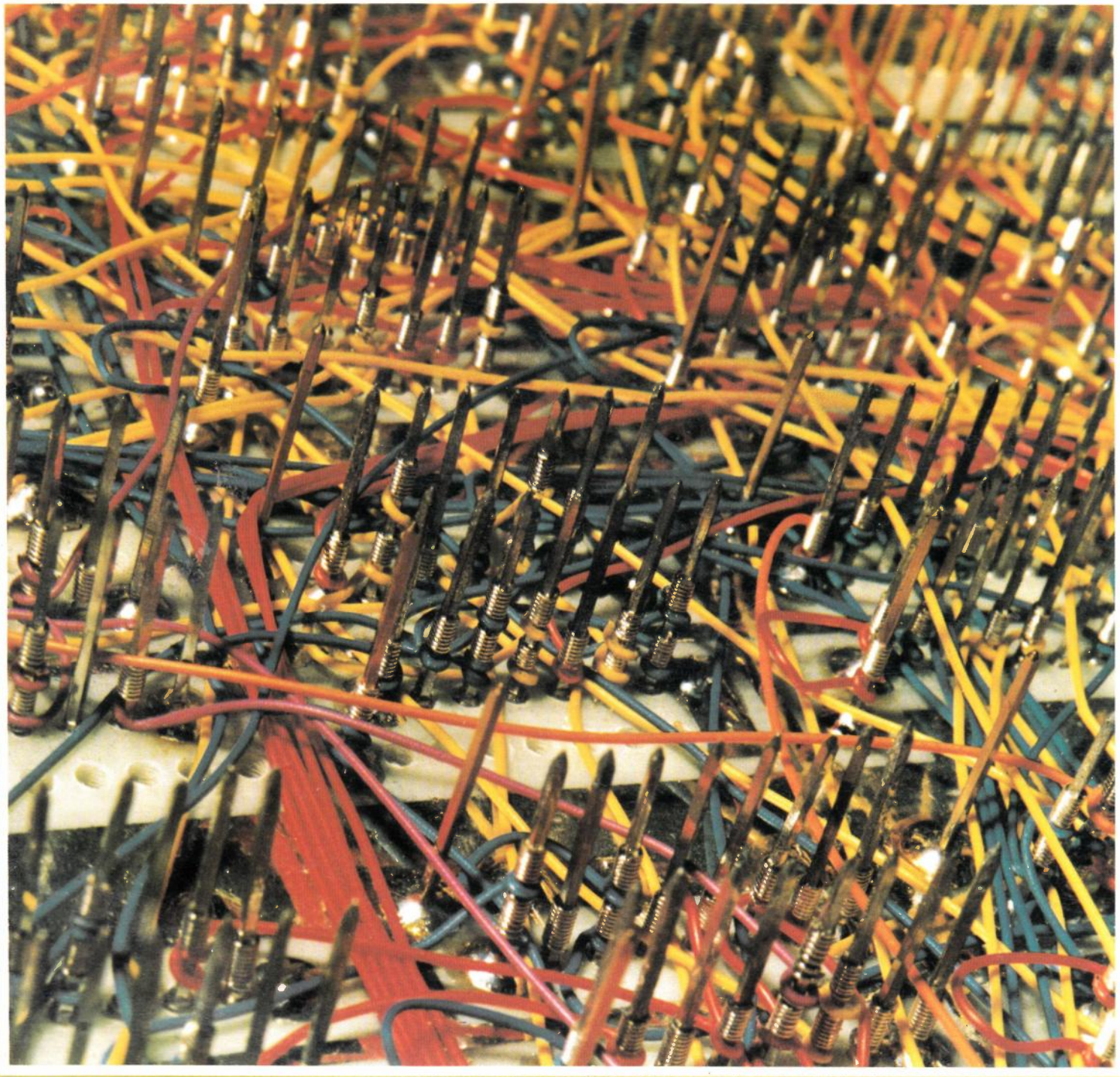
Research Laboratories

REVIEW OF ACTIVITIES

1975-1976



Telecom Australia

REVIEW OF ACTIVITIES

Research Laboratories 59 Little Collins Street Melbourne 3000 Australia

Telecom Australia

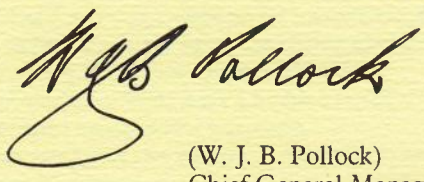
Foreword

In facing its responsibilities to provide the national telecommunications services required by the Australian people, Telecom Australia is aware that technological advances provide it with a powerful tool for the provision of existing services with improved efficiency, at reduced cost or with an improved standard of service. New technology also offers Telecom Australia the opportunity to increase the types of telecommunications service which it is able to offer the public.

The management of technology is closely allied to the planning and realisation of developments of the telecommunications network. In formulating policies and plans for network development, Telecom Australia must weigh, alongside social and economic factors, the technical alternatives which are available from existing technology already in use in the network or from developing technology on the near and far horizons. These factors, considered together, yield the decisions on when and how network developments can best be accomplished, within the resource and other constraints faced by Telecom Australia.

There is an element of research and development in most of the engineering activities of Telecom Australia, but the concentration of scientific and technical R & D effort is found in the Research Laboratories. The Laboratories provide a consultant service to the whole of the organisation and, through practical involvement in selected R & D projects, explore new technology to contribute to the knowledge and competence of Telecom Australia to make independent and soundly based planning decisions, and to implement these decisions by purchasing the most suitable network systems on the world market and interfacing these, where necessary, into the Australian network environment.

It is realised that, relative to other developed countries, Australia has limited resources and that our telecommunications R & D projects must be selected carefully to use these resources to the best possible advantage. However, I am sure that this Review of the activities of the Telecom Australia Research Laboratories demonstrates the breadth and excellence of the projects in hand, and I have pleasure in recommending it for your perusal.



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

Custom wire wrapped patterns upon standard format printed wiring boards provide a very cost-beneficial approach to the construction of large experimental digital systems.

Contents

The Role of the Research Laboratories

The Telecommunications Act 1975, which established the Australian Telecommunications Commission out of the former Australian Post Office on 1 July 1975, charges the Commission with the responsibility of providing the nation's internal telecommunications services. It is required to fulfil this responsibility economically and efficiently, on a scale appropriate to the needs of the Australian society and with a degree of sophistication matching demands and resources. In meeting this responsibility, the Commission is conscious of the benefits which can be gained by the timely adoption of new and improved techniques, equipment and systems that result from advances in the science and technology of telecommunications.

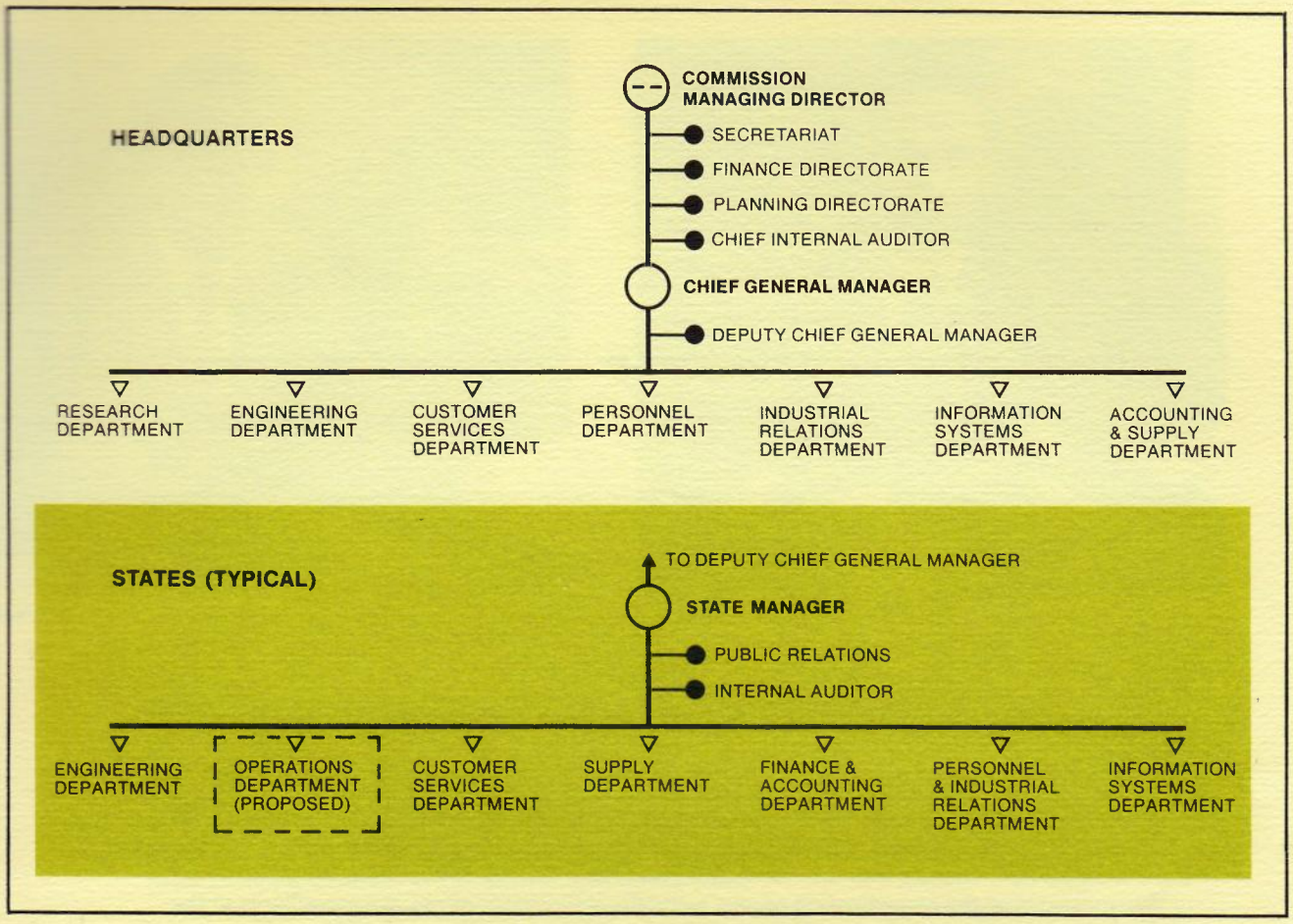
The tasks of planning, developing and operating the telecommunications networks rely heavily on the correct choice of technology to ensure economies, efficiency and continuing technical flexibility in the ongoing task of network development. The accelerating rate of technological change in the telecommunications field demands emphasis on the efficient management of technology in all engineering activities of the Commission and the Commission recognises that the conduct of relevant research and development is an essential ingredient in the effective management of technology.

The focal point of the Commission's research and development effort is found in its Research Laboratories. The Laboratories were established in 1923 in the Headquarters Administration of the then Postmaster-General's Department and they were charged with the responsibilities of studying "the latest discoveries, inventions and developments in electrical communications" and advising "the Chief Engineer of those which are promising and likely to benefit the Department's telephone and telegraph services". The Laboratories are today a Department in the Headquarters Administration of the Australian Telecommunications Commission (Telecom Australia). The Laboratories are headed by the Director (Research) who is directly responsible to the Chief General Manager. The work program of the Laboratories is determined in consultation with other Departments in Headquarters and the State Administrations, but predominantly with the Engineering Department at Headquarters.

Through the conduct of relevant R & D projects, the Laboratories seek to develop expertise in the scientific and technological fields which will assist the formulation and the implementation of the Commission's policies and plans for the introduction of new or improved services, systems, equipment or 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 plant items in service in the telecommunications networks.

To meet their responsibilities, the Laboratories must maintain a high level of expertise in telecommunications and associated engineering disciplines, and in the related disciplines of physics, chemistry and metallurgy. This is done through the conduct of research and advanced development on topics that are relevant to operations in Australia, having regard to work that is known to be in hand elsewhere in Australia and overseas.

It is recognised that telecommunications research and development engages the attention of very large organisations in overseas countries and it is inevitable that many of the improvements proposed for adoption in Australia will originate overseas. Nevertheless, long experience has shown that without advanced knowledge available within the Commission, there is a danger that its technical judgements and decisions will be influenced by suggestions and pressures from outsiders whose interests differ from the long term interests of Australian telecommunications. The Commission has therefore sought, through its own R & D efforts, as well as in other ways, to enable itself to judge the way in which a new development can be incorporated into the networks and to assess the special requirements and adaptations necessary to make it effective in the Australian environment.



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

To provide the knowledge and expertise necessary to enable these judgements to be made with confidence, it is necessary to have first hand knowledge of the technology concerned, and the best way to achieve this is through the conduct of advanced development in the relevant field. Many advanced development projects in the Laboratories are undertaken with the understanding that they will not be carried to the production stage and that the principal benefit will be knowledge which will find application in the specification of new requirements or in the assessment of offers from manufacturers. At the same time, the Laboratories do not underrate the ability of their own staff to produce successful innovations, and each advanced development project is monitored carefully and, in appropriate cases, the development is carried through to production and field use.

In addition to playing a research and development role, the Laboratories staff have specialist knowledge and the facilities in a number of disciplines, including the physical sciences, to conduct investigations into difficult technical problems that arise in the operation of telecommunications plant. Furthermore, the Laboratories are responsible for the electrical standards and the time and frequency standards used by the Commission. In the latter case, they are an agent of the National Standards Commission.

It is also recognised that a great deal of research talent exists in centres of higher learning and in industry in Australia, and the Commission would be foolish to ignore the contribution that these sectors can make to telecommunications knowledge. The Research Laboratories attempt to provide a focus for telecommunications research in Australia and to encourage other organisations to undertake appropriate research tasks.

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 the Commission to decide when and to what extent new technology should be introduced into the operational networks.

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 1975-1976.

Highlights of the Year

THE LABORATORIES BECOME A DEPARTMENT IN TELECOM AUSTRALIA

In order to understand the reasoning behind the organisational changes which accompanied the establishment of Telecom Australia, it is useful to refer to the appropriate parts of the Report of the Commission of Inquiry into the Australian Post Office chaired by Sir James Vernon.

When discussing the co-ordination of new technological developments, the consultants to the Commission of Inquiry made the following statement (P IV-3, Vol. 2, April 1974).

> "Evaluation of new technology and its translation into operational success have particular implication for organisation. Because of the inherent technical and economic uncertainties involved, there are frequent valid differences of professional opinion which need to be aired and evaluated at a senior level before commitments are made.
>
> The present organisational arrangements within the A.P.O., however, are not conducive to early senior-level appraisal of new technology, or to smoothing the way for major projects once commitment has been made.
>
> Another consequence of the present arrangements for managing major technological change is that the A.P.O. can be drawn into new projects more as a result of energetic efforts of branch-level managers than of conscious strategic choice, and becomes committed before top management has an opportunity to appraise the potential clearly."

The above quotation makes it clear that an appropriate organisational arrangement for a Commission necessarily involved with effective management of technological change, is one which makes it possible for the Laboratories' view to be heard directly at the top level. As a consequence, in the organisation finally adopted, the Head of the Laboratories reports direct to the Chief General Manager, and the Laboratories become a separate department from the Engineering Department, at Headquarters, even though the majority of the Laboratories' activities are engineering oriented.

As a consequence of the arrangements adopted, the Laboratories are required to maintain a high level of expertise in telecommunications and associated engineering disciplines, as well as the related disciplines of physics, chemistry and metallurgy. In addition, they have to select from the mass of engineering and scientific developments throughout the world, which are likely to be of more importance to Telecom Australia, so that by the time such developments come to be applied in Australia through the introduction of improved equipment, new systems or services, the Research Laboratories are able to offer valid technical and scientific advice based on studies and first hand laboratory investigations. It is inevitable that, because of the limited scale of telecommunications research and development in Australia, by comparison with the scale of resources applied in more industrially advanced overseas countries, many of the developments finally adopted in Australia will originate overseas. However, it is rare for an overseas development to fit Australian requirements directly without modifications. Thus an important application of the Laboratories' expertise is to assist Telecom Australia evaluations of the extent and difficulty of modifications required to overseas systems and equipment to make them meet Australian network or other local constraints.

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

P. R. Brett, B.Sc., F.I.R.E.E.

NEW HEAD OF THE LABORATORIES — EDWARD F. SANDBACH, B.A., B.Sc.

Mr. Rollo Brett was in charge of the Laboratories from 1964 until the end of June 1975. At the start of operations of the Australian Telecommunications Commission on 1 July 1975, he was promoted as Director (Planning), and Mr. Ed Sandbach was consequently promoted as Director (Research), the new title of the head of the Laboratories.

Mr. Sandbach was no stranger to the Laboratories having spent most of his professional career as a member of the staff. He joined the Post Office as a Clerk in 1941. Following graduation as a Bachelor of Science with honours in Physics and Radiophysics from Melbourne University he joined the Laboratories as an acting Engineer in the Radio Section early in 1944 at a time when some early work on time division multiplexed, pulse operated microwave radio systems was started. Following a period as a Cadet Engineer during which time he also acquired a B.A. degree from Melbourne majoring in mathematics, Mr. Sandbach returned to the Laboratories in 1947 as an Engineer engaged on VHF and UHF multi-channel radio system developments.

