

**NATIONAL
ACOUSTIC LABORATORIES
AUSTRALIAN DEPARTMENT OF HEALTH**



INTERNAL REPORT 6

APRIL, 1978

EARLY HISTORY OF NATIONAL ACOUSTIC LABORATORIES

JOAN CORDELL

MILLERS POINT
SYDNEY, AUSTRALIA

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I ESTABLISHMENT OF NAL AND ITS FORERUNNERS, ARL, ATL.

Reason for Establishment of Acoustic Testing Laboratory.

Two of the main acoustical problems facing the Armed Services during the 2nd World War were communication under conditions of excessive noise and the harmful physiological effects of excessive noise occurring around guns.

In the early years of the war, the RAAF had set up a Flying Personnel Research Committee (FPRC) which in turn appointed sub-committees to deal with various physiological problems, including those of hearing and vision, connected with flying. Because of difficulties in finding laboratory facilities, the FPRC turned to the National Health and Medical Research Council (NHMRC) for help. NHMRC was prepared not only to finance the research but also to recruit civilian scientists to do it.

However one important problem concerned laboratory facilities for the acoustic research. At that time the National Standards Laboratories had ample facilities for studying physical problems of light, but had made little or no provision for work on sound. Since it was evident that a lot of the work of a sound laboratory would be of a physiological nature, Dr. J.C. Eccles, then Director of Kanematsu Memorial Institute of Pathology, Sydney Hospital, urged NHMRC to establish laboratories for research in acoustics. For all of the above reasons the Commonwealth Government readily agreed to provide funds for equipping special laboratories for acoustic research (p. 413).

Establishment of Acoustic Testing Laboratory.

In April, 1943, the NHMRC with funds provided by the Commonwealth, established the *Acoustic Testing Laboratory at the Kanematsu Institute of Pathology, Sydney Hospital (p. 74).

The grant provided for the establishment of the Laboratory was £2500 and Mr. N.E. Murray, B.E., BSc, was seconded from PMG's Department to be engineer in charge of the project. The Laboratory was to investigate the problems of noise, hearing and intercommunication that arise in the services particularly in the Army and Air Force and was to work largely through the Armoured Fighting Vehicle Committee and the Flying Personnel Research Committee (p. 417).

* According to Annual Report of Kanematsu Memorial Institute of Pathology, Sydney Hospital, 1943 the Laboratory at that stage was called "Acoustic Testing Laboratory" (see p. 417). However, in the reference quoted in the text, it was actually named Acoustic Research Laboratory.

Change of Name to Acoustic Research Laboratory.

In April, 1944, the Acoustic Testing Laboratory was transferred to the New Medical School, Sydney University (p. 417). Although no official document has been found concerning change of name, it would appear from reports of the Laboratory at this period that the name was changed to Acoustic Research Laboratory at about the same time.

Staffing of Laboratories during War-time.

In the early investigations of the Laboratory, Mr. Murray was given the assistance of other physicists and physiologists from the army and air force and arrangements were made to enlist the help of a number of medical students to act as "guinea pigs".

Acoustic Research Laboratory in Early Post-war Period.

With the termination of hostilities attention was directed to civilian problems in the acoustic field, the most immediate of these being associated with the rehabilitation of deafened ex-servicemen, (. 74). ARL was given a research grant of £1,000 by the Repatriation Commission to investigate this problem of rehabilitation, with particular reference to development of a standard hearing aid. (pp, 130, 131).

At the end of the war, attention was also given to the problems of a large group of children with congenital deafness resulting from an epidemic of maternal rubella in 1940/41 (pp. 281, 285, 288, 291, 292). Techniques for taking accurate measurements of the hearing deficiencies of these children were devised, and special hearing aids were designed to assist in their education and speech development. (p. 74).

Transfer of Acoustic Research Laboratory to Commonwealth Department of Health.

In 1946, NHMRC decided that, as the war-time research activities had ceased and the amount of routine civilian work was increasing, it was no longer justified in financing the operations of the laboratory. As the laboratory was too valuable to be disbanded, NHMRC recommended that ARL be taken over by Commonwealth Department of Health.

Cabinet agreed to this proposal in May, 1946, and the transfer was effected on 1st January, 1947. (pp. 74, 117).

The name of the establishment was then changed from ARL to Commonwealth Acoustic Laboratory (pp. 74, 75) and its new location was to be in Erskine House, Sydney.

Early Extension of C.A.L. Services to other States.

The special facilities, which included two sound proof clinical testing rooms, a class room with observation windows for training purposes and a workshop, were completed for CAL's first laboratory in Erskine House in January, 1948. (pp. 197, 200).

In April, 1947, a request was received from the Repatriation for assistance in the choice, fitting and maintenance of the hearing aids which were being supplied to deafened ex-servicemen.

An arrangement was made with the Commonwealth Department of Health that acoustic laboratories should be established in Sydney, Perth, Adelaide, Melbourne and Brisbane and that the Repatriation Commission should contribute to the cost of their establishment and maintenance. (p. 75).

Details of these early arrangements for the Repatriation Commission's contribution are as follows:-

- (i) Certain initial capital cost for equipment to be shared by the Repatriation Commission.
- (ii) The amount of approximately £5,000 was to be transferred from the Repatriation Department vote to the Health Department vote.
- (iii) New hearing aid parts, maintenance parts and batteries were to be purchased by the Repatriation Commission in amounts and types recommended by the Commonwealth Acoustic Laboratories' staff in various states. (p. 263).

The first branch Laboratory was opened in Perth in April 1947. This was followed by branches in Adelaide (November, 1947) Melbourne (December, 1947), Brisbane (October, 1948). (pp.132, 189).

A separate branch laboratory in Tasmania was not originally planned for reasons of size. It was considered that in the case of a small state like Tasmania it could be costlier to provide a service through a branch of C.A.L. than through commercial hearing aid houses (p. 68). Approval was not given for establishment of a branch Laboratory in Hobart until February, 1949 (p. 240). Even then it was to be staffed initially by a Technical Assistant with occasional visits by the Psychologist from Melbourne, (p. 239). The Hobart branch was opened on 14th March, 1949 (p. 300). Plans were subsequently made for appointment of a Psychologist during the 1949-1950 financial year (p. 241).

Country and Regional Visits

Following representations in 1955 to the Commonwealth Director-General by the State Director-General of Health Queensland, Dr. Fryberg, approval was given for the setting up of regional laboratories initially in Queensland at Rockhampton, Townsville and Cairns. These were not permanently staffed but were visited by staff from Brisbane. Dr. Fryberg was prompted to make these representations since he felt it unsatisfactory that a Commonwealth benefit to children should necessitate children travelling so far to the capital city (pp. 242, 252).

It was decided that these visits were also of advantage since they enabled CAL to test and fit hearing aids to Repatriation patients who would otherwise be brought at Commonwealth expense to the capital city for some days.

After discussions between the then Director, Mr. Murray, and Dr. Richards of Central Office, it was decided that this policy should be adopted generally but that the visit should never be to a centre which did not have an ear, nose and throat specialist who could carry out the necessary preliminary E.N.T. examination which is required before consideration can be given to the fitting of hearing aids. In addition it was considered that the country

visits could be assisted if they were set up in a Health Laboratory or Commonwealth premises, as this often provided assistance in the way of making appointments, or a Commonwealth Centre or local authorities such as hospitals (p. 252).

The first visit in Queensland to Rockhampton, Townsville and Cairns commenced on 24th November, 1955. Although full laboratory facilities were not yet available, portable audiometric equipment allowed most Repatriation benefites in these areas to be investigated and fitted with aids as well as allowing valve Calaids to be changed over to transistor Calaids. These visiting services were to be provided three times a year. (pp. 173 & 243). Furthermore it was recommended that each trip be no longer than one week, with two days at Rockhampton and Townsville and one day only at Cairns (p. 245).

These visits in Queensland were gradually extended in 1964 to include Toowoomba as well (pp. 231, 252).

In Tasmania, arrangements were also made at end of 1955 for O.I.C. Hobart to visit Launceston every three months (p. 173). In May, 1959, it was suggested that a visit of one or two days duration might perhaps be made to Burnie every six months (p. 250). However perhaps this suggestion was not taken up, as Burnie is not mentioned as a visiting centre in a letter dated 10th March, 1964 (p. 253).

In Victoria officers from C.A.L. had been visiting the deaf school in Bendigo once every school term. After an inspection of the Bendigo Health Centre on 1st March, 1956, by Mr. Murray and Mr. K. Maine, acting O.I.C. of the Melbourne Laboratory arrangements were made for an officer of the Melbourne Laboratory to attend the Health Laboratory when visiting Bendigo. Portable audiometric apparatus was used initially (p. 247). In August, 1962 approval was given for visiting services to Ballarat (p. 251). By 1964, visits were being made to Ballarat where a sound-proof room had been installed in the recently opened Commonwealth Offices. At the same time, facilities were also being planned for the Commonwealth Offices which were then being planned for Geelong. (p. 253).

