# Research Laboratories Review of Activities • 1979 – 1980

Telecom Australia

# Review of Activities

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Telecom Australia

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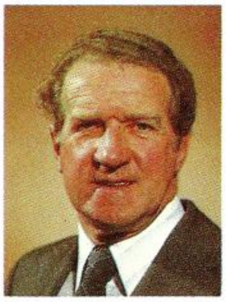
# Foreword



This particular edition of the annual review of the activities of Telecom Australia's Research Laboratories makes special mention of the recent re-organisation of the Laboratories and emphasises that one of the major motives for this re-organisation was to provide a better focus for, and to integrate, Telecom's research activities which are oriented towards improvements or advances in customer services and facilities.

In a coming decade in which saturation of demand for basic telephone services is seen as a possibility, Telecom realises that it will still have to continue to direct much of its research towards the containment of costs in providing these services. Perusal of this Review will show that Telecom's R&D centres heavily on investigations concerned with the adoption of digital techniques for switching, signalling and transmission, coupled with the use of stored program control techniques for the development and operation of the future telecommunications network. This future network will also see the introduction of new transmission media, such as optical fibres and communications satellites, which have the bandwidth potential to offer a variety of new services to Telecom's customers.

The technology and network developments foreshadowed above also make technically possible a wide variety of new telecommunications services which might be offered to various customer groups. This Review also shows how Telecom is turning more of its research attention to the determination of the needs of society for these new types of services.

I commend this selective, necessarily brief, but informative outline of Telecom's research activities for your reading.

W.J.B. Pollock
Chief General Manager

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# The Role of the Research Laboratories

Under its Charter established by the Telecommunications Act, Telecom has the national responsibility 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 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 on-going 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 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 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, this 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.

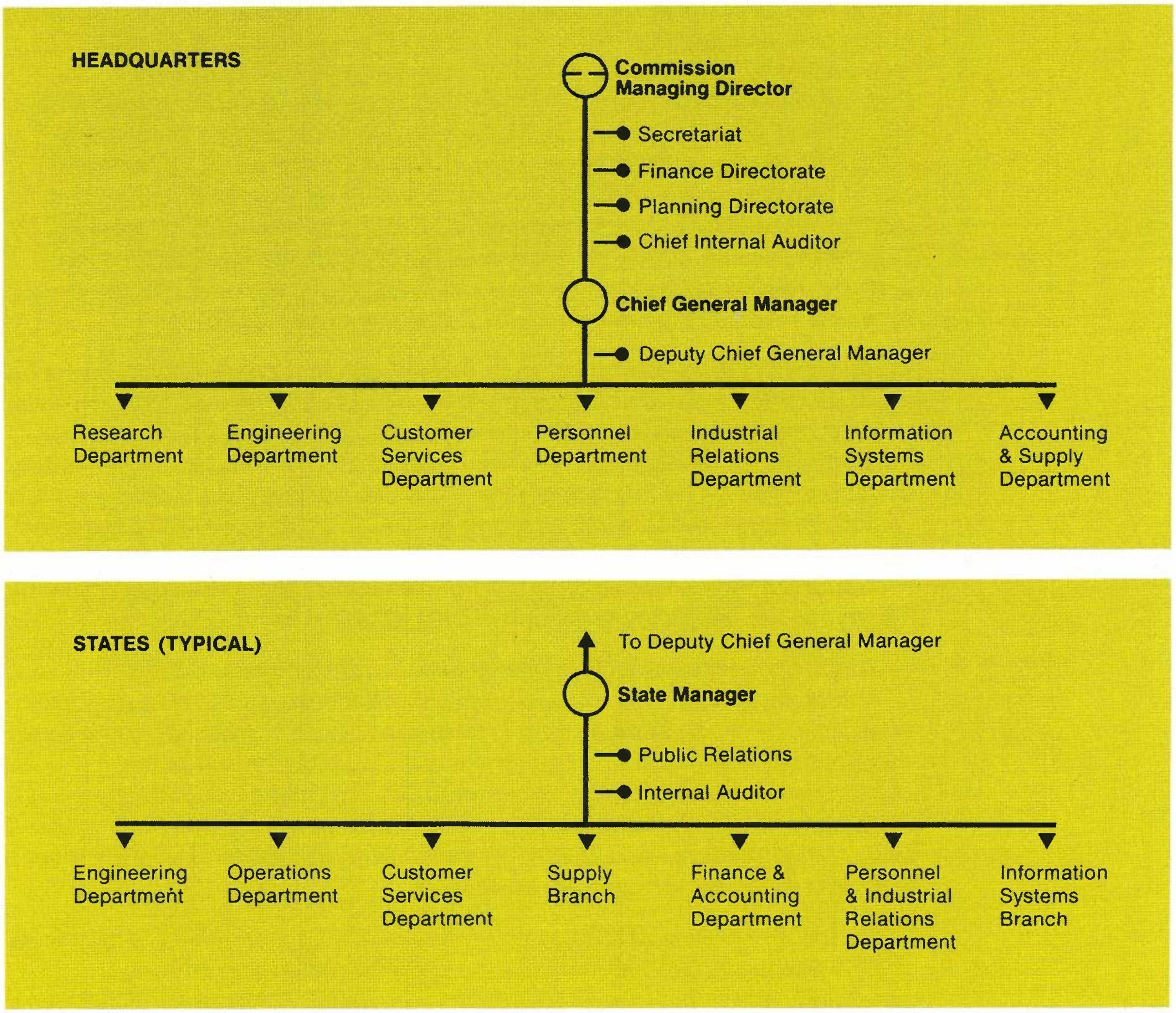
The Laboratories, by selecting relevant R&D projects in scientific and technological fields, seek to develop expertise which can be used to assist Telecom in its formulation and implementation of plans and policies for new or improved services, systems, equipment and practices. Through the application 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 to have advanced knowledge of these developments so that they may be evaluated soundly on social, economic and technical grounds, before they are accepted, or adapted and modified for incorporation into the Australian telecommunications system. To help make these decisions and judgements with confidence, it is necessary for Telecom 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 in these new and

*Organisational relationships of the Research Laboratories with other units of Telecom Australia*




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 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 applied sciences, who conduct investigations into difficult technical problems that arise in the operation of telecommunications plant. Further, the Laboratories are responsible for Telecom'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, 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 and act as focus for this activity for Telecom.

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 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 1979 - 1980.

# Organisational changes in 1979

There had been no significant organisational changes in the Research Laboratories since the implementation of the Engineer Restructure in 1972, which occurred as part of the process current at that time in all Commonwealth Departments and Authorities. The creation of Telecom in July 1975 brought with it few changes to the functions of the Laboratories, or of the Branches and Sections within them, apart from some changes of title and the elevation of the status of the Laboratories to that of a Department.

However, from an examination of the corporate policies of Telecom and indications from the trends in the corporate Research, Development and Innovation (RDI) Programme, it was clear that a better focus for research activities related to customer services was desirable. Apart from the organisational reasons mentioned, the rapid development of microprocessor technology has made it possible to provide economically a whole range of new "intelligent" terminal devices for customers, with a potential range of facilities limited by economics and customer needs rather than technical design practicability.

While the emphasis towards providing a better focus for customer services oriented research was the major motive for implementing an organisational change, the opportunity was also taken to introduce changes in other areas of the Laboratories' operations to suit changing technology, particularly that related to the sophistication and accuracy of measurement equipment, and especially that used for the scientific examination and analysis of materials and components. Accordingly, approval was obtained for an organisational investigation, which was subsequently carried out in conjunction with the Personnel Department, Headquarters. The new organisation was implemented to a substantial extent in July 1979.

The most significant change was the introduction of a sixth Branch, namely, the Customer Systems and Facilities Branch, which has brought together the various customer-related activities of the Laboratories and strengthened some of the more important of them. The Sections in the Branch are concentrating on aspects concerned with voice services, business communication and human communication in active association with both the Customer Services and Engineering Departments of Headquarters. In accordance with a specific provision in the Telecommunications Act in 1975, another Section in the Branch is concentrating on research and development into telecommunications facilities for subscribers in the rural and remote areas of Australia. An organisational feature of the new Branch is the inclusion of a team of three psychologists, who are studying various matters relating to customer communications needs and behaviour.

The establishment of the Customer Systems and Facilities Branch, to a large extent by transfer of units from the previous five Branch organisation, necessitated some balancing re-adjustments. At the same time, the opportunity was taken to increase emphasis in important areas of work as revealed by the RDI Programme. For example, the emphasis of the switching and signalling work was increased by the addition of a new Section in the Switching and Signalling Branch, specifically to focus on important signalling and control studies. At the same time, the transmission oriented work was consolidated in the Transmission Branch, by including all of the Laboratories' work on optical fibre systems within that Branch.

Advances in scientific instrumentation, which provide opportunity for studies of material science phenomena not amenable to traditional analytical methods, also resulted in organisational changes being made to the former Physical Sciences Branch, now called the Applied Science Branch. The opportunity was also taken to give some emphasis to important reliability studies of telecommunication components.

As a great deal of the operations of Telecom are dependent on precision measurements of various types, the opportunity was taken to amalgamate the previous Electrical Standards and Time and Frequency Standards Sections to form a consolidated Reference Measurements Section in the Standards and Laboratories Engineering Branch. The particular functions of this new Section will involve the co-ordination of measurement policy across a number of Research Branches, together with a greatly increased role with the Headquarters and State Engineering and Operations Departments.

The former Advanced Techniques Branch has been renamed the Telecommunications Technology Branch and it is the focus for much of the Laboratories longer term, future looking activities. The former Solid State and Quantum Electronics Section has been renamed the Solid State Electronics Section to indicate its somewhat wider range of functions. As opportunity offers, it is intended to add an Energy Technology Section to the Telecommunications Technology Branch to ensure that research elements of the greatly increased national effort on energy research and development are investigated with a view to their application for Telecom purposes.

The Laboratories, apart from their research and development responsibility, have the responsibility for industrial property matters on behalf of Telecom. This corporate responsibility, together with the central Laboratories' information functions, as well as some technical training responsibilities, have been incorporated in the Research Secretariat to provide a central staff group for the Director of the Laboratories. During the re-organisation, the administrative support structure was also reviewed to make it more appropriate to the functions to be performed in the coming situation where all the Laboratories' operations will be transferred to the Clayton area on completion of the second stage of the Monash Laboratories about 1982.

# Items of Special Interest

## Distinguished visitors to the Laboratories

Like most Research 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:

**Commissioners visit the Laboratories** On Wednesday 20 February 1980, several members of the Australian Telecommunications Commission visited the Research Laboratories at Clayton.

The visiting party consisted of Mr. J.H. Curtis, Managing Director and Commissioner, and fellow Commissioners, Mrs. J. Hancock and Mr. C.B. Quartermaine. Mr. E. Sandbach, Director of the Research Laboratories, and the Assistant Directors welcomed the visitors. Before inspecting a number of Laboratories' projects, the Commissioners joined in discussion with the Laboratories' management to exchange general views on the interpretation of the research and development objectives of Telecom and in particular, the impact of these objectives on the role of the Laboratories. The discussions were extended when the visitors joined members of the Laboratories' staff to see a number of projects "on the bench".

Projects inspected included those concerned with work in the fields of "thick film microelectronics", "reliability of telephone components", "optical fibre transmission systems and measurements", "field investigations of new customer services", "digital radio concentrator", "remote switching unit" and "processor performance monitoring". In all cases, the likely results and the relevance of the R&D work to future management decisions by Telecom were discussed.

*Staff member Dr. G.K. Reeves explains the process involved in thick film hybrid circuit fabrication to the visiting commissioners. Left to Right: Mr. C.B. Quartermaine, Dr. G.K. Reeves, Mrs. J. Hancock and Mr. J.H. Curtis.*

A number of the above projects are reported on later in this Review.

It was evident from the interest shown by the Commissioners that their visit had been a useful one.

**Visit by Mr. R.L. Nixon-Bell Canada** On Thursday 6 March 1980, Mr. R.L. Nixon, a District Plant Engineer from Bell Canada, accompanied by Mr. V.W. Fitzgerald, the Field Engineer South West, Geelong, visited the Laboratories.

After introductory discussions with the Director, Research, the visitors toured the Applied Science Branch laboratories and held discussions with staff of the Polymer, Reliability Studies, and Applied Physics Sections on matters generally related to external plant engineering.

The visitors then met staff of the Transmission Branch and discussed mutual areas of interest covering such fields as PCM, digital radio systems and optical fibre transmission systems.

Discussions were then held with staff of the Switching and Signalling Branch. An experimental remote switching unit, designed and built in the Laboratories was inspected, and general talks on the use of remote switching stages, the use of concentrators, multiplexers, and the possible application of digital techniques to subscribers' local lines were held.

Thermocouple placement for analysis of thermal gradients within a laboratory oven.

## NATA registration for environmental testing

The increasing use of solid state devices in telecommunications equipment and the interest being taken in new technologies such as solar photovoltaic cells and optical fibres has led to an increasing demand for test facilities to enable evaluation of these devices and equipment under extreme environmental conditions. While the Research Laboratories' current facilities allow environmental tests such as those described in Australian Standard 1099 to be carried out, there has, in the past, been no independent assessment of the quality of this facility.

In view of the increasing demand for the use of the facilities, the growing importance of environmental testing and the possible emergence of a scheme for an Australian-wide grading of all environmental test facilities, it was felt that it was an appropriate time to seek registration of the Laboratories' environmental test facilities by the National Association of Testing Authorities (NATA).

Such a registration, carried out by this independent body with national standing, will enable recognised test certificates to be issued and will help to guarantee confidence in test results.

Initially, registration has been sought in the fields of resistance and thermocouple thermometry and calibration of temperature-controlled enclosures. The Laboratories' present equipment limits the thermometry certification to temperatures between −70°C and 90°C. New equipment being obtained will allow calibration to be extended, at a later date, to a maximum of 200°C.

NATA certification in these fields will give recognition of measurements of temperature and humidity carried out during environmental test programmes, as well as allowing certificates to be issued for specific environmental cabinets, defining their thermal operating characteristics.

The Laboratories' environmental cabinets and calibration facilities for thermocouples and resistance thermometers were inspected by a NATA assessing team on 20 November 1979. In addition to inspecting the facilities and methods of measurement, the theory and general practice of temperature measurement were discussed with Laboratories' staff members. At the conclusion of their visit the assessing team complimented the Laboratories on the high standard, both of the equipment and of the competence of the staff involved.

It is intended to gradually increase the scope of the terms of registration so as to register at least some of the environmental cabinets for the implementation of specific Australian Standard 1099 tests in their entirety. With these upgraded capabilities, it should then be possible to examine and certify, according to the terms of the registration, all environmental cabinets held by the Laboratories, as well as to perform temperature and humidity measurements in general, with a known degree of confidence.

*CCITT Working Party XI/3 delegates and officials.*

## CCITT Melbourne meeting

Between 24 September and 11 October 1979, Telecom hosted a meeting of Working Party XI/3 of the International Telegraph and Telephone Consultative Committee (CCITT) in Melbourne. This was the first time that Australia has been a venue for a CCITT Study Group XI meeting, which is normally held in Europe—usually in Geneva.

Study Group XI of the CCITT is concerned with the study of international signalling systems and with certain aspects of control in Stored Program Controlled (SPC) switching systems. Working Party XI/3 of this Study Group has the task of developing and standardising the three CCITT languages for use in SPC switching systems. These languages are the Specification and Description Language (SDL) for the specification and description of the behaviour of SPC systems, the Man-Machine Language (MML) for man-machine communication in an SPC switching system and the CCITT High Level Language (CHILL) for writing the controlling programs of an SPC switching system.

Over 80 delegates, representing both manufacturing and telecommunications operating organisations from around the world, met in Melbourne for a series of meetings to prepare recommendations on the three CCITT languages. The recommendations were to be presented to the final meeting of Study Group XI in March 1980.

Australia has been involved for many years in contributing to the development of SDL, drawing upon Telecom's experience since 1972 in developing the Call

State Transition Diagram (CSTD) technique for application to SPC projects within the Research Laboratories of Telecom. The SDL is expected to be used internationally as a medium for specification for tendering purposes, and also offers an attractive methodology for system documentation.

The MML and CHILL are expected to have major influences on both manufacturers and users of SPC switching systems, since they will become the internationally recommended ways of conducting man-machine dialogue with the switching system and of programming an SPC switching system, respectively.

Telecom was fortunate to be the host for this particular meeting, where for the first time, all three CCITT languages reached a stage where they can be readily used in practical SPC applications. The Melbourne meeting of Working Party XI/3 offered a unique opportunity for many Australians to participate in CCITT decision-making, while also providing many visiting delegates with their first chance to visit Australia.

The organisation of this international meeting was jointly carried out by Telecom staff from the Research Laboratories and the International Branch.

## Satellite used for remote telephony trials

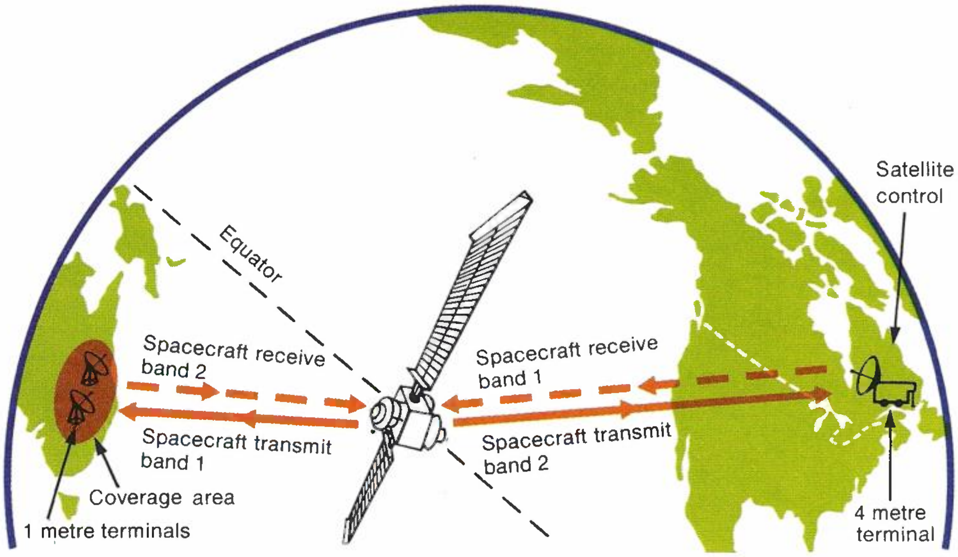
The technical feasibility of providing a fully-automatic telephony service in remote areas of Australia via satellite was demonstrated successfully during August 1979. It is believed that this was the first time in the world that a satellite connection has been used as a part of the subscriber's loop between the telephone instrument and the local automatic exchange.

The Research Laboratories provided the overall co-ordination for the telephony trials and associated experiments for which Telecom was responsible. Companion trials of broadcasting by satellite to remote areas were carried out by the Broadcasting Engineering Division of the Postal and Telecommunications Department.

The satellite used in the trials was known as Hermes. It was a joint Canadian/United States experimental satellite and, by arrangements made between the Postal and Telecommunications Department in Australia and the Department of Communications in Canada, the satellite was moved to a location over the Pacific Ocean in view of both Australia and Canada.

The Hermes satellite used two steerable antennas, each with 2.5° angle spot beams, to establish the satellite circuit for the Australian demonstrations. One antenna was directed at the east coast of Australia and the other at Ottawa, Canada, where satellite telemetry and control was maintained. Two Canadian terminals were provided for the trials. One was located at the remote

*Pictorial view of satellite beams used in telephony trials*




subscriber site and the other was used to interface with the terrestrial system. The Hermes satellite characteristics were such that any signal received on one beam had to be retransmitted on the other beam. This resulted in a "double-hop" for communication between any two points in Australia, with the signal being "patched" through Ottawa, Canada. Consequently, any echoes in the circuit had delays of a little over one second.

Special interface equipment was independently built up by the Queensland and New South Wales Administrations to incorporate the satellite link into the terrestrial system. The equipment was designed and implemented in a three week period and provided an automatic telephone facility to participants, as well as telex, facsimile, etc., facilities.

The Canadian earth stations and the Telecom interface equipment worked very well throughout the trial period and public participants were able to dial national and international numbers without difficulty. Most participants commented favourably on the transmission quality, even though the circuit was only just over 2 kHz wide due to the filtering off of the upper part of the voice band for signalling purposes. Those who tried the demonstration circuit were able to converse satisfactorily after a minute or two of learning how to cope with the long time delay.

A major public relations effort was mounted in Longreach, Queensland, on 9 August 1979, when a press luncheon was held at the demonstration site, the Jumbuck Motel. Journalists and selected dignitaries were invited to this luncheon, which had, as the main speakers, the Minister for Post and Telecommunications, the Hon. A.A. Staley, M.P., and Telecom's Queensland State Manager, Mr. P. Dubois. This press function resulted in wide and

*Canadian earth station and Telecom interface equipment located at the Jumbuck Motel, Longreach, Queensland.*

generally favourable publicity. Demonstrations were also held at Emerald, Queensland and at the national capital, Canberra.

In addition to demonstrating technical feasibility, the telephony trials were also intended as a Telecom contribution to the public consideration and debate which followed the publication of the Commonwealth Government Task Force Report on a National Communications Satellite System. The experience gained will also be valuable in connection with Telecom's involvement in the proposed national satellite system.

# 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.

*Photo below:*

*Multi facility subscribers instrument for field investigation - showing visual display, push button controls and printer.*

# customer systems and facilities

## Introduction

The customer related activities of the Research Laboratories cover a wide spectrum, which includes studies of the basic techniques utilised in various forms of customer equipment, of various forms of customer systems and of customer needs and reactions in relation to various newly emerging customer systems.

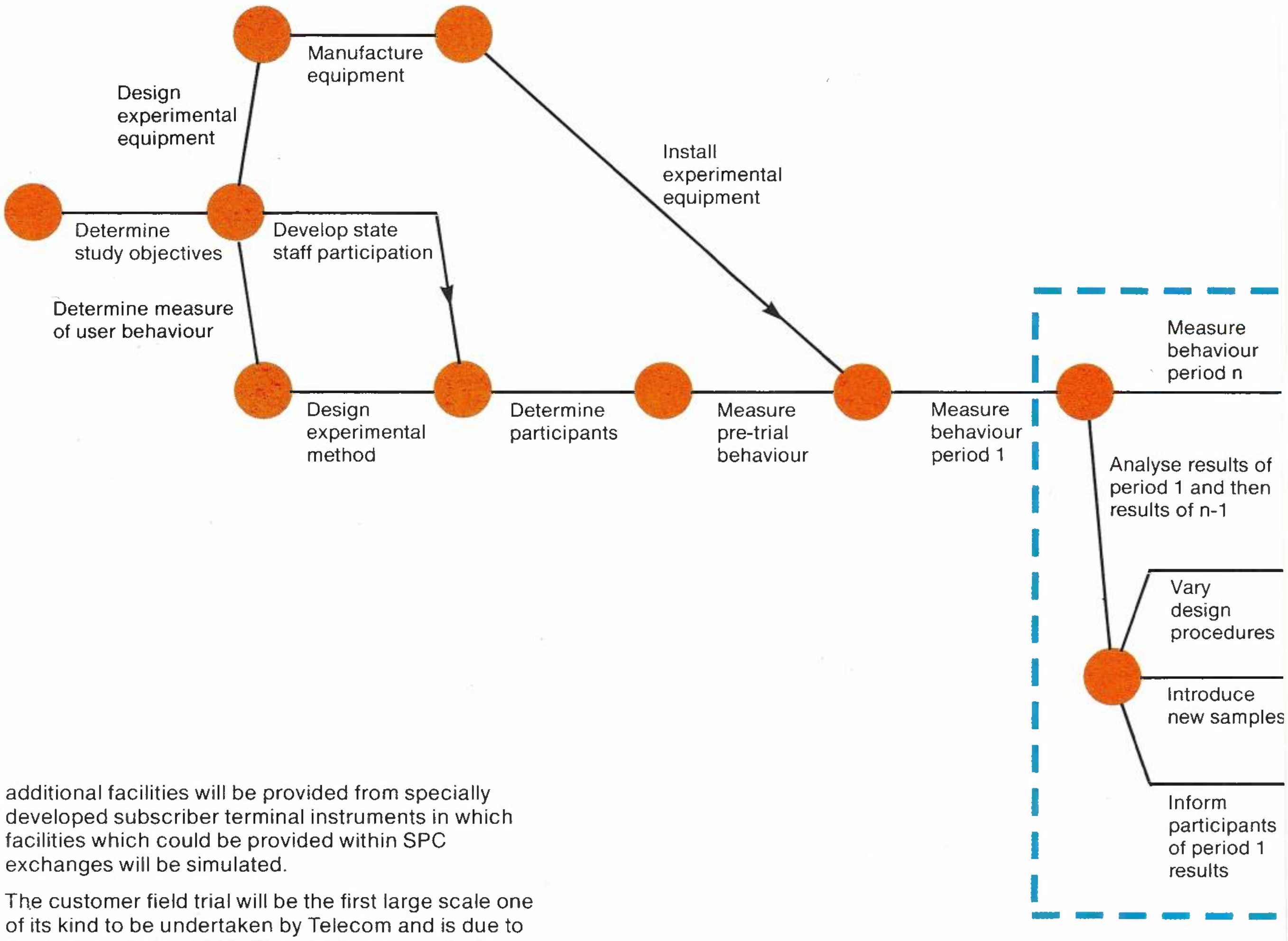
Customer needs and fashions and the availability of new technology of ever-increasing power and decreasing costs are providing pressures which are causing far more rapidly occurring changes in the customer equipment and systems areas than are being encountered in the network related areas.

The rapidity, scope and complexity of these changes necessitate the development of new methods of assessing new technologies and the likely demand for new systems, facilities and terminals. Some illustrations of the work in these fields follow.

## Field investigation of new customer facilities

The introduction of computer controlled local exchanges offers the possibility of providing additional customer telephone facilities which may have significant customer appeal, and thus Telecom is embarking on a field investigation of new customer facilities. One object of the investigation is to specify in detail the operating procedures and operational aspects of any such new facilities so that necessary design work can be completed to enable their inclusion in the new exchanges or as new customer terminal facilities.

First, there is a need to evaluate the desires of customers for facilities over a range of types of customers grouped by interest or location. In order to minimise the impact of the trial on the existing network and to simplify the conduct of the investigation, the




additional facilities will be provided from specially developed subscriber terminal instruments in which facilities which could be provided within SPC exchanges will be simulated.

The customer field trial will be the first large scale one of its kind to be undertaken by Telecom and is due to commence during 1980. The trial is one result of a policy decision by Telecom to use field research as a means of obtaining customer contributions to its planning of future telecommunications facilities. As well as providing valuable information about the responses of customers to the facilities that are currently of interest, part of the rationale for the study is to set up generally applicable mechanisms for handling future customer field trials. The study is therefore expected to serve as a model which will make subsequent studies simpler to execute.

In designing and implementing the trial programme, psychologists and engineers from the Research Laboratories are co-operating with staff of Telecom's Customer Services Department, Headquarters, and with consultants from the University of Melbourne's Public Policy Research Unit. Staff from some State Administrations will also be involved at a later date. The initial participants in the trial will be customers in the small business sector who are high users of their present service.

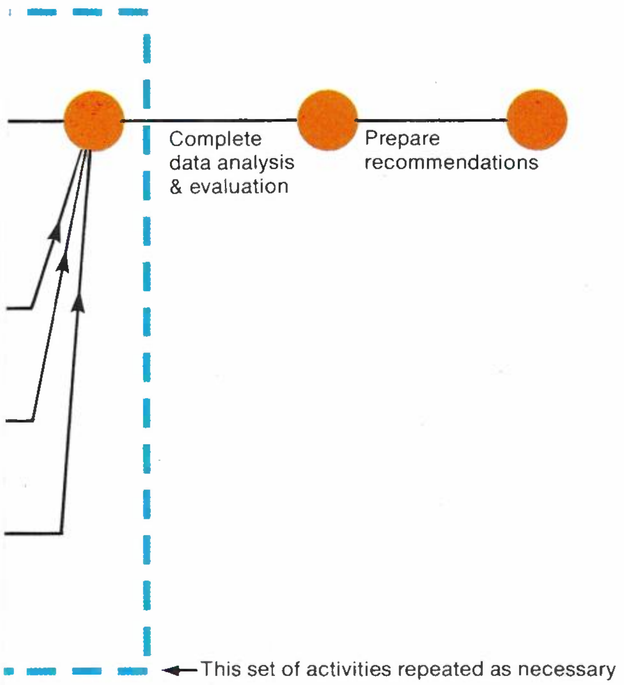
The special customer terminal instruments that have been developed for the trial use the latest semiconductor technology and operate under microprocessor control; this will give them a versatility surpassing that of other "intelligent telephones" being developed elsewhere.

The facilities which will be provided include:

- various forms of access barring under subscriber control;
- provision of charge information on a per call basis in real time;
- abbreviated dialling for up to 56 numbers;
- call waiting;
- hands free operation;
- tone ringing, and
- a digit display which can display charge information, numbers called, etc.

The instrument also incorporates highly automated maintenance features. These are intended to greatly simplify production testing and field maintenance.

*Simplified activities network for field investigation*




Production of the instruments has been carried out in Telecom's Melbourne Workshops.

The field study will have a quasi-experimental design. One aspect of this design is that the experimental instruments will be introduced into the field in a series of phases. This strategy allows the researchers to gauge the extent to which changes in levels of use are caused by factors unrelated to the facilities themselves—such as the annual business cycle. It also allows adjustments to be made, either to the instruments or to the research programme, as a result of unforeseen problems or of deliberate experimental variations.

Both objective and subjective data will be collected from the participants in the trial before, during and after their experience with the instrument. A data capture unit adjacent to the telephone will store objective data which will be read out at intervals by a centrally-located computer. Analysis of the records will permit insights into how usage patterns develop; for example, how many errors the participants make in learning to use the new facilities and how long it takes for novelty effects to subside. Subjective measures are being developed by the Research Laboratories' psychologists in conjunction with the project consultants. The customers' opinions about the facilities offered will be sought, using such techniques as questionnaires, interviews and daily records kept by participants.

With the insights gained from analysing the data collected during this initial part of the investigation, further stages are envisaged, extending to different population sectors. It is also expected that evaluation of the new facilities will entail laboratory experimentation and preference testing.

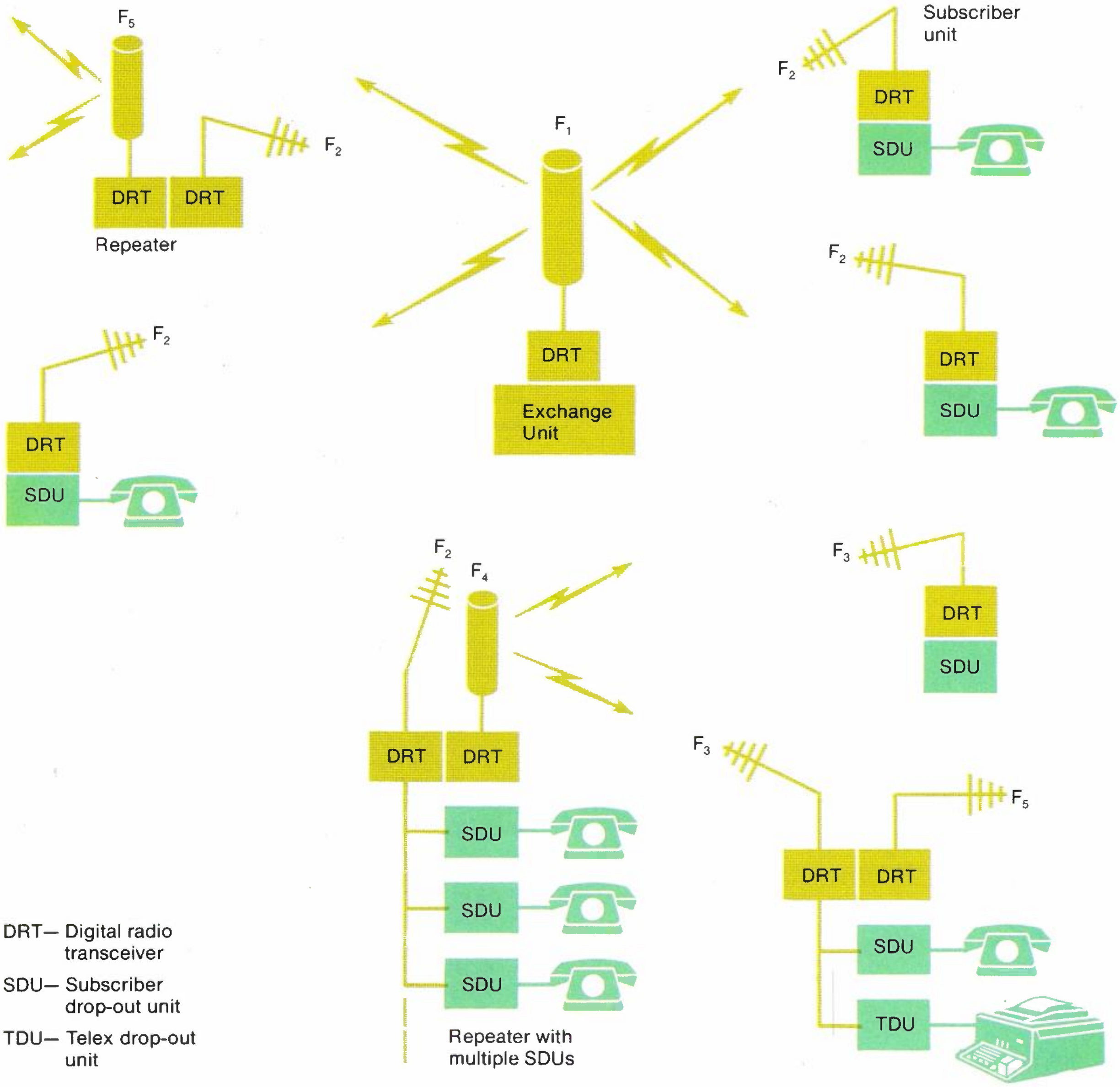
## Digital radio concentrator system for remote area services

Telecom is currently engaged in a Rural Automation Programme which aims to convert the 90 000 manual services remaining in rural and remote areas of Australia to automatic working by the end of this decade. This programme will leave a hard core of some 10 000 manual services in rural areas after 1985, which will be very expensive to upgrade to automatic working by the use of currently available equipment. In response to this challenge, the Research Laboratories investigated alternative technical solutions that could be used for the provision of services to the more distant rural and remote subscribers. The Laboratories' investigation yielded a report recommending the development of a novel radio subscriber system using existing techniques which included:

- the use of Time Division Multiple Access (TDMA)—which allows a number of different transmitters to share a single frequency;
- Pulse Code Modulation (PCM) as the method of encoding speech and other voice frequency signals into digital form;
- regenerative repeaters—which enable the service area of a system to be extended virtually to any length and in any direction without noticeably degrading the transmission quality of the circuits; and
- digital radio transmission in bursts—which enables significant reduction in power consumption to be achieved at the subscriber and repeater units, allowing them to be totally powered by solar cells.