In 1948 he was placed in charge of the Time and Frequency Standards Division and was appointed Divisional Engineer in 1951. During the fifteen year period commencing in 1948 a number of important developments took place in the Post Office frequency standard installation and associated equipment. These developments, which included the design of new frequency standards built around high precision B.P.O. type 100 kHz ring crystals, the introduction of speaking clocks, the development of VLF phase tracking techniques for precise inter-continental frequency comparisons, experiments with an ammonia MASER from Signals Research and Development Establishment, Ministry of Aviation, U.K. (S.R.D.E.), the introduction of Post Office standard frequency and time broadcasts from Lyndhurst Victoria and the advent of caesium atomic clocks involved a hundredfold increase of frequency keeping precision.

During 1964 the Laboratories' organisation was extensively restructured and at this time Mr. Sandbach was appointed as Assistant Director-General (Apparatus and Services) with responsibility for the Physical Sciences, Standards, and Service activities of the Laboratories. As a result of this appointment he became intimately involved with the new building developments for the Laboratories. During 1967 he completed the advanced course at the Australian Administrative Staff College. With growth of the Laboratories during the last decade, organisational changes occurred so that the Apparatus and Services Branch became the Applied Science and Laboratory Services Branch and then the Standards and Laboratories Engineering Branch, when the physical sciences activities of the Laboratories were given Branch status.

With the development of satellite communication techniques Mr. Sandbach became extensively involved in C.C.I.R. Study Group IV (Space Systems and Radio Astronomy) from 1962 and for a while in Intelsat conferences in association with O.T.C.(A) personnel. He led the Australian delegations to C.C.I.R. Plenary Assemblies in 1966, 1970, and 1974. He also participated in I.T.U. Administrative Space Conferences in 1963 and 1971, and the Plenipotentiary Conference during 1973.

For some years he has been involved with various committees of the S.A.A. and is currently Telecom Australia representative on the Telecommunications and Electronics Standards Board and its Executive.

TELECOM AUSTRALIA COMMISSIONERS VISIT THE LABORATORIES

Mr R. Smith (right), Transmission Systems Branch, discusses some aspects of Pulse Code Modulation with the Commissioners during their visit.

L to R: Mr J. H. Curtis, Managing Director; Mr R. D. Somervaille, Chairman of the Commission; Mrs J. Hancock, Mr T. E. May and Mr K. C. Turbet, Commissioners; and Mr R. Smith

On 19 February 1976, Mr. R. D. Somervaille, Chairman of the Australian Telecommunications Commission, and all but one of his fellow Commissioners visited the Laboratories' complex at North Clayton. The visiting party included Mr. J. H. Curtis, Managing Director and Commissioner, Mrs. J. Hancock, Mr. T. E. May and Mr. K. C. Turbet, Commissioners, and Mr. W. J. B. Pollock, Chief General Manager of Telecom Australia. Mr. F. J. Green, the remaining member of the Commission, apologised for having to cancel his plans to join the visiting party, explaining that he was forced to do so by urgent and unforeseen business.

Mr. E. Sandbach, Director of the Research Laboratories, the Assistant Directors and the Manager Administration welcomed the guests. It was noted that the occasion was an historic one for the Laboratories in that it was the first time that the Commissioners had been able to visit the Laboratories in one body since Telecom Australia was established under its new Commission status on 1 July 1975. Both the Commissioners and the Laboratories' management expressed mutual satisfaction for the opportunity which the visit provided for the Commissioners to see the Laboratories in action and to meet some of the staff in their working environment.

Before inspecting a number of Laboratories' projects, the Commissioners joined in discussion with the Director and Assistant Directors, to exchange general views on the interpretation of the research and development objectives of Telecom Australia and in particular, on the impact of these objectives on the role of the Research Laboratories in Telecom Australia and the manner in which this role could be fulfilled most effectively. The discussions were illustrated by reference to past and present projects being pursued in the Laboratories and the discussions were extended when the visitors joined members of the Laboratories' staff to see a number of projects "on the laboratory bench".

Projects inspected by the Commissioners included those embraced by the topic "Pulse Code Modulation (PCM) Studies" and the relevance of the work to future policy decisions by Telecom Australia on the introduction of PCM transmission systems into the Australian network was briefly outlined.

Another project field demonstrated to the visitors was that of "Processor Control of Switching Systems". Recent work of the Laboratories in the field was outlined and various aspects of the work were discussed in the broader context of the current evaluations of stored program controlled (SPC) exchanges being conducted by the Engineering Department at Headquarters.

Staff working in the radio antenna field outlined one of their more significant current projects which was directed at the evaluation and design of the antenna systems which will provide mobile radio services from the tower under construction on Black Mountain, Canberra.

Two other projects were demonstrated to the Commissioners. Both projects share the common aim of improving present procedures for periodically extracting the records of the number of metered calls made by individual subscribers from the electro-mechanical call meters located in step-by-step and crossbar exchanges and relaying these records for analysis and subscriber billing at a computerised accounting centre. The comparison of the two projects, which are reported later in this Review, enabled the Commissioners to be shown how different types of expertise, one in the photographic field and the other in the computer field, had enabled the Laboratories to postulate two alternative solutions and to demonstrate them experimentally. It was pointed out that the photographic solution yielded the promise of a more expedient but lesser improvement at lower initial cost, whereas the mini-computer based solution offered a longer term solution with the maximised improvements of a completely computerised procedure compatible with the accounting procedures at greater initial cost.

It was obvious from the informal flow of questions and answers between the visitors and the Laboratories' staff that the occasion was a mutually pleasant one, and that the discussions held during the visit were mutually beneficial. The visit also served to visibly publicise the fact to Laboratories' staff that Telecom Australia has "Commission" status and that the Laboratories are regarded as an important contributor to the overall activities of the Commission.

THE EIGHTH ASIA ELECTRONICS CONFERENCE

Every second year, delegates from member countries of the Asia Electronics Union and observers from other interested countries and international organisations gather together in formal Conference to discuss matters of mutual interest in the field of electronics. The biennial events comprise a four-day Asia Electronics Conference which culminates in a one-day General Assembly of the Asia Electronics Union.

The Australian Government, represented primarily by Telecom Australia and the Department of Manufacturing Industry, and the Australian Telecommunications Development Association (A.T.D.A.), the principal association of the Australian electronics industry, were joint hosts to the Eighth Asia Electronics Conference and Fourth General Assembly of the Asia Electronics Union. The events were held in Melbourne from 1-7 October 1975.

Arrangements for the Conference were undertaken jointly by staff of Telecom Australia and the Department of Manufacturing Industry. The major roles in organising the Conference were played by the International Branch and the Research Laboratories of Telecom Australia, and in retrospect, it can be claimed that the organisation behind the Conference lent a great deal to its success and to Australia's prestige in the union.

A total of 53 delegates from 12 member countries of the Union (Australia, India, Indonesia, Iran, Iraq, Japan, Korea, Malaysia, Philippines, Singapore, Sri Lanka and Thailand), from New Zealand (a non-member country) and from the Asian Broadcasting Union (A.B.U.) and the United Nations Educational, Scientific and Cultural Organisation (U.N.E.S.C.O.) attended the Conference. In addition, observers from Australian Government departments, and agencies, from industry and educational institutions attended sessions of the Conference which aligned with their interests.

The 1975 Conference was inaugurated by His Excellency, the Honourable Sir John Kerr, A.C., K.C.M.G., K.St.J., Q.C., Governor-General of Australia, on the morning of 1 October. The ceremony was attended by a number of distinguished guests, including representatives of Federal and State Governments and the Lord Mayor of the City of Melbourne.

The Australian delegation comprised eight representatives from Telecom Australia, the Department of Manufacturing Industry and from the Australian Electronics Industry. It was led by Mr. P. R. Brett, formerly Head of the Laboratories. Mr. F. W. Arter of the Laboratories was also a member of the official delegation, as was Mr. L. M. Harris, O.B.E., who is now retired but who had a long association with the Laboratories during his career with Telecom Australia.

The Asia Electronics Union was formed in 1968 with the objectives of promoting co-operation between member countries of the Union in the field of electronics, science and technology, through discussion and exchange of information based on a mutual awareness of the state and trends of development of the electronics industry in the countries of Asia and Oceania. It achieves its objectives through its journal, through promotion of co-operative training schemes and symposia, and through studies of specific topics conducted among members in the interval between the biennial Conferences. The Conferences review the current activities of the Union and plot the course of future activities.

The business of the Eighth Asia Electronics Conference followed the usual pattern. Reports were presented by the Secretary-General on the activities of the Union since the previous Conference held in New Delhi, India, in 1973. Each country and organisation represented, reported on developments in the electronics sphere in their area of interest, and these reports set the stage for discussions of the reports of the chairmen of four study groups, which covered the topics:

- Ways for Regional Co-operation in Training in the Electronics Field – chaired by Mr. F. W. Arter (Australia).
- The Problems of Establishing the Telecommunications Industry in the Countries of Asia and Oceania – chaired by Professor M. G. K. Menon (India).
- Ways for Regional Co-operation in R & D in the Field of Electronics – chaired by Mr. I. Negishi (Japan)
- Approaches to Maintenance – chaired by Mr. K. J. Nielson (Australia).

Two symposia were also associated with the Conference Programme. One addressed the topic "Technology Transfer in the Electronics Industry" and the two keynote speakers, Professor L. W. Davies (Australia) and Dr. N. Seshagiri (India) led a discussion of aspects of the topic after delivering their papers. The second embraced the topic "Standards and Electronics" and the keynote speaker was Mr. K. Saito (Japan).

The discussions of the various reports and symposium topics led the Conference to make a number of recommendations concerning future activities of the Union to the General Assembly. These were adopted after discussion and amendment as Assembly resolutions.

The concluding business of the Assembly concerned the election of the office-bearers of the Union and Mr. P. R. Brett was elected to the office of President for the next two years. This and the many laudatory comments received from delegates about the outcome of the Conference suggest that Australia's role as host to the Conference was successfully played and that future Conferences can build on developments which, though not spectacular, arose to advance the objectives of the Union on Australian soil.

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 the telecommunications 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 the Laboratories' projects and activities 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.

Specialised Engineering Activities

INTRODUCTION

The Research Laboratories are unique in Telecom Australia in that the wide range of activities undertaken in the engineering and scientific fields, in one compact organisation, has required the build up of a team with various highly developed specialities. While staff members can concentrate on particular disciplines, they also work together to develop unique solutions to fringe area problems which arise in many areas of Telecom Australia activity. On the engineering side there are groups working in such diverse fields as solid-state research, antenna development and mechanical design and construction, and the basic physical sciences are similarly covered. The organisation chart herein provides an indication of the breadth of the work.

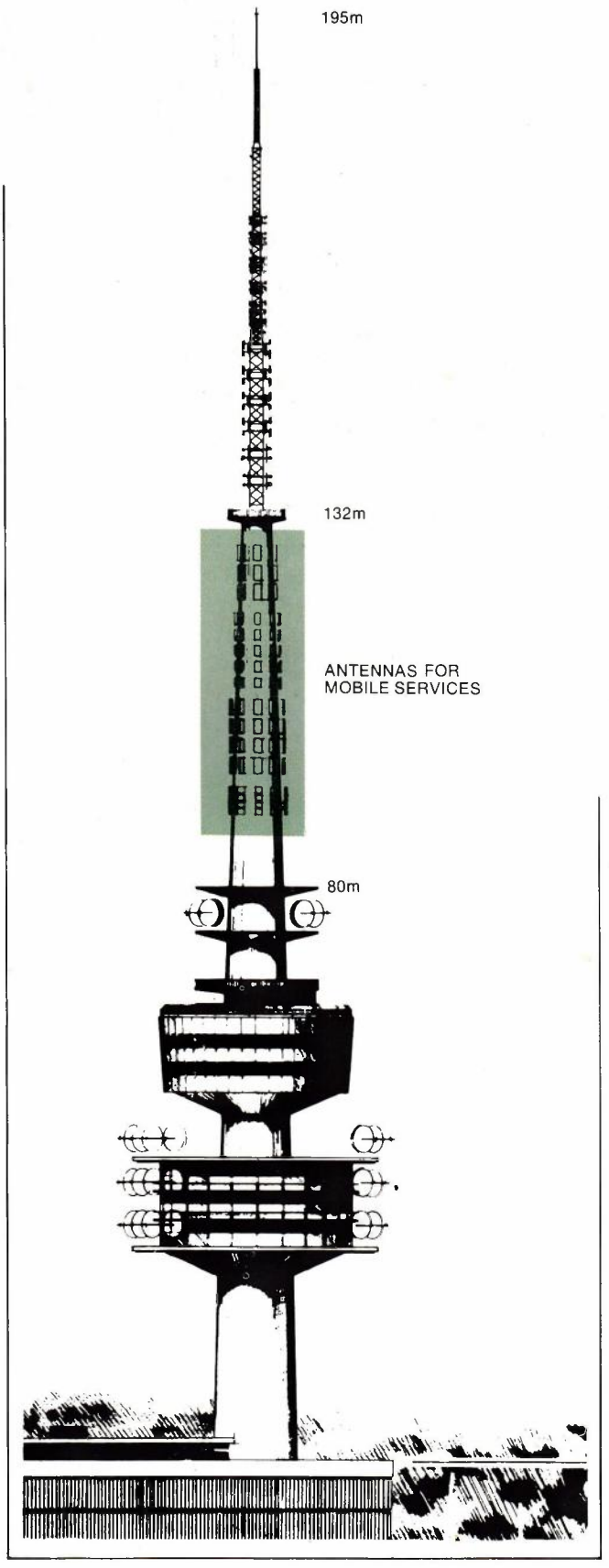
On relatively small projects, personal consultation between experts in appropriate fields provides the required cross-fertilization often necessary to develop the optimum solution to a problem. For larger scale investigations project teams comprising staff drawn from suitable engineering or scientific areas are established for the duration of the task.

The following are some current examples of projects which illustrate this ability to bring a range of specialities to bear on particular problems.

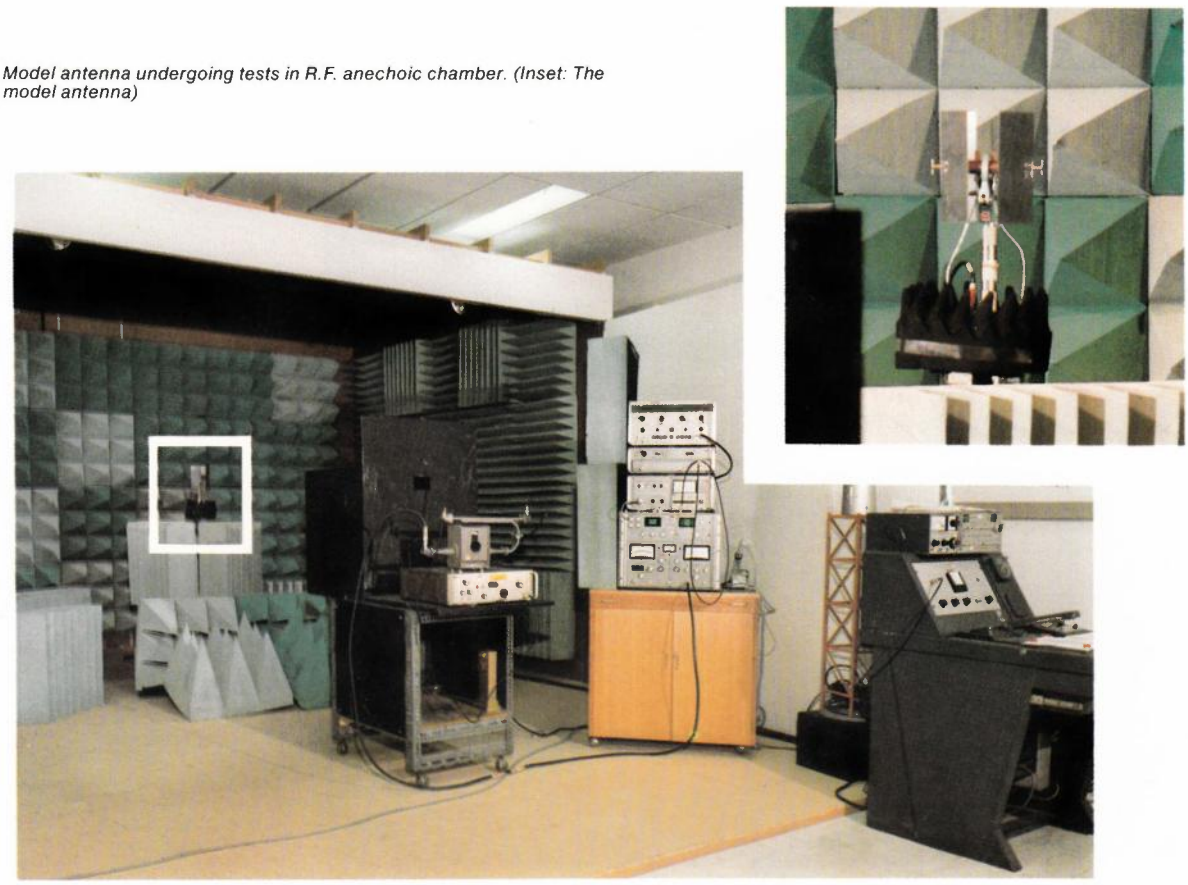
ANTENNAS FOR MOBILE COMMUNICATION SERVICES, BLACK MOUNTAIN TOWER, CANBERRA

The construction of the Telecom Australia tower on Black Mountain, Canberra, is now well advanced. When complete, it will rise 195 m above ground level. The top 63 m is an open lattice steel structure supporting TV and FM broadcasting antennas. The lower 132 m is a tapered reinforced concrete column which carries three stages for radio communication equipment, including microwave trunk services, two enclosed levels for public use, and a number of antenna systems. These antenna systems are mounted on the upper 52 m section of the column which tapers from 6.7 to 4 m in diameter over this distance.

