measurements are: condenser, electret, piezo-electric microphone.

As stated earlier, it is not possible to construct a mic with all characteristics, so that it can be used for all the types of measurements in all the situations. Each microphone varies with their specification such as sensitivity, frequency response, temperature and humidity

range etc under which it can be used. Microphones also comes in different sizes like 1/2", 1" etc.

One should also see that the same mic can also be used to other purposes like for the presentation of speech stimuli in speech audiometry, for the recording of speech sample etc.

SOUND LEVEL METER

A SLM is generally a combination of a microphone, an amplifier with controlled frequency weighting and a detector - indicator with controlled time weighting characteristics (IS-1981).

Purpose : 1) Used for the accurate measurement and evaluation of sound and noise levels.
2) Calibration of audiometer.

iforpes:) Commercially available SLMs are designed- to meet specific needs. They may be classified as (according to IS, 19779-1981).
TYPE 0 - It is for use as laboratory reference standard.
TYPE 1 - This is for use in laboratories and in field where the acoustic environment can be controlled/is specified.
TYPE 2 - It is designed for general field application.
TYPE 3 - Used for noise surveys.

Buying a SLM

Two points need to be considered:
1) To what extent is the SLM to be used?

If one has no extensive noise problems, although problems do occur from time to time. He/she may need to measure noise once or twice a year. One need not buy a precision SLM and octave band analyzer of the highest quality, it is neither sensible nor economical. A portable SLM would be adequate for such measurements.

If noise problem is extensive, the noise control officer may be using a SLM almost daily. For such measurement one can buy precision SLM with octave filter and some accessories.

2) How much can you afford?

Depending on the budget and the need, one can either buy portable or precision SLM.

Once it is decided to purchase a particular type of SLM, i.e., type 0, 1, 2 or 3, then the buyer must decide whether he would like to purchase SLM manufactured to meet the specifications of a particular national (ANSI, ISI etc) or international (IEC) specifications. Then the buyer must refer to the latest available technical specifications as these specifications may be revised from time to time. So, a reference may be made to organization such as Bureau of Indian Standard, ANSI, ISO, IEC (Addresses-8, 32).

It is very important that the buyer keep in mind the fact that the SLM, microphone, filter set are used in combination. So the buyer must ensure that the equipment that he intends to purchase can be used along with equipment/

instrument that he already has or intents to purchase at a future date when it is feasible economically or the needs of the buyer change.

Sometimes the instrument have to purchase in a group, so that the instrument may be put in use fully. For ex: If one has decided to purchase type 0 SLM, the availability of tripod, suitable mic, piston phone or acoustic calibrator etc is a must. If the instruments are to be used for outdoor, measurements then purchase of accessories such as wind-screen, nose core, rain cover etc are necessary. It would be desirable for buyer to have a discussion with the manufacturer representation regarding the purchase of other accessories such as adaptor, extension cable etc.

One should see that the SLM is marked with the following information.

- Name or trade - mark of the manufacturer.
- The type and serial number.
- Indicating of the range of SPLs that it is designed to measure with each weighting.
- The angle of incidence for which the apparatus is calibrated.
- Power supply requirements and
- Country of manufacturer.

One should look at the technical specifications which should include measuring range (for all the weighting

networks), frequency response, meter, external filter, inherent noise, calibration, temperature and humidity range under which it should be used, batteries etc.
Manufacturers: 4,7,11-16,29,34,38,41,44,55,62,69,70,111, 128,137.

Power supply: Require from main or it is battery operated. If it is battery operated, battery life should be more than 8 hours. Number and voltage of batteries are as specified by the manufacturer.

Service and repair facilities - while purchasing the instrument one should make sure that service and repair facilities are available. One should find out whether it is available indigenously or not. If it is imported then user roust make sure that the manufacturer provides repair and service facilities.

Accessories generally required along with the SLM are input adaptor, tripod stand, rain cover, adaptor, nose cone, random incidence corrector, wind screen, extension connector, carrying case, calibrators, preamplifier, and de-humidifier. One should see that all these accessories, can be used along with the SLM which you are planning to purchase. For ex: Pistonphone it should be able to calibrate the SLM which you are purchasing.

If one needs to do detail analysis (such as frequency analysis) he can purchase instruments like spectral analyzer. It comes in two types.

1) Constant percentage band width (Octave, 1/3 octave, 1/10 octave band etc).

2) Constant or fixed band width (heterodyne and digital type). Recently, real-time analyzer (29, 69, 70, 90), using digital filtering systems often in conjunction with tape-recorder can be used for detail analysis. The constant percentage band width analyzers are portable one and can be used for the field measurement. While purchasing the spectral analyser one should look at the technical specification which should include frequency range (selective and linear), band pass filter, input and output impedance, batteries, inherent noise, temperature and humidity range under which it should be operated and accessories required.

Manufacturer: 19,29,37,55,68,69,70,106,136.

If one needs to do frequency analysis at different measurement position and needs to have permanent record of the results of the measurement, then one can purchase **Graphic level recorder** (GLR). It is a device which display, store, a pen and ink record of the history of some physical event. Two types-desk or bench model and portable model. Technical specifications for GLR-frequency range, sensitivity, resolution, writing speeds, writing system, paper drive, paper speed, types of recording writing pens/style, recording papers, external drive facilities etc. Accessories provided with the GLR are ink kit, chain drive, flexible shaft, gear, mechanical extensor connector, response test unit, two channel selector (Manufacturer: 29,55,69,70).

Another recorder is **X-Y recorder** used for the graphical recording of the relationship between two variables.
Manufacturer: 96.

Read out devices: If one wants to have display in graphical form, then he can purchase instruments like Oscilloscope. Today, there are more oscilloscope manufacturers then ever before. Even in India there are many manufacturers makes oscilloscope right from 5MHz to 100MHz. For our field i.e., for noise measurements and calibration purpose oscilloscope of 15 to 20MHa is sufficient. Types - dual trace, digital and portable oscilloscope. One should look at the specifications like vertical axis, frequency response, horizontal axis, sweep mode, trigger facility, display mode, Z-axis, voltage, temperature and humidity range etc. It costs around 11,000 to 16,000/-(for 15 to 20 MHz).
Manufacturer: 28,29,30,**44**,45,47,57,61,69,70,76,97,137 .

Electronic counter or frequency counter: This is used to measure frequency, period and time relationship of the electrical signals. It can be available with the only function of frequency counter or frequency and time counter. One should look at the specifications like frequency range, gate time, resolution, gate indicator, read out, accuracy, display etc.
Manufacturer: 10,44,45,47,61,136,137.

MAGNETIC TAPE RECORDER: (29,69,70,etc) (For detail information see page -92

Dosimeter: Used for noise measurement. It integrates the sound energy over a period of time, it given the overall idea of the noise which varies in terms of time and intensity. It comes in 3 types - Stationary dosimeter, ear born dosimeter, and pocket siaed dosimeter. Pocket sized dosimeter is a miniaturized dosimeter which is of the size of the hearing aid and which can be placed behind the ear with the mic at the entrance of the ear canal. One should look at the specifications like mic used, frequency range, amplitude weighting, sound level range, display, temperature and humidity range under which it can be used and power supply etc.

Manufacturers: 3,23,29,30,45,54,60,69,70,85,106,108.

The instruments required for noise measurements are microphone, SLM and other instruments as described above can be used along with the SLM for detail analysis. While purchasing it, one should keep in mind that SLM should provide connection for all these equipments directly or indirectly ie., with the help of adaptor. Also one should see that it can be used for other purposes like calibration of the audiometer etc. So it should be able to connect to the artificial ear, artificial mastoid etc.

EARMOLD

Earmold lab way or may not be attached to a speech and hearing centre. Wherever such a lab is attached then the earmold materials and equipment have to be procured, the purchase procedure such as calling for quotation & opting for lowest quotation (unless there are strong reason for not accepting the lowest quotation) are to be observed. Whenever it is an imported item the additional steps as described previously have to be gone through.

Bulk purchase can be made to take advantage of any concession that bulk purchaser permits. However, it must be in mind that not all materials required for the earmold lab have good shelf-life. Those item which have shorter shelf-life would have to be purchased in smaller quantities and shorter interval. Before purchasing one must collect information from sources like talk to the people who have experience, discuss with other earmold labs etc.

Requirements of material depends upon types of ear molds one wants to make (hard or soft mold). List of materials required are given in Appendix-H. Instruments/equipments required for earmold broadly can be divided into 2 parts: l) Clinical purpose and (2) Research purpose. Minimum equipments required are (for clinical purpose):

Dental flask with clamp made up of gun metal used for the flasking of the impression and clamp is used to maintain

the pressure during curing. **Dental lathe** is a motor used to trim, drill and polish the ear molds. It has speed of 1500 rpm and 3000 rpm (rate per minute). It requires accessories like silicon sand paper for trimming, Carborendom disc, Drill bit to make base hole of the ear mold, cotton polishing brush to polish mold etc. **Hanging Motor** used for minute trimming and to make sound bore. 2 types (1) Hanging motor with straight handpiece. The motor and handpiece is separate. Speed varies between 12,000 to 20,000 rpm. (ii) Micromotor - motor is present in handpiece itself. Speed varies between 1,000 to 25,000 rmp. It requires accessories like cutter for trimming the mold, burs of different size to make bores. **Rubber bowl** - of different si2es are used to mix impression material. Only rubber bowls should be used. **Electric stove or oven for curing** - Instead of electric stove gas stove with vessel can also be used. **Hydraulic press** used for the manual pressing of the flask, when the flask is filled with earmold material. **Ear mold rings** available in 2 form - plastic and metal. Life of the metal ring is longer than plastic. Plastic rings are generally used with childrens. Other stainless steel equipments used are **plaster spatula** to mix impression material in the rubber bowl, plugger to insert cotton, **wax carver** to scoop impression material from plaster cast, **plaster knife, probes, excavator, cement spatula.** Hammer is also required.

Equipments used for research purposes are **injectgun, syringe** used when silicon-nonshrink material is used, Gelomat to melt the gel, **hearing aid analyzer** for the measurement of the electroacoustic characteristics with ear mold modification etc.

Some of the earmold labs takes additional care like use of vibration isolating mount to reduce the noise, use of equipments which absorbs dust or air curtons to keep environment dust free. Above mentioned most of the equipments are available indigenously, which can be purchased from the dental depot which is nearer to your place.

Manufacturer: 25,43,52,71,121. Further modifications like acoustic horns, tubing, tubing adaptor, venting kits and syringe etc are available at 2,11-16,26,82,85,96,108.

SPEECH PATHOLOGY

Selecting instrument today can be a challenging task. With the proliferation of specialized instruments and recent advances in electronics technology, the simple instrument has evolved into a sophisticated tool capable of much more sophisticated operation. When it is time to replace an aging instrument or to purchase a new one, several points should be kept in mind which can help make the selection process a bit easier.

In the field of audiology, there are standard techniques clinically used for the examination of the auditory function. The same techniques are used all over the world. But this is not the case in speech pathology, various methods have been proposed and used by many clinicians and researchers all over the world. None of the techniques have been standardized on an international basis. Instruments used in speech pathology is not as much as in audiology. Speech pathologist have relied heavily almost exclusively on their trained ears for judgements. Based upon careful listening, clinicians often would make interferences. But auditory processing often does not leave the listener with a conscious awareness of the acoustic details that have combined to generate a given perception. So one may need to buy instruments.