Subsequent evaluation of the Research report within Telecom has revealed economic and technical advantages of the digital radio concentrator system (DRCS) with the result that tenders are being called from industry for the development and subsequent bulk supply of equipment to Telecom's specifications.

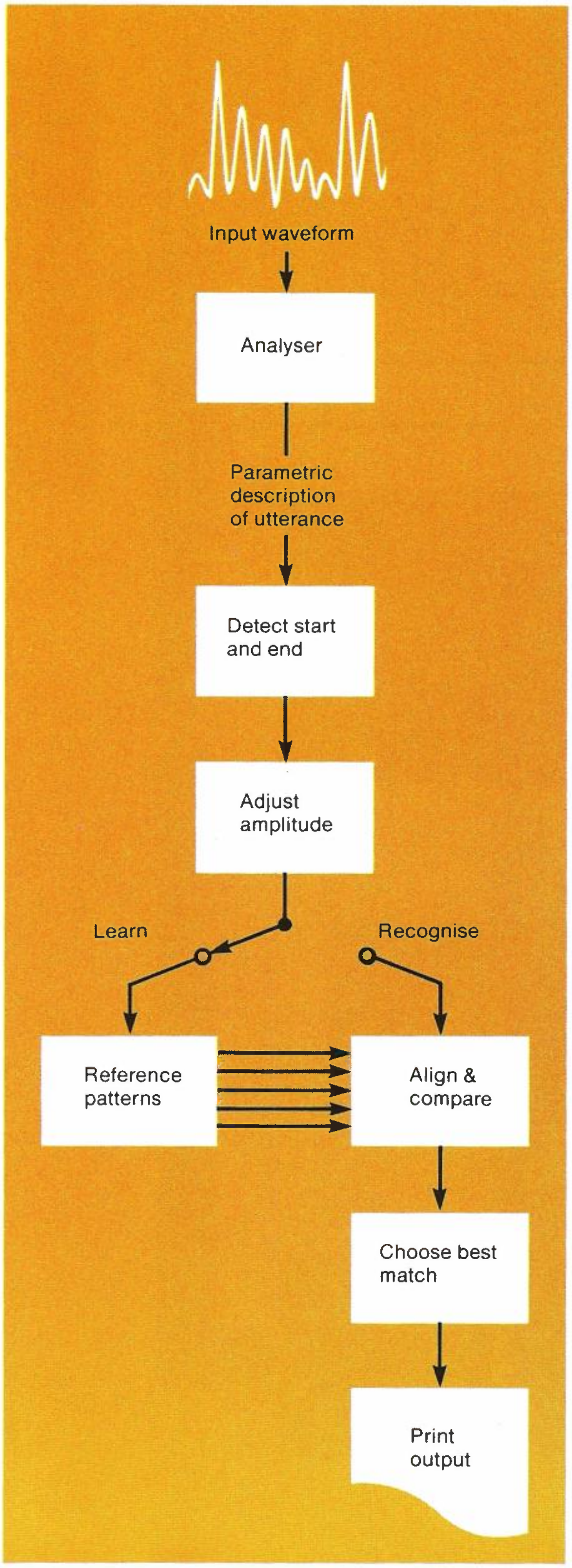
*Schematic of a digital radio concentrator system*




The proposed capacity of the DRCS is 14 speech channels, 42 telex or low rate data channels plus a common signalling channel. The specification allows any one of the 14 speech channels to be assigned to any subscriber in the system for the duration of a call. This means that, although a maximum of 14 subscribers can talk at any one time, up to 120 subscribers can be connected to the system—with each one having an acceptably high grade of service.

Although the DRCS is primarily being developed for application in the Rural Automation Programme, it should prove attractive for use in more remote areas. Such indications are coming from Telecom's Northern Territory Remote Area Study. This study aims to determine the demand for various telecommunications services in remote areas. The use of regenerative repeaters in the DRCS provides the means for serving large geographical areas with high quality circuits. Combined with privacy of communication, the use of solar power and the availability of telex and low rate data services, this makes the system suitable for application in remote areas.

*Basic form of an isolated word recogniser*




## Speech communication with machines

Speaking machines are as old as the invention of the telephone and the phonograph, and machines with program controlled speech output date back to at least 1936, when the first British Post Office Speaking Clock was brought into service. Some concept of the economic value of speaking clock services is conveyed by Telecom statistics—nearly 70 million calls are made yearly to Telecom's speaking clock service throughout Australia.

Modern research into speech communication with machines could be regarded as commencing with the invention of the voice coder "Vocoder" by Dudley in 1939, whereby speech was represented by, and reconstructed from, spectral parameters. Parametric representation offers the possibility of minimising storage requirements for speech generation, as well as providing a convenient basis for other operations of interest—for example, speaker identification and speech recognition. The real challenge of the future lies in the recognition and "understanding" of speech by machines, and despite slow progress over the past few decades, there has been some significant progress made in certain aspects of the technology.

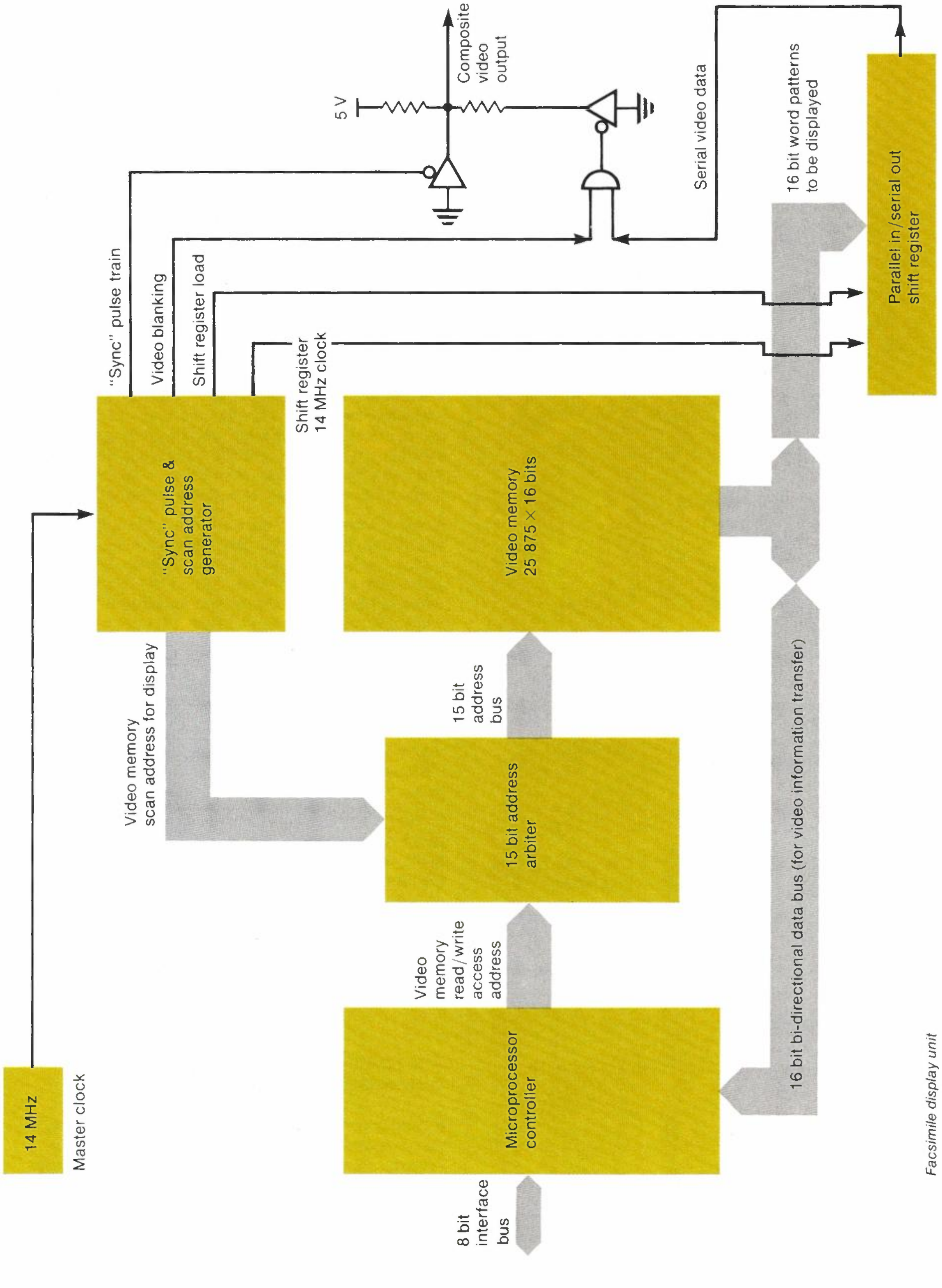
Isolated word recognisers capable of identifying up to about 100 individual words have become available during the past five years or so. They could be used for voice-operated telephone diallers, but are not economically attractive for that application. However, some success has been achieved recently in identifying words embedded in continuous speech and this success has brought the development of a practical speech understanding machine a little closer.

Nevertheless, the possibility of a computer being able to respond to a spoken telephone request from a member of the public—for example, for directory information—without strict regimentation of the customer enquiry, is still a long way off.

In the meantime, Telecom research staff are performing work which seeks to lead to contributions to the total store of knowledge of the subject, and at the same time, they are providing consultative services to teams working on systems which can be implemented with current technology.

## The loudness rating of telephone connections

Rating telephone connections by loudness, using the human voice as a signal, and the human ear as a detector, dates back to the early days of telephony when test equipment was relatively unsophisticated. Even today, the loudness rating is still one of the most important human factors which is considered when designing telephone systems.




*Facsimile display unit*

Instrumental methods have been developed over the years in an attempt to simulate the loudness rating, but these have not been completely successful because of the difficulty of defining and measuring the subjective factors involved.

While no major breakthroughs have arisen in instrumental methods of measurement, some improvements have occurred. One of the more important recent developments, which has been proposed by the CCITT, is the use of a better reference system against which the loudness of the unknown connection is compared. By making the reference system very similar to a typical telephone connection in both physical and electro-acoustic properties, deficiencies in simulating the factors involved will tend to cancel out. In addition, carbon microphones (a particular source of difficulty) are expected to be phased out in the near future.

By such means it is now becoming practicable to compute loudness ratings from objective measurements, and consequently engineering planning of the telephone network will become more precise.

A minor variation of the proposed method is already in use in the Research Laboratories for subjective assessments.

## A facsimile display unit

The paperless office, a concept that not too many years ago was considered a fanciful idea, is now being widely predicted to become the norm of the business world of the 1980s. With this in mind, investigations being conducted within the Research Laboratories into document facsimile services will become increasingly important to Telecom in the near future.

It is important that the data actually transmitted over the network for a given document be kept to a minimum, since this increases the network's capacity to handle a given volume of traffic in a period of time. To achieve this, various coding and decoding techniques can be used to reduce the amount of data necessary to represent a given document. However, some of these approaches can result in a marked degradation in the quality of the characters of the document when it is reproduced by the receiving machines. Hence, to evaluate the effects of the various coding and decoding techniques on character quality, it is necessary to have a systematic means whereby the received image can be readily examined at user definable levels of magnification. To this end, a "Facsimile Display Unit" (FDU) was designed and constructed within the Laboratories.

The FDU outputs a video signal that generates a black and white TV picture with a horizontal resolution of 720 picture elements (pels) per line and a vertical resolution of 574 lines. It receives and transmits data via a digital interface bus.

The hardware of the FDU has been designed around a microprocessor to provide it with "function flexibility". To provide flexibility in the manner in which it interprets and processes information received via the interface bus, this facility is fully defined in the FDU's software. At present, it is configured to recognise a command repertoire that can be broken into two functional groups. The first allows the user to transmit picture information to, or receive information from, the FDU. Such a transfer could involve as much as the entire screen, or as little as one pel. The second group allows the user to manipulate a picture already resident within the FDU. Examples of allowable manipulations are screen complement, line complement and pel complement—to name a few of the current repertoire of twelve commands. Of course, new functions are readily inserted by altering or adding to the system software.

The FDU allows the user to selectively examine and "magnify" segments of facsimile documents used in coding studies. In its present form, it has helped in the preparation of material for a submission to CCITT Study Group XIV concerning coding schemes. In the future, it could continue to serve in this role, or be reconfigured to meet other experimental needs as they arise.

# switching and signalling

## Introduction

Two important policy decisions have been taken by Telecom over the last twelve months and they will have a major impact on the switching and signalling aspects of the Australian telecommunications network.

The first decision was to plan the future network on the basis of an integrated digital network. This policy has opened the way to the application of new switching and signalling techniques such as digital switching in tandem and local exchanges, common channel signalling and the later extension of digital working to the customer.

In advance of the widespread application of these techniques in the network, the Research Laboratories have been conducting investigations relating to these techniques, as outlined in the examples described below.

The second policy decision was to call tenders for the provision of a public packet switching network for data services, and an outline is given of some of the Research activities supporting the implementation of this network.

Microprocessors have almost become an indispensable part of modern switching and signalling systems, bringing about a considerable shift towards distributed control and distributed processing. An example is given of an application and investigation involving six processors combined to form a signal processing system.

## Extending digital working to the telephone customer

Telephone networks have undergone a gradual change in recent years, first with the introduction of Pulse Code Modulation (PCM) as a transmission technique and more recently, with digital switching. These steps are largely a consequence of rapid progress in digital electronics technology which has gone hand-in-hand with the development of the computer industry. While these changes may appear radical to the engineering specialist, they have as yet had little or no individual effect upon the telephone customer.

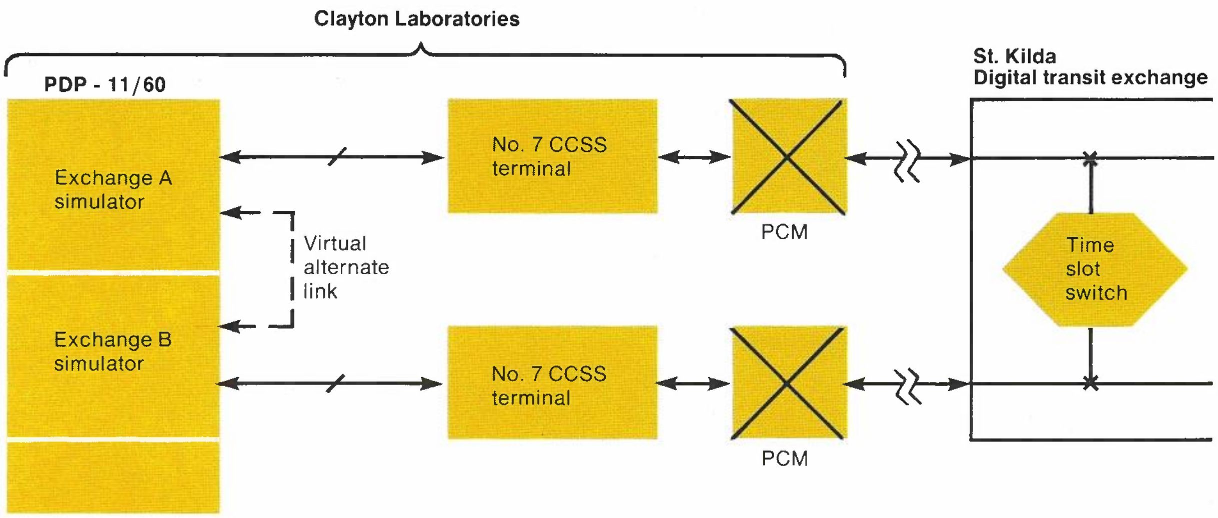
A further step in this trend is the introduction of digital techniques in the local line between the exchange and the customer's premises and in the telephone itself. While the engineer may regard this as but a final step in an orderly evolutionary process, towards a wholly digital network it may eventually appear to the customer that a revolution has taken place. With careful planning design, a digital telephone may shortly be made to provide a host of new types of services which are either impracticable or far too expensive to provide by existing analogue methods.

From an engineering point of view, these new techniques are also attractive on several counts. A prerequisite for many new types of service is a more powerful signalling scheme between a telephone and the exchange, and this may be achieved by digital methods. Other expected advantages include:

- an improvement in transmission, so that telephone calls more closely provide a desirable standard of transmission, regardless of line length;
- design advantages at the exchange termination of the line, which may also flow into cost reductions through use of electronic equipment between exchange and customer (multiplexers, concentrators) which allow economies in cable provision.

Although these factors can be expected to encourage considerable research and development in telecommunications' laboratories towards the rapid provision of suitable equipment, a major stumbling block is the absence of agreed international standards for the services to be provided and the techniques to be used. In addition, each telecommunications administration must satisfy itself that what is by now a very large investment in its cable plant can be adequately used with the new methods. This problem of cable plant "characterisation" is particularly acute, in that very little presently available knowledge is directly applicable to the new techniques, which use a much higher range of frequencies than those previously considered in analogue telephony system design.

The Laboratories are currently and energetically engaged in a wide range of activities designed to ensure that the benefits of these new digital techniques are derived on the basis of a competent knowledge base within Australia at an early date. Laboratories' activities include the sponsorship of industrial research and development on relevant aspects of the topic (a study contract was completed by STC Australia in December 1979 and others are current), sponsorship of appropriate research projects in centres of higher learning, and an extensive in-house research programme. To ensure the timely dissemination of knowledge of these new techniques, the results of this work are reported and discussed with appropriate Branches of the Headquarters Engineering Department, and where opportunities arise joint seminars are held to guide the direction of future investigations.




## CCITT no. 7 common channel signalling system

Increasing introduction of computer controlled telephone exchanges and use of digital PCM transmission circuits provides the opportunity to reduce the cost of the signalling equipment that is needed to send the various control signals between exchanges to set up and supervise telephone calls. At present, this is performed over individual circuits, but an alternative method is possible in which all the control signals are collected together and sent on a common signalling channel.

The Research Laboratories are currently developing a laboratory model of the new CCITT No. 7 Common Channel Signalling System (CCSS). The No. 7 system is optimised for operation on a 64 kbit/s PCM voice channel, but lower transmission rates can also be used. The message format is very flexible, allowing variable length signal messages. It includes a service indicator field, so that signalling can be provided not only for telephony but also for other future services—such as public switched data and facsimile.

The Laboratories' objectives in developing the experimental No. 7 signalling system are:

- to assess its potential performance, in terms of its capacity, its delay characteristics and its reliability;
- to assess its probable costs and cost sensitivities;
- to evaluate its potential application to the Australian network and identify any problems in interworking with the existing signalling systems.

The signalling traffic needed to test and evaluate the No. 7 CCSS will be provided by exchange simulators running in a multi-task minicomputer system. The signalling terminals themselves are microprocessor controlled and have been designed using functional modularity concepts. This approach is expected to reduce the disruption of the system when alternative procedures are implemented and tested. A looped PCM link of approximately 20 km total length is used to connect the two terminals together, and this also allows the use of standard PCM test equipment for error performance testing.

The reliability of a common channel signalling link is vital, because its failure may affect the operation of several thousand voice channels. All signalling links will therefore be at least duplicated and alternative signalling routes provided. It is necessary to ensure that the strategies and algorithms used to transfer signalling traffic from one route to another perform this function with no loss of signalling information. In the experimental system, these alternative routes will be provided by virtual links within the minicomputer system, thus obviating the need for additional terminals.

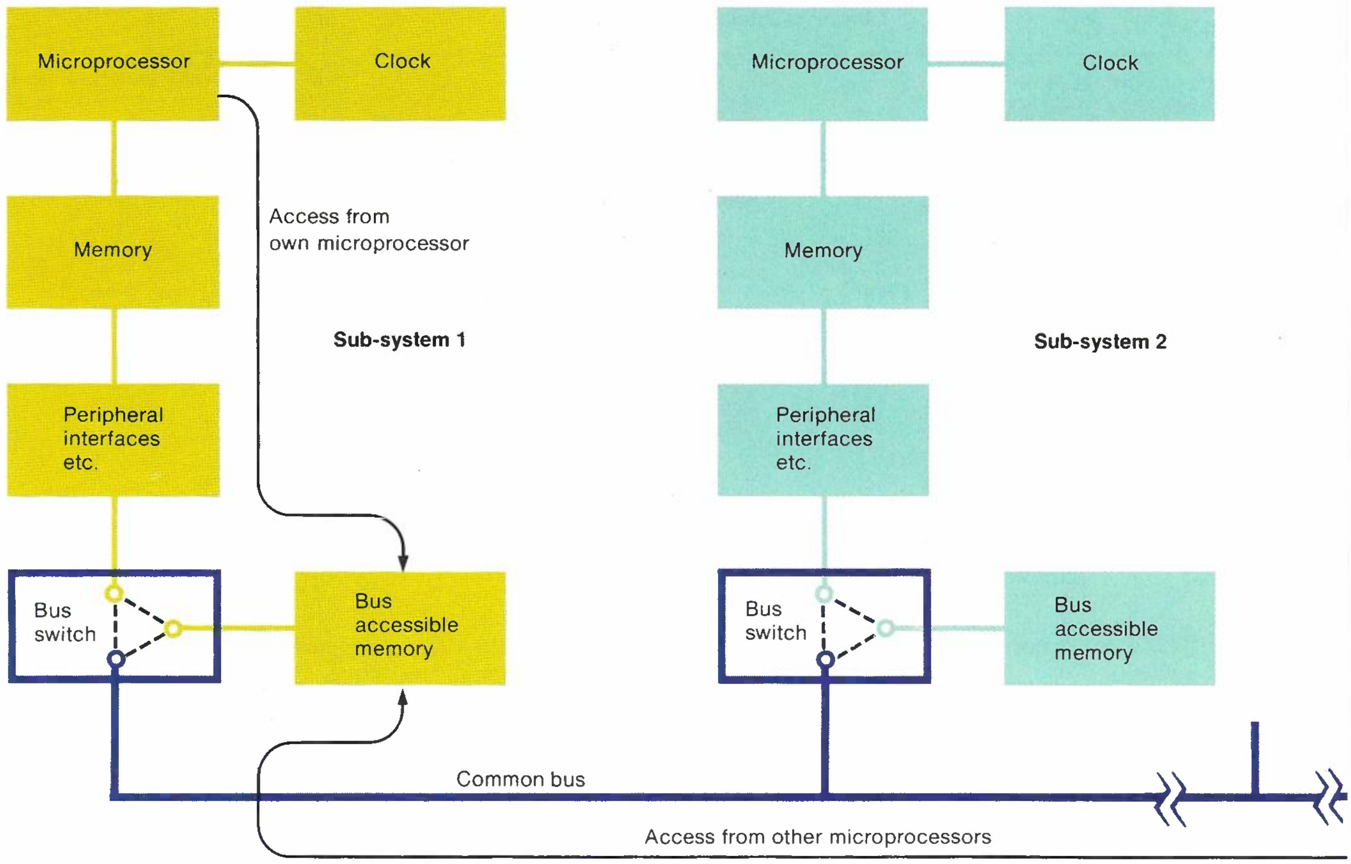
## Multi-microprocessor techniques for signal processing in a digital telephone exchange

To some extent, the control of telecommunications switching machines has come full circle with the advent of the microprocessor.

Control, which was distributed very widely through the individual switches in Strowger-type exchanges, became more centralised into registers, markers, etc. in the first types of common control exchanges, and was then highly concentrated in the main processors of the earlier stored program control (SPC) exchanges.

Microprocessors are now reversing the trend - with the distribution of control power into the smaller working

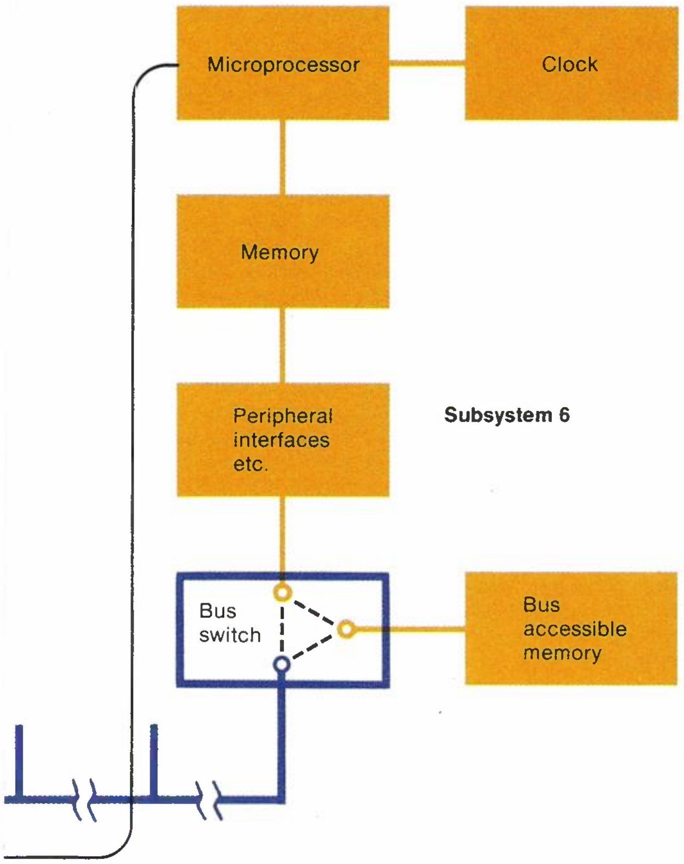
*Schematic of multi-microprocessor system for signal processing in a digital telephone exchange*




elements of exchanges. Exchange systems of the future are likely to be conglomerates of many microprocessors working together in the handling of traffic.

The Experimental Integrated Switching and Transmission (IST) Exchange developed in the mid 1970s by the Research Laboratories is a fully digital telephone exchange using Pulse Code Modulation (PCM) carrier systems to connect it into the Melbourne telephone network in an experiment under live traffic conditions. Four of these PCM systems are obsolete 24-channel systems with a very high fault incidence and they are now being replaced by modern 30-channel systems complying with CCITT standards. As the required format of the bit streams for this replacement is radically different from that of the 24-channel systems, it has become necessary to replace the input/output stage of the IST exchange. The buffering and timing sections of the new stage use conventional digital circuitry; but the opportunity has been taken to use a multi-microprocessor system for the signalling lead extraction and transmission, in order to be able to evaluate the suitability of microprocessors for this type of application. Each of the four PCM systems has a microprocessor controlling its signalling bits, and a fifth microprocessor provides the interface between the PCM systems and the main exchange control processor. A sixth microprocessor provides for some of signalling functions associated with telephone dial signalling.

Each of the six microprocessors operates autonomously with its own clock, memory, etc., - with communication between microprocessors via a common bus which is seized by a particular microprocessor when it has information to pass. Each microprocessor has associated with it a block memory, which it can access, or which can be accessed by one of the other microprocessors via the common bus. The operation is somewhat analogous to placing and removing mail from a mail box. Each microprocessor can access its own bus-accessible memory at any time provided no other microprocessor is accessing it; but only one access using the common bus may occur at any one time. Circuitry within the bus switch-block allocates the bus on a "first-come first-served" basis, and this avoids contention by causing the later microprocessors to wait their turn.




## Packet switching–techniques and protocols

Packet switching for data traffic was devised in the late 1960s and early 1970s as a technique for supporting computer-to-computer information transfer. Information transfer between human beings during a conversation over the telephone network can appear to be simple, provided that both parties speak the same language, but information transfer between two relatively "unintelligent" computer systems can present a complex problem. This is because computer data communication normally does not have all the redundant information and procedures (i.e. syntax, grammar, context) that are taken for granted in human communications. Data transfer is particularly sensitive to the errors and delays which can be introduced by the computer systems communicating over a data network, or by the physical network itself. To overcome these problems, data transfer in a public data network must observe special complex rules and procedures known as protocols. These protocols must be standardised to allow consistent access techniques and to support universal intercommunications between computer systems.

To prepare for the introduction of an Australian public data network, the Research Laboratories are studying the causes of the error and delay problems associated with packet switching techniques and are working on the development of formal methods for the specification and verification of protocols. Packet switching separates a data flow into relatively small "packets", for example, 1000 bits or less. These packets are transmitted individually from one switching node to another switching node in the network, working progressively from origin to destination. At each node, packets to be sent over any particular transmission link are queued and transmitted in sequence. This leads to efficient and flexible use of the transmission link but results in variable delays and the possibility of congestion and overload problems, which must be controlled. The Laboratories' studies are aimed at understanding the behaviour of packet switching systems and networks, with a view to guiding the selection and evolution within Telecom of techniques for use in a public data network.

Data network protocols are concerned with the procedures for detecting and recovering from errors, for establishing and clearing a connection across a network between two computer systems and for controlling the flow of data. These protocols are complex and are generally specified using natural language text. This tends to result in specifications which are ambiguous and difficult to understand. The Research Laboratories have been deeply involved in the development of a formal specification method called the Specification and Description Language (SDL). This was originally devised for the specification of telephone systems. Recently however, it has been successfully applied to the specification of data switching protocols. The method is based on state transition diagrams which employ graphical techniques and pictorial symbols—resulting in unambiguous specifications. Current work is aimed at further development of the method and at encouraging the CCITT and ISO, which are the international standards organisations concerned with data networks, to adopt a similar approach.

*Diagram below:*
*Components of a public packet switching data network*

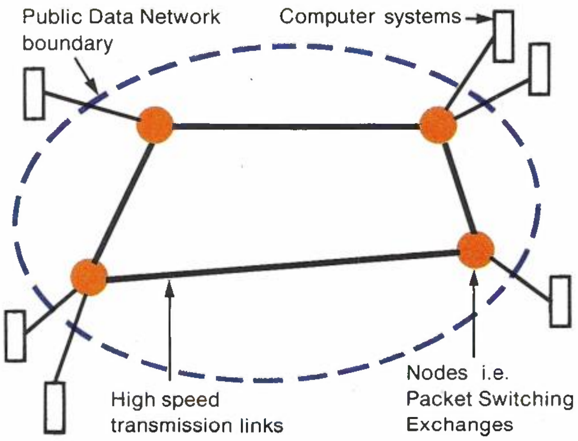


*Diagram below:*
*Crosstalk interactions arising from the presence of a digital transmission system*

# transmission systems and techniques

## Introduction

The decisions to implement a Digital Data Network (DDN) and to develop the urban network as an Integrated Digital Network (IDN) have added further impetus to Telecom's study of digital transmission techniques and systems. These studies have ranged from consideration of the evolution of IDNs, through the requirements of established IDNs, to investigations of new digital transmission systems.

Some particular aspects of these studies are reported in the articles in this chapter, as follows:

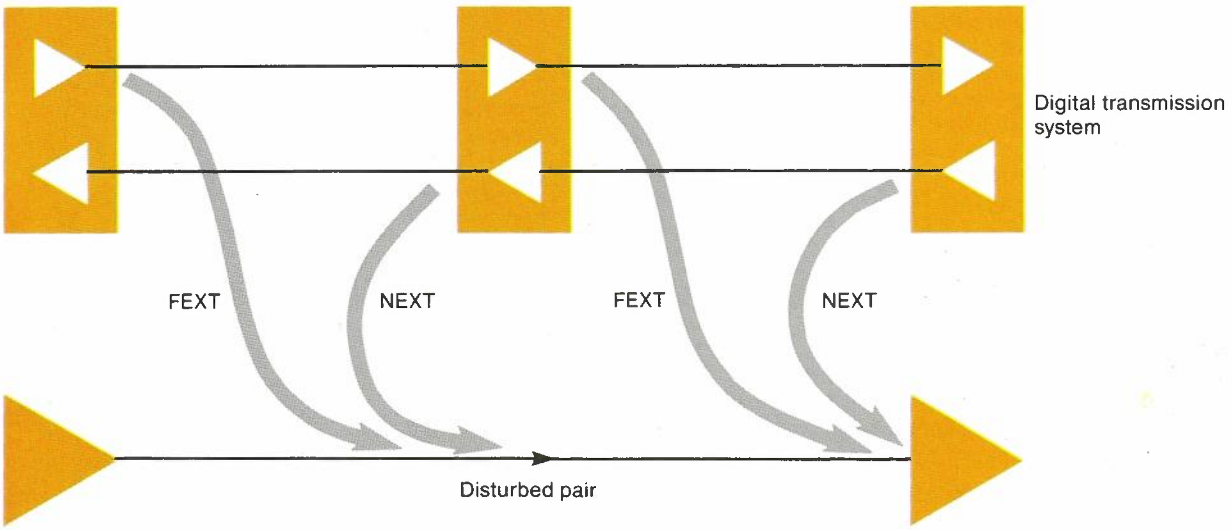
- the compatibility of newly introduced digital systems with existing analogue systems operating on multipair cable, and the use of the existing long-haul FDM network for high speed data transmission;
- the requirements of IDNs for timing synchronisation, and the effects on transmission and system compatibility of timing jitter;
- the application and characterisation of optical fibre systems and digital radio systems in the inter-exchange junction network.