The antenna systems will provide the base stations for public and essential private mobile radio communication and paging systems. The latter systems will eventually operate in both the VHF and UHF bands. To radiate equal power around the tower, the antenna system requires an array of radiating elements around the mast surface which produce an omnidirectional horizontal radiation pattern. As each antenna system is also to carry a multiple number of channels (services), multiplexing networks with significant insertion loss are required. This loss can be compensated by appropriate vertical directivity (gain) of the antenna system. This vertical directivity can be achieved by stacking several tiers of radiating elements.



Black Mountain Tower, Canberra



Model antenna undergoing tests in R.F. anechoic chamber. (Inset: The model antenna)

The large diameter of the column in terms of the electrical wavelength, the tapered surface and the reinforcing structure of the concrete, present complications in the design of the omnidirectional antenna system. With conventional configuration and using simple dipoles as radiating elements, more than twenty elements per tier may be required to produce the specified omnidirectional characteristics.

Investigations are being conducted in the Research Laboratories to assess the various suitable antenna system configurations and to identify their performance characteristics and associated parameters. The investigations are directed towards finding antenna array configurations offering the optimum technical and economical advantages.

Computer studies on the radiation patterns and frequency bandwidth characteristics were undertaken, and these studies are now being complemented by experimental investigations, using model techniques at 2 GHz, of promising antenna arrays.

The antenna systems investigated so far can be broadly classified into two categories:

- Cylindrical arrays employing elements with an all-round radiation pattern (e.g. vertical dipoles).
- Cylindrical arrays employing elements which produce a radiation pattern isolated from the concrete column. These elements may be a reflector antenna or, in general, an antenna with a shaped radiation pattern.

Multi-tiered cylindrical arrays, where the tier configuration differs from one another, may offer considerable economies in the total number of elements required by the system. However, horizontal pattern variations occur at different vertical elevations and their characteristics, in general, vary considerably across the frequency band of interest.

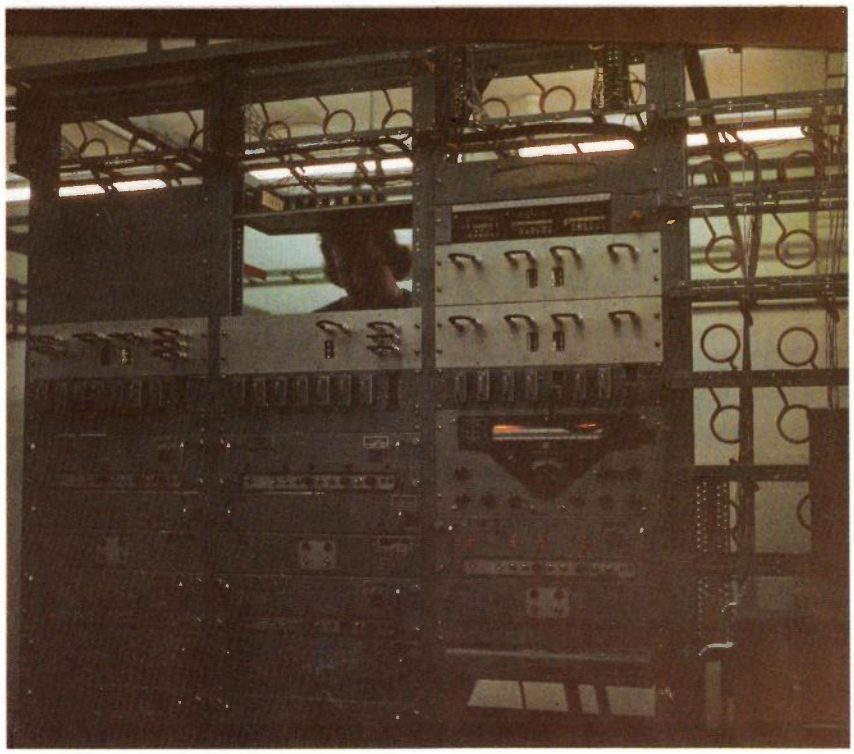
A different configuration employing radiating elements which produce patterns isolated from the concrete column and directed towards an appropriate spatial orientation is being examined. This type of configuration promises a need of fewer elements to produce the desired horizontal pattern, but problems associated with other characteristics are still to be investigated.

In general, satisfactory vertical and horizontal patterns prove difficult to realize in the one design, and the optimum solution is essentially a compromise dependent on the weights given to the radiation pattern variations, the performance across the band and the cost.

PROTECTION OF ESSENTIAL SERVICES IN CARNARVON

Carnarvon in Western Australia is an important centre for essential service communication having a Royal Flying Doctor base, a Department of Transport base and an Overseas Telecommunications Commission — "Safety of Life at Sea" station.

In December 1975, Radio Australia commenced transmission from the old NASA site on Brown's Range just south of Carnarvon. The first transmitter to go on-air was a Brown-Boveri with an output power of 250 kW. Early this year a second transmitter with an output power of 100 kW went on air. Together with the local broadcast station these two transmitters cause very high field-strength in and around Carnarvon, and it was feared that they may disrupt the essential services.



Installation of filters — to protect essential services at Carnarvon

In July 1975, the Research Laboratories commenced taking measurements at the Radio Australia station in Shepparton (Victoria) to simulate the conditions of the Radio Australia broadcast at the receiver inputs of the essential services in Carnarvon. Further laboratory measurements were performed on receivers to determine the maximum allowable interfering signal at all the Radio Australia transmitting frequencies. From this information a set of filter characteristics were drawn up for each receiver which required protection, and restrictions were put on the use of certain combinations of frequencies for the Radio Australia transmissions.

Fourteen different filters required to protect the essential services were completed and installed by 20 December 1975, when Radio Australia first went on-air from Carnarvon.

The associated photograph shows the filters supplied to the Department of Transport as they were being installed. Each filter (there are two filters in a panel) consists of; static charge bleed resistors, lightning protection gas arrestors, and filtering networks. The Department of Transport use 90 Ω balanced aerial circuits and consequently care had to be taken to provide a high longitudinal rejection as well as the required filter characteristic. In three cases, the Department of Transport operates more than one receiver from an aerial, and it was considered wise to incorporate a lossless hybrid power splitting network to facilitate this, and provide isolation between the receivers.

Tests carried out show that there are no interference problems with only one transmitter. Further experiments must be performed to prove the effectiveness of the filters now that both transmitters are on-air.

TELEPHONE CALL METERING

At present, subscribers' meters are read in situ by technical staff at local exchanges and the readings are then relayed by telephone to data punch operators, who prepare computer input tapes for the computerised billing of subscribers. The method is costly and prone to error, and a spate of customer complaints in 1973 led to the formation of two (Telecom Australia) working parties to investigate the processes currently used with a view to improving accuracy and reducing costs. This was done in the realisation that although future processor controlled exchanges will eliminate the manual process of meter reading and recording, presently installed exchanges will remain in service for several decades.

There were at least two methods of approaching this problem of accurately metering telephone calls. The first approach was based on using photographic techniques to record the meter readings; as a quick solution which could be readily implemented but which did not automate the whole process. The second approach was a longer term solution aimed at using a minicomputer and simple electronic interfacing equipment to automate the process of recording and relaying meter readings in a format compatible with the computerised billing processes.

- Photographic Approach. The first solution mentioned, photographs the banks of 100 subscribers' call meters, and displays the photographic images on a suitable viewer, for direct reading by the data punch operator. This approach has the advantages of:

- reduction in errors and hence customer complaints,
- reduction in manpower employed in meter reading,
- provision of permanent record.

Early attempts by a commercial manufacturer to meet Commission needs having proved unsatisfactory, the problem was referred to the Research Laboratories, where the project is well advanced. A description of the system follows.

A suitably hooded 35 mm camera, with appropriate lighting attachments fitted, is used to photograph individual banks of 100 meters. The developed film is then displayed to the data punch operator on a modified film strip viewer, adapted from a commercial audio-visual aid viewer. This provides a means of advancing the film, one frame at a time, as the data punch operator works through the record.

The image she must work from consists of 10 rows of 10 meters, which presented a problem of avoiding confusion between rows. To overcome this problem, the individual row being processed is underlined by 5 miniature light emitting diodes fitted to the projection screen — a total of 50 being fitted. The rows are illuminated in this way, in turn, by operation of a foot controlled switch. This effectively ensures that the correct row is read. As a further check of the accuracy of reading and transmitting, each row is punched twice and any difference, and hence error, is machine detected before the operator can advance to the next row. Successful trials have demonstrated the suitability of this approach and work continues to determine the optimum location of the viewer at the data punch operator's desk and to provide suitable lighting conditions to reduce eye strain.

This system has provided an answer for reading the meters in crossbar exchanges, which have the 10 x 10 format in the meter banks. Many older exchanges have a 5 x 20 format and it is planned to produce a second viewer and camera design to cope with this rather awkward format.

- Computerised Approach. The second, longer term approach, being considered by the Research Laboratories, seeks to automate the process of recording subscribers' meter readings, and to extract this data for billing purposes by using a mini-computer located in the exchange. Inputs to the mini-computer memory would be activated by the computer and derived from one-bit electronic registers connected in parallel with the existing electro-mechanical meters and activated by the same metering pulse. These pulses are used to indicate the number of "message units" for which the subscriber is to be billed and they occur at differing rates, depending on whether the subscriber has made a local, trunk (STD), or international (ISD) call.

In the system under investigation, the mini-computer scans all one-bit registers each half second. If the register has been "set" by a meter pulse in the half-second interval, the count in the mini-computer memory location for the particular subscriber is incremented by one, and the register reset. Thus, the mini-computer builds an electronic record of the message units incurred by each subscriber in parallel with the subscriber's meter record.

Periodic reading of any or all the meters in an exchange may then be effected from the mini-computer's memory merely by entering an appropriate directive at the keyboard of the typewriter attached to the mini-computer. The readings can then either be written onto a flexible-disc or magnetic-tape cassette at the mini-computer site, or transmitted directly to an accounting centre. The typewriter may also be used for local examination of selected meter readings, etc. Scanning continues unabated

Viewer and data input console used in the photographic approach

whilst such typewriter-initiated processes are in progress.

Even during periods of high traffic, and thus high metering activity, the mini-computer spends some of its time in an apparently idle condition, awaiting the arrival of a keyboard command and/or counting down under the control of an internal clock to determine when the next register scan should commence. Whilst in this apparently idle condition, the mini-computer is actually made to perform a number of checks on its own operating status and on the interface circuits. It is also able to detect certain anomalous conditions in the metering pulses.

A small sample of the experimental equipment has been exposed to an actual exchange environment in order to determine the incidence of interference between the electro-mechanical exchange operations and the micro-circuits used in the automatic recording interface. Since the experience in this experiment indicated no major problems, it is intended to extend the capacity of the hardware to one hundred meters, and investigate the reliability of the automatic equipment in a larger trial on live traffic.

If the technical feasibility of this concept proves successful, detailed cost studies of alternative hardware and software configurations will need to be made to ascertain the relative benefits of the automatic process versus the cost of the current manual process. Considering the billing of some three million customers distributed over five thousand exchanges and meter reading operations at monthly intervals, it is confidently expected that an automatic system of the nature discussed here should prove superior, both technically and economically.

COLOUR TELEVISION TRANSMISSION OVER SINGLE QUAD CARRIER CABLE

A requirement frequently occurs to provide relatively short high quality colour television links between, for example, TV studios, relay points, and commercial enterprises. In Australia this type of link has been provided mainly by systems operating over standard (2.6/9.5mm) co-axial cable.

As standard co-axial cable is very expensive the use of balanced pair cable has been considered. One of the more attractive of these cables for the transmission of full bandwidth TV signals is the single quad carrier cable (2/1.27mm) which offers a good compromise between cost and performance.

A transmission system was developed by the Research Laboratories initially for transmitting monochrome TV on a 740 m single quad bearer in Hobart, Tasmania; this system was installed in May 1972. Since then, the design has been upgraded for colour transmission. The first colour system was installed on a 400 m single quad bearer between the BCV8 studios, Bendigo, Victoria, and the Bendigo radio telephone terminal in April 1975.

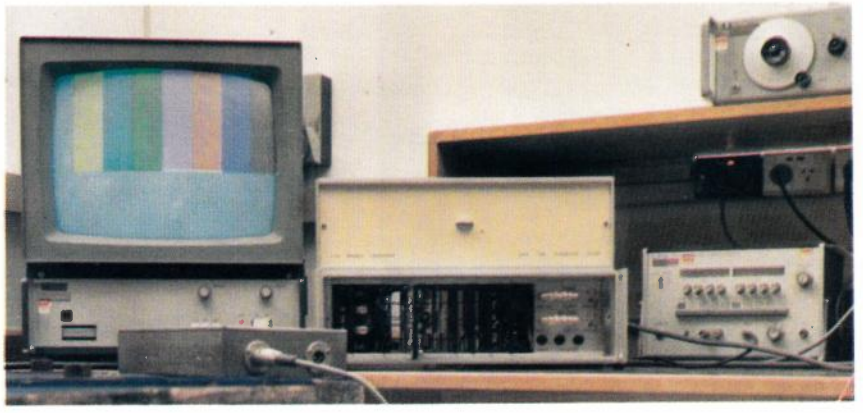
The single quad cable is comprised of two balanced pairs. The system design is such that one pair may be used for each direction of transmission, or alternatively, both pairs used in the same direction. If desired, only one pair may be utilised, the other pair then being spare.

The present system does not employ intermediate repeaters and the transmission limits are determined by near-end crosstalk for two way operation and thermal noise for unidirectional transmission. When the strictest performance objectives are met, the transmission limits are of the order of 1 km for two-way transmission and 2 km for unidirectional transmission.

The greater economies of this system, against those using standard co-axial cable, also make it suitable for areas where less stringent performance is required. Further applications are seen in commercial and industrial areas for surveillance and closed circuit television.

To extend the transmission limit of the system and therefore its possible application, the feasibility of using intermediate repeaters is being considered. In this case the transmission limit is mainly dependent on the build-up of thermal noise and non-linear distortion; the latter is considered the more significant. The use of repeaters should result in a significant increase in transmission length, particularly for applications requiring less stringent performance requirements.

The single quad cable TV transmission system fills a requirement for the provision of high quality colour television links not always economically suited to other TV transmission systems. Its lower cost also makes it attractive for applications where less stringent performance is necessary.



Terminal equipment for a single quad carrier cable

Specialised Scientific Activities

INTRODUCTION

During the year under review the chemists, physicists, and metallurgists of the Research Laboratories supported by the sub-professional staff, have been engaged over a very broad spectrum of scientific investigations. These have been directed at gaining insight into the properties and behaviour of materials and components, as well as the solution of problems in most fields of activity of Telecom Australia. This work has ranged over such areas as the study of electrical, mechanical, chemical, thermal and optical properties; the development of new analytical techniques; the formulation of polymers and their method of application under service conditions; the causes and prevention of failure and degradation by corrosion and other environmental effects; and the protection of staff and equipment from electrical and electro-mechanical hazards.

Whilst it has been possible to apply the findings from many of these investigations immediately and directly, with resultant benefits in procurement, maintenance, operations or safety; other studies which are aimed to produce information for the design and performance of equipment and devices of the future, will involve many years of experimentation before valid conclusions can be made.

The items which follow describe some of the current scientific activities, and have been chosen to highlight the wide variety of subject matters, but do not necessarily represent those projects which have required the major share of resources or the greatest experimental effort. Other interesting investigations are described in the many Research Laboratories Reports issued annually.

CORROSION INHIBITION IN AUTOMOTIVE COOLING SYSTEMS

Probably one of the most neglected areas in automobile and stationary engine servicing is cooling systems. Quite often it is not until failure occurs or efficiency is greatly impaired that much thought is given to their maintenance.

