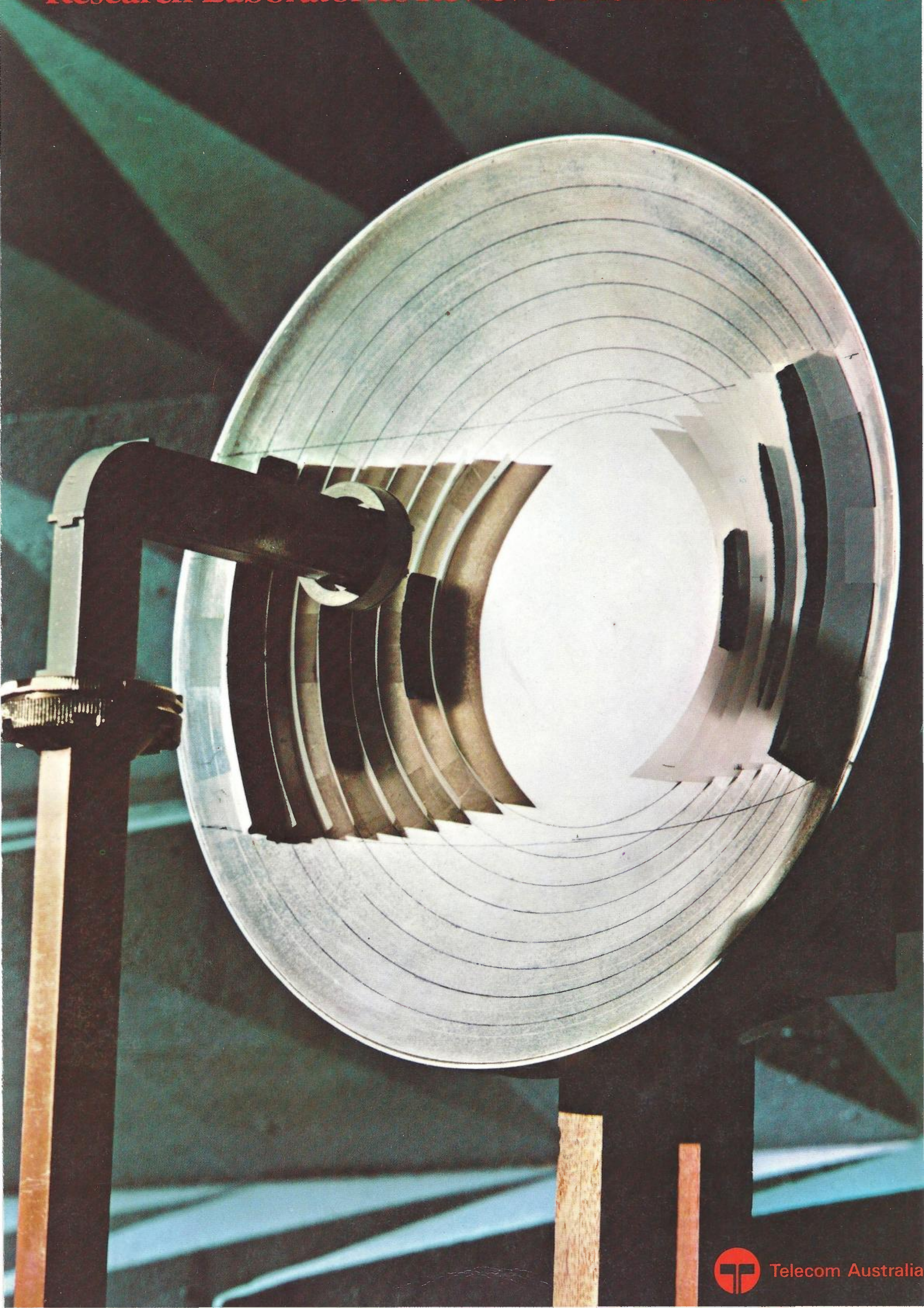
Research Laboratories Review of Activities • 1978–1979



Telecom Australia

Review of Activities

Research Laboratories 770 Blackburn Road Clayton, Victoria 3168 Australia

Telecom Australia

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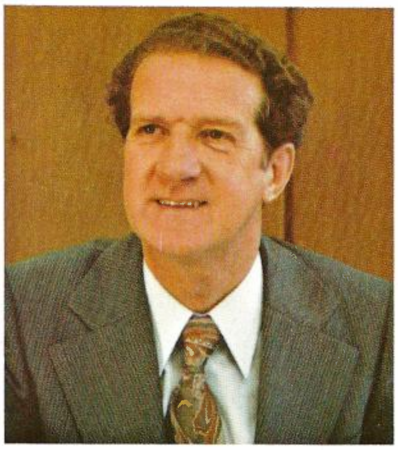
Foreword



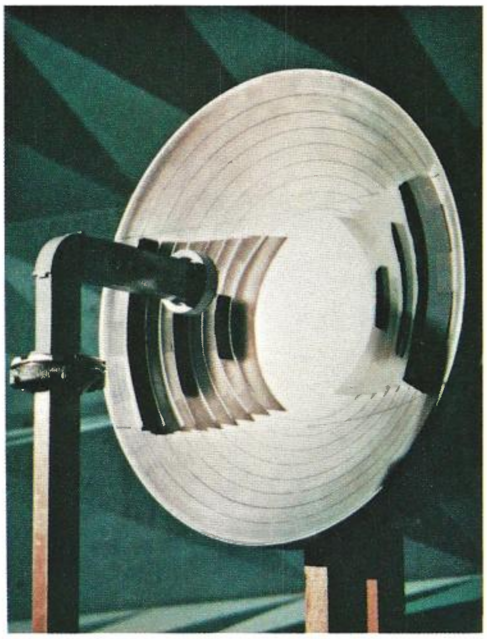
The rapid advancement made in the development of new telecommunications systems and services is due largely to the effective realisation of new materials, components and devices. These technological advances can be applied to a wide range of telecommunications equipment and plant to yield a greater array of customer services or improved existing services at reduced cost.

The Research Laboratories of Telecom Australia are in the forefront of many of these newer technologies and in this way the Laboratories fulfil an investigatory role for, and an advisory role to, other areas of Telecom. In particular, the Laboratories provide information, through their Research and Development (R & D) programme, to Telecom so that its management can plan effectively for the future and make soundly based decisions on customer services and network systems.

Now that the Laboratories are firmly established at their new location at Clayton - some 24 kilometres from the central business district of Melbourne, it is more important than ever to ensure that this somewhat geographical remoteness does not result in an "ivory tower" effect where technical people work in a vacuum producing ideas and concepts which are out of touch with the real telecommunications world.

The articles in this Review illustrate that this has not happened. I commend it for your reading.

(W.J.B. Pollock)
Chief General Manager



The cover shows a model antenna undergoing laboratory tests. See article on page 41.

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The Role of the Research Laboratories

Under its Charter established by the Telecommunications Act, Telecom Australia is responsible to provide, maintain and operate telecommunications services in Australia which best meet the social, industrial and commercial needs of the people of Australia, and to make its services available throughout the country so far as reasonably practicable. The Charter also requires that services are to be kept up to date and operated efficiently and economically, with charges as low as practicable.

In meeting this responsibility, Telecom Australia is mindful of the economic and practical benefits to be gained by the adoption of new and improved techniques, equipment and systems that result from advances in telecommunications science and technology. The correct choice of technology and emphasis on the efficient management of this technology in planning, developing and operating the telecommunications network ensures economy, efficiency and continuing flexibility in the ongoing task of developing the network which provides the services to the community.

The Research Department, known as the Telecom Australia Research Laboratories, is the focal point for much of Telecom's research and development effort. The Laboratories began in 1923 as a Research Section in the Headquarters Administration of the then Postmaster-General's Department, having been established to provide specialist technical advice to the Chief Engineer on "the latest discoveries, inventions and developments in electrical communications and their promising and likely benefits to the Department's telephone and telegraph services".

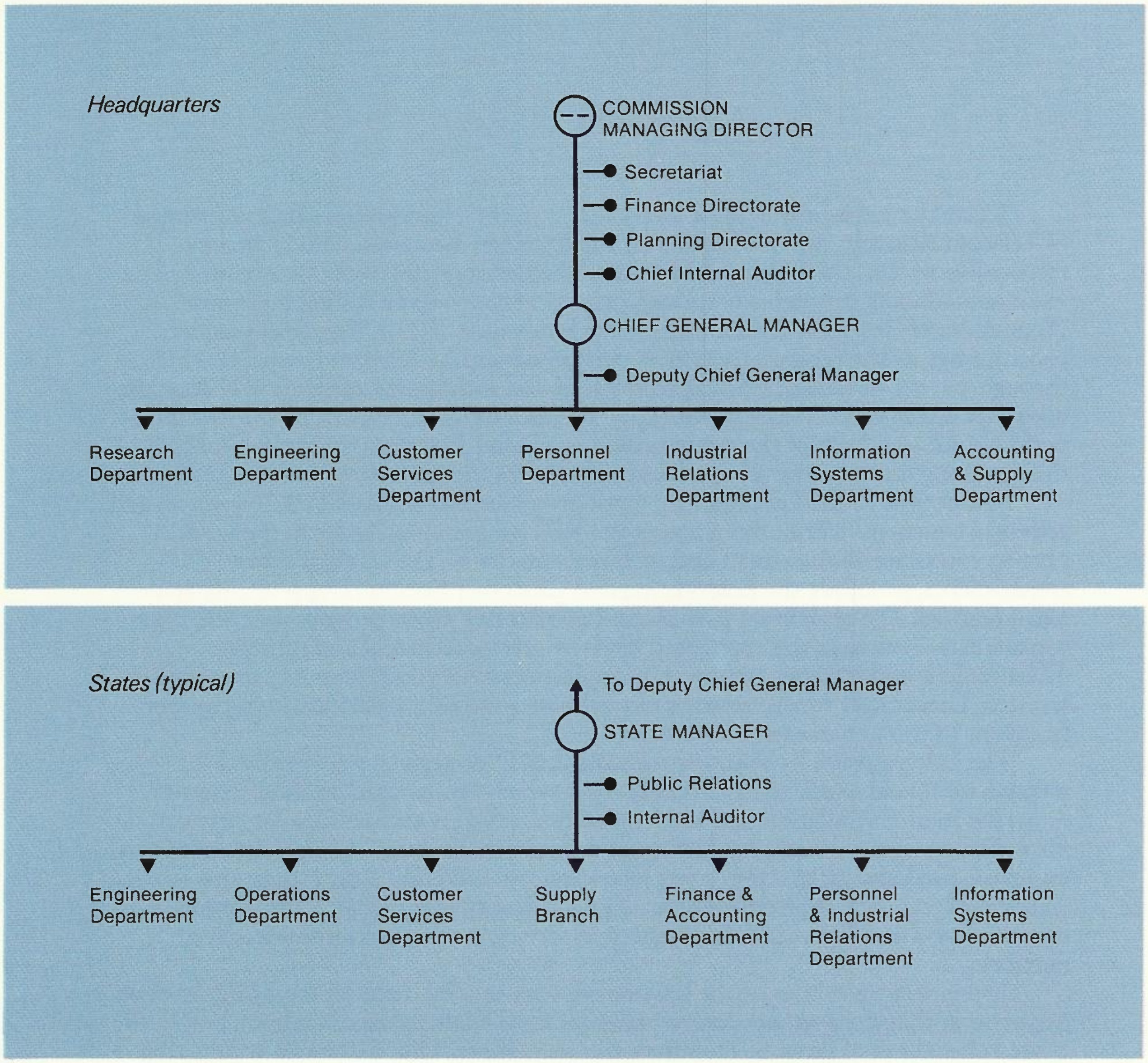
Today the Laboratories are a Department in the Headquarters Administration of Telecom Australia and are headed by the Director, Research, who is directly responsible to the Chief General Manager. The Laboratories' work programme is reviewed annually through a corporate process which yields a rolling three year Programme of Research, Development and Innovation (RDI). The RDI process encompasses all the technical activities performed within Telecom Australia which, through the use of new or existing technology and techniques, can or will change the telecommunications services provided by Telecom to its customers, or the technical performance standards of the systems used in the telecommunications network, or the operating efficiency by which Telecom provides these services over the network.

About 90% of the Laboratories' work programme comprises R & D projects and activities which are within the scope of the RDI programme. As such, the work obtains corporate endorsement and is co-ordinated with the work of other Departments, primarily the Engineering and Customer Services Departments at Headquarters. The remaining 10% of the Laboratories' work programme comprises consultancy services in the specialised fields of precise technical and scientific measurement and analysis, technical information services and industrial property services. These latter functions are a natural extension of the primary investigatory functions of the Laboratories.

The Laboratories, by selecting relevant R & D projects in scientific and technological fields, seek to develop expertise which can be used to assist Telecom Australia in its formulation and implementation of plans and policies for new or improved services, systems, equipment and practices. Through the application of this expertise, the Laboratories also assist Headquarters and State Administrations in the solution of technical problems that arise in the design, manufacture, installation, operation and maintenance of equipment in service in the telecommunications network.

These responsibilities of the Laboratories are met by maintaining a high level of expertise in the telecommunications and associated engineering disciplines, and in the related disciplines of physics, chemistry and metallurgy. This is done by conducting research and advanced development work on topics that are relevant to the Australian network, having regard to the work known to be in progress elsewhere in Australian research laboratories and in similar institutions overseas.

Many of the innovations, ideas and improvements proposed for the Australian network originate overseas. However, it is necessary for Telecom Australia to have advanced knowledge of these proposals so that they may be evaluated soundly, on social, economic and technical grounds, before they are accepted, or adapted and



Organisational relationships of the Research Laboratories with other units of Telecom Australia modified for incorporation into the Australian telecommunications system. To help make these decisions and judgements with confidence it is necessary for Telecom Australia to have, at first hand, sound and competent technical advice. This is best derived from its own R & D, conducted in each relevant technological or scientific field.

Much of the technical advice received by Telecom Australia in these new and developing fields of telecommunications is offered by the staff of the Research Laboratories. Most of the projects undertaken by the Laboratories, rather than being directed at production specifications, find their ultimate expression in the performance requirements incorporated in procurement specifications for the systems and equipment which are bought from the world-wide telecommunications industry. Other work is expressed in the assessment of materials, components and assembly practices used by suppliers in equipment tendered against Telecom Australia procurement specifications. Occasionally, a project is carried to production when it is evident that the innovation, design and development work of the Laboratories will yield equipment directly suitable for field application.

Apart from carrying out a research and development role, the Laboratories have specialist staff with knowledge and facilities in a number of disciplines, including the physical sciences, who conduct investigations into difficult technical problems that arise in the operation of telecommunications plant. Further, the Laboratories are responsible for Telecom Australia's scientific reference standards for the measurement of time interval, frequency and electrical quantities. In the former case, they are an agent of the National Standards Commission.

Telecom Australia, through its Research Laboratories, recognises the great variety and depth of research talent which exists in centres of higher learning and in industry in Australia. The Laboratories encourage these other research organisations to undertake specific projects of interest to Telecom Australia and acts as focus for this activity for Telecom Australia.

The role of the Research Laboratories remains basically the same as it was when they were first established. In essence, their basic function is to develop knowledge and skills in the advancing areas of telecommunications science and technology to assist Telecom Australia to decide when, and to what extent, new technology is to be harnessed to provide new or improved customer services and systems.

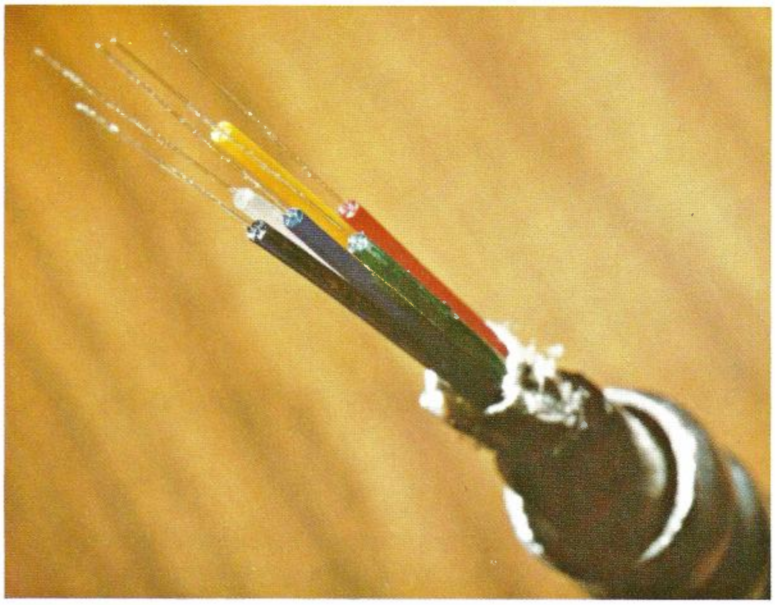
In the selection of activities reported in the following pages, this edition of the Review of Activities of the Research Laboratories illustrates the ways in which the Laboratories have sought to fulfil their role during 1978-1979.

Items of Special Interest

Telecom lines staff hauling optical fibre cable into underground ducts adjacent to Clayton Research Laboratories

OPTICAL FIBRE SYSTEM FIELD EXPERIMENTS

The successful transmission of narrow optical pulses along several kilometres of hair-thin glass fibre has served notice that cables containing these optical fibres will play an important role in the future evolution of telecommunication networks. In order to derive the earliest benefit from this new technology, Telecom Australia, in common with many telecommunication authorities throughout the world, has embarked on a programme of field experiments aimed at investigating the technical



The six optical fibres which form the fibre cable

advantages claimed for optical fibre technology. These include an increase in both the distance between cable repeaters and in the circuit capacity for a given cable size, when compared to conventional metal-based cable systems.

Telecom's initial field experiment commenced in October 1978, when a 1.5 km length of fibre cable was installed in underground ducts adjacent to the Research Laboratories at Clayton. The cable contains six low loss fibres (3 db/km) shielded from water ingress and mechanical damage by a metal sheath. Prior to the field installation, the transmission characteristics of each fibre core were measured in a laboratory environment. These measurements were repeated after installation and results are currently being analysed. At a later date, digital terminals capable of providing simultaneous transmission of 120 one-way voice channels will be connected to the cable and the system performance monitored.

To allow successful completion of optical fibre system field experiments, some equipment items of novel design have been purchased. These include instruments which ascertain the continuity and loss of the cable fibre cores, and demountable connector sets which permit a relatively low loss connection to be made between successive fibre ends.

More elaborate field experiments are planned for the future. These will incorporate digital terminals and line repeaters of a higher capacity than those mentioned above, together with wideband analogue terminals suitable for TV transmission. Such experiments will require the installation of a higher capacity optical fibre cable.

All activities relevant to the field experiments are being co-ordinated through a working party whose delegates are drawn both from the Research Laboratories and the Headquarters Engineering Department.

RESEARCH LABORATORIES' CONTRIBUTION TO WARC 1979

In September 1979, the International Telecommunication Union will convene a World Administrative Radio Conference (WARC) in Geneva to revise major portions of the ITU Radio Regulations. The Conference will last 10 weeks and will be a major influence on the development of radiocommunication services for the rest of the 20th Century.

National preparations for WARC 1979 have been under way since 1976 in an Australian Preparatory Group (APG) which includes wide representation from Government Departments and Statutory Authorities, Industry and users of radio services. There are eight APG Committees established to cover the various radio services. For their respective services, these Committees initiate and develop proposals for Australia to submit to the Conference and contribute to the national brief that will guide the actions of Australian delegates at Geneva.

In these national preparations, the Laboratories have played a major role in the area of space radiocommunications and radio-astronomy services. This is the province of APG Committee 6 for which the Laboratories have provided the Chairman and Secretary. Major issues which have been considered by the Committee are the need for additional frequency spectrum for these services, including adequate provision for the up-links for broadcasting satellites allowed by the agreed international plan and the operation and development of regulations to ensure equitable international use of the geostationary satellite orbit.

Other contributions from the Laboratories have been made in APG Committee 4, which is responsible for fixed and land mobile services of which Telecom is a major user.

On the international scene, a Special Preparatory Meeting was convened by the International Radio Consultative Committee (CCIR) in October 1978 to prepare a report providing the technical bases for WARC. Over 700 delegates from 85 countries attended this meeting and the Australian delegation of 20 members included Mr. E.R. Craig and Mr. G.F. Jenkinson of the Laboratories. The work of the meeting was organised into eight major Committees. Of these, Mr. Craig was Chairman of Committee C, which dealt with technical bases for Space Services and Space/Terrestrial Sharing.

In addition, one seminar was held in each of the ITU Regions. The Region 3 Seminar, to cater for the Countries of Asia and Oceania, was held in Sydney in April 1979, and for this event, the Laboratories contributed a paper and provided a Technical Secretary.

DISTINGUISHED VISITORS TO THE LABORATORIES

Like most Laboratory organisations, Telecom's Research Laboratories are visited by a variety of people for a variety of purposes in any one year. Whilst all visits are considered important, some particular visits are more notable than others, either because the visitors are people of high distinction or because the purpose of the visit is one of significant importance.

The following paragraphs record details of two more notable visits which occurred during the year.

Standing Committee on Communications and Administrative Services

On 20 November 1978, Members of the Government Standing Committee on Communications and Administrative Services visited the Research Laboratories complex at Blackburn Road, Clayton.

The visiting Members were: Mr. A.J. McKenzie (MHR), Committee Chairman, Senator S.J. Collard, Mr. J.W. Bourchier (MHR) and Mr. E.C. Cameron (MHR).

The visitors were welcomed by the Director and senior staff of the Laboratories, and held general discussions regarding the responsibilities, functions and work of the Laboratories within Telecom Australia. They also discussed and inspected a number of particular research projects.

The Director explains some of the uses of the environment chambers - one shown in background

A senior scientist demonstrates the concept of filled cables

The visitors witnessed a demonstration of Wired Teletext, which illustrated the computer-based information services which might be provided in the future from a central computer centre to a subscriber via the telecommunications network. A typical subscriber terminal facility was used in the demonstration. It used an enhanced version of a domestic TV receiver controlled by a keypad as the demonstration home data terminal.

In a display of the Laboratories' activity in the field of optical fibre transmission, TV signals were transmitted over a length of fibre. The optical fibre system used in the demonstration comprised a light emitting diode (LED) modulated by the TV signal to transmit analogue signals over a 1 km length of fibre to a photo-detector, which then reconverted the optical signal to its electrical form for display on a normal TV receiver.

The visitors inspected the facilities used by the Physical Sciences Branch in its task of testing materials and components used in Telecom's network to assess their reliability and adequacy in the wide variety of environments encountered in Australia. They also visited the high voltage testing laboratory and were shown the range of facilities of this laboratory, including the High Voltage Impulse Generator used to simulate the effects of lightning strikes on telecommunications plant.

Other work discussed with the visitors centred upon the evolutionary development and associated life testing of new varieties of telephone cables, particularly those for underground applications. One major development discussed was that of jelly filled cables, in which the air space between plastic insulated conductors is filled with a semi-solid hydrophobic jelly to impede water ingress and moisture penetration along cables. The recent work of the Laboratories in evaluating nearly a dozen possible filling compounds for their suitability in Australian conditions was outlined and its wider application to the preparation of a Telecom Australia specification for jelly filled cables was explained.

Chinese Computer Scientists

On 6 February 1979, a party of six Chinese computer scientists, accompanied by Professor P.C. Poole of the University of Melbourne, visited the Research Laboratories. The visit to the Laboratories was included in the Australian visit itinerary of the Chinese scientists, whose visit was arranged under the auspices of the Academia Sinica - Australian Academy of Science Exchange Agreement.

Senior staff from the Transmission Systems Branch welcomed the visitors to the Laboratories and presented an outline of data transmission in Telecom Australia. The presentation covered the history and growth of Telecom's Datel Service up to the present time and surveyed future plans for both Datel Services and the proposed Digital Data Network. The visitors then inspected several research projects in the field of data transmission, including 72 kbit/s data tests. Projects concerned with PCM equipment studies and optical fibre transmission were also demonstrated to the visitors.

Visitors view laboratory simulation of the effect of various telephone line impairments on a 9600 bit/s data modem signal

Scientists examine optical fibre cable sample

The visiting party then met senior staff of the Switching and Signalling Branch for discussions on the microprocessor-related activities of the Laboratories. The visitors inspected microprocessor development facilities and discussed Telecom's investigatory work directed at the standardisation, as far as possible, of microprocessor components and systems adopted in Telecom Australia's equipment design activities. Work being done on bit-slice microprocessors was described and the problems of assessing the performance of semiconductor memories was discussed.

The visiting party, accompanied by the Assistant Directors of the Switching and Signalling and Transmission Systems Branches then departed for Telecom's Computer Centre, where senior staff of the Information Systems Department showed the visitors over this large computer complex operated by Telecom Australia.

A Selective Review of Current Activities

In accord with their functions, the Laboratories are engaged in a large number of investigatory and developmental projects and specialty activities in the engineering and scientific fields. This work has application in telecommunication networks, and comprises a wide variety of specific topics pertinent to the present technical standards and future technical advance of these networks.

It is not possible to report, even briefly, on all of the Laboratories' projects in this review. As a consequence, the activities reviewed in the following pages have been selected to give an overall picture of the type and breadth of work undertaken, and of the degree to which the Laboratories are keeping abreast of world developments in communications science. A more comprehensive list of current projects is issued in the "Research Quarterly" and this is available to selected bodies with special and more specific interest in the work of the Laboratories.

The normal method of publishing the detailed results of a research project is through a Research Laboratories Report, prepared when an investigation has reached a conclusion or a conclusive stage. It is the vehicle by which the results of the work are conveyed to the "client" and other interested sections of Telecom Australia, and in many cases, to other telecommunications agencies and industry as well as to other research bodies, both local and overseas.

In addition, the staff of the Laboratories often contribute to Australian and overseas technical journals and present papers to learned societies. An indication of the scope of this activity can be gained from the lists given in the last section of this Review of Activities.

CUSTOMER SYSTEMS AND FACILITIES

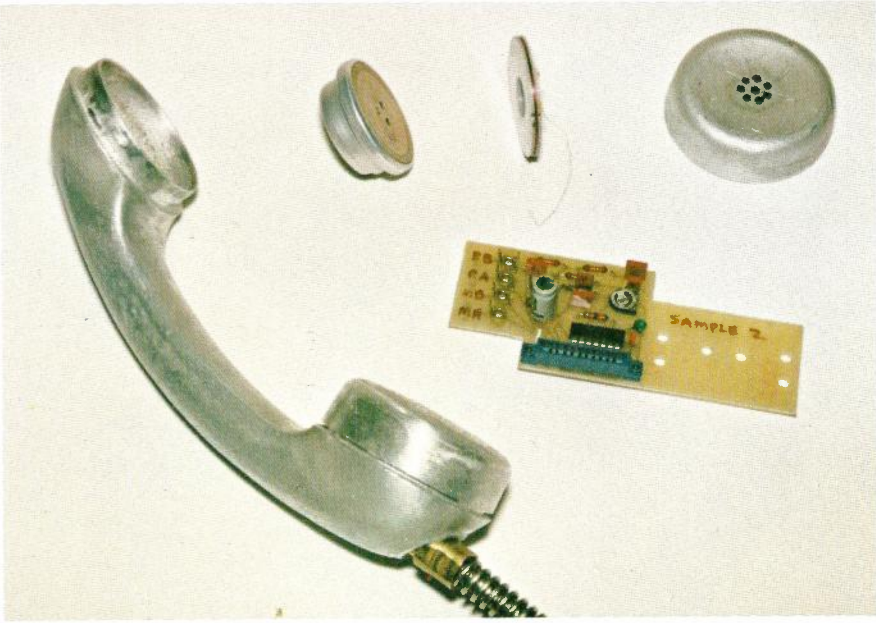
In Australia, an increasing telephone density which is approaching saturation and a reduction in population growth are both beginning to produce a situation in which the demand for new telephones will decrease. The emphasis is already starting to change from a situation in which technology is primarily used to assist the provision of telephones more cheaply to a situation in which technology will be directed towards expanding the variety of telephone services and the uses to which they are put. This changing scene will be accompanied by a changing approach in research and development. Future developments will not be technology-driven but rather technology-aided. The development push will consist of an intermingling of sociological, economic, ergonomic and technological factors which will result in quite new approaches being adopted in the determination of future customer services, systems and facilities.

Some new approaches in these fields are described in the following articles.

NEW DIMENSIONS IN TELECOMMUNICATIONS RESEARCH

There used to be widespread acceptance of the view that technology develops according to its own momentum, and that society's role was restricted to that of keeping up with the inevitable march of progress. In the 1970s, however, few people are sanguine about allowing technology to dictate social change; there is an increasing awareness of the need to incorporate social considerations into the process of innovation. The focus of the present debate, then, is not whether in principle society should be taken into account, but how this is to be achieved in practice.

In 1976, the Research Laboratories added a psychologist to its staff. Since then, several projects have been carried out in which engineers and psychologists have collaborated, and more ambitious interdisciplinary programmes are now being planned. A potential obstacle to effective interdisciplinary research is the different kinds of knowledge base from which the team members operate. The engineer, accustomed to the fixed principles and the special methodology of the natural sciences, is likely to have qualms about the probabilistic texture of the social sciences and the variety of methods which they employ. He is most comfortable with those areas of psychology which most resemble the natural sciences - such as ergonomics and controlled laboratory experiments. Unfortunately, studies in these areas have only limited relevance to the problem of gaining insights into the social effects of telecommunications. Given the present state of our knowledge about these effects, the emphasis must be upon analysing the dimensions of socio-technical change, and formulating the kinds of



Aluminium handset, showing thin flat coil located between receiver and earcap. Used in conjunction with the small amplifier, it provides a magnetic field for coupling ear-worn hearing aids to the telephone output.

Experimental box-type magnetic coupling coil for body-worn hearing aids. (Shown with receive-amplified telephone)

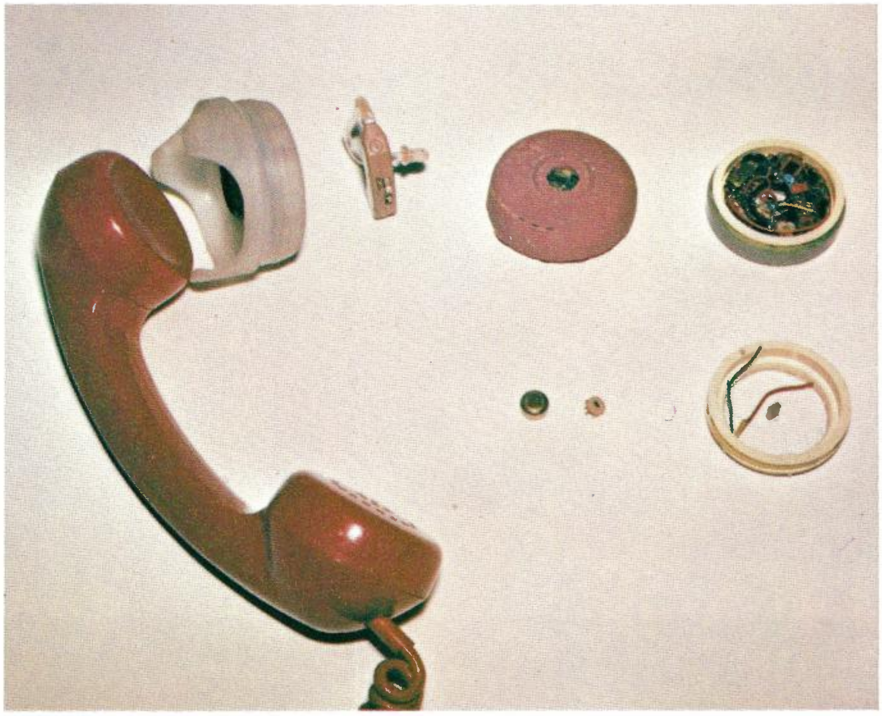
questions which will lead to fruitful research.