By November, 1955, arrangements were also being made for regular visits to Port Pirie in South Australia although the actual times and frequency of visits had not by then been determined (p. 249). Approval was given on 9th February, 1956 for visits to Port Pirie to commence early in the second school term of 1956 (p. 246).

In Western Australia arrangements were being made by November, 1955 for visits to Kalgoorlie (p. 173) with the first visit to this centre during 1956 (p. 248). The visit to Kalgoorlie was to take place on only once a year (p. 248) and in May 1957, it was proposed that any C.A.L. activities at Kalgoorlie should be undertaken at the Health Laboratory there (p. 249).

Visiting services in Newcastle, N.S.W. were commenced during 1955-1956 (p. 231) and by the beginning of 1964 it was realised that a permanent psychologist, technician would be required to take over all Newcastle and surrounding districts (p. 253). During 1955-56, investigations were also made at the Health Laboratories at Lismore, Tamworth and Albury with a view to possible extension of visits to these places later (p. 231). By 1964, visiting facilities were almost completed at the Civic Centre, Canberra, and it was expected that facilities would be available at Wollongong within a year or two.

Visits to Northern Territory.

The first approval for a visit to Northern Territory appears to have been given in September, 1954, when the Director-General approved a visit to Darwin, Katherine and Tennant Creek by Mr. Tonkin, then Psychologist-in-Charge, Brisbane, for the purpose of testing school children and instructing the local staff in any further tests considered necessary. Mr. Tonkin was to leave Brisbane for Darwin on 18th September, 1954, and return to Brisbane on 10 October, 1954, (p. 331).

In October, 1954, approval was given by the Director-General for a visit to Alice Springs by Mr. A.N. Lewis, then Psychologist-in-charge of Adelaide to visit Alice Springs for the purpose of testing the hearing of school children in the Alice Springs area. Mr. Lewis was to leave Adelaide on 18th October, 1954, and return to Adelaide on 22nd October, 1954 (p. 332).

Visits to New Guinea.

By the beginning of 1957, approval had been given for CAL to lend a battery audiometer to Department of Territories for use in New Guinea by Dr. J.J. Refshauge, Medical Officer in charge of the Infant and Maternal Welfare Section, for School Medical Services. (p. 333). The battery audiometers subsequently lent to the Department of Territories for the screening of deafness in children in Papua and New Guinea were provided, supervised and maintained from CAL's Central Laboratory in Sydney.

Following a request from the Department of Territories that CAL assist with the provision of Calaids to deaf children Dr. Harold, then of CAL Central Laboratory, visited New Guinea at the expense of the Department of Territories between 23 and 27 March, 1959. As it was thought that, if a service of Calaids to Papua and New Guinea were approved, it might be better arranged through Brisbane Laboratory and that possible future visits to New Guinea might be co-ordinated with visits to Northern Queensland, Dr. Harold also inspected facilities and services at Rockhampton, Townsville and Cairns (p. 334).

Branch Laboratories Opened Since 1966.

The first of permanently staffed branch laboratories other than the capital city laboratories was opened in Newcastle in September, 1966. Many additional laboratories both permanent and visiting have been opened since then.

Original Reason for Choice of Name Acoustic Laboratories rather than Hearing Centres.

During the early days of CAL's operation, it was considered that the term 'hearing centre' for professional activities in the field of audiology tended to be less used, as the term was used by many hearing aid agents. A more general term for a professional scientific group was Acoustic or Audiology Laboratories or Centres (p. 435).

Use of Name National Acoustic Laboratories and Hearing Centres.

In November, 1973, the Minister approved the proposal that the name of the Laboratories be changed from Commonwealth Acoustic

Laboratories to National Acoustic Laboratories. He also approved the suggestion that the term Hearing Centre be used as a title for field laboratories (p. 254).

II STAFFING AND FUNCTIONS OF N.A.L.

Staffing: In the early years of CAL, the staff of each clinical laboratory comprised at least one psychologist, one technical officer, with some typing and clerical assistance (p. 68).

Staff approved for the Laboratories for the year 1947-1948 were as follows:-

Sydney: 1 Officer in charge, 1 Medical Officer, 1 Senior Physicist, 1 Engineer Grade 3, 1 Chief Psychologist, 1 Draftsman, 4 Psychologists, 1 Technical Officer, 3 Technical Assistants, 3 Laboratory Mechanics, 1 Typist Grade 2, 1 Assistant (Female) (Typing).

Victoria: 1 Senior Psychologist, 1 Psychologist, 1 Technical Officer.

Queensland: 1 Psychologist, 1 Assistant Psychologist, 1 Technical Officer.

Sth. Australia: 1 Psychologist, 1 Technical Officer.

Western Australia: 1 Psychologist, 1 Technical Officer (p. 188).

Reason for Employment of Psychologists.

In a report in 1953, Mr. Murray pointed to the problem of qualifications and training of non-medical clinical workers handling patients. Because of the developments in audiology and different types of specialists involved, it was considered essential in major clinics in U.S.A., for the patients to be handled by persons with professional training in some related clinical field such as psychologists, hearing therapists, speech therapists.

In some U.S. and U.K. clinics it was considered that the essential non-medical personnel for all but routine cases was the psychologist. If maximum clinical insight into each patient was to be obtained, it was desirable that the patient be handled by a single person capable of undertaking all tests necessary in each case for diagnosis and prognosis and able to follow up on each patient with any combination of rehabilitation training necessary.

This was thought possible only if the clinical staff was recruited with a basic qualification as psychologist and then given post-graduate training and experience in a large centre in problems of the deaf, clinical audiology and audiologic rehabilitation. This was the basis for recruiting and training clinical workers in C.A.L. and allowed the same facilities for evaluation, prognosis and rehabilitation to be set up in Perth and Hobart as is available in the main centre in Sydney.

It was stated that the use of such clinical workers in C.A.L. was found necessary initially because of CAL's work with young deaf children. Although the same officers were used for ex-servicemen for reasons of convenience and availability, it was thought that the same background and training were best for ex-service and other deaf cases (pp. 223, 224).

It was also pointed out by Dr. Farrant in 1964 that the recruitment of psychologists had ensured that CAL's clinical workers, on appointment, have a substantial background knowledge of psychophysics, testing principles and relevant statistical concepts such as reliability and validity, as well as general scientific knowledge and methods regarding human behaviour, and clinical background. This agrees with the view expressed by Davis & Silverman that psychology is basic in audiology (p. 436).

Early Suggestion for Use of Designation, Audiologist.

I was suggested in 1952, that as the designation psychologist did not describe the general field of work performed by CAL psychologist, permission should be given for it to be changed to the designation, audiologist, a term by then universally used for professional clinical workers (p. 410). However it was pointed out by the Psychologist in Perth e.g. that the term audiologist had the drawback of being a new term carrying meaning for few people outside the medical field. Moreover it was considered that the term psychologist had more weight in educational circles (p. 411).

At the time the Public Service Board considered it was better to retain the official designation Chief Psychologist, Senior Psychologist, etc. but had no objection to the use of the term audiologist as a local designation, if desired (p. 412).

Functions of CAL

In reading of the Acoustic Laboratories Bill 1948, the functions of CAL were stated to be:

- (1) to carry out the requirements of the Repatriation Commission for deafened ex-service personnel and to provide a similar service for the Commonwealth Department of Social Services in respect of deafened ex-service personnel whose disability was not caused by war service.
- (2) to assist the education departments of the States in measuring deafness, fitting aids and maintaining hearing aids for school children.
- (3) to act of behalf of various State and other authorities who desire to have independent tests made before assisting financially in the purchase of hearing aids for people under their care.

During the reading of the bill it was also said that with development of acoustic laboratory service:-

- (a) activities would be extended to the investigation of noise in industry. Staff would be provided for measuring noise levels in various industries and for advising on methods for reducing of noise to safe proportions or for the protection of the workers from ill effects.
- (b) investigations would be made to develop apparatus to detect early deafness in children.
- (c) A commonwealth - wide acoustic laboratory would be valuable as part of a national health service in providing advice and assistance with the equipment necessary for measuring degrees

of deafness and for the maintenance of efficiency in hearing aids.

- (d) To encourage the production in Australia of hearing aids and their component parts, technical advice and information as to the standard to be achieved would be available to manufacturers. (p. 75)

In addition to functions as laid down in Acoustic Laboratories Act (1948), the then Minister for Health, Sir Earle Page, in November, 1952 approved the following specific functions:

1. Audiometric testing of pre-school and school children.
2. Ear, nose and throat service following the screening of children for deafness.
3. Fitting and maintenance of hearing aids for school children.
4. Testing of Repatriation cases, fitting and maintenance of hearing aids where necessary.
5. Testing of Civil Aviation Pilots.
6. Testing of miscellaneous cases for hospitals.
7. Provision and maintenance of battery audiometers for school medical services.
8. Calibration of audiometers.
9. Investigations into audiology testing equipment and subsequent construction and maintenance in all States.
10. Tests in respect of hearing aids to develop more efficient and economical types.
11. Investigations into noise in industry.
12. Investigations into boilermakers' deafness in conjunction with the N.S.W. Railway Medical Services, the major employers of this class of worker.
13. Development of preliminary tests to measure susceptibility to noise and enhance the possibility of recruiting apprentices, now a major staff problem because of noise hazard.
14. Advice to the Armed Services regarding noise problems. (D33, D34, D35). (pp. 218, 219, 220).