## Signal transmission compatibility in multipair cable

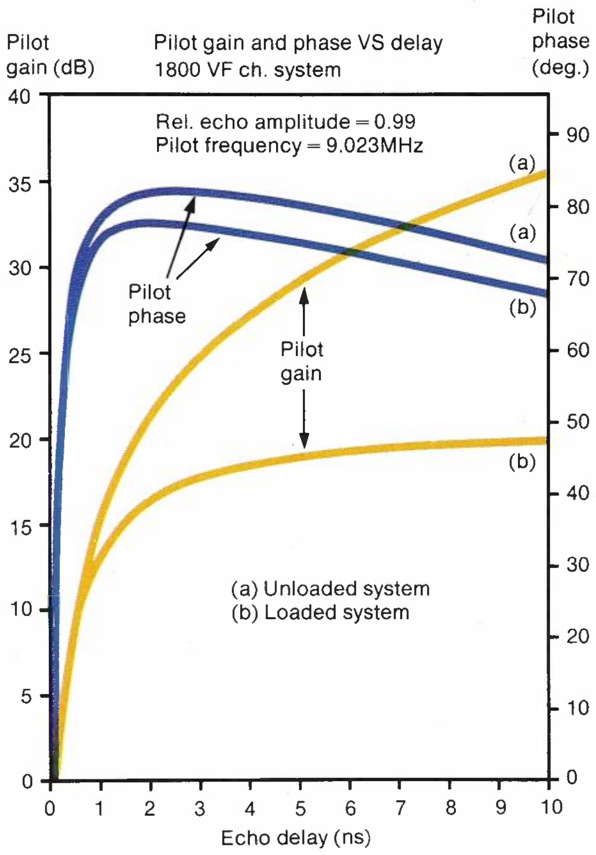
At present, a number of digital transmission systems are being introduced into the local and junction networks and these are to operate on the existing multipair cable originally provided for analogue voice transmission. Many of these systems operate at high bit rates—with the result that the transmitted signal possesses a wideband power spectral density. As a consequence, crosstalk interference will arise from such systems into many existing systems and services, and in some cases, this may place restrictions on the co-existence of systems in a cable.

To fully utilise the existing cable network, compatibility studies are being undertaken in order to determine interference levels which will allow co-existence of systems. The adjoining figure illustrates the crosstalk interactions that arise between a four wire data circuit and a second system that occupies the same cable. Of the two crosstalk interactions indicated, near-end crosstalk (NEXT) dominates in the vast majority of cases as this interference is not attenuated by the cable, whereas this does occur with far-end crosstalk (FEXT). Many systems equalise the received signal, and in such cases, an equaliser amplifies the crosstalk interference while maintaining a constant signal level at the output. For such systems, the operating section loss is of importance, together with the transmit level of the data system and the relative positions of the systems within the cable.

Previous investigations in the Laboratories have been concerned with the interference arising from the existence of primary level PCM systems in junction cables, but present studies are concerned with



*Gain and phase variations due to frequency selective fading*




determining permissible transmit levels for the baseband data systems which are to operate within the planned Digital Data Network.

## Effects of FM radio signal fades on data transmission

Microwave radio systems form a 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 being transmitted between computers.

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

The Research Laboratories are collaborating with the Headquarters Engineering Department in the study of these transient effects on data transmission. In particular, the results of a theoretical analysis of fading in frequency modulation (FM) radio systems indicate large amplitude and phase transients during fading which correlate with observations on data transmission tests over single-hop radio routes during such fading conditions. The analysis shows that the magnitude of these transients is dependent on the "loading" or the number of telephone calls that are being carried on the system at the time. The effect on the gain and phase shift of a high frequency pilot for a deep fade is illustrated in the adjacent figure.

A data modem has an automatic gain control (AGC) and a phase tracking loop which can adapt to variations in gain and phase, provided they are not too fast. The Research Laboratories are studying the speed of these variations during fading to assess the resultant effect on data transmission, especially in high data rate systems operating over many voice channel bandwidths.

This work is part of an overall assessment of the ability of the analogue telephone network to carry ever-increasing quantities of digital data traffic. In the proposed Digital Data Network (DDN), this traffic will be carried in large bundles of telephone channel bandwidth and this necessitates a better characterisation of the transmission medium, and especially of such phenomena peculiar to radio systems as fading. The Research Laboratories are assisting the Engineering Department in the recognition, characterisation and minimisation of these effects.

## Digital network synchronisation studies

Telecommunication networks around the world are experiencing structural changes and digital networks are emerging as important new entities. This trend is already being reflected in the development of the Telecom network by the planned introduction of a Digital Data Network (DDN), the likely future installation of digital telephone exchanges and the planning of a packet switched data network.

Digital networks differ in their requirements from the familiar analogue networks, and one unique requirement of a digital network is the preference for nodal synchronisation, so that each node (exchange) in the network should maintain an absolute time reference. The transmission performance of digital networks is dependent on the quality of synchronisation throughout the network, and the Research Laboratories are studying network synchronisation and its impact on transmission performance. Digital network transmission performance is degraded by slip, which causes the loss or necessary repetition of information through imperfect synchronisation, and slip is the focal point of current studies.

*Diagram below:*
*Accumulated jitter of regenerators 1, 3, 5, 6, 8, 10*

Slip is caused by differences in nodal (exchange) clock frequencies and excessive transmission path delay variations (wander). Elastic buffer stores are used to compensate for most wander, but their capacity is occasionally exhausted and a slip results. The CCITT recognises slip as an unavoidable phenomenon in digital networks and is active in developing slip rate objectives. The Laboratories are following the CCITT studies of this topic with a view to possible contributions in the future.

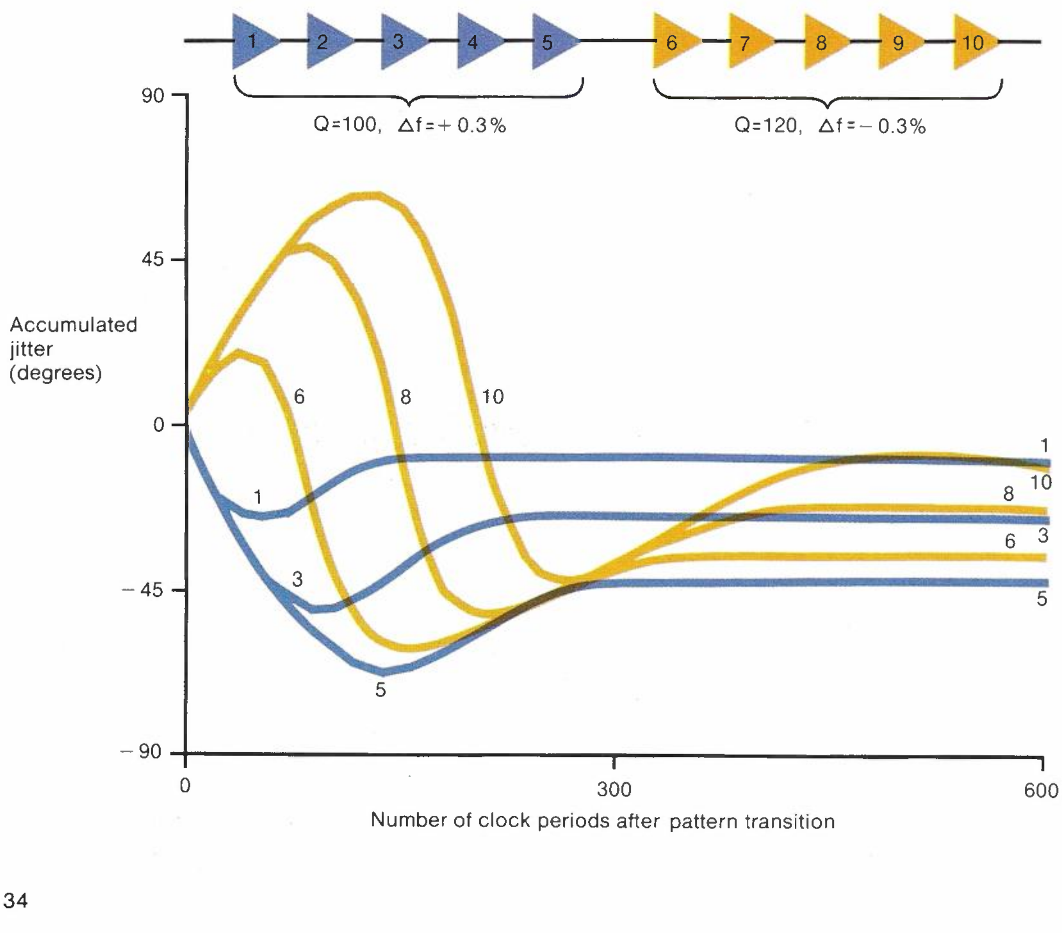
The synchronisation studies are presently aimed at predicting slip rates in the digital networks proposed for introduction into the Telecom network and at evolving a suitable synchronisation strategy which will minimise the occurrence of slips in a cost effective manner.

Digital telephony networks within large cities are of particular interest and relevance. The study is proceeding on two fronts, namely, the gathering of information concerning network structures and the details of slip generation at their nodes, and the prediction of wander in Telecom's transmission networks. Progress has been made on both aspects, though wander on long-haul transmission facilities remains largely unexplored at present. When sufficient data has been accumulated, a synchronisation model will be established so that quantitative analyses of slip rates in the proposed Telecom digital networks can be performed.

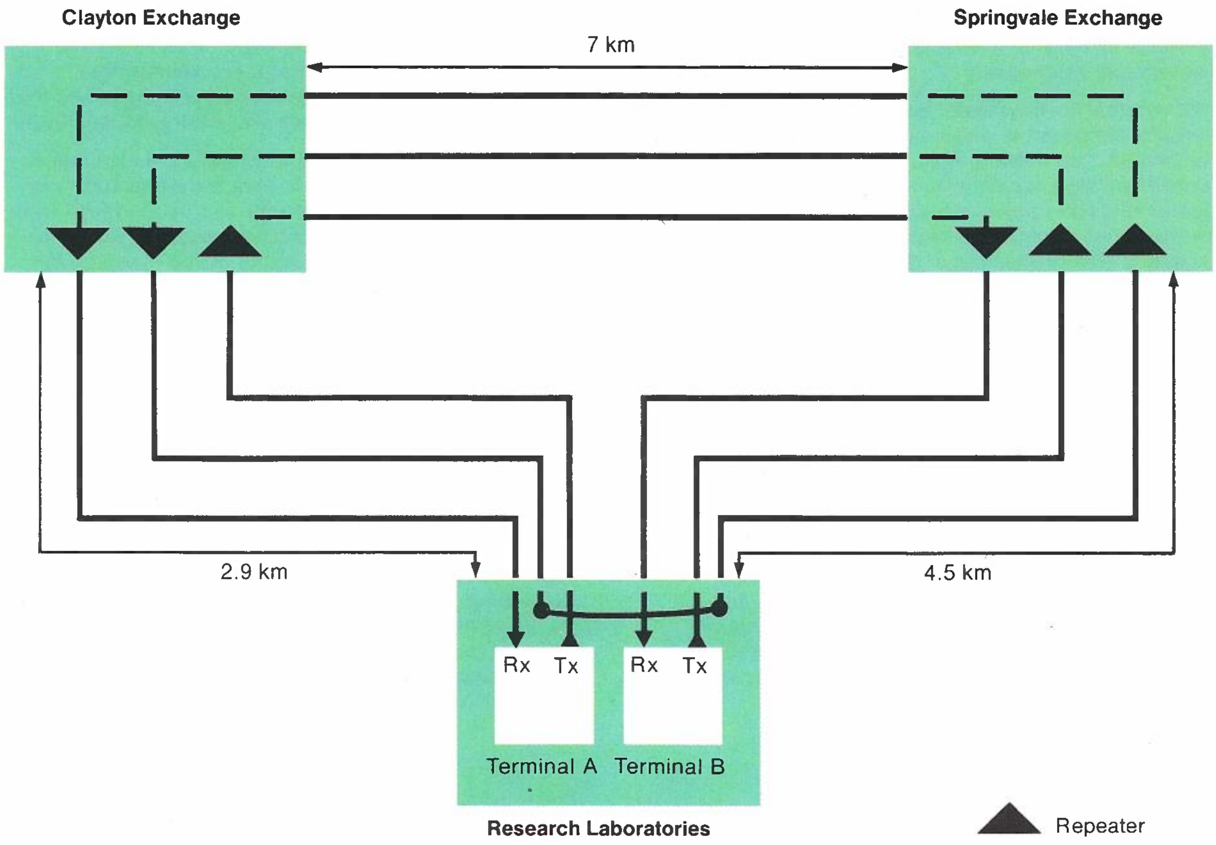
## Jitter in digital networks

An impairment to digital networks is caused by timing jitter of the digital signals. Jitter is defined as short-term variations of the significant instants of a digital signal from their ideal positions in time, where the significant instants are conveniently interpreted as the transition times of the digital signal. The effect of jitter can be to increase the error rate of the digital system and to cause distortion of reconstructed analogue signals.

To ensure satisfactory performance of the digital network, the jitter of digital equipment must be limited. The Laboratories have been investigating methods to specify jitter in a digital network, along similar lines as those being developed within the International Telegraph and Telephone Consultative Committee



*Plan of field experiment between Clayton/Springvale Exchanges and the Research Laboratories*




(CCITT). The approach being taken by the CCITT is to recommend limits on the allowable jitter at equipment interfaces, with the purpose of achieving compatibility between digital networks at international interconnection points. The CCITT recommendations provide a basis from which a national jitter specification can be formulated which is appropriate to the Australian network.

One approach being investigated is to consider a digital network as comprised of component digital equipments with jitter specified at the equipment interfaces; that is, with specified limits on the tolerable input jitter and maximum permissible output jitter. The method has application to multiplex equipment, digital exchanges, modems, etc., as well as to digital line systems. The studies have concentrated on jitter specifications for 2048 kbit/s digital equipment, as this is the bit rate planned for most equipment interconnections.

The approach of specifying the input and output jitter at an equipment interface deals with the compatibility of equipment, but this does not provide a complete method of prescribing jitter in a digital network. Further aspects which require specification are the output jitter and jitter transfer function of individual equipments, since these are important in limiting jitter accumulation. These aspects are also the subject of Laboratories' investigations.

## A field experiment with an optical fibre system

In view of the rapid development now evident in optical fibre and associated device technologies, and of the important role optical fibre systems will no doubt play in the network's future development, a field experiment in optical fibre systems was commenced early in 1980.

The purpose of the field experiment is to demonstrate the viability of the new cable technology and give hands-on experience in optical fibre systems. To ensure that maximum benefit is derived from this experiment, a working party was formed to co-ordinate its execution. Working party delegates are drawn from the Research Laboratories and from relevant Branches within the Headquarters Engineering

*Photo below:*
*Research Laboratories staff measuring the variation of the AWA/Olex optical fibre cable characteristics as a function of temperature.*

Department. Assistance is also being provided by the Victorian State Administration, from time to time as the experiment progresses.

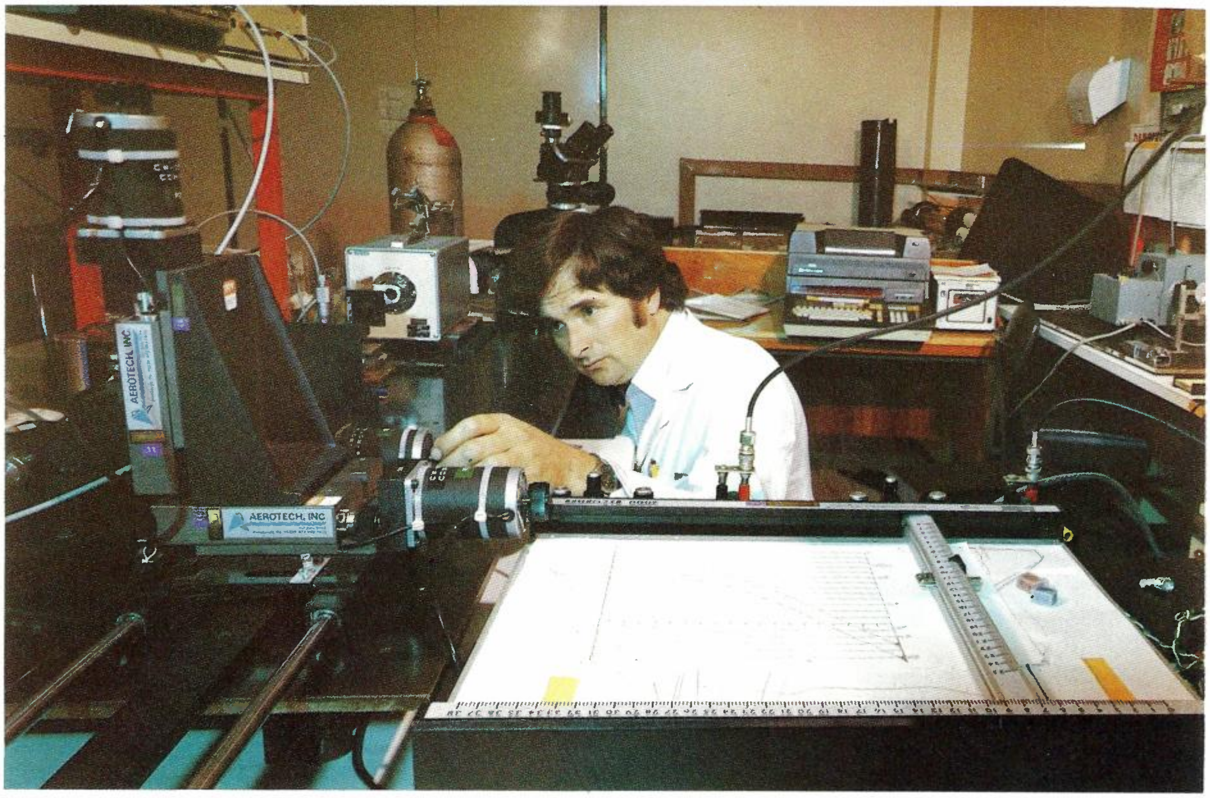
With optical fibre systems, long repeater section lengths are possible when digital transmission techniques are utilised. Also, the light-weight optical cables are significantly smaller in physical diameter than metal pair cables of equivalent traffic capacity currently in use, offering better utilisation of duct space. It is thus anticipated that the first application of optical fibres in the network will be between metropolitan exchanges and, that, with digital transmission, the great majority of these systems will not require intermediate repeaters.

For the planned experiment, an 8 km length of optical cable is being purchased from an overseas supplier. The cable has an outside diameter of 18 mm and contains six low-loss, high-bandwidth graded-index fibres. Also, industry has been invited to tender for the supply of terminal and line equipment. Depending on Telecom's evaluation of the tenders received and the foreseen demands on existing cables between exchanges, systems capable of transmitting 480 (34 Mbit/s) or 1920 (140 Mbit/s) voice frequency circuits will be installed for the experiment. Before installation, the cable and equipment will be evaluated in the laboratory. Post-installation cable evaluation will also be conducted. The proposed cable route and location of terminals and repeaters between the Clayton and Springvale telephone exchanges and the Research Laboratories is shown in the adjacent figure.

At a later stage, possibly during 1983, the experiment will be advanced in status to become a feasibility trial involving live traffic between the two exchanges—with terminals located at the exchange ends. At the same time, a fibre pair within the cable will be reserved for ongoing research work, aimed at evaluating second generation fibre systems.

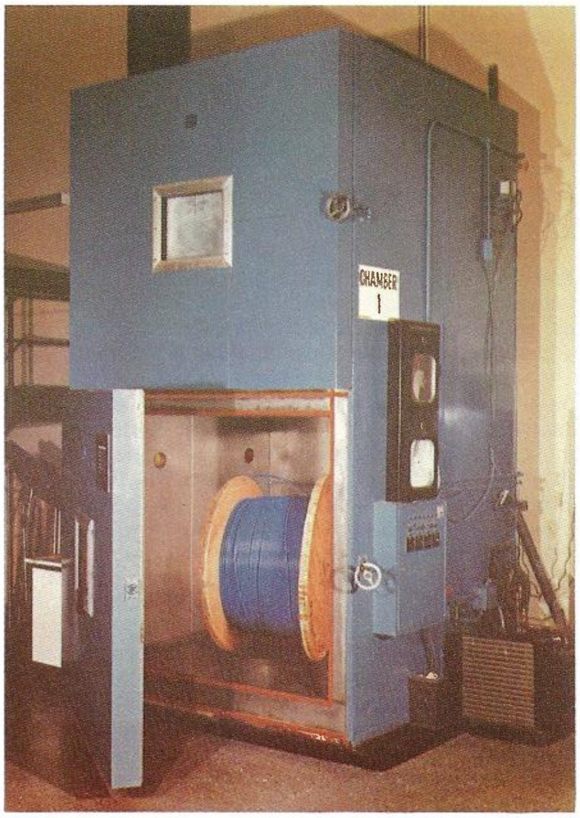
## Optical fibre cable research in Australia

Planning studies recently carried out by Telecom indicate a potential usage of optical fibre cable in its network beginning in about 1985 and increasing during subsequent years. As already suggested in the previous item, the primary application is expected to be "the provision of" telephone circuits in high growth areas of the metropolitan junction network. Current indications are that digital transmission systems



*Top: Optical fibre cable undergoing tests in environmental chamber.*

*Bottom: Measuring the refractive index profile of an optical fibre by video scanning of the near-field intensity distribution.*




incorporating low-loss, high-bandwidth graded-index optical fibres will allow high capacity links between most, if not all, metropolitan exchanges without the need for intermediate regeneration, since the majority of these links are less than 10 km long. These will provide 480 (34 Mbit/s) or 1920 (140 Mbit/s) telephone circuits per fibre pair.

With this application in mind, Telecom has contracted with the Research Laboratories of Amalgamated Wireless (A'Asia) Limited (AWA), in collaboration with Olex Cables Pty. Ltd., to investigate processes for the manufacture of fibre cables. Work under this contract, completed this year, is a preliminary step toward a detailed examination of the advantages and disadvantages of various cable configurations in terms of transmission performance, size, mechanical performance and cost. There are many issues to be resolved and technical versus economic trade-offs to be assessed. Further study contracts planned for 1980/81 are expected to to be directed towards the determination of an optimum design for fibre cable for application in the junction network.

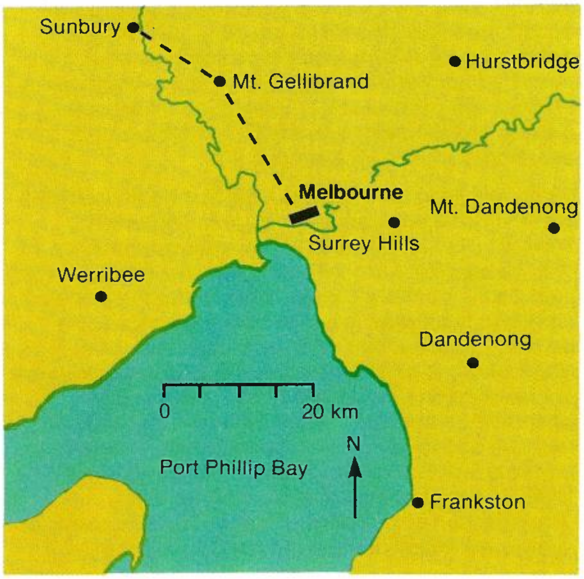
The AWA/Olex cable manufacturing investigations were completed towards the end of 1979 and culminated in the production of 1550 m of cable containing six stepped-index fibres. Two different fibre structures were employed, with three fibres of each structure. Telecom's Research Laboratories are currently engaged in detailed environmental testing and analysis of this cable to determine the effects of temperature variations, water ingress and ageing on the transmission properties of the enclosed fibres.

## Optical fibre characterisation using video techniques

One of the most important parameters that must be determined in order to characterise an optical fibre is its refractive index profile. This parameter describes the variation of the material's refractive index along a cross-sectional diameter of the fibre and largely determines the transmission bandwidth.

Near-field intensity scanning of light emitted from a fibre is the most convenient technique for measuring the fibre's refractive index profile. The method relies upon the close resemblance that exists between this profile and the fibre near-field intensity distribution. In the technique, a short length of fibre, with flat end-faces, is excited by a diffuse light source. A microscope objective focussed on the output end of the fibre projects an image of this face. In a conventional arrangement, this enlarged image is scanned mechanically by a small-area photo-detector and the resultant output intensity distribution is plotted on an X-Y recorder.

The system developed in the Research Laboratories allows the image of the output face of the fibre to be projected onto the face-plate of a monochrome vidicon




*The Melbourne metropolis*

camera, thereby allowing a picture of the illuminated fibre-core to be produced on a monochrome television monitor. A video line selector enables a single line-scan of the video signal to be displayed on an oscilloscope and provides a cursor to indicate the position of this line-scan on the television image. By adjusting the line selector, the oscilloscope trace can be made to describe the variation in near-field intensity measured along a diameter of the fibre output face. This near-field intensity distribution closely approximates the fibre refractive index profile. The exact profile can be deduced by simple numerical procedures.

Advantages of the video signal processing technique, as compared with the conventional mechanical scanning system, include more rapid measurement and greater measurement accuracy, due to the elimination of errors caused by scanning a defocussed image or recording a misaligned scan that does not pass through the centre of the fibre core.

In the Laboratories' technique, the black and white video signal can also be fed into a synthetic colour video unit especially developed within the Laboratories. This unit divides the signal range into eight equal sub-ranges and allocates a distinct colour to each sub-range. The output colour television signal can be displayed on a standard colour monitor. In the present application, a coloured contour map of the fibre near-field intensity distribution is thereby produced. The map highlights geometrical asymmetries, inhomogeneities in the fibre core material, and also the central refractive index dip which characterises fibres manufactured by the modified chemical vapour deposition process. In each instance, these aberrations are revealed with greater clarity than can be observed with a monochrome picture.

## Inter-exchange digital radio transmission experiments

The continuously changing structure of a communications network depends at any one time on the choices of available technology for its development and on their respective economies of implementation. These considerations have historically brought us to the present status of a national network in which most local traffic is carried by cable systems, and trunk traffic is borne by a combination of analogue radio and cable carrier technologies. Present trends are for the introduction of digital switching machines and a growing penetration of PCM transmission of telephony over cable systems. These initiatives have also spurred an important new perspective in radio transmission with the advent of digital radio systems, in which the phase or amplitude (or both) of the carrier is modulated by the digital information. Medium (10-100 Mbit/s) and high capacity ($>$ 100 Mbit/s per RF carrier) systems are presently under intense development by manufacturers, and the optimism for their implementation is reflected in overseas business forecasts for the next decade. These forecasts predict that investment in digital radio plant will outstrip other alternatives for medium and long haul transmission.

In preparation for the inevitable introduction of digital radio systems into the Australian network, the Research Laboratories have for some time been studying the technical aspects of both medium and high capacity digital radio systems, and are currently involved in field experiments with the Victorian State Administration into medium capacity (34 Mbit/s) 13 GHz systems for the Melbourne telephone zone. The incentives for this programme of experiments derive from a foreseen need, in the near future, to provide relief to the growing outer Melbourne area, and digital radio may prove a feasible alternative to more traditional cable alternatives for inter-exchange connections. The accompanying map of the Melbourne metropolis illustrates the first route under evaluation between the central Lonsdale trunk exchange and the outer suburban local exchange at Sunbury. In this particular case, line-of-sight between terminals does not exist and an intermediate repeater is sited at Mt. Gellibrand, as shown. Of special interest to the studies of this route are the effects of air traffic in the vicinity of several airports located close to the repeater site.

# telecommunications technology

## Introduction

Changing customer demands for communication services and the necessity to improve the performance and diversity of the network by the adoption of new techniques and practices provide a continuing stimulus for research and development of new, cost-effective technologies to provide the skills, components and systems that will be needed to meet these requirements of the future. Advancing developments in telecommunications technologies and techniques also require considerably detailed study to determine when, where and how they should be cost-effectively applied in a dynamic telecommunications network.

Part of Telecom's R&D programme is devoted to the application of newly emerging technologies. This work is applied both to solve present day problems and those of a more fundamental nature having a potential longer term impact. Some examples of this work are reported in the following sections of this chapter.

In the trend towards higher frequency systems, many of the technological investigations are focussed on key propagation and equipment aspects of terrestrial and satellite microwave systems, and on the effects of radio frequency allocations and interference. Early work in optic fibre communication techniques has been extended into optical frequency circuit components, optical signal processing and optical information storage and retrieval. Backing this effort is a programme exploring new semiconductor materials, devices and processes for prototyping devices and circuits for experimentation with advanced high frequency systems.

These investigations are aimed at extending Telecom's independence in understanding the skills required to cope with advancing technologies and to develop its in-house experience and capabilities in the technologies and in their potential applications in the field of telecommunications.

## The 1979 world administrative radio conference (WARC-79)

The development and utility of the many services using radio techniques requires that an adequate number of frequency assignments be available. There must also be an assurance that these assignments can be used with the knowledge that unacceptable levels of interference will not exist.

The first application of radio techniques was to provide communications and it was not long before the problem of interference was recognised. Since radio waves do not recognise national boundaries, the solution to contain the interference problem necessarily required the introduction of regulation by international agreement. This was commenced with the production of a Table of Frequency Allocations covering the range 10 kHz - 60 MHz at an International Conference in Washington in 1927. Subsequent conferences expanded this Table into Radio Regulations which also included associated rules and procedures. The last general revision of the Radio Regulations took place at a conference in 1959.

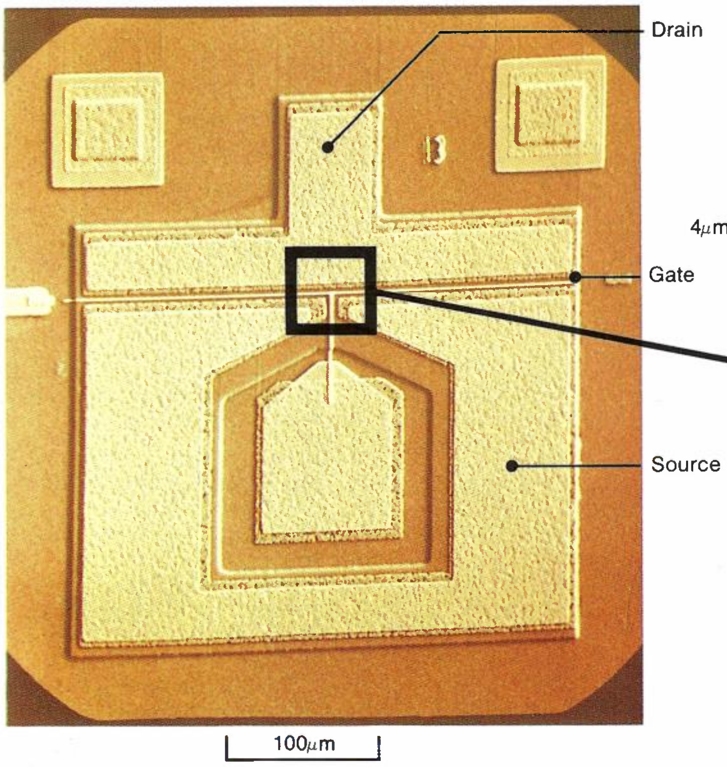
In the intervening 20 years since the last conference, radiocommunications and other services depending on radio techniques have expanded enormously. Satellite communications techniques have also been introduced for many applications and these require that problems likely to arise from the use of the geostationary and other communications satellites must also come within the ambit of the Radio Regulations. Consequently, a World Administrative Radio Conference (WARC-79) was convened in 1979 to review and revise the Radio Regulations. This conference was attended by some 2000 delegates or observers from 142 member countries of the International Telecommunication Union.

The Laboratories provided two members for the Australian delegation to WARC-79. They were concerned primarily with technical regulations affecting sharing between space systems and between space and terrestrial systems. The Australian delegation totalled 23 members.