For this purpose, field studies offer the best opportunities; but the success of this stage depends very largely upon the knowledge and perceptiveness of the researcher. While the action research model offers general guidance, it does not prescribe rules or methods. For this, there need be no apology. The problem-formulating phase is common to all sciences, and special considerations apply to the study of people which do not apply to the study of inanimate objects. The major difference is that, in the social sciences, this phase is likely to take longer. It is followed by a systematic attempt to refute error - the initial problem formulation is submitted to empirical test, the findings critically considered, and new research questions formulated in the light of the evidence.

An effort by both engineers and psychologists to understand and to use to the fullest the contribution which each discipline is capable of making will result in innovations intelligently shaped by both technological and social information. Such innovations must assist Telecom Australia in carrying out one of its central responsibilities - that of serving the communication needs of the Australian people.

TELEPHONE AIDS FOR THE HARD-OF-HEARING

Special facilities such as receiver-amplifiers, gliding tone callers and magnetic field coupling coils (alone or in combination) are available to help the hard-of-hearing subscriber make more effective use of the telephone service. Several experimental developments to increase the range of facilities available to the hard-of-hearing telephone user have been



A clip-on coupling device for converting the acoustic energy from a telephone receiver to a magnetic field for coupling into a hearing aid

(Shown, from upper left - telephone receiver, commercial prototype clip-on coupler, behind-the-ear hearing aid, laboratory prototype coupler microphone side uppermost, and a view of the circuit board and circumferential coil of a similar unit. below are some of the component parts, viz., battery, gain control, coil and miniature electret microphone.)

carried out recently.

Experience with magnetic field coupling suggests that if the hard-of-hearing person wears a hearing aid for face-to-face communications and his aid has a magnetic field pick up facility, he prefers to make use of this facility to obtain magnetic, rather than acoustic, coupling of his aid to incoming telephone signals. This suggests that it would be convenient for these customers if all telephones in use in the Telecom network provided a suitable magnetic coupling field.

Unfortunately, the presently available coupling coil which is provided with the standard telephone does not provide a sufficiently strong magnetic field on all calls, and it has not been possible to increase this field without introducing excessive receive loss in the telephone. However, in the public telephone situation, spare electrical power is available and the received signal can therefore be amplified in the telephone instrument to generate an adequate field to couple into a hearing aid without affecting the normal receive sensitivity of the telephone.

An experimental receive-amplifier/equaliser/coil combination has been developed which enables an adequate field to be provided from a public telephone instrument which is fitted with a cast aluminium handset.

In addition, some hard-of-hearing subscribers, obliged to use body-worn hearing aids, find that the field produced by the telephone receiver is not conveniently located to achieve the desired magnetic coupling into their hearing aids. With these people in mind, an experimental "box" coil which attaches to the side of the telephone has been developed to provide an improved coupling field. Intended basically for use with the receive- amplified telephone, it can also be used with the standard telephone, albeit with some performance limitations.

Another aid for the hard-of-hearing telephone user undergoing experimental evaluations comprises a self-contained battery-operated acousto-magnetic coupler which can be carried around in a pocket or handbag. The device is adapted to clip on to the receiver end of the normal telephone handset, converting the acoustic energy to magnetic energy in a field suitable for coupling with the pick up coils of conventional in-the-ear hearing aids.

TELEPHONE SERVICES FOR RURAL AND REMOTE SUBSCRIBERS

Telecom Australia is charged under the Telecommunications Act 1975 to have special regard towards provision of services in rural areas. One of Telecom's stated objectives is the virtual completion of conversion to automatic services by 1990. This means the elimination of most privately erected open wire lines.

In remote areas and many urban areas, the use of radio transmission offers substantial economic advantages over cable systems in the provision of telephone services. To date, the radio systems used have not been specifically designed to meet the needs of the Australian rural and remote subscribers, which are largely determined by local conditions.

Telecom plans increased activity in this area, with an estimated expenditure of some $300 million. As part of this activity, the Research Laboratories established a Working

Group to determine the suitability of using up-to-date digital transmission techniques to connect rural subscribers by radio to the network.

The Working Group concluded that an integrated digital VHF/UHF group subscriber system offered a solution, with a number of significant advantages, to the problem of providing basic telephony services. The proposed system uses Pulse Code Modulation (PCM) and Time Division Multiplexing (TDM) with non-overlapping transmissions in bursts back from the various subscribers. The diagram shows an example of the time slot structure for a seven-channel system. Any one of the 1 to 7 time slots can provide a channel to any subscriber in the system, while time slot 0 is used exclusively for common channel signalling, synchronisation and supervisory functions.

The main advantages of the proposed digital system are:

- a significant reduction in power requirement,
- the ability to incorporate increased supervisory and remote fault locating facilities,
- the ability to easily extend service areas by the use of repeaters (regenerators),
- the ability to provide privacy without additional costs or loss of transmission performance, and
- reduced equipment costs, mainly due to the use of common channel signalling. Reduced overall costs are also expected from the system's capability of using repeaters and the consequent increase in the number of subscribers that can be served from a single base station.

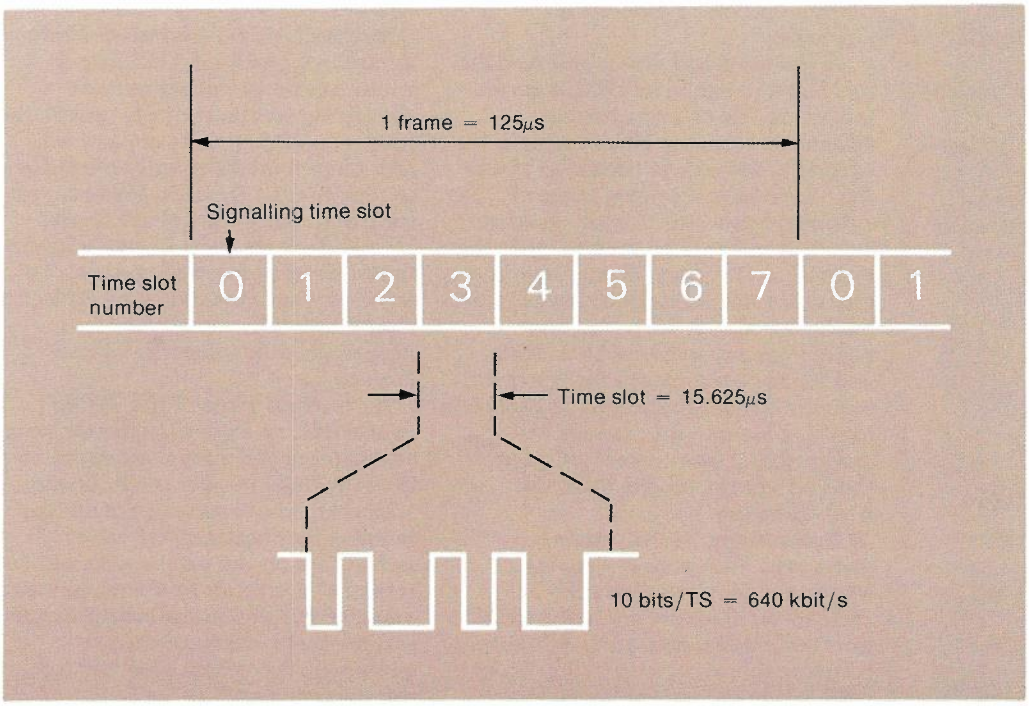
Application studies of such a system are being carried out in the Engineering Department.

FIELD INVESTIGATION OF NEW CUSTOMER SERVICES

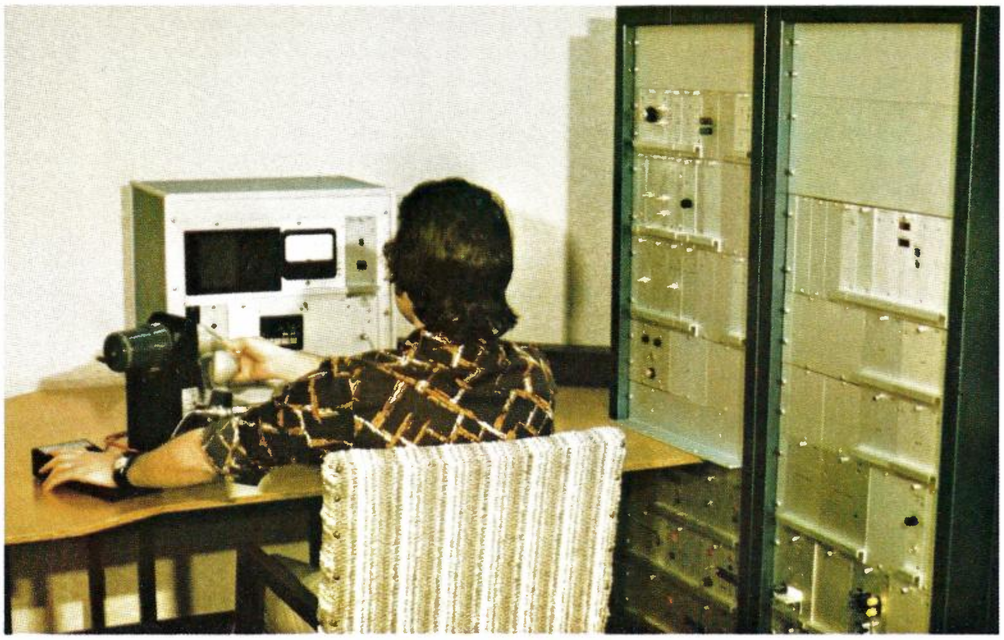
The introduction of stored program controlled (SPC) exchanges opens the way for new facilities to be provided to the telephone customer. Indeed, one of the often cited advantages of SPC systems is the wide variety of new customer facilities which they can provide. However, the definition and presentation of new facilities needs very careful consideration if the new facilities are to be fully utilised by a wide spectrum of customers. In many cases, a particular facility will be seen to fulfil different purposes and be utilised in differing ways by individual customers. Only after these aspects have been fully considered and evaluated will it be possible to develop soundly based facility specifications for implementation in SPC systems.

The recognised hazards of developing new facilities to meet real customer needs and also the unknown nature of their possible market potential are such that a programme of action research has been commenced by Telecom Australia to test various embodiments of new facilities in a real field situation and with existing customers.

The flexibility required for the trial is such that it will involve customers in various exchange areas and charging zones. Accordingly, to minimise network disturbance, the facilities to be evaluated will not be exchange-based, but will be simulated by "intelligent" telephones. Feasibility studies of this approach have yielded the interesting conclusion that almost all the so-called "new SPC" customer facilities can be provided by an



Time slot structure for a 7-channel rural radio system



TAMS-4 being used to measure the performance of a telephone handset

intelligent telephone. This then suggests that, in low penetration situations, the new facilities could be provided advantageously by this approach - with little, if any, exchange modification and without restriction of the range of facilities offered. Obvious advantages also present themselves for this approach in the case of customers connected to relatively inflexible equipment such as step-by-step exchanges.

A batch of 50 intelligent telephones is being prepared by the Research Laboratories for a trial, involving customers, scheduled to commence in August 1979.

TELEPHONE APPARATUS MEASURING SYSTEM - SERIES 4

Telecom is fortunate in having uniform procedures and test equipment used for measuring the electrical and acoustic performance of new and reconditioned telephone terminal equipment, not only throughout its own plant, but also by its Australian manufacturers. Today, nearly one hundred instruments known as Telephone Efficiency Testers (TET) are in use, all of which derive their standardisation from a central Telecom laboratory in Adelaide.

A few years ago, it was realised that the TETs, designed in 1960, were no longer capable of being further developed economically. A new, more adaptable design was needed to meet the continually changing range of customer apparatus. It was seen that automation could be used to assist the operator and reduce testing time, and that more attention should be paid to human factors. Also, it was now possible to design for better stability and for the equipment's electrical and acoustic standardisation to be checked in situ. This was not possible in 1960 and periodic return of critical parts of the TETs to the central laboratory has been necessary.

Accordingly, a new system, designated "Telephone Apparatus Measuring System - Series 4" (TAMS-4), has been produced and is now undergoing field trial. A highly modular approach, employing modern hardware and circuitry has been adopted. However, as TAMS-4 must be capable of being manufactured over a period of at least 15 years, care has been taken to avoid using components which are available from only one source. If necessary, individual modules could be reconstructed from new components on a "black box" principle. Using the standard modules as building blocks, TAMS installations can be assembled to meet the testing specifications for particular products. As new tests are devised, new plug-in modules will be designed to replace existing ones. Memory and control functions are based on the MC6800 microprocessor, and changes to test programmes and concessional test limits can be handled by replacement of plug-in memory units, programmed by a central Telecom laboratory.

In the field trials of the TAMS equipment, an inter-disciplinary team of engineers and a psychologist is investigating not only the technical and work flow aspects of the design, but also the impact of this new technology on the people who will be using it. As a result of the trials, many valuable insights regarding the design and implementation of the new equipment have been obtained from the operating staff.

TRANSMISSION STUDIES

Improved performance and economy may be obtained by a better understanding of the existing network, consequently enabling some re-design, and by the application of new techniques which greatly increase the utilisation of existing plant. Transmission studies have continued on a number of topics, embracing both of these aspects and examples are given in the following sections.

The transmission measurement programme in the switched network is essentially a characterisation of the existing plant in that it measures what exists and, assuming tolerable impairment levels, allows new technology such as digital operation to be introduced with greater advantage. However, this work has led directly to a consideration of the design factors affecting the present performance, for example, the design of terminating sets in exchanges, and to an examination of methods of improvement.

The limitations of existing cables are a significant factor in the introduction of pulse code modulation (PCM). Considerable work has been done in recent years to evaluate the effects of these limitations and to endeavour to obtain criteria which would be useful in specifying equipment to work in this environment. The development of the crosstalk noise measurement technique described has enabled a key parameter utilised in route design to be included as an equipment specification and used for comparative equipment assessment.

Bearer characterisation is continuing for high information rate data circuits to be provided in conjunction with specialised data networks.

Short haul digital radio systems are of interest and some interesting network applications are foreseen. Experiments are presently being conducted and more are planned. Typical systems derive 480 telephone channels and operate in the 13 and 15 GHz band.

The use of optical fibre transmission in the network, both for provision of telephony circuits and for short haul TV purposes, is being carefully studied and field experiments, described elsewhere, are in progress and are being planned.

TRANSMISSION MEASUREMENTS IN THE SWITCHED TELEPHONE NETWORK

The Research Laboratories are assisting the Headquarters Engineering Planning Branch with a study of the transmission and stability performance of switched telephone connections. The purpose of the study is the facilitate planning for reduced speech attenuation and improved stability of amplified circuits. Only then can the full advantage of PCM links and exchanges be realised in a mixed PCM and analogue network.

The parameters of circuits in the two-wire switched network are particularly important. Since insufficient data is available, a field survey is being conducted in country and metropolitan areas in several States. This requires division of routes in the two-wire switched network into suitable sections and a thorough measurement of samples of these sections. Four-wire and carrier-derived circuits are included in the survey.

The survey method measures the reflection co-efficient at one end of each section while sets of known terminations are connected to the other end, which is often some distance away. The complex reflection co-efficients of both ends of the section, and its transmission co-efficients, are calculated from these measurements and placed on central computer files. A very large number of complete connections can then be simulated in that computer. This will permit the evaluation of proposed impedance simulation and compensating networks, and techniques for circuit adjustment, at far less cost than by further field trials.

The Research Laboratories designed and supplied the measuring bridges for the survey and programmed the computer which controls all of the measuring equipment and calculates the circuit co-efficients.

The bridges contain electronically simulated high inductance line feeding coils, and transformerless impedance bridges capable of accurate measurements over a wide frequency range. Automatic controls are used to overcome problems associated with circuit drop out and surge current.

CROSSTALK NOISE PERFORMANCE OF PCM REGENERATORS

PCM line systems, providing 30 voice circuits over two cable pairs, are being installed on inter-exchange junction cables in most states of Australia at present. Approximately 12% of pairs in a cable are intended for PCM use. PCM regenerators, which reconstruct the transmitted signal, are required to overcome cable loss and are installed about every 1.5-2 km. Thus, the cost of PCM installations is minimised by maximising the regenerator section lengths, because fewer regenerators are then required to span the intended PCM routes.

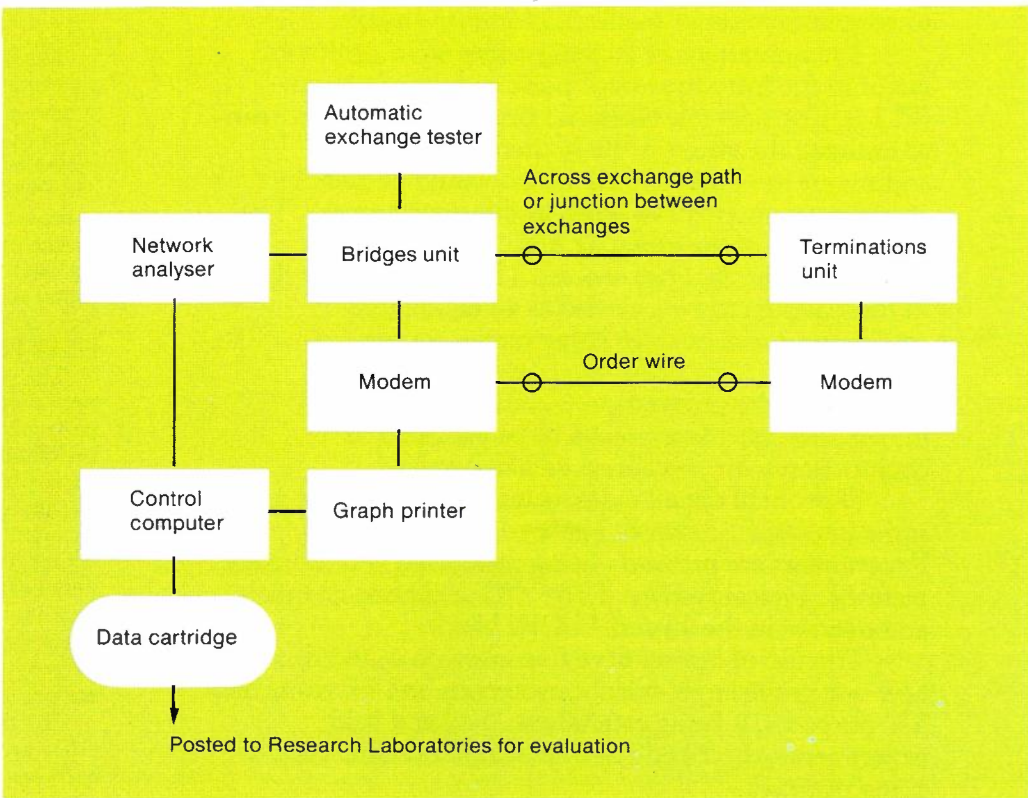
The performance of a PCM line system depends on the line error rate, and this is primarily determined by the effectiveness of the regenerator equaliser, which has a two-fold purpose, namely:

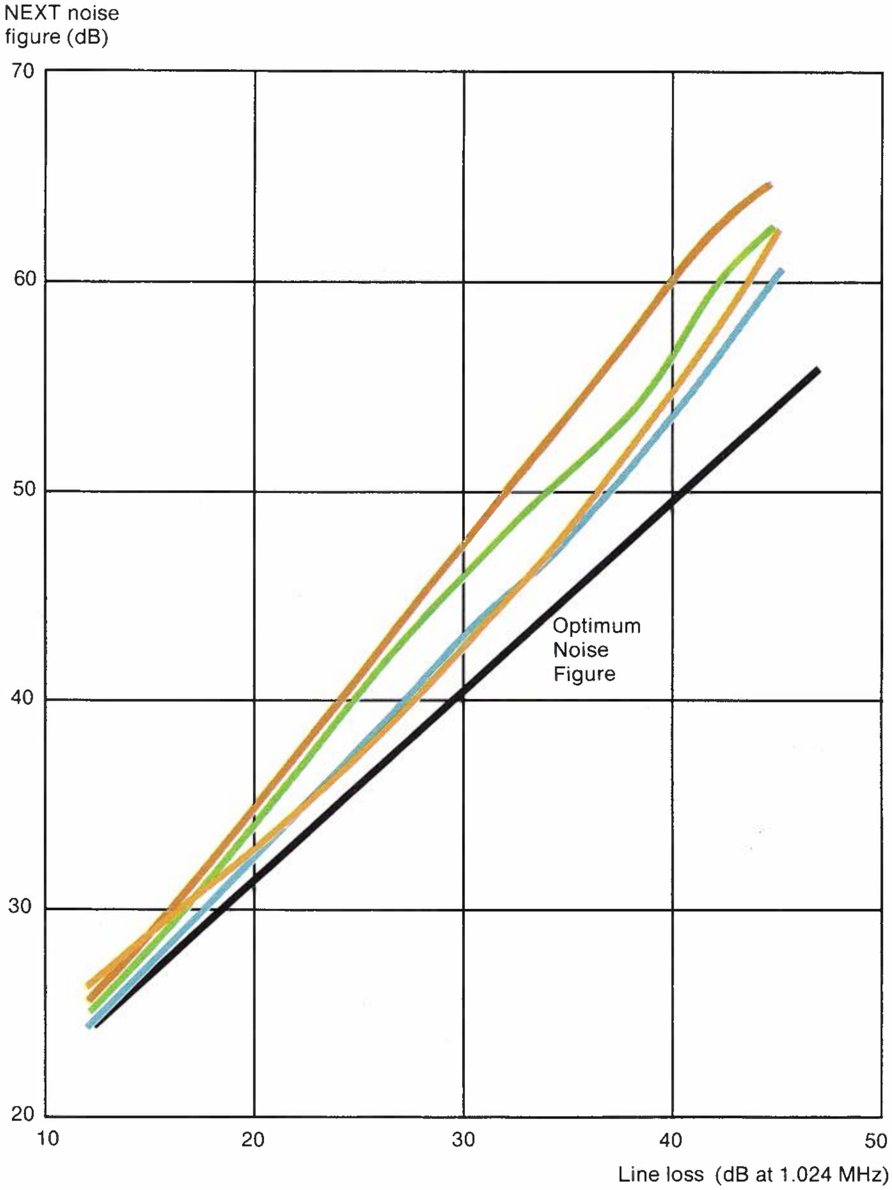
- the reduction of interference between transmitted pulses (inter-symbol interference) caused by the imperfect transmission of the cable pair, and
- the limitation of the amplification of crosstalk noise arising from other PCM line systems installed under the same cable sheath.

These requirements are conflicting; limitation of noise amplification by reducing the equaliser bandwidth usually means increasing inter-symbol interference, which degrades the error rate. Regenerators which achieve the optimum balance between these two requirements will minimise the cost of PCM by allowing maximum regenerator section lengths.

An objective measure of the balance between noise and inter-symbol interference, termed "regenerator crosstalk noise figure", has been defined and a method for its measurement is the subject of Australian Patent Application No. PD6790/78. The method consists of simulating crosstalk interference in a hypothetical cable of zero crosstalk loss and feeding this into a regnerator

Schematic diagram shows method of measuring circuit parameters on switched network sections





Regenerator crosstalk noise figure for various regenerators. Error rate : 10^{-6}

through an attenuator. The value of the attenuation required for a specified error rate of say, 10^{-7} is the crosstalk noise figure, and this is simply related to the minimum acceptable cable crosstalk loss. Also, theoretical work has shown the existence of an optimum (that is, minimum) regenerator crosstalk noise figure.

This new measurement technique enables commercial regenerators to be assessed relative to each other, and absolutely against the "best possible" regenerator. The graph shows the optimum regenerator crosstalk noise figure together with those measured on several different commercial regenerators submitted to the Research Laboratories.

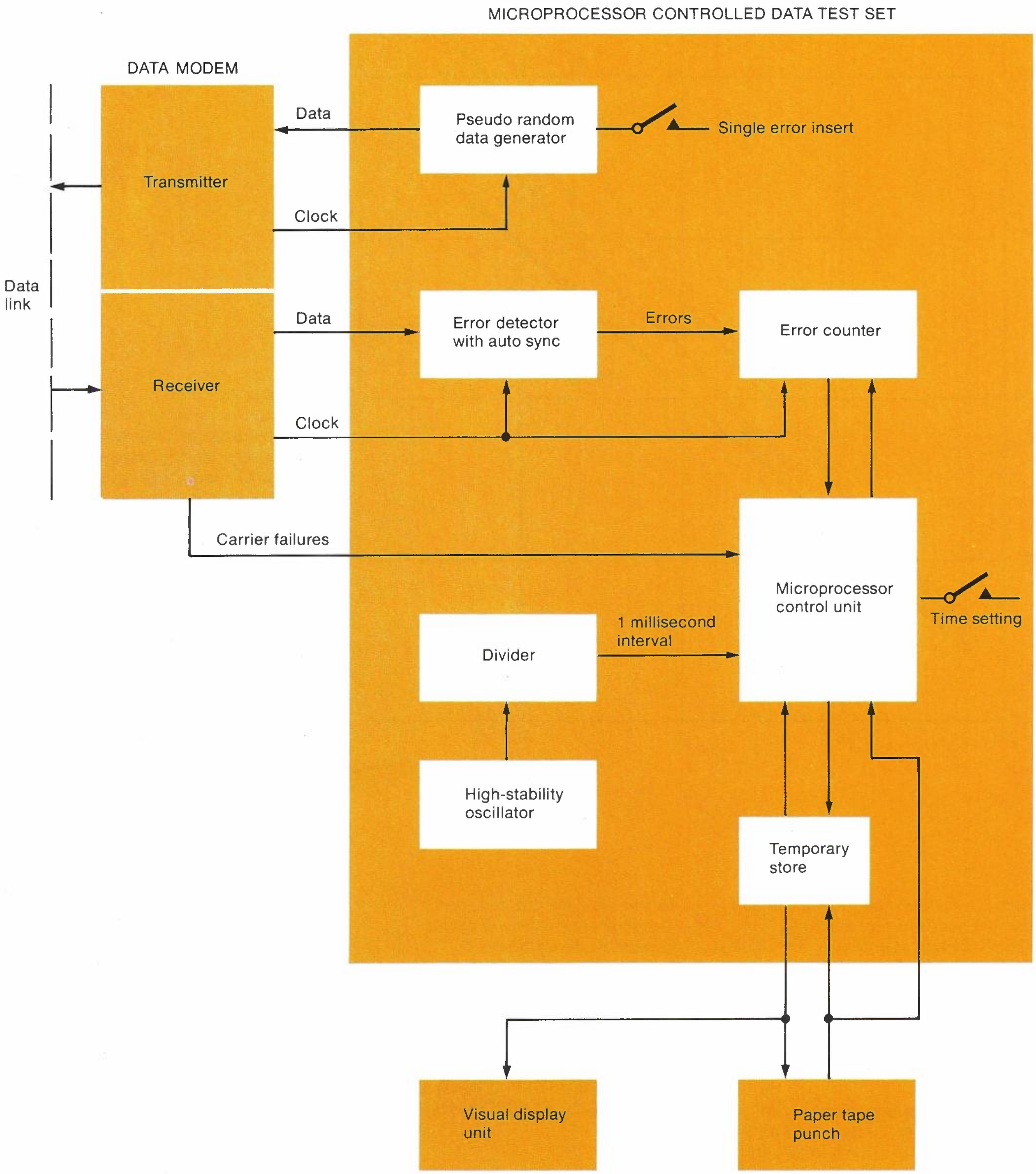
THE DESIGN OF BALANCE NETWORKS FOR TERMINATING SETS IN LOCAL EXCHANGES

The balance network in a terminating set is designed to be a good impedance match to the two-wire line and thereby achieves a high isolation between the "return" and "go" pairs of the four-wire circuit. When terminating sets are used in local exchanges (that is, on subscribers' circuits), the impedance of the terminating set balance network should ideally provide a good match to the impedance of all subscriber's circuits. However, in practice, this is difficult to achieve, since the impedance of subscribers' circuits varies with the feed current, the length of the subscriber's circuit, and the variable components in the subscriber's telephone instrument.

One approach to the design of terminating set balance networks has been to consider only the average length subscriber's circuit, ignoring the extremes of the very short ('zero') and the very long ('limit'). This approach results in a poor performance for the short length subscriber's circuits, in that the isolation between the "return" and "go" pairs is as low as 13.1 dB (6.1 dB Apparent Return Loss), and is approximately constant over the whole telephony band.

A better approach is to design the terminating set balance network so as to maximise the minimum isolation for the whole range of subscriber's circuits. This approach realises isolations of 15 dB at the low frequency end of the band and 19 dB at the high frequency end of the band. The increase from 13.1 dB to 19 dB at the high frequency end of the band is considered well worth while.

There is no possibility of significantly improving these results



Block diagram of data test arrangement unless adaptive terminating sets are used, or the impedance of subscriber's circuits is modified in some way.

Investigations into build-out networks - networks used to modify the impedance of subscriber's circuits - shows that the isolation between the four-wire circuits can be increased to 21 dB at the low frequency end of the band and 19 dB at the high frequency end of the band simply by building out all short subscriber's circuits so that their electrical length is not less than the average length subscriber's circuit. Such a build-out network could be included in the telephone socket at the subscriber's premises and strapped in at installation.

Early work on adaptive terminating sets indicates that isolations of about 25 dB can be achieved by allowing only one component in the balance network to vary. A number of techniques for controlling this variable component are under investigation.

TRANSMISSION PERFORMANCE MEASUREMENTS OF DATA CIRCUITS

As part of an investigation into the performance of data links which may be used in the proposed Telecom Australia Digital Data Network (DDN), tests are being conducted on selected inter-capital groupband (48 kHz) data circuits. As the transmission quality of some microwave radio bearers is dependent on the prevailing weather conditions, long-term measurements over some routes are necessary to allow for seasonal patterns. Furthermore, it is desired to gauge the transmission performance of various data links and compare these with the proposed DDN error and availability performance objectives.

In order to carry out the study, the Research Laboratories have designed and constructed a microprocessor-controlled data test set suitable for long or short term measurements. With suitable interfaces, the test unit is designed to allow operation at all data rates up to 2.048 Mbit/s. All measurements are performed in real time, time of day information being provided by a clock driven by a high-stability oscillator. The measured transmission characteristics are recorded on punched paper tape, with on-line monitoring of the recorded data provided on a visual display unit.

The following transmission parameters are presently measured:

- the distribution of the bit error count for each error-second within 15-minute measurement intervals,
- the distribution of error-free-second runs within the 15-minute intervals above,
- the start and finish times (to the nearest millisecond) in real time of any carrier failures detected by the receive data modem,
- the start and finish times (to the nearest second) in real time of any events of 10 or more consecutive error-seconds. These are defined as outages.

The recorded performance data is subsequently analysed on the Telecom Australia Computer Network and the results are summarised on a weekly basis. Any periods of time during which no measurement was made or the recorded data is invalid are ignored. The genuine outages as defined earlier then constitute transmission unavailability. The remaining time or available time is divided into error-free seconds and error-seconds. From the latter information, the percentage of error-free seconds is evaluated for the various time intervals of interest for example, 15 minutes, 1 hour, 1 day. The measured transmission performance of the tested data links can thus be compared against the proposed objectives. In addition, the distributions of bit error counts and error-free-second runs can provide some insight in the error causing mechanisms on various bearers.

As the data test set is microprocessor-controlled, its capability can be readily enhanced to allow monitoring of certain other transmission characteristics. For example, the inclusion of bearer alarms is being investigated. This information is expected to yield useful information such as identification of bearer sections that consistently suffer transmission impairments. In addition, owing to the complexity of the test unit and the importance of long-term measurements, a periodic self-checking facility is being studied. A cassette/floppy disc recorder is being provided in place of the paper tape punch.