Following representations made by British Medical Association, Brisbane on 3rd June, 1953, approval was given for CAL to test certain difficult cases that occur in the private practice of otology. These cases included:

Suspect malingering

Suspected hysterical deafness

Severe perceptive deafness when the fitting of a hearing aid is in question.

Certain cases when an accurate assessment of bone conduction is necessary to determine prognosis with a fenestration operation. (pp. 221, 222).

Appointment of E.N.T. Specialists

The first approval for appointment of part-time ENT specialists to CAL was given in November, 1948 for providing assistance in a survey of the medical cases of deafness of some hundreds of children found to be deaf during the screening survey by the Education Department. It had been found impractical to cover the necessary thorough E.N.T. examinations by referring these cases back to hospital clinics, which were already overcrowded. Moreover, from a research point of view it was essential to have some degree of uniformity and adequate detail in the clinical investigation, which was impossible when cases were referred to various clinics (pp. 404, 405, 406, 407).

Subsequently in 1949, in Cabinet Agendum No. 1171B, which approved the provision of hearing aids to children, it was stated that each child would be examined by an Ear, Nose and Throat Specialist ... to ensure that any medical or surgical necessary to either improve or cure his condition is availed of before an aid is provided (pp. 133, 324).

The reason for tying up the Calaid issue with a preliminary E.N.T. Specialist examination was that the provision and maintenance of a hearing aid throughout a child's life are expensive and a thorough preliminary examination by a specialist is first required (p. 324).

III NOISE, HEARING CONSERVATION AND DEFENCE SERVICES.

Blast and Noise Measurement during Wartime.

At the end of 1943, ATL was requested by Army to develop urgently a piezo electric blast gauge and associated recording apparatus for measuring blast waves from guns. (p. 418).

Wartime Investigations of Communication efficiency in Noise.

Investigations were made of means of increasing the efficiency of communication under the excessively noisy conditions prevailing in tanks and aircraft. In cases where communication between members of the crew of a tank or an aeroplane was by means of a telephone, investigations were made of the design of earphones which would exclude as much external noise as possible (p. 414).

A study was made of the efficiency of all existing types of head gear and a completely new design was evolved. The main feature of the new design was the incorporation of new principles of mounting the earphones and earpads in order to give long term comfort and to take into account all likely variations of head size. The earpads were designed from the point of view of attenuation of outside noise and efficiency as an electro-acoustic transducer (p. 425).

A detailed examination was also made of the speaking tube then in use for communication in aircraft and revealed a number of factors responsible for its poor efficiency. To overcome these defects, Mr. Murray and Flight Lieutenant Pollard designed a system

incorporating ear-piece and mouth-piece in the form of folded or twisted exponential horns suitably shielded against external noise. These were mounted and connected into one piece. With this new system, under standard conditions of noise, 95 per cent of test words in a Harvard word list could be clearly identified (p. 414).

Ear Plugs and Other Ear Protectors

Because of the danger of deafness from blast from bombs or gunfire, attention was turned to the design of ear plugs particularly those suitable for the protection of gun crew (p. 415).

The efficient neoprene ear plug that was developed was later adopted by the Army as Protectors eardrum (Aust.) M 1 and mass produced for the Army. This plug was later modified by inclusion of a specially controlled air leak for use by the RAAF in aircraft (p. 425).

After the war, the ear-plugs were made available commercially by a Sydney Company, Chesterfield Pty. Ltd.; The original air type with an air leak, called a ventilated earplug, was costly to manufacture because of the very small air leak required for pressure changes which do not affect too greatly the acoustic insulation of the plug. C.A.L. later developed a new ventilator in which it was possible to obtain a very small air leak by first making a hole which could be drilled and then filled with wire of the nearest standard wire gauge (p. 427).

During the 1950's C.A.L.'s attention was turned to the design of earmuffs. Thus the Calmuff was designed to allow reasonable ability to communicate and therefore to allow perception of warning signals, etc., while providing sufficient protection from hearing damage by most industrial and aircraft noises. By 1960, the muff was commercially available from the Protector Goggle Co. Pty. Ltd. (p. 430).

Industrial Noise Work

In the second reading of the Acoustic Laboratories Bill, it was stated that it was proposed to extend the activities of the Acoustic Laboratories to the investigation of problems associated with noise in industry (p. 75). However it was pointed out at the same time that the Government has no power constitutionally to interfere in the industrial field (p. 85).

In 1953, an intensive study was being made of hearing of workers in industry, particularly of boiler makers and other similar workers. It was intended to obtain a mobile truck to facilitate the work and extend it throughout Australia (p. 435).

Acoustic Advice for R.A.N.

As early as 1949, CAL was giving assistance to the RAN in the special design of earpads and headsets for their communication apparatus for use in warships and also to improve the protection afforded personnel against gun blast. Investigations were also carried out for the R.A.N. on noise conditions in Australian built Tribal class destroyers during sea trials (p. 212).

Hearing Conservation and Acoustic Advice for RAAF.

In 1954-1955, due to rapid extension of jet and prop jet aircraft urgent investigations were carried out for the RAAF on the effects on personnel of the use and testing of aircraft and aircraft engines (p. 229).

By 1955-1956, the major emphasis of investigations into the effects of noise were being concentrated on work at RAAF air stations where exposure of personnel to the high level noise from jet aircraft had become a serious problem. It had become apparent that in most cases a routine measurement of personnel for hearing loss was necessary at RAAF stations to discover the personnel suffering from hearing loss and to check that methods of protection were sufficient (p. 232).

In 1957, an investigation was made of whether hearing conservation programmes could be set up throughout the RAAF by means of routine checks of a single frequency only, 4000 Hz (p. 359).

In 1959, an implementation order was sent out from RAAF Headquarters at Point Cook to facilitate their co-operation in the C.A.L. hearing conservation programme. By February, 1960, hearing conservation programmes had been set up at Amberley, Williamtown, Richmond, Laverton, Townsville, Pearce and Butterworth and a programme was to be set up at Edinburgh the following week. (p. 361).

Hearing Conservation for Australian Army.

In 1961, Mr. Murray agreed to assist with an extensive and extended audiometric survey amongst members of the Australian Military Forces (p. 365).

IV HEARING AIDS

Commercial Hearing Services and Hearing Aids Available in Australia during the 1940's.

During the war, American hearing aids were available in Australia. They were mass produced in America, where the special small components and valves had been in manufacture for many years. (p. 112).

By 1947, so called British hearing aids were also sold in Australia. However the main parts of the aid were made in America, and therefore the cost of the British aid was similar to that of the American aid. At that period the British aids had not reached a stage of development equal to that of the American aids (A26). In fact an investigation instigated by the British Medical Research Council at the end of the the war and prior to the introduction of the National Health Schemes in England showed that for an efficient aid, it would be necessary to use American microphones, valves and earphones (p. 112).

In these early days, CAL endeavoured to encourage all sources of local manufacture of components and many of these components were produced locally to CAL's specifications for use in the commercial aids that CAL maintained for the Repatriation Commission. It was hoped to have an aid produced in Australia with American parts and CAL sought to give encouragement and advice to any firm known to be attempting manufacture in Australia (p. 113).

By the end of 1949, five firms were manufacturing commercial hearing aids in Australia. These aids were considered as equal to any of the British aids then available. However there was much propaganda against C.A.L.'s policy of assisting, wherever possible, local production of aids and parts (D24). The five private manufacturers of hearing aids in Australia were Crystalaid, Paton, Commander Zephyr, Eco. (p. 147).

Up to 1949 at least, commercial methods of selling aids in Australia had been dominated by two large long established companies, Western Electric and Sonotone, both having Headquarters in Sydney. By acquiring exclusive agencies of American aids, these companies were able to take advantage of the early development in America of small wearable individual aids containing subminiature tube which had been made in America for the previous ten years, but only for about one or two years in England. In addition, because of American production throughout the war years, these companies were able to expand considerably during that time.

The nature of these businesses was compared to that of a high pressure American sales organisation such as set up for selling vacuum cleaners or any other similar household article. The prime criterion for a hearing aid salesman was his sales ability, and no general educational, scientific or medical training was required. During the previous year, many of these hearing aid firms had attempted to acquire some sort of pseudo-scientific status by setting up an Australian Audiometrists Association and taking the designation "Audiometrist" (p. 102).

In a letter concerning this Association, it was pointed out that aids were sold in Australia at that time not only by hearing aid firms, but also through opticians, departmental stores, chemists, electrical firms, and, in some cases, by advertising directly from the agent's home. One member of the Audiometrists Association, previously employed with an insurance firm, obtained an overseas agency and set up in his wife's hairdressing establishment (p. 214).