Corrosion of a metal in water involves electrochemical oxidation and the form and extent of such corrosion depends on a number of interrelated factors. The pH of the water, the amount of dissolved and entrained oxygen, and the existence of dissimilar metal couples forming galvanic cells, are some of the components involved in this complex process.

The dissolution of iron and other metals in water involves the metal dissolving at active sites on the metal surface called anodes, leaving electrons behind in the metal. These electrons flow through the metal to other sites called cathodes, where reactions which consume electrons can occur.

Corrosion inhibitors work by interfering with the cathodic or anodic reaction, or with both. This interference may be mechanical, which involves a simple absorption on the metal surface to prevent contact between metal and water. It may be a chemical interference, when a reaction takes place to form an inert and protective surface compound.

Research Laboratories' tests have shown the ability of several corrosion inhibiting mixtures to influence the corrosion rate of mild steel and other metals in water. The accompanying table illustrates the inhibiting effect of a nitrite-borate-silicate mixture in water. The non-ferrous metals were coupled to mild steel.

The figures listed give the mass loss in milligrams per square centimetre of surface area of the metal, after 700 hours immersion in distilled water, and in distilled water containing the corrosion inhibitor. The water was heated to 95°C for 8 hours and allowed to cool to ambient temperature during the subsequent 16 hours. This cycle was repeated for the whole period of the test.

	Mass Loss in $mg.cm^{-2}$	
Metal	Distilled water	Distilled water containing inhibitor
Mild steel-uncoupled	19.4	0.01
Zinc	10.2	0.3
Aluminium	0.3	None detected
Copper	0.2	0.1

Table comparing mass loss with and without corrosion inhibitor

In a trial using this inhibitor in an automobile cooling system, the most obvious effect was the almost complete absence of rust in the cooling water over a period of 18 months.

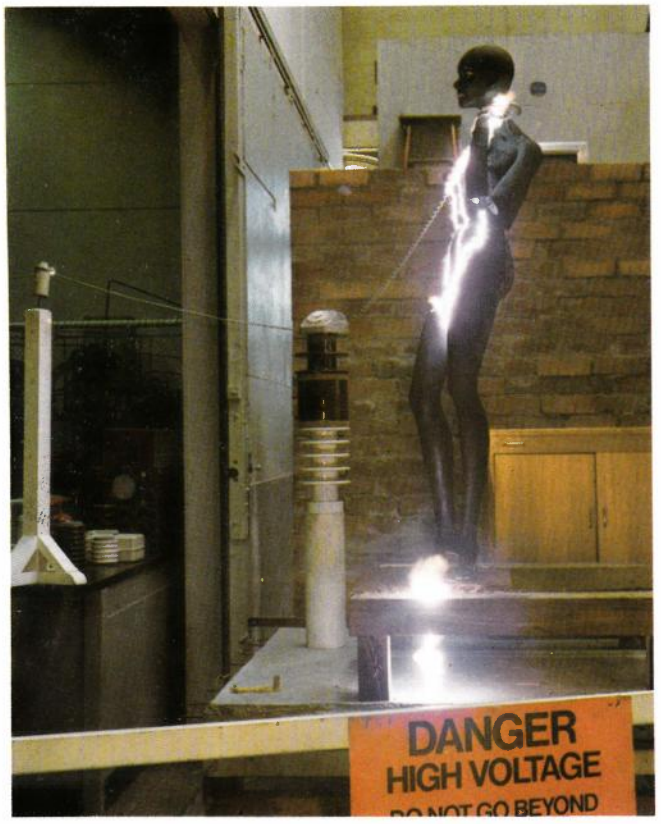
LIGHTNING HAZARDS TO TELEPHONE USERS

Over the past few years, the effects of lightning storms on telephone services have received considerable publicity in the news media. In addition to the disruption of service and damage to plant caused occasionally by lightning storms, a number of subscribers who used their telephones during the storms received electric shocks.

Inspections of some of the affected areas and subscriber premises, together with the information supplied by local staff and staff of other public utility departments, suggests that the problem is caused by lightning strikes to ground and that it is variously aggravated by high soil resistivity, the environment of the telephone in dwellings, and a combination of the installation practices used by Telecom Australia and other public utilities providing water and cable services to Australian homes.

Subsequently, the Research Laboratories conducted a number of experimental tests on simulated telephone installations in surroundings typical of subscriber premises in the affected areas.

At this stage, investigations have examined, reproduced or evaluated the following aspects of the problem: hazards to subscribers, effects on the telephone instrument, the magnitudes and distribution of potentials and the energies involved in the reported incidents; environmental factors contributing to the



◀ *The effects of a simulated lightning strike on an unprotected telephone installation*

problem. The object of the investigations has been to assess the need for subscriber protection and the effectiveness of the normal subscriber protection in current use, in the particular cases examined and in general terms.

The cases studied show that the environment chosen for the location of the telephone in the subscriber's home is the most important factor contributing to the likelihood of hazards due to lightning discharges. In cases where phones are placed near household fittings earthed through water supply and drain pipes or near mains-operated appliances earthed through the mains power supply, such that the telephone user can come into contact with these fittings or appliances, the likelihood of serious hazard is greatest. This conclusion is being considered and new guidelines for telephone installation staff on the location of telephones in subscribers' premises are being discussed. Other aspects are also being considered — for example, the effect of the length of aerial lines in the subscribers' distribution system on the likely incidence of lightning hazards.

The normally provided subscriber protection practices are considered adequate, except for severe and almost direct lightning strikes to the service or its immediate environs, and these practices are currently used to alleviate the problem in the affected areas. The photograph shows the effects of a simulated lightning strike on a particular type of unprotected telephone service installation, where the user is standing on a well earthed platform.

STATIC ELECTRICITY IN CARPETED AREAS

In recent years, static charge accumulations have given rise to "environmental" problems in computer terminal and manual assistance areas of stored program controlled (SPC) telephone exchanges.

Both equipment operation and staff safety are affected by the accumulation of static charge and a solution to the problem is being sought in the Laboratories.

This problem has two main causes; firstly, carpet materials which have a very low conductivity, for example 100% nylon or 80%/20% wool/nylon mixture, and secondly shoe sole materials with high resistivity, for example PVC, micro-cellular rubber and cork. Operators walking over carpets, or moving whilst seated in a chair, or arising from an insulated chair, can build up very high body potentials, up to 20kV under typical conditions.

Subsequent touching of earthed panels, keys etc. may produce a shock causing a natural inhibition to repeat the act and accordingly can cause a reduction in operator efficiency.

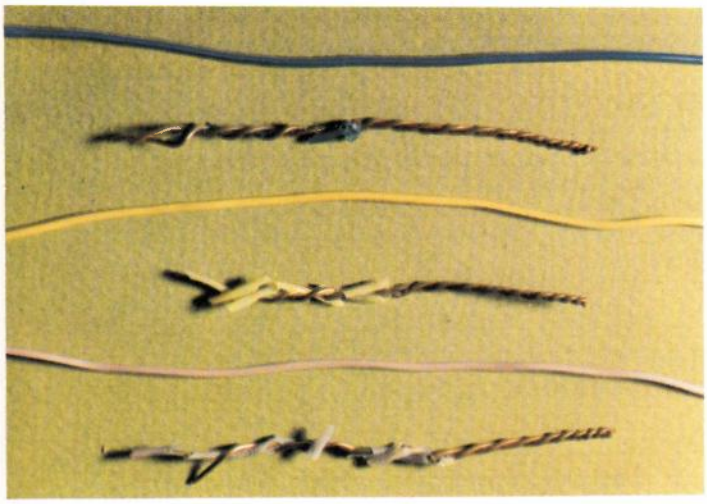
Recently it has been found that such discharges also have a harmful effect on the operation of micro-circuitry in the vicinity of the contact point.

This effect is due either to the intense electric fields in the vicinity of the contact point just prior to discharge, or to the magnetic fields produced by the current impulse flowing in the equipment after discharge.

In an effort to lessen the problems of static charge, the Research Laboratories are studying a range of antistatic sprays and similar preparations for use on carpets.

These carpet treatments increase the volume conductivity of the carpet; however, they also can render the carpet "tacky", likely to attract dirt and may produce degradation of the pile and discolouration. For this work, sophisticated static charge measuring equipment is required, and pending delivery from overseas, a loan of a suitable instrument has been arranged from the C.S.I.R.O. Protein Chemistry Division, Parkville, Victoria.

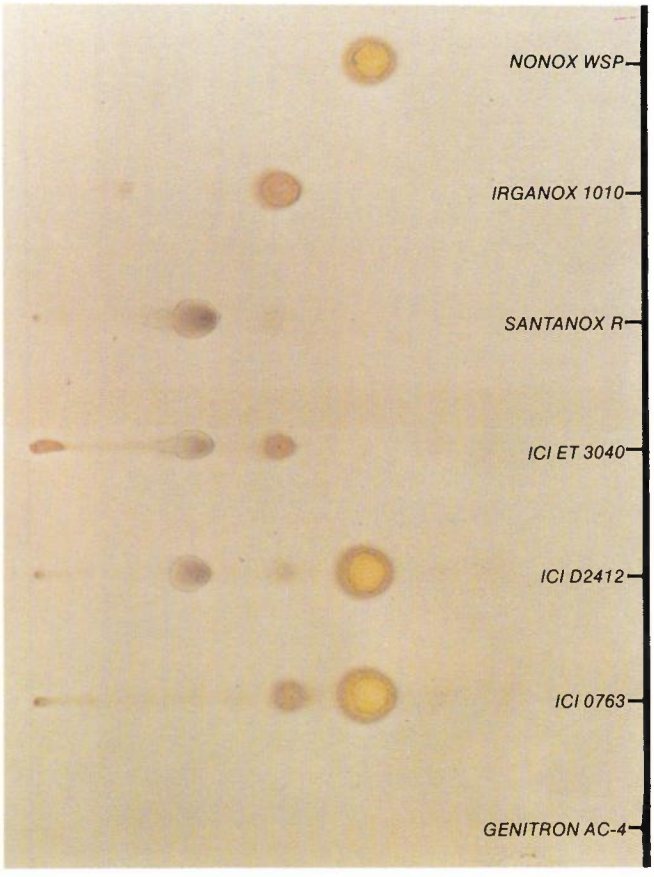
A carpet sample being scuffed in an environmental chamber raises the body potential of the scuffer



Top left: Specimens of conductor wire insulation — upper sample with antioxidant, lower sample without antioxidant

Lower left: Polythene coating joint ends

Below: Thin-layer resolution of antioxidants



The investigation is centred around the standard, 100% wool, carpet tile in use at Weymouth Exchange, Adelaide, and being installed at the Lonsdale, Melbourne, and Pitt, Sydney, Exchanges. However, a large range of carpet types will be studied; natural — 100% wool, synthetic — 100% nylon, and the commercial mixture — 80%/20% wool/nylon.

The relative humidity (r.h.) of the surrounding air in the carpeted area is an important consideration, together with the carpet type, spray composition, concentration and method of application as well as the effective lifetime of the anti-static treatment. The investigation will produce recommendations concerning these parameters, and the minimum r.h. desirable in an air-conditioned manual assistance area for safe operation.

A pilot experiment conducted in 1970 by the C.S.I.R.O. in conjunction with the Research Laboratories, concluded that the composition of the shoe sole material was the single most important factor in determining the magnitude and rate of decay of the body potentials produced. Shoe sole materials of leather, PVC, micro-cellular rubber and cork etc. are being studied to determine the most suitable types for use in manual assistance areas.

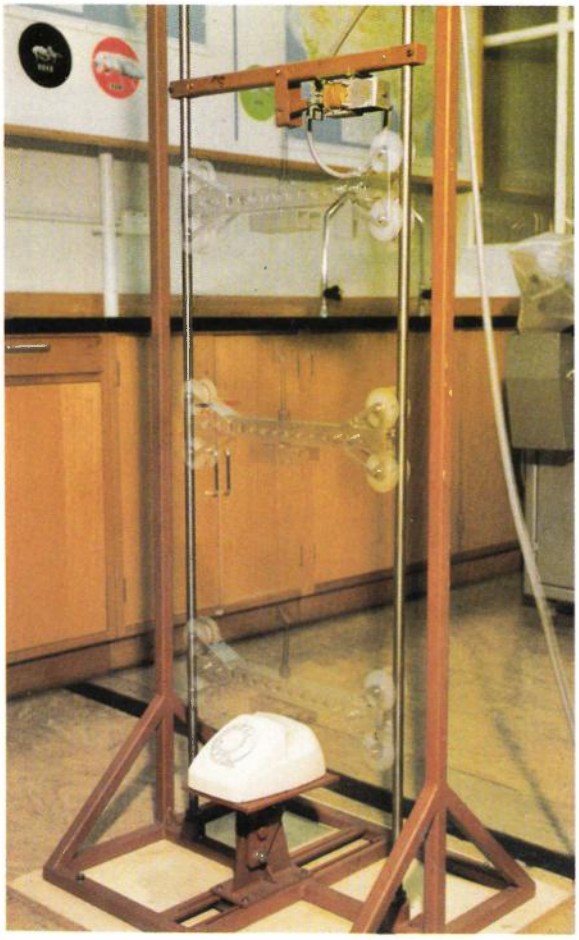
It is possible that this work may lead to more suitable chair designs, chair materials, as well as identifying clothing materials regarded as potentially hazardous in such environments.

THE DETERMINATION OF ANTIOXIDANTS IN POLYMERS

Very few polymers have the inherent stability to render them unaffected by heat, light, oxygen and other environmental factors. Consequently, the majority of polymers are protected against degradation by the inclusion of one or more stabilising systems.

Oxidation (the addition of oxygen to a polymer) which may occur during the heat of processing or during the working life of an article is the major cause of polymer breakdown, usually demonstrated by brittleness and cracking of the polymer. It may be suppressed by the inclusion of antioxidants of which there are various types that react in different ways to provide a range of protection.

The presence, type and concentration of an antioxidant has in the past, been determined by such methods as thermal analysis, spectroscopy, and gel permeation chromatography. But these are sophisticated and costly techniques unsuitable for use as routine control checks. Much effort was therefore put into finding an inexpensive, relatively quick method for determining antioxidants and this resulted in the modification of the well known thin-layer chromatography technique. This work by the Research Laboratories has been published under the heading "Antioxidant Analysis Incorporating a Thin-Layer Chromatography Separation Procedure" in "The Analyst" Vol. 99, November 1974. The article describes the novel development of a mixed silica gel/alumina thin layer coating in place of the usual single silica gel coat.



◀ *Telephone Impact Tester — triple exposure shows test weight dropping onto telephone housing*

IMPACT STRENGTH OF TELEPHONE HOUSINGS

The Telecom Australia specification for injection moulded telephone housings made from the plastics ABS (Acrylonitrile, Butadiene, Styrene), covers the physical and chemical evaluation of this terpolymer as a raw material. It does not, however, call for an evaluation of the moulded ABS article to determine if the plastics properties have been impaired in any way by the moulding process.

Deterioration of the plastics and/or residual moulding stresses can be most readily detected by a reduction in the impact strength of material. Consequently, an impact test device for telephones has been developed by the Research Laboratories which will enable routine testing of moulded articles to be conducted on the factory floor during production.

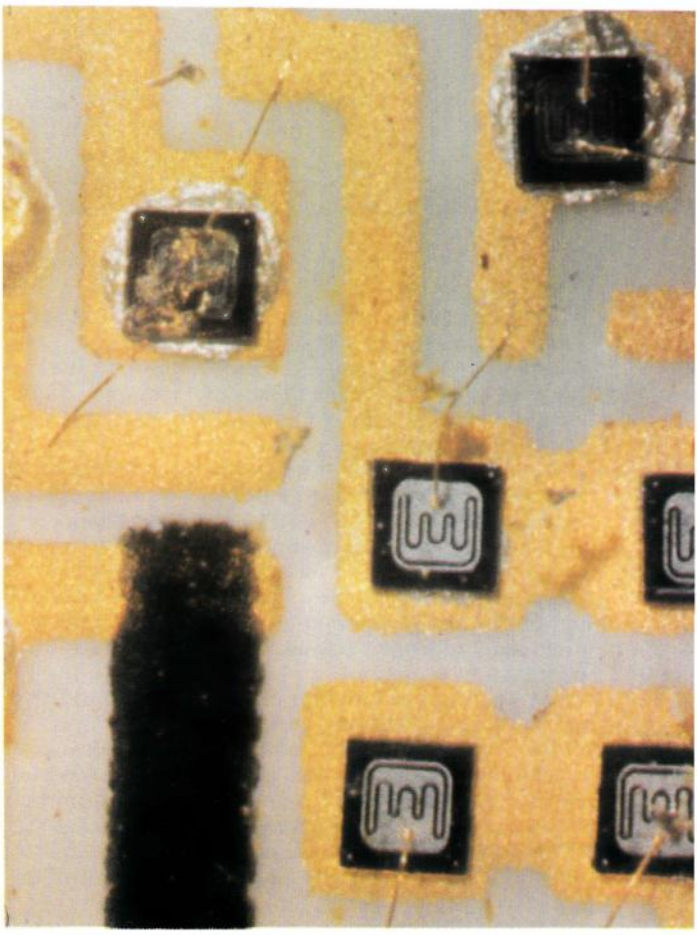
The idea of testing the moulded telephone is not new, since both the British and German Telecommunications Administrations have conducted such tests for many years. Both drop the handset itself onto a hard surface; the Germans by sliding the telephone down a steep incline, and the British by vertically dropping the telephone in free-fall. Both methods have the limitation of not being able to accurately pre-determine the point of impact. This is a major feature of the Australian design, the essential elements of the apparatus being the specimen holder and the mass. The holder allows a telephone housing to be so positioned as to permit it to be struck on any pre-determined spot by the striker attached to a guided falling mass. The latter is the same mass as a fully equipped telephone without handset.