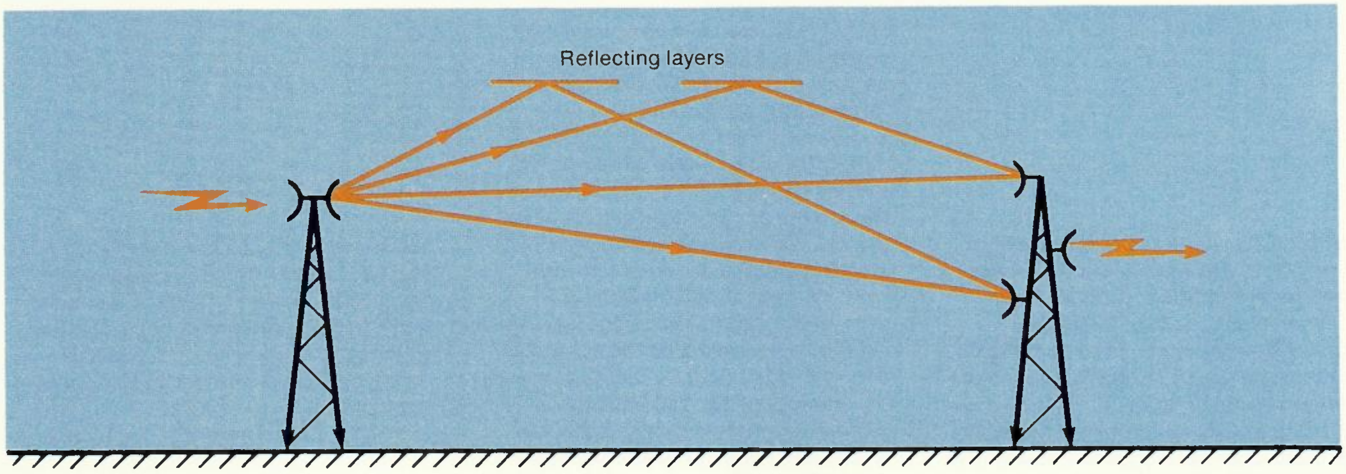
SPACE DIVERSITY FOR DATA TRANSMISSION AT 2 MBIT/S OVER RADIO BEARERS

Microwave radio systems form the dominant method of carrying telecommunications traffic between the major cities in the Australian network. The major part of this traffic comprises telephony and television signals, but a small and rapidly growing part of this traffic is data for transmission between computers.

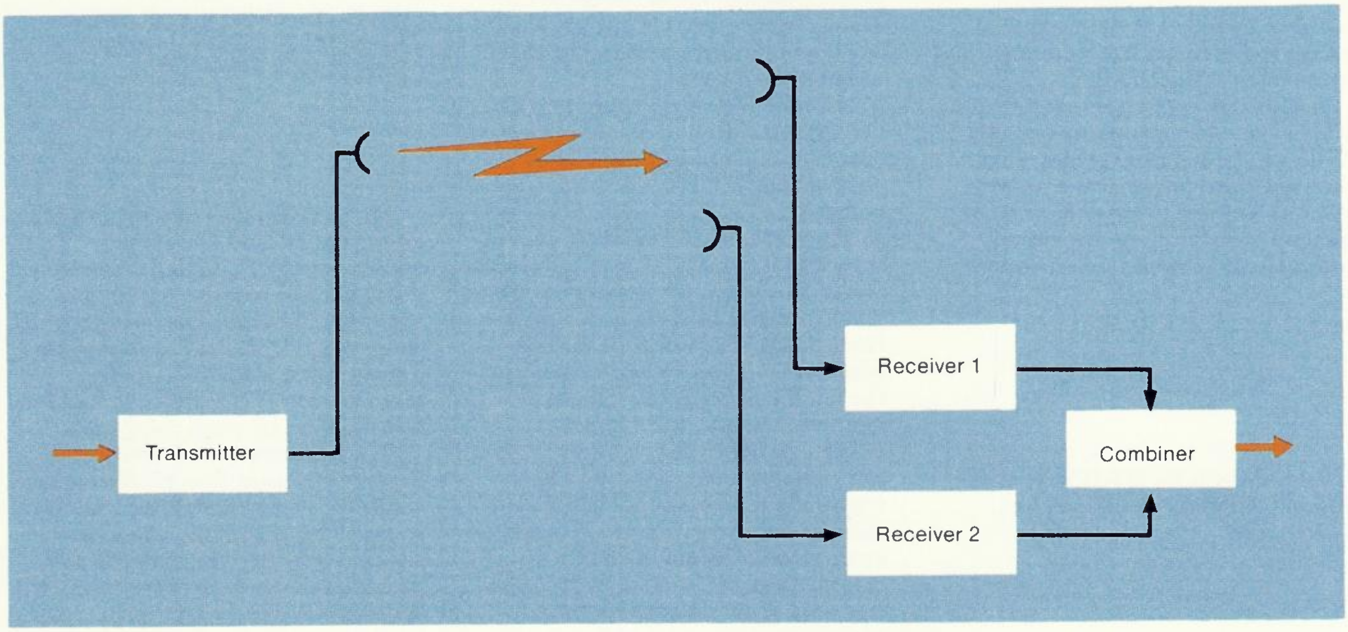
The transmission of data signals demands transmission performance characteristics which differ from those required for telephony and video signals, for which the network was primarily designed. In particular, radio systems produce variations in signal level due to "fading" during certain meteorological conditions and these variations are of particular concern in data transmission.

The Research Laboratories are collaborating with the Headquarters Engineering Department in the conduct of tests on various radio systems to investigate the effects of fading on data transmission. Tests on one hop of a system have shown that data errors are strongly correlated with signal fades. For such "problem" hops of a system, a technique known as "space diversity" may be used. This technique uses two separate receiving antennas to derive a combined signal ("combining diversity") or only the larger of the two received signals ("switching diversity").

The need to examine the effects of



Hop with space diversity



Combining space diversity

such diversity techniques on the quality of data transmissions has been increased with the proposal to introduce a Digital Data Network (DDN). The DDN will multiplex low speed data streams into one 2.048 Mbit/s data stream for transmission over the trunk network. Switching diversity, while adequate for low speed data transmission, does not necessarily overcome fading effects adequately for 2.048 Mbit/s data streams. Thus, the "combining diversity" technique is being evaluated for potential future use.

Test transmissions of 2.048 Mbit/s data are being evaluated over one hop of a system to assess the improvement of combining diversity over switching diversity and no diversity. Preliminary results indicate that combining diversity offers a 40:1 improvement over no diversity in the number of error seconds during severe fading. Switching diversity, while adequate for lower data rates, does not offer the same degree of improvement for 2.048 Mbit/s data transmission.

So far, the test measurements have provided much needed experimental data and a better understanding of high speed data transmission performance of the network. This information will assist the design of future trunk radio systems and determine the need to upgrade present systems to provide reliable data transmission for Telecom's customers in the Digital Data Network.

SWITCHING AND SIGNALLING

Recent developments in semiconductor technology and signal processing techniques are now producing quite significant changes in approaches to switching and signalling equipment and networks. Manufacturers are exploiting the economic and functional advantages of these new devices. The resulting systems have new characteristics, features and properties, which are in turn attractive to those developing telecommunication networks. These developments require detailed study to ensure that optimum usage of the new systems and techniques can be obtained.

The fields under investigation in the Laboratories include studies of digital switching systems and their integration into existing networks, applications of common channel signalling in both trunk and local networks, device technology and software engineering. Lately, studies concerning operational and maintenance techniques having relevance to digital networks have been commenced.

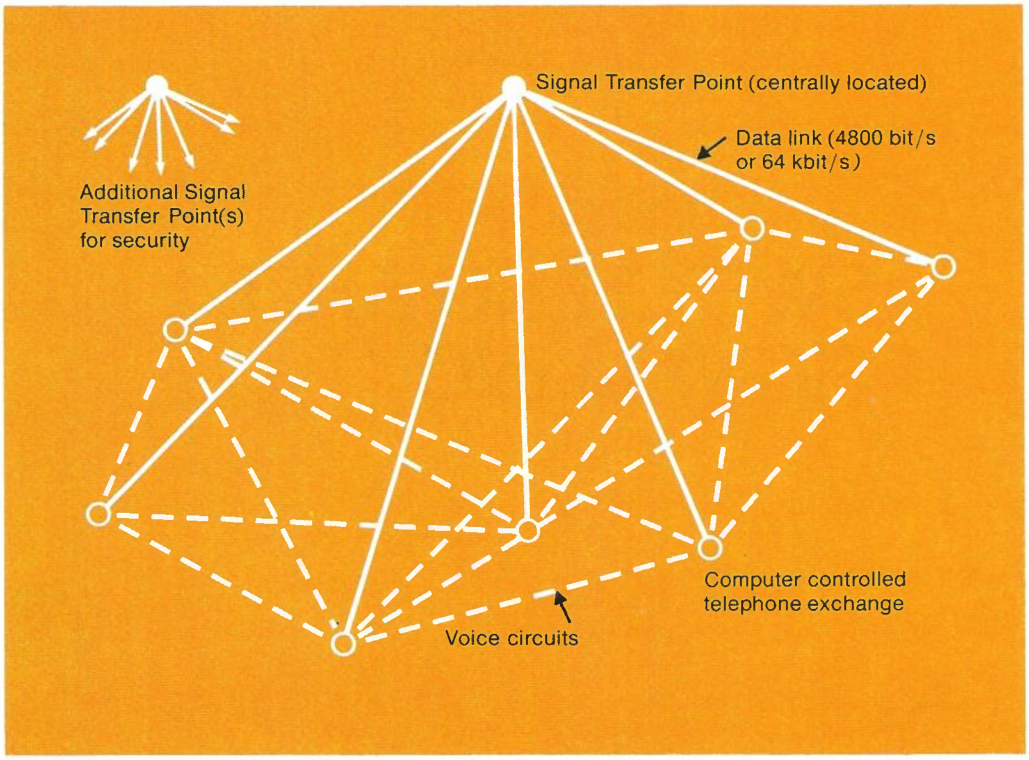
These investigations are leading towards a better understanding of new technologies and their application and hence the development of application principles and design rules to assist Telecom to plan and develop its switching networks.

SIMPLIFICATION OF CIRCUIT DESIGN BY USING PROGRAMMABLE LOGIC

Digital logic is becoming increasingly important in the design and construction of electronic switching equipment. In order to evaluate the many new developments in circuit design, a thorough understanding of component characteristics is required. Research Laboratories' activities in this area include the investigation of means for simplifying the design of digital logic circuits without sacrificing system performance.

Programmable logic devices provide a new commercially developed approach to the design of logic circuits. Unlike earlier logic devices, the function of a programmable logic device is determined by the user. Different configurations of the same programmable device can provide a wide range of logic functions and significantly reduce the number and diversity of components required for a system. Considerable improvements in equipment cost and performance can arise from the use of programmable logic.

A recent Laboratories' survey of available programmable logic devices has revealed a wide range of performance and complexities. The devices range from simple collections of gates through to large arrays requiring the use of computer aided design procedures. A practical assessment of programmable devices is in hand to define their potential for application



Possible form of a common channel signalling network

within Telecom. The investigations include the determination of special documentation and test procedures for the maintenance of equipment incorporating programmable logic.

Programmable logic is emerging as a powerful tool in the design of electronic circuits and its impact will be seen increasingly in the design of new and improved equipment. The results of this investigation will provide a basis for assessing the long term value of this new technique and provide guidelines for its use in Telecom.

COMMON CHANNEL SIGNALLING NETWORKS

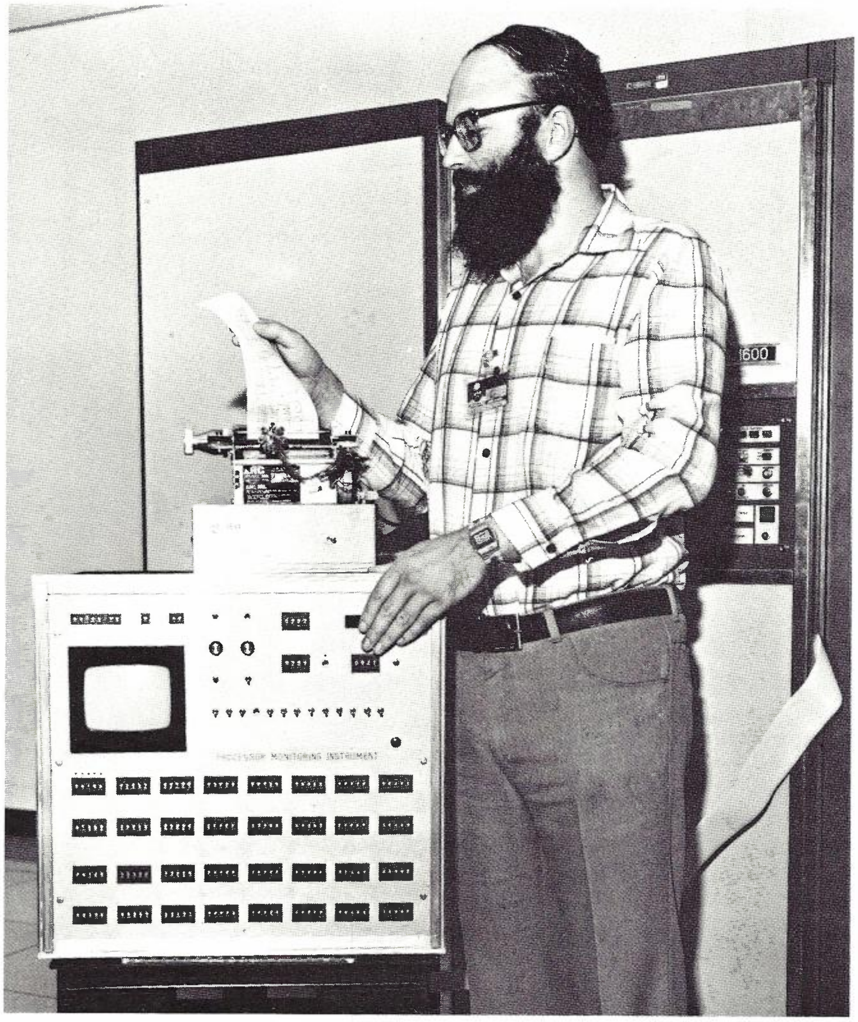
A variety of control signals are sent between telephone exchanges in order to set up and disconnect telephone calls. These signals are presently transmitted over voice circuits between exchanges. This approach requires expensive equipment to be connected to each circuit to both send and receive the signal information. With computer controlled exchanges, the individual circuit equipment can be eliminated and signalling information sent over a data channel connecting the processors of the two exchanges. As the data channel between exchanges can be shared by a large number of calls, this signalling method is known as Common Channel Signalling (CCS). The use of CCS equipment rather than individual signalling circuits results in significant cost savings, as well as reduced call establishment times and an increase in the range of signals possible.

The introduction of the LM Ericsson AXE computer controlled exchange system into the Australian network in the 1980s will allow the use of CCS. To prepare for its use, a number of factors influencing its introduction are being investigated, including:

- the operation of CCS networks,
- the cost and reliability of networks of various complexity,
- the requirements for interworking with the existing telephone network,
- introduction strategies.

Numerous network arrangements are feasible. A single CCS data link has sufficient capacity to carry all the telephone signalling requirements of an exchange. Signal Transfer Points (STP) with links to all exchanges and other STPs can be used to route signals economically to any required destination. A network of data links and STPs can provide an extensive and reliable signalling network, with low growth costs.

The reliability of the signalling network is of prime importance, as without its continuing operation, no calls can be set up or cleared. Factors that determine reliability include data link security, STP reliability and network configuration. For example, reliability can be greatly increased by the use of duplicated signalling links over geographically separated paths at the cost of increasing network complexity. Computer methods are necessary to calculate the reliability of CCS networks in order to take account of the complex paths by which a signalling message can reach its destinations. Such methods are being developed as part of the investigations which are in hand in the Laboratories.



A Research Laboratories' staff member demonstrates PMIs data logging capability with miniature line printer

MONITORING PROCESSOR PERFORMANCE IN STORED PROGRAM CONTROLLED EXCHANGES

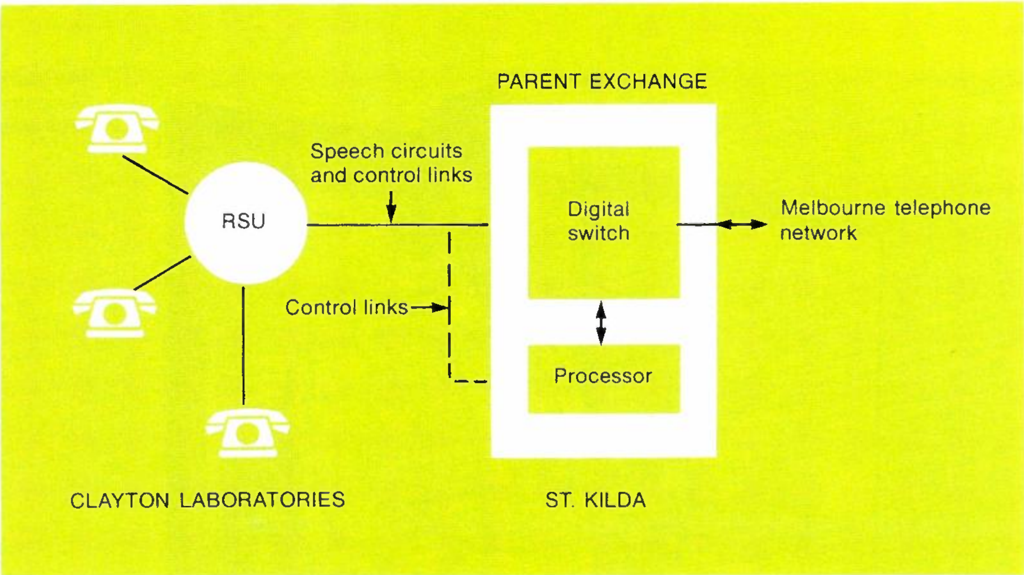
The monitoring of stored program controlled (SPC) telephone exchange software operation is a valuable aid in improving the traffic-handling efficiency of the exchange and in deducing its ultimate capacity limits. This monitoring task may be attempted within the SPC system itself by modifying its software, but at the expense of valuable processor traffic-handling capability, an expense which usually is not permissible. Consequently, there is great advantage in using an independent hardware monitoring system, especially if the monitoring can take place without any changes being made to the normal operation of the SPC exchange.

Within Telecom Australia, a need for a new instrument arose from a desire to monitor the performance of large SPC exchanges, in particular the 10C Trunk Exchanges. The most important type of measurement to be made is that of "processor loading". This may take the form of counts of different classes of calls handled, or the frequency with which particular call record buffers are used, or the processing time occupied by particular program sequences - all of which may need to be measured simultaneously. Measurements to aid system debugging, or measurements of processing times and frequencies to provide input data for traffic engineering or other planning studies, may also be needed.

The Processor Monitoring Instrument (PMI) was therefore developed in the Laboratories to monitor up to 32 selected computer memory addresses. Combinations of these addresses are used to indicate the process being performed. Fourteen processes may be simultaneously counted or timed over a preset measurement period. By presetting start and stop times, the PMIs own real-time clock permits measurements to be made automatically, without the operator needing to be present.

The measured data is processed by a built-in microcomputer giving instantaneous results, in either numerical or bar chart form, on a miniature TV screen. A hard copy of results may be made simultaneously via the PMIs miniature line printer.

The PMI was completed and successfully tested in January 1979. It is currently being used by staff in Telecom's National Support Centre in Melbourne where its initial application is to the performance of processor loading measurements on a model 10C exchange.



Experimental remote switching unit and digital local exchange network

LINK SECURITY IN REMOTE SWITCHING UNITS

Processor controlled exchanges can readily and economically control switching stages in locations which are remote from the processor. Control information is exchanged between the Remote Switching Unit (RSU) and the parent exchange via a telecommunications link. High security of the control link is a necessary feature in the reliable operation of the RSU.

An RSU, designed and built in the Laboratories, was commissioned in December 1978, at the Clayton Laboratories. The unit is controlled by a processor located 16 km away at the parent digital exchange at St. Kilda. Speech and signalling information is carried over two 30-channel PCM transmission systems in which time slot 16 of each system is used to provide duplicated 64 kbit/s channels over which control information is exchanged between the RSU and the parent exchange.

The security of the control link is maintained by duplicating the signalling channel and the associated high level scanner-drivers at each end, and by providing automatic change over between links and duplicated devices in the event of faults. Extensive error detection techniques are used to check the validity of the signals interchanged between the RSU and the parent exchange. For example, in one segment of operation a 16-bit cyclic redundancy code is applied to control messages. Basically, every message sent has a check character added as the last word. This is compared by the receiving equipment with another character generated from the message information content. If the characters do not match, the message is considered to have been corrupted and retransmission is requested. Correct messages are acknowledged as part of the protocol.

The RSU also transmits fault and alarm conditions, for example, power supply voltage conditions, PCM alarms, card absent alarms, etc., over the control link. The fault-group facilities provide information for maintenance personnel in testing and fault diagnosis activities, as well as for control of a particular link.

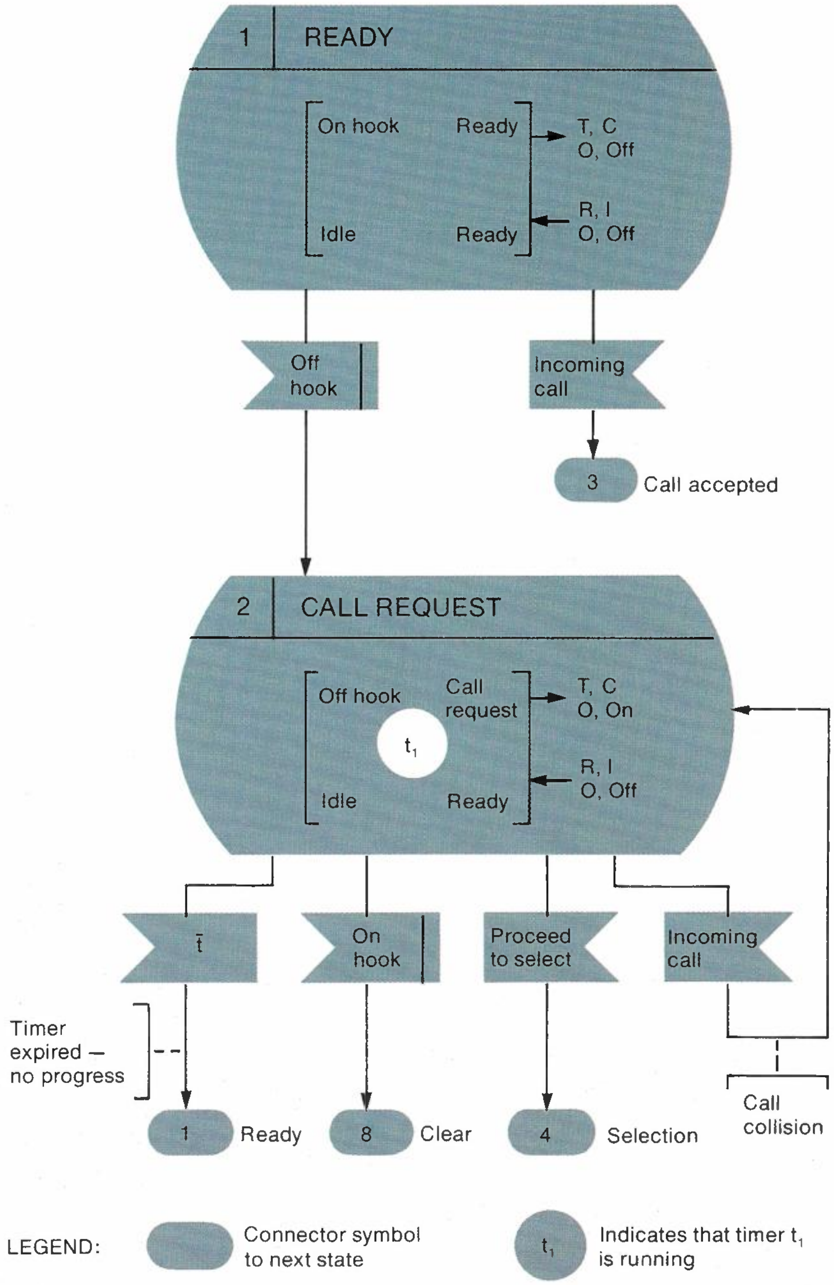
The RSU carries live telephone traffic in order to verify reliability calculations and the effectiveness of the design strategy adopted in providing the link facilities. The resulting operational and maintenance experience will enable the requirements to provide control link security for remote switching units in a telecommunications network to be better understood.

STATE MACHINE DESIGN TECHNIQUES

The "State Machine" approach is a systematic and precise way of describing a digital system - including digital telecommunicating systems. In general, the behaviour of a system depends on the state it is in at the time of examination; hence, the name "State Machine Design". State machines are divided into five classes, according to their complexity.

A State Machine Design starts with a formalised system specification. From this specification, a functional partitioning of tasks is prepared. A "black box" (or module) is then assigned to accomplish each desired task, and the behaviour of each module is precisely specified. The final stage is to design each module.

Current investigations being carried out in the Laboratories include the identification of new, complex integrated circuit devices suitable for simplifying the implementation of State Machine designs. The investigations are intended to lead to the development of design procedures for the various classes of State Machines, and to guidelines for the selection of suitable integrated circuits for use in conjunction with these design procedures. The ultimate aim of this work is to assist Telecom's designers to implement functional circuitry using the most appropriate techniques and devices.



Section of the Call State Transition diagram for the X21 protocol study

PROTOCOLS FOR CIRCUIT SWITCHING DATA NETWORKS

Public switched data networks use complex procedures called protocols which set up and govern the transfer of information through the network. A detailed understanding of protocol behaviour is essential for specification and design of data switching systems. Data protocols are defined internationally by CCITT series 'X' recommendations. Development of these protocols is proceeding rapidly and the Laboratories have commenced a series of studies aimed at exploring their use and implications.

One of the CCITT recommendations, X21, defines the interface conditions for connecting Data Terminal Equipment (DTE) to a public data network. The recommendation outlines the possible sequences of interface events brought about by the interaction of the two separate systems, the DTE and the network. The X21 recommendations are complex and it is necessary to understand the network implications and behaviour involved. The graphical Specification and Description Language (SDL) developed within the CCITT for voice switching applications was adapted within the Laboratories to deal with this complexity. This form of representation is independent of the means used to implement the system.

A set of Call State Transition Diagrams (CSTD) using SDL were drawn in the Laboratories to show the complete protocol for X21 interface conditions. These documents specify the connection of a call between two DTE equipments.

Because no commercial equipment is presently available using the X21 protocol, a data terminal equipment model was constructed in the Laboratories. The SDL method described above facilitated the design of the model. Experimental studies of the model's performance have increased the practical understanding of the X21 operation. This method will also be used to study other new data protocols.

The detailed understanding of signalling protocol is necessary for the purposes of specifying, designing and testing switched data networks. The outcome of laboratory studies of this nature can assist Telecom in formulating specification and selective criteria for future systems.

INSTRUMENTATION DEVELOPMENT AND CALIBRATION

The successful pursuit of the various projects and investigations undertaken within the Research Laboratories is largely dependent upon the sophisticated instrumentation used to control, measure and process experimental data. Where possible, such instrumentation is obtained from commercial sources and some $1.4 million was spent in this way during 1978/79.

However, it is often necessary to adapt or develop instruments or systems to perform special measurements, and many of the Laboratories' sections make unique contributions to improved instrumentation. This expertise is often channelled towards special development projects performed for other departments of Telecom Australia and the first three articles in this section describe a selection of these activities.

A further responsibility of the Research Laboratories is to develop techniques for the precise calibration of measuring instruments and to ensure that all measurements are traceable to the appropriate reference standard. An important and continuing study is the identification of those factors which influence measurement error and the final article in this section describes some of the work being done in this field.

IN-BUILT SUBSCRIBER'S METER PULSE RECORDER

In the interests of giving its customers greater satisfaction, Telecom Australia has been examining alternative ways by which a telephone subscriber might have available in his own home an indication of his call meter registrations and hence, an indication of his call charges.

One means of achieving this is already marketed by Telecom in the form of the Private Telephone Meter Type 2, a relay-operated stand-alone unit.

The Research Laboratories have recently designed a further two alternative means of providing these recording facilities to the telephone subscriber. The work was undertaken at the request of the Headquarters Customer Services Department, which intends to use the prototyped designs as market research tools to assess customer acceptance and to gauge the market potential of these innovations.

The Research-designed recorders use all-electronic circuit modules which draw their power over the telephone line from the exchange battery. The modules have the advantage that they can be integrated into the telephone instrument, providing a more aesthetically pleasing and convenient alternative to the existing electro-mechanical device. Both new designs also offer a greater variety of facilities than the Private Telephone Meter Type 2.

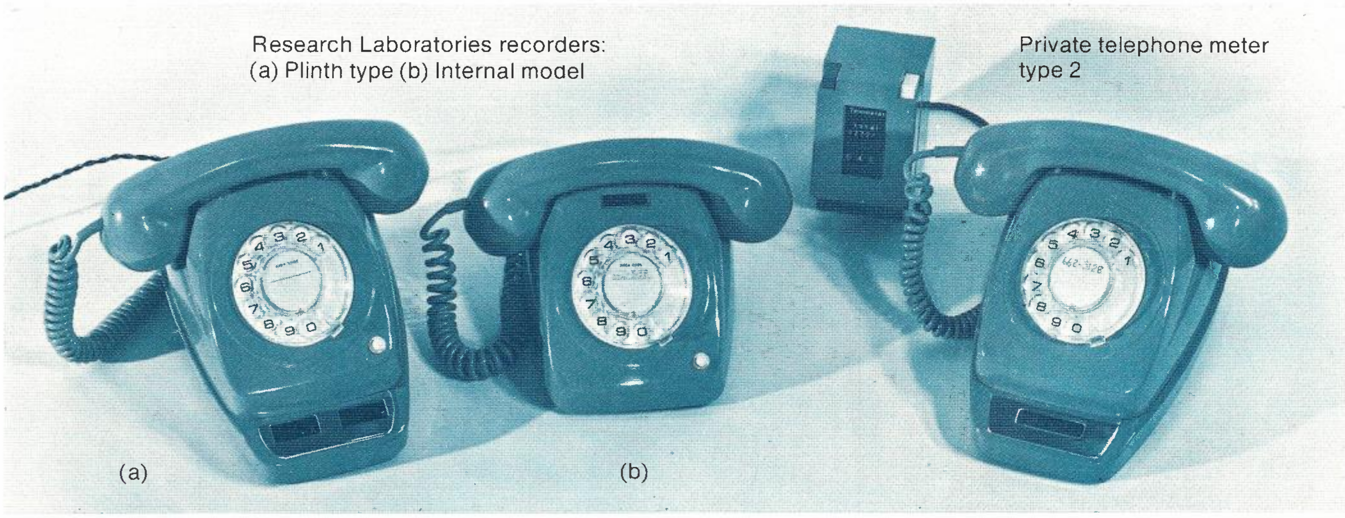
The first of these recorders fits within the normal 800 type telephone case. Its digital display is located between the dial and the handset cradle.

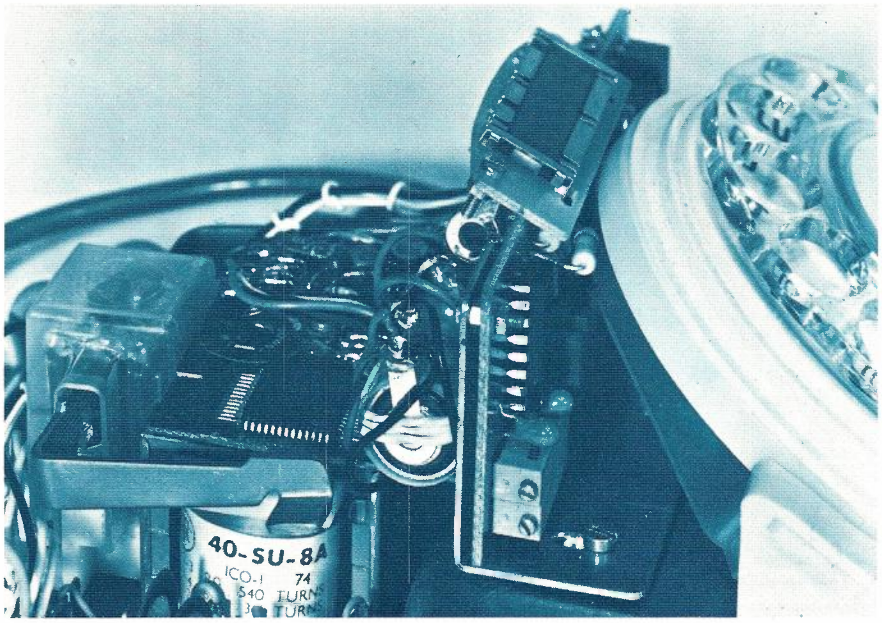
This recorder can be configured to provide either of the following facilities:

- With internal reset (inaccessible to subscriber), to indicate the accumulated total of meter pulse registrations only.
- With external reset (accessible to subscriber), to indicate the registrations for a given period of time, for example, for the duration of a single STD (trunk) call or over a fixed number of days of telephone usage.