In 1951, there were said to be about 50 hearing aid dealers in Australia of whom about 30 were dealing only in hearing aids and in no other articles. The average price of hearing aids was about £35 and there were no legal regulations or certificates for the trade in hearing aids (pp. 147, 148).

Apart from providing advice to any firm known to be manufacturing aids in Australia, CAL did as time permitted carry out tests on aids for manufacturers or agents (pp. 143, 145, 146, 149, 155, 156). However a suggestion by Australian Association for Better Hearing for a list of approved hearing aids which might be submitted to C.A.L. for test was not taken up (p. 142). Also in view of dollar shortages, it was suggested that C.A.L. should give advice to the Department of Trade and Customs on which hearing aid spare parts had to be obtained from America and which could be developed or made locally or obtained from England (p. 138).

CAL's Early Work on Development of Aids

Even while still working under the auspices of NHMRC, CAL had turned its attention to the design of hearing aids. At the beginning of 1946, a supply of miniature electron tubes had been obtained through the Ministry of Munitions and were being used in

a number of small hearing aids for the teaching of deaf children (p. 137).

This aid designed by CAL was referred to as a desk type hearing aid. The amplification, power output and volume adjustments of the set were such that it could immediately be adjusted to most deaf children able to attend ordinary school. It could also be adapted by individual fitting of a special earphone for use with some very deaf children.

At the same time CAL was actively engaged, following previous measurements of the children's deafness, in obtaining, calibrating and fitting small commercial type hearing aids to these children (p. 286).

It was not until later CAL was to turn its attention to the design of the Calaid.

Reasons for Initial Production of Calaid.

Reasons advanced for production of the first Calaid include the cost factor, including excessive maintenance and repair costs; difficulties in obtaining aid components and other problems associated with import quotas and dollar allocations; general dissatisfaction with commercial hearing services; delays in obtaining commercial aids; unsuitability of British aids.

The excessive cost of commercial aids seems to have been one of the main reasons for production of Calaid (pp. 125, 129, 131).

Comparison of costs of commercial aids and Calaid was given in a Confidential Report on Suggested Use of Hearing Aids in the National Health Services, dated 16.3.1949 (pp. 52, 53, 88, 89, 95, 96). In estimates for 1949/50, it was said that "maintenance cost of the Calaid with replacement parts is less than half the maintenance of commercial aids due to standardisation of mechanical parts and method of direct purchase" (p. 60).

In a memo to the Minister from the Director-General, dated 16.2.50 and dealing with the Australian Audiometrists Association, it was stated that "the cost (of the Calaid) is about one quarter of the price of commercial aids and the maintenance cost has been very greatly reduced. The Repatriation Commission gave a very close study to this aspect before adopting the "Calaid" for all future use estimated that this year the saving to the Repatriation Commission will be approximately £34,000" (p. 55). The dollar shortage was also one of the main reasons for production of the Calaid.

On 1.11.49, in a letter to Department of Trade and Customs "Due to the necessity for conserving dollars we have recently designed the Calaid" (p. 125).

"..... the steady demand (i.e., on CAL services by Repatriation cases) coupled with the fact that the dollar situation made the ready purchase of many American aids difficult have resulted in a shortage of aids even for new cases" (p. 121).

In a memorandum dated 22.6.48, it was pointed out that the method of restricting licences for hearing aids to a quota on past imports is also very seriously affecting our work for the Repatriation Commission in the following ways:

- (i) As we have no direct quota we are unable to obtain import licences for sample new components which are in some cases higher efficiency than those now used.....
- (ii) We are unable to obtain licences for sets and parts directly to assist in maintaining children's aids.....
- (iii) The Repatriation Commission is unable to obtain licences for alternative parts which we have recommended as of high or equal efficiency and less dollar cost " (p. 114).

In a memorandum dated 23.12.47, it was stated that although "it is the intention of the Customs Department to allow importation of all-spare parts required for the maintenance of existing sets of American origin the importation of American sets has been prohibited for the remainder of this financial year" (p. 116).

The Repatriation Commission was also dissatisfied with the service of dealing through commercial agents (p. 68).

Initially hearing aids (i.e., for Repatriation cases) were purchased by tender, but this was found to be unsatisfactory (p. 55).

In a confidential report submitted on 16.3.49 on Suggested Use of Hearing Aids in the National Health Service, great dissatisfaction was expressed with commercial methods of selling aids. The market was described as being dominated by two large, long-established companies, Western Electric and Sonotaone, who employed high pressure sales tactics and a large amount of highly pitched advertising to attract sales and who demanded no general educational, scientific or medical training for their staff. High advertising costs greatly inflated final retail price without providing any advantage in properly fitting the patients. Other methods of selling such as in chemist shops or through electrical houses also proved unsuccessful (p. 102).

Dissatisfaction was also expressed with the practice of bringing out so-called "new" models each year, varying very little in performance, but greatly in shape, colour, size and battery cord connections.

It was therefore recommended "that the general practice be to disregard commercial aids in applying the "Calaid" scheme (p. 103).

In a letter dated 4.2.49, to Repatriation Commission, Mr. Murray mentioned delays in delivery of aids. Thus he pointed out that the tender form asking for delivery to be made within 14 days of notification of acceptance of tender was unrealistic as it was "extremely unlikely that any tenderer would have 100 sets in Australia all ready for delivery".

Mention was made of a case where "the final delivery of aids brought immediately by air freight from overseas was not made to the laboratory until ...4½ months after the Commission decided to call for aids immediately" (p. 121).

The Medresco, the aid designed by the Medical Research Council for use under the British Government Health Service was tested but considered unsatisfactory for CAL's purposes. Various deficiencies in the aid were noted. These included the fact that the aid was not capable of modification to give fullest range of performance necessary for all cases; also the insert earphone

provided was of the crystal type which was not considered to be suitable for the humid conditions in Australia which cause deterioration requiring early replacement (pp. 93, 94).

Moreover the method of allowing eligible ex-servicemen and women to select their own aid was economically unsound because of the multiplicity of makes and ever changing shapes and varying battery and earphone connections. It was extremely difficult to service aids of 34 different makes most of which were manufactured in and imported from either Great Britain or U.S.A. and which were purchased for eligible Repatriation cases.

Early Development of Calaid

Even before 1947, CAL had been investigating theoretical and practical considerations regarding the use of individual hearing aids (p. 88), in addition to the group hearing aids that had been designed for educational purposes as mentioned earlier.

In 1948, investigations were continuing into the use of hearing aids and types, both group and individual, with the object of devising an aid which would be most suitable and economical for use with children and the Repatriation Commission and for any other Government purposes (p. 197).

In a letter to the Repatriation Commission on 16 December, 1948, Mr. Murray recommended that, because of the desirability of setting a standard type and connections for all future Repatriation aids and because of the economies resulting from the purchase of many components as spare parts rather than as part of an aid, CAL should immediately seek to procure sufficient parts to put together an aid for Repatriation purposes...."the aid should take economy size batteries with the detachable earphone and battery cords, that these cord connections should be standardised and not alter.

The internal arrangement of the set should be such as to take standard parts developed as far as possible in Australia or from non dollar sources. The internal arrangements proposed should be suitable to cover all cases required by the Repatriation Commission, a proposed set being capable of alteration internally to either a 3 or 4 valve aid. The 4 valve aid will be with 2 strengths of output valves enabling a set of the maximum possible designed strength to be used for the deafer cases. In addition it is proposed that for the real extreme cases automatic volume control conditions be provided to prevent blasting of the ears by loud sound and to prevent distortion of speech that occurs when speech needs high amplification to overcome the serious degrees of deafness.

Investigations have already covered the source of parts required and their procurement can be obtained in most cases about a month after approval is given for their purchase. The sets would be assembled in the number and types desired in the Sydney Laboratory.

It is recommended that approval be given for that step and for the purchase of sufficient parts for 250 hearing aids immediately. This procurement can then be continued from time to time by further orders and spare parts as desired. It is intended that spare parts

be used for assembling sets will be such as to be capable of maintenance as far as possible on all previous sets purchased by the Commission. Thus in fact the spare parts will be bought in larger quantities and should be eventually obtained much cheaper than in the past" (p. 37).

Repatriation Commission approved the above proposal on 2nd March, 1949 (p. 123). However delivery of the first Calaid was delayed because of industrial stoppages due to widespread blackouts. About mid-June 1949, the first ten sample bakelite cases were produced for inspection before the case die was finally hardened and finished for mass production of cases. A few Calaid were made up and issued to urgent cases about mid-June 1949 (p. 124). By the end of December, 1949, 300 of these aids had already been fitted to ex-servicemen (p. 211).

The initial Calaid was described as a "hearing aid in which, while the mechanical parts such as case shape, cord and plug connections, etc., have been standardised, the performance has been designed to cover the widest possible range by means of different internal arrangement of valves and components. Thus, although the Calaid always looks and is controlled in the same way, the performance covers the widest range incorporated in all hearing aids, even of many different makes. New components that may affect performance are added as they become available so that the Calaid performance is continually kept up-to-date (p. 305). Thirty different types of performance could be allowed for initially and each of these could be varied by choice of any B batteries made (p. 211).