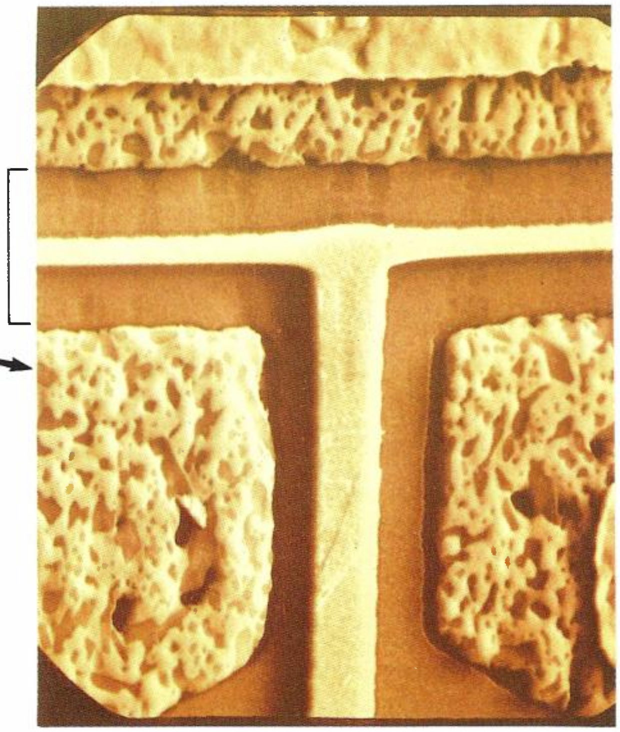
The Final Acts of WARC-79 provide a new set of Radio Regulations which allocate frequencies up to 275 GHz. They will come into force on 1 January 1982. The general nature of the changes made to the existing Radio Regulations was to introduce more sharing between multiple services of most frequency bands throughout the spectrum.

As a result, the co-ordination procedures or set of rules to make this sharing practicable have been

*Sub-micrometre Ga As MESFET fabricated using both photolithographic and electron beam writing techniques.*




*Ga As MESFET - showing the 0.7$\mu$m gate defined by electron beam writing.*




added to, and, in many respects, made more stringent. In addition, a number of Resolutions and Recommendations were adopted, some of which provide guidance as to what changes are likely to occur to the Table of Frequency Allocations and Rules in the future. It is expected that these Final Acts will be the basis for the development of radiocommunication services for the remainder of this century.

## Electron beam lithography for the fabrication of microwave devices

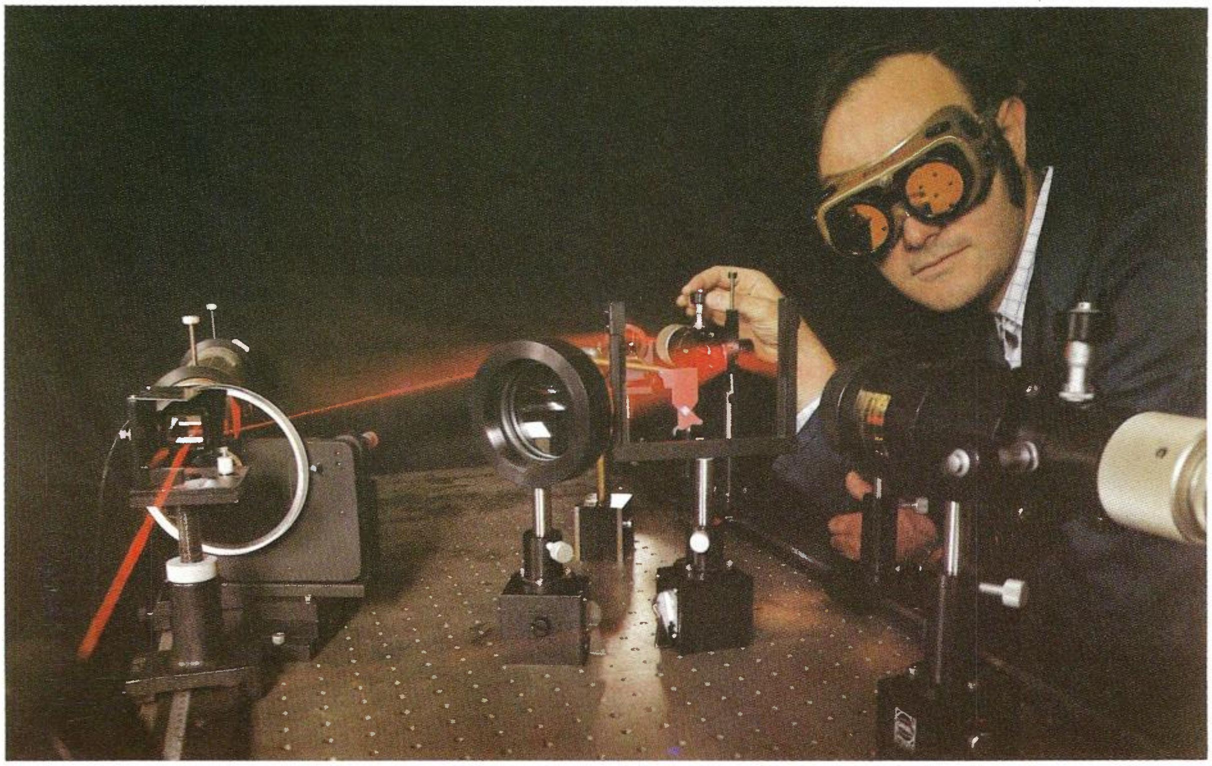
Photolithography is a well established technique used in the fabrication of integrated circuits. In this technique, a light sensitive coating material is optically exposed through a mask which defines the circuit or device pattern required. Due to the resolution limits of optical exposure systems, the very small structures required in some high frequency devices cannot be realised with adequate definition using conventional visible light photolithography. Electron beam lithography, wherein a focussed beam of electrons is used to write the desired device pattern onto an electron-sensitive coating, can achieve the necessary increase in definition. In large-scale production processes, computer controlled scaning electron microscopes (SEMs) and dedicated electron beam instruments have been used for high resolution device fabrication. However, in the Laboratories, where only a small number of laboratory-produced prototype devices are required, it is difficult to justify the expense of these systems. The use of the existing Laboratories' SEM facilities has therefore been investigated to determine whether an electron beam photo-lithographic technique can be developed for laboratory-scale experiments, with the constraint that the SEM remain in an unmodified form.

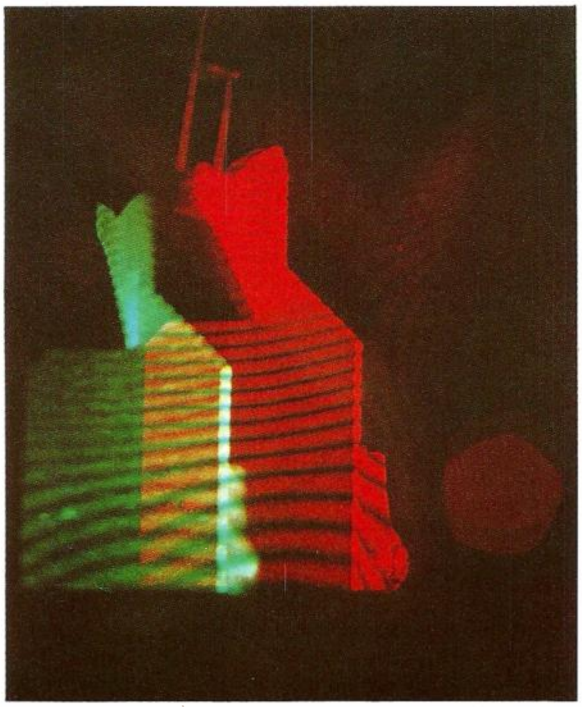
In these investigations, the Research Laboratories JEOL JSM 50A scanning electron microscope has been used for the writing of sub-micrometre structures using poly-methyl-methacrylate (PMMA) as the electron sensitive coating material. PMMA has been extensively studied and is now well characterised. A technique has been developed which allows precision positional registration of the beam within $\pm 0.1$ micrometre ($\mu$m).

The technique has been applied to the fabrication of prototype gallium arsenide metal-semiconductor field effect transistors (GaAs MESFET) for high frequency circuit applications. As a result, gate electrodes have been fabricated on these devices which are typically

*Top: An experimental arrangement for the recording and subsequent reconstruction of three dimensional holographic images.*

*Bottom: Holographic interferogram of a "wallfone" telephone switch-hook, stressed at its tip. The two images result from simultaneous reconstruction by two laser wavelengths.*





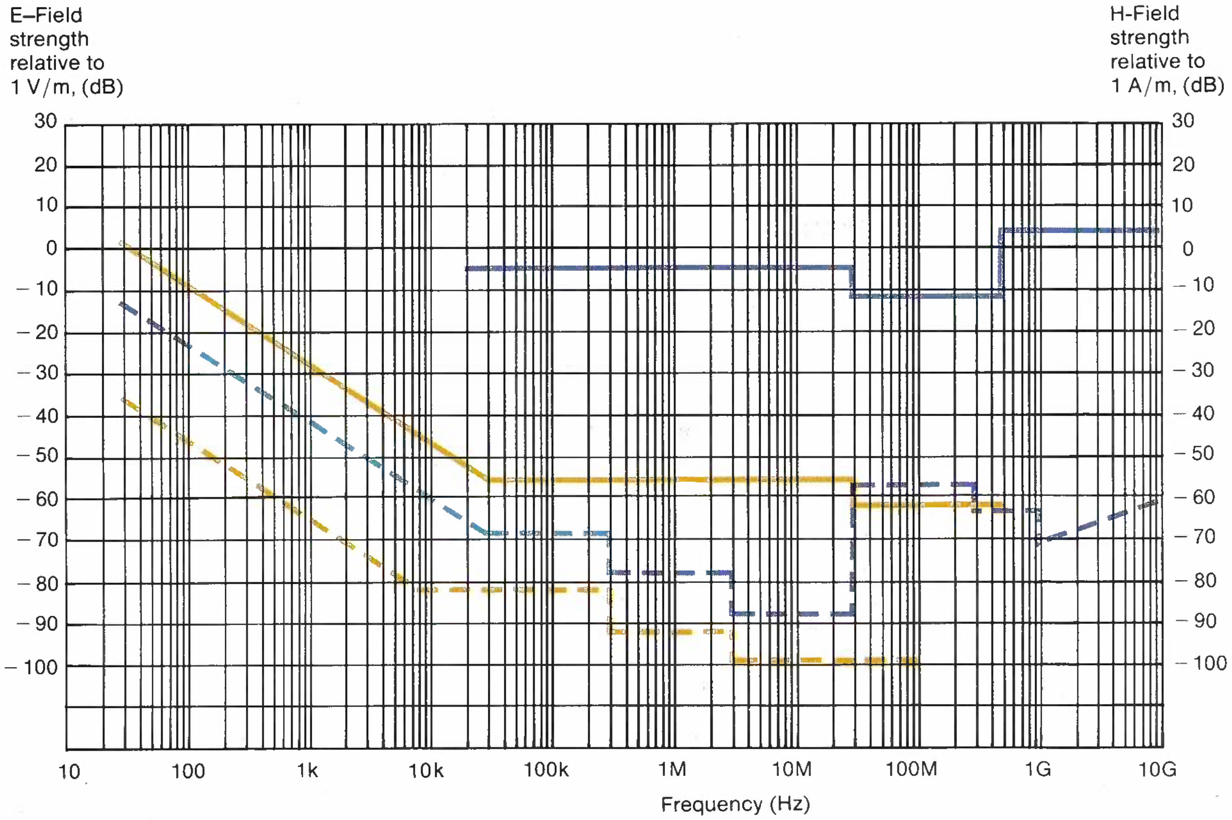
0.7$\mu$m by 275$\mu$m and have positional and parallelism accuracy better than $\pm 0.1\mu$m.

In addition, the technique has applications to many other research-oriented fabrication processes requiring devices in limited production numbers with sub-micrometre precision. Some other examples include integrated optics components such as precision sub-micrometre diffraction gratings and also high frequency surface acoustic wave structures.

## Holographic studies aid telecommunications R&D

Holography is a two-step process used to record and reconstruct a wave. In the first step, the interference pattern of an object wave and a reference wave is recorded on a recording material, for example on photographic film. This recorded pattern is called a hologram. In the second step, the original object wave can be reconstructed by illuminating the hologram with the reference wave alone. The most striking feature of a hologram is the three-dimensional image which it forms.

*Graphical representation of a typical equipment manufacturer's environmental EMI specification (Full lines) for single frequency interference sources, together with typical sensitivities (Dashed lines) employed during an EMI survey, for both E- and H- field measurements*




One research project being conducted by the Laboratories applies microwave holography to fading studies over a line-of-sight microwave radio path, such that the angles of arrival of waves (angles of fire), the effective earth radius and the spatial distribution of radio sources can be determined by utilising microwave holographic techniques. A field experiment, part of which is based on this microwave holographic technique, is currently being undertaken by the Laboratories to more systematically determine the effects of these contributing factors to fading.

Microwave holography can also be used to visualise electromagnetic fields emanating from antennas or scattered by objects, to obtain complete radiation patterns of a test antenna or to detect buried objects such as underground cables used in telecommunication networks.

However, it is at optical wavelengths using a laser light source that holograms are most spectacular, and particularly when special techniques are used to enable ordinary white light to reconstruct the holographic image. The necessarily high resolution of holographic film suggests the possibility of information storage and retrieval systems based on holographic techniques. The Laboratories are at present conducting experiments to examine ways of exploiting the attendant qualities of such systems, with particular reference to information redundancy, security, information density and laser-less (white light) retrieval of the information.

Optical holography can also be used to measure very small deformations or strain in stressed objects such as structural parts and electronic components, antennas, transistors, resistors, waveguides, loudspeakers and circuit boards. These strains can arise from static loading, vibration, heating due to electrical current or radiation, or other causes. This technique is known as holographic interferometry, and it is becoming a powerful tool in the non-destructive testing of materials and components. The most common way to make an interferogram is to use the "double exposure" method by which two successive holographic exposures of an object, first in its relaxed state and then in its strained state, are recorded superimposed on the same film. Then, the reconstructed image of the object will be covered with dark and bright interference fringes which reveal the deformations of the object caused by its strained state.

*Photo below:*
*Loop and discone antennas used for EMI survey.*

## The need for electromagnetic compatibility–EMI site surveys of telecom buildings

All electronic systems are susceptible to some extent to the influence of electric, magnetic or electromagnetic interference. The variety of digital equipment in increasingly widespread use in the telecommunication systems installed and operated by Telecom is no exception. Whilst digital technology by its nature tends to ignore low level electrical noise and interference, nevertheless there exists a threshold level above which interfering signals will cause equipment malfunction.

It is important, therefore, that careful attention be paid to the electromagnetic environment in which digital telecommunication equipment is expected to operate. Such equipment includes systems which range from microprocessor-based systems to large-scale computers, digital switching and transmission systems, control processors, digital data terminals, and so on.

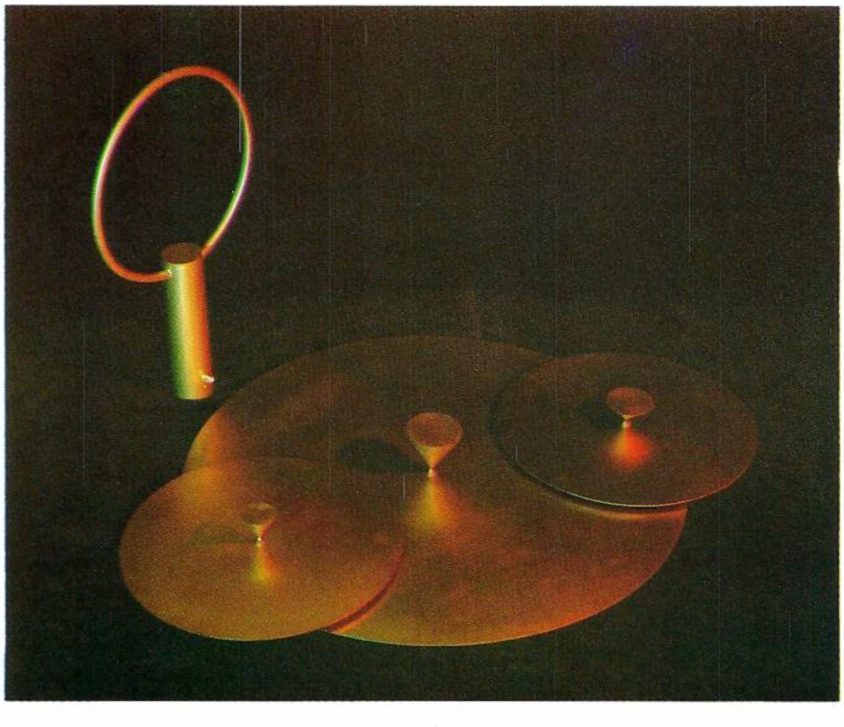
Ideally, the required attention consists initially of making an Electromagnetic Interference (EMI) survey of the proposed site at which equipment is to be accommodated. This identifies potential sources of harmful interference and enables the proposal of suitable protective measures that can be adopted early, and therefore economically, in the site preparation phase. This should then be followed up by a check survey to assure specification compliance after site completion.

The measuring methods adopted for the site EMI survey must provide means to perform a spectrum search for potentially interfering sources, typically over the frequency range 0 - 10 GHz or more, and to measure transient electric, magnetic and electromagnetic fields, generally originating from building services either associated with or near to the site.

For both spectrum search and transient measurements, initial broadband measuring techniques considerably simplify the actual measurement procedures. As well as improving the possibility of detecting intermittent emissions during a spectrum search, the broadband measurements provide the accuracy necessary for truly representative transient measurements and enormously improve the efficiency of such measurements in terms of the manpower resources consumed.

The high sensitivity of modern measuring instruments has made it possible for the Laboratories to develop measuring techniques employing very simple, very broadband, relatively non-directional antennas. They are, of course, very insensitive when compared with the more traditional tuned, directive communications antennas.

The number of antennas currently required for a site EMI survey has thereby been reduced to three, namely:



- an electrostatically-shielded loop antenna—for magnetic field (H-field) measurements up to approximately 2.5 MHz;
- an inverted cone monopole over a ground plane (discone antenna) driving an active field effect transistor (FET) probe mounted at its base—for electric field (E-field) measurements up to 1 GHz; and
- another discone antenna driving a passive 50 ohm load for E-field measurements in the frequency range 1 - 10 GHz.

Further work is continuing to allow refinement of these measurement techniques, as well as to extend the H-field measurement frequency range beyond 2.5 MHz and the E-field measurement frequency range beyond 10 GHz.

## Antenna test facilities

One of the key elements which determines the transmission efficiency of a radio system is the antenna. Today, because of the demands for wider use of the radio frequency spectrum without cross interference between a wide variety of telecommunications and broadcasting services and for increased capacity and complexity of radio systems, more attention is being paid to the refinement or advancement of antenna designs to more stringent performance specifications.

To aid the development and evaluation of advanced antennas, the Research Laboratories operate well equipped indoor and outdoor antenna test facilities. These comprise an indoor anechoic chamber in the Laboratories' complex at Clayton and an outdoor antenna test range at Mt. Cottrell in the western suburbs of Melbourne. These facilities are being used for:

- the evaluation of prototype antennas being considered for application in Telecom's radio systems, for example, VHF, UHF or microwave antennas for use in point-to-point radiocommunication systems; and
- empirical measurements of the predicted performance of new or special types of antennas designed in the course of particular R&D projects.

At the outdoor test range, the antenna under test is operated as a receiving antenna and is illuminated by a radio frequency source situated at the transmitter end. The source and test-antenna heights are adjusted in conjunction with the distance between them, such that the electromagnetic wave illuminating the test antenna simulates the actual operational condition. As the test antenna is mounted on a receiving tower of fixed height, added testing flexibility is achieved by using a portable transmitter as the source. The tower at the receiving end is equipped with two polarisation positioners and an azimuth-over-elevation positioner. These positioners, together with associated antenna monitoring facilities, are remotely controlled from a console in a receiving "hut" which is located immediately underneath the tower.

The receiving terminal is also equipped with a two-channel precision phase + amplitude wideband receiver, an analogue rectangular pattern recorder, a digital angular position indicator and an amplitude ratiometer. With these instruments, the antenna test range can record data in both analogue and digital forms. Measurements can be conducted at frequencies from 100 MHz to 40 GHz, with a recording dynamic range of 80 dB. The use of the amplitude ratiometer and the two-channel receiver enables more accurate gain comparison measurements to be performed, since uncertainties caused by transmitter power variations and operator-error can be avoided.

The measurement system is controlled by a desk-top computer which records the measured test data and performs computations and analyses of this data.

The system has been designed to be flexible—to allow for its further development when more sophisticated measurements might need to be performed.

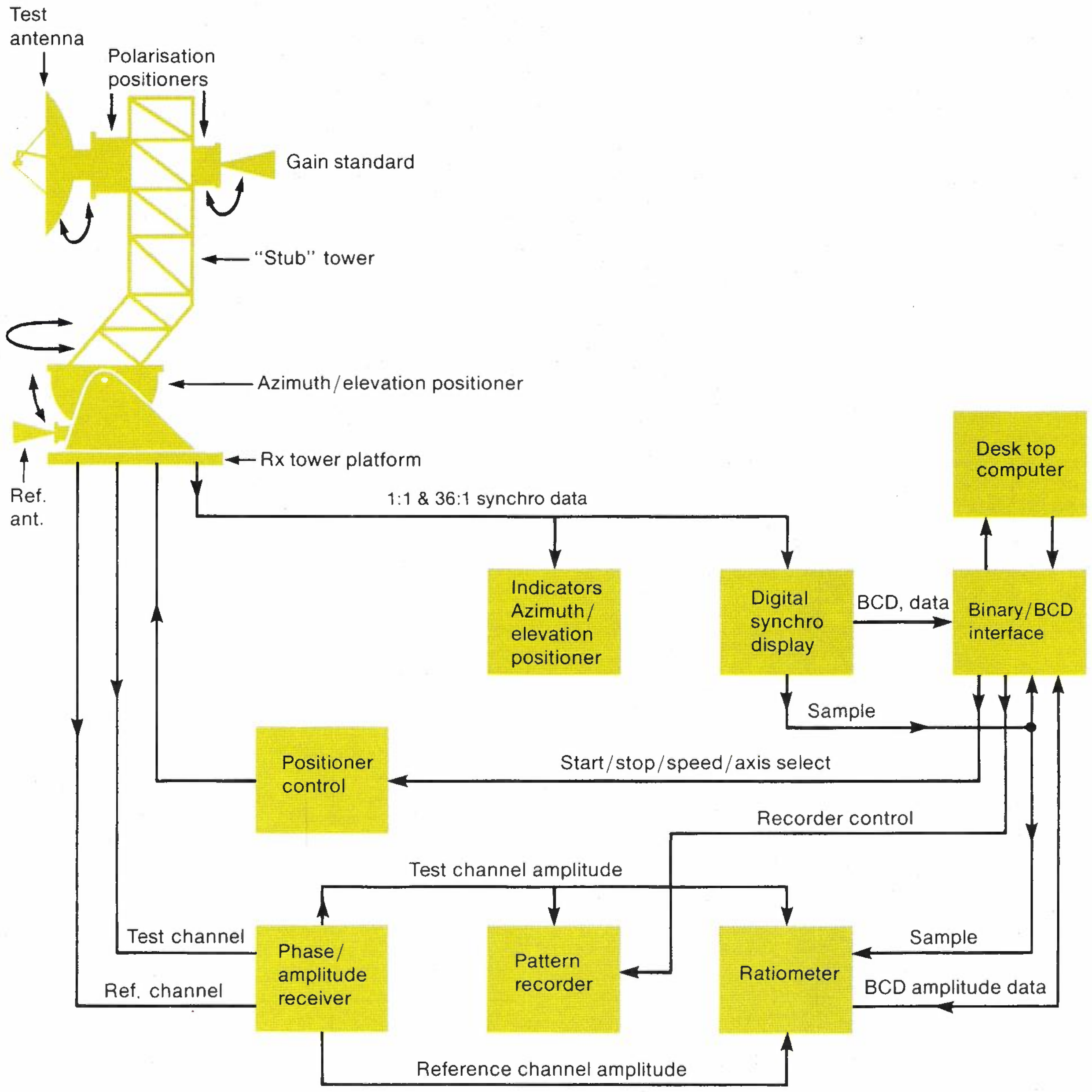
The usefulness of the present outdoor range at Mt. Cottrell is limited by its restricted area, several environmental constraints and also by its remoteness from the new Laboratories buildings at Clayton, to the east of Melbourne. Consideration is now being given to the relocation of the outdoor range to a more geographically convenient site which will also yield some improvements to the technical facilities required for foreseeable future antenna testing activities.

To assist the selection and specification of a new outdoor site, studies of various alternative possibilities have been made by the Laboratories in conjunction with the Headquarters Buildings Branch. Topographical configurations considered have included:

- a flat "over-water" range, where the main transmission path would be over a lengthy, open, but comparatively calm body of water;
- a flat "over-land" range, where the path would be over a long strip of land comparatively clear of reflective objects, such as buildings, trees, fences, etc.; and
- an elevated "across-a-valley" range, where the transmission path would be over a deep valley, arranged so that its extremities were at high points, clear of nearby reflective land masses or objects.

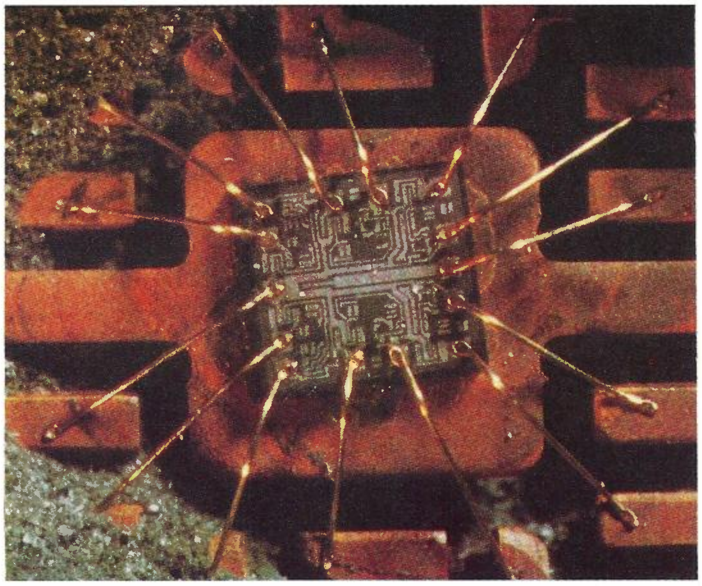
Following these studies and further actual test measurements conducted to assess specific potential sites, negotiations are now in hand to obtain and establish a new outdoor site in the vicinity of the eastern shore of Westernport Bay in Victoria—to the east of Melbourne.

*Block diagram of receive site at the Mt. Cottrell antenna test facility*



# applied scientific activities

*View of an IC decapsulated to show the internal construction.*



## Introduction

During the year under review, the Laboratories have once again been called upon to tackle a multiplicity of scientific problems. Some of the investigations have been in response to urgent network operational problems requiring an early solution—for instance, the possible deleterious effects on equipment of the combustion by-products following a fire in a main trunk exchange. Other investigations which have been initiated have important longer range objectives—such as the determination of cheaper alternative materials to replace gold in some plating and contact applications.

The year has seen a need to test increasingly larger numbers of samples of materials and components used in telecommunication plant and to perform high precision materials analyses, component parameter measurements and reliability monitoring on a continuous basis. This workload has led to the development of a number of microprocessor-based measurement, control and data logging systems to increase work productivity, and it is possible that at least some of these developments may also find use outside the Laboratories.

As described elsewhere in this chapter, an advanced surface characterisation facility, incorporating the first commercial Secondary Ion Mass Spectrometer installed in Australia, was commissioned during the year. This valuable new facility will add to the specialised scientific facilities already in use in the Laboratories, giving Telecom new capabilities for precise investigations into surface phenomena.

## Plastics encapsulation of integrated circuits

The technology associated with the plastics encapsulation of integrated circuits (ICs) has undergone considerable development in an attempt to provide a low cost, highly reliable product. Integrated circuits are manufactured by and made available from a wide range of sources using production techniques which are continually subjected to change. Because telecommunications equipment is required to remain in service for longer than most other electronic equipment, it is necessary for Telecom to monitor these developments, and accept only those components produced by techniques which will meet Telecom's specific reliability requirements.

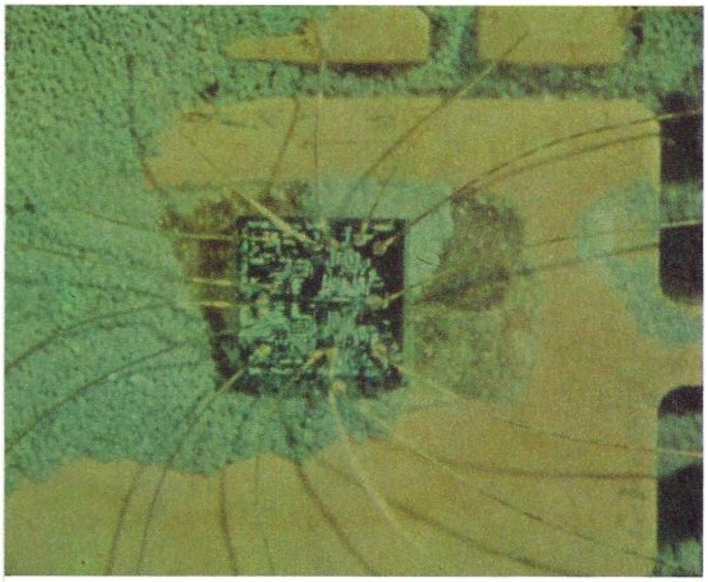
A necessary part of any reliability assessment of an IC is the analysis of the materials and packaging techniques used by the manufacturer. All plastics-encapsulated ICs utilise a filled thermosetting resin, usually epoxy or silicone type. To examine the chip, this resin must be removed by using a combination of mechanical and chemical techniques. It is both desirable and usually possible to decapsulate ICs without impairing the function of working ICs or destroying causal evidence of failure of failed ICs. Techniques such as scanning electron microscopy and energy dispersive X-ray analysis are then applied to identify the materials used or to help elucidate causes of failure.

Integrated circuits recently examined in the Laboratories have included failed high threshold logic ICs from coin telephones. Whilst these ICs were found to have failed predominantly as a result of line voltage surges, analysis of several hundred of these devices also revealed evidence of production batches in which potential weaknesses were present. These included voids in the encapsulant poor wetting of the chip surface by the inner silicone encapsulant, and the use of a silver-doped adhesive for attachment of the chip to the lead frame. In some of the latter ICs, silver had migrated from the adhesive up the side and across the face of the chip, causing subsequent device failure.

Other studies of IC packaging techniques have been directed at assessing the effects of removing unused leads, the comparison of plastics and ceramic

*Top: SEM micrograph of an IC which has failed as a result of silver migration.*

*Bottom: View of decapsulated IC which has failed as a result of moisture induced corrosion.*



packaged equivalents, determination of residual moisture levels in ceramic packages and the characterisation of materials and techniques used in ICs which are commercially available in Australia.

In most of these investigations, accelerated stress testing has been used to promote early failures. Combinations of elevated temperature, high relative humidity and electrical biassing were used. However, the general objective of producing a series of screening tests for plastics encapsulated ICs which would cover different application categories has not yet been achieved, mainly because of the uncertainty inherent in attempts to correlate test results to field performance. However, it has been possible to show that there are some plastics encapsulated ICs which can resist moisture ingress in extended stress tests, and that approval for the use of these high reliability devices in selected plant application categories is now worthy of consideration. However, it is expected that such approvals will be confined to well-established types of devices obtained from manufacturers known to apply and maintain very strict quality and process controls.

## A new surface analytical facility

Over the past few years, significant use has been made of the Laboratories' Scanning Electron Microscope (SEM), utilising its X-ray analysis facilities for the solution of a variety of materials science problems arising in the operation of telecommunications plant. However, these X-ray facilities allow only bulk analysis of the sample surface, integrating the composition over a minimum thickness of about 1 micrometre. The availability of an enhanced SEM visual image of the surface has also been of great benefit to scientific investigations. However, for some time, it has been recognised that much important information, including that concerned with surface degradation phenomena, resides in the first few atomic layers of the surface and that it is therefore most desirable for the scientist to be able to analyse thicknesses of the order of 10 - 20 nanometres at the surface.

Typical examples where surfaces have to be analysed to this degree are those where investigations must be made of the effectiveness of surface treatments or the influence of surface contamination or composition. Corrosion deposits, contact contamination or the presence of undesirable impurities on microelectronic device surfaces can thus be analysed—if necessary, layer by layer—and accurate deductions can then be made on the basis of composition and spatial distribution.

Towards the end of 1979, the Laboratories took delivery of a new Surface Analysis System, which includes the first commercial, integrated Secondary Ion Mass Spectrometer in Australia. This system will enable comprehensive studies of surface-related problems and should provide enhanced insights into the reliability and causes of failure of materials and components used in Telecom's network. The Surface Analysis System consists of three main pieces of equipment:

**A nanometrics field emission scanning electron microscope (SEM).** This instrument can produce a hydrocarbon-free vacuum in the sample chamber of the order of $1 \times 10^{-8}$ Torr. The fine electron beam will permit a resolution of 7 nm at 18 keV and better than 30 nm at 1 keV. The low energy capability will assist in

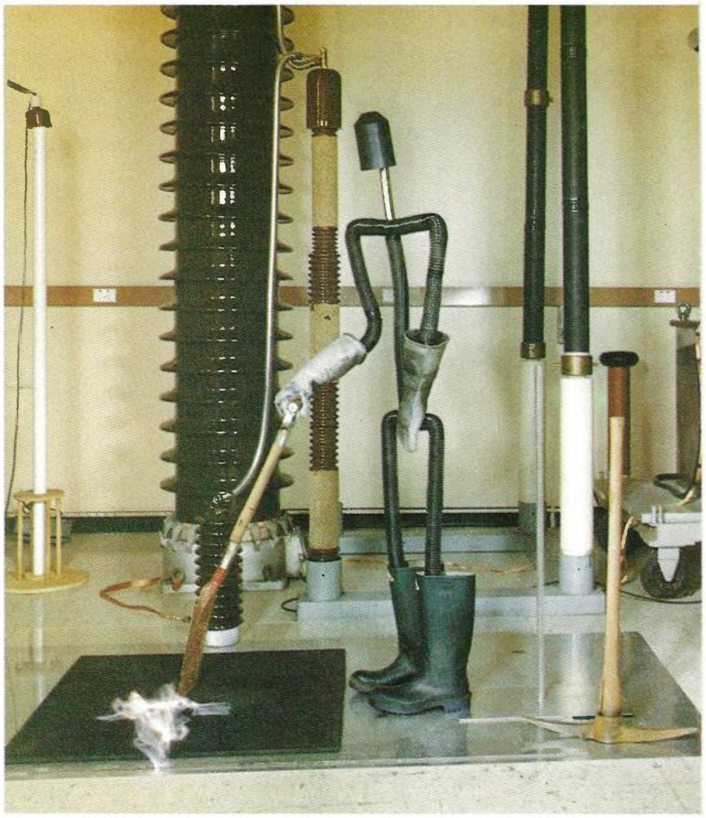
Top: *Surface analysis facility in operation - using secondary ion mass spectrometry combined with scanning electron microscopy and x-ray analysis.*

Bottom: *A demonstration of the effectiveness of two items of protective clothing.*

the microscopy of beam sensitive materials such as polymers.