Instruments used in speech pathology can be divided under the following headings:

Speech Instrument

Acoustics		Aerodynamic	Physiological
Production	Perception	Expirograph	EEG
		Nasometer	Palatography
Visipitch	Synthesizers	TONAR	Articulo-
PM 100	Tape recorder	Aerophone	graphy
Vocal II	etc	Spirograph	EMG
S-indicator		etc	Bio-feedback
N-indicator			etc
Fo-indicator			
Metronome			
Heretrodyne			
Spectrogram			
Stroboscopy etc			

system. Other measurements like vital capacity, mean air flow rate to see whether there is any respiratory problem. So one may require instruments to measure the above mentioned parameters.

In a neurological setup one may expect cases like aphasia, CP, MR, dysarthria etc more frequently. Not much instruments are available for these types of disorders other than standardized tests and instruments used for augmentative communication.

For the voice measurements like fundamental frequency, intensity, frequency range, and other many measurements (but if the need is only this), then one can buy either **visipitch** or **PM 100** or **Vocal-II.** One should look at the frequency range, frequency accuracy, intensity range, distortion etc of the instrument which is of interest while purchasing it. All of the these three equipments are equally good. However, instruments can also be purchased on the basis of appearance, bulkiness, availability and cost. In the appearance vocal-II and PM 100 appears better than visipitch. Visipitch is portable type than Vocal-II and PM 100.

Manufacturer: Visipitch - 72.

Vocal-II - 9,80

PM 100 - 139.

If one needs the measurements of Fundamental frequency alone, then Fo **meter** or Fo indicator can be purchased

(manufacturer, 53,61), same way one can purchase **intensity-meter** (manufacturer, 53), for the measurement of intensity.

On should see, whether the instruments provides connections for the tape recorder, EGG etc for the analysis purpose. PM analyzer is actually a modular system. Different programs can be plugged into the same housing to offer a combination of functions (much in the way that any microcomputer is expanded).

Along with the frequency, intensity measurements, if one needs other measurements like formant frequency, VOT, speech characteristics analysis - one can purchase spectrograph or if one wants to know harmonics, H/N ratio and other laryngeal measurements like SQ, OQ, Shimmer, Jitter etc one can purchase EGG. As the technology is becoming more and more complex, the instruments are also moving from analog spectrograph to digital spectrograph (manufacturer spectrography 2,23,30,72,85,108. EGG 53,139 and Laryngograph Ltd.)

Heterodyne analyzers: It is a constant band width narrow band frequency analyzer covering a particular frequency range (B&K 2010 - 2Hz to 200KHz) with selectable band widths. The analyzer also contains a beat frequency oscillator (BFO), the frequency of which is synchronized with the tuning frequency of the analyzer. Used to find natural frequency of the vocal tract and optimum frequency. One 3hould look at the

specifications like frequency range, sensitivity, accuracy, constant band width filters, frequency read out etc. (Manufacturer, 29, 69,70, etc).

Motion analyzer or atroboscopy: It is used to study the vibratory pattern of the vocal folds. Specifications frequency range, flash characteristics (Flash rate, duration, life, intensity, type), phase deviation range, power supply, accessories etc. One should see that it has the facility for the connection of the other instruments like mic, SLM, frequency analyzer, signal generator etc for further analysis (Manufacturer, 29,30, 69, 70, 135). Refer to Appendix-H for the individual capabilities of the equipments.

TAPE RECORDER

Tape recorder has become an indispensable tool in diagnosis and therapy and an invaluable aid in the maintenance of adequate client records.

Two categories:

1) Tape deck: Provides system with for recording playing back and erasing the tape but donot amplify the output and external speaker has to be used.

2) Tape recorder: It has its own power amplifier and a built in set of speaker.

Better recording quality is obtained in tape deck which freed from the necessity of providing power amplifier, can be optimized for best possible record and reproduce functioning.

Amplifier that are built in the tape recorders are unlikely to offer the quality obtained in free-standing amplifiers and high-fidelity speakers cannot be built into a tape recorder.

Recorder are of two types:

1) Spool type : (i) Spool recorder - has power amplifier.

(ii) Spool deck - does not have power amplifier.

2) Cassette type ((i) Recorder and (ii) Deck In last several years the popularity of the cassette tape formate has grown enormously. It offer convenience. One needs to have spool recorder when the best possible fidelity is needed or when data recording demands recorder flexibility, such as high tape speed that cassette units cannot deliver.

The quality of recording is good in spool type than cassette one.

Cassette tape width is - 1/8"

Spool tape width is 1/2" and 1/4"

Functional Classification

1) Amplitude modulated (AM): Instantaneous amplitude of the recorded signal is related to intensity of the stored magnetic field, is called direct or AM recording.

Moreover generally used tape recorders are AM. But an attempt to record DC by AM is failed. Many physiological signals (airflow, airpressure, heartbeat etc). Characteristics have very low frequency and some come very **close** to the DC. AM recording will not work for them.

Dynamic range - 36 to 60dB.

2) Frequency modulated (FM) recording: In FM a waveform (called carrier) is made to vary in the frequency in proportion to the amplitude of some other signal. Even DC signals can be recorded. But it is more costly and complex than AM recording. Dynamic range - 36 to 78dB,

With the current advances in technology, the difference between high fidelity cassette and spool tape recorders is getting smaller.

There are several considerations in selecting and using tape-recorder. The number of channels available for recording will depend on the number of signals to be recorded simultaneously. Usually, these vary from 1 to 4. It is preferable to have at least 2-channel recording capability. The number of tracks will also determine quality of signal. A full track spool type will provide a one-channel high quality recording of the signal. A half track recorder provides upto 2-channels and a quarter track up to 4 channels. The greater the number of tracks, the poorer is the quality of the signal recorded. Recording speed is another factor. While this is not an option on cassette recorders whose speed is set at 3 3/4 ips (inches per sec), the spool type offer 1 7/8, 3 3/4, 7 1/2 ips and in some cases 15 ips. The faster the speed of the recorder, the wider the frequency response. Usually a half tract 2 channel, spool tape is preferred for high quality of recording. For the minimum specification of the tape recorder refer to Table-A.

With the availability of the **digital - Audio tape (DATs)** recorders, none of the above considerations become that important. In DATs which provide for 2-channel recordings, the signal of interest is usually digitized using a 16 bit analog-to-digital converter, with a fairly high sampling frequency 48 KHz - standard one. We may require 24KHz or 36KH2, DATs offer recording quality that are superior to either spool or cassette recorders. It may cost around 30,000 rupees (deck).

Manufacturer: (digital): 93, 127.

TABLE-A: MINIMUM SPECIFICATIONS FOR TAPE RECORDERS

Specification	Reel-To-Reel	Cassette
Frequency Response: 7.5 ips 3.75 ips 1.875 ips	 30-20KH2 + 3dB 40-14KHz ∓ 3dB	 (Speed not used) (Speed not used) 30-15KHz ± 3dB.
Signal/Noise ratio: Without Dolby With Dolby	 55dB or higher 60dB or higher	 55dB or higher 60dB or higher
WOW and flutter: Unweighted Weighted	 0.15% or less 0.10% or less	 0.15% or less 0.10 or less
Stereo, Separation (Signal leakage from Lt to Rt channel or vice versa)	50dB or higher	40dB or higher
Cross - Talk (Signal leakage from between adjacent tape tracks)	60dB or higher	60dB or higher

For the training of the voiceless /s/ sound one makes use of **S-indicator,** and for training nasalization - N-indicator. One should see it has got a mic (inbuilt for the

S-indicatbr and magnetic contact type for N-indicator), lamp or deflection of the niddle to show the presence of response, facilities to connect special equipments like electric toys, vibrator etc (manufacturer-53).

Stammer suppressors portable, battery operated can be carried easily in the pocket, used to prevent stuttering by occluding the sound of the patients voice from himself by means of low frequency (manufacturer-18).

DAF - used for treating stutterers. Specifications time delay (25 to 220msec), frequency and intensity range, etc (Manufacturer,98,99). Other instrument used for treating stutterers is **metronome** (36). There are other many equipments used are **mini-fonator** for speech training of deaf person (113-117), **speech emphasis Indicator (9, 80), pitch computer** used to teach prosodic features of the language (53), **manophone** to measure air pressures in speech cavities (53).

Artificial larynx - used in the rehabilitation of the laryngectomy. Two types pneumatic and electrical type. Manufacturers: 17, 24, 35, 46, 74, 79, 86, 88, 114, 121.

For the aerodynamic measurements like vital capacity, means air flow rate one may need equipment like **Expirograph.** It is water sealed instrument, so the amount of water has to be specified by the manufacturer and other parts like bellow, single way value, pulley unit with chain, breathing unit, Divider, mouth Piece, nose **clip** etc (129-133)-

Instruments used for the nasality measurements are accelerometry, TOMAR, nasometer etc (72).

Today, there are many instruments available that can be used for alternate or augmentative communication like vois 160, canon communicator M etc (Manufacturer, 34,50,98,99,),

There are many more other instruments used for the diagnosis and rehabilitation by the speech pathologist.

COMPUTERS IN THE SPEECH AND HEARING

Speech pathologists and audiologist have incorporated new technologies into their clinical practice when they felt that doing so would benefit those whom they serve professionally. A recent technology which involves the use of computers.

A computer is a tool. It is an electronic instrument that accepts information, stores information, processes information, and gives out processed information. There are different types of computers: main frames, minicomputers, and microcomputers. Microcomputers - which are the smallest and least expensive type, are the computers that speech pathologists and audiologists have used most often. These sometimes are referred to as home computers or personal computers (PC). Clinical software of interest to speech pathologists and audiologist has developed for a number of such computers including the Apple-II, the Apple Macintosh, the commodore 64, the Radio Shack TRS-80, the Radio Shack color computer and IBM personal computer or compatible computers.

The choice of computer system is the most difficult decision. There are several here that could be purchased depending in part on budget. The discussion here is confined to microcomputers because they are very common, very inexpensive and fairly adequate for clinical and research purposes.

Not long ago only 8 bit computers were used for quite a long time. Based on this the computers were standardized as 1 byte computers. However, recent days have seen the birth of 16 and 32 bit or 2 and 4 byte computers.

		Approx. cost
PC	8 bit	30,000
PCXT	16 bit	40,000
PCAT	16 bit	70,000
PCAT 386	32 bit	100,000
PCAT 486	32 bit	160,000

For clinical purpose one can make use of PCAT which is a 16 bit computer. The 286-based PC's are 16-bit computers whereas the 386 based PCs are 32 bit computer. For the research purpose, one can make use of PCAT 386, which is a 32 bit PC much faster and provide much higher performance. The 32-bit PCs have enough power to run most speech analyzes programs fast enough for a number of applications.

Before purchasing one must collect information from the reliable source like other professionals (particularly other speech pathologists and audiologists) who have computers for doing tasks similar to those for which you want to use potential source of data. Another potential source of them are a informations is persons who sell computers. If possible, discuss your needs with knowledgeable consults from several dealers. If their recommendations are similar and intuitively make sense to you, this should increase your confidence that you are selecting appropriate computer.

Computer can be used to replace all instruments in speech pathology. The findings of various tests done on the client can be stored permanently. It can also be used for efficient record maintenance.