Certain components of the aid, such as the case, battery holds and the internal wiring chassis were designed by CAL. Production of these items was obtained in the usual way on the basis of competitive quotes from local manufacturers. Other components common to all hearing aids, such as valves, condensers, resistors and battery cords were readily obtainable from local and overseas suppliers (p. 66).

Completed Calaid were assembled from these components to CAL's detailed assembly drawings, by private manufacturers. In 1949, about 20 different manufacturers were associated with the production of the Calaid and parts in New South Wales, Victoria, South Australia and Queensland. Complete aids and parts were received at the Laboratory in Sydney for acceptance tests and then, after calibration, forwarded to interstate laboratories as desired. No manufacturing was carried out at CAL. The cost of each completed Calaid in 1949 was estimated to be £7.10.0 (p. 211). It was estimated that the cost of the Calaid was about a quarter of the price of a commercial aid and maintenance cost was also considerably less (p. 214).

The early Calaid was a two-piece instrument as the batteries were supplied free by the Government and were therefore of the larger economy type (p. 305). However in July, 1951, it was recommended by Mr. Murray that the Repatriation Commission give approval for use of smaller batteries or of the one piece Calaid. (p. 151). Both recommendations were adopted in the case of aids to children in 1951.

By December 1952 no answer had been received to this

recommendation from Repatriation Commission. It was hoped to have the one piece aid out in a flesh colour for Health cases in the middle of 1953 since it was thought that the one piece aid might be more helpful in some ways during a teaching demonstration (p. 318).

When in October, 1952, CAL considered making their own earmoulds, the general principles of earmould size followed were those laid down in an article by Little and others in Journal of Laryngology and Otology, October, 1949 (p. 154).

Transistor Calaids

In 1953, CAL was already experimenting with all-transistor and also part-transistor aids (pp. 159, 160). Early investigations were with a 3-transistor aid with three transistors in place of the three valves then used, and also a 2 valve/1 transistor aid with 2 valves in the first stage and a transistor in the output stage (p. 161).

Because of noise problems with the early transistors, it was thought that the part-transistor aid might be preferable in some cases (p. 165). However battery and maintenance costs showed the greatest reduction in the case of the all transistor aid (p. 166).

On 16 December 1953, the Director General of Health approved production of three transistor calaids for field trials with new cases of deaf children (p. 169). In January 1954, Repatriation Commission approved the supply of three - transistor Calaids to eligible Repatriation Patients (p. 170).

In a letter, dated 4 March, 1955, to the Repatriation Commission, Mr. Murray stated that it was intended to begin the issue of the new transistor Calaid simultaneously in all States to all new cases beginning 21 March, 1955. The final price to the Commission was to be £12/-/- as compared with £87/1/-/- for a somewhat similar commercial transistor aid.

The case of the transistor aid was to be of stainless steel as this was considered to give the greatest strength and also allowed the thinnest possible case. Moreover it was unbreakable. Only one type of battery, an imported mercury cell was used initially on all aids (p. 171).

The aid was made up initially in a range of five graded strengths from a very low powered to a high powered aid (p. 172).

In November, 1955, a low gain aid using two transistors and known as type 5TA was introduced, (p. 174). In December, 1956, use of a two transistor model for about 20% of Repatriation cases led to a reduction in average cost from £9 to £8, (p. 175).

Production of a stronger aid the T8, which is arranged to have 3dB greater power output than the T5, commenced during January 1957 (p. 176).

By 1959, when the changeover to transistor Calaids had been completed, it was pointed out that although the transistor aid had retained its original physical form, it had consistently been improved in performance as the interior workings were by then made up in several different types and strengths and more efficient transistors and circuits were available (p. 177).

Because of difficulties in production of stainless steel cases, it was decided in January, 1957, to change over to cases made out of nickel-silver, that was grained and chromed (p. 176). However it was found that the grained surface tended to increase the noise caused by moving clothing across the case front. Therefore it was decided to produce cases from nickel-silver with a highly polished chrome finish (p. 235).

On the Head Aids

In April, 1963, work was commenced on the production of a quantity of on-the-head Calaid's for a field trial. At the same time a study was made of overseas developments of head-mounted hearing aids. Both the spectacle aids and many of the behind-the-ear aids then available were considered to be much more inefficient than necessary because, for appearance reasons, only a very small earphone was included in the hearing aid and the sound was conducted to the ear by a plastic tube. It was considered that a Calaid head mounted hearing aid could be made most efficient and found most acceptable if the earphone was separate to the hearing aid and fitted to the ear by the present earmould used for the present Calaid (p. 179).

By November, 1964, an on-the-head model suitable for production and to be known as the Calaid E had been designed and developed. This proposed model was an in-the-ear model with the earphone built into the earmould, and the aid itself directly fixed to the earmould (p. 181).

Issue of Calaid E in Australia commenced in Sydney on 4 July 1966, and was extended to Melbourne on 18 July, to Brisbane on 1 August, to Adelaide and Perth on 15 August and to Hobart on 22 August 1966 (p. 183).

Induction Coils

In 1959, it was decided that an induction coil was useful in many cases in allowing direct pick up from the telephone and improved telephone reception. Some theatres and churches were wired with a loop which allowed pickup directly by an induction coil in a hearing aid. Experimental models were made up and fitted to a few selected cases in Sydney and had a very favourable reception.

Therefore quantities of induction coils also known as telephone coils were tooled up and ordered for inclusion in future Calaid's in cases that could benefit. Coils were fitted from the latter half of September, 1959 (p. 177).

With the advent of the Calaid E in 1966, it was decided that a coil was not required for telephone use as the receiver could be placed adjacent to the Calaid E with good listening results (p. 187).

However in 1967, because of difficulties some cases were experiencing in using the Calaid E with television, investigation was made of the design of a new model Calaid E with a coil (p. 186).

Auditory Training Equipment

For many years until about 1955, the group hearing aid was the most efficient instrument for assisting the teaching of children with some residual hearing. However its technical efficiency was always counteracted by the difficulty of using the instrument physically, because of the necessary cords or wiring, headphones and individual control gear and a microphone (p. 281).

With the advent of the transistor aid, it was considered that individual aids should be the main hearing aid unit for teaching, in conjunction with auditory training units such as CAL's own unit (p. 283).

CAL was not authorised to lend auditory training equipment to be used in school class rooms for the teaching of deaf and partially deaf children, but was able to provide advice to Educational authorities on type of equipment available, including information on the latest developments in Australia and overseas, and also advise on operation and installation (p. 366).

V AUDIOLOGICAL SERVICES FOR REPATRIATION DEPARTMENT

Early Commercial Services for Repatriation Cases

Prior to and in the early days of the Second World War, all eligible Repatriation Commission patients were issued on a loan basis with a suitable commercial hearing aid recommended by an aural consultant and the Senior Medical Officer. Batteries and replacement parts were issued as necessary.

Hearing aids of many types were supplied by the Commission and it was the practice to allow the patient to try out and select the most suitable type for himself, subject to a medical opinion as to its suitability. These aids were manufactured in England or the U.S.A., and at the time the Commission was concerned about the apparently exorbitant prices charged by the various agents.

The Commission was also concerned about the cost of servicing the aids and a request for advice was therefore made to the chief Engineer of the P.M.G.'s Department. Being unable to help, the Chief Engineer referred the Commission to the Army Signals Corps, who drew attention to the work being carried out on hearing aids at the Acoustic Research Laboratories, Sydney University (p. 131).

Early Assistance to Repatriation Commission by A.R.L. (later C.A.L.)

On 29 January, 1946, Mr. Murray, then Director of ARL suggested that a meeting be held between the Commission and himself in Melbourne. At this meeting, Mr. Murray advised that ARL aimed at developing a standard hearing aid in co-operation with manufacturers. He undertook to advise the Commission of makes of aids which had been tested by the Laboratory and found suitable. The Commission subsequently made £1,000 available to assist in the research.

Considerable research was undertaken by the Commission in co-operation with Mr. Murray into types of hearing aids, including their suitability, manufacture and costs, and on 4 December, 1946, the Commission approved the purchase of 250 sets of Telex hearing

aids on tender at a cost of £13/15/- per set. This provided Mr. Murray with a guide for possible standardisation of accessories and spare parts, so that he could gradually undertake the maintenance of all aids for the Commission (p. 131).

During 1947, some major firms that were interested in supplying ex-servicemen with aids were advised by the then Minister that the policy of permitting a patient to select his own aid was unsound and that arrangements had been made with CAL for supply and maintenance of hearing aids. In addition there was a protest against the Commission's calling for tenders for large lots of hearing aids as it was considered that this would limit the aids to those of one or two manufacturers, thus decreasing the range available (p. 132). It is interesting to note that the calling of tenders had an immediate effect on prices. Prices to the public for some types of hearing aids ranged from £25 to as high as £54. On the other hand, as stated above, the price for a Telex aid on tender was £13/15/- and this was a high class instrument which complied with all requirements (p. 140).