Work is at present proceeding to determine realistic specification limits for impact strength, by the falling mass method, on injection moulded ABS telephones, and to ascertain the change in impact strength of telephone housings subjected to natural weathering conditions.

PLASTICS ENCAPSULATION OF SOLID STATE DEVICES

The reliability of plastics encapsulated semiconductor devices, as compared with hermetically sealed devices, is a subject which is under continuing review in the Research Laboratories. Plastics encapsulated devices, at times, offer substantial savings, and in some instances, may be the only types readily available from commercial sources.

As yet no ideal plastics encapsulant exists, and in fact, some of the requirements for this encapsulant are mutually exclusive. For example, very low water absorption and ionic impurity content are at present only achievable with a non-polar resin. However, good adhesion requires a chemically active, polar resin, free from filler and mould release agents. Without a filler



Enlarged view of portion of a thick film circuit, showing a failed transistor (left) and undamaged transistors

Melbourne exposure site for anodised aluminium

there is no chance of matching the coefficient of thermal expansion of encapsulant, lead frame, bonding wires and die. A mould release agent is necessary to avoid mecahnical damage in freeing components from the mould. The present moulding materials are thus, of necessity, a compromise. All classes of integrated circuits are especially vulnerable to moisture induced corrosion of the aluminimum metallisation. Whatever the details of the corrosion mechanism, the plastics encapsulant permits water vapour to reach the die surface and whilst overglazing and priming coats may slow the process, ultimate failure due to corrosion appears inevitable. Despite the seeming impossibility of a perfect plastics encapsulation, considerable gains have been made in recent years. A recent evaluation of various plastics encapsulated transistor types, indicated that transistors produced to the current state of the art are suitable for use in environments where there is sufficient continuous power dissipation to minimize water vapour uptake. However, the results of an investigation of plastics encapsulated integrated and thick film circuits suggest that they are not reliable enough to be preferred for general use in the telecommunications network, when alternative, hermetically sealed, equivalent devices are available.

ANODISED ALUMINIUM FOR ARCHITECTURAL PURPOSES

Over the last 20 years the consumption of aluminium for architectural purposes has increased markedly and currently it is particularly popular for window framing. One of the major virtues of aluminium is that provided it is suitably protected against corrosion, maintenance is minimal.

From a chemical point of view aluminium is a very active metal in that it combines readily with other elements. In practice aluminium generally resists corrosion if it is allowed to naturally develop a surface film of aluminium oxide. This film is about 0.01 μm thick.

The corrosion resistance of aluminium can be improved by artificially increasing the thickness of the oxide film. This process, which is called anodising, is accomplished electrolytically in an aqueous solution by passing current through the solution and connecting the aluminium to be treated to the positive terminal. With the passage of current the oxide film on the aluminium increases in thickness. For good corrosion resistance the film thickness should be about 25 μm. The oxide film formed in this way is gelatinous and needs to be sealed to prevent ingress of stains or dirt.

Anodised aluminium can be used clear or coloured. With the former, the metal retains the natural aluminium colour, and the latter can be achieved in various ways. Some aluminium alloys, as a consequence of alloying elements present (eg. silicon) colour during anodising. Alternatively the clear gelatinous film can be coloured with organic dyes or by electrolytically impregnating with metal oxides. After colouring, the film must be sealed to provide a barrier to prevent bleeding or staining.

For quality control of anodising, a number of laboratory tests have been developed. However these tests are no substitute for long term exposure to the elements.

To increase Telecom Australia's confidence and understanding in using anodised aluminium architecturally, two outdoor exposure sites have been established. One is at Tully in North Queensland and was chosen because of its heavy rainfall and intense sunlight; the other site is on the roof of one of our Research Laboratories' buildings in the Melbourne city area, and was chosen for its industrial atmosphere and convenience.

Anodised aluminium produced by different processes is currently being exposed at these two sites as well as being subjected to short term laboratory tests.

Digital Transmission

INTRODUCTION

At the present time, consideration is being given to the introduction of pulse code modulation (PCM) transmission systems into the Australian inter-exchange network. Until now, PCM systems have been installed in Australia under field trial conditions only, or as digital bearers, for an integrated switching and transmission experiment being conducted by the Research Laboratories.

Two significantly different PCM system types have been recommended by the C.C.I.T.T. for use on symmetric pair cable. They are both primarily intended to provide short-distance inter-exchange circuits. The 24-channel system is preferred by a number of Administrations including U.S.A., Canada and Japan. This system is essentially the same as that which went into commercial operation in the U.S.A. in 1962. The 30-channel system is of much later origin, being defined in moderate detail as late as 1972. It is the choice of the European Administrations.

The question as to which of these two systems is the more suitable for Australia is under consideration within Telecom Australia. Theoretical and practical studies on PCM equipment conducted in the Research Laboratories are directed towards establishing those system characteristics which have a bearing on this choice. Some of the studies include the extent of international standardisation, compatibility of equipment from different manufacturers, allowable regenerator span losses and their effect on the penetration of PCM systems into inter-exchange cables, signalling capacity and data transmission capabilities. Considerable work has been done on the transmission performance in respect of non-voice signals over PCM systems.

PCM systems are seen as being potentially important as a means of providing high-capacity data channels to meet the increasing demands of the future for such channels. This aspect of PCM is also under study together with investigations into data networks and digital transmission over subscribers cables.

These and other related studies are highlighted in this section of the Review.

THE TRANSMISSION OF NON-VOICE SIGNALS OVER PULSE CODE MODULATION (PCM) CIRCUITS

Two investigations have recently been carried out in the Research Laboratories to gain insight into the possible effects that the widescale introduction of PCM systems into the Australian telecommunications network may have on the transmission of non-voice signals.

The first investigation examined the effect of tandem VF links on the transmission of non-voice signals such as VF data (600/1200/2400/4800/9600 bit/s), multi-frequency code signalling (MFC), voice frequency telegraph (VFT) and facsimile. The aim of this investigation was to examine the effects of the transmission impairments produced by the successive encoding/decoding operations performed by the PCM terminal multiplexing/demultiplexing equipment associated with the individual PCM links in tandem connection. The measurements were performed on commercial primary level PCM multiplex equipment which conformed to the relevant C.C.I.T.T. Recommendations G732, G733 and G712. The tandem connected circuits used were derived from both 24 channel and 30 channel PCM systems. The PCM multiplex terminal was looped at the multiplex/line equipment interface, and no attempt was made to include the transmission impairments, which could arise in a field situation due to the possible introduction of digital line errors, and the accumulation of timing jitter on the PCM bearers between terminal equipment.

The second investigation examined the effect of bearer line errors on the transmission of non-voice signals. This investigation was carried out on a commercial 24 channel 1.544 Mbit/s PCM terminal which conformed to the C.C.I.T.T. G733 and G712 Recommendations. The 24 channel PCM multiplex terminal was looped at the multiplex/line equipment interface, through a special bipolar error insertion unit, which allowed bipolar errors to be introduced into the PCM line signal in a controlled manner. Tests were carried out on a range of commercial data modems involving different modulation techniques and transmission rates. A pseudo-random sequence generator was used to introduce errors into the PCM line signal in a pseudo-random fashion to produce a pre-selected average error rate. The distribution of the resulting PCM line errors, although not purely random, was representative of the distribution of line errors which could occur on an actual PCM bearer. For a particular measurement the PCM line error rate of the looped PCM multiplex terminal was preset to a particular value. The modem under investigation was looped through a VF channel from the PCM terminal and its error rate measured with a conventional data test set. Measurements were carried out with different PCM line error rates and with the level of the data signal at the 4-wire input to the PCM VF channel adjusted in turn to −10 dBm0 and −25 dBm0 to establish the significance of the data signal level on the sensitivity of the modem's operation to the PCM line errors. No attempt was made to include the effect of bearer timing jitter, and the additional impairment that may arise from this source in a field situation remains for further study.

It was found that the accumulated transmission impairment produced by the terminal multiplex equipment

The caesium atomic clock — used as master timing source for a data network

of up to 14 tandem PCM links had negligible effect on the transmission of MFC, VFT (FM), facsimile and data signals up to 4800 bit/s. However, the effect of PCM bearer line errors was found to be significant for data rates above 2400 bit/s. To achieve satisfactory data transmission at 4800 bit/s over PCM, a bearer error rate of more than an order of magnitude better than the maximum data error rate that can be tolerated, is necessary. Satisfactory data transmission at 9600 bit/s over PCM would be limited to cases where few tandem links are involved (e.g., say less than four) and the overall bearer error rate must be about two orders of magnitude better than the maximum data error rate permissible on the data channel. Although the effect of PCM line errors on VFT, MFC and facsimile was not investigated it is unlikely that line errors will have any significant effect on the transmission of these non-voice signals due to the relative insensitivity of the lower speed data modems (i.e., at 600, 1200 and 2400 bit/s) to this form of interference.

Overall the investigations indicated that the wide-scale introduction of primary PCM carrier systems into the telecommunication network should not place any restriction on the transmission of non-voice signals currently used (with the exception of baseband, 4800 bit/s and 9600 bit/s data) provided the effect of PCM bearer timing jitter (which remains to be investigated) is not significant.

DATA NETWORK SYNCHRONIZATION

At the points of interconnection (nodes) of a synchronous data network, the clocks of the network are synchronized to prevent the loss or repetition of data bits (slip). While slip is tolerable to a certain degree in pulse code modulated speech channels because of the redundancy inherent in speech, in data transmission slip will cause data mutilation or even loss of frame alignment which may result in temporary loss of the data circuits involved.

Two methods of clock synchronization are under investigation in the Research Laboratories, namely, master-slave synchronization and mutual synchronization.

In master-slave synchronization, the master clock, usually a high stability atomic clock (caesium or rubidium), determines the frequency of the entire network. Synchronizing information is inherent in the network data streams and is distributed from the master to the slave clocks. Each slave node contains a clock with good short-term stability which is phase-locked to the incoming synchronizing signal. In the event of a failure of the master clock, the slave clocks will free-run for a few days with reasonable slip performance.

In mutual synchronization there is no master clock, and the frequency of the network is determined by averaging the frequencies of each nodal clock. Two methods have been proposed, namely, single-ended and double-ended. In the single-ended case, clocks are derived from each incoming data stream and the average difference between these and the local clock is used as the error signal which controls the local clock. In the double ended case, these error signals are transmitted between nodes and are also included in the comparison which determines the control signal for the nodal clock.

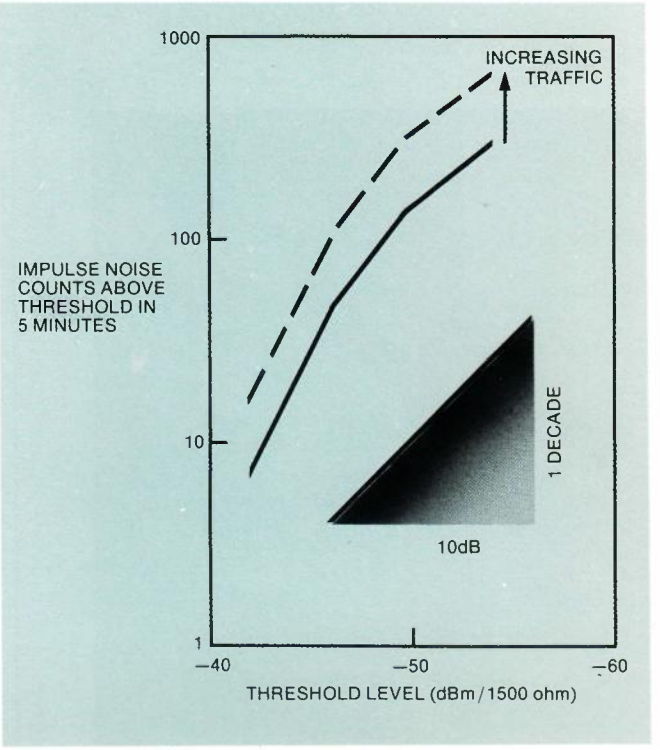
The Research Laboratories are currently studying data network synchronization in a model data network with three nodes. Topics under investigation include jitter performance, slip performance, effect of signal failure and error rate performance. Master-slave synchronization is employed with rubidium clocks at each node.

RETICULATION OF DATA SIGNALS TO SUBSCRIBERS BY EXISTING LOCAL CABLES

The provision of information services to business and homes will be a rapidly growing segment of the traffic in the telecommunications network in the 1980s. Subscriber facilities such as newspaper and mail by facsimile, banking transactions, weather and travel information, and slow-scan television are mentioned as significant data services of the future. This information is often most appropriately transmitted digitally, typically at rates of up to 64 kbit/s.

Existing subscriber-type cable is being used to carry wideband data signals on a limited scale as a part of the 48 kbit/s Datel service. Bearing in mind that Telecom Australia has an investment of about $1000 million in subscriber cable, it is important to ascertain the ability of these cables to carry such data signals, and the resulting interaction with existing telephony signalling

A typical impulse noise amplitude distribution showing constant shape as telephone traffic varies ▶



and other services. The Research Laboratories have considered in some detail two of the factors that limit the operating range of these data services, namely, impulsive noise and crosstalk interference between the data signals.

Impulsive noise is usually characterised by measuring the number of times the noise impulses exceed a fixed threshold in, for example, a five minute period. This is usually done simultaneously at a number of thresholds to give an amplitude distribution of the noise counts. A typical distribution is shown in the diagram. From an inspection of a large number of these distributions, measured both overseas and in Australia, it has been observed that there is a tendency for the inverse of the slope of the distribution to have a value of about 10 dB/decade. For a given type of switching equipment and cable, the crosstalk characteristics of the cable are a major factor in determining the shape of the amplitude distribution, while the absolute value is governed by the traffic level.

The results of impulse noise measurements have been used to provisionally estimate the maximum distance of operation (dictated by impulse noise) of 64 kbit/s data signals over several types of cable and at different error rates. Further work is proceeding to give more accurate estimates of these distances which will govern the reticulation of 64 kbit/s data signals, because studies have shown that for the transmit levels expected to be employed, the crosstalk interference between data services in the same cable is dominated by the effects of impulsive noise.

	Error Probability	
Cable	10^{-8}	10^{-6}
0.64 mm PIQL	7.5 km	12.7 km
0.4 mm PEIUT	4.1 km	6.9 km
0.32 mm PIUT	3.0 km	5.0 km

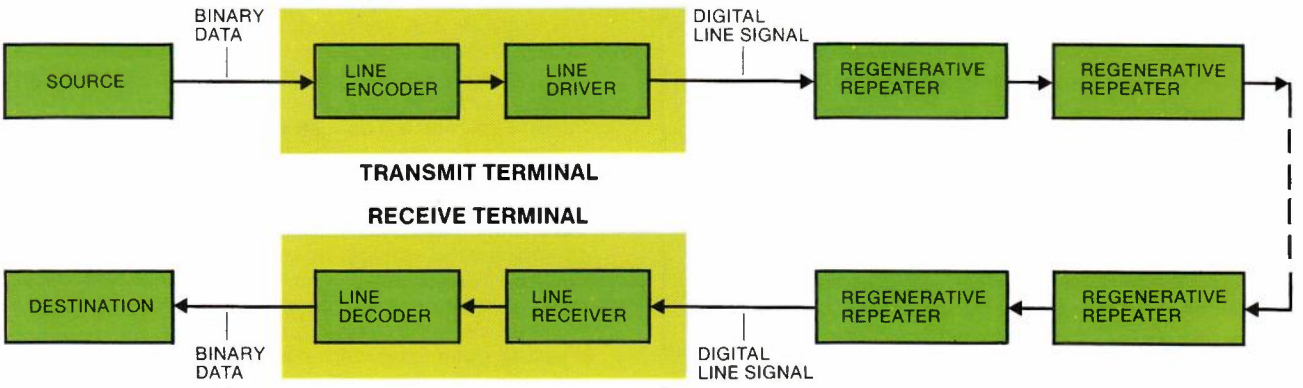
Provisional estimate of the maximum distance, in km, of transmission at 64 kbit/s on local cable

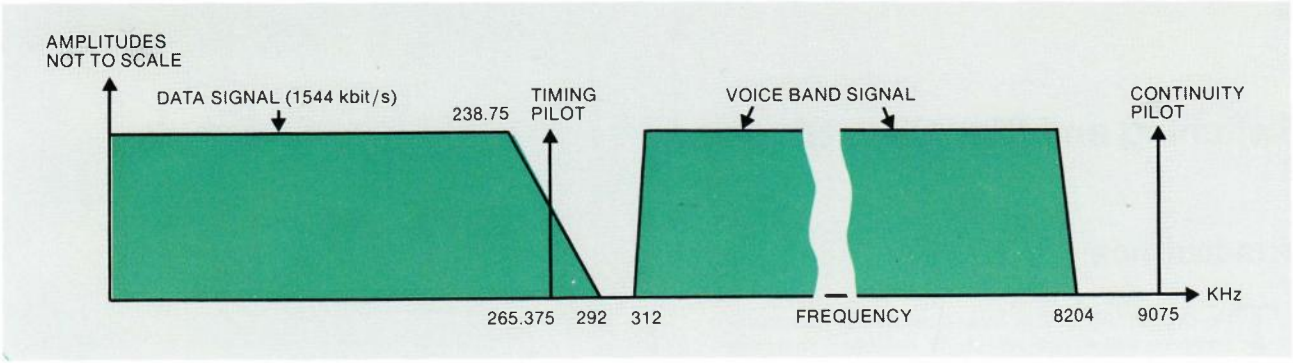
LINE CODES FOR BASEBAND DIGITAL TRANSMISSION

In baseband data transmission over cables it is essential to transform the basic two-level or binary data information into some appropriate digital line signal having desirable transmission properties. A large number of such encoding procedures have been proposed and some are in use. These transformations have different characteristics which may be advantageous depending on the application.