Analog signals are representations of the physical word, and are usually represented as continuous signals. In the computer, the analog signal is digitised ie., analog signals are represented in terms of a sequence of discrete numbers. The process of converting analog signals into discrete or digital signals is called analog-to-digital (A/D) conversion and device is called as A/D converter or interface unit. There are several important considerations in the choice and usage of an A/D converter given in Appendix-J(a).

Filters and low-pas3 filtering:

In order to prevent aliasing during the process of converting an analog signal into digital form on a computer, the analog input signal is first low-pass filtered before it is send to the A/D converter. This is done by a separate filters device outside of the computer and the A/D card, although recent A/D cards have an option for a filter card to be attached to them to alleviate the need for a separate external filter. Low-pass cut-off frequency of interest must be set at the highest frequency of interest. Certain specifications of a low-pass filter must be taken into consideration as given in Appendix-J(b).

Speech output and signal generation (speech synthesis)

The computer is an ideal device for generating signals (and speech) because it provides a high degree of precision, flexibility and stability. These discrete signal from the computers are given to D/A converter which takes the discrete values and generates a continuous or analog output that is low-pas filtered and results in the actual analog signal.

Considerations discussed in the A/D converter are equally applicable to the D/A converters. But there are some additional considerations. When listening to any audio signal, if the onset amplitude is quite high it introduces unwanted clicks at the beginning of the signal. One way to eliminate these clicks is by use of an on-board deglitcher. In the absence of the deglitcher, the output signal must be rampled through software i.e., amplitude in first few millisces during the onset of the signal must be allowed to grow gradually. The output from the D/A converter is low-pass filtered and smoothed and results in the output analog waveform in an electrical form. The signal can be passed into an amplifier and then into a loudspeaker or headset.

PC's are available indigenously. Purchase of it depends upon the use i.e., clinical or research oriented. For the clinical oriented one may require minimum of 150,000/- rupees including other components to be used. For a research lab minimum of 200,000/- required. Following are the minimum requirements for the clinically oriented centre.

PCAT with:

CPU - Intel 80386 as MP or Intel 80387 as NDP

Speed - 25MHz for clinicsl purpose

33MHz for research purpose

Memory - 2MB RAM (0 wait state)

128K Coche memory

Floppy Drive - 1x 1.2 MB 5 1/4"

1x 1.44 MB 3 1/2".

Hard Disk Drive: 150MB HDD/300MB HDD

Monitor - VGA Card with VGA colour monitor (VGA-Virtual

graphic monitor) or Soft white

Key Board - 101 keys

Ports- 2 series and 2 parallel ports.

SIU (SP interface unit) 12 bit - Speed - 50KHz for clinical purpose

16 bit high speed 100KHz - for research purpose

ADC and DAC card multi point antialaisingfilter 72dB/ Oct can be purchased and 96dB/Oct for research purpose.

Option:

Printer - 3OOCps 24 Pin, 136 Colour Dot matrix printer is must. 300 DPI post script laser printer can be optional.

Other requirements are - computer should have connection for tape input, tape output, mic input, speaker and head phone output etc.

Regardless of the type of computer chosen, there are enough options in the market today to satisfy a wide range of clinicians and researcher with very different needs.

Manufacturer: 28, 45, 95, 123, 141, 142, 143).

SPEECH SOFTWARE:

The most critical part of the instrumentation for speech research is the actual speech software itself. There are several different speech analysis software packages with vastly varying capabilities and flexibility. Appendix-K(a) gives information about the basic capabilities of the different softwares. Appendix K(b) gives information on hardware requirements of speech analysis software.

BIBLIOGRAPHY

Ashish Kumar Purwar (1981): "Technical facilities available for the speech and hearing handicapped in hospitals in India - A Survey", Unpublished Master's Independent Project, Mysore (1981).

Ashok Kumar Sinha: "A draft for ISI specification for electro-acoustic Impedance audiometer". Unpublished Master's Independent Project, Mysore (1980).

Baken, R.J. (1987): "Clinical measurement of speech and voice". Taylore and Francis Ltd. London.

Bell H.Lewis and Associates (1982): "Industrial Noise Control" Fundamentals and Applications Edited by L.L.Fallkgrer and S.B.Menkes, Marcel Dekker, Inc. New York and Basel.

Bernard Sohn and Dorinne Davis,: "Acoustic reflectometry: A new tool for impedance screening". Hearing Instruments, Aug.1991, Vol.42, No.8, 26-27.

Bess, H.Fred, Humes,E.Lary (1990): "Puretone Audiometry" in Bess.H.F. "Audiology the fundamentals", Chapter-4, Williams and Wilkins, Baltimore, Hong Kong.

Birck D. Jonathan and Deborah L.Stewart,: "Selecting an impedance instrument". Hearing Instruments, Aug.1991, Vol.42, No.98, 11-14.

Directory, Hearing Instruments, May 1991, Vol.42, No.5, Page 12-19.

Duerden, C. (1970): "Noise Abatement". London Butterworths.

Indian Standard: Specification for Body Level Hearing Aids". IS:. 10775-1984.

Indian Standard: Specification for Hearing Aid3". IS: 4482-1967.

Indian Standard: Specification for pure tone audiometers". IS: 9098-1979.

Indu V. (1989): "Assistive listening devices for the deaf: A review unpublished Master's Independent Project, Mysore

Lansbury-Martin, B.L., Whitehead, M.L. and Martin,G.K. (1991): "Clinical Applications of Otoacoustic Emission, J.S.H.R., 34(5), 964-981.

Latha,J. (1986): "Question and Answers on Instruments and Instrumentation". Unpublished Master's Independent Project, Mysore (1986).

Laura Ann Wilber (1985): "Calibration: Puretone, Speech and Noise Signals" in Jack Katz - "Hand book of Clinical Audiology" 3rd Edition, Chapter-7, Page No.116-150, Williams and Wilkins, Baltimore, Hong Kong.

Manimegalai R. (1982): "A manual for Noise Measurement". Unpublished Master's Independent Project, Mysore.

Martin, N.Frederick (1986): "Audiometer" in Martin,N.F. "Introduction to aduiology, 3rd Edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Pollack C.Michael and Ron Morgan (1980): "Earmold Technology and Acoustics". In M.Pollack Amplification for the Hearing Impaired Ed.2 Chapter.3, 91-141, Grune and Stratton, New York.

Read, C, Buder H.E., Kent D.R. (1990): "Speech analysis systems, A Survey", J.S.H.R., 1990, Vol.33, 363-374.

Silverman, H. Franklin: "Microcomputers in speech-language pathology and audiology". A Primer Prentice Hall, Inc. Englewood Cliffs, New Jersey".

Suchita V.S.: "A Guide for the Hearing Aid User". Unpublished Master's Independent Project, Mysore, 1990.

Swan C. Gorin,: "Special features of Immittance equipment-then & now". Hearing Instruments, Aug.1991, Vol.42, No.8, 15-17.

Viyayalakshmi Basavaraj (1990): "Introducing the project "SAFA for the Hearing Impaired. In Test-the ISHA battery". Editors - Santosh K. Kacher and Vijayalakshmi Basavaraj, 1-9.

Wood, K.S. (1971): "Terminology and Namenclature" in "Handbook of Speech Pathology and Audiology, Edited by Lee Edward Travis, Chapter-1, 3-23.

APPENDIX-A

SPECIFICATION FOR PURETONE AUDIOMETER
INDIAN STANDARD (1979)

Requirements of Audiometer for AC measurement:

Frequencies - 8 tone frequencies 250, 500, 1K, 2K, 3K,, 4K, 6K and 8KHz. Additional tone frequencies (optional) 125, 750, 1.5KHz.

Accuracy of tone frequencies - ± 3%

Harmonic distortion - For the frequencies and HL settings listed in Table-1 the max level of the harmonics relative to the fundamental of the tone shall not exceed the values given in Table-2. Distortion shall be measured at the HL listed or at the max HL setting on the audiometer, whichever is lower.

TABLE-1: Output levels

Frequency (Hz)	Maximum	Upper Limit of HTL
	Air dB	Bone dB
125	70	
250	90	30
500	100	50
750	100	
1K	100	50
1.5K	100	
2K	100	50
3K	100	50
4K	100	50
6K	90	
8K	80	

TABLE-2: Maximum permissible harmonic distortion

Frequency (Hz)	AC			BC		
	125	250& 8000	500 to 6K	250	500& 750	**IK** to **4K**
HL (dB)	75*	90*	110*	20*	50*	**60***
2nd Harmonic	2%	*2%*	*2%*	10%	5%	**5%**
3rd Harmonic	2%	2%	*2%*	5%	2%	**2%**
4th & each higher harmonic	0.3%	.3%	.3%	2%	2%	**2%**
All subharmonic	-	.3%	.3%			**—**
Total harmonics	3%	3%	3%	12%	6%	**6%**

* - or relevant max output level for the audiometer, whichever is lower

Note: 1) Due to limitations of the acoustic coupler, artificial ears and mechanical couplers, measurements of harmonics occuring at frequencies above 4KHs maynot accurately describe the nonlinear properties of the system.
2) These distortion values donot necessarily apply to insert transducers; for such transducers, electrical determination of distortion should be made.

Hearing Level control (Attenuator) - SPL of each tone shall be adjustable in steps of 5dB or less. The maximum level for AC and BC shall be indicated on the hearing level dials.

Tone switch: The audiometer shall be provided with a tone switch of normally Off type for the presentation of test tone by operator and its operation shall be such as to establish and eliminate the tone without producing audible transients or extraneous frequencies. Facilities for locking device may be provided to keep the tone switch in continuous "ON" position.

When the tone switch is "ON" position, the time taken for the SPL produced by the earphone to attain -ldB relative to its final steady value shallnot exceed 0.2sec from the instant of operating the switch. The time taken for SPL to rise from -20dB to -ldB relative to its final steady value shall not be less than 0.02sec. At no time during the build up or decay of the tone shall the SPL produced by the earphone attain a value exceeding ±ldB relative to its steady value in the "ON" position.

When the tone switch is moved to the "OFF" position, the time taken shall not be more than 0.2sec and less than* 0.02sec.

Sound Source: Each audiometer shall be provided with 2 earphones. Each earphone shall be equipped with earcushion or supra aural type and shall be provided with suitable spring head band having adequate tension to hold the earphone against the ears to provide a satisfactory seal with a force of at least 4N. It shall be possible to obtain accuracy of positioning. The left earphone shall be marked blue and right red. Note- It is desirable that the ear cushion be of a kind which can readily be cleaned.

Range of SPL - By the earphone shall extend from the standard reference equivalent threshold SPL to a higher value, which shall be atleast that given in Table-1. An extension below the standard reference equivalent SPL is optional.

Accuracy of the SPL and vibration levels:

The acoustic measurement for the accuracy of SPL produced by the earphone should be carried out at 1KHz and at 60dB. At other settings of the attenuator only the electrical measurements should be carried out. The difference between the actual SPL of a tone at 2 neighbouring settings of the attenuator scale shall be within ±.1dB or by not more than 1/ 10 of dial separation of the difference between the scale readings at 2 settings which even is larger. The difference between the actual SPLs of a tone at each pair of settings of the attenuator scale shall be within ±2dB of the difference between the scale readings at the 2 settings.

Deviation between the actual SPL a tone, set up by the earphone in an artificial ear, at each setting of the attenuator (at 60dB) and the standard reference equivalent threshold SPL, should not exceed the following values.