NAL's Audiological Services to Repatriation Cases Since 1948.

On 14 April, 1948, the Repatriation Commission advised all its State Branches that hearing aids to eligible persons would be supplied only through the Commonwealth Acoustic Laboratories where these had been established in the States (p. 132).

The Commission approved Mr. Murray's proposal for the production of the Calaid, as mentioned earlier, on 2 March 1949 (p. 123).

An amount of £7,000 per annum was provided direct in the Health Department vote for C.A.L. to cover all activities for the Repatriation Commission including design and provision of hearing aids, parts and batteries, and acceptance tests for some, and the work of testing, fitting and maintaining Repatriation hearing aids in all States. This vote was allowed under Cabinet approval for 1949-50, 1950-51 and 1951-52 (p. 263).

The approximate cost to the Commission of the early Calaid was £9/-/-. From 1st July, 1950, when joint purchasing of stores was taken over by Health Department, this price was £8/-/-, which was increased to £8/10/- as from July 1951 (p. 266).

The price for each aid for Repatriation cases varied from year to year with changes in types and costs of components and also with development of newer types of aid. However it was later decided that recovery of costs by Health Department in respect of hearing aids supplied to other Departments should cease from 1 July, 1969 (p. 271).

Aural Rehabilitation for Repatriation Cases.

In the early days of C.A.L., investigations were made into supplementary assistance such as auricular training, speech reading and speech correction that might be associated with the hearing aid where necessary. Aspects of the assistance were studied in various U.S. rehabilitation centres in 1947-1948 by Miss Maureen Brown, then Psychologist in Charge of Perth Laboratory (p. 193).

A full aural rehabilitation programme, including all aspects of hearing aids, training in their use, speech reading and speech training commenced for the Repatriation Department during 1951. The first programmes began in Western Australia and New South Wales from 1 July, 1951, in Victoria from 1 August, in Queensland from 1 October and in South Australia from 1 December, 1951. (p. 401).

Special films used by the Veterans Administration in U.S.A. to assist in speech reading training were procured for the programmes. Miss Brown also gave lectures and demonstrations of the training to the staff members concerned (p. 402).

Stethoscopes and Artificial Larynges for Repatriation Cases.

At the end of 1956, the Repatriation Department authorised the issue of the Stethetron, an electronic stethoscope, to deaf medical practitioners, for whose rehabilitation they take responsibility. The instrument was to be provided through CAL's Central Laboratory (pp. 267, 268).

In 1963, the Repatriation Department stated that its policy with regard to artificial electronic larynges was that each case should be dealt with on its own particular merits. In most cases, a real attempt should be made to obtain artificial voice without external device (pp. 269, 270).

VI AUDIOLOGICAL SERVICES FOR CHILDREN

Services Prior to 1947

In the early days after World War 2, ARL turned its attention to the problem of deafness in children. At the end of 1945 or beginning of 1946, a kindergarten for deaf children was opened at Pymont. Such a move was necessitated by the large number of children born deaf as a result of the maternal rubella epidemic in 1940-41. It was felt that it would be better if these children were isolated for special education in a separate kindergarten.

By the time the kindergarten opened, ARL's services had reached the stage where it was possible to take precise measurements of the children's hearing and design hearing aids to help them overcome their hearing loss. It was felt that as it was possible to measure the children's hearing at an early age, it might be possible to help them develop enough language and speech by means of aids, so that they could later be educated in normal kindergartens and normal schools using individual hearing aids (p. 281).

Because of the number of deaf children spread over the vast expanse of Australia it was considered that the later education of these rubella children in normal schools by means of individual aids was not only be far the best solution, but possibly the only practical solution at that time. Mr. Murray also believed that if these children were provided with properly designed individual aids at an early age, then they could be educated in normal kindergartens by normal kindergarten teachers without special training and then complete their education in any school desired (p. 282).

ARL's first objective at Pymont was to have a place for observing these children and bringing them together where group hearing aids and later individual aids might be used. The next objective was to place these children in normal schools as soon as they were sufficiently advanced in language and speech and as soon as individual aids could be designed and produced. One primary objective once all the children were grouped at Pymont was to see whether continuance of the kindergarten could be made completely unnecessary (p. 283).

During this early period, ARL was also actively engaged, following previous measurements of the children's deafness, in obtaining, calibrating and fitting small commercial type aids to these children, so that the sets were then worn continuously both at home and at school (p. 286). These aids, 100 altogether, were purchased by the parents either directly or with the assistance of the State Social Service Department who, on ARL's recommendation, assisted poorer parents to purchase these individual sets so that no child, however poor, missed out (p. 288).

It was considered that no hardship would be inflicted if the Pymont kindergarten reverted to its function of a kindergarten for children with normal hearing in 1947, since by then it would have served the major purpose of enabling ARL to overcome to a large extent the social effects of the deafness resulting from the maternal rubella epidemic in 1940-1941. The establishment of the Pymont Kindergarten as an experimental centre under normal Kindergarten Union teachers had in fact enabled ARL to set up a method of dealing with partially deaf children in a much better way. The method of attempting to assist these children to take their place in a normal school with hearing aids and to take a normal part in life was by then firmly established and recognised by the Education Department as a most desirable attack (p. 289).

Services since 1947

By the beginning of 1947, CAL's services to children were described as fitting into three groups:

1. Assisting parents with the precise fitting of aids for the child's individual use if a hearing aid could be of assistance.
2. Assistance to the normal educational authorities, both pre-school and primary school, in the fitting and methods necessary for these children to attend ordinary schools.
3. Assistance to deaf schools with apparatus and calibration of apparatus for children who are to be educated in the deaf school or under trained teachers of the deaf (p. 293).

After a meeting between Mr. Murray and Mr. McKenzie, the Director of Education for N.S.W. at the time, a special officer was appointed whose full time task was to work as liaison with CAL and study the placement of children who could benefit in normal schools. No children were placed in departmental schools until a thorough joint study was made of the children, measurements were taken of their degree of deafness and judgement was made by the Education Department of the likely results in the particular school (p. 294).

At the end of 1947 a request was made to the Kindergarten

Union that one of its teachers be seconded as an itinerant teacher to work with CAL and visit the various children in kindergarten to give specific assistance as desired (H21). However this was not possible because of the extreme shortage of kindergarten teachers (p. 299).

In 1952, however, Mr. Murray arranged for Miss Barbara Roberts, who had been trained at Manchester, to look after and assist pre-school children and give parental guidance, using CAL's classroom and facilities until such time as the Education Department set up its own facilities, (H60). Initially Miss Roberts visited CAL only on Tuesday but during 1956, the visiting time was increased to include Thursday as well (pp. 322, 323).

Although CAL was willing to provide assistance in selection of hearing aids for deaf children, there were many parents who were unable to afford to purchase and maintain the aids. Some financial help was given to poorer parents by the Department of Labour and Industry and Social Welfare (p. 302). In some cases, charitable assistance was given to assist in the purchase of commercial aids at an approximate cost of £35. Even when assisted in the initial cost, many poorer parents were unable to buy batteries and maintain their child's aid at the commercial cost of about £20 per annum (p. 70).

Therefore in March, 1949, the Minister gave approval for 100 aids to be assembled at a cost of £1000 for experimental use in school children and to be maintained without charge. The children selected were to be nominated by the various educational authorities and priority was to be given to cases where the aid assisted education in a normal environment (pp. 86, 87). Twenty of these aids to the laboratory design, by then known as the Calaid, were fitted in all States towards the end of the 1949 calendar year (p. 204).

In early estimates of costs of a scheme for children, it was pointed out that the average cost of aids for young children would be higher. Thus apart from the basic aid, a headband and earpad would often be required to assist in retaining the earphone in the very small ear. Moreover a second earmould was often necessary before a correct fit could be obtained (p. 62).

Approval was given in Cabinet Agendum 1171B, dated 18th October, 1949, for the provision and maintenance of hearing aids without charge to deaf school and pre-school children. The relevant paragraph of the Agendum reads:
"It is proposed that the Commonwealth Acoustic Laboratories obtain, fit and maintain hearing aids, which would be on loan and remain the property of the Commonwealth, to all pre-school and school children needing them in Australia. The issue would be made to children selected by the State Education Authorities following upon a survey of the needs. Each deaf child would be examined by an ear, nose and throat specialist (p. 134).

The general programme was to cover all children requiring hearing aids by 30 June, 1951. While a few initial aids would be available for issue during April, 1950, the scheme would not be in full swing until May, 1950 (p. 304).

In February, 1953, the scheme was extended when the Minister gave approval for children leaving school to retain their Calaid

and have them maintained by CAL free of charge. However this maintenance was not to include the provision of batteries, which was to become the child's own responsibility (p. 319).

Subsequently in August, 1959, the Minister approved a recommendation that the scheme be extended to cover those cases where hearing loss is found in persons who have left school but have not reached the age of twenty one, the cost of batteries to be borne by the persons concerned (p. 325).