**An analytical system/3M secondary ion mass spectrometer (SIMS).** In this instrument, the sample surface is bombarded with a beam of ions from an ion gun, which erodes or sputters the surface a monolayer at a time. A quadrupole is used for mass analysis of the secondary ions ejected from the bombarded surface. The presence of all elements can be detected, with varying sensitivity, at only tens of nanometres depth resolution.

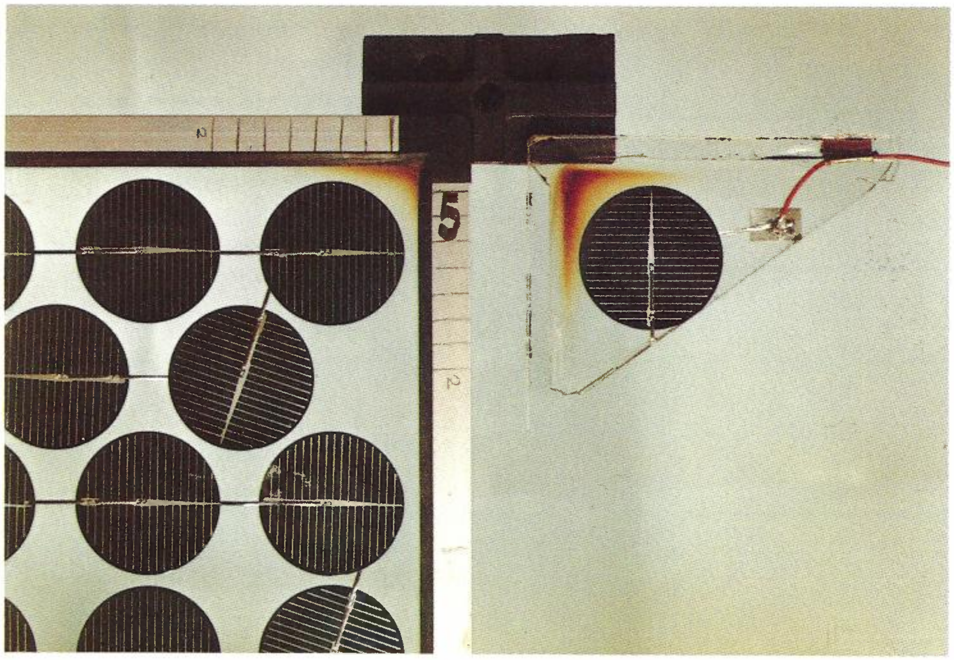
**A nuclear semiconductor hypersense X-ray detector with a microcomputer-based X-ray analysis system (EDX).** This enables high resolution X-ray analysis mapping and point analysis and also provides basic data processing for the SIMS system.



## Electrical safety of digging tools

While laying cables and when repairing faulty cables, Telecom field staff must often excavate near underground power cables carrying voltages up to 22 kV. Although Telecom has a good accident prevention record under such circumstances, this record can only be maintained by periodic reviews of current safety practices and by recognising new hazards which arise as work methods change. Such

*Portions of two solar cell panels showing staining of the encapsulant.*



an assessment was made recently by the Laboratories. The main emphasis of this assessment was an evaluation of the hazards presented by digging implements penetrating high voltage cables and of the protective value of a wide range of industrial clothing such as rubber boots and gloves in these circumstances.

There are two main classes of hand held excavation tools: picks and shovels which have wooden handles, and crowbars which are wholly metallic. Although the latter tools clearly present the greatest hazard, tests indicated that, due to the ease with which wood takes up and retains moisture, the safety margins provided by the normal wooden handles of picks and shovels could not be considered satisfactory within the range of electrical voltages that could be met in the work environment.

A method of protecting the user by covering all but the working extremities of the tools with plastic heat-shrink tubing was evaluated. Since heat-shrink tubing wears with handling, the use of two concentric sheaths of different colours was found to be the most functional because, as the outer sheath wears, the contrasting colour of the inner sheath becomes visible, giving an early warning of the need to replace both sheaths.

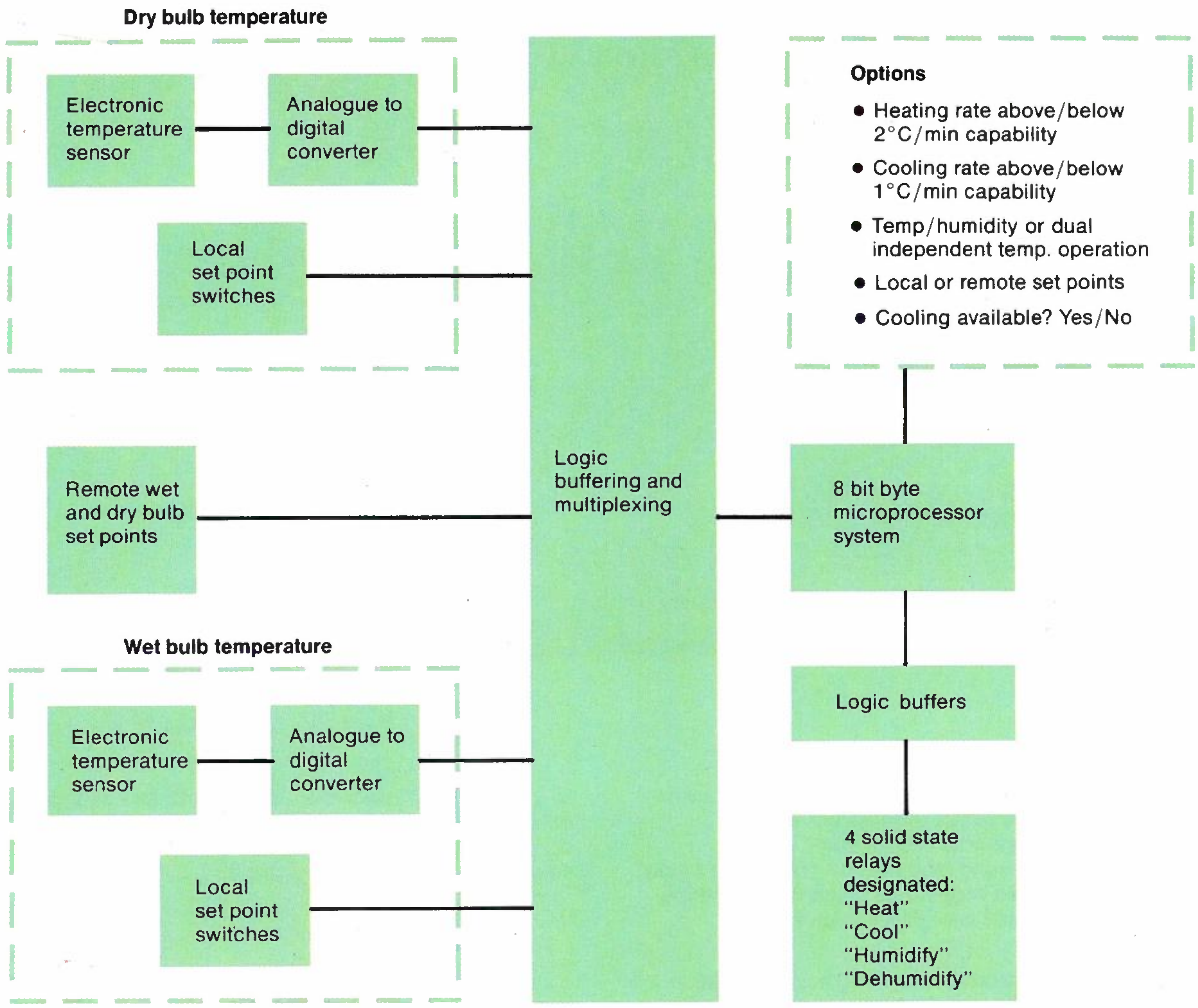
From these investigations, it has been possible to evaluate the hazards and to determine the degree to which they can be reduced under particular working conditions by a combination of tool modifications and the use of suitable types of safety clothing. This information has made it possible for the Laboratories to assist in the development of methods for training field staff in work practices which minimise the degree of risk in the event of an accidental contact with high voltage underground power cables.

## Discolouration of solar cell panels

Telecom is using solar photovoltaic cells in increasing numbers to power telecommunications services in isolated areas. In such applications, one major concern has been the reliability of their packaging.

A possible degradation of the sealant used in the solar cell panels employed in arrays to power remote repeaters of the Alice Springs Tennant Creek microwave link was detected by the Headquarters Engineering Department and referred to the Laboratories for determination of the cause and an assessment of the likely longer term aspects. This particular case was of special concern since the phenomenon was noticed during the arrays' first year in service. The encapsulant in which the cells were embedded had begun to show discolouration at the corners of each panel, and it was felt that this discolouration could spread across the panels and eventually decrease the incident illumination of the solar cells to the extent where the available power output was affected.

*Block diagram - high sensitivity temperature controller for environmental test cabinets*




The agent causing the discolouration was found to derive from the black neoprene rubber mounting blocks used to locate the corners of the individual panels of solar cells in their aluminium mounting frames. The neoprene formulation incorporated a dark, aromatic processing oil, a staining anti-oxidant, carbon black and a sulphur-containing vulcanising compound. Some of these constituents in the neoprene had permeated through the black silicone rubber seal around the edge of the panels and entered the clear silicone encapsulant which covered the cells. Under the action of light, this permeated material then darkened. In addition, the sulphur compounds were found to have tarnished the silvered rear side of the photovoltaic cells.

Accelerated weatherometer testing of non-discoloured panels, as well as of laboratory test specimens, was able to reproduce the discolouration effect encountered in the field. It was then determined that a specially formulated Ethylene-Propylene-Diene Methylene Terpolymer (EPDM), using a peroxide curing system, no processing oil, and a non-staining anti-oxidant, resulted in minimal or no discolouration of the silicone sealant under similar test conditions. A number of different silicone rubbers also gave satisfactory results under similar exposure tests.

While the investigations have shown that it is not feasible to remove any existing discolouration from the panels, further accelerated exposure tests indicate that, at the level of contamination present in samples recovered from service, neither the tarnishing of the cells nor the possible illumination screening by the discoloured portions should present a significant problem, if the affected panels are re-installed with suitable mounting blocks.

*Photo below:*
*Microprocessor based temperature controller.*

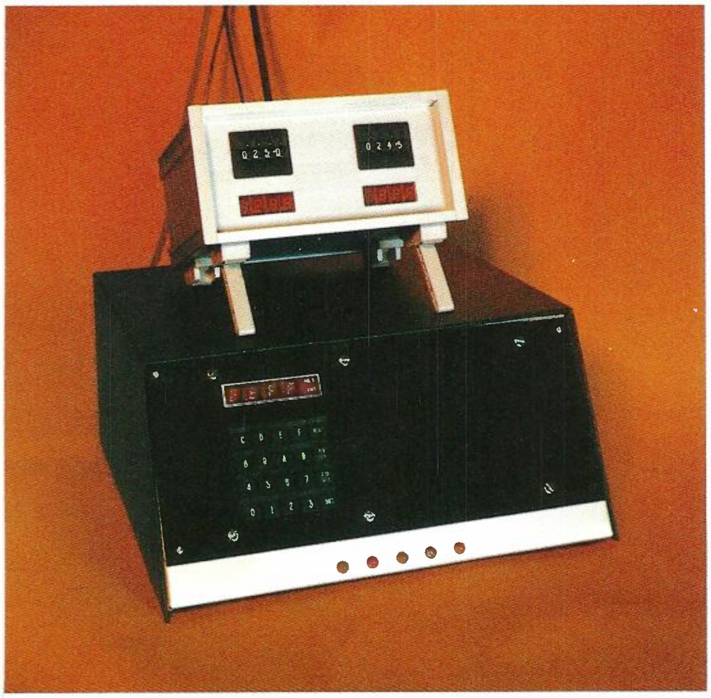
## A high sensitivity temperature controller for environmental test cabinets

The Laboratories operate a large number of environmental test cabinets which are used to conduct performance tests in accordance with the relevant Sections of Australian Standard AS1099 (Basic Environmental Testing Procedures for Electronics and Telecommunications Purposes).

As many of the test cabinets in use were acquired prior to the publication of the Australian Standard, they were not necessarily capable of meeting all required operating parameters and therefore it has been found necessary to progressively upgrade them. In almost all cases, a significant improvement in cabinet performance can be obtained by improving the temperature stability and tolerance characteristics of their control systems.

To meet the new requirements, it was considered that new control equipment was required, and that it should be capable of operating to the following specification:

- **Temperature Range**
  −50°C to +150°C **Dry Bulb**
  +20°C to +99°C **Wet Bulb**
- **Control Accuracy of Installed System**
  ±0.25°C **Wet** and **Dry Bulb**
- **Control Stability**
  ±0.5°C overall, throughout the temperature range from 0°C to +40C ambient typically occurring during a 12 month period.
- **Indicator Accuracy**
  ±0.2°C
- **Settability**
  0.1°C increments over whole of range, either manually or by remote electronic means (i.e. programmable).
- **Response Time**
  Measuring system should track to within 0.1°C for rates of change of air temperature up to 2°C per minute.
- **Compatibility**
  System to be capable of operating in association with cabinets using resistive heating (up to 4 kW) and solenoid controlled mechanically refrigerated cooling systems.



An extensive investigation of commercially available control systems showed that the cost of re-equipping all of the Laboratories' cabinets would be extremely high. In view of this, it was decided to develop a control system in-house. The design criteria determined were:

- simplicity and low cost;
- suitability for all types of cabinets in use, as well as for possible future cabinet purchases; and
- ability to act either as an individual, stand-alone unit or under remote computer control.

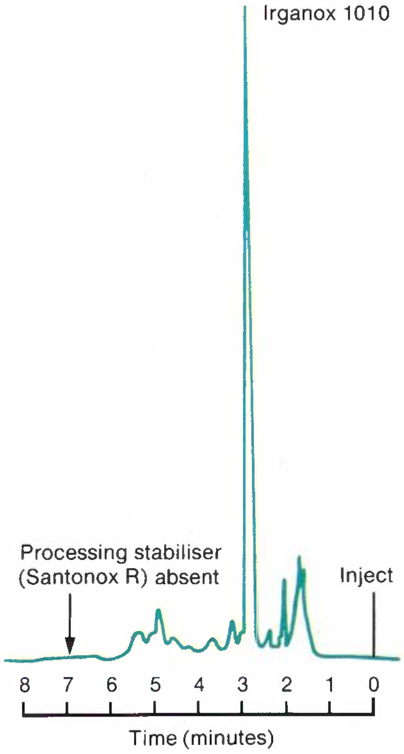
With the above criteria in mind, a microprocessor based design approach was chosen. Following a successful trial of an experimental control system design, a working system was developed, initially to control heating and cooling. Refinement of the system program software has now produced a controller which operates virtually independently of the thermal characteristics of any particular cabinet. This was achieved by programming the microprocessor to calculate the effect of electrical power input changes upon consequent temperature changes, and then to vary the heating/cooling rate to match the thermal characteristics of the enclosure. The use of an electronic temperature sensor to measure cabinet temperature facilitates the provision of wet and dry bulb temperature readouts in convenient digital form.

The system has improved cabinet temperature control to well within the desired specifications. Minor software program variations are in hand to optimise the control stability, and extension of the software to include improved facilities to humidity control is under development.

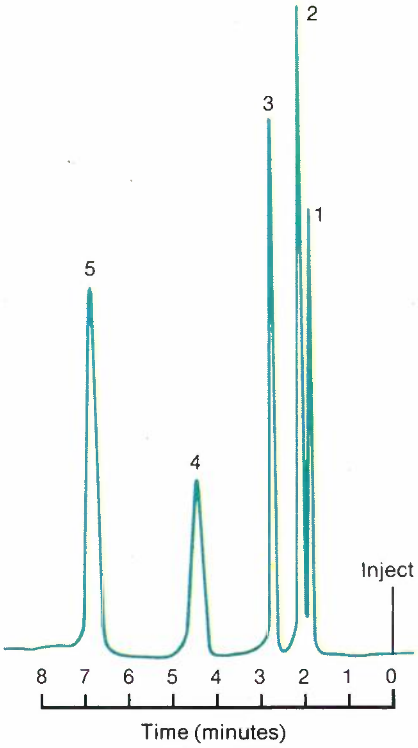
As thirty of these temperature control systems will ultimately be required to re-equip the Laboratories' cabinets and it is considered that the control technique devised could be suitable for other industrial purposes, consideration will shortly be given to adopting the approach of letting an R&D contract to Australian industry to further develop these microprocessor-based control systems for application both to Telecom's requirements and for other potential markets.

*Photo: A basic HPLC system*

*Diagram: Resolving power and analytical capability of HPLC*



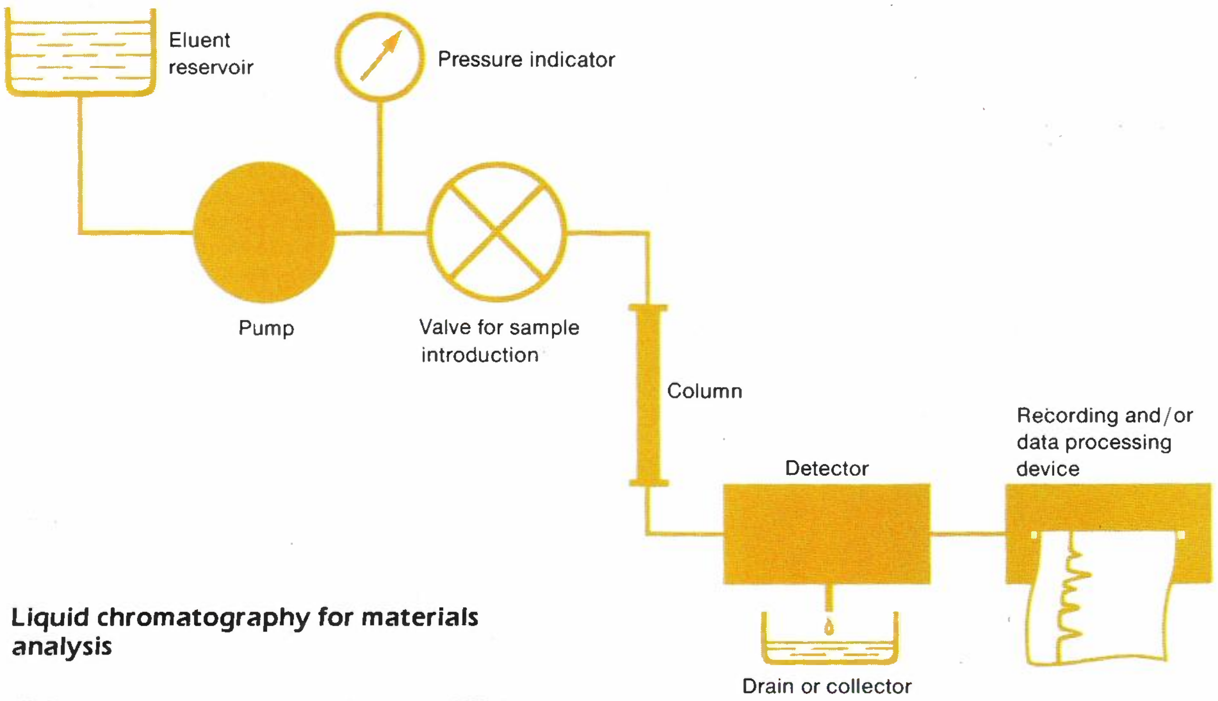

**A polyethylene extract containing Irganox 1010**




1. Ethyl 330
2. Nonox WSP
3. Irganox 1010
4. Irganox 1024
5. Santonox R

**Mixture of polyethylene stabilisers**

*A basic HPLC system*




## Liquid chromatography for materials analysis

High performance liquid chromatography (HPLC) is an analytical technique for the rapid separation of complex mixtures of chemical compounds in the liquid phase. The technique is often referred to alternatively as high pressure liquid chromatography.

Most frequently, the reasons for separating components of a mixture are to characterise it or to quantify its components. A chemical compound may also be required in a very high state of purity. When large quantities of a sample are handled, HPLC in its preparative mode is ideal for this purpose.

In HPLC, separation of chemical compounds takes place inside a relatively short column (150 - 1000 mm). The column is packed with a material, typically, silica or alumina, which has the property of chemically or physically interacting with the compounds to be separated. The degree of this interaction, called retention, determines the rate with which each compound travels through the column. A solvent (eluent) is forced under pressure through the column by a specially designed pulseless pump, so that the separated compounds emerge sequentially from the column, whence they are conveniently detected and, if necessary, collected for further investigation. Separations are possible within a matter of a few minutes, whereas with previous techniques such separations may have taken hours or even days. As the eluent can play an active role in the separation process, its composition, polarity, ionic strength, or pH, may be chosen to be held constant (isocratic chromatography), or to be varied with time (gradient elution chromatography).

As a result of recent advances in the field of microelectronics, large scale integrated circuitry is revolutionising analytical instrumentation. Because of multiple functions (eluent flow rate and composition, sample injection, detector attenuation, temperature etc.), HPLC systems have been ideal application areas for microprocessor-based technology. Many microprocessor-controlled models are currently available, with varying degrees of function sophistication. The essential elements of an HPLC system are shown schematically in the adjacent figure.

The applicability of HPLC in materials science activities is vast and varied. Analytical problems involving the application of this technique to problems arising in the operation of the telecommunications network include quantitative studies of toxic isocyanate residues in urethane resins and the separation and estimation of active ingredients in insect repellents. The HPLC technique has proved invaluable in the development of procedures for the analysis of complex chemical stabilisers that are incorporated in cable insulation and sheath materials. The accompanying figure demonstrates the analytical capability of HPLC where a complex synthetic mixture of polyethylene stabilisers is resolved within seven minutes. Chromatograms of an actual polyethylene cable insulation extract show the presence of a long-term stabiliser, Irganox 1010, and the absence of the processing stabiliser, Santonox R (note the relative peak positions). With appropriate calibration, the quantity of any one stabiliser can be determined. Analytical precision of better than 1% is possible.

# measurement and engineering technology

## Introduction

Many investigations in a telecommunications environment require a considerable amount of specialist instrumentation to gather the necessary data from which conclusions may be drawn. In many instances, such instrumentation is not readily available from commercial sources and it is then necessary for the Laboratories to develop appropriate instrumentation systems and specialised measuring techniques.

The first three articles in this section describe some of the work required to collect and process data associated with three important areas of Telecom's activities, namely, telephone traffic flow studies (as an aid to dimensioning telephone networks to ensure that future communication needs are met), battery power studies (the reliability and economics of which has a direct consequence on the viability of most telecommunications and radio systems) and telephone transmitter impedance studies (an understanding of which can lead to fundamental improvements in transmission parameters).

In addition, it is often necessary to fabricate special components in small quantities for experimental purposes, particularly where such components are not commercially available or where the small quantities required preclude industry from economically supplying such devices. The last two articles in this section describe two techniques which have been developed in the Laboratories to meet special needs.

## Time clock for telephone traffic recording

In order to match future network growth more closely to changing public demands, Telecom conducts detailed studies of the traffic flow through selected telephone exchanges in the network. The studies are made on a regular basis and take place in a range of large and small crossbar exchanges, operating in both local and remote situations. At each test site, provision is made for an assembly of automated equipment to gain access to the exchange wiring. This equipment monitors the activity of parts of the exchange equipment at predetermined intervals and collects information relating to the number and duration of calls passing through those parts. This information is then stored on a magnetic-tape recorder. Once a sufficient quantity of data has been obtained, the tapes are read at a centralised computer facility where data reduction programs produce statistics which give an assessment of network performance. This assessment later forms the basis for predicting the direction of optimum network expansion.

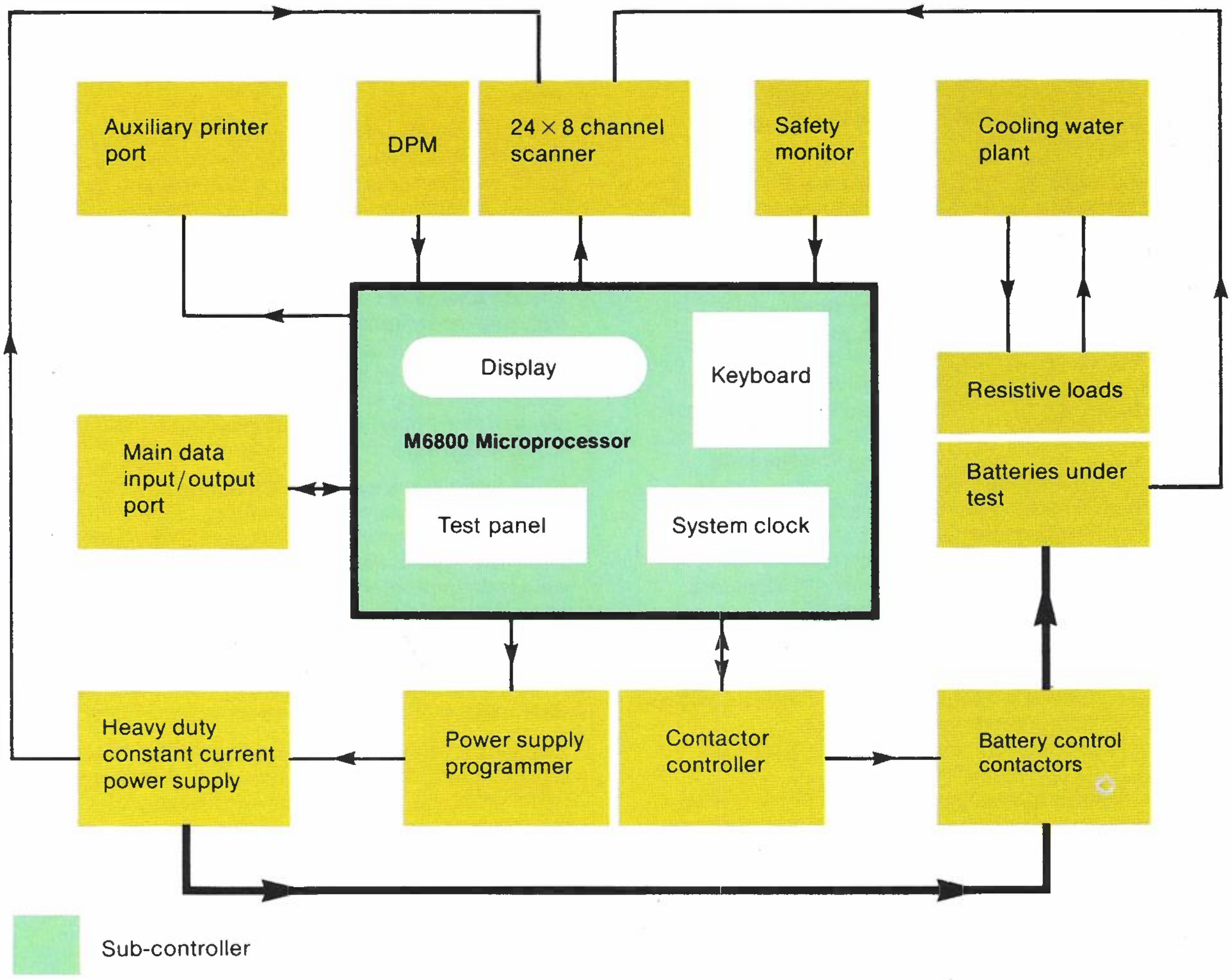
An improvement over the presently used system of timing and supervisory control was sought so that both the applicability and reliability of the data collection processes might be increased. With this aim in view, the Research Laboratories were requested to develop equipment which would provide the required improvement while retaining physical and electrical compatibility with the preceding unit. The objective was to facilitate the change-over to the new system by obviating the need to modify any wiring already existing at each test site.

These aims were met by a design, constructed essentially of CMOS logic circuitry powered by a standard inverter which uses the exchange supply as its primary source. A crystal controlled oscillator was employed to give an accurate clock source and timing reference, and semi-conductor interfaces were incorporated to provide both output and input signals to the system.

These modifications resulted in an enhancement of the timing system reliability. To improve the operation of the system, thumbwheel and conventional switches were used in a re-designed control panel, which replaced the earlier, more cumbersome, strapped terminal block with a set of self-annunciating controls. These not only tell the user at a glance which of the four recording sessions are in use during a nominal recording day, but also when each of those sessions start and finish, and on which days, over a four week period, recording will take place. As a secondary improvement to aid the servicing of faulty units, light emitting diodes were used throughout the system to serve as status indicators and a fast clock advance facility was built-in to allow rapid cycling of the timing chain.

A laboratory model of the completed design, which occupies less than half the space of the equipment it is intended to replace, is at present undergoing field trials—prior to the eventual construction of production prototypes.

*Functional diagram of battery charge/ discharge control system*




## Battery testing

Telecom has a large investment in secondary storage batteries providing power sources for telecommunication plant. These batteries, mostly of the lead-acid type, vary in size from small 12 volt 25 Ah. capacities to large 3000 Ah. single cells. To ensure proper manufacture of these by local companies and also to ensure a satisfactory life span of the batteries, the Laboratories are undertaking investigations of battery characteristics under different environments and applications.

Over the last few years the amount of testing has increased and the size of batteries, and hence the maximum test current, has also become significantly greater. To reduce the labour content of this work and to improve control and data acquisition capabilities, the Laboratories are developing a system to automatically control the testing of groups of batteries of different capacities and to produce graphical outputs of the test results using computer techniques.

Under test, the batteries are mounted on benches—together with load resistors, control contactors and constant current power supplies. The control system then arranges these contactors such that charging takes place from the power supply through all batteries connected in series. When the batteries are fully charged (as determined by the measurement system), they are switched out of circuit. Discharging is carried out in a similar manner, but in this case, the load resistors are also connected in series. Measurements of cell characteristics are monitored for control purposes and are available as outputs for analysis by external computer.

Each type of battery, comprising five different capacity sizes up to 1000 Ah., has its own test bench and sub-controller. A further test bench and sub-controller caters for all the heavy duty batteries that is, those exceeding 1000 Ah. The system therefore requires a total of six sub-controllers which eventually will be connected to a main computing controller. This main controller will perform limited pre-processing before passing the data to a central computer for storage and graphical presentation.

The sub-controller unit was designed in the Laboratories around an M6800 microprocessor, using commercially available micromodules. The processor has its own keyboard, display, system clock and test panel. The sub-controller controls the operation of a number of external devices. These include:

- a multi-channel scanner and digital panel meter (DPM) for measuring cell characteristics;
- a power supply programmer and contactor controller module for controlling both power supply and control contactors;
- an auxiliary printer for obtaining intermediate results while the test is running;
- the main input/output port for connection to the main controller; and
- a safety monitor detector, which checks the concentration of hydrogen in the test room and cooling water flow and temperature.

Other main parts of the system are:

- the power supply which provides charging currents ranging from 3.5 A for testing the smaller batteries to 2000 A for testing the larger ones;
- battery control contactors adequately rated to switch the above currents;
- load resistor elements, some of which are water cooled, suited to the performance of ten, three and one hour discharge tests; and
- a cooling water system capable of removing the heat generated in the loads.

The software for the microprocessor was written in assembly language and compiled using a Tektronix 8002 development system. The entire program occupies about ten kilobytes of memory.

## A high speed impedance measurement technique for the audio frequency range

In most countries, including Australia, the most common type of telephone transmitter is the carbon microphone. This device has numerous advantages and disadvantages. Among its disadvantages is the fact that its impedance, and that of any telephone in which it is used, is difficult to measure with a reasonable degree of precision. This is because in normal use, the carbon granules in the transmitter are continually in motion thus varying the electrical and electro-acoustic properties of the transmitter. Stable measurements can be obtained if the transmitter is clamped, but the values obtained are usually significantly different to those obtained in an actual use situation. If a measurement of its impedance over a range of frequencies is required, the dilemma arises of trying to perform a measurement which requires a significant time interval, on an object which is known to be varying in an unpredictable manner in that time interval.

To overcome this problem, a measurement system has been constructed in the Laboratories in which actual measurements on a telephone take place in about 20 milliseconds. In this interval, measurements are performed at 14 frequencies between 200 Hz and 4 kHz.

The advantage of the system is that it enables the accurate measurement of telephones in a situation corresponding to actual use. For example, a person can be asked to lift the handset of a telephone and bring it to his ear, and the system can be set to measure the impedances just after the handset reaches the ear.