Nominal frequency of the test tone (Hz)	Maximum permissible deviation (dB)
125	+3
250	+3
500	+3
750	+3
1K	+3
1.5K	+3
2K	+3
3K	+3
4K	+3
6K	±5
8K	±5

Note: It more than one channel for signals and/or noise can be connected simultaneously to a single transducer the output level of either signal (or noise) from the transducer with both channels connected shall differ by less than ±ldB from the level obtained when the channel is connected for 125 to 4KH2 and ±.2dB higher frequencies.

Requirements of audiometer for BC measurements

Test tone frequencies - 6 tone frequencies. 250, 500, 1K, 2K, 3K and 4K. Accuracy - within ±*3%*

Constant Area of bone vibrator - Plane circular contact area of 175 ±. 25mm2

Head band: To connect bone vibrator and to exert a static force of 5.4±0.5N. The headband shall permit the simultaneous use of one of the air conduction test earphones as a source of masking noise to the ear not under test.

Calibration: The bone vibrator shall be calibrated according to the normal threshold of hearing BC using the mechanical

coupler. The zero setting of the audiometer hearing level dial for AC shall apply also for BC for a stated placement of the bone vibrator.

GENERAL REQUIREMENT

1) Warm-up-time: Should be specified by the manufacturer and shall not exceed 10 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 elapsed.

2) Stability with respect to variation in the environmental conditions: The audiometer shall be capable of operating with the specified requirements at temp. +15 to +35°C; Humidity - 30 to 90% checking should be made at 70dB - 1KHz.

3) Battery level indicator: Shall be provided to ensure that the battery voltages are within specified limits.

4) Housing: Protector cover shall be provided with suitable windows where necessary.

5) Carrying means: A suitable carrying means shall be provided.

6) Unwanted Acoustic Radiation:

Extraneous sound of electrical origin from the earphone: Shall of such a magnitude that SPL is any 1/3 octave band is at least lOdB below the signal from the "ON" earphone.

Unwanted sound from a bone vibrator: At any test frequency of 4KHz or lower and at higher test frequencies where provided,

the bone vibrator shall not radiate sound to such an extent that the sound reaching the test ear by AC through the unoccluded ear canal might impair the validity of the BC measurement. As judged by an otologically normals the sound radiation from the bone vibrator shall be heard at a level at least 10dB below the level with the vibrator generates the BC when in contact with the head.

Unwanted sound from an audiometer: Any sound due to the operation of audiometer controls during the actual listening tests, or to radiation from the listening test, or to radiation from the audiometer, shall be inaudible at each setting of the hearing level dial upto and including 50dB, The test for this requirement shall be made by an otologically normal subject wearing a pair of disconnected earphones and located at the recommended test position, the electrical output of the audiometer being a absorbed in a resistive load equal to the impedance of the earphone at 1KHz, where the BC facility is available, the test shall be repeated with one ear only occluded by an earphone.

Masking source: Audiometer shall provide broad band weighted or narrow band masking sounds for the given puretone signals. Audiometer shall consists of an "ON/OFF" switch for the masking sound.

Harrow-band noise: Shall be centred around the test tones. The recommended band limits for the masking sound are given

in Table-3. The minimum attenuation rate out side the pass band should be at least 12dB/0ctave.

TABLE-3: Narrow-band Masking sounds (upper and lower frequency limits at the 3dB points of the spectral density)

Central Frequency (Hz)	Lower limits (Hz)		Upper limit (Hz)	
	Maximum	Minimum	Minimum	Maximum
125	105	112	140	148
250	210	223	281	297
500	420	445	561	595
750	6 1	668	842	892
1K	841	891	1120	1190
1.5K	1260	1340	1680	1740
2K	1680	1780	2240	2380
3K	2520	2680	3370	3570
4K	3360	3560	4490	4760
6K	5040	5360	6740	7140
8K	6720	7120	8980	9520

Note: These band limits correspond to 1/3 octave as a minimum and 1/2 octave as a max. These bands are wider than the critical bands and thus require approximately 3dB more energy than critical bands for effective masking.

Borad-Band Noise: It shall have a spectrum pressure level, as measured in the acoustic coupler or artificial ear, which is uniform with in $\pm$5dB relative to the 1KHz level over the frequency range of 250Hz to 6KHz.

Masking sound:

Intervals - masking level dial should have only one scale and a fixed index point. The masking level shall be adjustable in steps of 5dB or line.

Reference levels - For NBN, the level control shall be calibrated in decibels of effective masking. The masking

noise in each 1/3 Octave band centered at the frequencies specified shall have a SPL equal to the corresponding reference equivalent threshold level +3dB at the frequency of the puretone about which the band is centred.

For other noises, the masking level control shall be calibrated in SPL or in effective masking as measured with the earphone on an artificial ear or acoustic coupler.

Specification of masking effect: For each type of audiometer and earphones combination, the manufacturer shall supply data showing the masking effect for each test signal and the corresponding SPL on the coupler or artificial ear.

Accuracy of the masking level: Earphone - +5 -3dB. Measured difference in output between any 2 successive designations of masking level shall not differ from the indicated or ldB, with ever is smaller.

Masking level range:

Frequencies (Hz)	Minimum level (dB)
250	60dB
500	75dB
1K to 4K	80dB

The overall output SPL of masking noise shall not exceed 125dB.

APPENDIX-B
TECHNICAL SPECIFICATIONS FOR THE AUDIOMETER

	Screening	Diagnostic	Clinical	Example-Screening Amplaid-99	Example Diagnostic KLIKON EDA -3M3	Example - Clinical Madson OB 822
Frequency Range						
AC	+	+	+	125 to 8KHz	250 to 8KHz	125 to 12 KHz
BC	+*	+	+		250 to 4KHz	125 to 4KHz
FF	-	-	+			
Hearing level range:						
AC	+	+	+	-10dB to 100dBHL	0 to 120dB ISO 64	120-125dBHL (500-6KHz)
BC	+*	+	+		0 to 70 (500to4KHz)	70-80 (500-4KHz)
FF	-	-	+			
Attenuator range or level control	+	+	+	5dB steps & additional +10dB increment	5dB step +10 &+20dB increment facility	-10 to+149dB in dB & 1dB steps with range extender function
Accuracy						
Frequency	+	+	+	±3%	within 2%	Better than ±1%
Intensity	+	+	+			Within ±3dB indicated
Channel	Singal	Double	Double		Double	Double
Speech: Intensity level						
SP AC	-	+	+		120 dB HTL	
SP BC	-	-	+			
SP FF	-	-	+			
Masking						
NBN - AC	-	+	+		Effective masking range	WN SPN, NBN
NBN - BC	-	-	+		60-120dB at ISO	
NBN - FF	-	-	+		each at 1KHz	
WN - AC	-	+	+			
WN - BC	-	-	+			
WN - FF	-	-	+			
SPN - AC	-	+	+			
SPN - BC	-	-	+			

Note: + - Has or manual present.

	Scree-ning	Diag-nostic	Clini-cal	Example-Screening Amplaid-99	Example Diagnostic ELKON EDA -3M3	Example - Clinical	
External input microphone	-	+	+		Built in Mic	Dynamic or electret, for sp.& patient communication	
Tape 1	-	+	+		Tape input facility for recorded	Sensitivity 0.1-4.7rms for recorded	47 kohm.
Auxiliary (Tape2)	-	-	+		audiometry	Sensitivity 0.1-4.7rms 47 kohm.	
Outputs							
Phone	+	+	+	Pair of matched TDH-49	+	Air conduction	
Bone	+*	+	+		+	Bone conduction	
FF	-	+*	+			Free field loudspeaker via external amplifier	
Insert	-	+*	+			Insert phone	
Ipsilateral	-	-	+			Left+right signal mixed	
Signal & Noise presentation:							
Normally "ON"	+	+	+	+	+	Normal	
Normally "OFF"	-	+	+			Reverse (tone on) operation	
Paused	+	+	+	Interruptor rise-fall time-40msec		Rate 4/sec	
Warble tone	+*	+*	+				

	Screening	Diagnostic	Clinical	Example-Screening Amplaid-99	Example Diagnostic ELKON EDA -3M3	Example - Clinical
Standard functions						
SISI -	-	+*	+			Pulse increment lamp, pulse counters and automatic stop with indicator for 20 presentations increment 1, 2,3, 5dB.
TDT	-	+	+		TDT	TDT with automatic stop watch function.
STAT	-	+	+		STAT	STAT +
ABLB	-	+*	+			ABLB (fowler)
MLB	-	+*	+			
MLD	-	-	+			
DL1	-	-	+			Luscher test- intersity modulation oto ±5dB increment 0-0.2-0.4-0.6-0.8-1-2-3.5dB
DLF	-	-	+			Warble tone frequency modulation 0 to ±5%
Stenger	-	+*	+			Tone lock.
SAL	-	-	+			
VRA*	-	-	+*			
Hearing level lock	-	+*	+			Locking of the Lt&Rt attenuator with any chosen difference.
Tone lock	-	-	+			Internal tone switch synchronization for stenger test.
Communication & monitoring:						
Builtin take over	-	+	+			Built talk over and talk-back amplifiers with individually adjustable monitoring of left and right channels.
Take back amplifier	-	+*	+			
Distortion	+	+	+		All hormonics of any freq.not greater than 45dB below fundamental	Less than 1%
Standards: IEC				IED 645		IEC standard publication 645 audiometers.
ANSI	+	+	+	ANSI -1969	ANSI-69	
ISO etc				ISO 389	ISO-64	
Calibration	+	+	+		ISO-64 ANSI-69	ANSI S3.6-1971 Rev/ISO-389-1975/B.S.2497 individual calibration of all stimuli calibration data are stored in a programmed memory
Power supply	+	+	+	UL115-230Vac 50-60Hz IEC115-230 vac 50-60Hz	120 Volts DC	AC50/60Hz-110/125/150/220/240V +1% (specify with order)

	Screening	Diagnostic	Clinical	Example-Screening Amplaid-99	Example Diagnostic ELKON EDA -3M3	Example - Clinical
Operating temperature range	+	+	+	15 to 400I		0-35oC (32-95oF)
Dimensional/weight	+	+	+	Cm.40Wx240x14h 3.5Kg.		WxDxH, 515x430x195mm 15.6/12.oKg.
Standard accessories	-	+	+		Head phone & bone vibrator	Head set fitted with TDH39 phones with or without noise excluding domes MK70 (specify with order) BC B-71 with head band. Test patient signals blue and red, dust cover, audiogram pad, 2-color ball point pen, uses manual, mic, insert phone & monitor.
Optional Accessories	-	+	+	Foot switch External mic		Free field londspeakers, amplifiers and speech units RS 232 C data Interface kit.
Special function	-	-	+			Internal programing of several functions according to customers specification.
Patient safety	-	+	+			The range extender is automatically detected to reduce output levels when the frequency, input or output are changed.