Further extensions to the scheme, such as retention of aid after attaining age of 21 years, and binaural fitting of children who may benefit, were undertaken during the 1960's and 1970's.

Age of Fitting Hearing Aids

In 1949, by means of special psychometric tests involving training children in a conditioned response to sound, good measurements could be made of congenitally deaf children at about four years of age. Aids were fitted if necessary, at this age (p. 204).

The advent of the transistor and the resultant development of a much smaller one piece transistor aid assisted greatly in fitting aids to very young children where the weight of the previous batteries was a disadvantage (p. 228). By the end of 1955 aids were often fitted at the age of two years (p. 322).

By March 1964, it was considered that because of the maturation of the child, the earliest age for fitting children with hearing aids was at about the sitting up and crawling stage, i.e., about 6-8 months (p. 327).

Special Services for Babies and Infants

C.A.L. was not in favour of the enthusiasm shown in some quarters in the mid 1960's for neonatal testing, as investigations demonstrated that new born infants may require as many as four re-tests before they show a definite response even with normal hearing (p. 328). Because C.A.L. realised the limitations of the then existing methods of screening the hearing of infants approval was obtained for a collaborative long term follow-up study on early ascertainment of hearing defects (p. 329).

Because of the desire to extend the screening of children to kindergarten and nursery age children, battery audiometers were lent for use by medical officers of the Department of Infant Welfare to screen children in kindergartens. An investigation was also made of means by which the hearing of infants could be observed or screened by nurses at Baby Health Centres (p. 327).

In December 1969, the Minister gave approval for A.C.T. Health Services to commence an infant screening programme at Baby Health Clinics in Canberra in July 1970 (p. 330).

In the mid-1960's an Assistant Pre-School Officer was appointed to the staff of Central Laboratory. In 1967 a pre-school training and parent guidance programme for parents of deaf children aged between 18 months and three years was commenced. Parents and children were seen on an individual basis, both at Grace Building Laboratory and through home visits. In addition to this, group situations for 10 parents and children were provided.

Special Services for Adolescents

When in 1953, Ministerial approval was given for children on leaving school to retain their Calaids, it was considered that C.A.L. had a continuing interest in assisting in the general and vocational adjustment of these adolescents. Arrangements were therefore made for assistance to the Employment Division of the Department of Labour and National Service with the vocational guidance and placement of these adolescents (p. 320).

In August, 1954, the Director General of Health agreed that co-operation with Department of Labour and National Service in screening visual and auditory tests for adolescent children was desirable and gave approval for CAL to provide assistance for the testing of these children (p. 321).

VII AUDIOLOGICAL SERVICES FOR OTHER GROUPS

Services for All Sections of the Community

During 1949 it was suggested that a free hearing aid scheme be set up for all sections of the Community (pp. 88, 89). However at that stage, the Government was reluctant to make any commitment with regard to the provision of hearing aids for other categories in the adult population (p. 128).

Services for Pensioners

Various suggestions were put forward in the early years for the extension of CAL's services to pensioners but were unsuccessful. Thus a letter from the Director General of Health to the Director of CAL in December, 1953, states:

"The anticipated expenditure for the issue of Calaids to pensioners is interesting but it is stressed that at present, the Government has no intention of supplying pensioners with aids and any suggestion that might leak out to the contrary would be most embarrassing." (p. 169).

Announcement of a scheme for pensioners was not made until August, 1967. The scheme began at Adelaide and Newcastle on 1 April, 1968, for pensioners in the 65-69 years age group and was gradually extended to pensioners in other areas and other age groups until August, 1968, when all pensioners were covered.

The aids were initially supplied at a nominal hiring charge of \$10. They were maintained free of charge by CAL but the pensioners were required to buy their own replacement batteries (pp. 367, 368). Subsequently in August, 1973, it was announced in the Budget that the \$10 hiring fee would be abolished and batteries would be provided free of charge under the pensioner hearing aid scheme.

Audiological Services for Defence Services

In December, 1955, an arrangement was entered into with the Department of the Army, under which serving members could attend the Laboratories for audiological tests and, if recommended for a hearing aid, be fitted with a Calaid. The cost of fitting

and maintenance was to be reimbursed to the Health Department by the Department of the Army. This service was expected to assist the Department of the Army by retaining members who had been sufficiently rehabilitated by the provision of a hearing aid to continue in the Service.

Similar arrangements were made for serving members of the RAAF in October, 1956, and for serving members of the Royal Australian Navy in August, 1957.

In January, 1961, when the Director of Medical Services of the Australian defence forces decided to include pure tone audiometry in the medical examination of recruits, CAL commenced a scheme for training medical orderlies in audiometry.

Audiological Services for Social Service Cases.

As early as 1946, ARL carried out hearing tests for persons who applied to Department of Labour and Industry and Social Welfare of N.S.W. for hearing aids. This Department supplied aids on a gratuitous basis only in cases where persons were in very poor circumstances and where the acquisition of an aid was likely to have some particularly good effect, e.g., enabling a deaf person to commence employment (p. 272).

In the early years a few Calaids were issued to Social Service cases. The issue of such aids was treated as experimental (pp. 126, 273, 274). However except for cases eligible under CAL's repatriation and children's schemes, hearing aids were provided by the Commonwealth Social Services Department, who was legally permitted to grant loans for such purposes as the purchase of hearing aids, and also by various charitable organisations including the Hospitals and Charities Commission, the Citizens Welfare Service and the Red Cross (pp. 431, 432).

Eventually in February 1952, approval was given for CAL to provide and maintain hearing aids to persons needing them for rehabilitation purposes under the provisions of the Social Services Consolidation Act. (p. 275). In view of the relatively short duration of the rehabilitation period of such cases, it was decided that aids so issued would not be sold to the Department of Social Services but would be issued on a loan basis only (p. 278). In March 1957, it was decided that after the recipient ceased to be a responsibility of the Social Services Department the aid could be retained and maintenance would be continued but no batteries would be supplied (p. 278).

Services for Other Government Departments.

In August, 1957, the Director-General of Health advised:

It is desired that, whenever Commonwealth Medical Officers in capital cities suspect hearing loss in appointees to the Service or other persons subject to medical examination, such persons should be investigated by officers of the Acoustic Laboratory services.

If either the examining Medical Officer or the Acoustic Laboratory Officer considers that the person should be examined by an Ear, Nose and Throat Specialist, and approval for such examination has been obtained from the Department concerned or the Public Service Inspector's Office, where practicable these should be arranged at the subsequent session of the visiting

E.N.T. specialist to the Acoustic Laboratory (p. 280).

Services for Aborigines

Reference has already been made in section I to early visits by NAL to the Northern Territory.

In June, 1959, the Minister of Health approved that:

"The Director of the Acoustic Laboratories be authorised to supply hearing aids in cases recommended by the Director of Welfare, Northern Territory Administration, provided:

- (i) the Director of Health, Darwin, certifies that the issue of the aid is justified on medical grounds, and
- (ii) the cost of the aid is borne by the Northern Territory Administration."

It was considered that this service should be provided from the Central Laboratory as this would result in maximum assistance in selection of cases and simplification in reimbursement of the cost of the aid (p. 336).

However a request for supply of hearing aids to part and full blood aborigines under the care of the Aborigines Protection Board in South Australia was not approved in January 1963. It was felt that if this request was agreed to, a precedent would be established for supplying hearing aids to all aborigines throughout Australia (pp. 277, 278, 279).

Services for Department of Civil Aviation

Approval was given in July, 1948, for the Department of Civil Aviation to use CAL for the audiometric testing of professional flight crew members and applicants for these positions (p. 341). Tests in accordance with International Civil Aviation Organisation rules that required accurate pure tone tests of all crew at not less than yearly intervals commenced during 1948 and the number tested to the end of 1948 was 359 (p. 197).

By the end of 1949, it was stated that these checks were required twice a year. Pure tone tests were required normally but special practical tests involving ability to understand words in a synthetic noise background were required for doubtful cases. (p. 202). A summary of the history of the development (up to 1953) by CAL of practical speech hearing tests for Commercial aircrew is to be found on pages 342-355. A practical test for listening in noise recommended for adoption by ICAO was standardised for possible use by CAL about the end of 1956 (p.231).

During 1964, arrangements were made for staff members from CAL to visit New Guinea to test the hearing of Department of Civil Aviation aircrew stationed there (pp. 338, 339, 340). It was intended that further tests of this type would be undertaken during CAL's future visits to New Guinea which were to take place about every eight months commencing February, 1965 (p. 340).

Services for School Medical Services

In March, 1949, approval was given for the Acoustic Laboratory to assemble and calibrate sufficient audiometers to supply the needs of the school medical services in all states. The number estimated to be required was 20 to 25 audiometers at a cost of approximately £20 to £25 each, or a total expenditure of £500. The audiometer would remain the property of the Health Department, who would keep them in calibration through the various branch Acoustic Laboratories. The audiometers would be lent to the school medical services whose staff would carry out the actual screening tests.