The second model has been built into a low profile plinth under an 800 series telephone. This unit has been designed to be reset internally and to provide call registration information in the following sequence for each call made by the subscriber:

- When the handset is lifted, the unit displays the grand total of registrations at that time.
- After being connected to the called party, the display will clear back to unity on the first meter pulse and continue registering if the call is an





Case removed from standard 800 type telephone to show circuit modules of meter pulse recorder (integrated circuit at lower left of centre; light emitting diode display above dial)

STD call and multi-metering occurs.

- After the handset is replaced, the internal logic causes the total registrations for the last call to be added to the accumulated total. However, the specific registration for the last call remains in the display, until the handset is lifted again at which time the up-dated grand total registrations appears and the last call reading is lost.

These two units have been operating in a field situation successfully for about two years.

PHOTOGRAPHIC TECHNIQUE FOR CALL METER READING

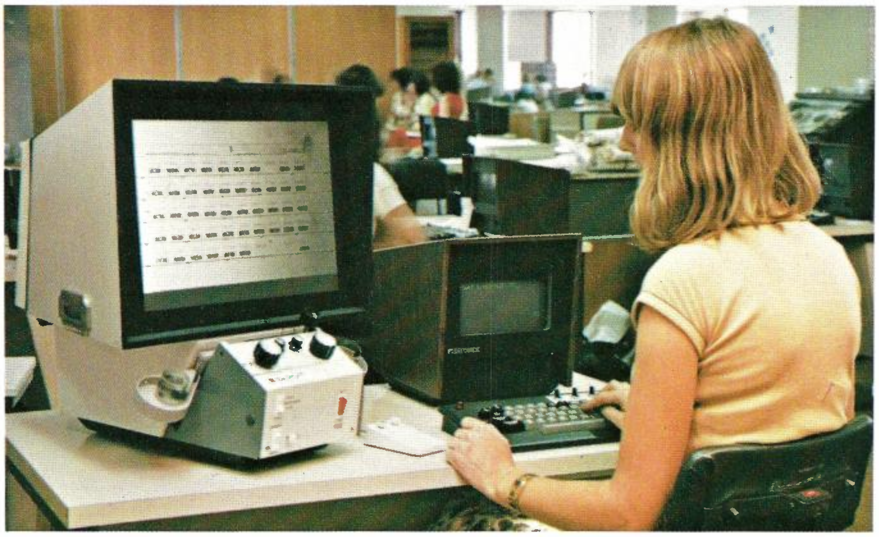
In Telecom's telephone billing process, large numbers of readings registered by elecro-mechanical call meters located in telephone exchanges must be recorded and the data transferred into computer files for subsequent automated processing and billing of the customer. Some State Administrations of Telecom Australia have been examining the use of photographic techniques to record meter readings quickly and accurately in exchanges for relay to the computerised billing centres.

Various techniques have been tried, the most recent and successful involving the recording of call meter readings on 35 mm strip film which is then transported to the billing centre. At the centre, the film is projected onto a viewer screen located near the computer keyboard terminal. The operator then reads the data from the viewer screen and keys it directly into the computer. The operator is provided with facilities to mark the particular register which is being read into the computer and also to step the film frame by frame.

A prototype system providing these facilities was developed in the Laboratories several years ago. It was based on the use of a commercially available viewer adapted to incorporate the desired operator-control facilities.

The prototype performed successfully in field trials and, after unsuccessful attempts to interest industry to undertake further development of the viewer, the Laboratories undertook the task of refining the earlier design at the request of the Headquarters Customer Services Department.

In the period since the earlier prototype had been completed, the commercial viewer had undergone restyling to such an extent that it was



Modified viewer combined with computer input terminal

now significantly different in its physical shape and style. It thus became necessary to seek another commercially available viewer and the opportunity was taken to select one which when adapted, would offer:

- A superior quality optical system.
- A larger screen.
- Simpler film loading and powered frame stepping.
- Illuminated high lighting and row identification facilities.
- Greater compatibility with the layouts of the latest computer terminal consoles in the accounting offices.

The latest prototype incorporates the above improvements over the earlier design. It provides a slightly larger than full size image of each call meter register included in the film transparency of a matrix of such registers. Uniform focussing is achieved over the total projection screen area and the operator is provided with improved film control facilities.

This latest prototype has been assessed by over 100 operators in five states and it has been enthusiastically received.

A pre-production sample of this model is now being manufactured in Telecom's Melbourne Workshops. It will incorporate some additional minor modifications to suit production methods. Consequent upon further assessments of this unit in the Laboratories and in the operational environment, larger scale production of the units is planned.

AUTOMATIC CALIBRATION OF RADIO FREQUENCY POWER METERS

Instruments used for power level measurements at radio frequency (RF) are usually operated on a different principle to the level meters used in carrier telephony work. While the latter are generally frequency selective devices similar in principle to the super-heterodyne receiver, RF power level meters are broadband devices typically operating up to 18 GHz.

The most widely used RF power meter consists of a power absorbing section known as a mount or head and an associated electronic read-out device. The calibration of the electronic instrumentation is a well established procedure and normally presents few problems. However, to fully calibrate the power meter requires a knowledge of the absolute power sensitivity of the head or mount. This is an involved process and the Research Laboratories are one of the few establishments in the country able to perform full calibrations of power meters over a wide frequency range - with accuracies directly traceable to the Australian National Standard. Calibrations are especially important with this form of meter because of the mount's fragile nature and its susceptibility to change without external sign. Calibrations must also be performed when a mount is repaired or replaced.

One of the factors which influences the accuracy of mount calibration is the variation of power indication that occurs when a mount is repeatedly connected and disconnected to the same unvarying power source. Typically, changes of 0.5% are found for mounts in good condition, which corresponds to a connector loss change of 0.02 dB. Such variations are caused by mechanical irregularities and non-uniform tightening of connectors. To gauge the extent of this effect considerable repetition is required and because each actual measurement is in itself a complex process, a semi-automatic system has been developed by the Laboratories to reduce the time for this and the complete calibration. It requires minimal operator participation and features exceptional programming flexibility.

Mounts are calibrated in terms of a "Calibration Factor" which, when applied to the power meter indication, gives the power that would be delivered to a load of the nominal system impedance.

Calibrations are always performed using extremely low reflection sources to minimise errors due to impedance mismatch. Such a highly desirable condition is seldom encountered in practice since system source impedance is rarely measured or known.

Up to 8 GHz, mounts can be calibrated to a accuracy of 0.5%, a figure approaching the "state of the art" for high frequency power measurement.

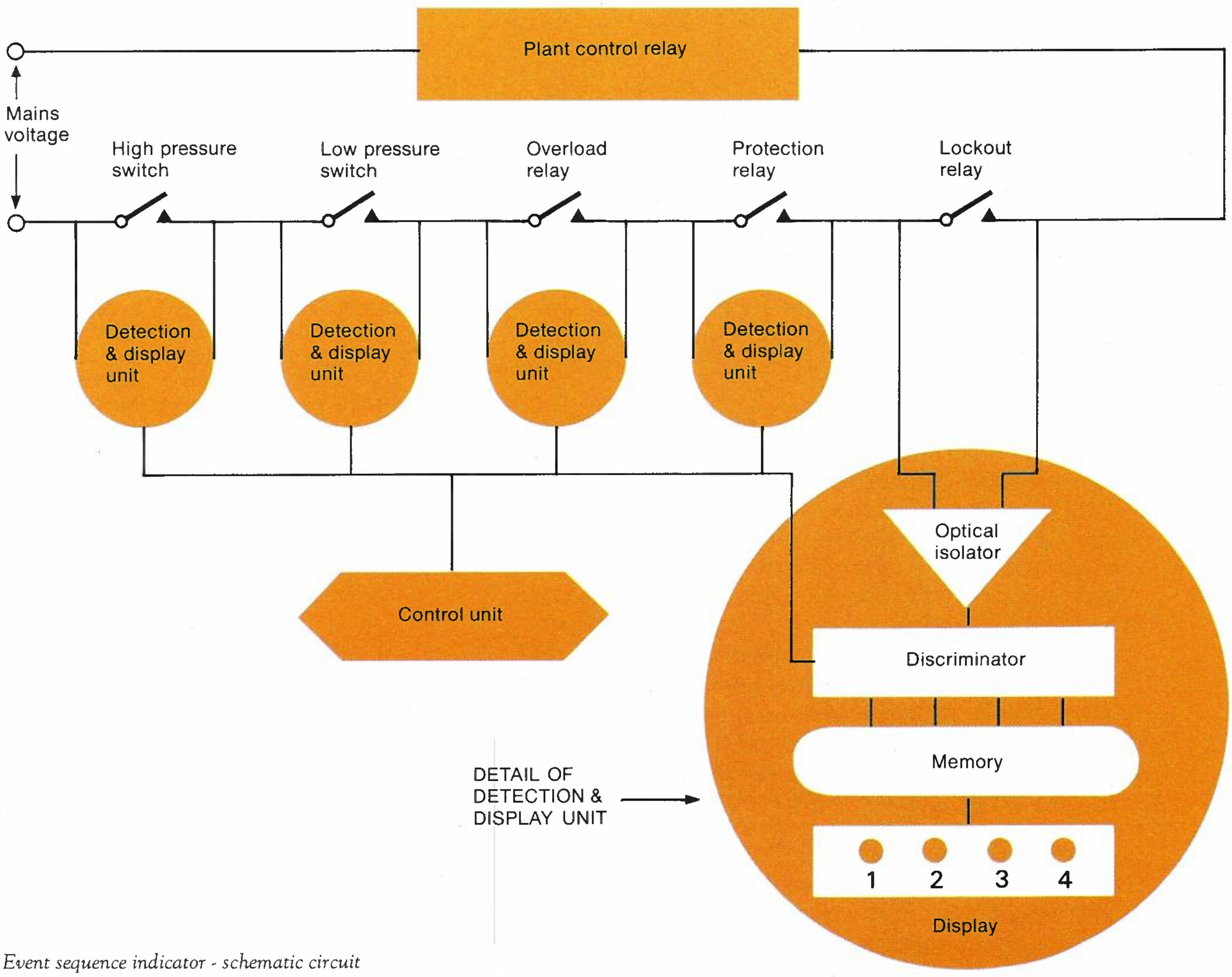
EVENT SEQUENCE INDICATOR FOR FAULT DIAGNOSIS IN CONTROL SYSTEMS

To determine the failure sequence of building services plant such as control units for air conditioning plant, the Buildings Branch of the Headquarters Engineering Department required a reliable method of recording which was the first of a number of series contacts to open when the plant automatically switched off. This record was needed because the first contact to open under such conditions generally causes several other contacts to be activated in sequence as or before the overload shut down comes into operation. As a result, it is difficult to determine the original cause of plant failure. Consequently, the Research Laboratories were asked to design and produce a prototype event sequence indicator to assist the Buildings Branch to diagnose fault events and thus to determine the possible causes of the faults.

A prototype instrument has been designed with emphasis on system flexibility, with the aim of facilitating its wider application as a monitor in the general control circuitry field.

The instrument will identify and display the first four contacts to open and the order in which this occurs. The device can be configured to monitor up to ten contacts, which may be all in series or may be in two separate groups.

The circuitry comprises two types of printed circuit boards, namely, a detection card and a control card. Each detection card monitors one set of contacts, while the control card provides the basic control and test functions for several detection cards. The detection card circuitry consists essentially of an optical isolator, memory control gates and display. The optical isolator interfaces the digital circuitry with the high voltage contacts and also provides the necessary isolation from mains voltages present across the contacts. The circuitry identifies the opening sequences and this information is stored in a memory. The information from this memory is directly coupled to a light emitting diode display on the front of the case. The information remains in the memory until manually cleared, when the display is subsequently reset by the user.



Event sequence indicator - schematic circuit

TELECOMMUNICATIONS TECHNOLOGY

Telecom Australia's ability to improve and diversify the utility of the Australian telecommunications network relies substantially on the development and application of new skills and technologies. A proportion of Telecom's R & D programme is therefore directed at projects concerned with the more fundamental sciences and technologies of telecommunications and electronics. This work ranges in application from the solution of present day problems in operational systems to the exploration of new materials, devices, signal processing concepts, etc, which may be used in future network systems.

Since only a limited number of projects can be undertaken with the resources available, projects are selected for their particular relevance to Telecom Australia's present or future operations. Projects with longer term potential are framed to provide multiple outputs in a number of application areas, and their selection is made after consideration of world trends in telecommunications technology. Whilst some projects seem primarily concerned with advanced concepts, the competence gained through their pursuit provides a body of technological expertise which can be readily turned to the efficient analysis and solution of more immediate problems arising in operational equipment in the network.

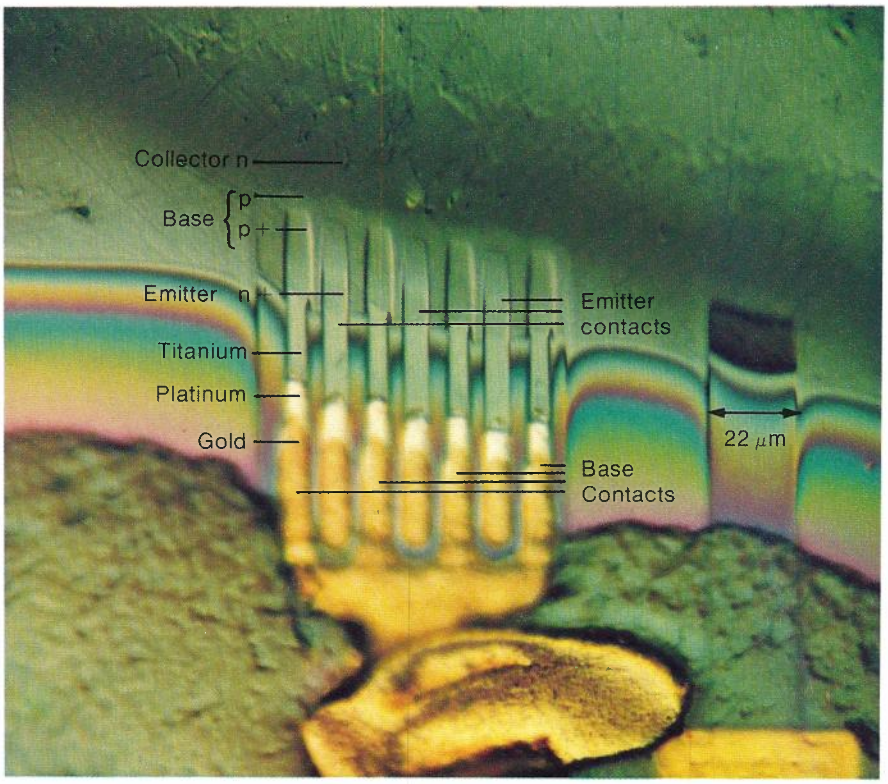
This section illustrates the range of projects concerned with telecommunications technology - as depicted by reports of work involving advanced components and techniques which have application in carrier equipment systems, automated equipment using microprocessors, microwave and optical fibre transmission systems.

TRANSISTOR FAILURE MECHANISMS

Many millions of transistors are used in both discrete and integrated circuits in the switching, signalling and line transmission equipment which makes up the Australian telecommunications network. The reliability of these transistors is thus of fundamental importance in providing a reliable service to customers, and a knowledge of failure modes in the transistors is fundamental to improving transistor reliability.

Laboratory studies to determine the causes of transistor failure were initially prompted by a high incidence of failures in the repeaters of a particular type of line transmission equipment. Located as they were in the more remote parts of Australia, the repeaters were expensive to repair and rapid corrective action was required. Subsequently, the studies were extended to provide further knowledge to assist general reliability assessments of discrete and integrated circuits.

Failure modes in transistors consist of both catastrophic failures such as short and open circuits or of gradual parameter degradation with the passage of time. In operational networks, catastrophic failures of transistors are the more serious type of failure as there is generally no indication of the impending failure, while the degradation of parameters can be noted through performance monitoring practices and timely corrective action taken. Failure mechanisms can be broadly grouped into semiconductor material related failures, semiconductor chip metallisation failures and connecting lead failures.



A high reliability silicon N-P-N transistor sectioned to reveal its internal structure

An unusual aluminium whisker growth, magnification 5000 times

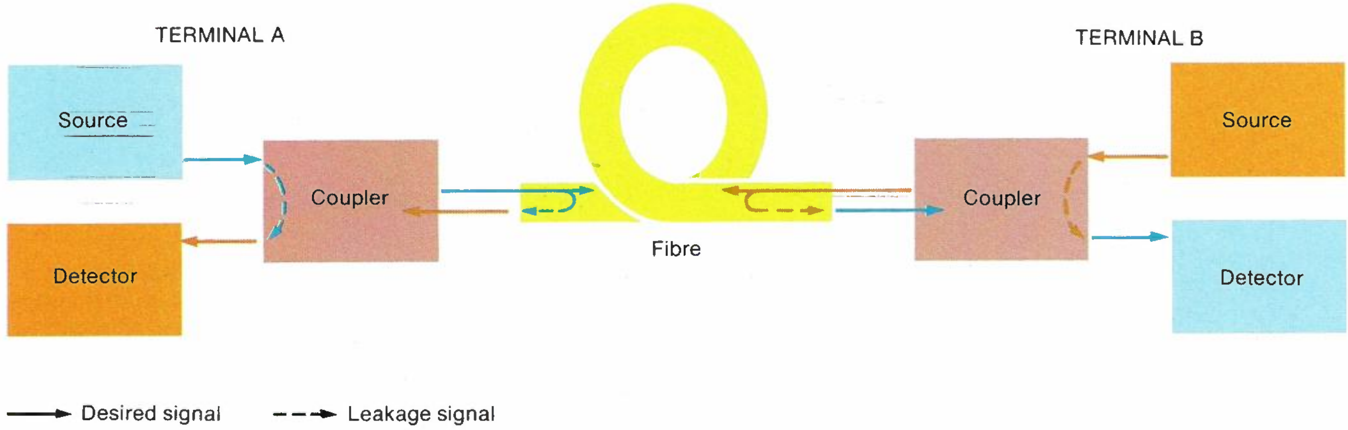
Semiconductor Material Related Failure

Transistor failures which occur in the semiconductor material usually affect parameters such as gain and leakage current. These types of failure occur in the junction regions of the transistor. In order to examine the junctions for defects, a part of the transistor must be polished away. Special etching solutions are then applied to highlight the different "p" and "n" junction regions. The width and depth of the junctions can then be easily measured and failure mechanisms determined. This type of examination can also be applied to new transistors for quality control purposes.

Semiconductor Metallisation Failure

The most widely used transistor chip metallisation is aluminium. It is easy to evaporate and adheres well to the semiconductor material, thus providing a good conduction path. However, aluminium is not very reliable as a semiconductor metallisation because it is prone to open circuit failure. For high reliability applications of transistors, layers of different metals, such as titanium and aluminium or titanium, platinum and gold, are used for the metallisation. Sometimes however, in spite of the most thorough tests being carried out, these metallisation systems can prove to be unreliable in field use. For instance, with titanium-aluminium metallisation, excessive stress can develop in the aluminium due to an intrinsic stress between the aluminium and titanium and also to field induced stress when the transistor is operating. This stress is relieved by hillock and whisker growths from the aluminium. In turn, the whiskers and hillocks can cause short circuits and thus failure of the transistor.

The information gained from these studies is being examined to assess the long term reliability of both discrete and integrated circuits used in telecommunications equipment.



A two-way optical fibre communications link

BI-DIRECTIONAL COUPLERS FOR OPTICAL FIBRES

In present-day optical fibre links, two-way communication is generally accomplished by using two separate fibres - one fibre for each direction of transmission. For many telecommunications applications, it is both practical and economically desirable to provide two-way transmission in a single optical fibre.

The main problem to overcome is crosstalk between the two counter-directional signals. In a well-designed fibre system, constructed with high-quality components, there are two major sources of crosstalk. The first is Rayleigh scattering, which describes the back-scattering of light from microscopic density and composition fluctuations in the glass fibre core material. Rayleigh scattering is an inherent optical loss mechanism and source of crosstalk and, as such, cannot be prevented. The second major source of crosstalk arises from the back-scattering of light at surface imperfections in dielectric interfaces, for example, at fibre joints and connectors. The most vulnerable components are the essential bi-directional couplers that separate the signals, from the two directions of propagation, at each terminal of the link.

Most bi-directional coupler designs demonstrated to date employ, as the coupling mechanism, the splitting of an incident optical beam into two beams of equal intensity. Semi-transparent mirrors provide the simplest implementation of this concept. Each coupler wastes 50% (or 3 dB) of the available optical power, giving a total coupling loss of 6 dB optical power for a two-way link.

Recently, the Laboratories invented an alternative bi-directional coupling technique that decreases this coupling loss and also minimises crosstalk. The coupler is formed at the end of the fibre by carefully cutting and polishing the end-face at a specified angle to the fibre axis. At this bevelled fibre face the mechanisms of refraction and total internal reflection are exploited to separate the counter-directional signals. In a two-way fibre transmission system incorporating these couplers, theory predicts a total coupling loss of less than 3 dB. Practical investigations to confirm this performance are being undertaken. An application for the grant of a patent for a coupler embodying the technique has been lodged by Telecom Australia.

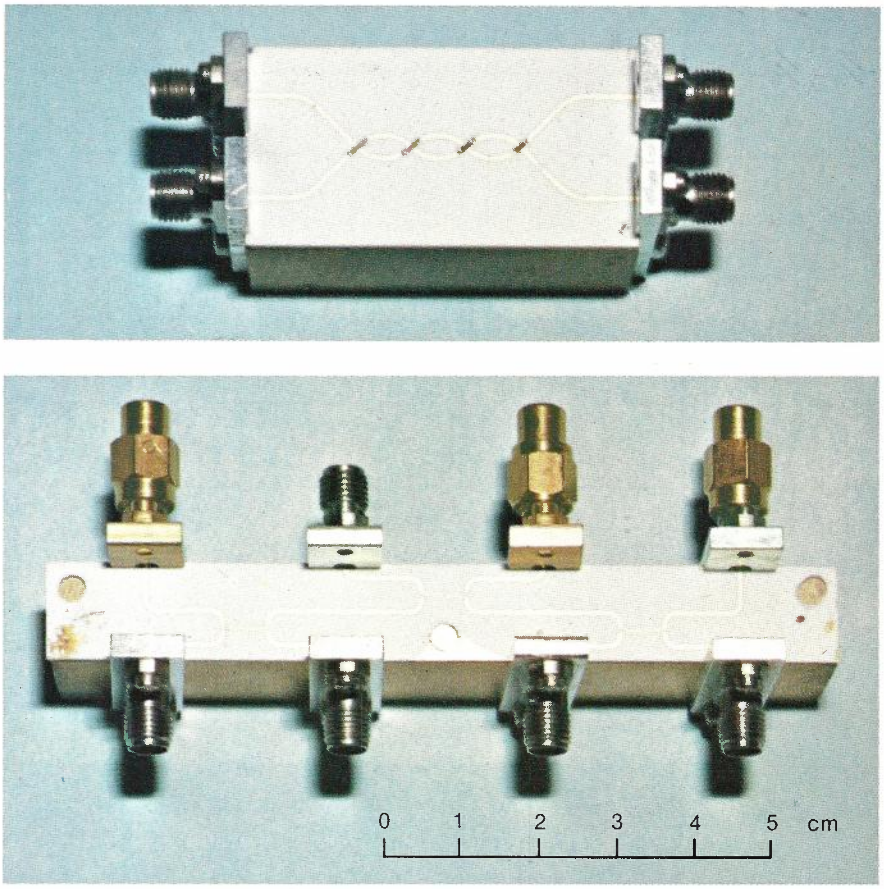
ADVANCED MICROWAVE COUPLER CONCEPTS

Among the components available for signal processing at microwave frequencies, directional couplers and hybrids have a great variety of useful applications. These applications demand, from the basic device, either a paring off of a substantial proportion of power, as in power splitting applications, or the provision of a small directional sample of the main RF signal. The main RF signal and its sample are usually phase-related.

In line with a general trend towards planar integration of microwave solid-state sub-systems, contemporary couplers and hybrids have been developed in stripline or microstrip form, which are both smaller in size and more economical than their equivalent waveguide or coaxial predecessors. Designs in microstrip which are suitable for power splitting and sampling have been investigated in the Laboratories.

One very popular form of power splitter in microstrip is the inter-digitated coupler, which relies on the coupling which exists between interleaved fingers of main and secondary transmission lines. A production problem with this type of coupler exists because of the fine dimensions of the conductor fingers, and work in the Laboratories has led to an interdigitated geometry which is much less sensitive to manufacturing tolerances. As a result, arrays of these couplers can now be fabricated with greater confidence, and the photograph illustrates an array of three couplers which is used as a 4-way power splitting component. This component is intended as an integral part of a 6 GHz solid-state power amplifier which comprises four parallel amplifier chains.

Work on directional sampling components in microstrip has led to a new form of coupler, called the 'Mirrored Meander' coupler, also



Advanced microwave couplers in microstrip (upper - 'mirrored meander' coupler, lower - 'interdigitated coupler array')

shown in the photograph. This device consists of a main and secondary RF line which intersect at defined intervals. At each intersection a cross-over element capacitively couples a small sample of the main RF signal onto the secondary line. On the secondary line, these individual samples add constructively in one direction, and destructively in the opposite direction thus giving rise to the directional sampling required.

COMPILERS FOR MICROPROCESSOR SOFTWARE

For some time now, the Research Laboratories have assisted in the software development of micro-processor based projects within Telecom Australia. This has been achieved through the provision and maintenance of several programs available on the Telecom Australia Computer Network (TACONET). The programs have consisted of a backbone of cross-assemblers for various types of microprocessors and a simulator for one of them. All of these programs are supported by a tape punching program and various object conversion programs.

The use of these programs by Telecom Australia has allowed many users of microprocessors to carry out developmental work without purchasing expensive development hardware.

The latest addition to the microprocessor software support programs has been a MPL compiler. The compiler converts a high level language into equivalent assembly language instructions for the micro-processor, which are in turn fed into the assembler to generate object format or BPNF format files suitable for programming the microprocessor memory.

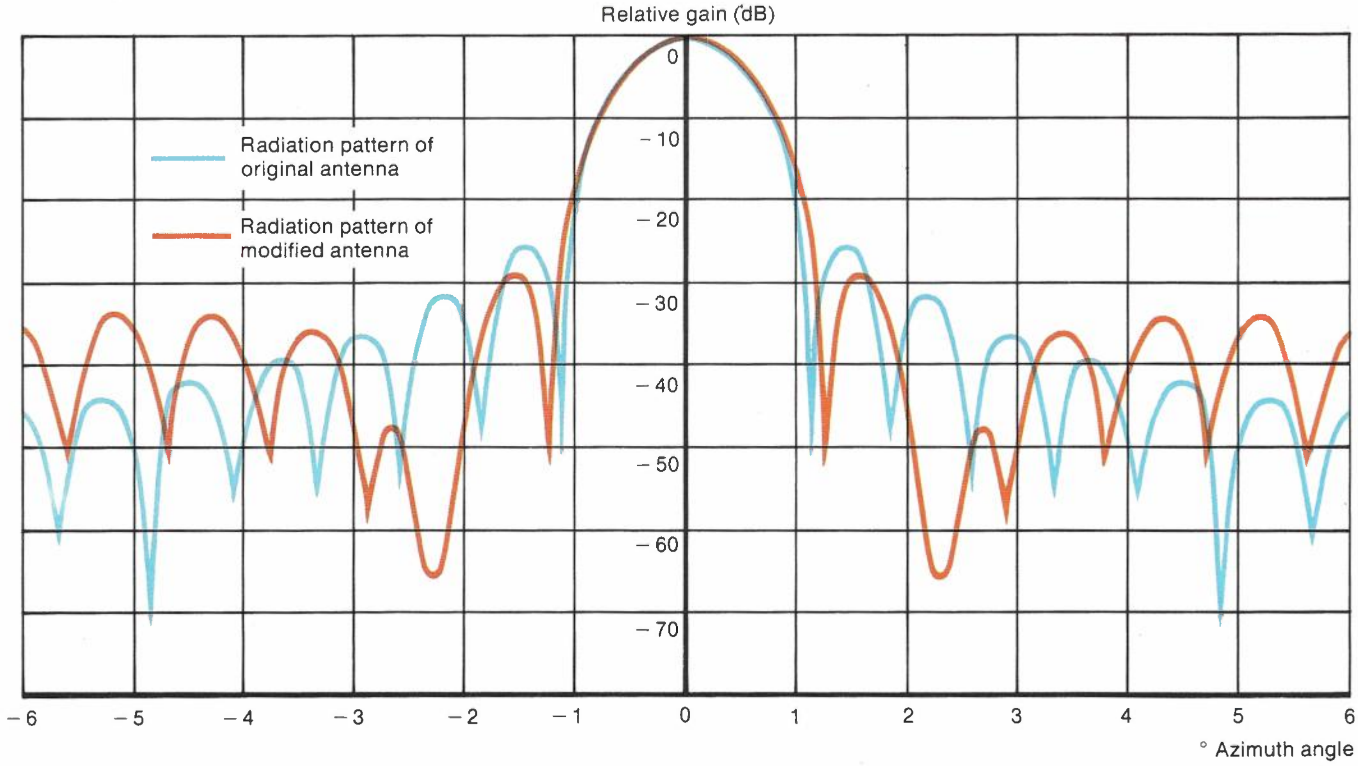
Writing in a high level language can save many man-hours in development cost, because each line of high level code can generate several lines of assembly code. Since the accepted rate of writing programs, irrespective of the language, is 5-20 lines of code per day for fully documented and debugged code, it can be seen that a programmer using a high level language can produce more assembly language code in the same time than a programmer working in assembly code only.

The Laboratories are presently arranging the purchase of a PASCAL compiler. This language suits all types of microprocessors, and is fast becoming the accepted standard computer language. Hence, future microprocessor programmers will not be required to learn the many languages now in use. It is planned to make this language available to Telecom programmers throughout Australia shortly per medium of TACONET.

INTERFERENCE REJECTION ANTENNAS

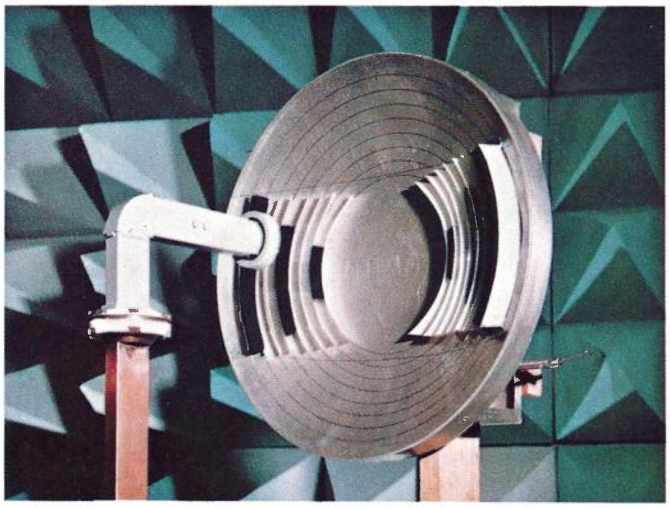
The planning and engineering of various types of microwave radio-communication systems must take account of possible radio interference mechanisms which can cause transmissions from one system, or part of a system, to affect the receivers for other transmissions. This type of problem can arise, for example, between repeater sections or systems of terrestrial microwave bearers, or between a satellite communication earth station and terrestrial microwave repeaters or terminals.