APPENDIX-C

SUMMARY OF THE EQUIPMENTS USED FOR THE CALIBRATION OF THE AUDIOMETER

Calibration of	Artificial ear	Artificial mastoid	Condenser mic	SLM	Octave filter set	Pistone phone	Micro-phone adaptor	Frequency counter	BFO (beat frequency oscillator)	AF analyzer	GLR	Recor-ding paper	Distor-tion factor meter	Oscillo-scope
Audiometer output intensity via														
AC	+	-	+	+	+	+	+	-	-	-	-	-	-	-
BC	-	+	-	+	+	+	adaptor	-	-	-	-	-	-	-
Frequency calibration of pure tones								+						
Frequency response of Earphone	+		+						+	+	+	+		
Bone vibrator		+							+	+	+	+		
Speech audiometer mic input	+		+	+	+	+	+							
Tape input	+		+	+	+	+	+							
Distortion measurement													+	
Temporal parameters	+		+				+			+	+			+
SISI test	+		+				+			+	+			+
ABLB	+		+				+			+	+			+
Masking noise	+		+				+			+	+			

APPENDIX-D

TECHNICAL SPECIFICATIONS FOR THE IMMITANCE AUDIOMETRY

Specifications	Screening	Clinical	Research	Example ZO-2020 madsen
A) Compliance:				
(i) Pure tones				
226Hz	+	+	+	85dB SPL
660Hz	-	+*	+	78dB SPL
1KHz	-	+*	+	75dB SPL
(ii) Total Range:				
at 226Hz	+	+	+	0.1ml to 8.0ml
660Hz	-	+*	+	0.1ml to 7.0ml
1KHz	-	+*	+	2.0ml to 5.0ml
(iii) Reflex Range	+	+	+	0 to 0.15ml 0 to 0.3ml
(v) Tympanogram range	+	+	+	0 to 1.5ml 0 to 3.0ml 0 to 4.5ml
B) Air Pressure:				
(i) Control (one or both)				
Manual	+	+	+	+
Automatic	+	+	+	+
(ii) Range of the air pressure:				
Maximum positive	+	+	+	+400 daPa
Maximum negative	+	+	+	-800 daPa
(iii) Accuracy	+	+	+	

Note: * may or maynot present.

Specifications	Screening	Clinical	Research	Example ZO-2020 madsen
(iv) Air Pump speed	+	+	+	Plunger type, stepper motot - digitally controlled speed-selectable 400dapa/sec; 200dapa/sec, 100dapa/sec; 50dapa/sec.
C) Acoustic Reflex:				
(i) Stimuli				
Tone	+	+	+	+
Noise		+	+	+
(ii) Presentation				
contra stimulation				Normal Range Extended range
-Pure tone(range)				
500		+	+	0-110dBHL 0-125dBHL
1K		+	+	0-110dBHL 0-125dBHL
2K		+	+	0-110dBHL 0-125dBHL
4K		+	+	0-110dBHL 0-125dBHL
6K		+*	+	0-110dBHL
8K		+*	+	0-100dBHL
-White noise		+	+	0-110dBSPL, extended rang -125dBSPL
-Click train		+*	+	0-110dBSPL, 100usec square waves at a rate approx. 100/sec.
- Pulsed tone		+	+	all frequencies with ON/OFF cycle of 250msec.
- Attenuator steps	+	+	+	
- External input		+*	+	external input
Ipsilateral stimulation:				
Pure tone 500		+	+	0-115dBSPL
Pure tone 1K		+	+	0-115
Pure tone 2K		+	+	0-115
Pure tone 4K		+	+	0-90
- Click train		+*	+	0-110dBSPL, 100usec square waves at a rate of approx. 100/sec.
Bilatral stimulation		+*	+*	Any 2 tones may be selected for simulatenous bil presentation.
Dual contra "		+*	+*	The tones from the ipsi ranges may be presented to the contra earphone, permitting simulatneous presentations of any 2 tones to contra ear.

Specifications	Screening	Clinical	Research	Example ZO-2020 madsen
(iii) Formant				
Automatic	+	+	+	+
Manual	+	+	+	+
(iv) Measurement				
-Threshold	+	+	+	+
-Adaptation		+*	+	+
-Latency			+	+ cursor for latency-measurement.
D) Audiometric mode:				
Puretone		+*		
Normal range				
Extended range				
Step size				
E) General:				
(i) Display				
-Graphic	+	+	+	
-Meter indicator	+	+	+	
(ii) Graphic Printer:				
Built in printer				
Paper type		+	+	Thermal
Paper width		+	+	110mm
Print speed		+	+	4 character lines/sec 25ms per dot line
External printer		+*	+*	
(iii) Dimension	+	+	+	190H, 475W, 465DMM
(iv) Weight	+	+	+	Net/Gross, 11kg/14kg
(v) Power supply	+	+	+	170W 110/120V 50/60Hz AC
(vi) operation temperation range	+	+	+	

Specifications	Screening	Clinical	Research	Example ZO-2020 madsen
(vii) Standard accessories	+	+	+	Headset including TDH 39 & probe set of ear trps 2cc cavity operation maual.
(viii) Optional accessories	+	+	+	Insert phone, service manual, Carrying case.
(f) Standards	+	+	+	

SPECIFICATIONS FOR AUDITORY EVOKED RESPONSE INSTRUMENTATION

	Amplaid/AND/OR Corp. Models MK4 (2Ch.), MK5 (2Ch.), MK6 (2 to 4 Ch.), MK 7 (4 Ch.)	Amplaid/ AND/OR Corp. Model MK10	Axonics Audit TMV Model AX-135	Bio-logic Model Brain Atlas	Bio-logic Models System 6, 7,7B,7H,7HB,7N2,7N4	Cadwell Model 5200A	Cadwell Models 7400 (4 Ch.) and 8400 (16 Ch.)	Life-Tech Model 8101AR	Life-Tech Model 8102AR	Madsen Models ERA 1250 and ERA 2250	Nicolet Model Pathfinder I/II	Nicolet Compact Four	R.C. Electronics, Inc. Models CPS-AEP and APL-AEP	R.C. Electronics, Inc. Models CPS-ABR and APL-ABR	Teca Corp. Models EP40A (4 Ch.), TD10 (1 Ch.), TD20 (2 Ch.), NeuroLab (16 Ch.)	Teledyne Avionics Model TA-1010	Tracor Northern Model TM3000	Tracor Northern TM 3500	Tracoustics Model Tracy
1.	•	1 or 2	1	21	4	1 or 2	•	1	2	4	8	4	2	2	•	1	4	16	2
2.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•
3.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•
4.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
5.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
6.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
7.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
8.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
9.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
10.	•		•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•
11.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•
12.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•
13.	•		•	•	•	•	•			•	•	•	•	•	•	•	•	•	•
14.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
15.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
16.	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
17.	•			•	•	•	•	•	•	•	•	•	•		•	•	•	•	•
18.	•		•	•	•	•	•			•	•	•	•		•	•	•	•	•
19.	127 dB SPL	130	0-90	0-120 dB SPL	0-120 dB SPL	0-126	0-126	0-129	0-129	159	113-Manually 155-Program	140	0-120		130	0-110	0-95	0-120	0-130
20.	1	5	10	1	1	2	1	10	2	5	2 or 5	1	1		5	5	5	1	1
21.	125 to 8K + 12K + 16K	125 to 8K + 12K + 16K	500 Hz, 1K, 2K	250-8K	250-8K	250-8K	250-8K	250-8K	250Hz, 500 Hz, 1K, 1.5K, 2K, 3K 4K, 6K, 8K	250Hz, 500Hz, 1K, 2K, 4K, 8K, 10K	250Hz, 500Hz, 1K, 1.5K, 2K, 3K, 4K, 6K, 8K	250-8K	20 Hz-10		125 Hz 250 Hz 500 Hz 750 Hz, 1K, 5K,	2K, 4K 150 and 400 msec click	125Hz, 250Hz, 500Hz, 750Hz, 1K, 1.5K, 2 0K, 2.5K, 3K, 4K, 5K, 8K	40 Hz 16K	250-8K
22.	TDH-49	TDH-49	Miniature Receiver	TDH-49	TDH-49	TDH-39	TDH-39	Telex 1470 (Shielded)	Telex 1470A	TDH-39P & magnetic Shielded Headset	TDH-39	TDH-39P	Telex 1470A		2K, 2.5K, 3K, 4K, 6K, 8K	Telex 1470A	TDH-49	TDH-49	TDH-39
23.	•			•	•	•	•	•	•	•	•	•			•	•	•	•	
24.	•		•	•	•	•	•			•	•	•			•		•	•	
25.	•		•	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•
26.	•		•	•	•	•	•	•	•	•	•	•	•		•		•	•	•
27.	•		•	•	•	•	•			•	•	•	•		•	•	•	•	•
28.	•	•	•	•	•		•	•	•	•	•	•	•		•		•	•	•
29.	•			•	•		•			•	•	•	•		•		•	•	
30.	•	•	•	•	•	•	•	•	•	•	•	•			•		•	•	
31.	•	•	•	•	•	•	•	•	•	•	•	•			•		•	•	

● Indicates product has this capability.

[P.T.O.]

Classification categories

1. Maximum number of data channels
2. Mass data storage
3. Mass data storage includes storage of recording parameters
4. On-line artifact rejection
5. View input mode
6. Interactive cursor
7. Absolute units for cursor readout
8. Difference measurements with cursors
9. Plotter
10. X-Y or digital plotter
11. Data reduction and storage of same
12. Interface with other computers
13. Automation/programmability
14. Click stimulus unit
15. Phase control of click
16. Gated tone generator unit
17. Phase control of tones
18. Masking noise unit (external filtering capability)
19. Attenuator range (dB)
20. Attenuator stepsize (dB)
21. Frequencies (Hz)
22. Earphones (type)
23. Bone vibrator
24. Insert type earphones
25. Amplifier low-pass settings
26. Amplifier high-pass settings
27. Calibration for physiological amplifier
28. Built-in electrode impedance measuring device
29. Cognitive response stimulus unit
30. Somatosensory stimulus unit
31. Visual stimulus unit

Maico Hearing Instruments Co.
7375 Bush Lake Rd., Minneapolis, MN 55435

Medical Coaches, Inc.
P.O. Box 129, Oneonta, NY 13820

Micro Audiometrics Corp.
P.O. Box 987, Amherst, NH 03031

Nicolet Biomedical Instruments
5225-4 Verona Rd., Madison, WI 53711

Oto-Data, Inc.
842 N. Highland Ave. N.E., Atlanta, GA 30306

Alfred Peters & Sons Ltd.
Wreakes Lane, Dronfield,
Sheffield S18 6DH, England

Phonic Ear, Inc.
250 Camino Alto, Mill Valley, CA 94941

Qualitone
4931 W. 35th St., Minneapolis, MN 55416

Quest Electronics
510 S. Worthington St.,
Oconomowoc, WI 53066

R.C. Electronics
5386-D Hollister Ave.,
Santa Barbara, CA 93111

Rexton Danplex A/S
Dr. Tvaergade 48,
DK-1302 Copenhagen, Denmark

Rexton International, Inc.
768 Foster Ave., Bensenville, IL 60106

Saico, Inc.
511-11th Ave., #250
Minneapolis, MN 55415

Siemens Hearing Instruments, Inc.
685 Liberty Ave., Union, NJ 07083

Starkey Laboratories, Inc.
P.O. Box 9457, Minneapolis, MN 55440

Teca Corp.
3 Campus Dr., Pleasantville, NY 10570

C.A. Tegner AB
P.O. Box 20003, S-16120 Bromma, Sweden

Teledyne Avionics
P.O. Box 6400, Charlottesville, VA 22906

Telex Communications, Inc.
9600 Aldrich Ave. S., Minneapolis, MN 55420

Tracor Instruments
Medical Instruments Div.
6500 Tracor Lane, Bldg. 27-5
Austin, TX 78721

Tracor Northern
2551 W. Beltline Hwy., Middleton, WI 53562

Tracoustics, Inc.
P.O. Box 3610, Austin, TX 78764

Jay L. Warren, Inc.
P.O. Box 25413, Chicago, IL 60625

Welch Allyn
State Street Rd., Skaneateles Falls, NY 13153

APPENDIX-F

SUMMARY OF THE CONTROLS OF THE DIFFERENT TYPES OF HEARING AIDS

Sl. No.	Controls	Body level hearing aids		Behind the ear	Spectacle hearing aid		In the ear	In the cana
		AC Aid	BC aid		AC Aid	BC aid		
1	ON/OFF switch	+	+	+*	+1	+1	+2	+2
2	Volume control	+	+	+	+	+	+	+
3	Tone control	+*	+*	+*				
4	Telephone coil	+*	+*	+*	+	+	+	
5	Battery compartment	+	+	+	+	+	+	+
6	Cord	+	+	-	-	-	-	-
7	Tubing	-	-	+	+	-	-	-
8	Reciever	+	+	+	+	+	+	+
9	M.P.O.	+*	+*	+*	+*	+*	+*	+*
10	Cell	Pc	Pc	Bc	Bc	Bc	Bc	Bc

Note: 1 = Combined with volune control
2 = If cell is present it is "ON", if not it is "OFF"
Pc = Pentorch cell
Bc = Button cell
* = May or may not present.