At the heart of the system is a minicomputer which controls the measurement process, calculates the impedance and presents the results in the desired form. The system also incorporates a special current waveform generator which generates a signal containing the 14 frequencies at which the impedance measurements are desired. The current from the generator is passed through the telephone and the resulting voltage waveform is fed to the minicomputer via a filter and an analogue-to-digital converter.

The minicomputer uses a Fast Fourier Transform algorithm to calculate the Discrete Fourier Transform of the voltage and current waveforms and then uses this information to calculate the impedance at the 14 frequencies.

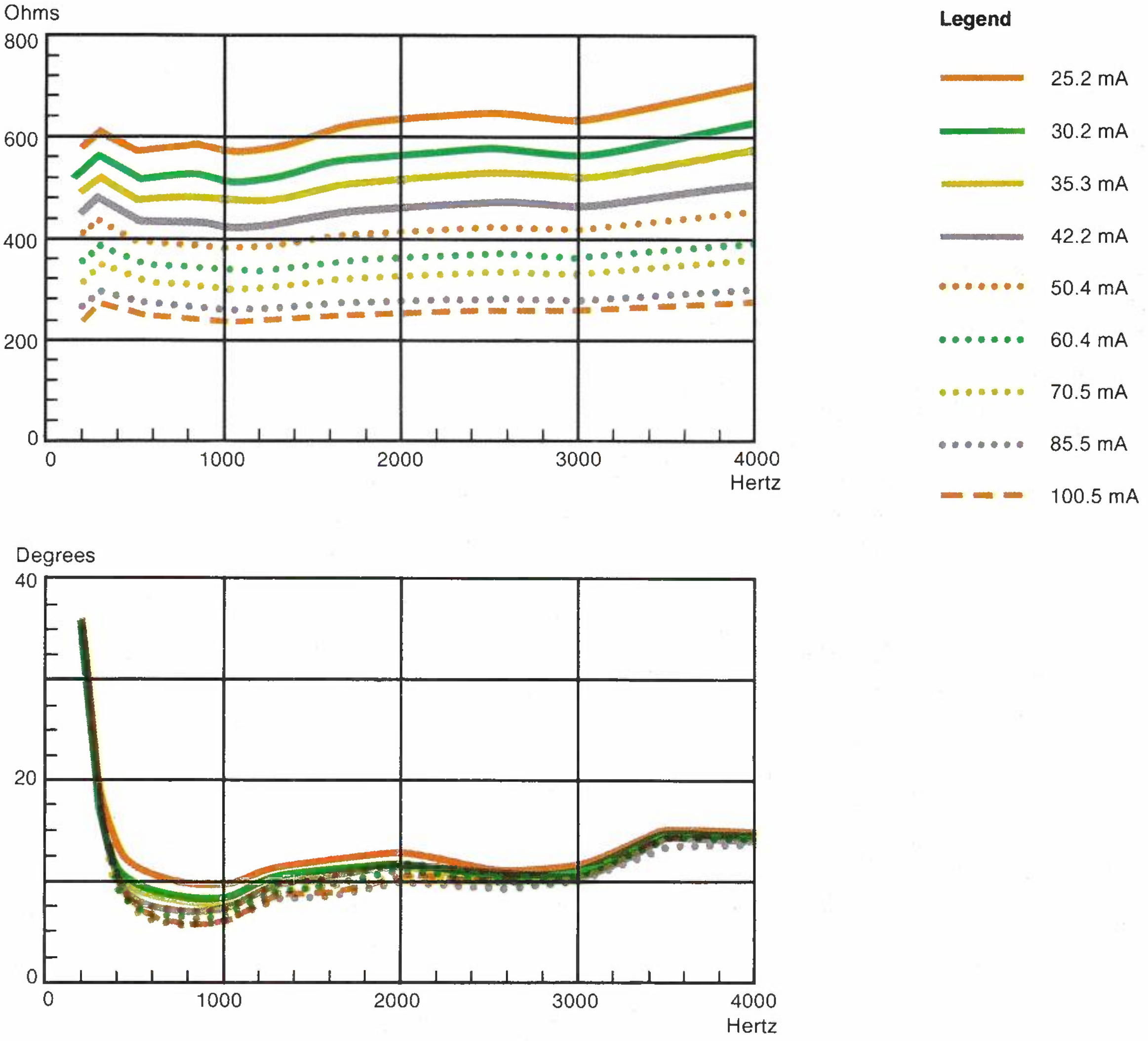
The accompanying graph shows some of the results of measurements on telephones using this system.

## Large micro-stripline circuit fabrication techniques

During 1979, the Laboratories undertook the fabrication of a novel ultra-high frequency (UHF) micro-stripline circuit for use in laboratory experiments aimed at evaluating devices utilising this new technology. The particular circuit was a Lange coupler array employing a complex inter-digital structure, which was to be etched on the copper coated surfaces of a special low-loss dielectric material. The novelty of the fabrication task centred on the critical nature and physical tolerances of the inter-digital structure demanded by the circuit design, coupled with the rather large overall size of the circuit, which was approximately 800 × 600 mm.

The layout of the circuit was developed on the Laboratories' Interactive Design System (IDS). However, that system's photo-plotter, which is used to produce the photographic replica of the circuit (normally called the phototool), is limited in capacity to overall sizes less than 500 × 400 mm. The required

*High speed impedance measurement of a group of eleven telephones measured at 9 feeding current values 10 seconds after handset lift-off*



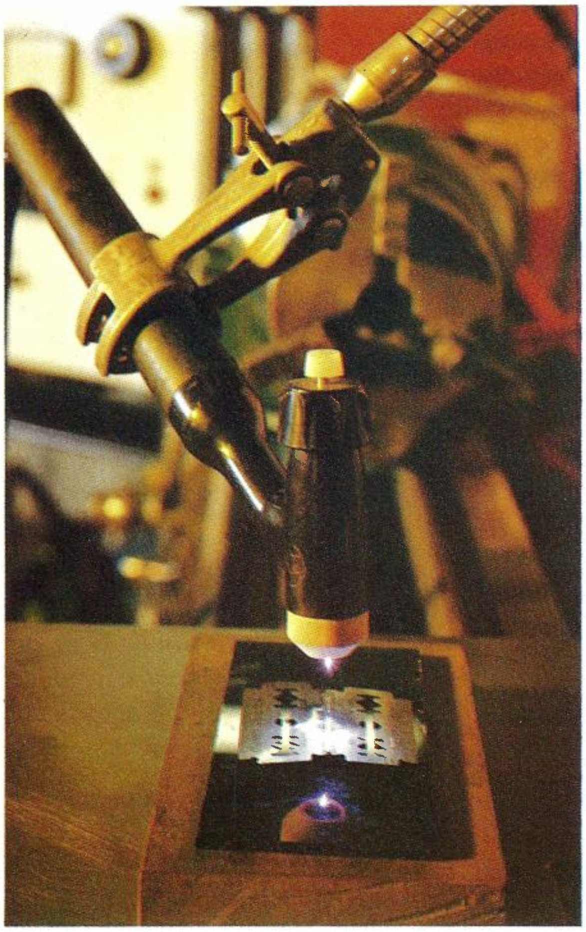

final accuracy precluded the production of the phototool in sections, for subsequent photographic integration. This problem was therefore overcome by obtaining the use of a very large precision photoplotter at the Ammunition Factory of the Commonwealth Department of Productivity. This has a capacity of 2400 × 1500 mm. Punched paper tape was used as a quick and convenient interchange medium between the Laboratories' IDS and the remote photoplotter. The preparation of the tape required the development of an assembly language computer program and checks for format, code and punch accuracy. The efficiency and convenience of this technique has since been improved by using magnetic tape rather than punched paper, and by the development of a further program module to enable the taped information to be quickly verified.

Development of this system, which now provides compatible working between the IDS and the large external photoplotter, will allow the production of other large phototools which may be required in the future.

Accurate transfer of the large circuit pattern to the copper coated dielectric material required considerable modification of the Laboratories' equipment and processes, which were originally developed for more normal-sized, precise printed circuit board fabrication. For example, a special etching tank was constructed and very careful controls were established for the cleaning and etching processes.

This particular task has demonstrated the practicability of producing large-size, precision, UHF micro-stripline circuits for telecommunications applications.

*Micro-plasma arc welding torch demonstrating its ability to weld thin metals.*



## Micro-plasma arc welding

A micro-plasma arc welder has the capability of welding ferrous and non-ferrous metals of foil thickness as thin as 0.05 mm. Operating at currents as low as 0.1 A, this welding technique offers advantages which include a very narrow weld bead, good weld penetration and little distortion of the work. A large work-to-torch distance allows easy viewing of the weldment, which is especially beneficial in the field of miniaturisation.

The versatility of the micro-plasma arc is achieved by its ability to produce a stable and directional column of plasma forced through a small orifice at temperatures between 10 000 and 20 000°C.

The principle of operation is that argon gas is ionised by a pilot arc within the torch, resulting in a column of electrically conductive gas (plasma) being forced out through the orifice of the torch. With the pilot arc established, the conductive column of gas from the torch to the weldment permits instantaneous ignition of the weld arc when an electric circuit is made between the torch and the workpiece. A shielding gas is used to surround the plasma column to prevent oxidation during welding.

The ability to produce, with a high degree of control, such low distortion fusion welds in thin foil section metals has considerable potential for applications within the broader activities of the Research Laboratories, and a programme to investigate these welding techniques was commenced in 1978.

Initial investigations centred on test samples in stainless steel and brass as a means of assessing the capability of the micro-plasma arc welder. These were followed by the development and evaluation of techniques to achieve porosity-free welds in stainless steels. The use of back shielding gas on the opposite side of the weldment to the torch was found to ensure a porosity-free weld and leave a scale-free surface.

Special jigs and manipulators have since been designed, developed and manufactured to aid the precise operation of the micro-plasma arc welder in tasks where operation in a non-manual mode is required. This is essential when welding metals about 0.05 mm thick. When welding at these thicknesses, the current is about 0.1 A, and any contamination, such as oil or even a finger print, can cause the arc to wander off the weldment.

Because of its micro-welding capability, the micro-plasma arc welder now allows superior quality welding in Laboratories' projects which were not previously achievable by other welding facilities.

# consultative activities

## Introduction

The Laboratories are continually developing expertise and laboratory facilities in the engineering and scientific disciplines which are somewhat special and uniquely concentrated in Telecom. As can be seen from earlier sections of this review, these are necessary for the pursuit of major technical and scientific research projects which cover the whole range of advanced materials, components, equipment and systems which make up the network by which Telecom provides Australia's internal telecommunications services.

It can be expected that, in addition to performing larger project-scale research investigations in an on-going work programme, the staff of the Laboratories will often be called upon by other Departments of Telecom to give ad hoc consultant advice and assistance on problems which arise in their day-to-day activities and which can be quickly and effectively solved by such calls.

The following items provide examples of such consultancy calls made on the Laboratories during the past year. They range from assistance in the design and specification of specialised equipment; to assessment of the reliability of materials and components; to evaluations of the adoption of particular process technologies in equipment manufacture; or to assessments of the likely causes and effects of problems arising in field operations through component or equipment failures, through the adoption of particular operational practices, or as the result of accidents or equipment malfunctions.

These smaller scale tasks undertaken by the Laboratories do not attract the same "prestige" as the larger-scale R&D projects, in terms of their effect on the Laboratories' contributions to major corporate decisions. Nevertheless, they are regarded as an essential part of the Laboratories' role to provide cost-effective and speedy assistance, where possible, to other Departments of Telecom—to avoid or solve minor, but often costly, problems arising in the operation of a large telecommunications network.

## Fluxes for machine soldering of printed circuit boards

During processing, printed circuit board assemblies are exposed to a number of chemicals which may have deleterious effects on the operation of the circuits long after they have been installed in telecommunications equipment. The Laboratories are making an intensive study of one of the most obvious of these potential trouble-producing chemicals, namely, the fluxes used during the wave soldering process. Their active ingredients and the composition of their residues are being studied to identify the parameters which are indicative of fluxes with good soldering performance and which leave only benign residues on the board.

*Photo below:*
*Cell design showing measuring electrodes to establish the electrical leakage characteristics of fluxes.*

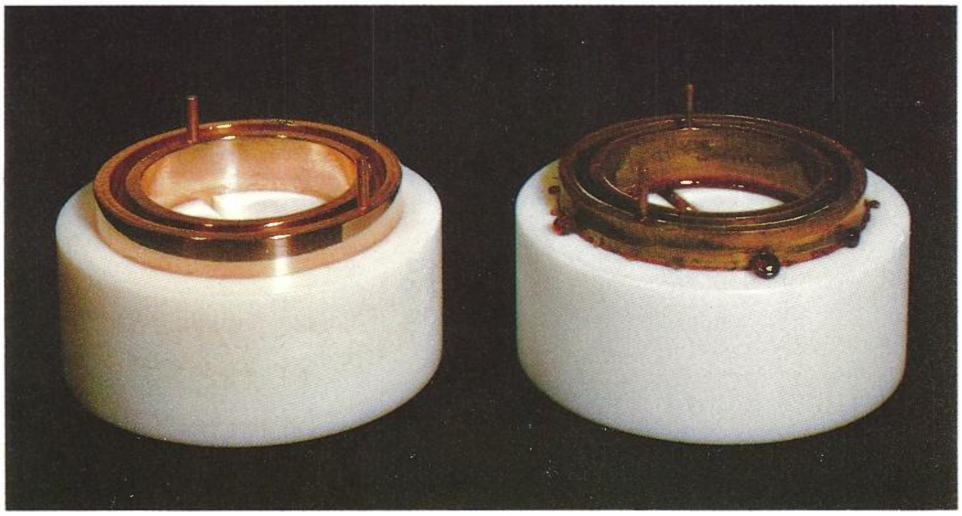


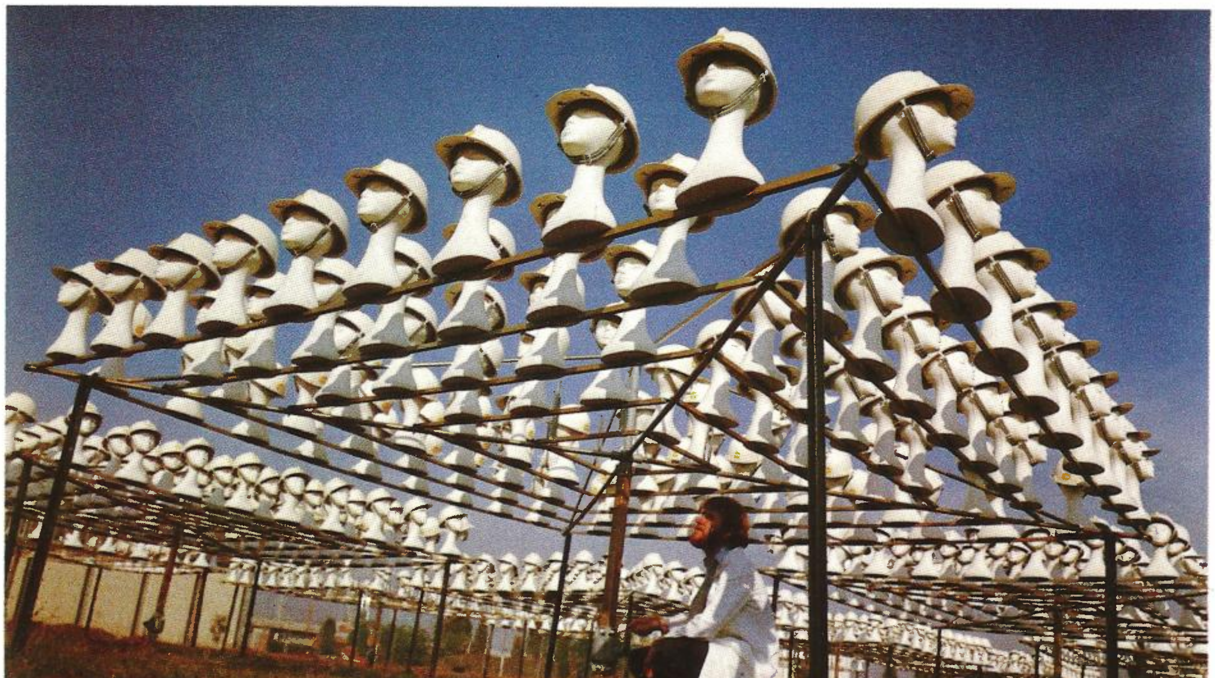
*Photo below:*
*Outdoor safety helmet exposure site.*

## Life expectancy of industrial safety helmets

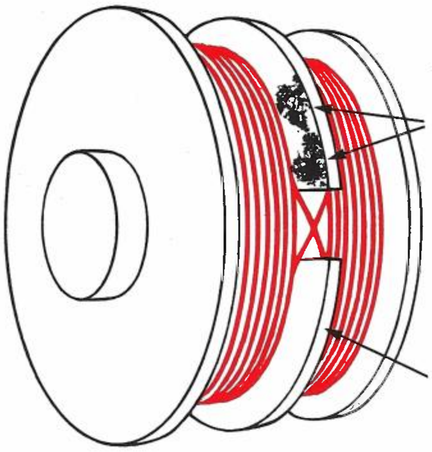
Safety helmets are an important part of the general protective equipment worn by approximately 23 000 Telecom officers throughout Australia. For safety and economic reasons, it is important that such equipment retain its protective quality over lengthy periods of time, even when subjected to harsh environmental conditions during service. Each new helmet must satisfy the stringent physical, electrical and flammability test requirements of Australian Standard AS1801-1975, to ensure an effective level of protection for the wearer. However, since commercially available helmets are made almost entirely of plastics materials, continued outdoor use would be expected to affect the performance of the helmet, principally as a consequence of the combined effects of ultra-violet (UV) light and atmospheric oxygen. Whilst AS1801-1975 states that the recommended "working life" for helmet shells used outdoors is five years, this figure has had no experimental basis to date, as comprehensive data on the degradation of properties due to weathering is not available. A project has therefore been commenced to determine which thermoplastic compound offers the best resistance to the photo-oxidation process, and hence, when helmets should be recalled and replaced.

Representative materials from five classes of polymers were selected for the study. Four of these materials are currently used for helmet shells manufactured in Australia, namely, Acrylonitrile-Butadiene Styrene (ABS), Polycarbonate (PC), High Density Polyethylene (HDPE) and Polypropylene (PP). A fifth material, Acrylonitrile-Styrene-Acrylic elastomer (ASA) was included since this material had been found in other studies by the Laboratories to have good weathering properties. White helmets have been moulded from each material. Some are being held as controls, others under typical warehouse storage conditions and the remainder are being exposed outdoors at the Research Laboratories' Monash site on 1200 painted polystyrene headforms. These are mounted on modified clothes hoists which are rotated through 90° each week, completing one revolution per month to ensure equal irradiation of all samples. At six monthly intervals throughout the intended five year exposure programme, samples of helmets are withdrawn and subjected to impact and stiffness tests at temperatures ranging from $-5°C$ to $+50°C$.

A total of 2295 helmets are under evaluation in the current programme, and it is expected that a further 450 helmets will be added at a later stage. Keen interest in the study has been shown by the Standards Association of Australia and the prospective benefits of the project in improving the protection given to safety helmet wearers in Telecom and elsewhere are widely recognised.



*Sketch of a loading coil showing failure*




## Loading coil failures

In 1978/79, the failure rate of 88 mH loading coils was found to be ten times the failure rate experienced in 1972/73. It was at first suspected that lightning induced stresses were responsible, but a study of faulty coils returned from the field showed that only a small proportion had sustained damage in this way. Most had failed either by arcing at much lower voltages, which caused a short circuit between the two coils on the single core where the coil windings crossed over on the coil-former, or by an open circuit at the same place.

It was established that most faulty coils were from one manufacturing batch. The varnish insulation on the coil winding wire was found to strip very easily from the wire. The failures were therefore attributed to defective wire insulation or badly mixed or formulated potting compound used for that particular batch of coils. Because of the time elapsed since manufacture, no remedial action is possible and further failures of this nature could occur.

## Speech clipping in the mobile radio telephone service

Public automatic mobile telephone systems linked with the public telephone network are planned for installation in the Melbourne and Sydney metropolitan areas. These systems will include signal level compressors and peak-level clippers in the speech paths in order to optimise signal-to-noise performance of the mobile radio links.

Laboratory investigations within the Voice Services Section found that for telephone quality speech entering the mobile system, up to 10 dB of peak clipping produced insignificant degradation of speech quality and that up to 15 dB was just tolerable. At the mobile end, where pre-emphasis of the speech is required to minimise the transmission of vehicle ambient noise, less clipping was tolerable. As a result of the Laboratories' investigations, recommendations were made that maximum values be 7 and 12 dB, respectively.

## A video filter

The 12 MHz coaxial cable transmission systems in service in Australia are equipped to carry television programme material as well as telephony signals. A function of this equipment is to ensure minimal interference with the telephony signals which occupy the frequency band below the television signal band. However, interference with the system regulating pilot, whose frequency is above the television band, can occur unless separate provision is made to bandlimit the incoming television signal before transmission over the 12 MHz system. In Australia, this is done by a commercial low pass filter, which is phase equalised to reduce distortion. It has been found that, under some conditions which occur in service, this filter causes excessive distortion of the colour signals.

The Research Laboratories analysed the behaviour of a number of possible new filter designs to work out a satisfactory compromise between pilot frequency rejection, colour signal distortion and circuit complexity. Several of these alternatives were tested in service and a low pass filter having somewhat wider passband, steeper skirt selectivity and considerably more phase equalisation was designed for use in the system.

## An improved insect repellent

For several years, an insect repellent for personal use has been issued to Telecom outdoor staff. This formulation was based on a repellent used against bush and house flies. No particular emphasis was placed originally on mosquito repellency. It was considered that as outdoor staff were working mainly in daylight hours, they would not be subject to mosquito attack to any great extent.

During the time this repellent mixture has been in service, it has been the subject of a number of complaints, and a study of Defective Material Reports revealed user dissatisfaction, namely that:

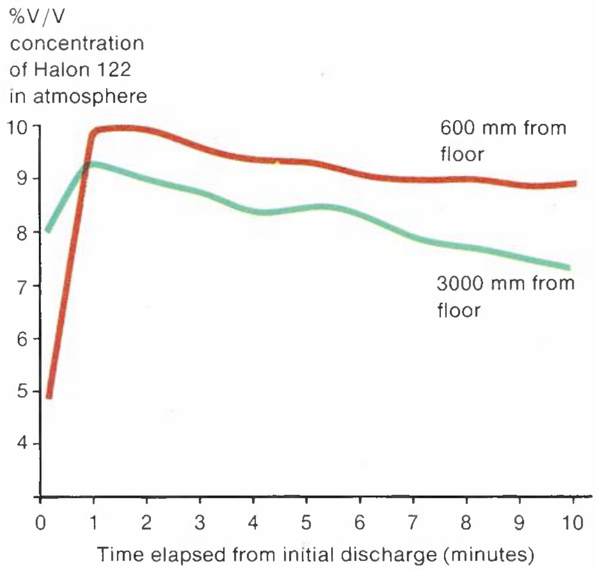
- it was not effective against mosquitoes;
- it was too oily;
- its period of effectiveness was too short;
- it was not as good as some well known, nationally advertised products.

Based on these criticisms, certain changes were made to the formulation. However, it was also recognised that some of the comments were purely subjective and that changes to the formulation would not wholly eliminate user dissatisfaction. In an attempt to achieve better understanding, articles have been written for the house journals "On the Line", and "Telecom", in which the validity of some comments was acknowledged and the basis for the development of a newly formulated insect repellent was explained.

The new formulation, which has been reasonably well accepted in field trials, uses higher concentrations of active ingredients than the original formulation, and also contains an additional mosquito repelling agent. In the original formula, the carrier for the repellents consisted of an isoparaffinic solvent and a small amount of light mineral oil. In the new formulation the mineral oil has been removed.

On account of the concentration of its active ingredients, the new insect repellent should be equal, if not superior, to any commercially available product of this kind.

*Graph of HALON 122 concentrations after initial discharge at two heights above the floor*




## Fire suppressant tests

Some of the chemical analysis facilities of the Laboratories were used recently to monitor the effectiveness of a gas flooding fire extinguishing system, recently installed in a metropolitan telephone exchange control centre. When operational, the system is charged with the gas bromo-trifluoro-methane (Halon 1301), but pre-acceptance trials were conducted with a charge of dichloro-fluoro-methane (Halon 122). This test gas, while having no significant fire extinguishing properties itself, has other physical properties similar to Halon 1301, enabling it to be used as a more economical alternative for running preliminary checks on the flooding system.

The trial was conducted in December 1979, with the processor room of the exchange control centre being flooded with Halon 122 gas from the system. Samples of the resultant atmosphere in the room were taken 10 seconds after flooding commenced, and then at one minute intervals for 10 minutes. There were two sampling points, one 600 mm and the other 3 m from the floor. A total of 22 samples were taken. Quantitative analyses of the Halon 122 in the air samples were carried out by gas chromatography in the laboratory.

The samples taken at the upper level (3 m) had Halon 122 concentrations of 8.0% V/V after 10 seconds, 9.4% V/V after one minute and 7.5% V/V after 10 minutes. At the lower sampling level (600 mm) the concentrations at the same time intervals were 4.8% V/V, 10.0% V/V and 9.1% V/V respectively. Ninety five kilograms of Halon 122 had been discharged into the room which had a volume of approximately 220 $m^3$. This would give a theoretical concentration of 8.0% V/V instead of the desired concentration of 7.0% V/V Halon 122. The average value obtained from 20 samples, ignoring the first two samples taken at 10 seconds, was 8.9%.

Allowing for the quantity of Halon 122 discharged, the test results show that the initial fire "knock down" concentration was reached in just over 10 seconds, with the "soaking period" concentration being satisfactorily held for 10 minutes.

## Programme line transformer

It has been apparent for some time that the transmission of sound programme signals on physical lines can be improved by using a low impedance amplifier to drive the line. This concept has not been used because of the need to isolate the amplifier from the line to prevent dangerous voltages caused by, say, a fault in the amplifier or other attached equipment, from appearing on the line. A suitable isolating transformer was not available.

As part of an effort to resolve this problem, the Research Laboratories undertook to define the design parameters of a suitable isolating transformer and to assess whether such a device could be made at a reasonable cost.

It was found that a transformer could not be made economically. However, the principles uncovered by this investigation were instrumental in enabling an alternative proposal to be recommended, in which isolation is incorporated in the amplifier design.

*Diagram below:*

*Block diagram of "ideal power converter" – a basic element in modern voice-switched 2-wire repeaters*

## Technical information services

The Headquarters Library technical information services are designed to satisfy user requests for both current and retrospective information. The library was the fourth in Australia to access the United States based DIALOG on-line information retrieval service. With the aid of this sophisticated system, reference staff are able to satisfy user requests for retrospective literature searches more quickly and comprehensively than ever before. In 1979, the Overseas Telecommunications Commission introduced MIDAS (Multi-Mode International Data Acquisition Service), which dramatically reduced communication costs, thus permitting the Library to increase on-line time without drastic cost increases. As a result, longer, more complex searches could be undertaken, and other applications for the service developed.

The current awareness service (SDI) is also machine based. User profiles have been updated, and the service is operating with considerable success.

These two machine based services are supported by two manually produced bulletin services—one, a daily press clippings service, designed for senior management; the other a series of weekly listings of articles from the journals received in the Library.

## Inspection of welded components for solar system

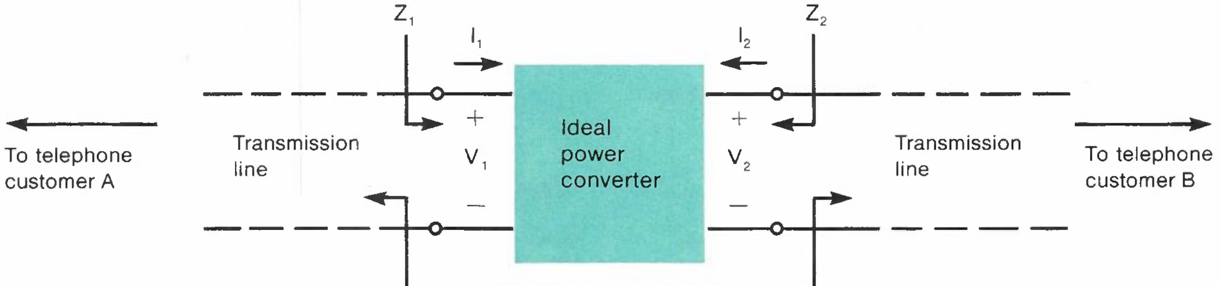
The $0.5m solar power system for the Tennant Creek/ Alice Springs microwave link, the first system of this type installed in the world, consists of 13 stations. Each has an array of solar panels, spread over three aluminium frames mounted on a shipping container roof. Weld quality and strength of the aluminium frames is required to be of a very high order, due to the harsh and remote conditions under which these stations operate.

The frames were built directly from preliminary drawings without the benefit of testing the design in a prototype development, and the sub-contractor involved experienced early difficulties in meeting the specifications required. At the request of Headquarters Engineering Department, regular consultation between Laboratories' staff and the sub-contractor was established to assist in the achievement of satisfactory weld quality in the frames, and periodic metallurgical examinations were carried out to determine weld strength and penetration. These included full inspection by a NATA certified body.

## Telephone repeaters employing voice-switching

Some of Telecom's customers are business firms with a Private Automatic Branch Exchange (PABX) located in their headquarters building. Most of the extension telephones are "internal extensions" located in the headquarters building, but sometimes there are "external extensions" at a branch office or warehouse up to several kilometres away. This can create the difficulty that calls from external extensions through the PABX into the public network have greater line loss and consequently lower speech volumes than calls from the internal extensions.

One way of tackling this problem is to install a repeater in the line between the PABX and the external extension to amplify speech signals, usually by 6 - 15 dB. The Laboratories have been consulted on the desirable characteristics to be specified for voice-switched repeaters. Such repeaters ensure circuit stability by providing amplification in the direction of speech flow and an equal loss in the other direction. Investigations show that to achieve satisfactory operation, attention must be paid to switching threshold levels and noise levels to ensure that one direction of speech flow is not favoured over the other.




$$\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} k & 0 \\ 0 & -k \end{bmatrix} \begin{bmatrix} V_2 \\ I_2 \end{bmatrix}$$

## Power level measurements

The accurate measurement of the power level of radio and telephone signals is essential to provide effective communication links over the vast distances of the Australian continent.

The higher operating frequencies of the level meters in current use have outstripped the facilities available for their calibration. To ensure that the instruments used to measure these levels are giving the correct information, the Reference Measurements Section has developed and distributed to the State Calibration Centres, a series of level transfer standards and return loss measuring bridges for the commonly used impedances.

Consisting of basic non-active devices with phase compensated resistor networks appropriate to the nominal impedance of the level meters, each level standard has been adjusted for an extremely low return loss. The companion return loss bridge is used to measure the return loss of the level meter being calibrated, to determine the degree of error that the mismatch contributes to the overall accuracy of the calibration and all subsequent measurements made with that instrument.

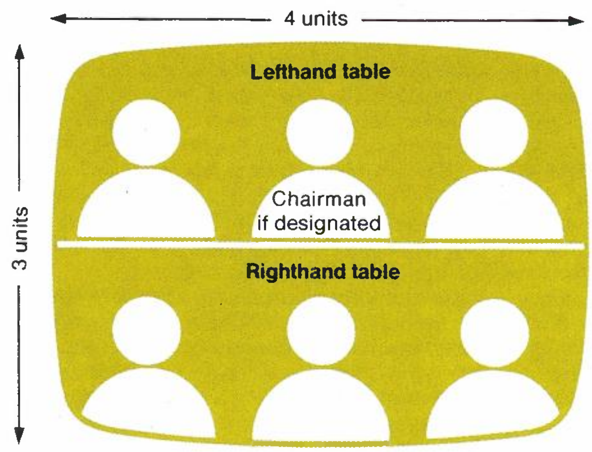
The operating instructions are given in a step by step form and a minimum of auxiliary equipment is required, making the devices convenient and simple to operate.

## Data capture analyser interface

The Data Capture Analyser Interface (DCAI) was developed by the Laboratories at the request of the New South Wales (NSW) State Administration. The DCAI interfaces a Data Capture Analyser unit (DCA) with the controlling processors of a stored program controlled telephone exchange—such as the Pitt 10C trunk exchange in Sydney. The unit was developed by NSW staff in order to collect data on the behaviour of the exchange and to assist with fault diaosis. Laboratories' assistance to develop the interface was requested because of previous experience in this field, especially in the development of the Processor Monitoring Instrument, described in the 1978/79 Review of Activities.

The DCAI for the Pitt 10C trunk exchange monitors the program memory address signals of up to four processors. Each address for each of the four processors is compared with four preset addresses, giving a total of 16 detectable events. Whenever an address match is detected, a trigger signal is sent to the DCA. On receiving this signal, the DCA captures 256 sequential addresses for each processor being monitored. This information is stored on a bulk storage medium which enables maintenance staff to later trace the exchange operation prior to a malfunction, thereby assisting in the detection of the cause of the malfunction.

*Stacked picture format*




## Specification of a Confravision studio

The application of closed circuit television in conjunction with a loudspeaking telephone system to provide a conference facility between two or more geographically separated sites held out early promise of reducing the need to travel, with its many direct and indirect expenses and inconveniences. In 1969, the Research Laboratories established an experimental CCTV conference facility between two Telecom Headquarters buildings. Later, the present Confravision service between Melbourne and Sydney evolved from that system.