One of the key components in controlling this interference effect is the antenna. Ideally, the antenna should transmit or receive only within



Above: Sidelobe suppression on experimental model antenna

Right: Model antenna, modified in accordance with Aperture Zone Cancellation Technique, undergoing laboratory test



a narrow "main beam" whose axis is pointed towards the station with which it is working. Outside this beam, the ideal antenna is inoperative. However, practical antennas have also some response in directions other than the main beam direction. These are known as "sidelobes" and it would be advantageous if techniques could be developed to suppress sidelobes in the directions from which interfering signals are expected.

Investigations into the upgrading of a number of Telecom Australia's terrestrial microwave systems indicate that antennas with suppressed sidelobes in directions close to the main antenna beam may be practicable. Several techniques providing nulls or suppressed sidelobes have been investigated in the Laboratories. These include the interferometer technique which uses a combination of two or more antennas. More recently, the Laboratories have begun investigating another technique for controlling the sidelobes of microwave parabolic reflector antennas. This technique is known as the Aperture Zone Cancellation Technique and it considers the aperture of the reflector as a composite of annular zones which individually contribute to the total radiation characteristics of the antenna. The suppression of a sidelobe can be achieved by removing the contributions from the aperture zones which have the most influence in the formation of the sidelobe to be suppressed. Computer simulation studies combined with laboratories measurements on models of such antennas suggest that sidelobe suppression of the order of 100 times (20 dB) in a direction as close as 2.5° from the main axis of a conventional microwave communication antenna is feasible.

The method has the advantage that it is structurally more attractive than other methods studied so far.

Further experiments are being undertaken in the Laboratories to investigate practical applications of Aperture Zone Cancellation Technique.

SPECIALISED SCIENTIFIC ACTIVITIES

The influences of new technology on telecommunications equipment and line plant are reflected in the range of specialist scientific studies undertaken in the Laboratories. In a publication of this nature, it is not possible to cover every aspect of the work of Telecom's professional physicists, metallurgists and chemists, but the following selection presents the reader with a typical sample of the projects in hand.

These encompass such diverse physics activities as the accurate measurement and control of colour to ensure uniformly interchangeable products; investigations of variations in pneumatic pressures within telephone cables; studies of lightning and power induction surges on telephone lines; and reliability studies of solar power systems applied as the primary source of energy for remotely located, unmanned telecommunications systems.

The development and application of new types of plastics leading to new or improved telephone cables have significant financial ramifications for the future containment of the costs of cable provision and maintenance. An increasing concentration on studies of the biological effects of possibly hazardous or toxic substances is notable in Telecom's operations. Telecom's scientific staff are making important contributions in these fields.

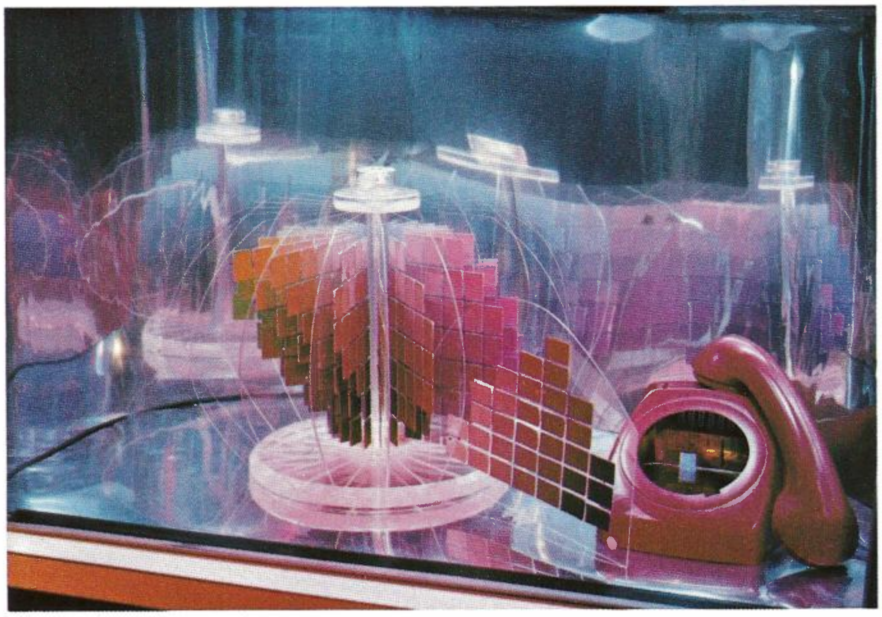
COLOUR CONTROL IN TELECOM AUSTRALIA

Colours play important roles in a number of aspects of Telecom Australia's operations. For instance, it is used for aesthetic effect in the Wallfone and Colorfone telephone instruments, where the customer has a choice of eleven colours. Telecom's corporate image is associated with a colour known as "Telecom Gold" and this colour is used to identify Telecom's vehicles, public telephone cabinets, notices, etc. The colour coding of conductors (using ten colours) is essential for the identification of conductors in multi-pair cables. In these and other applications, it is important that the colours applied in manufacture day by day and year by year vary only within narrow and specifiable ranges about standard colours. This is achieved by using a hierarchy of colour standards, to specify a colour and monitor its adherence to specification.

The chosen colour is accurately measured spectrophotometrically - to determine the Commission Internationale de l'Eclairage (CIE) tristimulus values. These define the colour numerically and become the primary standard. Colour tolerance cards are produced, based on a visual system of colour description such as the Munsell system. They consist of chips of the standard colour and six colours which lie at the tolerance limits along the hue, value and chroma axes of the Munsell colour space. Selected cards are chosen as secondary standards and are stored under optimum conditions to minimise colour change. The remaining cards are issued to the manufacturers, and are used to check the mouldings or paint chips used as working standards in day to day use.

Above: Checking a 'Telecom Gold' paint sample against its colour tolerance set

Below: A representation of the Munsell system of colour specification



The tolerance size is based on Munsell's AA tolerance and represents a practical combination of what can be realistically achieved by the manufacturer and a spread of colour that does not produce an objectionable mismatch.

As the colour seen by an observer depends on the illumination and this colour vision, lighting booths with standardised lighting are used for colour measurements, and all personnel using the cards are required to pass a colour vision test. Colour tolerance cards are easy to understand and use, do not require expensive equipment, and are therefore suitable for colour control where there is a large number of manufacturers and users. Their main disadvantage is that their colour will fade or darken with time. This is minimised by keeping them in a cool, dark location. Colour drift in the cards is checked regularly, with the Laboratories performing calibrations against standards and replacing those where drift is excessive.

If suitable instruments are available at all places where decisions have to be made on the acceptability of the colours of a particular product, the specification of these colours and their tolerances can be completely numerical. As well as being more precise, such a method is also faster, does not require highly skilled personnel to operate it and obviates the need for colour tolerance cards. Initial measurements made using a spectrophotometer define the colour precisely, but tristimulus colorimeters used in the difference mode are sufficiently accurate to do the day to day monitoring of colour tolerance. Although costly to set up, this method is practical where there is a high volume of production. It is being considered for application to the testing of telephone colours.

Colours which match under one illuminant may not match under another with a different spectral distribution. To guard against this effect, known as metamerism, Telecom requires that, when pigment changes are made in paints and plastics used by Telecom or its suppliers, colours be checked in the Laboratories against the colour standards before they are approved for use in Telecom operations.

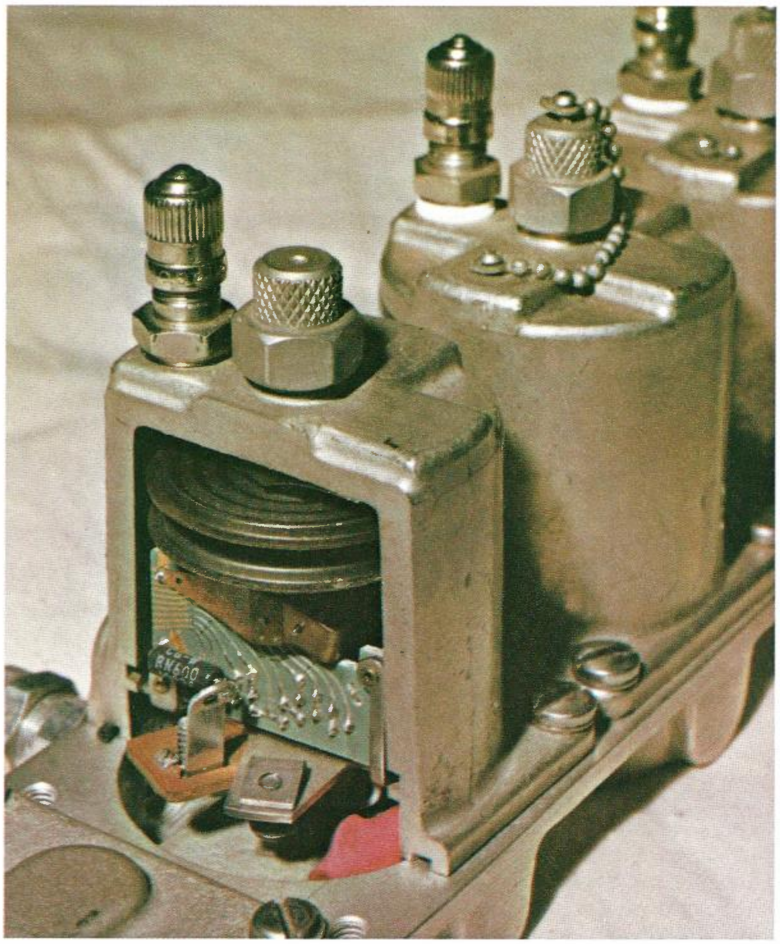
TESTS OF CABLE PRESSURE ALARM TRANSDUCERS

Many multi-conductor underground cables used in urban areas are pressurised with dry air from compressors situated in telephone exchanges. At points along cables, air pressure contactors are installed to indicate the cable air pressure. When the pressure falls below a preset value, alarms are operated.

Because these contactors merely show whether pressure is above or below the preset value, interest is being displayed in pressure transducers able to signal to the exchange, via spare cable pairs, the actual pressures along the cable. If a leak occurs, the resultant ability to plot the pressure gradient along the cable should enable the position of the leak to be pinpointed, whereas with the contactor system, an indication is given only of the section of cable (between contactors) which contains the leak. Also, the transducer method enables the magnitude of the leak to be determined more precisely and a decision to be made on the urgency for repairs to prevent possible cable damage.

Three types of alarm transducer are being studied in the Laboratories. Each transducer operates somewhat like an aneroid barometer, except that the bellows are inside an airtight enclosure which is connected to the cable interior. Cable pressure variations cause an arm to move across a number of contacts on a printed circuit board. As pressure falls, the contact arm successively reduces the shunt resistance across the alarm pair in measured steps.

The transducer's performance characteristics were measured by plotting resistance against cable pressure at both 5°C and 40°C. Tests were conducted at normal air pressures and at a reduced pressure simulating conditions at 1500 m altitude. Variations from the correct value never exceeded one step in resistance under the test conditions. Life testing, brine immersion and high potential tests were also applied and wear, corrosion and other degradations of the components were measured. Insulation resistance and output resistance versus pressure were monitored at each stage. The testing programme is continuing to establish more knowledge of the long term reliability and stability of performance of various types of transducer and to assess design principles for their use in plant situations.



Transducer enclosure sectioned to show bellows and circuit board

DETECTION OF POTENTIALLY HAZARDOUS MATERIALS

As Telecom moves further in the promotion of the highest standards of occupational health in the workplace, additional demands are made on the Research Laboratories to provide scientific support in various fields of industrial hygiene measurements. In the development of new materials and practices and in the safety assessment of current workplace situations, there are calls for sensitive and precise chemical detection and measurement techniques for toxic substances. Three typical areas recently investigated are briefly described in the following paragraphs.

Polychlorinated Biphenyls

Australian import regulations prohibit the entry of consumable goods containing substances known as polychlorinated biphenyls (PCBs). However, certain sealed durable items such as electrical transformers or capacitors containing PCBs may be encountered, as there are no material restrictions on overseas manufactured components of this type. In electrical devices, PCBs provide stable heat transfer fluids or efficient dielectric media, but the free chemicals present a major hazard to personnel as contact

Dissection of electrolytic capacitor prior to analysis for traces of polychlorinated biphenyls (PCBs)

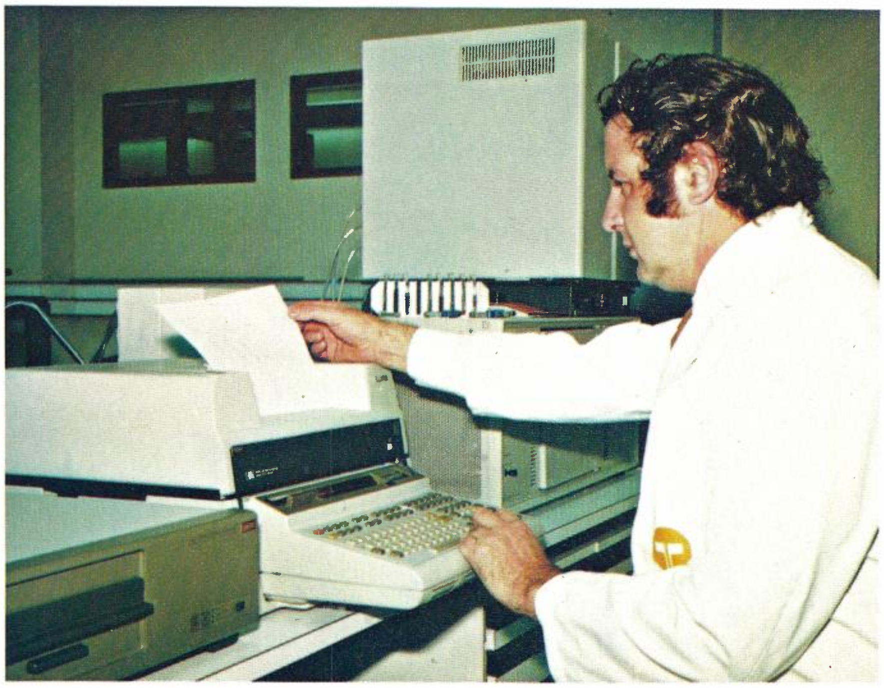
may give rise to intractable skin complaints.
In a telecommunications work situation, larger size discrete capacitors may leak or disintegrate on accidental large current reversals, sometmes arising from incorrect connection. To ascertain the safety of any clean-up, maintenance or repair task involving this type of capacitor, a representative number of imported components likely to be met in Telecom systems have been dissected and analysed for the presence of PCBs.
The capacitor contents have been analysed for traces of PCBs, using a high resolution gas chromatographic separation followed by a sensitive quadrupole mass spectrometer. All of the components chemically screened to date have been free of the PCB hazard.

Di-isocyanates in Polyurethane Formulations

There has been an increase in the number of products on the market where the ingredients for polyurethane plastic coatings or foams are mixed and reacted at the point of use, rather than in a factory or workshop location. This means that the materials handling hazards take on a new significance when processes involving polyurethane (PUR) are moved from the plant to field use.
A number of processes involving in situ formation of PUR for special field applications have been studied by Telecom and Australia Post engineering groups. They include aerial terminal box sealants, underground duct closures, cable end capping seals, two pack coatings and 'foam-in-place' packaging systems.
Di-isocyanates, one of the necessary compounds in PUR generation, are very reactive chemical compounds. This property of reactivity extends to physiological activity as well, and thus these chemical compounds are attended with considerably toxicological risk.
Whenever used, di-isocyanates, in the form of monomers or active prepolymers, call for safety standards set at very low levels of concentration of vapours or air borne droplets. These levels are aimed at providing acceptable working conditions when these substances are involved, so that no long term effects on persons result. Field sampling methods have been designed and analytical procedures have been validated in the Laboratories so that concentrations of harmful di-isocyanates considerably below the current allowable limits can be measured on a reliable and repeatable basis. These limits are set by the National Health and Medical Research Council and dictate the levels of contamination acceptable to current expert industrial hygiene opinion.
A major improvement to the analytical methodology is to use gas chromatographic techniques rather than photometric colorimetry to quantify field captured samples. Overseas medical authorities are now considering reducing the acceptable limits to concentrations of not more than 5 parts of toluene di-isocyanate per hundred million parts of air. The procedures developed in the Laboratories are adequate analytically, even for these diminished levels of contamination.

Asbestos Fibres

Although Telecom policy is against the continued use of asbestos in the workplace, there are occasional instances inherited from the past or outside Telecom control where a source of fibrogenic asbestos may be encountered.
On such occasions, dust analysis may be called for by Laboratories' staff, using approved industrial environ-



Above: Print-out indicates results of search for traces of PCBs in capacitors, using gas chromatograph/mass spectrometer

Below: Asbestos fibres in dust analysis

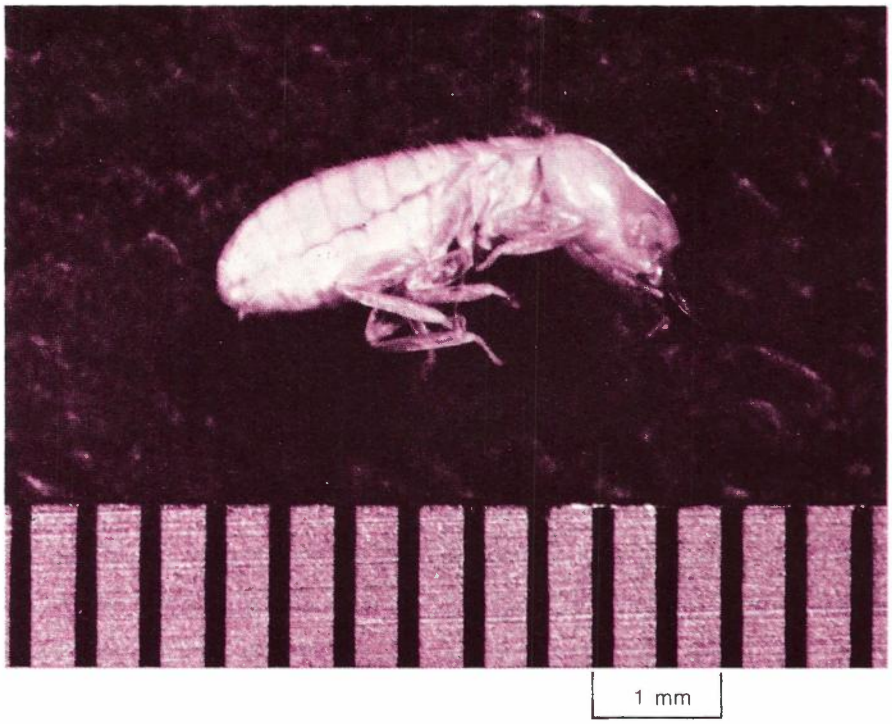
mental evaluation procedures. Airborne particles, which impinge on special retaining filters mounted in field or personal samplers, are counted and characterised by phase contrast microscopy and polarised light techniques in the laboratory. Results are provided to the Occupational Health Advisor of Telecom for risk assessment to be made. Close co-operation between the Industrial Health Division of the Victorian Health Department and the State Electricity Commission of Victoria in the matter of methods and techniques has been maintained in this specialised analytical field.

TELECOMMUNICATION CABLE DEVELOPMENTS

The Laboratories have continued their investigations into means of improving the critical components of three major types of telecommunication cables, namely, "filled" cable, moisture barriered cable and insect resistant cable.

Filled Cable

The filling compound currently used in Telecom's "filled" cable is a synthetic petroleum jelly composed of an oil/wax mixture. Absorption of the oil component by the polyethylene sheath or insulant in contact with the filler is approximately 13-17%. The effect of swelling and other phenomena due to the presence of oil in the cellular polyethylene insulant could affect the electrical characteristics of the cable, but this



In some parts of Australia this termite chews holes through plastic cable sheaths

has not been fully demonstrated. It has been shown that the physical properties of an unbarriered sheath are degraded by contact with the filling compound, and that the oily exudate on the outer surface may make handling of the cable more difficult. Replacement of the mineral oil in the oil/wax mixture with a polybutene of similar viscosity resulted in an approximate 50% reduction in the amount of material absorbed by the polymer and a marked improvement in water resistance. Polybutene, however, costs more than mineral oil and a change in filling compounds would only be warranted if the absorbed mineral oil was found to significantly degrade the physical and electrical properties of the cellular polyethylene insulant over the expected life span of the cable, or if it was decided to change to unbarriered cable.

Moisture Barriered Cable

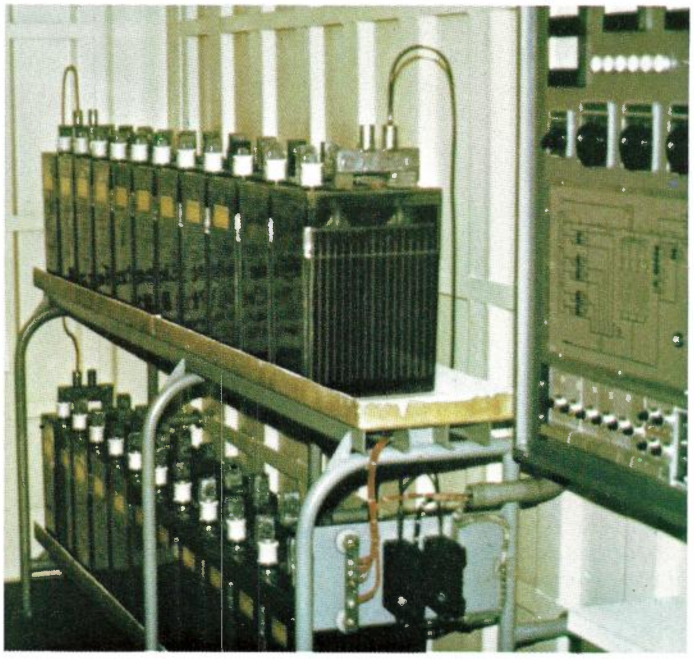
In moisture barriered cable, a polymer coated aluminium foil is bonded to the internal surface of the polyethylene sheath to prevent water vapour penetrating into the cable core and affecting the electrical properties of the cable. It had long been suspected that the bond strength between foil and sheath in cables manufactured in Australia was low, and that this value was being further reduced under normal operational conditions, and particularly so in cables installed in high-humidity or water-logged environments. Inadequacies of bond strength have also been found in instances where the cable sheath has become contaminated with petroleum-based liquids. Such fluids destroy the bond between foil and sheath or the bond at the foil overlap, thereby permitting vapours of such liquids to penetrate into the core of the cable. An extensive investigation on a large number of local and overseas manufactured foils proved that copolymer or chemically modified polyethylene coatings were greatly superior to the homopolymer polyethylene used currently in local production, both in initial bond strength and also after long term thermal ageing in air, water or petroleum-based liquid environments.

Insect Resistant Cable

Previous editions of this Review have described investigations of the protection against insect attack afforded to polyethylene sheathed cable by a thin jacket of the imported polymers, nylons 11 or 12. More recently, an experimental programme has been initiated as a joint project between the Laboratories and the CSIRO Division of Entomology, with the aim of finding a cheaper and locally produced protective material. A number of unplasticised polyvinyl chloride (UPVC) formulations, in which flexibility has been achieved by the inclusion of a polymeric plasticiser, have been tested under laboratory conditions for termite resistance by the Division of Entomology. The results indicate that the PVC materials possess resistance to the termite species, Coptotermes acinaciformis, at least equal to that of Nylon 12. To confirm these results under field conditions, arrangements are now being made to extend the experiments by installing a small amount of PVC jacketed cable at several sites in localities with significant termite activity.

Left: *Solar powered microwave repeater station using lead-acid batteries for energy storage*

Below: *Lead acid batteries for solar power applications*



LEAD-ACID BATTERIES FOR SOLAR POWER APPLICATIONS

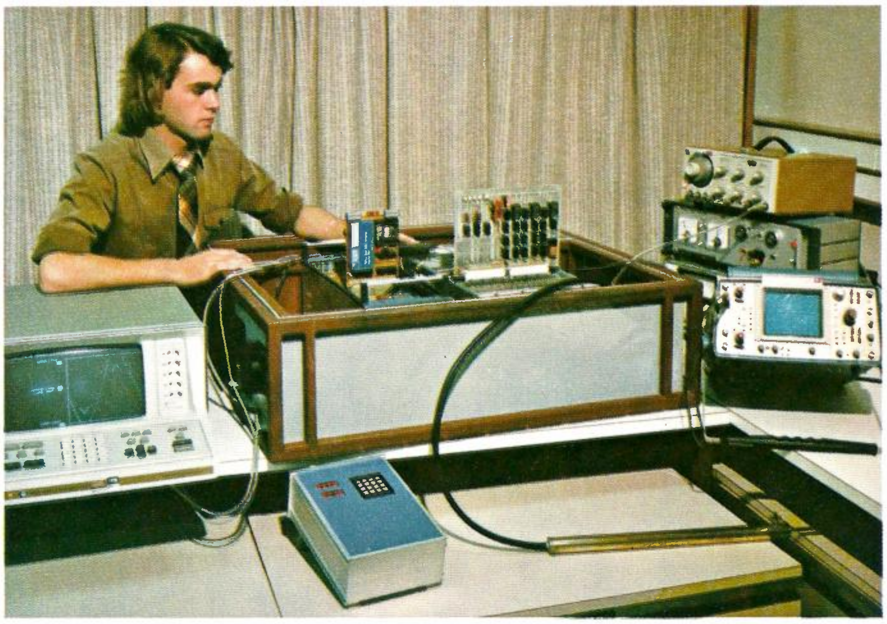
Previous reviews have reported Laboratories' work to evaluate the capacities and reliability of lead-acid batteries under various charge-discharge conditions. Most recently, battery studies have been directed at determining the suitability and reliability of stationary batteries in solar powered applications. The current test programme was designed to simulate the effects of both daily and seasonal variations in solar radiation. It has now been in operation for almost two years.

Six 2 V, 500 Ah cells have been under test at a constant temperature of 30°C. A daily cycle imposed on each cell consists of a 22 Ah discharge for 13 hours, followed by a 24 Ah charge for 11 hours. These figures approximate actual field conditions. Three cells were cycled in the fully charged condition and three cells in the 50% discharged condition, simulating summer and winter conditions respectively. The cells were tested after every 100 cycles. At this stage, 400 cycles have been completed.

The results indicate that the maximum charge potential can be expected to decrease when the batteries are cycled daily in the fully charged condition. This deterioration is associated with some capacity loss. The magnitude of the loss can be related to the brand of cell. Both the capacity and maximum charge potential were recovered during the test discharge/charge cycles. After 400 daily cycles, the capacity deviations from the original values determined at the start of tests were −10%, +0.5% and +4%.

In contrast, the maximum charge potential of the 50% discharged cells increased steadily during cycling. Their capacities also increased and at the end of 100 cycles they were approaching the fully charged condition. At the completion of the 400 cycles, the full test discharge showed variations from the original capacity of −11%, −3% and +6%.

The capacity increases obtained for the 50% discharged batteries during cycling may be attributed primarily to the 10% overcharge. Of the theoretical 217 Ah (from overcharging) available during the 100 cycles, one particular brand converted almost 100% to stored electrical energy. The other two brands converted 70-80% during the first 200 cycles, and only 50-60% during the next 200 cycles. High current converting efficiency is desirable during extended periods of low solar radiation, since this would reduce the possibility of the cells becoming deeply discharged.



Lightning-induced surge waveform recorder

Considering cells in both states of charge after 400 cycles, it was evident that the cell performance was related more to the make of the cell than the cycling condition. Two cells from one manufacturer lost 10% capacity over the cycling period. The effect on the other cells was insignificant.

Water usage recorded during the tests indicated a gradual deterioration of the two cells which lost capacity. The water losses in the other cells were markedly lower during the test period.

The testing will continue, with some modification to allow a better appreciation of the reasons behind the capacity losses which occur when the batteries are cycled in the fully charged condition.

RECORDING LIGHTNING & POWER INDUCED SURGES ON TELEPHONE LINES

Induced electrical surges resulting from nearby lightning strikes or power transmission line faults are a small but significant cause of breakdowns in the telephone network. In the past when only electro-mechanical equipment was used, protection against such surges was provided where it was necessary for safety reasons and when long lengths of overhead lines were involved. However, modern electronic switching and customer equipment is much more prone to damage from high voltage pulses and consequently, additional protection circuitry must be provided. To enable this circuitry to be designed for best effect, more detailed information than is presently available is required concerning the magnitude and waveshape of the pulses being induced onto telephone lines in Australia.

In order to obtain this data, a voltage and current surge recorder has been designed and built by the Laboratories to monitor surges on telephone lines in field locations. During the predominantly quiescent periods, it is designed to operate continuously at a slow sampling rate, recording line conditions and temporarily storing the data in memory. One of the six input channels is used as a programmable trigger to initiate sampling at faster rates when a predetermined level is exceeded by a line surge. The various recording parameters such as sampling rates, number of samples to be recorded, and the inter-relationship of the three programmable apertures are pre-set and controlled by a micro-processor.

Incoming surge pulses are applied to a voltage divider or current shunt as required and then to the input amplifier/attenuator, whose output is applied to an automatic ranging system. This enables a wide range of input voltage amplitudes (0-40 kV peak) to be recorded more accurately. The automatic ranging system is capable of switching through four separate ranges within two micro-seconds. This is accomplished using ultra fast analogue switches to direct the input pulses over four voltage divider networks which are controlled by voltage comparators pre-set to sense the various switching voltages. The pulses are then presented to one of two analogue-to-digital converters (two analogue-to-digital converters are used for greater speed and accuracy). After conversion to digital format, the data and automatic range information are stored in memory under direct memory access control. The maximum sampling rate is 2 MHz. Once a complete waveform has been stored in memory, that section is released for outputting via a modem to a floppy disc memory. Another section of memory is made accessable for new data, should a strike occur whilst outputting is in progress. This feature enables continuous recording of input pulses with a worst case recovery time between pulses of 50 microseconds.

The data stored on floppy disc is inputted to Telecom's Computer Network (TACONET), whence the waveform can be reconstructed and analysed in detail.

CONSULTATIVE ACTIVITIES

Through the pursuit of a wide spectrum of R & D projects in the engineering and scientific aspects of advanced telecommunications, the Laboratories' staff represent a body of knowledge which is available and can be used to advantage in many aspects of day to day operations. Laboratories' staff are often called on by staff in other parts of Telecom to provide consultant-type assistance with problems or questions arising in their work.

A glance through the following items indicates the range of assistance given. Space does not permit an exhaustive listing of this type of activity, but the examples given are typical ones. They range from design assistance for specialised filters and networks; evaluations of component reliability; assessments of a variety of customer telephone apparatus and ancillaries, including special telephone aids for the handicapped; assistance with public displays; and many more.

The advice offered on many of the topics has resulted in cost savings in the purchasing programmes undertaken by Telecom. In other cases, the advice has facilitated the specification or the manufacture of telecommunications equipment required by Telecom or it has helped to determine Telecom's standard practices for operation or maintenance of equipment in the field.

The assistance given by the Laboratories' staff is most often passed on to the engineering staff of the Headquarters and State Administrations of Telecom. To a lesser extent, assistance is also given to industry and other research organisations.

This consultancy activity is regarded by Laboratories' management as a very important one, even though it lacks the "prestige" of larger R & D projects. It is seen as a cost-effective means of solving or avoiding minor but often costly network problems quickly. It is also an effective medium for exposing Laboratories' staff to the equipment used in the present day network and to the types of problems faced by their colleagues in the operations sections of Telecom. This exposure becomes a means of enhancing the output from the longer term futuristic R & D projects in which the Laboratories' staff are also engaged.