APPENDIX-G
IS (10775-1984)
SPECIFICATION FOR BODY LEVEL HEARING AIDS

Characteristics	Requirement		
	Mild Class	Moderate Class	Strong Class
Max saturation SPL	115dB	125dB	135dB (Mote)
Average OSPL 90	105-114dB	115-124dB	125-134dB
Full-on acoustic gain	45dB(min)	55dB(min)	65dB(min)
Hf-average full-on-gain	40dB(min)	50dB(min)	60dB(min)
a) Basic frequency response b) Comprehensive frequency response	Measured results shall be recorded		
Frequency range	Shall be between 250Hz to 3150Hz		
Effect of gain position frequency response	Measured results shall be recorded		
Effect of tone control on frequency response			
Effect of full-on acoustic gain of variability of battery voltage	Shall not exceed lOdB		
Total harmonic distortion	Shall not exceed 7%		
Inter modulation disotortion /difference freq.distortion	Measured results shall be recorded		
Effect of variation of battery on distortion	Shall not exceed 10%		
Internal noise from hearing aid interms of equivalent input noise level	Shall not exceed 30dB(SPL)		
Batery current	5MA	10MA	15MA

Note: Hearing aid with max SSPL greater than 135dB are likely to damage the ear. Hence their use should strict medical advice)

Characteristics	Requirement
	Mild Class Moderate Class Strong Class
Induction coil sensitivity (in applicable)	The measurement value of the coupler SPL shall be within +6dB of the value specified below 100dB 110dB 120dB
ACG characteristics (if applicable) a) Steady state input/output characteristics	With the measured and specified curves matched at the point corresponding to 70dB input SPL, the measured carve at 50 and 90dB input SPL shall not differ in output SPL from the curve specified by the manufacturer for the model by more than ± 5dB.
b) Dynamic output characteristics	The attack and recovery times shall each be within +5msec or ±50% which ever is large, of the values specified by the manufactures for the model

APPENDIX-H

EARMOLD MATERIALS

EAR HOLD MATERIALS:

1) Lucite plastic (Acrylic): Chemical name - Methyl raethacrylate - hard mold material. Available in 2 form liquid (monomur) and powder (polymur).

2) Special acrylic (super alerite) for hard mold. Non-allergic material.

3) Ethyl methacrylate - Soft mold material.

4) Polyvlnylchloride (PVC) - soft mold material.

5) Polyethyl methacrylate - Acrylic body, vinylcanal, ie., hard body and soft canal.

6) Special acrylic body, vinyl canal - hardbody and softcanal.

7) Vinyl (thermoplastic) - Soft mold material.

8) Silicone - Soft mold material.

9) Polyethylence - Moderately soft to some what hard. Useful for severe allergic cases other materials used are.

10) Plaster of paris to make plaster caste of the ear impression.

11) Alginate materials - to take impression of the ear.

12) Cold mold seal - used to coat the plaster cast before packing it with earmold material to avoid reaction.

13) Pumice powder - also called polishing powder used to polish the mold.

14) Vasiline - pectroleum jelly - used in coating inner surface of falsk for easy deflasking of the ear mold.

APPENDIX-I
CAPABILITIES OF THE EQUIPMENTS

	Fo	Har-monic	Inten-sity	Freq. range	Inten-sity range	RT-FT	H/N ratio	S/Z ratio	Opti-mum freq.	Natu-ral freq. of VT.	Jit ter	Shi-mmer	Open quotent	Speed quotent	For-mant	VOT	Nasa-lity	Phona-tion dura-tion	Vital capa-city	MFR
Visi Pitch	†		†	†	†	†														
Vocal 2	†		†	†	†	†														
PM 100	†		†	†	†	†														
Fo. Indicator	†																			
EGG	†	†	†				†				†	†	†	†		†		†		
Spectrograph	†		†												†	†				
Heterodyne analyzer									†	†										
TONAR																	†			
Nasometer																	†			
Accelerometry																	†			
Stop watch								†										†		
Aerophone																			†	†
Expirograph																			†	†
Spirograph																			†	†

APPENDIX-J

(A) A/D CONVERTER

There are several important considerations in the choice and useage of an A/D converter.

1) **Resolution:**

Resolution is specified as the number of bits on the A/D converter. For ex: 12 bit or a 16 bit A/D converter. This resolution of the A/D converter is a function of number of bits of the A/D converter raised to the power of 2. Thus, a 1 bit converter provides only 2 steps of resolution (2'=2). 3-bit provides 8 levels of resolution (23=8) and so on. For speech signals, a 12 bit converter is acceptable, providing a resolution of 1 in 4096 parts.

2) Sampling rate:

Sampling rate refers to the rate at which the A/D converter samples a signal for digitization. The selection of the sampling frequency is dependent on the frequency range of the signal used. In order to represent any frequency component in the input signal, there are mathematical rules that govern the number of samples required for this purpose **(Nyquist theorem).** The sampling rate must be at least twice the highest frequency contained in the input signal. Usually, the input signal is low-pass filtered such that no frequencies higher than the highest frequency of interest are contained in the signal input to the A/D converter. However, due to the limitation of the A/D converters and low pass filters, a higher sampling frequency is used. For the speech

clinic one may require sampling frequencies of 16KHz to 20KHz. Because some consonants (like /s/) have energy in the higher frequencies around 6 to 8 KHz a higher sampling frequency of about 16KHz is desirable, while the lower sampling frequency of 8KHz is adequate for most vowel sounds. Most modern A/D converters provide sampling frequencies up to 150KHz. Analyses of infant speech, fricatives and female speech require sampling frequencies greater than 10KHs. If a sampling frequency lower than 2 times the highest frequency of interest is used, parts of the original signal are represented as being lower in frequency than they really are resulting in distortion of the real signal. The introduction of lower frequencies that do not actually exist in the original speech signal is referred to as **ALL**AS**ING,** and the distortion as alias frequencies. Thus it is important to use a high sampling frequency.

3) Triggering options:

Triggering is the process which signals the A/D board to commence conversion or digitizing. Most A/D boards provide for either internal or external triggering. In the external triggering, the A/D conversion can be started when the external triggering is applied. If there is no external triggering then the card must be informed through software as to when to begin the conversion usually based on detecting some specified point on the voltage rise of the incoming signal.

4) Number of channels: Most A/D converters provide more than one channel for converting signals. That is, more than one signal can be digitized at the same time. These channels are provided as either single -ended (SE) or differential input (DI). Typically, A/D cards provide 16SE or 8DI channels. In SE input, there is one common signal ground, and the signal is the difference between the input signal and the common ground. In DI mode, 2 channels are used to convert a single-signal input. The difference between the 2 channels is used to represent the signal to be digitized. When more than one channel is being converted, the A/D rapidly steps through each of the channels successively. The converted signals are stored as one continuous stream of multiplexed signals. The advantages of multiplexing is that when there is a need to digitize more than one channel, as in research on speech physiology, where the speech signal is sampled simultaneously with various physiological measure, a single card can handle several simultaneous conversions.

5) Input voltage range: It should be + 5 volts or ± 10 volts. Values exceeding this range may destroy the A/D card.

6) Direct-memory Access (DMA): When data is acquired at fast rates (greater than 10KHz), it becomes essential to use the DMA mode of conversion where in the converter directly deposits the samples into some memory location in RAM (Random-Access memory), entirely by passing the CPU (Central processing unit of the computer). If a non-DAM mode is used, each sample converted by A/D has to be moved from the

registers in the converter by the CPU to a memory location in the RAM, before the A/D can begin its next conversion, for higher sampling rates, this becomes too demanding on the CPU and there is a possibility of losing some of the original input signal. A number of manufacturers also provide soft ware (called drivers) that automatically transfer the data from the A/D to hard-disk. This is limited by the speed capabilities of the hard disk, disk controller and disk driver. For most speech research purposes, direct-to-disk A/D conversion is available for sampling frequencies upto 100KHz, or even higher. There is a major drawback of this process. If this option exist, then data can be acquired or digitized for an unlimited time interval, constrained only by the memory available on hard disk. If this option do not exist, then the duration of the input signal that can be digitized is limited by the available RAM on the computer.

The above mentioned considerations to be taken into account in the selection of an A/D converter card.

(B) Filters and low-pass filtering:

Certain specifications of a low-pass filter must be taken into consideration:

1) Programmable cut-off frequency:

Programmable filters are preferable to and much more expensive than fixed frequency cutoff filters. 4.8KHz, 7.5KHz, and 9.6KHz (used along with sampling frequencies of 10KHz, 16KHz, 20KHz respectively) are the most commonly used cut-off frequencies.

2) Roll-off frequencies:

There is some amount of leakage of frequencies beyond the cut-off frequencies i.e. unwanted frequencies do pass through the filter. The amplitude of this unwanted frequencies is indicated by the roll-off, which indicates how much attenuation occurs in the frequencies beyond the cut-off frequencies. A very steep roll-off (about 96dB/octave) indicates that frequencies beyond the cut-off value are present only at minimal amplitudes. For purposes of speech, a minimum of 48dB/0ctave is typically used, although 96dB/ octave is preferable. The steeper the roll-off frequencies, the more expensive the filters tend to be.

3) Input voltage range: Same as that of A/D converter.

4) Active or passive filters:

Active filters contain an amplifier along with the filter, they have a wide dynamic range, good linearity, provides selective amplification. All active filters require power source. Passive filters do not require power source. They usually work by cutting out the amplitude of the unwanted frequencies. Most of the active filters provides a much higher role-off rate (around 96dB/octave) than passive filters. Either type of filter is accepted in speech research.

These are only some of the important considerations in the choice of a low-pass filters.