A study is being carried out in the Research Laboratories to survey and assess line codes and their relevant characteristics; in particular the content of timing information and low-frequency components in the encoded signals.

Block diagram of a baseband one-way digital transmission system ▼



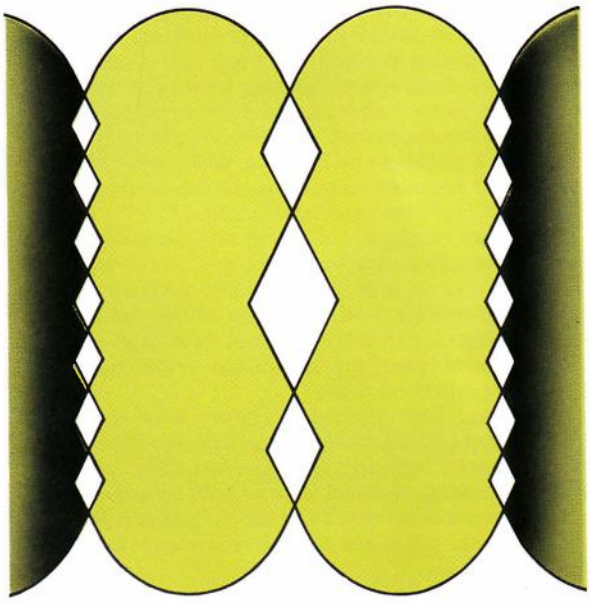


DUV Frequency Allocation

Timing information is necessary in the retiming operation of the digital signal at the end of a transmission section. This timing information may be extracted from the received signal itself. It may also be a timing component added to the transmitted signal. On the other hand, the line signal must have no d.c. component and contain only small amounts of low-frequency components because the digital signal is normally a.c. coupled to the line. In some applications, notably in the case of pulse code modulation (PCM) systems, d.c. power is fed to the remote regenerative repeaters via transformers over the same cable pair as the digital signal. If large low-frequency components are present in the signal, these must be first suppressed and filtered out before transmission, and later restored at the receiver.

The survey and assessment has already been carried out for the line codes commonly used in cable PCM systems. Work is now being directed to the codes used specifically for baseband digital data links.

Eye pattern associated with a commercially available 1544 kbit/s DUV equipment



TRANSMISSION OF DATA UNDER VOICE (DUV) ON FM RADIO BEARERS

Data transmission needs in Australia are following overseas trends and now represent the fastest growing segment of Australia's telecommunication services. Ways of accommodating the expected demand for data transmission capacity are being studied. A system known as Data Under Voice (DUV) is being introduced on FM microwave radio links in some overseas countries, notably U.S.A., Canada and Japan. The Research Laboratories are investigating the suitability of such techniques in the Australian network.

The main advantage of DUV is that under certain circumstances it allows for the addition of data channels to the FM radio telephony bearer network without significantly reducing the performance of the existing voice services. DUV transmission is accomplished by the insertion of a data signal into the sub-baseband below the telephony circuits on FM radio bearers.

In Australia, FM radio bearers in the main fall into one of two categories. Lower capacity systems providing 600, 960 and 1200 telephone channels with sub-basebands 0-64 kHz, and high capacity 1800 channel systems with sub-basebands 0-312 kHz. Some but not all sub-basebands in microwave radio bearers are used for supervisory, orderwire and other circuits. Those that are not used for such purposes or can be vacated are available for DUV transmission.

The accompanying graph shows the radio baseband spectrum occupancy of a representative 1800 channel bearer with an inserted DUV signal. On 1800 channel systems DUV signals of 1.544 Mbit/s or 2.048 Mbit/s can be accommodated. These two bit rates are the rates associated with 24-channel and 30-channel primary-level pulse code modulation systems. Correspondingly lower speed data signals can be accommodated in the smaller sub-baseband found on lower capacity radio bearers.

A typical DUV modem at the transmit terminal converts the binary data signal into a multilevel signal thereby reducing the required bandwidth. As an example, the 1.544 Mbit/s signal may be converted into an 8-level signal and the 2.048 Mbit/s signal into a 16-level signal, both with a resultant bandwidth of less than 300 kHz. The Melbourne-Albury-Canberra-Sydney route is equipped with 1800 channel systems which might carry the abovementioned DUV signals.

More detailed information describing different overseas DUV systems and their adaptability to the Australian network will be contained in a forthcoming Research Laboratories Report.

Switching and Signalling Studies

INTRODUCTION

The proportion of the total cost of telecommunications networks which is devoted towards switching and signalling equipment is continually increasing, both in Australia and overseas. This is a reflection of the rapid growth of the number of services, and of the complexity and variety of those services.

Several technology changes are now being developed with the aim of containing the rise in the proportion of the total cost devoted to switching and signalling equipment. One of the most significant, is the introduction of stored program control, which is now being introduced into both the trunk and the local network. Various aspects of this have been, and are being, studied within the Laboratories. Another change which will have a significant impact is the use of digital switching and transmission techniques, which offer the possibilities of reduced equipment space requirements, lower cost, and improved performance.

The fields of digital switching and stored program control are applicable to all forms of communication networks, and will probably find initial application in the fields of telephony, telex and data. Within the Laboratories, studies in the telephony field have been conducted for several years, and studies are now commencing in the data and telex fields.

A concept now gaining acceptance on the world scene is that of integrating the various services into one digitally based network, utilising a common switching and transmission medium with a common channel signalling system which will cater for the needs of the various services. Initial studies are commencing on this topic.

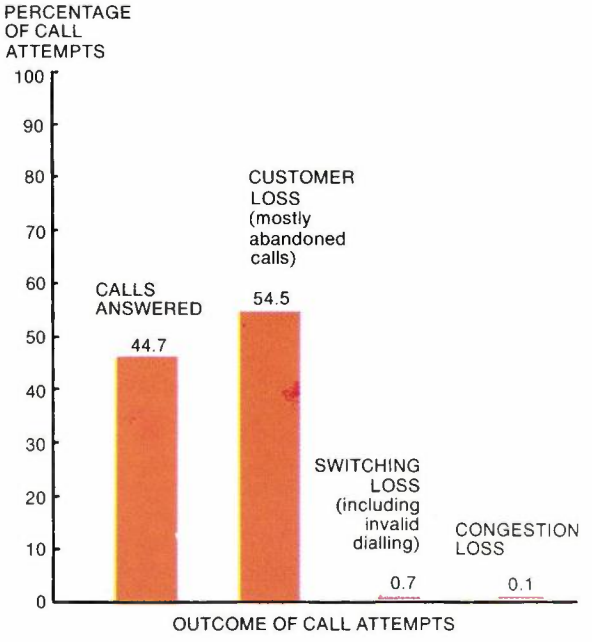
Interest is now developing in remotely controlled operating and maintenance centres to enable the management of networks to be handled more effectively, and these aspects are now receiving attention.

At the other end of the spectrum, various device technologies are being studied and assessed, particularly the small memory-based systems ranging through programmable read-only memories (PROMs), programmable logic arrays (PLAs), microprocessors and miniprocessors.

INTEGRATED SWITCHING AND TRANSMISSION (IST) SWITCHING EXPERIMENTS IN THE MELBOURNE TELEPHONE NETWORK

A model digital exchange was placed in service in the Melbourne network in August 1974, connected to approximately 100 circuits provided over four pulse code modulation (PCM) bearers. The digital exchange switches speech channels in the PCM streams directly without demultiplexing or decoding; it utilises stored program control, with two processors operating in a time shared mode.

The exchange has been evaluated against standard Telecom Australia specifications as part of an assessment program, and has been found to have satisfactory performance. The existence of precise timing processes and powerful traffic recording facilities within the exchange have enabled it to monitor the performance of the network which surrounds it, resulting in the detection of some switching and signalling faults not readily observable or detectable by more conventional methods.



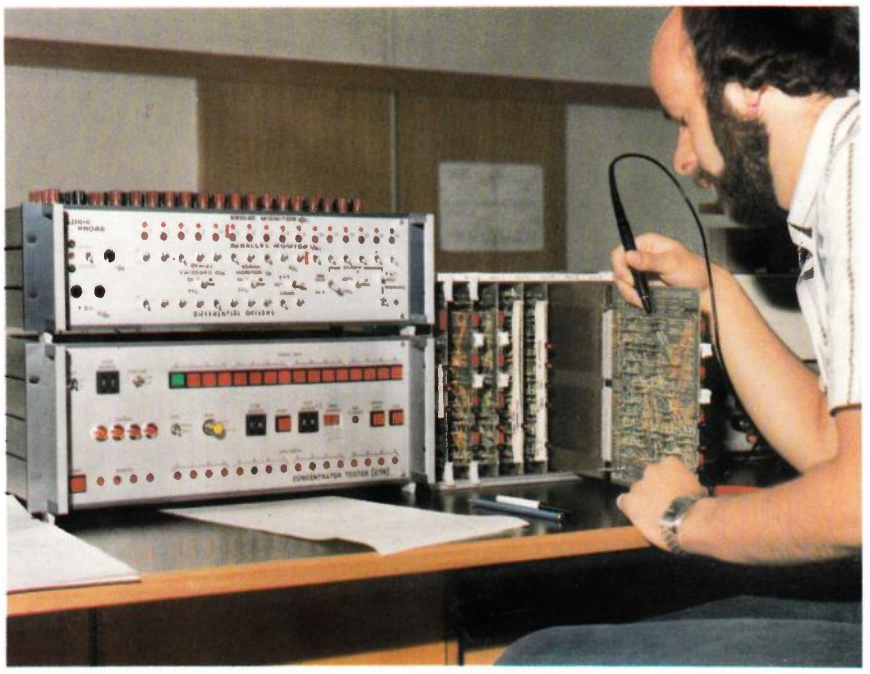
Live traffic statistics for IST switching — Dec 1974 to June 1975

A further interesting fact noted during the experiment is that only about 50% of call attempts handled by the exchange are successful, with the remaining 50% being either abandoned or encountering a busy subscriber.

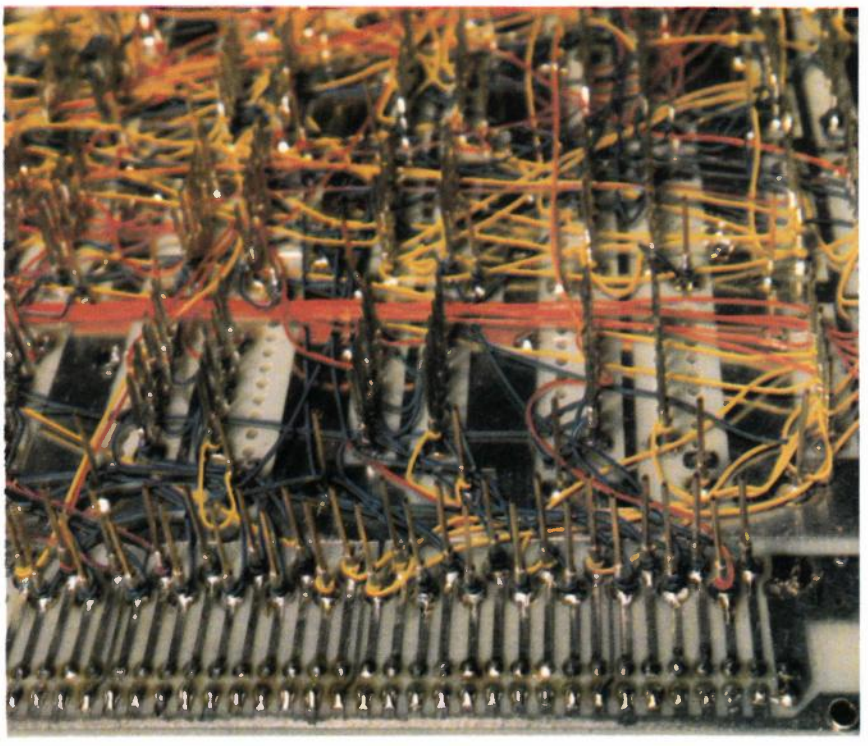
Tests are being conducted to establish the bit error rate through the exchange, which is a parameter currently being discussed within the C.C.I.T.T. This is difficult to establish with confidence, due to the low rate and hence the long observation time required, but it appears that this will be less than 1 bit in 10^{12} being in error.

Hardware performance has been generally satisfactory and has established confidence in the equipment practice and techniques that have been developed. Software performance has also been satisfactory, due mainly to the procedures used for initial testing, the use of special registers connected to light emitting diode arrays for visual monitoring purposes, and a powerful man-machine communications system.

A remotely controlled subscribers switching stage is being developed which will be installed at the Clayton Research Laboratories and connected to the digital exchange at St. Kilda, via a PCM link. This switching stage will be controlled by the digital exchange via a common channel signalling system. The digital exchange itself will also be operated on a remotely controlled basis in future, with supervision and control being effected from the Laboratories at Clayton.



Subscribers switching stage sub-system testing, showing programmable sequential controller and specialised test equipment



Custom wire wrapped patterns upon standard format printed wiring boards provide a very cost-beneficial approach to the construction of large experimental digital systems.

NEW SWITCHING TECHNIQUES AND TECHNOLOGIES

- ***High Level Languages and Documentation for Stored Program Control (SPC) Systems.*** The use of high level languages can contribute significantly to reduction of the time required for development of programs for SPC systems, and also to the accuracy of the initial program writing. These advantages must be weighed against the inevitable loss of efficiency of the resulting program due to the need for increased running time and storage, both of which are at a premium in SPC systems. The Laboratories have developed and implemented a high level language which has small penalties while still providing a significant reduction in program development time.
- A system independent technique has also been developed by the Laboratories for representing the processes involved in a sequential machine, such as an SPC system. Known as the ***Call State Transition Diagram (CSTD)*** technique, it is being considered by the ***C.C.I.T.T.*** as a possibility for a world standard. This technique enables the various processes to be represented in both a pictorial and systematic manner, resulting in a concise and complete description. The use of the CSTD technique is primarily intended for system description, but its possibilities for use as a design tool are currently being investigated.
- ***Dimensioning and Behaviour of SPC Systems.*** A processor in an SPC system has a limited capacity, consequently the processing system must be augmented as the load on the system increases. Methods of measuring the true load on the processing system as a proportion of its total capacity, together with rules for dimensioning the processor system to ensure that additional capacity is added at the most appropriate time, are being developed in the Laboratories.
- A further aspect of interest in an SPC system is the ***dynamics of overload.*** As the traffic presented to the system is progressively increased, the time response of the processors increases non-linearly, until an overload point is reached at which the carried traffic can drop sharply. There is a hysteresis effect in the recovery. The dynamics and parameters of these phenomena are being investigated with the objective of being able to monitor and control the behaviour of an SPC system.

This problem becomes particularly significant in a network of interconnected SPC exchanges utilising alternate routing, as an overload in one exchange will result in a sharp increase in load on other nearby exchanges. Methods of ensuring system stability are under consideration.

MEMORY SYSTEMS

In large digital systems, memories are an essential part of the system control equipment. Various types of memory circuits and devices are used in the control of digital switching equipment. High capacity memories comprise an integral part of the special purpose processors used in stored program controlled switching systems. These memories may be randomly accessed, with information continuously being written in and read out from the memory. Other types of memory, with permanently stored information which is accessed when required, are frequently used for the control of logic circuitry in a wide range of digital systems. These are known as read-only memories.