STABILISATION OF INSULATING GRADE POLYETHYLENE FOR EXTERNAL CABLE

Many instances of cracked polyethylene insulation from solid polyethylene insulated and sheathed cables, manufactured in the early 70s and terminated in above ground pedestals or tail-less boxes, have been examined recently by the Laboratories. In all cases, the failure is considered to be a thermally-induced, copper-catalysed oxidative breakdown of the polyethylene, due to inadequate stabilisation.

Stabilisation is required in all polymers exposed to heat, light and weathering conditions to prevent changes in the chemical structure of the polymer. The mechanism of breakdown of the different types of polymer and the degree of resistance to degradation are quite varied. In the case of the polyethylene insulants examined, the failure was found to be due to a change in molecular chain length (backbone bond scission), resulting in a dramatic loss of physical properties - as exhibited by cracking.

The stabilisation system used in Telecom polyethylene insulation in the early 70s was a single anti-oxidant, included to prevent oxidative degradation during manufacture and processing of the polymer. Investigations have revealed that the residual anti-oxidant after processing affords little protection to the insulant under service conditions, particularly if the insulant is housed in a semi-enclosed terminating unit, where the anti-oxidant can be lost by a number of physical processes as it migrates to the surface of the insulant.

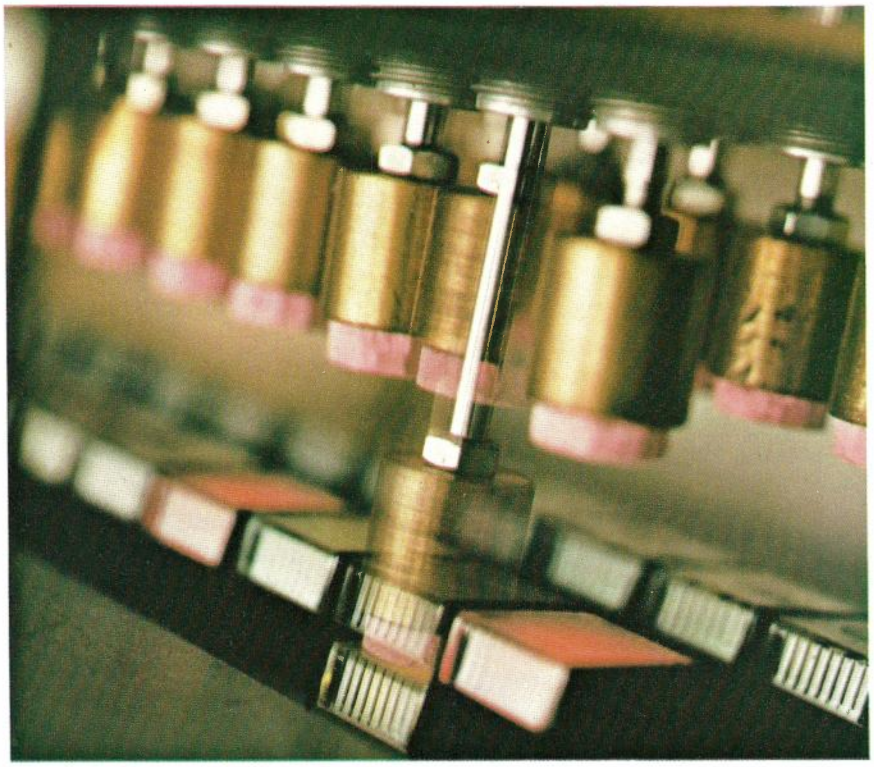
The current stabilising system contains an anti-oxidant and metal deactivator, both of which were chosen for their low volatility and water insolubility. These have been shown experimentally to provide long term protection of polyethylene insulation under service conditions.

EVALUATION OF PUSH BUTTON KEYS

Push button keys of the multiple contact change-over type are used extensively by Telecom Australia in a variety of applications which range from single keys in two-line telephones to banks of keys in combined intercom, multi-line units.

New types of keys are evaluated by subjecting them to various electrical, mechanical and environmental stresses. The types and levels of stress to be applied are selected according to the expected in-service and storage conditions.

Because of the continued demand for this type of testing and also the need to detect fault conditions immediately, automated testing and control equipment is used wherever possible. Although it is still necessary to physically connect the testing equipment to the wide variety of keys tested, microprocessor control of key operation and data collection have resulted in higher productivity in this type of testing.

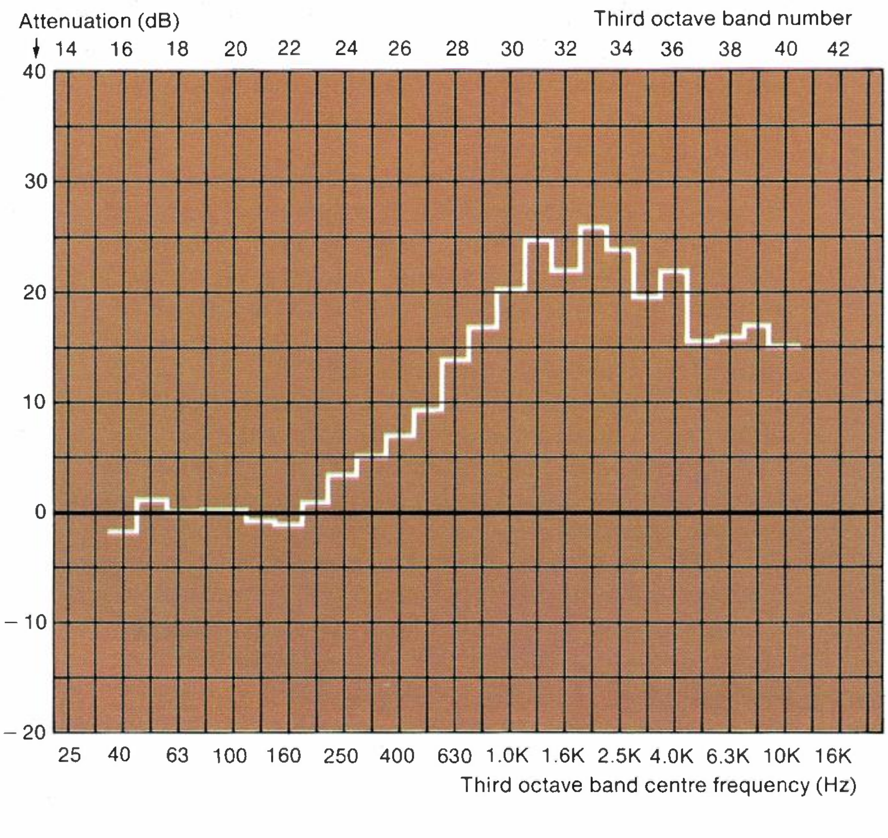


Microprocessor controlled pneumatic plungers operating a bank of interlocking push button keys

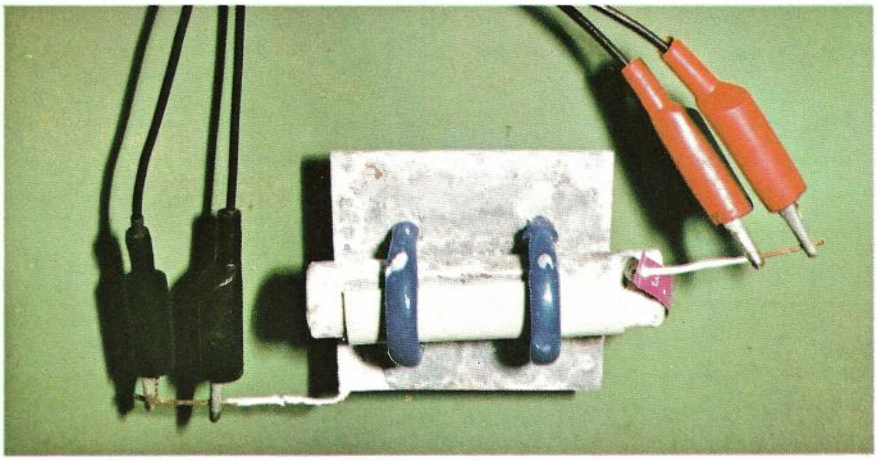
EAR MUFF EVALUATION FOR HEARING CONSERVATION PROGRAMMES

The Telecom Headquarters Co-ordination Group supervising the introduction of hearing conservation measures expressed concern at the apparent poor performance of ear muffs in field use. As a consequence, the Research Laboratories undertook laboratory tests in which field conditions were simulated, and these confirmed that the ideal performance of ear muffs is readily impaired. The main contributing factors appear to be long hair and bushy sideburns, safety glasses, and the difficulty (and perhaps inadequate care) in maintaining properly fitted ear muffs under working conditions.

It was demonstrated how, with reasonable care, the use of a noise-dose meter can provide effective assessments of ear muffs under field conditions.



Graph shows the measured attenuation of an ear muff



Testing joint resistance of bi-metallic samples (inset) after exposure to salt-fog environment

JOINTING PASTES FOR MULTIMETALLIC STRUCTURES

External metal structures can suffer severe corrosion particularly at crevices and metal junctions. Conducting or non-conducting pastes applied to a junction can prevent or significantly reduce this corrosion and retain conductivity if required. Nine pastes were evaluated during the past year for a number of bi-metallic combinations in a standard salt-fog atmosphere.

After 200 hours exposure, joint resistances were compared with their initial figures. The samples were examined for crevice and bi-metallic corrosion. The behaviour of the pastes at elevated temperatures was also investigated.

The corrosion protection varied considerably. Out of the nine different types of pastes, five samples were considered to be unsuitable. Recommendations regarding the choice from the remaining four samples would depend on the type of application. Factors such as conductivity, temperature performance, cost and ease of use influence final selection. One of the pastes recommended can cause crevice corrosion on aluminium when combined with more electropositive metals. However its overall performance warranted recommendation.

SUMMATION OF INTERMODULATION NOISE ON LONG RADIO RELAY ROUTES

This study was initiated, at the request of the Headquarters Radiocommunications Construction Branch, to investigate apparent errors between the calculation and measurement of noise on long modulation sections (incorporating more than seven repeaters) of several broadband radio relay systems.

Two methods for determining the intermodulation noise of a repeater, or of a repeater section, have been proposed.

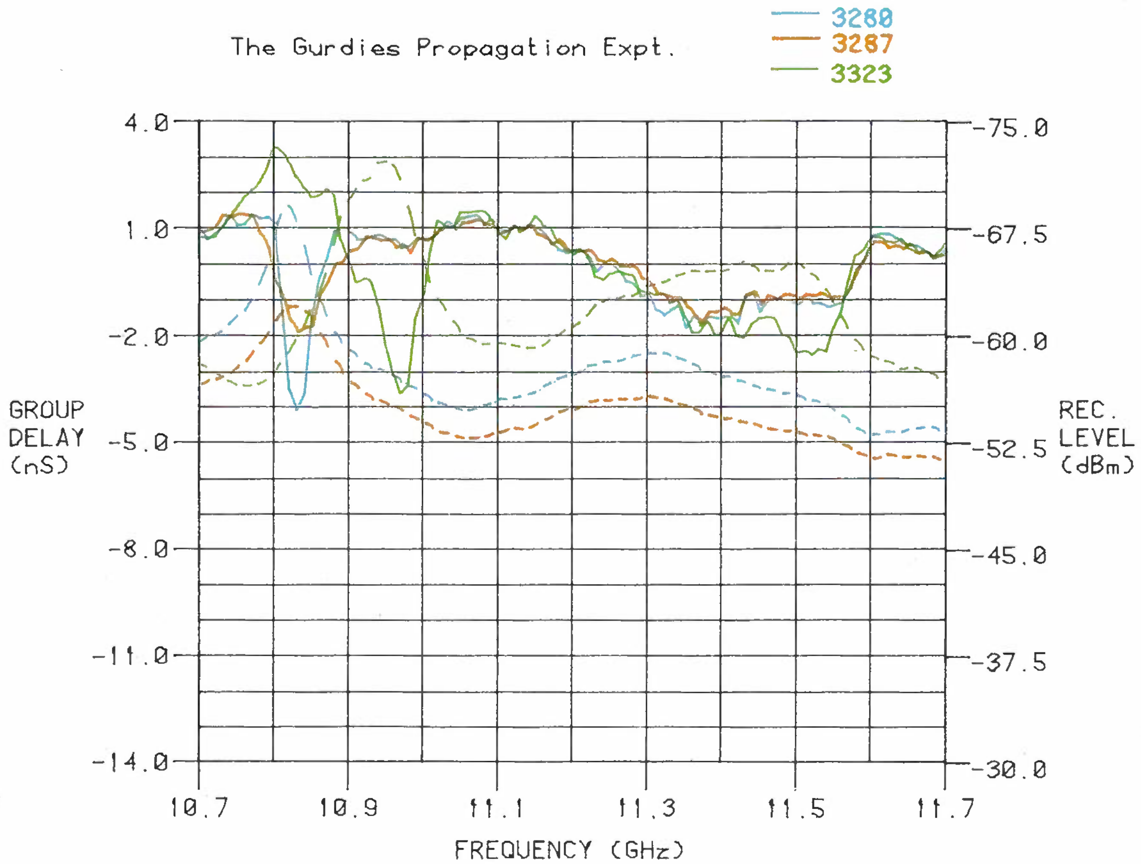
One method is an attempt to find a practical design equation for calculating the equipment intermodulation noise of a section from measurements on pairs of repeaters. The other uses a tone swept across the baseband to identify the numerous transmission deviations of a single repeater.

Both methods are currently being evaluated.

POWDER COATING TECHNIQUES

Powder coatings are a relatively new development in surface coating technology, where a decorative and protective coating is initially applied to an article as a solvent free powder. When the article is heated, the powder melts to form a continuous film. In the case of powders using thermoplastic resins, only fusion of the resin occurs with heating. With thermosetting powder resins, both fusion and polymerisation takes place.

The Laboratories have evaluated several powder coating applications in the recent year. One such evaluation concerned a polyester thermosetting powder coating which is being used on the zinc plated mounting frames of CT3 coin telephones. In this application, high resistance to heat and ultra-violet light is required as well as good corrosion protective properties. In another Telecom application examined, a thermosetting epoxy powder coating is used on



Computer plot of results from propagation research project

battery holders where high chemical resistance is required but resistance to ultra-violet light degradation is not so important. Preliminary investigations suggest that this latest development in surface coating techniques has merit in appropriate applications.

TACONET PLOTTING FACILITIES

On-line computer graphics facilities available within the Laboratories include a number of graphics terminals for program development, flat-bed plotters for obtaining hardcopy output and software to support these terminals. These facilities have been utilised in many projects but perhaps most beneficially, in long-term projects requiring extensive routine analysis of experimental data. Here, the relatively small initial programme development costs are offset by the later on-going savings in man-power which result. Computer generation of one-off plots is also made practical by the availability of sophisticated software packages which require little programming effort to obtain report quality graphical output.

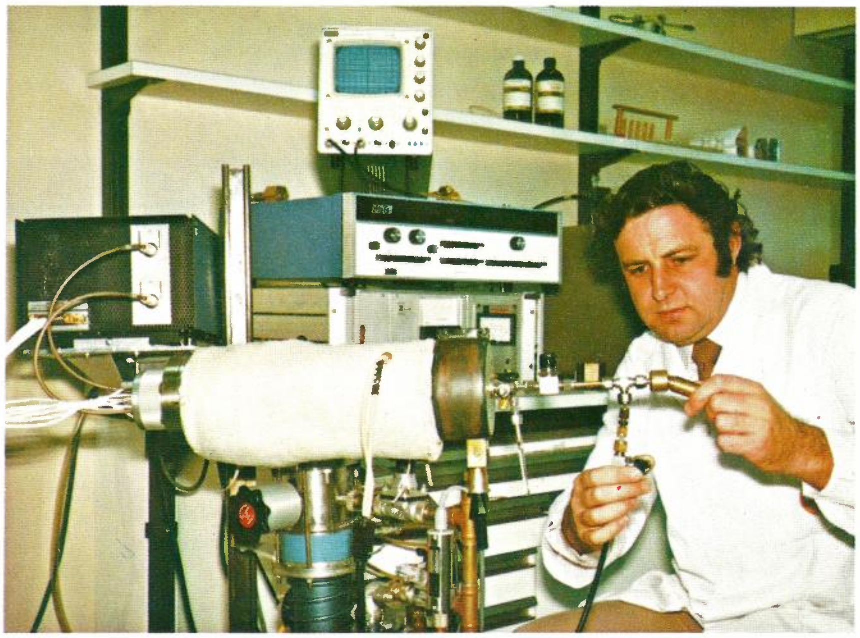
ACTIVE BAND-STOP FILTER FOR DATA-IN-VOICE TRANSMISSION

Two narrow band-stop filters which prevent an in-band data signal from interfering with voice communications have been built with conventional passive components as well as simulated inductors and impedance inverters. In the active realisation, all parallel tuned circuits in series branches were replaced by series tuned circuits in shunt branches flanked by impedance inverters. This use of impedance inverters ensured that one terminal of each inductor was grounded, thereby making the inductor realisable by one of the more conventional inductor simulating circuits. The impedance inverters were built in pairs using discrete components.

These filters require very high quality components to avoid a noticeable effect on the voice signal. The active filter was smaller and lighter than its passive counterpart and had significantly better attenuation characteristics. Experiment showed that a Q value of 500 in the inductors caused a worse degradation in the filter's response than realistic losses in the impedance inverters, or a 10% change in the inversion constant of the impedance inverters.

HERMETICITY EVALUATION OF COMPONENTS

For optimum reliability of service in the Telecom network, sealed electronic components must have outer casings or envelopes which provide a maximum protection for the active parts enclosed within them, to ensure that the protective micro-



Above: A range of hermetically sealed components

Below: Loading a helium pressurised sample into mass spectrometer for leak detection

environment sealed within the component does not leak away through the protective cover during its service lifetime.

To set up reliability objectives and quality control standards for these components, the leakage rates or hermeticity levels must be established. This calls for the most sensitive gas detection methods available, which are those of mass spectrometry.

One of the evaluation procedures used is the "back-pressuring" method where a gas under high pressure is induced to pass through any leakage pathway which may be present into the enclosed cavity. Then after a pre-determined time, the component is removed from the pressure vessel and monitored for the re-emergence of the pressurising gas. The inert gas helium, with its small atomic radius, is normally used.

Leak detecting rates are measured in the low pressure entrance port of a Quadrupole Mass Spectrometer, which is set to scan across the atomic mass number specific to helium. This instrument provides the most sensitive method available to match the low gas leak rates normally expected.

Initially this operation is being carried out on trial batches of reed relay inserts, as part of the reliability studies for components in ARE and AXE exchanges.

SPECIAL FILTERS

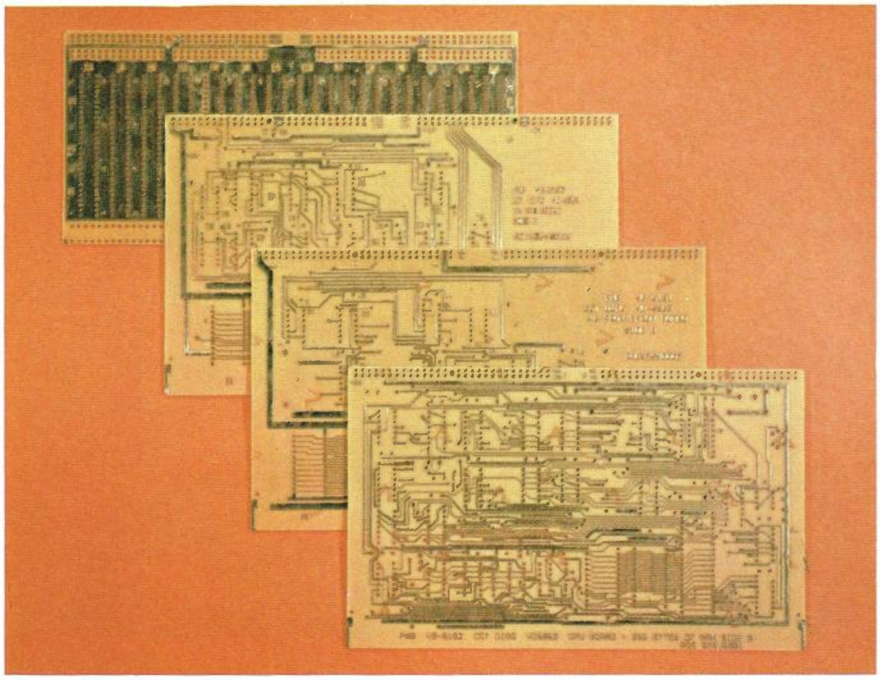
Each year, the Research Laboratories receive requests from the Engineering Departments in both Headquarters and the States for designs of special filters, equalisers and similar networks. These circuits are usually needed to assist in the testing of equipment, to develop new equipment, or to modify existing equipment to perform new functions. These requests draw on the armoury of skills and specialised computer design programs developed by the Network Theory Section of the Laboratories.
Some of the requests in the past year included circuits for pilot extraction and suppression in systems carrying TV and data signals; circuits for spectrum shaping of data and pulse code modulation signals; and microwave distributed circuits for selecting a signal from noise without phase distortion.

A voice frequency equaliser is another such example. This took the form of a cable simulating circuit whose purpose was to equalise the delay over various routes carrying voice frequency paging tones. The scheme was proposed by the Laboratories as a possible solution to the problem of transmitting paging tones for the Telefinder service over pair cable to distant transmitters, so that each tone arrives simultaneously at all transmitters.

PHOTOTOOLS AND PRINTED WIRING BOARDS

The printed wiring and microelectronics production facilities of the Laboratories are pressed into regular service to assist with the practical realisation of the prototype equipment designed by the staff of the Laboratories and of other Departments of Telecom. The facilities available include computer aided design of phototools, together with precision photographic, conductor etching and plating facilities for printed wiring boards. The facilities also extend to those required for all aspects of the production of thick and thin film hybrid circuits.

One notable task performed by the Microelectronics Section during the year was the development and production of printed wiring boards (PWB) for a microprocessor hardware system standardised for use by Telecom's designers. The standard system uses four plated-through-hole PWBs.



Above: Set of PWBs for Telecom's standardised microprocessor hardware system

STD TRUNK CHARGE DISPLAY PANEL

During the past year, the Laboratories assisted in the development of a public relations display item by designing and building the electronic component of a working exhibit to demonstrate various STD tariffs.

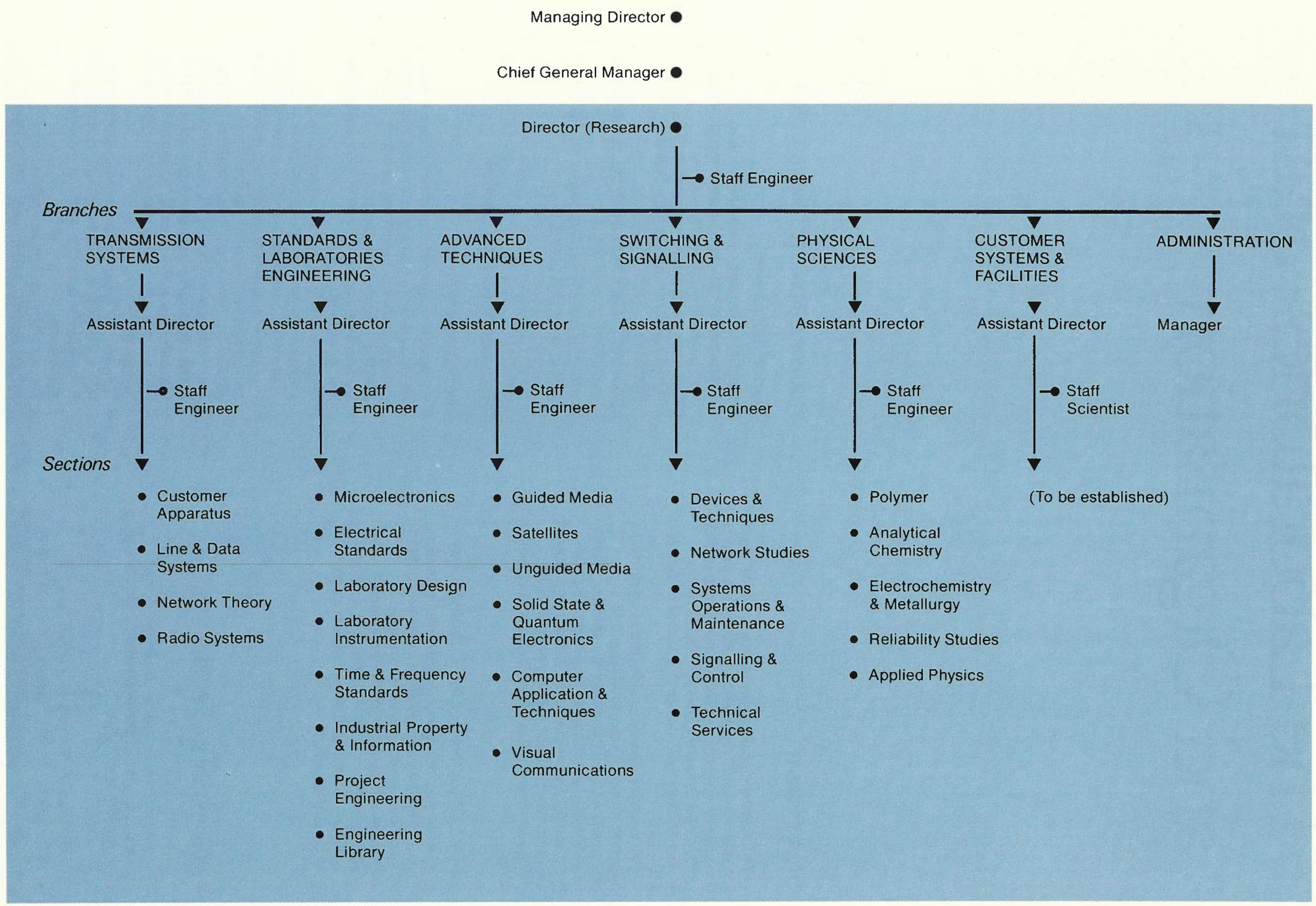
The system, which has been installed in a Telecom caravan for display to the public at various venues, is controlled from a recorded message and utilises micro-computer circuitry to indicate to the observer the cost in dollars and cents of an STD call from the caravan to three distant areas at each of four tariff rates, namely, Day, Sunday, Evening and Night Economy.

Below: Self-contained VHF/UHF field strength meter

SELF-CONTAINED VHF/UHF FIELD STRENGTH METER FOR MOBILE SURVEYS

This instrument was developed for the measurement and the calculation of statistics of the highly variable radio fields encountered in mobile VHF and UHF radio system reception areas. It is installed in an ordinary car or van and powered from its battery. The car is driven over a test route at ordinary road speeds, receiving a continuous test transmission. At regular intervals of say, one metre, the received signal level is measured and stored automatically by the instrument. The measurements are processed within the instrument and basic statistics are calculated. The results are immediately available. These may be displayed or printed, printing either automatically or on command.

Calculations may be made of the mean, rms, standard deviation and cumulative distribution of the received RF signal level. Measurements may be made at radio frequencies in the bands 148-174 MHz, 450-520 MHz and about 850 MHz.



The Research Laboratories organisation

The Laboratories- Staff and Organisation

Organisation

The Research Laboratories are a Department at Headquarters. The Director, Research, heads the Laboratories' organisation. He is responsible to the Chief General Manager who in turn is responsible to the Managing Director of Telecom Australia.

The Laboratories comprise 28 scientific and engineering sections, grouped into five branches, and an administrative section. The scientific and engineering sections comprise professional, technical and clerical support staff, with each section possessing expertise in particular areas of the engineering and scientific fields.

Overall Objectives of the Laboratories

- Ensure that Telecom Australia has available the necessary advice in the relevant fields of advanced science and technology.
- Provide services to Telecom Australia in the solution of problems requiring the application of specialised scientific and technological skills and experience.

Professional and Senior Staff

The names given below are those of the actual occupants of the positions (appointed or acting) at 30 April 1979.

DIRECTOR: E.F. Sandbach, B.A., B.Sc.

STAFF ENGINEER: F.W. Arter, B.E.E., M.Eng.Sc.

ENGINEER: O.J. Malone, B.E.E.

TRANSMISSION SYSTEMS BRANCH

Branch Objectives

- Maintain a reference competence in telecommunications transmission systems, and terminal equipment.
- Maintain the reference standards for telephonic transmission for Telecom Australia.

ASSISTANT DIRECTOR: R. Smith, B.E.(Hons.), M.E., M.I.E.E., M.I.R.E.E.

STAFF ENGINEER: M. Cassidy, B.Sc., M.E., D.P.A., F.I.E.Aust. F.I.E.E.,

Customer Apparatus Section

Section Functions

- Research the generation, transmission and reception of speech signals in the telephone system, and new telephone services and telephone customer apparatus.
- Develop new telephone customer apparatus and components.
- Investigate and specify performance of subscribers' telephone attachments and study associated impedance and loss compatibility.
- Develop measuring apparatus and techniques for telephone customer equipment in laboratory, field and workshop applications; determine performance levels to be expected in the production of subscribers' instruments.
- Research psycho-acoustic methods of rating speech transmission systems for engineering purposes.
- Develop an Australian reference standard of telephonic transmission including appropriate fundamental acoustic and electro-acoustic standards.
- Research the acoustic environment experienced by telephone system users.

SECTION HEAD: D.A. Gray, B.E.E., Dip.Mech. & Elec.Eng., M.I.E.Aust., M.A.A.S.

PRINCIPAL ENGINEER: E.J. Koop, B.E.(Elec.), Fell.Dip.Elec.Eng., M.A.A.S.

SENIOR ENGINEERS:
P.F. Duke, B.Tech., Assoc.Dip.Maths.
R.W. Kett, Fell.Dip.Comm.Eng., A.M.I.R.E.E.
W.E. Metzenthen, F.R.M.I.T., M.E., M.I.R.E.E.

ENGINEERS:
D.M. Blackwell, B.E.(Elec.)
G.M. Casley, B.E.(Elec), M.Eng.Sc., D.I.C., Ph.D., M.I.E.Aust., A.M.I.E.E., M.I.E.E.
J.P. Goldman, Assoc. Dip.Rad.Eng., Assoc.Dip.Comm.Eng., Grad.I.E.Aust.
B.W. Sneddon, B.E.(Elec.)
R.A. Seidl, B.E.(Elec. Hons.), Ph.D.
P.I. Mikelaitis B.E.(Elec.)

SENIOR TECHNICAL OFFICERS:
S.G. Beadle
T.R. Long
J.E.W. Lucas

Line and Data Systems Section

Section Functions

- Investigate and study line and data transmission systems and the inter-working with other parts of the transmission and switching network.
- Develop special line and data transmission systems and/or equipment peculiar to the Australian environment and not available commercially.
- Develop special line and data transmission measuring equipment.

SECTION HEAD: A.J. Gibbs, B.E.(Elec.), M.E., Ph.D., S.M.I.E.E.E. M.I.R.E.E.,

PRINCIPAL ENGINEERS:
B.M. Smith, B.E.(Hons.), Ph.D., M.I.E.E.E.
G.J. Semple, B.E.(Hons.), M.Eng.Sc.

SENIOR ENGINEERS:
R.J. Morgan, B.Sc.(Eng. Hons.), Ph.D. M.I.E.E.E.
A.Y.C. Quan, B.E.(Hons.), M.E., A.M.I.E.E.

ENGINEERS:
J.C. Campbell, B.E., M.Eng.Sc.
N.Q. Duc, B.E.(Hons.), Ph.D., M.I.R.E.E., M.I.E.E.E.
J.L. Snare, B.E.(Hons.)
L.J. Millott B.E.(Hons.) M.Eng.Sc, M.I.E.E.E.
G. Nicholson, B.E.(Hons.) M.I.E.E.E., M.Eng.Sc.
P.G. Potter, B.E.(Hons.)

SENIOR TECHNICAL OFFICERS:
J.L. Kelly
J. Gillies
R.B. Coxhill

Network Theory Section

Section Functions

- Conduct research into the theory and design of communication equipment circuits, including filters and equalisers.
- Conduct circuit synthesis and analysis in frequency and time domains.
- Develop mathematical models for the theory of circuits.
- Develop and test active and passive networks.