This move was necessitated by the investigations that had been proceeding since 1947 into methods of detecting deafness in school children. Full co-operation had been given by the school medical services in all States in carrying out screening of school children. For this purpose a special light-weight battery audiometer had been developed by CAL and, to be fully effective, needed to be calibrated and maintained by the Laboratory (p. 86).

Approval for the assembling of audiometers designed at the Laboratory for loan to State Education Department for testing of children by the School Medical Services was given in Cabinet Agendum No. 1171B dated 18 October, 1949 (p. 134).

Over the years, the number of audiometers on loan to the School Medical Services has greatly increased. Thus in September, 1960, a request was received from the School Medical Service in Victoria for an Additional six audiometers to allow a State wide coverage of hearing tests for school children including those in small country schools (p. 362). A similar request was received from the School Medical Service, South Australia, in July, 1961, for an additional three audiometers (p. 364).

Services to Hospitals

Among the specific functions of CAL, as laid down in 1952 by the then Minister for Health, was the following:

Testing of miscellaneous cases for hospitals (see Section II).

The assistance has also included the loan of audiometers to hospitals (p. 356). However policy regarding audiometric tests at hospitals was that CAL was to confine its activities to calibrating the audiometer and advising personnel on the operation of the audiometers installed at the various hospitals. Hospitals of course had approval to forward any difficult cases to the Acoustic Laboratory for full audiological tests (p. 360).

In cases where audiometric equipment was set up in hospitals, CAL was also prepared to make its own spondee and P.B. records available to them. It was considered that as these records had Australian voices, they were more suitable for Australian conditions (p. 363).

VIII HEARING TESTS

Early Audiometric and Standards

Because of restrictions on American audiometers due to the

dollar shortage, it was necessary for CAL to design their own early audiometers (p. 370). Pure tone audiometers were designed to be made up locally commercially as desired in such a way that they could be calibrated by the Central Laboratory and kept in calibration by various branch laboratories as desired. The audiometers were about half the cost of the imported models and as only the earphone was imported, a considerable saving in dollars resulted.

A very small portable battery audiometer was designed and made up for field work thus enabling CAL to test sick or bedridden cases in the Repatriation or Children's Hospitals (p. 195).

Since about 1943, CAL (previously ARL) had been responsible for setting up standards and calibrating audiometers. As the only standard available during that time had been the one established in the United States, CAL adopted their standards, including the particular earphones used and the 6cc coupler for measurement of acoustic earphone output (p. 381).

ARL's original coupler was a JRB (Joint Radio Board) coupler manufactured to the American dimensions. This was quite similar to the Bureau of Standards coupler 9A which CAL subsequently adopted. The dimensions of this coupler are given in *Journal of Acoustical Society of America*, November, 1950, 22(6), 837.

Because the Western Electric 705A and the Permoflux PDR-1 caused difficulties in calibration at 6 and 8 Kcps due to low sensitivity, the standard earphone for all CAL's own audiometers was the Permoflux PDR-10, using an MX 41AR cushion, (p. 377).

Also because it was thought that some accuracy was lost in attempting to make equalisation within an audiometer for a continuous frequency oscillator, all CAL's audiometers were made with fixed frequencies with each octave from 1000 down and each half octave from 1000 up. The output at each fixed frequency was calibrated independently to the individual earphone used (p. 378).

Because of the advantages of the American standard, it was retained by CAL until international agreement was reached on a suitable standard (p. 385).

CAL's Central and Branch Laboratories changed over to the ISO audiometric zero on 1 February, 1970 (p. 392).

Hearing Test Racks

In the early years of CAL, research was undertaken on tests required for full aural rehabilitation. In addition to pure tone audiometry, tests included speech audiometry, tolerance tests, air and bone thresholds with masking tests of comprehension ability through a master hearing aid adjustable to all power levels and quality rating, binaural thresholds in speech and malingering tests. The tests were installed in one single 6'6" rack built in Sydney for each laboratory. Switching facilities were concentrated on one panel by means of keys so that various tests could be selected at will by the psychologists doing the test. By the end of 1949, the first two racks were in use in the Sydney Laboratory (p. 208).

It was found necessary to make up these racks in panel form so that various new tests, continually being designed or improved, could be added once their desirable use had been determined. Only the special earphones, about 2% of the cost of the equipment was imported (p. 208).

Racks were installed in Melbourne in September 1951, in Brisbane in October 1951, and in Adelaide in December 1951 (p. 376).

Children's Auditory Testing and Training Unit

The children's auditory testing and training unit was designed to allow great flexibility in the informal hearing testing of children by providing the operator with a variety of inputs and outputs. The unit was also very useful in auditory training work as the audiologist was provided with a lightweight microphone attached to a harness. This facilitated movement, so that the audiologist was able to use toys, play equipment and/or a blackboard. One of the units was forwarded to each of the State Laboratories in January, 1962 (p. 389).

Tests using Psycho-galvanometer

At the end of 1952, a review was made of the whole question of testing the hearing of young children particularly with regard to use of the psycho-galvanometer. An investigation was subsequently made of the use and limitations of the psycho-galvanometer. A further investigation was to be made of material for eliciting the conditioned response so that CAL might have a complete range of equipment for testing hearing at the earliest possible age (p. 379).

Peep-Show Test

At the end of 1952, a modified peep show apparatus was designed experimentally for use with the rack turntable. By pressing a switch in the right sequence, a turntable would give a short spin and stop. The outside edge of a record had a number of toy animals to provide motivation (p. 379).

In 1948, however, CAL had had no plans for setting up peep show apparatus, as it was thought that the tests then in use at CAL were more useful (p. 369).

Recordings for Use in Speech Hearing Tests

During 1949, special speech tests were recorded to international standards for special audiometric tests. These were recorded by a professional announcer, and the results correlated with overseas recordings of similar special material (p. 207).

By August, 1951, several recordings had been calibrated and were ready for use with the CAL audiology rack equipment. These were CAL recordings of Spondee Word Lists Nos. 1A and 1B, 2A and 2B, 1E and 1F; CAL recordings of PB Word Lists Nos. 2, 5, 8 and 9; CAL recordings of Larsen Complete No. 1-19, Complete No. 20-34, Section A and Section B (p. 375).

In May, 1953, it was considered that spondees would be less often used when CAL changed to the Walsh and Silverman method of determining Social Adequacy Indices of Hearing, that involve

using only PB word list (p. 380).

By February, 1959, it was CAL's policy to facilitate the provision of CAL's PB recordings to outside bodies (p. 386).

E.E.G. Equipment

A proposal was put forward in the 1963-64 Estimates for electroencephalographic equipment for auditory research.

In a memorandum dated 10 April, 1963, justifying the purchase, it was stated that the equipment was required to study "brain wave" responses to pure tone audiometry of very young children, malingerers and other difficult to test by the more conventional means requiring co-operation of the patient; to study "brain wave" responses to various sound stimuli by normal adults and others for research purposes; to study "brain wave" responses to various sound stimuli including speech in aphasic and other brain damaged children and adults for research and clinical purposes.

It was pointed out that CAL had got along without the equipment till then largely by not carrying out this area of research and at the clinical level, by using less satisfactory techniques for some cases, such as skin resistance audiometry.

CAL's investigations were delayed until developments overseas indicated that more simple EEG apparatus could be used for this purpose (p. 390).

Noise Making Toys

In February, 1958, it was suggested by Brian Harold, then Psychologist of Melbourne Laboratory, that calibrated noise making toys should be made available to all Laboratories. The toys would enable psychologists to carry out screening hearing tests for very young children more effectively and would put CAL in line with current practice in American clinics.

It was considered essential to include a number of toys with mainly high frequency components and in particular the 4000 cps pitch pipe. In view of the increasing number of very young children referred for screening tests, the provision of such toys was considered urgent (p. 383).

Suitable toys were forwarded to the Branch Laboratories in March, 1960 (pp. 387, 388).

Warble Tones

In August, 1956, reference was made to a recent South Australian report about a supposedly new test for children with a wobulator with claims that it could be used for testing children at the age of six months. However it was pointed out that the wobulator or warble tone was part of the testing equipment of four of CAL's oscillators in Sydney. CAL had therefore been asked to cut records for other testing laboratories who did not have a sufficient range of wobulators available.

CAL had a series of warble tones cut on a record and these covered the full range of frequencies from 250 to 4000 Hz and warbled about the various single frequencies (p. 233).

IX MISCELLANEOUS

Work with Standards

At the end of 1961, when the Executive Committee of Council of the Standards Association of Australia (S.A.A.) authorized the formation of a Technical Committee on Acoustics, C.A.L. was invited to join the first committee (p. 438).

In November, 1961, Mr. Murray was invited by S.A.A. to represent Australia at meetings of ISO/TC 43, Acoustics and IEC/TC 29, Electroacoustic, in Germany in September, 1962 (p. 439).

Work with NATA

In July 1962, our first liaison with NATA was made, when Mr. R.A. Piesse, then Senior Physicist of CAL, was invited to join the Registration Advisory Committee on Acoustic and Vibration Measurement (p. 440).