APPENDIX-K(a)
BASIC CAPABILITIES

	CS speech	CSRE	ILS-PC	Mac speech	MSL	SSL
A) Waveform acquisition and display:						
Initial capture of signal:						
Recording: No.of channels	1-4	**1**	**1-3**	1	**1**	2
Display: Max.no.of channels	8	**1**	**16**	1	**1**	2
Capacity (disk memroy limit)	D	D	D	M	M	()
Record/playback	Y	Y	Y	Y	Y	Y
Monitor display	Y	Y	Y	Y	Y	Y
Zoom/Scroll	Z	Z	Z	Z	Z	Z/S
Time readout	Y	Y	N	Y	Y	Y
Amplitude readout	Y	Y	N	Y	Y	N
Amplitude resolution (max. bits)	16	**16**	**16**	12	**10**	12
B) Waveform operation (Subsequent to initial capture):						
View & play selected segment	Y	Y	N	Y	Y	Y
Splice	Y	Y	Y	Y	N	Y
Relicate	Y	Y	Y	Y	N	Y
Taper ends	Y	N	Y	N	N	N
Save/retrieve	Y	Y	Y	Y	Y	Y
Label segment	Y	N	Y	N	N	Y
Erase	Y	Y	Y	Y	N	Y
C) Spectral & pitch analysis:						
Spectrogram	N	Y	Y	Y	N	Y
Formant tracing in spectrogram	N/A	Y	Y	Y	N/A	Y
Readout time, frequency, amplitude	N/A	Y	N	Y	N/A	Y
Spectrum: FFT	Y	Y	Y	Y	Y	Y
LPC	Y	Y	Y	Y	N	Y
Water fall	Y	Y	Y	N	N	N
Readout frequency, amplitude	Y	Y	N	Y	Y	Y
Cepstrum	N	N	Y	N	N	N
Voice perturbation analysis	Y	Y	N	N	N	Y
Pitch extraction	Y	Y	Y	Y	Y	Y

	CS speech	CSRE	ILS-PC	Mac speech	MSL	SSL
D) Other functions:						
Speech synthesis	N	Y	Y	N	N	**Y**
Data import/export	Y	N	N	N	N	Y
Stimulus presentation utils	Y	Y	N	N	N	N
Simultaneous display:						
Wave form and spectrum	N	N	Y	Y	Y	Y
Wave from and spectrogram	N/A	N	Y	Y	N/A	Y
Spectrum and spectrogram	N/A	Y	Y	Y	N/A	Y
Spectra: FFT and LPC	Y	N	Y	Y	N/A	N
Fo & Wave form or spectrogram	Y	Y	Y	Y	Y	Y
ADDRESS:	94	42	118		120	140

Note: 1 = Can mark and save any continuous option.
In signal ABC, can mark B and Play AC, but cannot save AC in a file.

Other soft wares programmes used with PC are:

1) Speech work station (with DSP board): Cost = $ 4715 to $ 5996 - for analysis;
   Manufacturer - 124.
2) Real time speech lab - for analysis:
   Manufacturer - 109.
3) APRLS (Acoustic phonetic research) - for analysis and synthesis.
   Manufactuerer - 75.
4) Hypersignal plus - for analysis: Cost: $ 1000
   Manufacturer - 63.

APPENDIX-R(b)
HARD WARE REQUIREMENTS OF SPEECH ANALYSIS SOFTWARE

Equipment	CSpeech	CSRE	ILS-PC	MAL SP.	MSL
Computer	PC/AT, PS/2	PC/AT	PC/AT	Maantosh II	PC/AT
Math, coprocessor	Required	Required	Required	N/A	Not used
Memory (Kb)	512	640	640	2000	19L
Disk Space (Kb)	720	503	6000	133	360
Printer (s)	IBM/EPSON	HP PRINTJET	NOTE	IMAGE/LASER	IBM/EPSON
Display graphics	C.E.V.H	E	G.E.V.H	Macintosh	C
Mouse	Optional	Optional	Not used	Required	Not used
A/D, D/A Board(s)	Required	Required	Required	Included	Included
Audioequipment	Required	Required	Required	Included	Included
Input/Output filters	Required	Required	Required	Included	Included
Price (in Jan 90)	$1800	$350	$1000	$4990	$2010

Display graphs - G,E,V = IBM, CCA, EGA, VGA graphic standard and H = Hercules graphic standard.

P*rice: To each price, add the required computer system and other hardware.

APPENDIX-L (ADDRESSES)

1) Acoustic-Medical Instrument Inc.
2127, Research Dr.#13,
Llvermore CA94550,
Ph.415-455-6185
Fax-415-455-6187

2) Advanced elctronic instrument Co.
Rm 910 Wu Sang House
655 Nathan Rd,
Kowloon Hong Kong
Ph.(852) 3913836
Fax (852) 3912534

3) AIM Instrumentation
5232 Irminst,
Burnaby BC Canada
V5J 1Y7
Ph.604-438-3033
Fax 604-438-7755

4) Alfred Peters and Sons Ltd.,
Wreak Lane, Dronfield
Sheffield,
6DH, England, U.K.

5) ALPS Intl., Private Ltd,
B7/10 Safdarjung Enclave,
New Delhi-110029
INDIA
Ph.609370, 6862940

6) Amplaid SPA
Via Ripamonti 129,
20141 Milano Italy
Fo ZSITMI
Ph. (02) 5691903
. Fax 2/5391734

7) Amplaid U.S.A. Inc.
545, West Gulf Road
Allington Heights
IL-60005, USA.

9) Aparna Meditronics Private Ltd.,
B-301 Mount Banjara,
Rd No.12 Banjara Hills
Hyderabad-500034
India
Phone - 229798

10) Applied Electronics Ltd.,
Aplab House
A-5, Wagle Industrial estate
Thane - (Maharastra)
Ph - 591861-2-3

11) Arphi Electronics Pvt.Ltd.
Prabhadevi Industrial Estate.
VS Marg, Bombay-400025.
India
Ph: 4225292, 4220839
(Dealer for Alfred Peters and Sons Ltd).

12) Arphi Electronics Pvt.Ltd.
247 Borewell Road,
White field
Bangalore-560066
T.08112-2386

13) Arphi Electronics Pvt.Ltd.
21/2F Monohar Pukur Road
Calcutta 700029

14) Arphi Electronics Pvt.Ltd.
2/5 Sivagnanam Road
Pondy Ba2ar, T-Nagar
Madras-600017
Ph-440575

15) Arphi Electronics Pvt.Ltd.
203 Magnum House
Nazafgarh Commercial Complex, Karampura,
New Delhi - 110015
Ph.5412759

17) Artificial Speech Aids
Pneumatic Type
Red Wood Ward
3132 Waits
Fortworth; Texas 76109
USA

18) Associated electronic
Engineers
166, 17th Cross,
Mallesharam
Bangalore-55

19) Associated instrument
manufacturers Pvt.Ltd.
Naimex House
A-8 Mohan Cooperative
Industrial Estate
Mathura Road,
New Delhi -110044

20) AT & T National special
Needs center,
2001 Rte 46 Ste. 310,
Parsippany NJ07054
P-800-233-1222

21) ATLAZ Technologies
127/T.V. Industrial
Estate
S.K.Ahire Marg,
Bombay-400025
T-4923094

22) ATLAZ Technologies
28-A, Krishnaswamy
Iyer Avenue,
Luz Church Road,
Madras - 600004
Ph.73174, 77427

23) Audio electronics Inc.
7313 Ashcroft # 210,
Houston Tx 77081
713-774-4832,
Fax-713-774-6459

24) Aurex Corporation
337 South Franklin
Street
Chicago,
Illinois-60606, USA

25) Bangalore Dental Corp.
320, Albert Victor Road,
Opp.Bangalore Medical
College, Bangalore-560002
(Indian Dealer of Kavo)

26) Beltone Electronics Corp.
4201 W Victoria St,
Chicago IL 60646
Ph-312-583-3600
Fax-312-583-3980

27) Bernafon, Inc.
P.O.Box.35127
Edina, Minnesota-55435
P-l-612-897-3630

28) BPL-India, BPL-Centre,
32, Church Street,
Bangalore - 560001
Ph-52321/52322

29) Bruel & Kjaer
Naerum Hovedgade 18,
Naerum Denmark- 2850
P-42800500
Fax-42801405

30) Bruel & Kjaer Instruments
Inc., 185 Forest St,
Marlborough MA-01752
Ph-508-481-7000
Fax-508-485-0519.

31) Brel Precision Components
1621 University Pkwy,
Sarasota FL 34243
Ph-813-355-9791
Fax-813-355-1530

32) Bureau of Indian Standard
Manak Bhavan,
9 Bahadur Shah Zafar Marg,
New Delhi - 110002

33) Callpsonic "Deepavali"
Ground Floor, S.V.Road,
Andheri, Bombay-400058
Ph-578717

34) Canon Inc,
Audio&Visual Center, 7-1,
Nishi-Shinjuku 2-chame,
Shlnjuku-ku, Tokyo 163,
JAPAN
Ph-81-3-348-2121

35) Cardwell Associates Inc,
P.O.Box 1135,
Torrance
California 90505

36) Communication
94 Deshbandhu Apartments
(Near Deshbandhu college)
Kalkaji,
New Delhl-110019, INDIA

37) Computer Engineering Ltd
Wallance Way, Hitchin,
Herts SG4 OSE, U.K.

38) Cosomocrd Ltd,
Eleaner Cross Road
Waltham Cross,
Herts, O.K.

39) Dahlberg Inc.
4101 Dahlberg Dr,
Golden Valley MN55422
Ph.612-520-9500

40) Department of Science
and Technology,
Department of Education
technology, Bhawan
New Delhi, 110016.

41) Dawe International Pvt.Ltd
Western Avenue Action,
London, U.K.

42) Prof.Donald Jamleson
Speech Communication
Laboratory.
Dept.of Communication
Disorders,
University of Western
Ontario, London. Ontario

43) Dreve-Otoplastik GmbH.
max-Planck-Star Be 31
D~4760 Unnal Germany
Telex 8229296.

44) Electronic (Sales
Corporation, Electrical
Market, Chandni Chowk,
P.B.No.1174, Delhi
Ph.233215/238842

45) Electronics Corporation
of India Limited,
ECIL Post office,
Hyderabad - 500762
Ph.850131

46) Electronics Ltd,
Atma Ram House(7th Floor)
1, Tolstoy Marg,
New Delhi - 110001
Ph.3820001-2-3

47) Electroni & Scientific
Devices,
100 U.B. Jawahar Nagar,
Delhi - 110007
Ph.-2911520

48) Electrotech Corporation
D-76, Industrial Estate
Mohali, Panjab.

49) Elkon Private Ltd,
1203 Prasad Chambers,
Opera House,
Bombay-400004, INDIA
Ph-8112838

50) ES-Rehatec. Erik Spanow
Aps.
Po.Box.132,
Christian Shusvej 6
DK-2970, Horsholm
Denmark.

51) Euro Sonlt SRL
Via Principle Eugenlo 13,
20155 Milano Italy
Ph (02)33.10-16-57
Fax (02) 33.10.33.72

52) Eveready Plastics
Post Office Box 566
Forest Park,
Georgia 30061-0866

53) F-J Electronics Ellebuenzl
DK-2950 Vedback
Denmark
T-0289 1469.