SECTION HEAD: I.M. McGregor, B.E.(Hons.), M.Eng.Sc., Ph.D.

SENIOR ENGINEER: R.L. Gray, B.E.(Hons.), M.E., Ph.D., M.I.E.E.E.

ENGINEERS:
F.G. Bullock, B.E.(Hons.), Grad.I.E.Aust.
O. Tenen, Dip.Rad.Eng., M.I.E.Aust.
P.M. Gregory B.E.(Hons.),M.Eng.Sc.,M.I.E.E.E.

SENIOR TECHNICAL OFFICER: R. Owers, T.Eng.(C.E.I.) M.I.T.E.

Radio Systems Section

Section Functions

- Investigate and study radio transmission systems and the interworking with other parts of the transmission and switching network.
- Develop special radio transmission systems and/or equipment peculiar to the Australian environment and not available commercially.
- Develop special radio transmission measuring equipment.

SECTION HEAD: O.F. Lobert, B.E.E., M.I.E.Aust., M.I.E.E.

SENIOR ENGINEERS:
I.C. Lawson, B.E.E.
J. Steel, B.E.(Hons.), M.E., Ph.D., M.I.E.E.

ENGINEERS:
R.A. Court, B.E.(Hons.), B.Sc., M.Eng.Sc., M.I.E.E.E.
R.P. Coutts B.Sc.,B.E.(Hons.) Ph.D., M.I.E.E.E.
J. Billington B.E.(Hons.),M.Eng.Sc.,M.I.E.E.E.
P.R. Hicks, B.E.(Elec.), B.Sc., (App.Maths)
E. Vinnal, B.E.(Hons.)

SENIOR TECHNICAL OFFICER: D.J. Thompson

SWITCHING AND SIGNALLING BRANCH

Branch Objectives

- Maintain a reference competence in advanced telecommunications switching and signalling techniques, systems and related components.

ASSISTANT DIRECTOR: F.J.W. Symons, B.E.(Hons.),D.I.C., PhD, M.I.E.Aust.

STAFF ENGINEER: G.D. Clark, B.E.E.(Hons.), M.Sc., M.I.E.Aust.

Devices and Techniques Section

Section Functions

- Assess the potential of new devices and techniques for application in switching and signalling systems.
- Develop new techniques to exploit the latent potential of devices and techniques.
- Participate in the design and assessment of field trials of new systems and equipment which use novel devices and techniques.
- Prepare recommendations for the adoption or trial of new devices and/or techniques.

SECTION HEAD: A.M. Fowler, M.I.E.Aust.

SENIOR ENGINEER: P.S. Jones, M.Eng.Sc.

ENGINEERS:
D.J. Kuhn, B.E.(Elec.), M.Eng.Sc.
E. Tirtaatmadja, B.Eng.(Elec.)
D.M. Harsant, B.E.(Hons)

SCIENTIST: C.J. Scott, B.App.Sc., Grad.A.I.P.

Network Studies Section

Section Functions

- Conduct research into the basic nature of switching networks, and the manner in which changes in network parameters influence the technical and economic characteristics of the network.
- Assess the potential of new systems in relation to future network needs.
- Provide specialist consultative advice and assistance in relation to progressive integration of new systems into Telecom Australia's networks.
- Examine detailed requirements for switching and signalling systems in future environments and conduct feasibility studies of possible approaches.

SECTION HEAD: R.J. Vizard, Dip.Elec.Eng., B.E.E.

SENIOR ENGINEER: N.G. Gale, B.E.(Elec.)

ENGINEERS:
S.M. Jong, B.E.(Elec.)
G. K. Millsteed, B.E.(Hons.), Dip.Elec.Eng.

Switching, Operations and Maintenance Section

Section Functions

- Study the characteristics and potential of new approaches in the field of operations and maintenance.
- Develop models which will be used to validate theoretical studies of new operations and maintenance systems and techniques.
- Conduct field trials to assess the performance of new approaches and techniques in the field of operations and maintenance.
- Provide specialist consultative advice in matters pertaining to operations and maintenance.

SECTION HEAD: E.A. George, A.S.T.C., Post Dip. Elec. Comp., M.I.E. Aust.

PRINCIPAL ENGINEER: G.J. Champion, B.E.

SENIOR ENGINEERS:
M.A. Hunter, B.E.(Hons.), A.M.I.E.E.
A. Even-Chaim, B.Sc. M.I.E.E.

ENGINEERS:
B. Wickham, B.Sc., B.E., M.I.E.Aust., M.I.R.E.E., M.I.E.E.E.
G.J. Dickson, B.E.(Hons.), M.Eng.Sc.
F. Eastaughffe, B.Sc., B.E.(Hons.)

Signalling and Control Section

Section Functions

- Study the characteristics and potential of new approaches in the field of control and signalling systems and techniques.
- Develop models which will be used to validate theoretical studies of new control and signalling.
- Conduct field trials to assess the performance of new approaches and techniques in the field of control and signalling.
- Provide specialist consultative advice in matters pertaining to control and signalling.

SECTION HEAD: P.H. Gerrand, B.Eng.(Hons.), M.Eng.Sc., M.I.E.Aust.

SENIOR ENGINEERS
M. Subocz, B.E.(Elec.), M.I.E.Aust.
J.L. Park, B.E.(Hons.), M.Eng.Sc., M.I.E.E.E.

ENGINEERS:
P.A. Kirton, B.E.(Hons.), M.I.E.E.E.
N.P. Kennedy, B.E.,M.Eng.Sc.

SENIOR RESEARCH OFFICER: R.G. Addie, B.Sc.(Hons.)

RESEARCH OFFICER: G.M. Cody, B.Sc.

Technical Services Section

Section Function

- Provide field and laboratory planning, provisioning, investigations, development, production, testing and evaluation support for branch activities.
- Provide specialist expertise on national telecommunications network interworking and performance principles leading to the determination of standards and specifications for novel switching and signalling systems under research and development.

SECTION HEAD: W. McEvoy, A.A.I.M.

SENIOR TECHNICAL OFFICERS:
N.W. Wolstencroft
B.C. Gilbert
A. Romagnano
D.J. Duckworth
H.G. Fegent
P.C. Murrell

ADVANCED TECHNIQUES BRANCH

Branch Objectives

- Maintain a reference competence in frontier technology, systems and techniques relevant to the needs of Telecom Australia.

ASSISTANT DIRECTOR: E.R. Craig, B.Sc.(Hons.), M.I.E.E.

STAFF ENGINEER: N.F. Teede, B.E.(Hons.), Dip.Mgt., Ph.D.

Computer Applications and Techniques Section

Section Functions

- Conduct fundamental studies on the application of computers and processors to advanced interpersonal and business communication facilities providing optimum man/machine interface conditions, including the design and evaluation of associated hardware and software systems and peripherals.
- Investigate methods of mathematical analysis best suited to the application of computers to problem solving in telecommunications engineering.
- Investigate, define and co-ordinate the provision and development of computer systems and facilities to meet the needs of the Research Department.

SECTION HEAD: G.K. Jenkins, B.Sc., B.E.(Hons.), M.E., M.A.C.S.

SENIOR ENGINEER: P.J. Tyers, B.E.(Hons.), B.Sc., M.I.E.E.E.

ENGINEERS:
K.S. English, B.E. (Elec. Hons.)
L.A. Denger, E.N.S.E.M.N., M.I.E.E.E., M.Soc.Fr.de Elec., Grad.I.E.Aust.
R.A. Frizzo, B.E. (Elec. Hons.)
C.A. Hunt B.E.(Elec. Hons.)
I.M. Palmer, Assoc. Dip. Electron. Eng.

SENIOR TECHNICAL OFFICER: I.J. Moran

Guided Media Section

Section Functions

- Conduct research and exploratory development into the transmission of electromagnetic waves in situations where they are guided from end to end by some form of physical structure (such as an aerial line, a telephone cable, a coaxial cable, a waveguide or an optical fibre) with special reference to the development of high capacity transmission systems, the provision of wideband subscriber facilities, and associated problems.

SECTION HEAD: G.P. Kidd, B.E.(Elec.)(Hons.), B.Sc.

N. Demytko, B.E.(Elec. Hons.), B.Sc.

Satellites Section

Section Functions

- Conduct research and investigation into applications of communication satellite technology in Australia, including system and technique studies, hardware development and experimentation.

SECTION HEAD: G.F. Jenkinson, B.Sc., M.I.R.E.E.

SENIOR ENGINEER: R.K. Flavin, B.Sc., M.Sc., M.I.E.Aust.

SENIOR TECHNICAL OFFICER: G.B. Newman

Solid State and Quantum Electronics Section

Section Functions

- Investigate the properties of materials and compounds that are applicable to the development and fabrication of devices and circuit elements whose functions are based on the exploitation of special material properties. Conduct exploratory development and fabrication of such devices.
- Investigate active and passive circuit configurations employing such devices for the generation, amplification, modulation and processing of electro-magnetic and electro-acoustic signals and their application in microwave integrated circuits and sub-systems.

SECTION HEAD: W.J. Williamson, B.E.(Elec. Hons.), Ph.D.

PRINCIPAL ENGINEER: P.V.H. Sabine, B.Sc., B.E.(Elec. Hons), Ph.D.

SENIOR ENGINEERS:
R. Horton, B.Sc.(Hons.), Ph.D., A.M.I.E.E., M.I.R.E.E.
G.O. Stone, B.E.(Elec.), M.Eng.Sc., Ph.D., M.I.E.E.E., M.I.R.E.E.

ENGINEERS:
J. Hubregtse, Fell.Dip.Comm.Eng., Grad.I.R.E.E.
E. Johansen, B.E.(Hons.)
A.L. Martin, B.E.(Dist.) Grad. I.E. Aust.
G.K. Reeves, B.Sc.(Hons.), Ph.D., M.I.E.Aust.

SENIOR TECHNICAL OFFICERS:
B. Cranston
H. Wills, Assoc.Dip.Rad.Eng., A.M.I.R.E.E.

Unguided Media

Section Functions

- Conduct research and exploratory development in the field of freely propagated electromagnetic waves, with particular reference to the study of performance and design characteristics of high capacity communication systems. (This includes the study of propagation phenomena and of the interrelation of physical and meteorological mechanisms).
- Conduct research related to antennas for launching and receiving electromagnetic radiation, for application both in the design of antennas for exploratory development work and in practical engineering projects.

SECTION HEAD: J.H. Reen, B.E.E., M.I.E.Aust.
Principal Engineers:
J.V. Murphy, B.E.(Elec.), B.A.
S. Sastradipradja, B.E.(Elec.)

SENIOR ENGINEERS
W.S. Davies, B.E.(Elec.), M.Eng.Sc., Ph.D.
R.A. Harvey, Dip.Rad.Eng., B.Sc., A.M.I.R.E.E.

ENGINEERS:
A.J. Bundrock, B.E.(Elec. Hons.)
J.M. Burton, B.E.(Elec. Hons.)
Y.H. Ja, B.E., Ph.D.

SENIOR TECHNICAL OFFICERS:
E.D.S. Fall
R.J. Francis
S.J. Hurren

Visual Communications Section

Section Functions

- Investigate methods and systems for the transmission, generation, presentation and processing of visual information of all kinds, including engineering aspects of human visual perception.
- Study means of economising the bandwidth used to convey visual information from one point to another.
- Study advanced time domain and waveform techniques related to the processing and transmission of information.

SECTION HEAD: G. Rosman, B.E.E., M.E.

SENIOR ENGINEERS:
J. Craick, B.E.(Elec. Hons.), B.Sc.

SENIOR ENGINEER: R.W. Ayre, B.E.(Elec.)(Hons.), B.Sc.(Hons.), M. Eng. Sc.

ENGINEERS:
A.M. Duncan, B.Sc., B.E.(Elec. Hons.)
D.Q. Phiet, B.E.(Elec. Hons.), Ph.D.
G.R. Smart, A.R.M.I.T., A.M.I.R.E.E., J.P.

PSYCHOLOGIST: L.A. Albertson, B.A.(Hons.), Dip.Ed.

SENIOR TECHNICAL OFFICERS:
G. Quirk
B.W. Booth

STANDARDS AND LABORATORIES ENGINEERING BRANCH

Branch Objectives

- Maintain the standards of measurement and time for Telecom Australia.
- Protect Telecom Australia's patents, registered design and industrial property interests.
- Provide laboratory services for the Department.

ASSISTANT DIRECTOR: L.H. Murfett, B.Sc.

STAFF ENGINEER: G. M. Willis, F.R.M.I.T. M.I.E. Aust., M.I.R.E.E.

Microelectronics Section

Section Functions

- Conduct research studies of advanced techniques and technologies for the design and physical realisation of electronic circuitry, in particular those involving miniature and microminiature techniques and components, and for the interconnection and mounting of these circuits.
- Investigate and develop process sequences for the realisation of these techniques and technologies.
- Develop specifications and test criteria for quality control and reliability of packaged microelectronic circuitry.
- Develop microelectronic circuit packaging design expertise and facilities for all Laboratories sections.
- Provide in-house facilities for producing prototype microelectronic circuits in experimental quantities.
- Advise other areas of the Research Laboratories and of Telecom Australia (e.g. Telecom Australia Workshops) on the selection of techniques and processes for specific purposes, and the means to implement these.
- Assist and encourage Telecom Australia Workshops and local industry to establish suitable manufacturing facilities and quality assurance systems to meet Telecom Australia's needs.

SECTION HEAD: D.E. Sheridan, Dip.Elec.Eng., Dip.Mech.Eng.

SENIOR ENGINEERS:
G.J. Barker, Assoc.Dip.Mech.Eng., M.I.E.Aust.
H.S. Tjio, B.E.(Mech.), Assoc.Dip.Electron.Eng.

ENGINEERS:
A. Brunelli, Dip.Electron.Eng., B.E.(Comm.).
G. Heinze, Dip.Electron.Eng., B.E.(Elec.).
P.R. Murrell B.E. (Elec)
D.R. Richards B.E. (Elec) M.I.E.E.E.

SENIOR TECHNICAL OFFICER: M. Crarey

Electrical Standards Section

Section Functions

- Plan and oversight the implementation, operation and further development of a system of electrical calibration facilities involving Headquarters and all States.
- Development and operation of Telecom Australia's central reference electrical standards, for all measurements from dc to SHF excepting those of frequency.
- Investigate measurement techniques in new areas of advancing technology where appropriate standards facilities are not currently available.
- Develop special measuring techniques and standardisation procedures for the verification of working standards for all requirements of Telecom Australia.
- Liaise with and advise other national standardising laboratories and participate in appropriate national and international standardisation programmes, in particular the Standards Association of Australia and the National Association of Testing Authorities.

SECTION HEAD: J.M. Warner, B.Sc., M.I.E.E.

SENIOR ENGINEER: E. Pinczower, Dip.Elec.Eng., M.I.E.Aust.

ENGINEERS: R.W. Pyke, B.E.(Elec.), Dip.Elec.Eng. M.I.E.Aust.

SENIOR TECHNICAL OFFICER: J.B. Erwin

Industrial Property and Information Section

Section Functions

- Maintain an industrial property advisory service and information dissemination service in scientific and technological fields of interest to Telecom Australia.
- Develop and exploit Telecom Australia's portfolio of patents and registered designs, and protect Telecom Australia's interests in industrial property aspects of contracts and licensing arrangements.
- Edit and control standards of technical publications and technical manuscripts emanating from the Laboratories.
- Oversight the on-the-job training of trainee technical staff in the telecommunications field, for the whole of Laboratories.

SECTION HEAD: L.N. Dalrymple, Assoc.Dip.Elec.Eng., Grad.I.E. Aust.

SENIOR TECHNICAL OFFICERS:
C.D. Barling
A.K. Mitchell
W.W. Staley

Laboratory Design Section

Section Functions

- Plan and specify, in conjunction with other Telecom Australia staff, the future accommodation requirements of the Laboratories. Liaise with construction authorities and contractors during the alteration/construction phase to ensure those requirements are met.
- Plan, specify, and arrange or re-arrange accommodation, building services, and facilities for the Laboratories in existing owned and leased buildings. Plan and co-ordinate the movement of sections to new accommodation.
- Maintain special laboratory fittings, services, facilities, and equipment installed in accommodation occupied by the Laboratories. Co-ordinate Laboratories' requirements for building and building services repairs and maintenance with the Buildings Branch.
- Co-ordinate all safety, security, and fire protection matters within the Laboratories.

SECTION HEAD: D.S. Geldard, M.I.E.E., M.I.E.Aust.

ENGINEER: R. Day, Dip.Elec.Eng., Dip.Mech.Eng., M.I.E.Aust.

SENIOR TECHNICAL OFFICER: J.T. Blake

Laboratory Instrumentation Section

Section Functions

- Provide instrumentation services for the laboratories including the co-ordination of procurement action, preparation of technical schedules and technical reports on items offered under tender, acceptance testing of new equipment, development and operation of a specification assurance programme for the calibration of instruments, fault diagnosis and preventative and corrective action and specification of instrument making facilities.
- Design and develop laboratory instrumentation where commercially unobtainable.
- Investigate measurement and instrumentation problems and provide consultative advisory services in this field.

SECTION HEAD: A.M. Collins, B.Sc.

SENIOR ENGINEERS:
A.J. Stevens, B.E.(Elec.), M.I.E.E., M.I.E.E.E.
F.R. Wylie, B.E., M.I.E.E.E.

ENGINEERS:
I. Dresser, B.E.(Elec.) M.J.J. Valk, B.E.(Comm.)
N.A. Leister, B.E.(Elec.), Grad.I.R.E.E.

SENIOR TECHNICAL OFFICERS:
S. Curlis
P. Dalliston
P.S. Dawson
B.J. McEwen

Time and Frequency Standards Section

Section Functions

- Operate, maintain and calibrate standards of frequency and time.
- Research the development of improved frequency standards and devices for the use and application of such standards.
- Verify frequency and time interval references both within and without Telecom Australia.
- Liaise with other standardising laboratories and national and international standards groups.
- Research and investigate the propagation of high precision frequency and time signals in various media with minimum loss of precision.
- Investigate applications of standard frequency and time techniques and the scientific basis of radio frequency allocations.

SECTION HEAD: R.L. Trainor, B.Sc.

SENIOR ENGINEER: R.W. Harris, B.Sc.(Hons.), B.E.(Elec. Hons.), B.Comm.

ENGINEERS:
B.R. Ratcliff, Assoc.Dip.Comm.Eng.
D.A. Latin, B.E.(Elec.)
J.P. Colvin, B.E.(Elec.) Dip. Elec. Eng. M.Eng Sc.
P. Bernhard, B.E.(Elec.)

SENIOR TECHNICAL OFFICERS:
J. Freeman
A.L. Forecast
R. Yates

Project Engineering Section

Section Functions

- Provide for the Laboratories, a specialist engineering service involving mechanical and electromechanical engineering design, including the hardware involved in construction of telecommunication models. Liaise with other areas of Telecom Australia and with industry to arrange production of these designs; and when these sources are unsatisfactory, arrange production within the Laboratories.
- Conduct research into the application of new materials and fabrication techniques, and apply these to the design and construction of mechanical and electromechanical devices, equipment and tools which cannot be procured otherwise.
- Establish specification criteria and perform quality assurance inspections to ensure that equipment produced, either in-house or outside the Laboratories, is adequate to its function and reflects a high standard of competence in the field. Establish techniques and facilities for associated metrological measurements.
- Oversight the on-the-job training of apprentice artisans and trainee technical staff in the mechanical engineering field, for the whole of the Laboratories.

SECTION HEAD: R.L. Kilby, Assoc. Dip. Elec.Eng.

SENIOR ENGINEER: P.F. Meggs, Assoc.Dip.Mech.Eng., M.I.E.Aust.

ENGINEERS:
W.F. Hancock, Dip.Elec.Eng.
R. Gilchrist, Assoc.Dip.Mech.Eng., B.E.(Mech. Hons.), Grad.I.E.Aust.
K. Ho-le, B.E.(Mech.)

SENIOR TECHNICAL OFFICERS:
E.J. Cilia
W.L. Reiners

Engineering Library Section

Section Functions

- Provide a complete library service to the Engineering and Research Departments at Headquarters.
- Oversight the provision and conduct of library services to the Engineering Department within the State Administrations and provide consultative services thereto.

SECTION HEAD: M.I. Cuzens, B.A., F.L.A.A., A.L.A., F.R.I.P.A.

LIBRARIANS:
A.E. Guest, Dip.Lib.
S.M. Peters, B.A., B.Sc., Dip.Ed., Dip.Lib., A.L.A.A.
H.M. Wisdom, B.A., A.L.A.A., Dip.Lib.
R.C. Jordan, B.Soc.Sc.(Lib.)
D. Richards, Dip.Lib.

PHYSICAL SCIENCES BRANCH

Branch Objectives

- Provide services to Telecom Australia in the fields of Physics Chemistry and Metallurgy.

ASSISTANT DIRECTOR: R.D. Slade, Assoc.Dip.Met., M.I.M., M.A.I.M.F.

STAFF SCIENTIST: G. Flatau, F.R.M.I.T. (App.Sc.)

Polymer Section

Section Functions

- Provide information, advice and consultancy as defined in the branch objectives.
- Conduct exploratory research and investigation into the chemistry and application of polymeric and associated materials to the depth necessary to enable this scientific knowledge to be applied to the solution of Telecom Australia's problems.
- Carry out scientific studies into polymeric materials and develop methods for their application.
- Develop polymer materials with special properties for particular applications as required.
- Develop appropriate test methods and specialised equipment as required.

SECTION HEAD: H.J. Ruddell, Dip. App. Chem., A.P.I.A.

SENIOR PHYSICAL SCIENTIST:
B.A. Chisholm, Dip.App.Chem., Grad. R.A.C.I.

PHYSICAL SCIENTISTS:
D.J. Adams, Dip.App.Chem., Grad.R.A.C.I.
D.T. Miles, F.C.S., C.Chem., M.R.I.C., M.R.S.H.
R.J. Boast, Dip.App.Chem., Grad.R.A.C.I.
P.R. Latoszynski, Dip.App.Sc., Grad R.A.C.I

Reliability Studies Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct exploratory research and investigation into the reliability of components, devices and assemblies to the depth necessary to enable this scientific knowledge to be applied to the solution of Telecom Australia's problems.
- Conduct scientific studies into the causes of failure or degradation of components, devices and assemblies.
- Conduct research leading to the statistical prediction of the life expectancy of components, devices and assemblies.
- Design and develop specialised test equipment.
- Develop special analytical techniques for failure analysis.
- Conduct scientific studies into the properties of metals and components.

SECTION HEAD: D. McKelvie, B.Sc.(Hons.)

SENIOR PHYSICAL SCIENTIST:
G.G. Mitchell, B.Sc.(Hons), M.Sc.

PHYSICAL SCIENTISTS
: I.K. Stevenson, B.App.Sc., A.R.M.I.T., Grad.A.I.P.
S.J. Charles, Assoc.Dip.App.Phys., B.App.Sc. Grad. A.I.P.

SENIOR TECHNICAL OFFICERS:
W.V. North
E.L. Wallace, A.R.M.I.T.(App.Phys.)

Applied Physics Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct exploratory research and investigation in the field of Physics to the depth necessary to enable this scientific knowledge to be applied to the solution of telecommunication engineering problems.
- Conduct scientific studies into the physical properties of materials and components.
- Conduct research into the effects of the natural and man-made environment on staff and plant; devise means of protection from any deleterious influences.
- Conduct Research into high voltage phenomena and its effect on staff and plant; devise protection methods as appropriate.
- Design and develop specialised testing and measuring equipment as required.

SECTION HEAD: I.A. Dew, B.Sc., M.Sc., M.A.I.P.

SENIOR PHYSICAL SCIENTISTS:
E.J. Bondarenko, Dip.App.Phys., B.App.Sc., M.A.I.P., M.I.R.E.E., F.R.A.S.
G.W. Goode, B.Sc.

PHYSICAL SCIENTIST: A.J. Murfett, B.Sc.(Hons.) Grad.A.I.P.

SENIOR TECHNICAL OFFICERS:
M.C. Hooper
B. Listopad

Analytical Chemistry Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct exploratory research and investigations in the field of chemistry to the depth necessary to enable this scientific knowledge to be applied to the solution of telecommunication engineering problems.
- Conduct scientific studies into chemical pheonomena and hazards.
- Develop specialised techniques and equipment for the analyses of materials.
- Provide the scientific backing for the operations of the Australian Government Stores and Tender Board, including the formulation of new specifications and approval testing of all relevant types of material and consumer products.

SECTION HEAD: F.C. Baker, Dip.App.Chem., Dip.Chem.Eng., A.R.A.C.I., A.A.I.S.T., F.C.S.

PRINCIPAL PHYSICAL SCIENTIST: A. McKee B.Sc.(UNSW), Phd. Leeds, F.A.I.P.

PHYSICAL SCIENTISTS:
S. Georgiou, B.App.Sc.(App.Chem.) F.M. Petchell, Dip.App.Chem.
R.J. Western, Dip.App.Chem. A.R.A.C.I.
T.J. Elms, Dip.App.Sc., Grad. R.A.C.I.

SENIOR TECHNICAL OFFICER: R.R. Pierson, M.A.I.S.T.

Metallurgy and Electro-Chemistry Section

Section Functions

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct exploratory research and investigation in the fields of metallurgy and electro-chemistry to the depth necessary to enable this scientific knowledge to be applied to the solution of telecommunication engineering problems.
- Perform scientific studies involving electrochemical phenomena in such fields as corrosion, protection and electrical power sources.
- Conduct scientific studies into the properties of metals and alloys and their application.
- Develop appropriate test methods and specialised equipment as required.
- Conduct research into surface pheonomena and electro-deposition; develop practices for the satisfactory protection of equipment and plant.

SECTION HEAD: K.G. Mottram, Fell.Dip.Met.Eng., A.M.A.I.M.M.

SENIOR PHYSICAL SCIENTISTS (Metallurgy Group):
T.J. Keogh, Assoc.Dip.Sec.Met.

PHYSICAL SCIENTISTS:
J.R. Godfrey, Assoc.Dip.Met.
K. Keir, Fell.Dip.Met.Eng.
J.R. Lowing, Dip.Sec.Met.

SENIOR TECHNICAL OFFICERS:
M. Jorgensen, Assoc.Dip.Met.
J.W. Smith

SENIOR PHYSICAL SCIENTIST (Electrochemistry Group):
J. Der, B.Sc., A.R.A.C.I.

PHYSICAL SCIENTISTS:
P.J. Gwynn, Dip.App.Chem.
Z. Slavik, Dip.Eng., A.R.A.C.I.
R.F. May

CUSTOMER SYSTEMS AND FACILITIES BRANCH

Branch Objectives

Conduct studies, exploratory development and field experiments, contribute to specifications, assist in the assessment of tenders, and provide other advice and recommendations as appropriate and relating to:

- The needs and potential needs for communication within the community considering both human and technical aspects.
- User facilities and equipment which are new or which represent extensions to existing services.
- The interaction between users or users equipment and the Telecom system.
- Performance criteria for user communication.
- Cost sensitivity studies.

Maintain an awareness of:

- Community and commercial initiatives in the area of customer facilities and equipment.
- Actual and potential community needs for new, extended or improved customer facilities and equipment.
- Local and overseas technical developments relevant to the provision of new, extended or improved customer facilities and equipment

Assistant Director: H.S. Wragge, B.E.E.(Hons.), M.Eng.Sc.(Hons.), M.I.E.Aust., M.I.E.E.

SENIOR ADMINISTRATIVE STAFF

MANAGER ADMINISTRATION: J.B. Sidbottom
SENIOR PLANNING OFFICER: J.F. Reid
EXECUTIVE ASSISTANT: A.B. Conroy
PROJECT OFFICER: T.W. Dillon
BUDGETS OFFICER: E.J Scates
OFFICE MANAGER: R.J. Steventon
Branch Administrative Officers:
T.H. Brown (Standards and Laboratories Engineering)
C.J. Chippindall (Advanced Techniques)
M.A. Chirgwin (Physical Sciences)
D. Forster (Switching and Signalling) B.F. Donovan (Customer Systems and Facilities)
J.S. Sergeant (Transmission Systems)

Papers, Lectures, Talks and Reports

Research Laboratories Reports are the vehicle by which the results of research studies and investigations, development projects and other specialised tasks undertaken in the Laboratories are officially documented. The staff of the Laboratories also contribute articles to Australian and overseas technical journals and present papers to learned societies. This list shows those papers, lectures and reports from 1-5-78 to 30-4-79.

PAPERS

Albertson, L.A.	"Telecommunication as a Travel Substitute; Social and Psychological Aspects", Journal of Communication, February 1977.
Bullock, F.G.	"An N-Way Hybrid Circuit Divider", IEEE Transactions on Circuit and Systems, Vol. CAS-25, No. 10, October 1978.
Billington, J.	"Ladder Networks with Elements in Geometric Progression", IEEE Transactions on Circuits and Systems, Vol.CAS-26, No. 1, January 1979.
Cassidy, M.	"Is Communication/Electronic Engineering Education Correctly Orientated?", Monitor, Proceedings of IREE Australia, September October 1978.
Chisholm, B.A., Flatau, G. and Ruddell, H.J.	"Telephone Mouldings for the Australian Environment", Conference on "Plastics in Telecommunications II", Institution of Electrical Engineers, London, September 1978.
Coutts, R.P. and Smith, B.M.	"Effect of Phase Ripple on Class 4 Partial Response Data Signals", IEEE Transaction on Communications, Vol. COM-26, No. 9, September 1978.
Dickson, G. and Gunn, M.W. (University of Queensland)	"Rain Attenuation on a Microwave Link", Institution of Engineers, Australia, Electrical Engineering Transactions, Vol. EE14, No. 1, 1978.
Flavin, R.K.	"Earth-Space Path Rain Attenuation at 11 and 14 GHz - Darwin, Australia", Australian Telecommunications Research, Vol. 12, No. 2, 1978.
Freeman, L.L., Kuhn, D. and Fowler, A.M.	"Development Systems - Hardware and Software Requirements", IE Australia, Conference on Microprocessor Systems, Sydney, November 1978.
Freeman, L.L.	"Control Applications - The Need for High Level Language", Institute of Engineers, Australia, Conference on Microprocessor Systems, Sydney, November 1978.
Frizzo, R.A. and Jenkins, G.K.	"A Microprocessor-Based Telephone Metering System", Monitor, Proceedings of the IREE Australia, September/October 1978.
Frizzo, R.A.	"Some Processor Techniques for Subscribers' Call Metering", Australian Telecommunication Research, Vol. 12, No. 1, 1978.
Gibbs, A.J. and Addie, R.	"The Covariance of Near End Crosstalk and its Application to PCM System Penetration in Multipair Cable", Transactions on Communications, Vol. COM-27, No. 2, February 1979.
Gibbs, A.J.	"Cumulants of PCM System Crosstalk in Multipair Cable", Australian Telecommunications Research, Vol. 12, No. 2, 1978.
Gibbs, A.J.	"Measurement of PCM Regenerator Crosstalk Performance", Electronic Letters, Vol. 15, No. 3, February 1979.
Gray, R.L.	"Meeting Specifications with Practical Filters", The Telecommunication Journal of Australia, Vol. 28, No. 2, 1978.
Gray, R.L.	"Synthesis of Bridged Filters", IEEE Transactions on Circuit and Systems, Vol. CAS-25, No. 12, December 1978.
Heinze, G.C.	"Preparation of Microelectronics Phototools using an Interactive Graphics System", Seminar on Applied Computer Aided Design/Computer Aided Manufacture, Melbourne, September 1978.
Horton, R.	"Loss and Sensitivity of the Lange Coupler", Electronics Letters, Vol. 14, No. 13, June 1978.