Confravision studios are necessarily housed in substantial modern buildings so that air conditioning, lighting and other building services can be conveniently provided while maintaining an acoustically quiet environment. A total floor area of about 150 square metres is required, including reception and waiting areas. The studio specification, shortly to be issued, is technically demanding, largely because the lighting and acoustic conditions must be critically adjusted. If stereo sound and a split-screen picture of the conference participants is utilised, Confravision studio conditions give an illusion of naturalness, which is most desirable in providing an environment conducive to successful teleconferencing.

## Accidental erasure of EPROMS

Electrically programmable read only memories (EPROM), erasable by exposure to ultra-violet (UV) light, are widely used to store control programs for microcomputer-based equipment. It is most important that the contents of these memories are not accidentally erased or modified in service in Telecom equipment.

*Photo below:*
*Sample of submarine cable showing the lead sheathed conductor cable and damaged steel armour.*

The contents of an EPROM can be completely erased by exposure to ultra-violet light with an energy of about 10 - 15 Ws/cm², but tests on a small number of samples in the Laboratories have shown that less than 10% of this energy is required to erase some storage locations. Even less UV energy is required for erasure when normal operating voltages are connected to the EPROM.

An EPROM is also photo-sensitive, and if sufficient light of any colour shines on the silicon chip, the resultant photo currents will temporarily mask the stored program. This leads to soft errors which may seriously affect the process being controlled by the microcomputer.

Laboratory investigations have shown that both effects require that the EPROMs be adequately screened from all forms of light in equipment intended for plant applications.

## Microprocessor policy review

The economic design and development of microprocessor based equipment requires a substantial investment in special purpose development tools and in staff training. These costs recur for each different type of microprocessor used, and in 1977, Telecom decided to contain the development costs by fully supporting a preferred type of microprocessor.

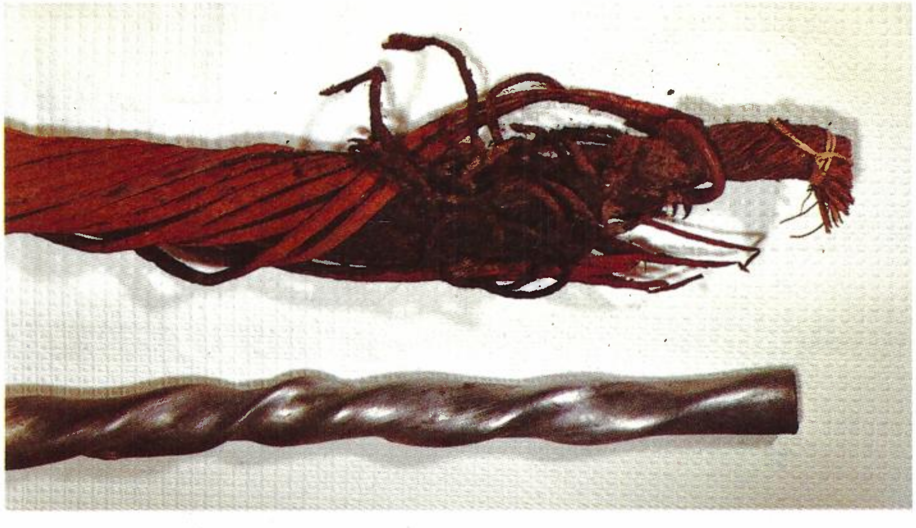
Staff from the Research Laboratories and the Engineering Department liaised closely as a project team to review this policy in 1979. Studies of both Telecom and commercial projects had shown that a major part of the cost of using microprocessors was in the development of modules especially for each project. A range of commercially available sub-assemblies have been selected to complement the standard modules previously developed within Telecom, and further substantial economies will be realised by using these in the development and prototyping of new designs.

The Laboratories will continue to provide a considerable degree of support for designers and others working with microprocessors, both by providing a range of cross-assemblers and simulators on TACONET, Telecom's in-house time share computer service, and by consultation on hardware and software design problems.

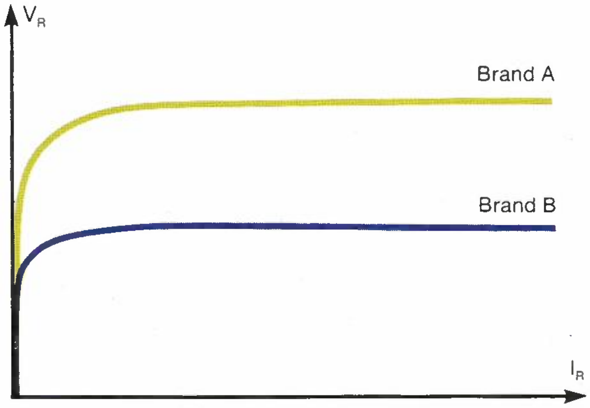
## Corrosion of a submarine cable

Samples from a recently abandoned submarine cable from the Derwent River, Hobart, have been studied in order to find out if it would be possible to extend the life of similar cables in the area. Severe corrosion of the steel armouring was found to have occurred, probably initiated when the cable was damaged about 20 years ago. The chemical and electrical agents responsible for the corrosion were found to include anaerobic bacteria, galvanic action and possibly long line cell formation due to tidal movement.

Cathodic protection was not considered suitable as a means of reducing corrosion at similar damage sites on other cables, because it would result in preferential corrosion of the lead sheath in lieu of corrosion of the steel armouring. Repair of the tar/jute cable covering at damage sites was recommended as the most effective protective measure.



*Relationship between reverse voltage and current for aluminium electrolytic capacitors*




## Reverse and overvoltage performance of electrolytic capacitors

It was found recently, that some electrolytic capacitors in exchange equipment had exploded after being subjected, during part of their operating life, to a few volts reverse bias as a consequence of an error in circuit design. This prompted an investigation into the long term effects of both reverse and overvoltage conditions on aluminium electrolytic capacitors. The relationship between reverse voltage and reverse leakage current, as shown in the accompanying graph, was found to be similar for all capacitors, but the voltage level at which the sudden current increase occurs varied considerably for capacitors from different manufacturers. The high current flow, which occurs once this critical voltage is exceeded, can generate large volumes of gas inside the capacitor and cause it to explode. At slightly lower voltages, an explosion may be delayed by hours or weeks. At yet lower voltages, the chemical reaction involved will reach equilibrium without sufficient gas being generated to cause an explosion; instead, there is a gradual capacitance decrease and the dissipation factor tends to vary.

Sustained application of voltages above the rated d.c. working voltage causes similar effects. In this case, the voltage above which current increases rapidly is the forming voltage of the capacitor.

Although it would appear at first sight that electrolytic capacitors can be used outside the manufacturer's ratings, the deterioration in parameters and the possibility of explosion make such a practice undesirable.

## The oxygen index test for plastics–international round robin

The Oxygen Index test is one of a series of tests for determining the combustion characteristics of plastics. In its various forms, it is widely used for plastics material evaluation and quality control purposes. Telecom has several specifications which refer to the Australian Standard method.

Recognising a pressing need for international conformity in such an important test, Australia and several other countries submitted specific proposals to the International Organisation for Standardisation (ISO), and as a result, a draft ISO Standard has been prepared, which at present includes several alternate procedures.

In order to select the single method which would ensure maximum inter-laboratory reproducibility, a round-robin test programme involving 18 laboratories in seven countries has been arranged. Australia was invited to participate, and the Standards Association of Australia nominated Telecom's Research Laboratories (specifically the Polymer Section) and the Division of Building Research, CSIRO. Several sizes of test specimens, made from seven types of plastics in film, foam or solid form, were supplied, each from a single source. The same two test methods, two ignition sources and two pre-conditioning regimes are used by all participants.

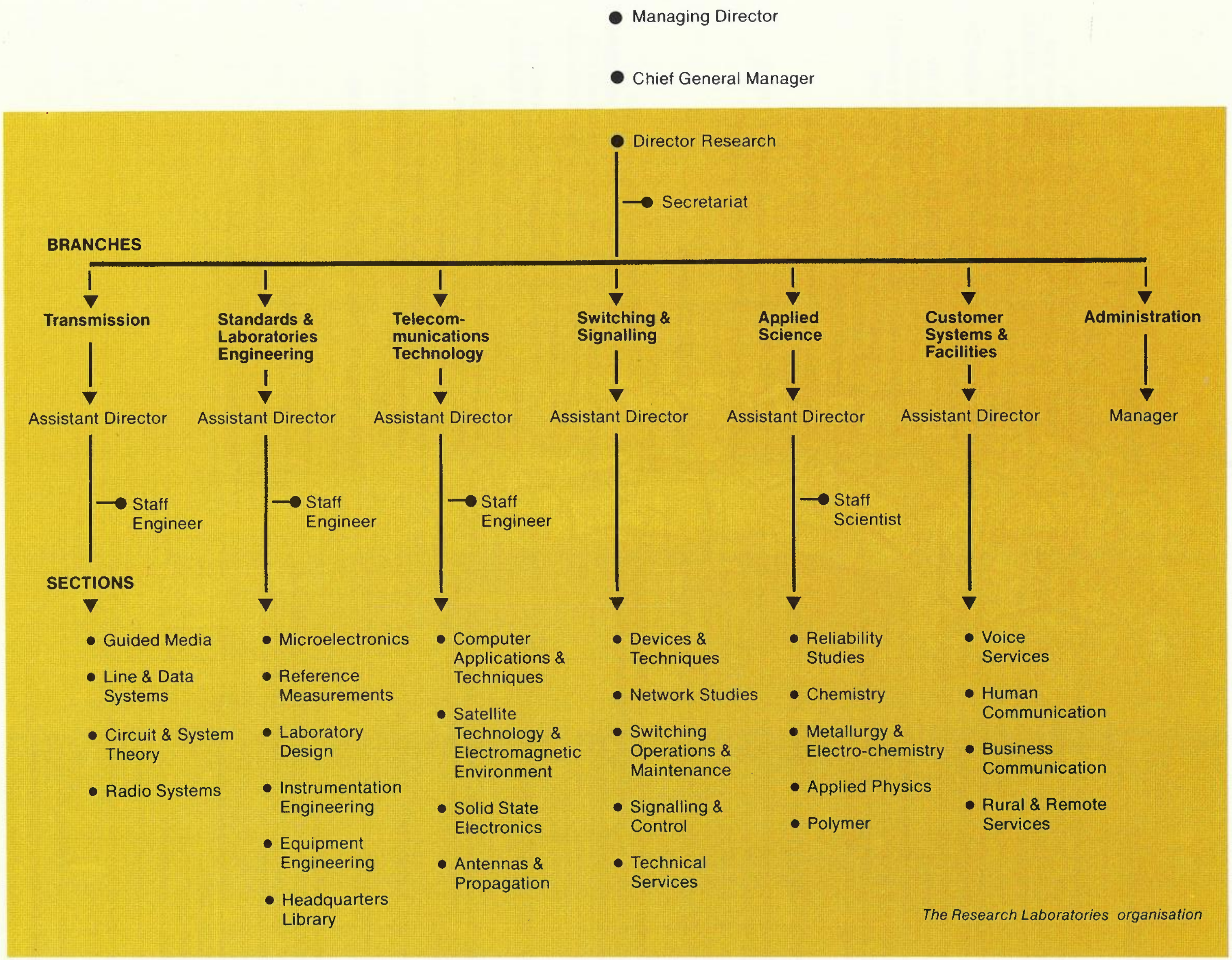
When the results from all laboratories have been assessed by ISO Committee TC61, a decision will be made on the test procedure to be adopted for the ISO Standard.

## Assessment of microwave system propagation performance

Propagation outages (traffic failures due to propagation) on the Dalby-Roma microwave system have been investigated by the Research Laboratories. From analysis of the meteorological records of the area, the outages are due to sub-refraction, being most severe on two paths which cross flat, open wheat fields. A model of the sub-refraction process has been developed, to estimate the probability of sub-refraction from meteorological data, and has been compared against system performance.

The analysis has been extended to provide design information for the Roma-Hughenden system, as this route traverses many flat open paths, subject to similar meteorology.

Recently the W.A. Radio Section of Telecom asked assistance from Headquarters to enable the rapid preparation of a design proposal for a "North West Shelf" (Dampier)—Perth gas pipeline microwave system. The Research Laboratories supplied a propagation assessment based on the likely propagation mechanisms derived from an aerial survey and an estimate of the effects of the meteorological conditions expected along the route.




*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 a Secretariat attached to the Director's Office, an Administrative Services Section and twenty nine scientific and engineering Sections, grouped into six Branches.
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

- Maintain a position at the forefront of knowledge in communications science and technology, in order to provide expert participation in the formulation and implementation of policies for the introduction of advances in science and engineering of relevance to Telecom Australia.
- Conduct specific development and design projects and scientific and engineering investigations related to telecommunications problems.

## Professional and Senior Staff

The names given below are those of the actual occupants of the positions (appointed or acting) at 30 April 1980.

**Director:** E.F. Sandbach, B.A., B.Sc.

### SECRETARIAT

Secretariat Objectives
Provide executive assistance to the Director, Research, in the management of the Research Department, in matters relating to:
- corporate planning and work programming;
- technical information services and external relationships;
- staff development;
- industrial property;

**Head, Secretariat:** F.W. Arter, B.E.E., M.Eng.Sc.

**Senior Engineer:** L.N. Dalrymple, Assoc.Dip.Elec.Eng., Grad.I.E.Aust.

**Engineer:** O.J. Malone, B.E.E.

**Executive Officer:** A.B. Conroy

**Senior Technical Officers:**
P.F. Elliott
A.K. Mitchell
W.W. Staley

### TRANSMISSION BRANCH

Branch Objectives
- In the field of transmission, conduct research, exploratory developments, system applications and field experiments, contribute to specifications, assist in the assessment of tenders and provide advice and recommendations as appropriate relating to:
- the technical aspects of signal transmission within the Telecom Australia network;
- new transmission systems and systems which are extensions of present techniques, with particular reference to their integration into the existing network;
- mutual compatibility of the various services and systems within the network;
- cost sensitivity studies.

**Assistant Director:** R. Smith, B.E.(Hons.), M.E., M.I.E.E., M.I.R.E.E.

**Staff Engineer:** R.J. Morgan, B.Sc.(Eng.Hons.), Ph.D.

**Branch Administrative Officer:** J.S. Sergeant

### Guided Media Section

Section Functions
- Provide information, advice, consultancy and recommendations as defined in the Branch objectives.
- Conduct research and exploratory development into the transmission characteristics of guiding media such as optical fibres, waveguides and cables.
- Evaluate the potential applications and utilisation of such media for the transmission of wideband signals in the local, junction and trunk networks.
- Develop and advise on new techniques for the measurement of transmission properties and characterisation of guided media.
- Maintain an awareness of and evaluate and advise on emerging techniques relating to guided media transmission.

**Section Head:** N. Demytko, B.E.(Elec. Hons.), B.Sc., M.Admin.

**Senior Engineer:** R.W. Ayre B.E.(Elec. Hons), B.Sc.(Hons.), M.Eng.Sc.

**Engineer:** K.F. Barrel, B.E.(Elec. Hons.), Ph.D.

**Senior Technical Officer:** J.H. Gillies

## Line and Data Systems Section

Section Functions

- Provide information, advice, consultancy and recommendations as defined in the Branch objectives.
- Conduct research into transmission systems which utilise metallic or optical bearers.
- Conduct research in modulation and multiplexing techniques and applications.
- Conduct research into methods of data transmission with particular reference to Datel type services and to dedicated data networks.
- Investigate the interworking of such systems with other parts of the transmission and switching network.
- Investigate and develop appropriate bearer and system testing methods.
- Conduct exploratory development of appropriate systems and testing apparatus which are not otherwise available.

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

**Senior Engineers:**
R.A. Court, B.E. (Hons.), B.Sc., M.Eng.Sc., M.I.E.E.E.
L.J. Millott, B.E.(Hons.) M.Eng.Sc., 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.
G. Nicholson, B.E.(Hons.) M.Eng.Sc., M.I.E.E.E.
P.G. Fotter, B.E.(Hons.), Ph.D.

**Senior Technical Officers:**
L.W. Bourchier
R.B. Coxhill
J.L. Kelly
R.I. Webster

## Circuit and System Theory Section

Section Functions

- Provide information, advice, consultancy and recommendations as defined in the Branch objectives.
- Conduct research into the theory and design of response shaping circuits which optimise the performance of transmission systems.
- Conduct research into the analysis and synthesis of filter-type circuits, including active and passive filters, equalisers, impedance simulating and compensating circuits, etc.
- Develop mathematical tools for the measurement, analysis and design of transmission circuits and systems.
- Provide a design and consultant service for filter-type circuits.

**Section Head:** I.M. McGregor, B.E.(Hons.), M.Eng.Sc., Ph.D.

**Senior Engineers:**
F.G. Bullock, B.E.(Hons.), Grad.I.E.Aust.
R.L. Gray, B.E.(Hons.), M.E., Ph.D., M.I.E.E.E.

**Engineer:** P.M. Hart, B.E.(Hons.), M.Eng.Sc., M.I.E.E.E.

**Senior Technical Officer:** R. Owers, M.I.T.E.

## Radio Systems Section

Section Functions

- Provide information, advice, consultancy and recommendations as defined in the Branch objectives.
- Conduct research into transmission systems which utilise radio bearers.
- Investigate the interworking of such systems with other parts of the transmission and switching network.
- Investigate and develop appropriate bearer and system testing methods.
- Develop appropriate systems and testing apparatus which are not otherwise available.

**Section Head:** O.F. Lobert, B.E.E., M.I.E.Aust., M.I.E.E.

**Principal Engineer:** R. Horton, B.Sc.(Hons.), Ph.D., A.M.I.E.E. M.I.R.E.E.

**Senior Engineers:**
R.P. Coutts, B.Sc., B.E.(Hons.), Ph.D., M.I.E.E.E.
I.C. Lawson, B.E.E.

**Engineers:**
J.C.N. Ellershaw, B.Sc., B.E.(Hons.), M.I.E.E.E.
P.R. Hicks, B.E.(Elec.), B.Sc.(App.Maths)
A.L. Martin, B.E., Grad.I.E.Aust.

# SWITCHING AND SIGNALLING BRANCH

Branch Objectives

In the fields of switching and signalling, conduct studies, exploratory development and field experiments; contribute to specifications and provide advice and recommendations as appropriate relating to:

- technical aspects of switching and signalling within the Telecom Australia network;
- new switching and signalling systems which use extensions of present techniques, or new techniques with particular reference to their integration into the existing network;
- compatibility of switching and signalling systems;
- cost sensitivity studies.

**Assistant Director:** F.J.W. Symons, B.E.(Hons.), D.I.C., Ph.D., M.I.E.Aust., A.I.E.E.

**Branch Administrative Officer:** D. Forster

## 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 new switching technology.
- Participate in the design and assessment of field trials of new switching systems and equipment which use novel devices and techniques.
- Prepare recommendations for the adoption or trial of new devices and/or techniques.

**Section Head:** P.S. Jones, M.Eng.Sc.

**Senior Engineer:** E. Tirtaatmadja, B.Eng.(Elec.)

**Engineer:** D.M. Harsant, B.E.(Hons.)

## 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 future systems in relation to network needs.
- Provide specialist consultative advice and assistance in relation to the progressive integration of new switching systems into Telecom Australia's networks.
- Examine digital 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.

**Principal Engineer:** M.A. Hunter, B.E.(Hons.), A.M.I.E.E.

**Senior Engineer:** N.G. Gale, B.E.(Elec.)

**Engineers:**
J. Billington, B.E.(Hons.), M.Eng.Sc., M.I.E.E.E.
S.M. Jong, B.E.(Elec.)

**Research Officer:** R. Bermanseder, B.Sc.

## Switching, Operations and Maintenance Section

*Section Functions*

Within the fields of switching and signalling:

- 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:**
G.J. Dickson, B.E.(Hons.), M.Eng.Sc.
A. Even-Chaim, B.Sc., M.I.E.E.

**Engineers:**
E.K. Chew, B.E., M.Eng.Sc.
F. Eastaughffe, B.Sc., B.E.(Hons.)
J.L. Snare, B.E.(Hons.)
B. Wickham, B.Sc., B.E., M.I.E.Aust., M.I.E.E.E.

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

## Signalling and Control Section

*Section Functions*

- Study the characteristics and potential of new approaches in the field of control and signalling.
- Develop models to validate theoretical studies of new control signalling systems and techniques.
- 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.

**Principal Engineer:** M. Subocz, B.E.(Elec.), M.I.E.Aust.

**Senior Engineers:**
N.Q. Duc, B.E.(Hons.), Ph.D., M.I.R.E.E., M.I.E.E.E.
J.L. Park, B.E.(Hons.), M.Eng.Sc., M.I.E.E.E.

**Engineer:** P.A. Kirton, B.E.(Hons.), M.I.E.E.E.

**Senior Research Officer:** G.M. Codsi, B.Sc.

## Technical Services Section

*Section Functions*

- Provide field and laboratory planning, provisioning, investigational, developmental, production, testing and evaluation support for Branch activities.
- Install, operate and maintain equipment in field experiments.

**Section Head:** W. McEvoy, A.A.I.M.

**Senior Technical Officers:**
R.L. Backway
W. Cameron
D.J. Duckworth
P. Ellis
H.G. Fegent
A. Romagnano
B.J. Wilson

# TELECOMMUNICATIONS TECHNOLOGY BRANCH

*Branch Objectives*

Conduct studies, exploratory development and field experiments, provide advice and recommendations, and contribute to equipment specification and assessment relating to:

- the application of newly emerging, extended or improved technologies in telecommunication engineering;
- the characteristics and properties of new devices, circuits and techniques in communications applications;
- the impact and compatibility of new technology and new applications of existing technology with those already in the Telecom Australia network;
- the forecasting and evaluation of developing trends in telecommunications technology particularly suitable for application in Australia;
- maintain and develop liaison with appropriate research establishments in Australia and overseas to provide information and advice on emerging technologies of interest to 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.

**Principal Engineer:** A.M. Fowler, M.I.E.Aust.

**Branch Administrative Officer:** C.J. Chippindall

## Computer Applications and Techniques Section

*Section Functions*

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct fundamental studies on and recommend or implement as appropriate, modelling and simulation methods, as applicable to telecommunication systems and techniques, and related activities.
- Investigate and make recommendations concerning processor technology, techniques and applications as they relate to telecommunications engineering.
- Investigate and make recommendations on methods of mathematical analysis best suited to the application of computers to problem solving in telecommunications engineering.
- Develop and provide computing facilities including hardware and software to meet special needs within Telecom Australia. Co-operate with the Instrumentation Engineering Section and Information Systems Department in provision of items of computer hardware for the Department's needs.

**Section Head:** P.J. Tyers, B.E.(Hons.), B.Sc., M.I.E.E.E.

**Senior Engineer: R.A. Seidl, B.E.(Elec.Hons.), Ph.D.**

**Engineers:**
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.)
A.I. Miles, B.E.(Elec.)
I.M. Palmer, Assoc.Dip.Electron.Eng., M.I.E.E.E.

**Senior Technical Officers:**
D. Drummond
I.J. Moran

## Satellite Technology and Electromagnetic Environment Section

*Section Functions*

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct research into, and advise on applications of communication satellite technology in Australia from system and technique studies, hardware development and experimentation.
- Conduct research into the utilisation of the frequency spectrum by satellite systems, including frequency re-use, and their co-existence with terrestrial radio services.
- Investigate interference effects of radio frequency radiation on telecommunications equipment and make recommendations on electromagnetic compatibility as appropriate.
- Establish and maintain a knowledge base on the biological effects of electromagnetic radiation and evolve design practices to take account of best available information, in consultation with and with inputs from experts in relevant medical specialities.

**Section Head:** G.F. Jenkinson, B.Sc., M.I.R.E.E.

**Principal Engineers:**
R.K. Flavin, B.Sc., M.Sc.
I.P. Macfarlane, A.R.M.T.C., B.E.(Elec.), M.I.E.E.E.

**Senior Engineers:**
A.J. Bundrock, B.E.(Elec. Hons.)
D.J. Kuhn, B.E.(Elec.), M.Eng.Sc.

**Senior Technical Officers:**
D.M. Farr
B.C. Gilbert
G.B. Newman

## Solid State Electronics Section

*Section Functions*

- Provide information, advice and consultancy as defined in the Branch objectives.
- Investigate and advise on the properties of materials and components that are applicable to the development and fabrication of devices and circuit elements which have functions based on the exploitation of these special material properties; conduct exploratory development and fabrication of such devices.
- Investigate and advise on active and passive circuit configurations, employing such devices for the generation, amplification, modulation and processing of signals and their application, especially in microwave and optical circuits and sub-systems.
- Develop and provide specialised facilities in the realm of engineering materials and devices arising from the above.

**Section Head:** W.J. Williamson, B.E.(Elec. Hons.), Ph.D.

**Principal Engineers:**
G. Rosman, B.E.E., M.E.
P.V.H. Sabine, B.Sc., B.E.(Elec. Hons), Ph.D.

**Senior Engineers:**
Y.H. Ja, B.E., Ph.D.
G.O. Stone, B.E.(Elec.), M.Eng.Sc., Ph.D., M.I.E.E.E., M.I.R.E.E.

**Engineers:**
A.M. Duncan, B.Sc., B.E.(Elec. Hons.)
J. Hubregtse, Fell.Dip.Comm.Eng., Grad.I.R.E.E.
E. Johansen, B.E.(Hons.), Ph.D.

**Principal Scientist:** G.L. Price, B.Sc.(Hons.), Ph.D., M.A.I.P., M.A.P.S., M.I.E.E.E.

**Scientist:** B.J. Linard, B.Sc.(Hons.), Ph.D., Grad.A.I.P.

**Senior Technical Officer:** B.P. Cranston

## Antennas and Propagation Section

*Section Functions*

- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct research and exploratory development in the field of freely propagated electromagnetic waves, including the study of propagation phenomena and of the interrelation of meteorological and other mechanisms, and make recommendations in relation to the performance and design characteristics of radiocommunication systems.
- Conduct research, undertake exploratory development and make recommendations on antennas for launching and receiving electromagnetic radiation, for application both in the design of antennas for experimental and 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.

**Engineer:** E. Vinnal, B.E.(Hons.)

**Senior Technical Officers:**
E.D.S. Fall
R.J. Francis
S.J. Hurren
B.W. Thomas

## STANDARDS AND LABORATORIES ENGINEERING BRANCH

Branch Objectives
To ensure a sound scientific basis for all measurements made by and within the Australian Telecommunictions Commission by arranging traceability of accuracy of measurement of fundamental engineering and physical quantities to the Australian National Standards.
Conduct studies, exploratory development and field experiments, contribute to specifications and provide advice and recommendations as appropriate relating to:

- development and application of standards of electrical quantity, time and frequency within the field of telecommunications;
- telecommunication instrumentation and equipment engineering practices;
- development and application of microelectronics components.
  Provide a mechanical, electrical and/or electronic equipment development facility for Telecom Australia.

Provide a laboratory design and instrumentation facility for the Research Department.
Provide Library Services for the Research and Engineering Departments.

**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.

**Branch Administrative Officer:** T.H. Brown

### Microelectronics Section

Section Functions

- Conduct research studies into the design and physical realisation of electronic circuitry, in particular that involving miniature and micro-miniature techniques and components, and into interconnection and mounting of these circuits.
- Provide in-house facilities for the production of prototype microelectronic circuits in experimental quantities; specify and develop test criteria and techniques for the control of quality and reliability of these circuits.

**Section Head:** D.E. Sheridan, Dip.Elec.Eng., Dip.Mech.Eng.

**Principal Engineer:**
G.J. Barker, Assoc.Dip.Mech.Eng., M.I.E.Aust.

**Senior Engineers:**
G.K. Reeves, B.Sc.(Hons.), Ph.D., 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.).
R. Proudlock, B.E.(Elec.)
D.R. Richards, B.E.(Elec.), M.I.E.E.E.

**Senior Technical Officers:**
M. Crarey
F. Gigliotti
D.P. Gordon

### Reference Measurements Section

Section Functions

- Plan and oversight the implementation, operation and further development of a system of engineering references and calibration facilities for Headquarters and all States.
- Operate, maintain and calibrate the Commission's central engineering references in terms of the Australian National Standards of Measurement.
- Develop improved engineering references, calibration and measuring techniques and procedures to meet the Commission's developing technology and operational needs.
- Develop special techniques, systems and equipment for the application of measurement technology to the solution of engineering plant problems.
- Operate as a Verifying Authority and Signatory in accordance with the requirements of the National Standards Commission and the National Association of Testing Authorities.
- Liaise with other Sections of Telecom Australia to ensure that all standards of reference have an appropriate authenticity of calibration as required by the Weights and Measures Act.
- Liaise with other national and international measurement laboratories and authorities, particularly the International Telecommunications Union, Union Radio Scientific Internationale, the Standards Association of Australia and the National Association of Testing Authorities.

**Section Head:** J.M. Warner, B.Sc., M.I.E.E.

**Principal Engineer:** R.L. Trainor, B.Sc.

**Senior Engineers:**
R.W. Harris, B.Sc.(Hons.), B.E.(Elec.Hons.), B.Comm.
E.Pinczower, Dip.Elec.Eng., M.I.E.Aust.

**Engineers:**
P. Bernhard, B.E.(Elec.)
J.P. Colvin, B.E.(Elec.), Dip.Elec.Eng., M.Eng.Sc.
D.A. Latin, Dip.Elec.Eng., B.E.(Elec.), M.I.E.Aust.
R.W. Pyke, Dip.Elec.Eng., B.E.(Elec. Hons.), M.I.E.Aust.
B.R. Ratcliff, Assoc.Dip.Comm.Eng.

**Senior Technical Officers:**
J.B. Erwin
C.R. Flood
A.L. Forecast
J. Freeman
R.H. Yates

### Laboratory Design Section

Section Functions

- Plan and specify, in conjunction with other Telecom Australia staff, accommodation requirements of the Department in future and existing buildings; liaise with construction authorities and contractors as appropriate; plan and co-ordinate the occupation of new accommodation.
- Maintain special laboratory buildings, fittings, services and facilities; liaise with Buildings Branch to arrange all buildings and building services, repairs and maintenance required within the Department.
- Co-ordinate all safety, security, and fire protection matters within the Department.

**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

## Instrumentation Engineering Section

*Section Functions*

- Study instrumentation trends relevant to present and future Telecom Australia applications; design and develop novel instrumentation systems for specific Telecom Australia needs which cannot be obtained from commercial sources.
- Develop and maintain facilities, including calibration standards, required for the calibration and maintenance of advanced laboratory test equipment and apply these facilities to ensure the high standard of performance required of the Research Department's instrumentation.
- Conduct the procurement programme for all new equipment for the Department, including preparation of technical specifications, tender evaluations and technical reports; perform acceptance testing of new equipment.

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

**Senior Technical Officers:**
S.P. Curlis
P.J. Dalliston
P.S. Dawson
D.C. Diamond
B.K. Eley
D.G. Marshall
B.J. McEwen

## Equipment Engineering Section

*Section Functions*

- Conduct research into the application of new materials, components fabrication and assembly techniques applicable to the design and construction of mechanical, electrical and electronic equipments and tools required within the Research Department and elsewhere in Telecom Australia.
- Provide for Telecom Australia a specialist design facility, including mechanical and electro-mechanical engineering design of the hardware aspects of telecommunications models; arrange for production of these designs within Telecom Australia or industry or, when necessary, within the Section; establish specification criteria for performance and quality, and the necessary measuring equipment, and employ these to ensure adequate performance of the items produced.
- Oversight the on-the-job training of apprentice artisans and trainee technical staff in the mechanical engineering field for the Research Department.

**Section Head:** R.L. Kilby, Assoc. Dip. Elec.Eng.

**Senior Engineer:** P.F. Meggs, Assoc.Dip.Mech.Eng., M.I.E.Aust.

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

**Senior Technical Officers:**
J.D. Kisby
D.J. McMillan
W.L. Reiners

## Headquarters Library

*Functions*

- Provide a comprehensive library service to all Departments and Directorates at Headquarters.
- Co-operate with State Administrations and provide consultative services in regard to common standards and systems.

**Principal Librarian:** M.I. Cuzens, B.A., F.L.A.A., A.L.A., F.R.I.P.A.

**Senior Librarian:** H.M. Wisdom, B.A., Dip.Lib., A.L.A.A.

**Librarians:**
A.E. Guest, Dip.Lib.
P. Millist, Dip.Lib.
S.M. Peters, B.A., B.Sc., Dip.Ed., Dip.Lib., A.L.A.A.
D. Richards, Dip.Lib.

# APPLIED SCIENCE BRANCH

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

- the properties of materials, components and equipment;
- the causes of degradation and failure, and the establishment of remedial measures;
- the influence of the environment on staff and plant and the required protective measures;
- the development and application of new materials and of new scientific test methods;
- the reliability of components and devices;
- participation in committees, conferences, etc., both national and international, and liaison with universities and research organisations.

**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.)

**Physical Scientists:**
C.G. Kelly, B.App.Sc. (App. Phys.)
J.R. Lowing, Dip.Sec.Met.

**Branch Administrative Officer:** M.A. Chirgwin

## 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 materials and components.

**Section Head:** D. McKelvie, B.Sc.(Hons.)

**Senior Engineer:**
I.K. Stevenson, B.App.Sc., Dip.Eng.(Electronic Eng.), A.R.M.I.T., Grad.A.I.P.

**Senior Physical Scientist:** G.G. Mitchell, B.Sc.(Hons), M.Sc.

**Physical Scientist:** S.J. Charles, B.App.Sc., A.R.M.I.T.

**Senior Technical Officers:**
C.W. Downing, Dip.Eng.(Comm.)
R.A. Galey

## 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 Telecom Australia's problems.
- Conduct scientific studies into chemical phenomena and hazards.
- Develop specialised techniques and equipment for the analysis 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.