Semiconductor random access memories have recently emerged as an acceptable alternative to magnetic core devices for large scale computer and processor applications. The semiconductor devices offer various technical advantages over alternative technologies. These devices are currently under investigation in the Laboratories.

Field-programmable semiconductor read-only memories are extremely useful in many circuit applications when the permanently stored information can be initially programmed into the memory by the system designer. A wide range of these programmable read-only memories is now commercially available, however their use and reliability is not yet well understood. A detailed study is being carried out on the device programming techniques and acceptable operating conditions for reliable performance.

Many complex logic circuit functions can be efficiently implemented using various memory circuit design techniques and programmable memory and logic array devices. New design philosophies are required using these techniques which often lead to a considerable saving in equipment costs. These novel design strategies are under investigation.

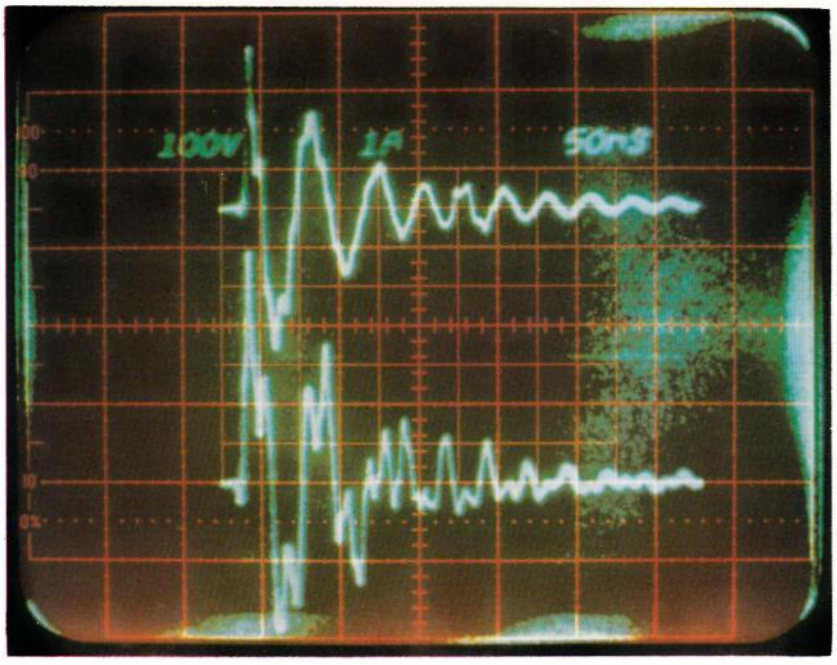
Reliability and cost are important considerations in the application of memory systems. The Research Laboratories are investigating the latest semiconductor memory systems with a view to recommending acceptable devices and circuit techniques for future memory applications.

ELECTRICAL NOISE EFFECTS IN DIGITAL SYSTEMS

The ubiquity of digital systems has simplified many tasks and contained the cost of performing many more. It has also served to demonstrate the importance of long-standing problems which are attracting increasing attention and investigation in many parts of the world. The problems arise from the susceptibility of electronic systems (particularly digital systems) to malfunctions induced by internally and externally generated electrical interference, and the various solutions required are vital to the successful operation of digital switching and signalling systems.

For such digital systems, investigations are currently being made in the Laboratories to identify the mechanisms by which interference can be generated, to characterise interference sources, to identify the modes of entry of electrical noise into digital systems, and to develop means of attenuating electrical interference that may be present, as well as developing design methods which will reduce the susceptibility of equipment to interference. Progress is being made in the solving of problems of mains-borne electrical noise and the effects of electrostatic discharge. The results are expected to contribute significantly to the development of methods of specifying and measuring interference susceptibility of digital systems, for the benefit of both manufacturer and user.

The electrostatic charge accumulated on a mobile chair mounted upon castors is a potential source of electromagnetic interference to digital equipment. Voltage and current wave forms along the outer shield of the 2 metre length of coaxial cable, discharging the mobile chair to ground. Peak voltage drop along the sheath is 400 volt, peak current in the sheath is 6 ampere, and the final "ringing" frequency is approximately 20 MHz.



Optical Fibres, Devices and Systems

INTRODUCTION

Much of the optical fibre work of the Research Laboratories over the past three years has been directed towards determining the transmission performance of the liquid-core fibres developed by C.S.I.R.O. in Melbourne. These fibres formed the basis of our studies because, firstly, they were readily available, and secondly, because they represent most nearly that class of fibre in which the refractive index changes abruptly at the core-cladding boundary.

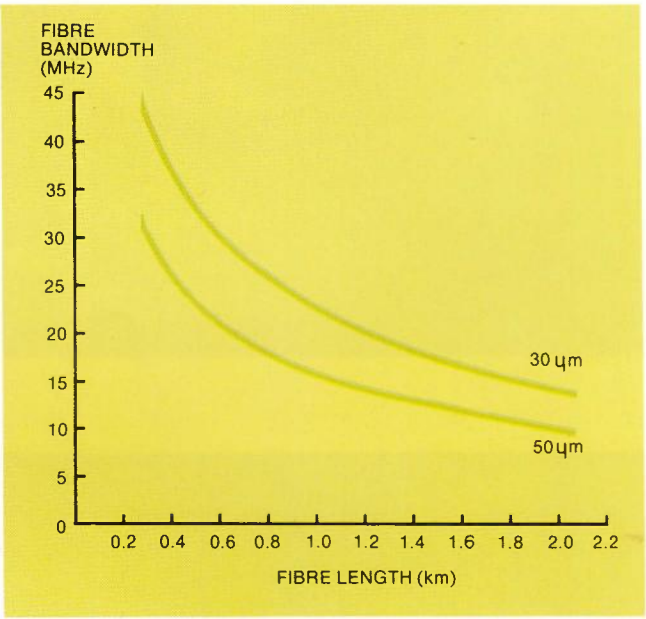
Investigations have recently commenced on stepped-index fibres in which the core is glass rather than liquid. The investigation will be further extended to cover fibres in which the refractive index is graded across the core to improve the bandwidth of the fibre.

A contract has been let to an Australian manufacturer to investigate the production of solid-core fibres using a chemical-vapour deposition (CVD) technique. In this method layers of high purity silica doped with a particular oxide (e.g. P_2O_5) to control the refractive index are deposited inside a silica tube which is subsequently collapsed into a solid rod and drawn into a low-loss fibre.

The fibres from this source will be used principally for experimental purposes to relate measured performance against physical characteristics.

The Research Laboratories' involvement with this work will provide an insight into the problems of manufacturing fibres, and should allow the eventual specification of fibres having both a technical and economical performance adequate for the particular systems to be used in the Australian network.

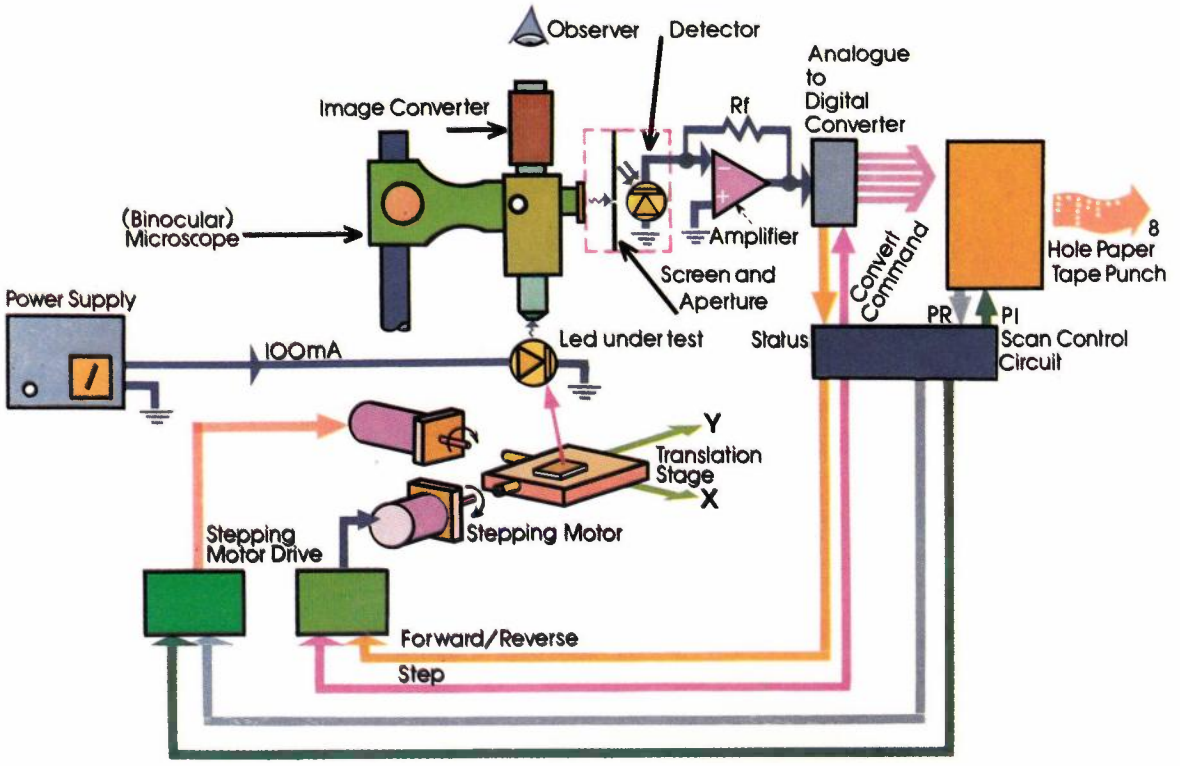
It is significant to note that over the past year there has been a noticeable trend throughout the world towards the development of system hardware. A number of major organisations have already demonstrated the feasibility of various types of systems and are anticipating extended trials in the near future. This trend was also noticeable at the first International Optical Fibre Communications Conference in London in September 1975, where a large proportion of papers described investigations into particular configurations which could form the basis of practical systems. The Research Laboratories in collaboration with other Departments of Telecom Australia have commenced the planning for feasibility trials of systems using optical fibres, in order to gain experience of the practical problems associated with their implementation.



A reduction in core diameter increases the fibre modulation bandwidth. Predicted curves for a high cladding loss, step-index fibre excited with a focussed light emitting diode. The fibre refractive index ratio is 1.0094

OPTICAL FIBRE TRANSMISSION SYSTEM STUDIES

To adequately appreciate the possible applications for, and anticipate the introduction of, fibre optic systems into the local network, computer models of fibre systems are being developed in the Research Laboratories. The particular system considered at present consists of a step-index multimode fibre driven by an incoherent light source. The model incorporates a number of existing results and is such that the inter-dependence of the various system parameters and their individual influence on system performance can be observed. For example, for a given source power and assumed source radiation characteristics, the best choice of receiver can be made for a particular fibre core diameter as the fibre length is varied. As a



The measuring system for diode brightness distribution

further example, the equalizer response of a digital receiver required to yield a given system performance, can be obtained as the fibre length increases, when using a fibre with a particular ratio of refractive indices.

This model can be used for both analogue and digital transmission, for example, PCM telephony, cable television, and wideband reticulation; and provides data whereby optical system performance can be compared with that of systems utilizing the existing media of coaxial cable and twisted-wire pairs.

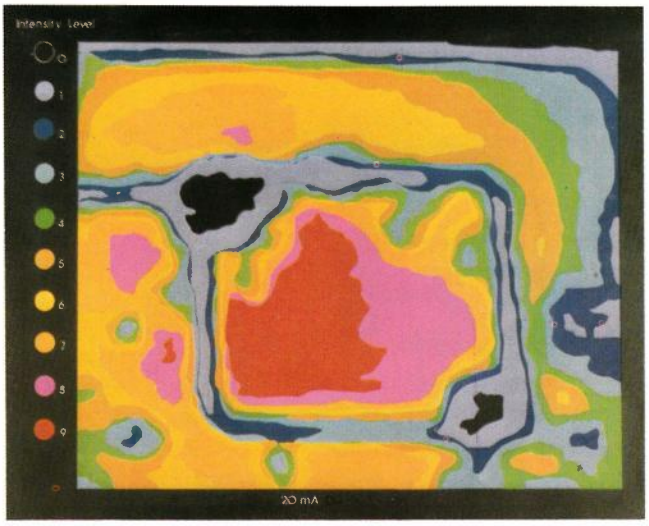
The model so far developed is limited in the sense that only step-index fibres can be considered in detail. Systems employing graded index fibres can be considered by using measured data from particular fibres or by assuming the fibre dispersion-length variation follows a square law dependence.

For a given application the model described will aid in selection of an optimum system configuration; from a performance point of view, when considering a fixed optical cable loss, or from an economic point of view, when assigning expected costs to system components. Also, by considering splicing and optical coupler losses, basic network studies can be realized.

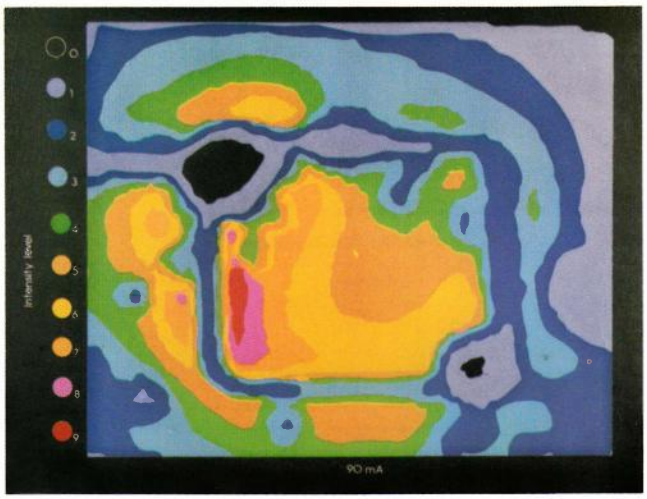
BRIGHTNESS DISTRIBUTION IN LIGHT EMITTING DIODES

Light emitting diodes (LEDs) are of interest as sources for optical fibre communication systems, particularly because of their small size, proven high reliability, low power consumption, and compatibility with integrated circuits. An experimental investigation has been carried out by the Research Laboratories into the variation of the brightness across the surface of LEDs being used in studies of optical fibre communication systems, as this information is needed in studies of techniques for coupling LEDs to optical fibres, and in studies of overall systems behaviour.

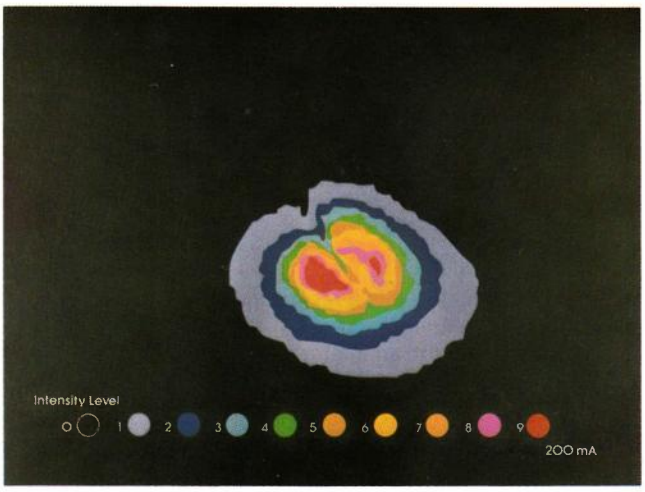
The measuring system used to examine the LEDs included a high quality optical microscope with a silicon photo-detector replacing the eyepiece lens. With a pinhole aperture of 0.2mm diameter placed in front of the photo-detector surface, and using typically a 36X objective lens, the photo-detector output indicated the brightness of an area about 1μm diameter on the surface of an LED placed at the focus of the microscope. Stepping motors were used to drive the microscope



Brightness distribution of a conventional diode at 20mA



Brightness distribution of a conventional diode at 90mA



Brightness distribution of a conventional diode at 200mA

stage traverses, so that the LED surface brightness was scanned in a regular way. At each point the output from the photo-detector was recorded and the resulting 140 x 140 element array was analysed and presented as a contour map of the surface.

In a map of the brightness distribution of conventional, commercially available LEDs, the position of the gold metallization and lead wire are clearly visible. More importantly, the map shows that the brightness distribution is extremely non-uniform. The light emission concentrates round the contact metallization, particularly near the lead bonding pad. Mechanical damage of the contact metallization and diode itself is often evident. The non-uniformity of light emission becomes more pronounced with increasing current through the diode.

In high radiance diodes designed specially for application in optical fibre communication systems, the light is emitted from a restricted area corresponding to a small area bottom contact. Again the brightness distribution varies with current level.

Apart from the non-uniformities caused by physical defects, the variation in brightness can be explained in terms of current crowding round the contacts. Calculations made using approximate models of the diodes give good agreement with the measured distributions. While the variable and non-uniform brightness distributions observed in this investigation are not expected to be important in many applications of LEDs, for example in card readers, there are important implications to applications in optical communication systems. Coupling to optical fibre will be sensitive to the position of the diode relative to the core face, and light will not be launched uniformly into the fibre. There may also be undesirable modulation effects, as the amount of light coupling into the various transmission modes of the fibre will vary with current, and as a result the effective dispersion and attenuation will be altered.