Horton, R.	"The 'Mirrored Meander' - a Directional Coupler in Microstrip", Electronics Letters, Vol. 14, No. 13, June 1978.
Hubregtse, J.	"Gold Alumina and Gold Quartz Bonds for Microwave Integrated Circuits", Australian Telecommunication Research, Vol. 12, No. 1, 1978.
Hunt, C.A., Jenkins, G.K. and Tyers, P.J.	"A Wired Teletext System and User Response", 8th Computer Society Conference, Canberra, August 1978.
Ja, Y.H.	"Numerical Evaluation of Phase Centres of Corner Reflector Antennas", Electronic Letters, Vol. 15, No. 1, January 1979.
Ja, Y.H.	"g 4.3 Isotropic EPR Line of Tourmaline", Journal of Chemical Physics (USA), Vol. 57, No. 7, October 1972.
Jenkins, G.K. and Tyers, P.J.	"The Application of Host-Resident Microprocessor Support Packages", 8th Computer Society Conference, Canberra, August 1978.
Johansen, E. and Sabine, P.V.H.	"Structural Characteristics of Optical Fibres", Australian Telecommunications Research, Vol. 12, No. 2, 1978.
Kett, R.W.	"Design Principles of a New Telephone Apparatus Measuring System - Part 2", The Telecommunication Journal of Australia, Vol. 28, No. 1, 1978.
Lobert, O.F. and Sastradipradja, S.	"Environmental Electromagnetic Fields around some Radiocommunication Systems in Telecom Australia", IREE-ERDA Seminar, The Biological Effects of Electromagnetic Radiation, Melbourne, August-September 1978.
Morgan, R.J.	"Some Trends in Low-Loss Optical Fibre and Cabling Technologies", Proceedings Institution of Radio and Electronics Engineers Australia, Vol. 39, No. 4, May 1978.
Morgan, R.J. and Thurman, W.H. (Transmission Planning Branch, HQ)	"Optical Fibre Transmission Systems. A Review of Present State of Development and Factors Related to Application in National Telecommunications Networks", IE Australia, Annual Engineering Conference, Perth, March/April 1979.
Nicholson, G. and Norton, J.P. (University of Tasmania)	"Bias and Residual Intersymbol Interference of Minimum-Variance Equalizers for Digital Communication", Electronics Letters, Vol. 14, No. 20, September 1978.
Rosman, G.	"Societal Impact of Portable Computer Terminals or Bring Home the Bacon", Australian Telecommunication Research, Vol. 12, No. 1, 1978.
Sastradipradja, S. and Lobert, O.F.	"Environmental Electromagnetic Fields around some Radio Communication Systems in Telecom Australia", Proceedings of IREE Australia, February 1979.
Smith, B.	M. "The Calculation of the Power Spectral Density of 30 Channel PCM Systems when in the Idle Condition", AEU., Vol. 33, No. 4, April 1979.
Smith, B.M. and Coutts, R.P.	"Effect of Phase Ripple on Class 4 Partial Response Data Signals", IEEE Transactions on Communications, Vol. COM-26, No. 9, September 1978.
Symons, F.J.W.	"Modelling and Analysis of Communication Protocols using Petri Nets", University of Essex TSG Report 140, September 1976.
Symons, F.J.W.	"Towards the Automatic Verification and Implementation of Communication Protocols", University of Essex TSG Memo 244, March 1977.
Symons, F.J.W.	"The Application of Numerical Petri Nets to the Analysis of Communication Protocols and Signalling Systems", University of Essex TSG Report 144, May 1977.
Symons, F.J.W.	"Modelling and Analysis of Communication Protocols using Numerical Petri Nets", Ph.D. Thesis, May 1978.
Teede, N.	"Solar Energy Research in Japan", Solar Energy Progress, No. 16, July 1977.
Tirtaatmadja, E.	"Designing with Bit-Slice Microprocessors", IE Australia Conference on Microprocessor Systems, Sydney, November 1978.
Willis, A.R.	"Diagnosis of Telephone Exchange Equipment Faults by Collation of Abnormalities in Real Traffic", Australian Telecommunication Research, Vol. 12, No. 2, 1978.

LECTURES AND TALKS

Addie, R.	"Estimates and Confidence Limits for the Parameters of a Non-Homogenous Poisson Process", Statistical Society of Australia, Retreat of Young Statisticians, Anglesea, December 1978.
Albertson, L.A. and Cutler, T.	"Social Experiments in Telecommunications", Telecommunications Society of Australia, NSW Division, Sydney, July 1978.
Ayre, R.W.	"A Report on Some Experiments with Single Mode Laser Diodes", 3rd Australian Workshop on Optical Fibre Communication, ANU, Canberra, December 1978.
Cassidy, M.	"Is Communication/Electronic Engineering Education Correctly Orientated?", IREE Australia, Symposium, May 1979.
Clark, G.D.S.W.	"Outcomes of Telecom 2000", Intermedia, Vol. 7, No. 1, January 1979.
Craig, E.R.	"The Role of CCIR Study Group 4 in Space Communications", ITU Association of Japan, Tokyo, June 1978.
Craig, E.R.	"Development of Space Radiocommunications Systems (National and Regional)", ITU Plan Committee for Asia and Oceania, Bangkok, December 1978.
Craig, E.R.	"Satellites and Television", The Television Society of Australia, Melbourne, February 1979.
Craig, E.R.	"International Pressures for Orbital Slots and Frequency Allocations - The 1979 WARC", Domsat 79 Conference, Canberra, February 1979.
Craig, E.R.	"Technical Bases for the Utilization of the Geostationary Satellite Orbit and Coordination between Space Services", ITU Seminar, Sydney, April 1979.
Duc, N.Q.	"Present Data Transmission Facilities and the Proposed Digital Data Network", Transmission Network Design Branch, July 1978.
Fowler, A.M. and Ross, D. (Engineering Department)	"Microprocessors in Telecommunications", Series of Lectures to various Victorian Country Members of the Telecommunication Society of Australia, May-November 1978.
Frizzo, R.A. and Jenkins, G.K.	"Processor - Based Subscribers' Metering Apparatus", State Engineers, Perth, July 1978.
Gale, N., Steel, J., Dew, I. and English, K.	"Nuclear Electromagnetic Pulses", Clayton Laboratories Seminar, Research Laboratories, July 1978.
Gibbs, A.J.	"Design of Digital Filters", Seminar on Digital Signal Processing, University of Queensland, May 1978.
Gibbs, A.J.	"Design of Binary Transversal Filters", Seminar on Digital Signal Processing, University of Queensland, May 1978.
Gibbs, A.J.	"Crosstalk in Multipair Cable", Department of Electrical Engineering, University of Melbourne, November 1978.
Gibbs, A.J., Semple, G.J. and Millott, L.J.	"PCM" Course for Engineers of the NSW State Administration, Sydney, April 1979.
Horton, R.	"The Design of Distributed Quadrature Hybrids", Department of Defence, Canberra, October 1978.
Jenkins, G.K. and Fowler, A.M.	"High-Level Languages for Microprocessors", 1978 Design Standards Engineering Conference, Melbourne, June 1978.
Jenkins, G.K. and Breen, J. (ADP)	"TACONET Software Facilities", Engineering Department, Computer Co-ordination Conference, Melbourne, June 1978.

Jenkins, G.K., Tyers, P.J. and Hunt, C.A.	"Wired Teletext for Australia?", Continuing Education Conference for Librarians, Monash University, June 1978.
Jenkins, G.K., Tyers, P.J. and Hunt, C.A.	"Wired Teletext Demonstration", Headquarters Co-ordination Committee, Melbourne, May 1978.
Jenkins, G.K., Tyers, P.J. and Hunt, C.A.	"Wired Teletext Deminstration", State Engineers, Melbourne, May 1978.
Kidd, G.P.	"Optical Fibres for Telecommunications", IE Australia, Monthly Meeting, Melbourne, March 1979.
Kidd, G.P.	"Intermodulation Distortion in Multiplexed Analogue Channels", 2nd Australian Workshop on Optical Fibre Communications, Melbourne, February 1978.
Kidd, G.P.	"Characteristics of Fibre Cable for Telecom Field Experiment", 3rd Australian Workshop on Optical Fibre Communication, ANU, Canberra, December 1978.
Martin, A.	"CV Techniques for Impurity Profile Determination in Semiconductor Material", Symposium at RMIT Department of Applied Physics, November 1978.
Millott, L.J.	"Primary Level PCM Bearer Supervision", Presentation to Headquarters and Victorian Staff at Clayton Laboratories, November and December 1978.
Millott, L.J. and Ballantyne, G. (TND Branch)	"Primary Level PCM Bearer Design", Presentation to TND and TS Staff at Clayton Laboratories, January 1979.
Morgan, R.J. and Quan, A.Y.C.	"TV Transmission over Optical Fibres", Seminar presented at Research Laboratories, Clayton, September/October 1978.
Morgan, R.J. and Quan, A.Y.C.	"Transmission of Television Signals over Optical Fibres", 3rd Australian Workshop on Optical Fibre Communication, ANU, Canberra, December 1978.
Morgan, R.J.	"Using Single Fibre Modes", 3rd Australian Workshop in Optical Fibre Communication, ANU, Canberra, December 1978.
Morgan, R.J.	"Optical Fibre - Transmission Systems", Telecommunication Society of Australia, Perth, April 1979.
Nicholson, G.	"A Numerical Model for Predicting Jitter Accumulation in PCM Regenerators", University of NSW, September 1978.
Quan, A.Y.C.	"Optical Fibre Transmission", Transmission & Line Planning Branch NSW, Sydney, March 1979 and Planning & Programming Branch QLD, Brisbane, March 27-28, 1979.
Quan, A.Y.C.	"Optical Fibre Cable TV Systems", Telecommunication Society of Australia, Brisbane, April 1979.
Sabine, P.V.H.	"Using Optical Fibres - Safety Aspects", 3rd Australian Workshop on Optical Fibre Communication, ANU, Canberra, December 1978.
Sastradipradja, S. and Lobert, O.F.	"Environmental Electromagnetic Fields Around Some Radiocommunication Systems in Telecom Australia", IREE-ERDA Seminar, "The Biological Effects of Electromagnetic Radiation", NSW Institute of Technology Sydney, and Clunies Ross House Melbourne, August 1978.
Smith, B.M.	"What is Happening in Data Transmission?", Department of Electrical Engineering, University of Melbourne, July 1978.
Smith, B.M.	, Vizard, R.J. and Jones, P.S. "Digital Subscriber Reticulation", Headquarters Branches, September 1978.
Steel, J.	"General System Aspects of Line-of-Sight Microwave Digital Radio Systems", DRS Seminar, Research Laboratories Clayton, December 1978.
Steel, J.	"Research Department's Proposal for a Rural/Remote Group Subscribers Radio System", Rural/Remote Study - Technology Tutorial, National Telecommunications Planning Branch, October 1978.
Vinnal, E.	"Digital Radio Systems (DRS) and Test Results", DRS Seminar, Research Laboratories, Clayton, December 1978

RESEARCH LABORATORIES REPORTS

Report No.	Author	Title
7096	R.E. Proudlock	A Single Phase Appliance Test Set
7131*	P.R. Hicks and E. Vinnal	Computer Programs for the Decoding and Analysis of the Magnetic Tapes from the Mobile Field Strength Receiver
7133	J.L. Park	A High Speed Regenerator for Baseband Digital Transmission Over Coaxial Cable
7136*	C.W. Downing	Type Approval of Miniature Thumbwheel Switches
7137	R.P. Coutts, G. Pridgeon and B.M. Smith	The Development of a Laboratory Prototype Digital Data Modem for Transmission over a 15 Supergroup - Assembly FDM Channel
7140*	M.W. Wawn and H. Ruddell	Examination of Filled Cable
7141	M.W. Wawn and H. Ruddell	Examination of Canadian "Filled" Cable
7142	M.W. Wawn	Evaluation of an Experimental Dry Core Cellular Polyethylene Insulated Cable
7146	R.J. Dempsey	A Television Transmission System for 2/1.27 mm PEIQC Single Quad Cable
7147	R.W.A. Ayre	A Handbook for the Sound in Vision System
7151	E.A.R. Livings	Application of Takacs Formulae to the IST Exchange
7173	J. Steel	Evaluation of the MARTS Field Strength Prediction Program
7175	R.W. Harris	High Voltage Pulsed Amplifier
7176*	I.C. Lawson, A.J. Stevens and R.W. Harris	An Apparatus for Mobile Measurement and Recording of Electric Field Strength at VHF
7179*	R.W. Ayre	A Video Link Fault Monitoring Instrument
7180	A.Y.C. Quan	Near End and Third Circuit Crosstalk Measurements on the St. Kilda-Clayton Laboratories and Oakleigh-South Oakleigh PCM Field Trial Routes
7187*	P.R. Hicks	A Wide Dynamic Range RMS Audio Noise Detector for Mobile Field Strength Receiver
7190	G.J. Semple	Effect of Bit Stealing on the Transmission Quality of 24 Channel PCM in an IST Environment
7200	J.L. Snare	Average Power Spectrum of HDB3 Line Code
7201*	K. Keir	The Heating and Control Characteristics of Small to Medium Soldering Irons
7201* Addendum 1	K. Keir	The Heating and Control Characteristics of Small to Medium Soldering Irons
7202	J.L. Snare	Time Domain Optimization of Filters and Equalizers
7206	L.J. Millott	The Sensitivity of PCM Penetration to Crosstalk Noise Parameter Uncertainties
7209	N.Q. Duc and B.M. Smith	Weighted Impulse Noise Measurements on Junction Cables for Group-Bandwidth Data Circuits
7210*	G. Barker	Report on Overseas Visit - August 1977
7214*	R.A. Frizzo	Cost Effective Debugging Techniques for Microprocessors

Report	Author	Title
7215	L.J. Millott	Supervising Primary Level PCM Bearers with Pulse Triples - Subtle Regenerator Faults
7217*	R.A. Frizzo, G.K. Jenkins and P.J. Tyers	A Wired-Teletext Simulation
7219*	N.Q. Duc	Multi-Metering and Its Effects on STD Data Circuits
7222	J.L. Snare	The Use of Contiguous Supergroups for High Speed Data Transmission
7223*	A.J. Stevens	Design of Interface Facilities for a Paper Tape Punch
7227	B.M. Smith	Interference of 30 Channel PCM Systems into 12 Channel FDM Systems
7228*	D.J. Adams and K.H. Jones	The Development of an Impact Test for Telephone Cases
7230*	A.J. Stevens and S. Curlis	Inbuilt Subscribers Meter Pulse Recorder
7231*	G.K. Jenkins	A Printer System for TACONET Display Terminal Sites
7232	B.M. Smith	Report on Overseas Visit, November-December 1977
7233	G. Kahan and G.M. Casley	A Receive Amplifier for T & N Intercom Telephones
7237	I. Stevenson	Wire Wrapping with Tin Plated and Bare Copper Wire
7238*	I. Stevenson	Microswitches for Switching DC Inductive Loads
7239	F.C. Baker and T.F. Molinski	Test Requirements for Polyvinyl Acetate Adhesives for Wood
7240	I.L. Jenkins	Communications Oriented 6802 Microprocessor Board
7241	L.A. Albertson and K.S. Bearlin	Melbourne Telelink : A Case Study
7242*	G.J. Semple	The Transmission of VF Data Signals Over PCM Derived Circuits
7244*	E. Slonim	An Archiving System for the Honeywell H6000 Computer
7246	J.M. Burton	An Examination of Some Problems Associated with the Design of Terrestrial Radio Systems Operating between 10 & 30 GHz
7247*	E.J. Bondarenko	Report on Overseas Visit - 13 October to 26 November 1977
7248	J.B. Carroll	A Modification to Hewlett Packard Model 1645 A Data Error Analyser to Prevent Loss of Information during Data Dropouts
7252*	G.K. Jenkins	A Microprocessor Object Format Conversion Facility
7270*	R.A. Frizzo	Results from the Microprocessor Based Meter Monitor

Note: The reports marked* are not available beyond Telecom Australia. In addition 19 reports of limited distribution were produced.

Staff Affiliations with External Bodies

Some of the staff of the Laboratories are active members of the governing bodies of educational establishments, learned societies and professional bodies and institutions. Staff members also serve on a variety of national and international committees. These include:

NATIONAL PROFESSIONAL BODIES (EDUCATIONAL)

VICTORIAN EDUCATION DEPARTMENT	
Higher Technician (Applied Science) Certificate Course Development Committee	G. Flatau
VICTORIAN INSTITUTE OF COLLEGES	
Academic Committee - Engineering	M. Cassidy
FOOTSCRAY INSTITUTE OF TECHNOLOGY	
Course Advisory Committee	H.S. Wragge G.F. Jenkinson
SWINBURNE COLLEGE OF TECHNOLOGY	
Electrical Engineering Departmental Advisory Committee	L.H. Murfett
Master of Engineering Ad Hoc Advisory Committee	L.H. Murfett
CAULFIELD INSTITUTE OF TECHNOLOGY	
Course Advisory Committee	H.S. Wragge
ROYAL MELBOURNE INSTITUTE OF TECHNOLOGY	
Capital Funds Committee	M. Cassidy
Course Advisory Committees	M. Cassidy R.D. Slade M.I. Cuzens
PRESTON INSTITUTE OF TECHNOLOGY	
Course Advisory Committee	R. Smith

NATIONAL PROFESSIONAL BODIES

AUSTRALIAN NATIONAL COMMITTEE FOR RADIO SCIENCE	E.F. Sandbach
RADIO RESEARCH BOARD	E.F. Sandbach
AUSTRALIAN INSTITUTE OF METALS	
Metals Technology Division (Melbourne Branch)	J.R. Lowing (Secretary)
AUSTRALIAN INSTITUTE OF SCIENCE TECHNOLOGY	
Victorian Branch Council	F.C. Baker
AUSTRALIAN ADVISORY COUNCIL ON BIBLIOGRAPHY SERVICES	
Victorian Regional Committee	M.I. Cuzens
Working Party on Systems and Communications	M.I. Cuzens
Convenor of Government Publications Sub-Committee	M.I. Cuzens
THE INSTITUTE OF RADIO AND ELECTRONICS ENGINEERS, AUSTRALIA	
Federal Council	A.M. Fowler
Publications Board	R. Horton
Melbourne Committee	R. Horton (Hon. Secretary) A.M. Fowler
THE INSTITUTE OF ENGINEERS, AUSTRALIA	
Board of the College of Electrical Engineers	H.S. Wragge
Electrical and Communications Engineering Branch Committee	H.S. Wragge B.A. Wickham (Hon. Secretary)
National Committee on Electronics and Telecommunications	H.S. Wragge (Chairman) E.A. George
AUSTRALIAN ACOUSTICAL SOCIETY	
Victorian Division Committee	D.A. Gray
Federal Council	D.A. Gray
TELECOMMUNICATIONS SOCIETY OF AUSTRALIA	
Council of Control	E.A. George H.S. Wragge
Board of Editors: "Australian Telecommunication Research"	H.S. Wragge G. Flatau A.J. Gibbs G.F. Jenkinson W. McEvoy I.P. Macfarlane L.H. Murfett
Board of Editors: 'Telecommunication Journal of Australia'	D.A. Gray

STANDARDS ASSOCIATION OF AUSTRALIA (S.A.A.)	
Telecommunications and Electronics Standards Board and Executive Committee	G. Flatau E.F. Sandbach
Australian Electrotechnical Committee	E.F. Sandbach G. Flatau
Acoustic Standards Committee	D.A. Gray
Plastics Industry Standards Board	R.D. Slade
Co-ordinating Committee on Fire Tests	F.C. Baker
Metallography Committee	T.J. Keogh

TECHNICAL COMMITTEES	
Acoustic Standards	
• Instrumentation and Techniques for Measurement of Sound	E.J. Koop
Chemical Industry Standards	
• Adhesives	F.C. Baker
• Zinc Rich Paints	F.C. Baker
Electrical Industry Standards	
• Indicating and Recording Instruments	J.M. Warner
• Electrical Insulating Materials	G. Flatau
• Dry Cells and Batteries	G.G. Mitchell
• Electrolytes	F.C. Baker
• Control of Undesirable Static Charges	G.W. Goode
Copper & Copper Alloy	K.G. Mottram
Mechanical Engineering Industry Standards	
• Tensile Testing of Metals	K.G. Mottram
• Solders	K.G. Mottram
Metal Industry Standards	
• Zinc and Zinc Alloys	K.G. Mottram
• Lead and Lead Alloys	K.G. Mottram
• Coating of Threaded Components	R.D. Slade
• Galvanised Products	R.D. Slade
• Electroplated and Chemical Finishes on Metals	R.D. Slade
Plastics Industry Standards	
• Polyethylene insulation of sheath electric cable	H.J. Ruddell
• Methods of Testing Plastics	G. Flatau
• Outdoor Weathering of Plastics	G.W. Goode
• Polytetrafluoroethylene	B.A. Chisholm
• Flammability of Plastics	H.J. Ruddell
• Mechanical Testing of Plastics	B.A. Chisholm
Safety Standards	
• Industrial Safety Gloves	F.C. Baker
Telecommunications and Electronics Industry Standards	
• Capacitors and Resistors	G. Flatau D. McKelvie
• Printed Circuits	D.E. Sheridan
• Wires and Cables	G. Flatau
• Semi-Conductors	I.P. Macfarlane
• Environmental Testing	G. Flatau
• Reliability of Electronic Components and Equipment	G. Flatau
• Electro-Acoustics and Recording	E.J. Koop

NATIONAL ASSOCIATION OF TESTING AUTHORITIES (NATA)	
Electrical Registration Advisory Committee	J.M. Warner
Assessor for Environmental Testing	G. Flatau
Assessor for Laboratories Engaged in Testing Plastics	B.A. Chisholm
Assessor for Aerial Equipment and Measurements	O.F. Lobert
Assessor for Laboratories Engaged in Electrical Testing	J.M. Warner E. Pinczower J.B. Erwin
(Subcommittee S.A.A.) Metal Finishes	T. Keogh
Plastics Advisory	H. Ruddell

INTERNATIONAL BODIES

The Laboratories participate in the activities of a number of international bodies and committees. These include:

- The International Telephone and Telegraph Consultative Committee (CCITT).
- The International Radio Consultative Committee (CCIR).
- The Australian and New Zealand Association for the Advancement of Science. (ANZAAS).
- The Bureau International de l'Heure (BIH)
- The International Electro-Technical Commission (IEC).
- The International Standards Organisation (ISO).
- The Asia Electronics Union (AEU).
- The International Federation of Documentation, Committee for Asia. and Oceania (FID/CAO)

Industrial Property

It is a policy of Telecom Australia to protect its interests in any worthwhile industrial property, notably patentable inventions but also registerable designs, which might be generated by its staff in the course of their work. Many of the inventions patented by Telecom Australia have been made by the Laboratories' staff, and the staff of the Laboratories also contribute to assessments of the novelty and likely usefulness of new ideas as they arise as possible subjects for patent or similar action. The list below summarises the portfolio of industrial property held by Telecom Australia. The property includes applications for letters patent and registered designs.

PATENT APPLICATIONS AND PATENTS

Invention Title (Inventor/s)	Patent Application Numbers: Provisional Specification	Patent Application Numbers: Complete Specification	Patent Number (if granted)	Country
Method and Apparatus for Testing Subscribers Telephone Instruments in Situ under Service Conditions (J.F.M. Bryant & R.W. Kett)		233699	3,261,926	USA
Self Adaptive Filter and Control Circuit (L.K. Mackechnie)	65671/69	23649/70	448805	Australia
		P2063183.8	2063183	Germany
		60513/70	1,334,250	Britain
		70-18580		Netherlands
		33,333A/70	913733	Italy
		70-45,859	70-45859	France
		17270/70	362,763	Sweden
		98800	3,732,410	USA
Dual Speed-Ratio Automatic Telephone Dial (R.J.W. Kennell)		23115/62	264,679	Australia
Tip Welding Means (E.J. Bondarenko)	49395/70	10361/70	455004	Australia
		4714/71	3,657,512	USA
Analogue Multiplier (H. Bruggemann)	43033/68	43033/68	414207	Australia
		43817/69	1,271,813	Britain
		P1945125.3	1945125	Germany
		GbmH6934984.4	-	Germany
		70940/69	728044	Japan
		855543	3,629,567	USA
Apparatus for Routing Discrete Telecommunication Signals (A. Domjan)	61428/69	19808/70	448958	Australia
		94405	756684	Belgium
		70-17142		Netherlands
		70-35267	70-35267	France
		44636/70	1,326,626	Britain
		P2046069-9		Germany
		8353370	859026	Japan

Invention Title (Inventor/s)	Patent Application Numbers: Provisional Specification	Complete Specification	Patent Number (if granted)	Country
Apparatus for Monitoring a Communications System and a Detector Therefor (J.A. Lewis)	PA1474/70	29415/71	458997	Australia
Monostable and Bistable Devices (I.P. Macfarlane)	PA2298/70	32612/71	465242	Australia
Control of Operation of a System (N.W. McLeod)	PA2035/70	31550/71	466670	Australia
		35385/71	1,362,707	Britain
		166819	3,745,418	USA
		71-28121	71-28121	France
		P2136516.2		Germany
		56442/71	888597	Japan
Apparatus for Use in Feeding Alternating Electric Current to a Load and an Antenna including such Apparatus (R.P.Tolmie)	PA7174/71	49340/72	484853	Australia
Smoke Detector (L. Gibson & D.R. Packham)	PA9230/72	56513/73	482860	Australia
		8221/73	564238	Switzerland
		25660/73	1,419,146	Britain
		63703/73		Japan
		367260	3,874,795	USA
Method and Apparatus for Detecting the Presence of Signal Components of Pre-determined Frequency in a Multi-frequency Signal (A.D. Proudfoot)	PB24/72	59138/73	480006	Australia
		387855	3,882,283	USA
		PV134.478	803494	Belgium
		38106/73	1,439,035	Britain
		178402	984,068	Canada
An Improved Nephelometer (L. Davidovits)	PC4285/75	20510/76		Australia
Nephelometer with Laser Source (L. Davidovits)	PC4286/75	20511/76		Australia
Tamperproof Telephone Apparatus (C.M. Hamilton & J.A. MacCaskill)	PC5285/76	23264/77		Australia
Fault Monitoring Apparatus (R.W. Ayre)	-	17251/76		Australia
Resilient Coupling Member (A.D. Pontin)	PC4019/75	19789/76		Australia
Optical Waveguides and a Method of Manufacture Therefor (P.V.H. Sabine & P.S. Francis)	PC4499/76	21232/77		Australia
Transmission System (I.R. Bryce and J.C. Blackburn)	-	22403/77		Australia
Method and Apparatus for Reducing Phase Jitter in an Electrical Signal (K. Webb)	-	24926/77		Australia
Programmable Digital Gain Control System for PCM Signals (A.M. Fowler)	PD3192/78	43735/79		Australia
Transversal Filter (K.S. English)	PD7273/79	-		Australia
Fibre Optic Termination (P.V.H. Sabine)	PD6157/78	-		Australia
Noise Assessment of PCM Regenerators (A.J. Gibbs	PD6790/78	-		Australia

Visitors to the Laboratories

The work of the Laboratories often calls for close liaison with various Australian universities and other tertiary colleges and with the research establishments of other Commonwealth departments, statutory authorities and private industry. Reciprocal visits are made by the staff of the Laboratories to these and other establishments for mutual participation in discussions, symposiums and lectures. In some instances, visitors with expertise in particular fields contribute more directly to the work of the Laboratories as consultants.

Laboratories' activities are also demonstrated to specialist and non-specialist groups from professional societies, other government departments, universities and other centres of tertiary education. This is achieved through arranged inspection tours and exhibitions, and at longer intervals by formal 'Open Days', when the work of the Laboratories is exhibited to invited guests from many walks of life.

During the year, experts from overseas telecommunications authorities, universities, government departments and manufacturing companies have also visited the Laboratories. Other overseas visitors have participated in the work of the Laboratories for longer periods to further their training in telecommunications technology. Often, these visitors are U.N./I.T.U. and Colombo Plan Fellows, whose visit to the Laboratories is a part of a more extensive period of training in Telecom Australia.

Some of the groups and individuals who visited the Laboratories during the year ended 30 April 1979 are listed below:

The Australian Administrative Staff College, Advance Course Attendees.

Australian Government Standing Committee on Communications and Administrative Services.

Australia Post Corporate Planning Personnel.

Bendigo College of Advanced Education - Final Year Chemistry Students.

Caulfield Institute of Technology -
Post Graduate Diploma of Science Students
Final Year Electrical Engineering Students.

CMGs Co-Ordinator Mr. F.A. Campbell and State Co-Ordinators.

Clayton District Telecom Office Staff - Line Supervisors Grade 1.

Chinese Computer Scientists.

Mr. J. Farrell, Researcher from ABC Science Unit.

Footscray Institute of Technology - Post Graduate and Senior Undergraduate Students.

Personnel of General Telephone and Electronics (USA).

Dr. Kumamaru, Sumitomo Electric Industries, Japan.

Line Supervisors from Supervisors course at Doncaster Linesman's School.

Polymer Group from the Victorian Branch of the Royal Australian Chemical Institute.

Dr. Rokunoe, Dainichi Nippon Cables Ltd.
Mr. M. Taki, Mitsubishi, Melbourne, Australia.

Subgroup J of the TTCP Technical Co-operation Programme.

Newly qualified Class 1 Engineers, Victoria.

Trainee Technical Officers, 1979 Intake, Victoria.

National Measuring Laboratories, Thermometry Staff.

Overseas Visits by Laboratories Staff

It is an important responsibility of any viable organization to keep abreast with developments and changes in particular fields of interest. To this end, the Laboratories arrange a programme of overseas visits each year during which members of staff interchange experience, technical knowledge, opinions and ideas. The visits are normally to other administrations, universities and industry, as well as to international forums and conferences of world telecommunications bodies and related organisations.

The following staff members have travelled overseas during the past year:
G. Barker
G.O. Stone
E.M. Sswenson
J. Der
R. Valk
G. Flatau
D. McKelvie
E.R. Craig
H.S. Wragge
R. Smith
P.H. Gerrand
G.F. Jenkinson
P. Duke
R.D. Slade

Assistance with Studies

The Laboratories have a policy of encouraging staff to further their educational qualifications and technical expertise by study in fields relevant to the work of the Laboratories. Professional staff are selected to pursue postgraduate courses, often leading to higher degrees, at universities and colleges of advanced education, or to broaden their expertise by working outside the Laboratories for short periods. Non-professional staff are also encouraged to seek higher technical or professional qualifications through part or full-time study. Incentives are offered in the form of paid study leave and other concessions for part-time studies, or of extended leave without pay for full-time studies.

B.A. Chisholm, University of Technology, Loughborough, Leicester, UK.

A.I. Miles, Undergraduate Scholarship, Royal Melbourne Institute of Technology, Melbourne, Australia.

K.F. Barrell, Australian National University, Canberra.

Sponsored External Research and Development

Telecom Australia is aware of the external telecommunications research and development capabilities which exist in universities and similar institutions, and also in local industry. Recognising the mutual benefits of co-operative effort, it actively supports pertinent projects in these organizations through formal contracts and agreements and through its participation in the activities of bodies such as the Radio Research Board.

The Laboratories, in particular, support outside research and advanced development projects in specialised fields, particularly those conducted by universities and other centres of higher learning. Current contracts administered by the Laboratories involve R&D on the topics below:

- Chemical Vapour Deposition (CVD) Technique for Manufacturing Stepped and Graded Index Solid Cored Optical Fibres.
- Electric Field Strength and Noise Distributions Relevant to Mobile radio Communications Systems.
- Correlation between Physical Properties of Plastics used in Cable Sheaths and Their Resistance to Termite Attack.
- Compensation of Gallium Arsenide by Proton Implantation.
- Electrical Parameters of Lightning Surges Induced in Telephone Lines.
- Generation of CHILL Code from Call State Transition Diagrams.
- Phase Discriminator and Display Unit for PCM Regenerator Test Set.
- Intermediate Reference Telephone System.

In addition, the Laboratories participate in joint projects with other national and international bodies, and where appropriate, seek to co-ordinate their research programme with those of the participating bodies to achieve the most effective use of the resources available.