**Senior Physical Scientist:** R.N.M. Barrett, B.Sc.(Hons.), A.R.I.C.

**Physical Scientists:**
T.J. Elms, Dip.App.Sc., Grad.R.A.C.I.
P. George, Dip.App.Sc.(App. Chem.), Grad.R.A.C.I.
S. Georgiou, B.App.Sc.(App.Chem.)
F.M. Petchell, Dip.App.Chem., A.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 Telecom Australia's problems.
- Perform scientific studies involving electro-chemical phenomena in the fields of corrosion 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 phenomena 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 Scientist (Metallurgy Group):** T.J. Keogh, Assoc.Dip.Sec.Met.

**Physical Scientists:**
J.R. Godfrey, Assoc.Dip.Met.
K. Keir, Fell.Dip.Met.Eng.

Senior Physical Scientist (Electro-Chemistry Group): J. Der, B.Sc., A.R.A.C.I.

**Physical Scientists:**
P.J. Gwynn, Dip.App.Chem.
R.F. May, Dip.App.Met., M.Sc.
Z. Slavik, Dip.Eng., A.R.A.C.I.

**Senior Technical Officers:**
F.M. Hamilton
M. Jorgensen, Assoc.Dip.Met.
J.W. Smith.

## 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 Telecom Australia's 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
I.M. Tippett

## Polymer Section

Section Functions
- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct exploratory research and investigation in 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 of the properties of 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., A.R.A.C.I.

**Senior Physical Scientists:**
D.J. Adams, Dip.App.Chem., Grad.R.A.C.I.
B.A. Chisholm, Dip.App.Chem., M.Sc., Grad.R.A.C.I., Grad.P.R.I.

**Physical Scientists:**
R.J. Boast, Dip.App.Chem., Grad.R.A.C.I.
P.R. Latoszynski, Dip.App.Sc., Grad.R.A.C.I.
D.T. Miles, F.C.S., C.Chem., M.R.I.C., M.R.S.H.

## 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 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 of existing services;
- the interaction between users or users' equipment and the Telecommunications 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.

**Branch Administrative Officer:** B.F. Donovan

## Voice Services Section

Section Functions
- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct studies and exploratory development of new telephone facilities and customer apparatus for voice services, taking account of switching, signalling, and multiplexing requirements of the telecommunication system.
- Provide standards for telephone transmission and make recommendations on the transmission performance criteria for voice services.
- Investigate the generation, transmission, perception, synthesis and recognition of speech signals in telecommunication networks.
- Conduct studies into audio frequency acoustic signal propagation and noise.
- Advise on methods for the quality control of the performance of customer equipment.

**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, Fell.Dip.Elec.Eng., B.E.(Elec.), M.A.A.S.

**Senior Engineers:**
P.F. Duke, Assoc.Dip.Maths., B.Tech.
R.W. Kett, Fell.Dip.Comm.Eng., A.M.I.R.E.E.

**Engineers:**
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.
P.I. Mikelaitis, B.E.(Elec.), (M.Eng.Sc.)
B.W. Sneddon, B.E.(Elec.)

**Senior Technical Officers:**
S.G. Beadle
T.R. Long
J.E.W. Lucas

## Human Communications Section

Section Functions
- Provide information, advice and consultancy as defined in the Branch objectives.
- Undertake fundamental studies of the processes of human communication.
- Undertake the design, exploratory development and experimental assessment of group and other novel communication facilities.
- Investigate the social and organisational implications of such facilities.
- Investigate, develop where necessary, and apply the techniques of the social sciences to the assessment of the effectiveness and acceptability of communication facilities.
- Investigate the effects of signal transmission, presentation and processing on human communication, including the interaction between telecommunication technology and user perception and behaviour.
- Conduct studies and exploratory development of communication devices and techniques which meet the special needs of the handicapped.

**Section Head:** G.D.S.W. Clark, B.E.E.(Hons.), M.Sc., M.I.E.Aust.

**Senior Engineer:** J. Craick, B.E.(Elec. Hons.), B.Sc.

**Engineer:** D.Q. Phiet, B.E.(Elec. Hons.), Ph.D.

**Senior Psychologist:** L.A. Albertson, B.A.(Hons.) Dip.Ed.

**Psychologists:**
J.R. Grimwade, B.A.(Hons.)
L. Perry, B.A.(Hons.), M.A.P.S.

**Senior Technical Officer:** C.D. Barling

## Business Communications Section

Section Functions
- Provide information, advice and consultancy as defined in the Branch objectives.
- Provide specialist advice and assistance in the use of television and record systems.
- Conduct studies and exploratory development of integrated multi-functional business communications systems.
- Investigate hardware and software techniques relevant to the provision of customer information systems.
- Investigate questions of technical compatibility arising when new facilities are added to existing business systems.
- Conduct studies and exploratory development of terminal equipment for the generation and display of TV and record signals.
- Undertake investigations and exploratory development of the processing of visual and record signals so as to facilitate their transmission within the Telecom Australia network.
- Study and develop techniques for the conversion between various forms of visual and record signals.

**Section Head:** M. Cassidy, B.Sc., M.E., D.P.A., F.I.E.Aust. F.I.E.E.

**Principal Engineer:** R.I. Davidson, B.E.(Elec.)

**Senior Engineers:**
A.R. Jenkins, A.R.M.I.T.
G.K. Jenkins, B.Sc., B.E.(Hons.), M.E., M.A.C.S.
W.E. Metzenthen, F.R.M.I.T., M.E., M.I.R.E.E.

**Engineers:**
D.M. Blackwell, B.E.(Elec.)
R. Exner, B.Sc., B.E.(Hons.), M.A.Sc., M.I.E.E.E.
G.R. Smart, A.R.M.I.T., A.M.I.R.E.E., J.P.
T.Y. Tan, B.E.(Elec.)

**Senior Technical Officers:**
B.W. Booth
P.C. Murrell

## Rural and Remote Services Section

Section Functions
- Provide information, advice and consultancy as defined in the Branch objectives.
- Conduct studies and exploratory development of equipment for remote and rural subscribers.
- Contribute to specifications for remote and rural subscriber's facilities.
- Assess the potential of new technology and facilities for remote and rural subscribers and provide recommendations for appropriate applications.
- Study, assess and recommend protocols for facilities, operating procedures and interconnection of remote and rural subscribers equipment.

**Section Head:** J. Steel, B.E.(Hons.), M.E., Ph.D., M.I.E.E.

**Senior Engineer:** G.K. Millsteed, Dip.Elec.Eng., B.E.(Hons.)

## ADMINISTRATIVE SERVICES SECTION

**Manager Administration:** J.B. Sidbottom
**Senior Planning Officer:** J.F. Reid
**Project Officer:** T.W. Dillon
**Budgets Officer:** R. Beveridge
**Staff Services Co-ordinator:** G.N. Galvin

## 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 papers to Australian and overseas scientific and technical journals and present papers to learned societies both in Australia and overseas. This list shows those papers, lectures, talks and reports presented or published during the period 1-5-79 to 30-4-80.

### PAPERS

| | |
|---|---|
| Addie, R., Codsi, G., Gerrand, P.H. and Rubinstein, M. (Engineering Department, Headquarters) | "A General Exchange Simulator for Capacity Studies of Telecommunication Control Systems", 9th International Teletraffic Congress (ITC-9), Spain, October 1979. |
| Ayre, R.W.A. | "Linearity of Light Emitting Diodes for Analogue Optical Fibre Links", Australian Telecommunication Research, Vol. 13, No. 1, 1979. |
| Blackwell, D.M. | "Developments in Coding Techniques for Digital Document Facsimile", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Boast, R. | "Plastics in Telecommunications", Telegen, Vol. 11, No. 4, July 1979. |
| Chisholm, B.A., Flatau, G. and Ruddell, H.J. | "Telephone Mouldings for the Australian Environment", Australian Telecommunication Research, Vol. 13, No. 1, 1979. |
| Coutts, R.P. and Billington, J. | "Effects of Fading on Data Transmission Over FM/FDM Radio Systems", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Coutts, R.P. | "Data Transmission Performance Over Terrestial Radio Relay Systems", IEEE 1980, International Zurich Seminar on Digital Communications, Zurich, March 1980. |
| Coutts, R.P. | "Recent Overseas Developments", Telecom Colloquium, New Propagation and System Techniques for Non-Trunk Radio Applications in the 1980s, Melbourne, April/May 1980. |
| Craig, E.R. (and Caruana, V.A., Engineering Department, Headquarters) | "Telecom Australia Preparation for WARC-79", Telecommunication Journal of Australia, Vol. 29, No. 2, 1979. |
| Davies, W.S. | "Report on the First Australian Electromagnetic Pulse Studies", Electricity Supply Association of Australia, Joint Conference, Adelaide, November 1979. |
| Davies, W.S., Coutts, R.P., Campbell, J.C., (Hollo, P., Engineering Department, NSW and Stevens, D.W., Engineering Department, WA) | "EMP Assessments of Two Telecom Australia Installations - Interim Reports", (Classified) - Telecom Australia, Melbourne, November 1978. |
| Davies, W.S., Coutts, R.P., Campbell, J.C., (Hollo, P., Engineering Department, NSW and Stevens, D.W., Engineering Department, WA) | "First Australian EMP Studies - Telecom Australia Report", (Classified) - Telecom Australia, Melbourne, May 1979. |
| Davies, W.S., Coutts, R.P. and Campbell, J.C. | "EMP - A Potential Hazard in Australia", IE Australia, Engineering Conference, Adelaide, April 1980. |
| Demytko, N. and Horton, R. | "A Sub-nanosecond Pseudo Random Noise Generator", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Denger, L.A.R. | "Recent Hardware Developments of Terminals for Data Processing Systems", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Dickson, G.J. | "X.21 : An Interface Between Data Terminals and Circuit Switched Data Networks", The Telecommunication Journal of Australia, Vol. 29, No. 3, 1979. |
| Duc, N.Q. (and Rudolph, L.D., Hartmann, C.R.P., and Hwang, T.Y., Syracuse University, USA) | "Algebraic Analog Decoding of Linear Binary Codes", IEEE Transactions on Information Theory, Vol. IT-25, July 1979. |
| Duc, N.Q. | "Data Transmission Developments and Public Data Networks", The Telecommunication Journal of Australia, Vol. 29, No. 3, October 1979. |
| Duc, N.Q., | "Estimation of Bit Error Rate from Error-Free Second Performance", Australian Telecommunication Research, Vol. 13, No. 2, November 1979. |
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| Gerrand, P.H. and Park, J.L. | "Development of a Processor Monitoring Instrument for SPC Exchanges : Facilities and Application Areas", The Telecommunication Journal of Australia, Vol. 29, No. 2, 1979. |
| Gibbs, A.J., Millott, L.J. and Nicholson, G. | "Optimum PCM Regenerator Performance in Presence of Crosstalk", Electronic Letters, Vol. 15, No. 16, August 1979. |
| Harvey, R.A. | "Propagation Effects in Outback Areas", Telecom Colloquium, New Propagation and System Techniques for Non-Trunk Radio Applications in the 1980s, Melbourne, April/May 1980. |
| Horton, R. | "Couplers in Microstrip and Their Application", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Horton, R. | "Variation of Lange Coupler Geometry with Dielectric Constant", Electronics Letters, Vol. 15, No. 20, September 1979. |
| Horton, R. and Lobert, O. | "Digital Radio Applications", Telecom Colloquium, New Propagation and System Techniques for Non-Trunk Radio Applications in the 1980s, Melbourne, April/May 1980. |
| Hunt, C.A. and Tyers, P.J. | "Broadcast and Wired Teletext Systems - A Review", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Ja, Y.H. | "Phase Centre of Paraboloidal Antennas", Electronic Letters, Vol. 15, No. 24, November 1979. |
| Jenkins, G.K. | "A General Purpose Data Compression Program", Dr. Dobb's Journal of Computer Calisthenics and Orthodontia, Vol. 4, Issue 8, No. 38, September 1979. |
| Kidd, G.P. | "The Telecom Australia Optical Fibre Field Experiment", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Kidd, G.P., Morgan, R.J. and Sabine, P.V.H. | "Optical Fibre Communications in Telecom Australia", Proceedings of the IREE Australia, Vol. 40, No. 3, June 1979. |
| Martin, A.L. | "Characterisation of Semiconductor Material Using the C-V Technique", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Martin, A.L. (and Beanland, D.G., Harrison, H.B. and Williams, J.S., Royal Melbourne Institute of Technology) | "Properties of Proton Bombarded N-type Gallium Arsenide", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Martin, A.L. (and Ladbrooke, P.H., University of NSW) | "Material and Structure Factors Affecting the Large-Signal Operation of GaAs MESFETS", Conference on Semi-Insulating III-V Materials, University of Nottingham, UK, April 1980. |
| McKee, A.N. and Lowing, J.R. | "Secondary Ion Mass Spectrometry (SIMS)", 6th Australian Conference on Electron Microscopy, Melbourne, Monash University, February 1980. |
| Metzenthen, W.E. | "Measurement of Telephone Impedance Using a Complex Test Signal", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Metzenthen, W.E. | "Alternatives to the Carbon Transmitter", Letter to Editor, Bulletin of the Australian Acoustical Society, Vol. 7, No. 2, August 1979. |
| Millott, J.L. | "Barrage Testing at PCM Regenerator Housings", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Murphy, J.V. and Bundrock, A. | "Recent Results of Broadband Microwave Experiments", Telecom Colloquium, New Propagation and System Techniques for Non-Trunk Radio Applications in the 1980s, Melbourne, April/May 1980. |
| Nicholson, G. | "A Numerical Model for Predicting the Jitter Accumulation on PCM Bearers", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Nicholson, G. and Norton J.P. | "Kalman Filter Equalization for a Time-Varying Communication Channel", Australian Telecommunication Research, Vol. 13, No. 1, 1979. |
| Park, J.L. and Kirton, P.A. | "A Processor Monitoring Instrument for Real-Time Stored Program Controlled Systems", IE Australia, Conference on Microprocessor Systems, Melbourne, November 1979. |
| Petchell, F.M. | "Insect Repellants for Personal Use", Telecom, No. 47, November 1979. |
| Quan, A.Y.C. | "Modulation Techniques for Transmission of Wideband Services over Optical Fibre", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Reeves, G.K. | "Contact Resistance of Ohmic Contacts to GaAs", IREE Australia, International Electronics Convention, Sydney, August 1979. |

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|---|---|
| Sabine, P.V.H. | "Bidirectional Couplers for Duplex Transmission over a Single Optical Fibre", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Sabine, P.V.H., Johansen, E., (Nicol, D. and Donaghy, F., AWA Research Laboratories) | "Characterisation of Low-Loss Optical Fibres", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Scott, C.J. | "Digital Storage - A Review of Current Technologies", The Telecommunication Journal of Australia, Vol. 29, No. 2, 1979. |
| Scott, C.J. and Kuhn, D. | "Erasable Memory Device Behaviour", Australian Telecommunication Research, Vol. 13, No. 2, 1979. |
| Seidl, R.A. | "Improving the Naturalness of Synthetic Speech", IREE Australia, International Electronics Convention, Sydney, August 1979. |
| Semple, G.J. | "The Effect of Bit Stealing on the Transmission Quality of 24-Channel PCM Systems in an IST Environment", Proceedings of the IREE Australia, December 1979. |
| Smith, B.M. | "The Effect of Short Breaks on Class 4 Partial Response Data Signals", AEU, Vol. 33, No. 6, June 1979. |
| Symons, F.J.W. | "The Description and Definition of Queueing Systems by Numerical Petri Nets", Australian Telecommunication Research, Vol. 13, No. 2, 1979. |
| Vinnal, E. and Burton, J. | "Assessment of Radio Propagation Above 10 GHz", Telecom Colloquium, New Propagation and System Techniques for Non-Trunk Radio Applications in the 1980s, Melbourne, April/May 1980. |
| Vinnal, E. and Burton, J. | "Microwave Propagation and Digital Radio Operation at Frequencies Above 10 GHz", IE Australia, Engineering Conference 1980, Adelaide, April 1980. |

## LECTURES AND TALKS

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|---|---|
| Ayre, R.W.A. | "Modal Noise on Fibre Systems", 4th Australian Workshop on Optical Fibre Communication, Sydney, University of NSW, December 1979. |
| Baker, F.C. | "Adhesives in Construction", Building Products Seminar, IE Australia, Victorian Division, Melbourne, June 1979. |
| Barrell, K. | "Calculation and Measurement of Impulse Response of Graded Index Fibres", 4th Australian Workshop on Optical Fibre Communication, Sydney, University of NSW, December 1979. |
| Burton, J.M. | "The World Above 10 GHz; A Viewpoint", Colloquium, Darwin Engineering Staff, June 1979. |
| Burton, J.M. | "The World Above 10 GHz", Professional Officers Association, Telepost Engineers Group, Lecture No. 275, Melbourne, June 1979. |
| Duc. N.Q. | "Performance Monitoring of Data Transmission Circuits", Defence Research Centre, Salisbury, SA, May 1979 |
| Duc. N.Q. | "Performance Monitoring of Data Transmission Circuits", Regional Operations Branch, SA, Adelaide, May 1979. |
| Duc, N.Q. | "A Performance Monitoring System for Data Transmission Circuits", Australian Computer Society, Special Interest Group on Data Communications (SIGCOM), Melbourne, April 1980. |
| Gibbs, A.J., Semple, G.J. and Millott, L.J. | PCM Course for Engineers of the Queensland Administration, Brisbane, July 1979. |
| Gibbs, A.J., Millott, L.J. and Nicholson, G. | PCM Course for Engineers of the Victorian Administration, Melbourne, May 1979. |
| Gibbs, A.J., Millott, L.J. and Nicholson, G. | PCM Course for Engineers of the New South Wales Administration, Sydney, November 1979. |
| Gibbs, A.J., Semple, G.J. and Millott, L.J. | PCM Course for Engineers of the SA Administration, Adelaide, October 1979. |
| Godfrey J. | "Precautions Required in the Use of Non-Destructive Plating Thickness Measurement Techniques", Australian Institute of Metal Finishing, Symposium on Testing of Surface Coatings, Melbourne, June 1979. |
| Horton, R. | "Interaction Arrays of Couplers", Department of Defence, Canberra, October 1979. |

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|---|---|
| Johansen, E. | "Scanning Electron Microscope Investigation of Fibre Manufacture", 4th Australian Workshop on Optical Fibre Communication, Sydney, University of NSW, December 1979. |
| Kidd. G.P. | "Fibre Standards and Measurements", 4th Australian Workshop on Optical Fibre Communication, Sydney, University of NSW, December 1979. |
| Martin, A.L. (and Harrison H.B., Royal Melbourne Institute of Technology) | "Electronic Isolation of Devices for Planar GaAs Application", Radio Research Board, Symposium on Millimetre Techniques, CSIRO Radio Physics, Sydney, February 1980. |
| McKee, A.N. and Lowing, J.R. | "Secondary Ion Mass Spectrometry (SIMS)", 4th Australian Conference and School on X-Ray Analysis, Canberra, February, 1980. |
| Morgan, R.J. | "Potential Application of Optical Fibres in the Telecom Network", IE Australia, Sydney, October 1979. |
| Murphy, J.V. | "Short Talk on Work within the Laboratories", Rotary International, Oakleigh Branch, April 1980. |
| Quan, A.Y.C., Kidd, G.P. and Morgan, R.J. | "Optical Fibres", Seminar for Engineers of the Engineering and Research Departments, Telecom, November 1979. |
| Quan, A.Y.C. | "Optical Fibre Systems Activity in Europe and Japan", 4th Australian Workshop on Optical Fibre Communication, Sydney, University of NSW, December 1979. |
| Sabine, P.V.H. | "Uncertainties in Fibre Refractive Index Profiles Measured by Near-Field Scanning Techniques", 4th Australian Workshop on Optical Fibre Communication, Sydney, University of NSW, December 1979. |
| Semple, G.J. | "PCM Regenerator Performance Assessment", Postgraduate Students, Department of Electrical and Electronics Engineering, Footscray Institute of Technology, November 1979. |
| Smith, B.M. | "Fundamentals of Digital Data Transmission on FDM-derived Carrier Channels", Headquarters Engineering Staff, December 1979 and February 1980. |
| Smith, R. | "PCM Systems : A Review of Standards and the Future", IREE Australia, Monthly Meetings, Melbourne, April 1979. |
| Steel, J. | "Telephone Services for Rural and Remote Subscribers", IREE Australia, Melbourne Division, November 1979. |
| Teede, N.F. | "Photovoltaic Power System Economies", Workshop on Concentrating Photovoltaic Systems for Energy Supply in Isolated Areas, Solar Energy Research Centre, University of Qld., August 1979. |
| Teede, N.F. | "Energy Demands for Solar Powered Remote Communications Systems", Workshop on Concentrating Photovoltaic Systems for Energy Supply in Isolated Areas, Solar Energy Research Centre, University of Qld., August 1979. |

## RESEARCH LABORATORIES REPORTS

| Report No. | Author | Title |
|---|---|---|
| 7102* | F.D. Mazzaferri | Evaluation of the Digital Tandem Exchange |
| 7164* | G.K. Reeves | Chemical Etching of Gallium Arsenide with the $H_2SO_4$ : $H_2O_2$ : $H_2O$ System |
| 7166 | E. Johansen | Scanning Electron Microscopy - General Description |
| 7170 | G.J. Semple | The Effect of Intersymbol Interference on the Operation of PCM Line Regenerators |
| 7199* | P.F. Duke | Overseas Visit, June/July 1977 |
| 7206* Addendum 1 | L.J. Millott | The Sensitivity of PCM Penetration to Crosstalk Noise Parameter Uncertainties |
| 7212* | R.A. Seidl | Support Software for the DCT-132 Batch Terminal, Part 3: GE-105 Emulator Documentation |
| 7226 | R.N. Swinton | A Method for Obtaining Gain Characteristics of Automatically Equalised Primary Level PCM Line Regenerators |
| 7229 | R.A. Harvey | Proposals to Alleviate Propagation Problems on the Moomba Gas Pipeline Communications System |
| 7234 | J. Hubregtse | Gold Alumina and Gold Quartz Bonds for Microwave Integrated Circuits |
| 7235* | F.M. Petchell | Corrosion Inhibitors for Internal Combustion Engine Cooling Systems |
| 7243* | N. Leister | Evaluation of the General Purpose Cable Identification Set |
| 7245* | I. Palmer | Field Testing of a Mini-Computer Based Telephone Metering System |
| 7249 | M.J. Valk | A Fully Buffered Taped Information Transfer System |
| 7250 | A.L. Martin | Capacitance-Voltage Analysis to Determine Semi-Conductor Majority Carrier Density Profiles |
| 7255 | R.J. Morgan | Overseas Visit - July/August 1977: Some Trends in Low-Loss Optical Fibre and Cabling Technologies |
| 7257 | E. Vinnal | Performance of Partial Response Encoding with Frequency Modulation |
| 7259 | G. Nicholson | A Numerical Model to Describe the Retiming Operation of a PCM Regenerator |
| 7264 | E. Pinczower and J.B. Erwin | Measurement Capabilities - Electrical Standards Section |
| 7265* | R.A. Frizzo | An Efficient Case Conversion Method for Disk Files on TACONET |
| 7269* | G. Nicholson | Spurious Tones in Groupband Circuits |
| 7272* | P.V.H. Sabine and E. Johansen | Some Characterisation Measurements of the Dainichi-Nippon Optical Fibre Cable Type OGF6-LAP-DLT |
| 7277 | C.V. Eyre | Micro Plasma Arc Welding Investigations |
| 7279* | W.E. Metzenthen, T.R.A. Long and D.M. Blackwell | Evaluation of a Group Two Facsimile Transceiver |
| 7280* | R.W.A. Ayre | Linearity of Light Emitting Diodes for Analogue Optical Fibre Links |
| 7284 | D. Richards | The Engineering Library SDI System |
| 7285 | G. Nicholson | State Transition Diagrams of HDB3 and Class IV Partial Response Line Codes |

| Report No. | Author | Title |
|---|---|---|
| 7288* | L.A. Albertson | Trying to Eat an Elephant |
| 7291 | D. McKelvie | Overseas Visit Report, September/October 1978 |
| 7297 | R.N. Swinton | AMI/HDB3 Line Encoder and Decoder |
| 7298* | B.A. Chisholm | Report on UK Visits during September 1978 |
| 7299 | G.K. Jenkins | A File Compression Facility for the TACONET (H6000) System |
| 7301 | G.K. Jenkins | A TACONET Implementation of an HP2100A Disassembler |
| 7302* | K. Jones | Comparison of Plastics Coatings for Stayrods |
| 7303 | P.F.J. Meggs | A Message Storage and Indication Console |
| 7307 | R.W.A. Ayre | Further Measurements of Linearity of Light Emitting Diodes |
| 7309* | D.M. Gellert | Weathering Resistance of Nylons used as Insect Resistant Jacket for Telecommunication Cable |
| 7311* | G. Nicholson | Objectives for the Timing Recovery in a 2048 kbit/s PCM Regenerator |
| 7312 | D.J. Adams, M.W. Wawn and S.D. Barnett | The Development of a Thermal Stress-Cracking Test for Polyethylene Insulation |
| 7313* | A.M. Impey, K. Jones and H.J. Ruddell | Sealing of Occupied Conduits |
| 7329* | J.L. Snare | Impulse Noise on Queensland PCM Systems |
| 7330* | R.L. Boast and A.M. Impey | Examination of Exotherm Performance Parameters of the Epoxy Resin Field Pack Using "Epoxide" 8 as the Reactive Diluent |
| 7336 | R.W.A. Ayre | The Use of Optically Coupled Isolators for Wideband Analogue Signals |
| 7337 | G.K. Jenkins | A Fortran Implementation of the Data Encryption Standard |
| 7339 | G. Nicholson and B.M. Smith | Synchronisation Aspects for the Digital Radio Concentrator System |
| 7340* | B.M. Smith and L.J. Millott | The Effect of PCM Sample Slip in a Plesiochronous Telephony IDN on Voiceband Data Modems |
| 7342 | D.T. Miles | Serial 177, Secondary Batteries - Case Sealing |
| 7344 | G.K. Jenkins | An H6000 Fortran Conditional Compilation Facility |
| 7352* | A.Y.C. Quan | Digital Transmission Tests on Step Index Optical Cable |

Note: The reports marked * are not available beyond Telecom Australia, in addition 12 reports of restricted 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
Communication and Electronic Engineering Department Advisory Committee — M. Cassidy
Master's Degree in System Engineering Advisory Committee — M. Cassidy
Course Advisory Committees — R.D. Slade, M.I. Cuzens

**Preston Institute of Technology**
Course Advisory Committee — R. Smith

### NATIONAL & STATE PROFESSIONAL BODIES

**Australian National Committee for Radio Science** — E.R. Craig

**Radio Research Board** — E.F. Sandbach

**Victoria CSIRO State Committee** — E.F. Sandbach

**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**
Publications Board — R. Horton
Melbourne Committee — R. Horton

**Australian Acoustical Society**
Victoria Division Committee — D.A. Gray
Federal Council — D.A. Gray (General Secretary)

**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 (SAA)**
Council of Executive and Staff Committee — E.F. Sandbach
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
- "Engineers" Hand Tools ME/10 — P.F. Meggs
- 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
- ISOTC 61 Plastics Advisory Committee — B.A. Chisholm, H.J. Ruddell
- Safety Helmets — R.J. Boast

Safety Standards
- Industrial Safety Gloves — F.C. Baker

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| Telecommunications and Electronics Industry Standards | |
| • Capacitors and Resistors | G. Flatau<br>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 | E.F. Sandbach<br>J.M. Warner |
| Assessor for Environmental Testing | G. Flatau |
| Assessor for laboratories engaged in Testing Plastics | B.A. Chisholm |
| Assessor for laboratories engaged in Acoustical Testing | E.J. Koop |
| Assessor for laboratories engaged in Electrical Testing | J.M. Warner<br>E. Pinczower<br>J.B. Erwin |
| Subcommittee SAA:<br>Metal Finishes | T. Keogh |

## INTERNATIONAL BODIES

The Laboratories participate in the activities of a number of international bodies and committees; these include:

- The International Telegraph and Telephone 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)

In particular, staff of the Research Laboratories held offices as listed in the following International Bodies during the year:

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| • Chairman, CCIR Study Group 4 (Fixed Service using Satellites) | E.R. Craig |
| • Chairman, CCITT Sub Group XI/3-1 (Specification and Description Language for SPC Switching Systems) | P.H. Gerrand |
| • IEC Joint Co-ordination Group - Optical Fibres, Working Group 4 | A. Quan |
| • Vice-Chairman, CCITT SG XVIII | H.S. Wragge |
| • International Confederation for Thermal Analysis | F.C. Baker |

# 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 | 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 |
| | | 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 |
| 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 |
| | | 166819 | 3,745,418 | USA |
| | | 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 |

| Invention Title (Inventor/s) | Patent Application Numbers<br>Provisional<br>Specification | <br>Complete<br>Specification | Patent Number (if granted) | Country |
|---|---|---|---|---|
| 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<br>387855<br>178402 | 480006<br>3,882,283<br>984,068 | Australia<br>USA<br>Canada |
| Nephelometer with Laser Source (L. Davidovits) | PC4286/75 | 20511/76 | 507518 | Australia |
| Tamperproof Telephone Apparatus (C.M. Hamilton & J.A. MacCaskill) | PC5285/76 | 23264/77 | 502780 | Australia |
| Fault Monitoring Apparatus (R.W. Ayre) | - | 17251/76 | 504585 | Australia |
| Optical Waveguides and a Method of Manufacture Therefor (P.V.H. Sabine & P.S. Francis) | PC4499/76 | 21232/77 | 507723 | 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 | 54367/80<br><br>00263/80 | | Australia<br>USA<br>Japan |
| Fibre Optic Termination (P.V.H. Sabine) | PD6157/78 | 50841/79<br>P2938649<br>G79271195<br>126329/79<br>078465 | | Australia<br>Germany<br>Germany<br>Japan<br>USA |
| Noise Assessment of PCM Regenerators (A.J. Gibbs) | PD6790/78 | 52160/79<br>793,025,727<br><br><br><br><br><br><br><br>339841<br>148305/79<br>093228 | | Australia<br>Europe<br>(designating:<br>France<br>Germany<br>Britain<br>Italy<br>Holland<br>Switzerland)<br>Canada<br>Japan<br>USA |

## 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 government 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, 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 UN/ITU 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 1980 are listed below:

Army School of Signals, Senior Electronic Technicians

Australian Administrative Staff College - Advanced Course Attendees

Australian Science and Technology Council Members

Ballarat College of Advanced Education - Staff and Final Year Students

Mr. C.H. Burton, CSIRO, Applied Physics Division

Canadian Executives from various Canadian Telecommunications Agencies and Companies

Caulfield Institute of Technology - Electrical Engineering Department Staff

CCITT Delegates Working Party XI/3

Commissioners of Telecom Australia

Design Standards Co-Ordination Committee of Telecom Australia

Mr. J. Fraser, Hughes Aircraft Company

Information Systems Department Staff - Telecom Australia

Line Supervisors from Supervisors Course at Doncaster Lines School

University of Melbourne - Final Year Electrical Engineering Students

Middle-Level Electrical/Electronic Teachers Association of Victoria Members

Newly Appointed Class 1 Engineers

Messrs. R. Nixon (Bell, Canada) and V. Fitzgerald (Supervising Engineer Geelong, Telecom Australia)

Dr. Isao Ohtomo, Yokosuka Electrical Communication Laboratory, NTT

Personnel Department Staff, Telecom Australia

Mr. B. Petrie, Telecom Publicity Office

RAAF, Ground Radar Squadron Staff

Messrs. B. Reimer and C. Wilhelm of the ABC

RDI State Co-Ordinators, Telecom Australia

Trainee Technical Officers, 1980 Intake

## Overseas Visits by Laboratories Staff

It is an important responsibility of any viable organisation 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:

R.G. Addie
R.P. Coutts
E.R. Craig
G.J. Dixon
P.F. Duke
G. Flatau
P.H. Gerrand
G.C. Heinze
Y.H. Ja
G.F. Jenkinson
J.R Lowing
A.Y.C. Quan
H.J. Ruddell
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.

R.G. Addie, Postgraduate Scholarship, Monash University.

## 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 organisations 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:

- Phase Discriminator and Display Unit.
- Optical Fibre Cable Manufacturing Process.
- Digital Reticulation of Telephone Subscriber Services.
- Prototype Speech Level Measuring Set.
- Birdproof Feeder Horns for Microwave Antennas.
- Correlation Between Terminate Resistance of Plastics and their Physical Properties.
- Studies of Electrical Discharges in High-Power HF Aerials.
- Electric Field Strength and Noise Distribution and Communication relevant to Mobile Radio Systems.
- Low-Noise Amplifiers for Microwave Applications.
- Optical Fibre Pre-forms.
- Compensation of Gallium Arsenide by Proton Implantation.
- Theoretical Aspects of Non-Ideal Optical Fibres.
- The Automatic Generation of CHILL Code from Call State Transition Diagrams.
- GaAs Mesfet modulation of Laser Diodes.
- Full Duplex Digital Communication on Subscriber Lines.
- Pulse Dispersion in Optical Fibres.
- Microwave Power Transistor Amplifiers.
- The Use of Adaptive Digital Hybrids on Subscriber Lines.

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.