54) Fraser Instrument Co.
412 37th St
Birmingham AL 35222
P-205-591-4279

55) General Radio
300, Baker Avenue
Concord, Massachersetts
MA - 01742, USA

56) Gujarat Communications & Electronics Limited,
Anurag Commerican Centre
Race Course
Baroda - 390005
Ph-324514/324495

57) Hawlett-Packard India Pvt.Ltd.
Neelam Centre, Unit No.l
"B" Wing, Hind Cycle Road
Worli, Bombay-400019
Ph-4934722

58) Hearing Aid Centre
Bank Road, Civil Lines,
Ludhiana-141001, INDIA

59) Hearing Aid Centre
Kailash Cinema Rd,
Civil Lines
Ludhiana-141001
India
Ph.91-161-50658

60) Hearing Aid Service
6008 Blue Boy Mansion,
Jalan Tong Shin,
50200 Kuala
Lumpur Malaysia
Ph.(03) 2488939
Fax-603-2488939

61) Hindustan Instruments
719 Bell Lane,
Opp.Bombay University
Bombay 400023,
Ph.273961

62) Hi-Tech Instruments & Controls
23,111 floor, Parsn Complex
600 Mount Road,
Madras 600006

63) Hyperception
9550 Skillman
LB 1255, Suite 316
Dallas, TX 75243
214-343-8525

64) Inorchem Power Systems Private Limited,
11-B MIQH, Sanjeevareddy Nagar, Hyderabad-500038
Ph-262036/895274

65) Instrument techniques (p) Ltd,
B-2, Cooperative Industrial Estate, Balanagar,
Hyderabad-500037, India.
Ph.262521, 262532

66) Instrumentation Assocs Inc
Trolly Crossing office Park, 8116 Caaenovia Rd,
Manlius NY 13104
P-315-682-4840

67) Johari Electro Medical Co
Ec-1, Electronic Complex
LIA, Jodhpur-342003
Rajasthan, India
Ph.34683

68) Joseph Leslie Agencies Pvt.Ltd.
11/12, Apeejay House,
4th Floor, P.O.Box 668,
130, Apollo Street
Bombay - 4000001
(Dealer for Quest Elect.)

69) Jost's Engg, Co.Ltd,
19 Kemp Road,
Bangalore
(Dealer for B&K)

70) Jost's Engg, Co.Ltd,
60, Sir Phiroaeshah Mehta Rd, Fort, P.O.Box-243,
Bombay 400001

71) Kavo'Electrotechnisches, Werk GmbH.
D-7970, Leutklrch In Allgau
West-Germany.

72) Kay Elemetrics Corp.
12 Maple Ave,
P.O.Box.2025,
Pine Brook NJ 07058-2025
P-201-227-2000
Fax-201-227-7760

73) Knowles Electronics Co.
73 Victoria Rd,
Burgess Hill West Sussex
RH 15 9LP England
Ph-022 46 5432
Fax-044 46 48724

74) Dr.Kubn & Co.GmbH
Ostermerhimer street,
198, D-5000 Koln 91
(Merheim) West Gramany

75) Laboratory Microsystems
450 Cloud Dr.11

76) Larsen & Toubro (L&T)
Gould Limited,
P.O.Box 13
Mysore-571186

77) Lotus Acoustics
5/177 "Jyothi"
Next to Wadala Church
Wadala, Bombay-400031
Ph-4110605

78) Lucas Grason-Stadler Inc
537 Great Road,
P.O.Box 1400
Littleton, MAO1460
Ph-(508) 486-3514

79) Luminaud,
P.O.Box 257,
7670 Acacia Avenue
Mentor, Ohio-44060

80) Madsen Electronics A/S
20 Vesterlundvej,
2730 Herlev, Denmark
Ph.+4544 946000
Fax.+45 44 946240

81) Maheswari Enterprises
17/2 Daulat Gang
Indore-452004 (MP)

82) Macio De Mexico SA DE CV
Puebla # 163-B
Col Roma,
06700 Mexico
Ph-915-525-72 31

83) Macio Hearing Instruments Inc,
7375 Bush Lake Road,
Minneapolis,
Minesota 55435
Ph-1-612-835-4400

84) Meditronix Corporation
Mr.J.Mathur,
Post.Box.9937
Delhi-110051
(Indian Dealer for Servox)

85) MED-TEC
Div Medical Tec. Inc,
3 Orchard Ave,
Watkins Glen NY 14891
Ph-607-535-9327
Fax-607-535-4990

86) Memacon,
Pres.Kennedy Laan 263,
P.O.Box.56.
Velp 6200, Netherlands,

87) Micro Electronics
Dr.V.S.Instronic Estate,
Tiruvanroiyur,
Madras-600041
Ph-413893

88) Neher Artificial Larynx Company,
103 6th Street, S.W.Kasson
Minnesota - 55944

89) Nicolet Blomedical Div
5225-4, Verona Road,
P.O.Box.4287,
Madison, WI 53711.

90) Nicolet Instrument Corp.
5225-4 Verona Rd,
Madison WI53711-0287
Ph-608-271-3333
Fax-608-273-5067

91) Northeastern
Technologies Group Inc.
40 Glen St,
Glen Cove NY 11542
Ph-516-671-4800
Fax-516-674-3507

92) Otican A/S
58, Strandvejen,
DK-2900, Hellerup
Denmark
Ph.+45 39177100
Fax.+45 39401440

93) Panasonic
One Panasonic Way
Secaucus, CA 90502

94) Mr.Paul Milenkovic (Prof)
Electrical & Computer
Engineering, University
of Wisconsin-Madison
1415 Johnson Drive
Madison, WI 53706
Ph-(068) 262-3892

95) PCs Data general India
Limited,
E-ll Panchshila Park,
New Delhi 110017
Ph-6428098, 6428099

96) Peico Electronics and
electrical Ltd,
Med Svst Dept
No3 Haddons Rd,
Madras-600006, INDIA

97) Philips Southern
Regional Office,
No3, Haddous Road,
Madras-600006

98) Phonic Ear Inc.
Torvat 1, Box.72,
DK-3400, Hillerod Denmark
Ph-(+45)-42267788
Fax(+45) 42266125

99) Phonic ear Ltd
7475 Kimbel St,
Mississauga Ontario Canada
L5S 1E7
Ph-416-677-3231
Fax-416-677-7760

100) Power Packs Private Ltd.
394/3RT,
Sanjeeva Reddy Nagar,
Hyderabad-500038

101) Pradlp Electronics,
Jay Krishna Road,
Patna-800009,
Ph-42039

102) Prefect Electronics(India)
171-E Kamla Nagar,
Delhi 110007
Ph-2522870

103) Priya Aids,
11, 4th Main Road,
Raja Annamalaipuram,
Madras-600028

104) Quadrant Instruments
14 Railway Crescent,
Croydon Victoria
Australia-3136,
Ph-03-725-5100
Fax-3-725-7874

105) Qualitone
4931 W 35 St.
Minneapolis
MN-55416
Ph-612-927-7161
800-328-3897
Fax-612-927-0976

106) Quest Electronics,
510 S.Worthington St,
Oconotnowoc
WI-533066
Ph-414-567-9157

107) Raj Hearing Aid Centre
122, Egmore High Road,
Madras-600008.

108) Rion Co, Ltd
20-41 Higashi-Motoroa
Chi 3-Chome,
Kokubunji, Tokyo 185
Japan
Ph-0423-22-1133
Fax-0423-25-8318

109) Robert Morris System
Engineering
Mac Kenzie Bid. Rm.377
Carieton University
Ottawa Ontario
KIS 5B6, Canada.

110) Sab Nife Power Systems
Ltd,
No.8-2-268, Road No.3,
Banjara Hills,
Hyderabad 500034
Ph-36779/36301

111) Sanjay Enterprises
14,15,16 Lalbahaddur
Stadium,
Hyderabad-500001
(Representative for
Amplaid USA

112) Scientific Mes-Technlk
Pvt.Ltd.
B-14 Industrial Estate
Indore-452003
Ph-31777-78

113) Siemens
Aktiengesellschaft,
Medical Engineering
group,
Hearing Instruments
Division,
Gebbertstrasse 125,
D-8520, Erlangen.

114) Siemens Corporation,
186, Wood Avenue,
Iselin,
New Jersey-08830

115) Siemens Hearing
Instruments Inc.
685, Liberty Avenue, Union
New Jersey 07038 (201)
U.S.A.

116) Siemens India Ltd.
Head Office
132-A Annie Besanth Road
Worli, Bombay-400018

117) Siemens India Ltd.
Jyothimahal, 68,
St.Mark's Road,
P.O.Box.5212
Bangalore-560001
(Indian dealer for
Siemens Hg.Inst.Inc.USA)

118) Signal Technology Inc.
120 Cremona Dr.
P.O.Box 1950
Goleta, CA 93117
(805) 968 - 3000
1-800-235-5787

119) Sintron Electronics
9-Blackers Rd,
Mount Rd, Madras-600002
India
Ph-833669; 833859

120) Software Research Corp.
3939 Quadra St.Victoria,
B.C. V8X 1J5
(604) 727-3744

121) Sonik Aids
52, 7th Cross Road,
S.P.Extn,
Bangalore-560003
Ph-363049

122) Sonotone Intl Inc
209 Moss Rd, Winter
Spring FL 32750
Ph-407-323-4960
Fax-407-327-5030

123) Sparrow Electronic.Pvt.Ltd
168,18th B Main,4th Cross
Koramangala, 6th Block,
Bangalore-560034
Ph-531568

124) Spectrum Signal Processing Inc
460 Totten Pond Road,
Waltham, MA 02154
Ph-800-323-1842

125) SS Audio Electronics Pvt.Ltd.
LIDO Building, 1st Floor
JUHU Road, Santacruz(?)
Bombay-400049
Ph-545318

126) Tamilnadu Alkaline batteries Limited,
D-23, Industrial Estate
Ambattur
Madras-600058
P-652838/652857

127) Teac.Co.
7733 Telegraph Rd,
Montebello, CA 90540

128) Teledyne Ray Industrial Electronics
"Srikunj" 4th Floor,
238 B.J. Road,
Calcutta-700036
Ph-528176

129) Toshniwal Instruments and Engineering Co.
10-A, Shivaji Marg,
New Delhi-15.

130) Toshniwal Bros Pvt.Ltd.
198, Jamshedji Tata Rd,
Bombay 400020

131) Toshnival Pvt.Ltd.
Round Tana,
Mount Road,
Madras-2

132) Toshnival Pvt.Ltd.
85-A, Sarat Bose Road,
Culcutta-700026

133) Toshnival Pvt.Ltd.
6-2-940, Raj Bhavan Rd,
Hyderabad-4.

134) Tracor Incorporated,
6500, Tracor Lane,
Austin, Texas-78721, USA

135) Unitec Electronic Development Laboratory,
6/3 Kirti Nagar,
Industrial Area,
New Delhi - 11015

136) Unitron Limited
1-Industrial Area,
NIT, Faridabad,
Haryana-121001

137) Yegakit Pvt.Ltd,
Instrument Division,
62, Rajesh Building,
I Floor, Opp.Police Station,
339, Lamlngton Road,
Bombay-400007

138) Virtual Corp.
521 SW 11th Ste 400,
Portland OR 970205
Ph-503-226-3000
Fax-503-228-2666

139) Voice Indetification Inc,
P.O.Box 714, Somerville
N.J. 08876
T-(201) 526-3408

140) Voice & Speech System
53, Girlnivas, Temple Rd,
13th Cross, Malleshwaram
Bangalore-560003
Ph-361019.

141) Wipro Information Technology Limited,
5th Floor, S.B.Towers
88 M.G.Rd. Bangalore-1

142) Zenith Computer Limited
19 Red Cross Rd, Sadar,
Nagpur-40001
Tel-533671

143) Zenith Computer Limited,
Zenith House, Chakala
Junction Andherl (E)
Bombay-400099,T-6366030-2