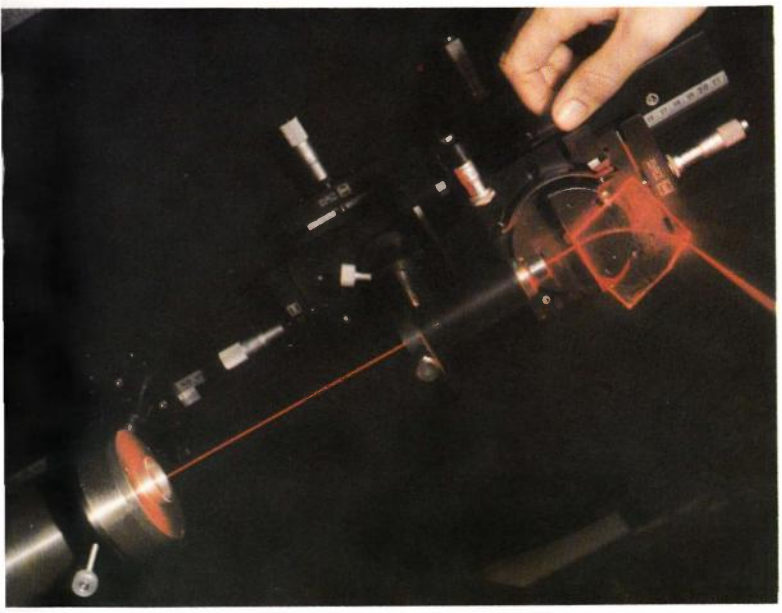
OPTICAL FIBRE SYSTEMS

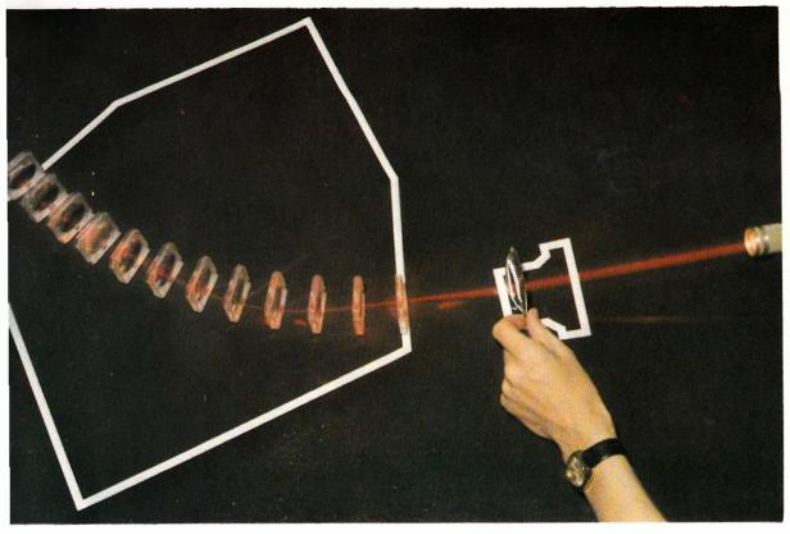
The bandwidth and attenuation of optical fibres can be controlled over a very wide range by suitable selection of the fibre parameters (particularly the core refractive index profile) and the purity of the starting materials.

Because of their very small cross-section, it should be possible to construct cables of moderate size, containing a large number of fibres. It follows that optical fibres have potential application in a range of systems, from those requiring only small bandwidths such as telephone circuits, through to those of very large bandwidth such as cable television distribution networks. The transmission distance or spacing between repeaters can extend from a few tens of metres through to possibly ten kilometres if very low loss fibres are used.

One possible application is as bearers in the local distribution network to allow the introduction of wideband services which could not be handled by existing copper pairs. These services could include initially the one-way transmission of entertainment television, and lead on eventually to more advanced services such as videotelephones. Telephone and data services would also be incorporated in this network.

These various services place special requirements on the fibre cable and terminal devices. In particular the cable must be no worse than an equivalent copper





Top left: Stress-induced optical waveguide excited by a helium-neon laser beam

Lower left: Stress-induced optical waveguide modelled with a series of discrete lenses

cable in its ability to be handled and drawn into ducts, while having about the same outside diameter. Since the first systems are likely to have analogue transmission, the light sources used must have both sufficient bandwidth and linearity to allow distortion-free transmission, particularly if some services are to be multiplexed onto one pair of fibres for each subscriber. The specifications for alternative fibre and terminal configurations are now being developed by the Research Laboratories. This will lead to field experiments in due course.

Another application in which fibres may have certain technical and economic advantages over conventional media, will be as PCM bearers in short-haul links. Here the relatively large information capacity for a given cross-section of cable, together with the freedom from interference between fibres and from external sources, should lead to superior technical performance at lower cost. In the long term the particular characteristics of fibres, namely their low transmission losses and large transmission bandwidths, should allow trunk systems of very high capacity to be realized with quite large repeater spacings.

WAVEGUIDES FOR INTEGRATED OPTICAL CIRCUITS

Integrated optical circuits are miniature optical counterparts of microwave devices and networks. These circuits are required to perform signal processing operations, such as optical carrier signal generation, coupling, filtering, modulation, multiplexing and detection, at the transmit and receive terminals of an optical fibre communications link. The future practical applications of integrated optical circuits depend, to a large extent, upon the development of low-loss "channel" optical waveguides which confine a light beam in both transverse directions.

Channel optical waveguides can be prepared by a variety of techniques, of which the simplest is embossing. In this process a suitable die, such as a wire or a glass fibre, is used to emboss a groove into the surface of a thermoplastic substrate. The groove is filled with another material, of higher refractive index than the substrate, to form a light guide.

A fabrication technique has been developed in the Research Laboratories, whereby light guiding can be established in the substrate material beneath unfilled embossed waveguides. The guiding effect is attributed to the presence of residual stresses in the substrate. Investigations, to date, have centred upon stress-induced channel optical waveguides fabricated in commercially available polymethylmethacrylate substrates with a 0.25mm copper wire embossing die. Experimental results indicate that these waveguides can exhibit a very low optical attenuation of 0.045 dB/cm at a wavelength of 633nm. Thin waveguide cross-sections have been examined in a Mach-Zehnder interferometer to determine the stress-induced refractive index profile. These measurements reveal that the waveguides have features similar to those of graded-index optical fibres. The focussing property of the stress-induced waveguide allows certain characteristics, such as losses at bends, to be studied with a discrete lens model.

Short lengths of low-loss stress-induced waveguides could form the basis for the design and manufacture of practical optical integrated circuits. The simplicity of the embossing process makes it amenable to large scale production. A "rolled" embossing process, recently developed and patented by the Research Laboratories, provides a convenient technique for manufacturing longer lengths of waveguide. By this process an array of parallel grooves could be embossed into thin, flexible plastic sheets. These stress-induced waveguides may find applications as optical data buses.

New Telecommunications Services

INTRODUCTION

In a recent issue of the Journal "FUTURES", an alternative society — the "Informational Society" — was discussed and suggested to be based on "total automation of all physical production and a world wide linkage of all computer systems, data banks and terminals. Integrated with this system would be telephone, video telephone, TV and CATV systems, and all information such as books, magazines, newspapers, live or taped entertainment would be processed in electromagnetic media for easy transfer." The author of that paper then attempts to describe the impact of this "social nervous system" on the individual and on society, suggesting that it would lead to an entirely different life style from that known today where "the individual is free to choose where he lives, since he is freed from having to be close to work" and hence "each community can be designed to have a distinct identity". It was argued that "community life in the informational society should provide its members with a more meaningful lifestyle than in any previous society" and that "community life is likely to be more personal than its counterpart in industrial society . . . yet with the great diversity of activities available through the social nervous system, it is unlikely to have the rigid social structure of the primitive tribal village."

It is obviously impracticable for this futuristic form of society to arrive at date "x" with a big bang. Rather, if ever, it will be the result of a very gradual evolution and, hopefully, of human social and political wisdom.

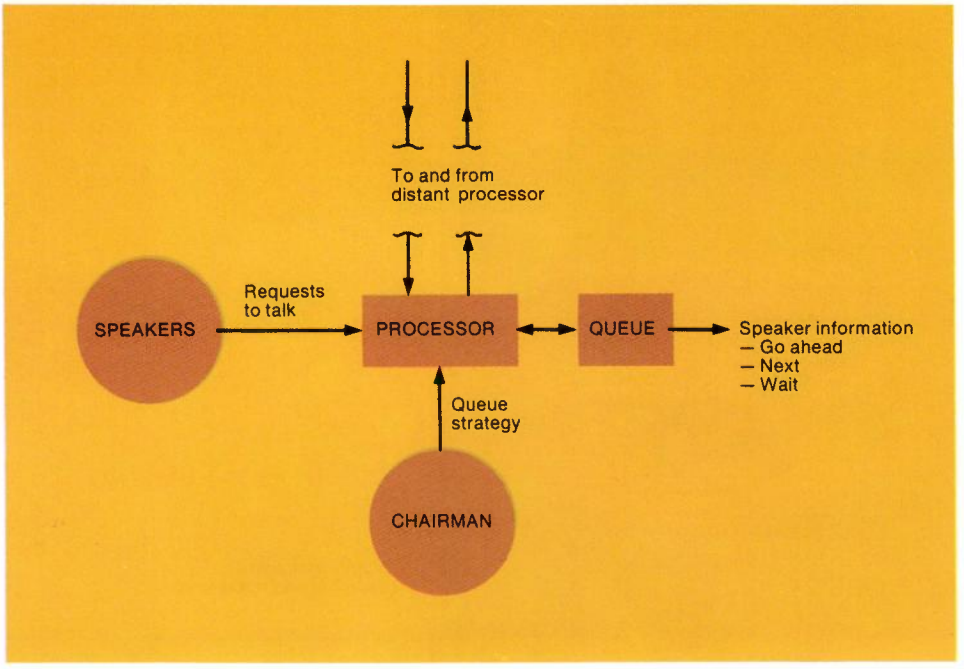
Most of the technological elements needed to facilitate the suggested new social nervous system are already existing today, waiting to be imaginatively integrated and refined to grow into the telecommunication networks and services of the future. The three projects reported in this section of this Review serve to illustrate that telecommunications R & D on new customer systems and services is already embarking on this new evolutionary path in that the projects, at least in concept, could lead to sub-systems of the social nervous system referred to initially.

AUDIO CONFERENCING

Although we live in an age that holds personal initiative and individuality in high regard, business and community decisions alike rely increasingly on consensus between such individuals. Thus decisions and proposals come increasingly from teams or committees, that is groups of individuals. The conference is of course an essential mode of communication for these groups and usually a face-to-face meeting is implied because telecommunication facilities for groups have yet to mature. With one person being possibly a member of many groups any innovation in telecommunications which could reduce the overall time and inconvenience of face-to-face meetings should be welcome.

The telephone system as it stands is essentially a one-to-one medium, although conference bridges interconnecting several telephones are made available by special arrangement. Alternatively loud-speaking telephones can be used at each end of a line to allow two sub-groups to communicate, but the operation of the voice switches in these devices tends to hinder the free flow of normal conversation. There is a general problem with both these methods, however, related in part to the role of the chairman at a 'formal' meeting. Simply put, it is the problem of knowing when to speak and who is speaking — the equivalent of catching the chairman's eye over the telephone. A real-time television link can provide this information, but is prodigal of bandwidth bearing in mind the minimal information being transmitted in the engineering sense for these 'control' functions alone.

The ready availability of microprocessors and the low information rate required by some chairman control functions leads to the possibility of providing not only speaker identification but also automating some of the meeting protocol over a telemetering link,. Although this may seem a rather mechanical intrusion it is interesting to note in passing that bells and lights are often used at formal meetings to reinforce the authority of the chairman in, say, keeping a speaker to a time table.



Audio teleconferencing experiment

Note that the protocol and general strategies are not directly hard-wired into the microprocessor but sorted as a program which can be changed at short notice, even during a meeting.

The figure shows in outline an experimental system, which is under construction at the Research Laboratories, catering for six participants at each of two locations.

A LOW-COST MICROPROGRAMMED DOMESTIC COMMUNICATIONS TERMINAL

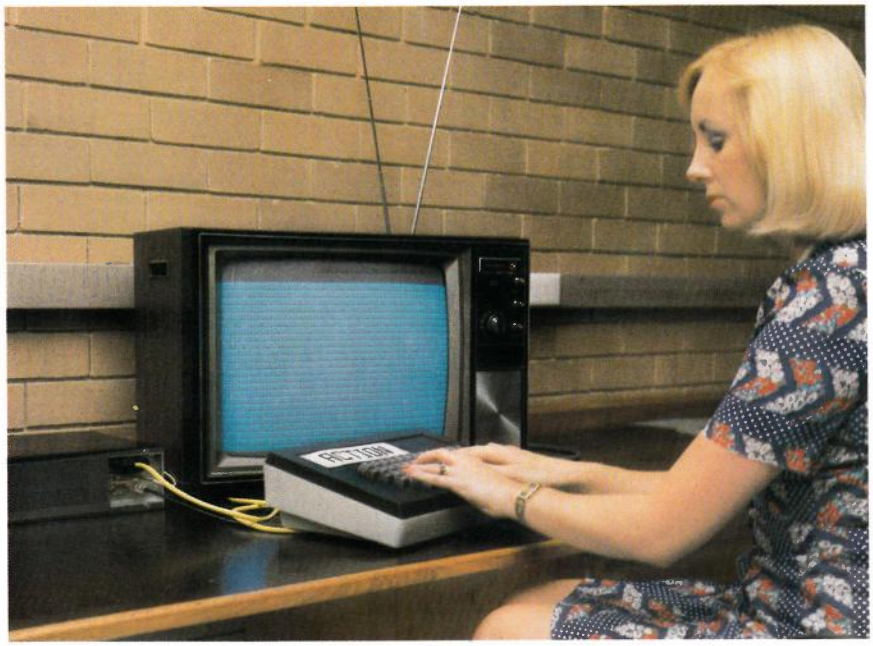
Almost every work of science fiction which has appeared during the past three decades has included a description of an advanced computer-controlled domestic terminal device used for conducting day-to-day employment/marketing/leisure transactions. However, it is only within the past couple of years that we have seen the realisation of such terminals. One of the reasons for this delay in actualisation has been the high cost of implementation.

Earlier works of science fiction tended to picture their terminals as clattering mechanical devices similar to typewriters, generating their output in hard-copy form on a paper-like medium. Perhaps the later writers were more aware of the ecological consequences which may have resulted from the widescale acceptance of such paper-spewing mechanical devices; in any event they were quick to appreciate the advantages of the television tube as a paperless display medium.

Today, almost every domestic dwelling is equipped with a television receiver, and we are already seeing the emergence of schemes (such as the British Post Office Viewdata facility) which enable the selective acquisition of textual information (transmitted over a conventional telephone line) on the screen of such a receiver. Thus, using a numeric keypad device connected to the receiver, a subscriber is able to view the day's news, or a resumé of television programs,etc.

The terminal under development in the Research Laboratories, functions in a similar fashion, but has a much wider range of capabilities, due in part to its being equipped with a full typewriter keyboard. A subscriber is able (in addition to using the types of services described above) to transmit textual messages to persons and/or computers. For instance, the terminal could be used to send a telegram (or even a complete letter) to a person or group of persons directly, thereby obviating the usual sorting/transport/delivery delays; moreover, it includes an inbuilt edit facility, enabling correction, reformatting operations, etc., to be effected immediately upon the entire letter/telegram from the keyboard whilst it is displayed prior to transmission. Alternatively, a Melbourne subscriber could use it to access a computer and display the telephone numbers of all the Jones' resident in Townsville; or to display the prices of designated items at his local supermarket, and place his order accordingly. A whole host of other potential applications will be apparent to the reader.

The most significant factor in enabling the Laboratories' terminal to be produced at a sufficiently low cost for consumer acceptance has undoubtedly been the inclusion therein of a microprocessor with associated high-density integrated circuit memory components. This tiny but powerful computer controls the reception and transmission (via an experimental integrated modem) of information at rates of up to 300 bauds. It also controls the storage and editing of this information in memory, and presents relevant portions of it to the television receiver at appropriate intervals during the picture tube scan for display in 24 lines of 72 characters. Some additional capabilities made possible by use of the microprocessor include a graphics display feature, an automatic telephone dialling facility, and the attachment of peripheral devices such as hard-copy



Prototype domestic communications terminal

(typewriter or facsimile) units, and flexible-disc/tape-cassette units for bulk storage. The terminal is also able (by microprogram alteration) to dynamically adjust its own characteristics according to the type of function it is performing at any time.

Two prototype terminals are presently in use. The first of these (pictured) consists of separate keyboard and electronics modules. These modules have been packaged in a briefcase, for portability, in the second prototype. New memory and microprocessor components recently released should enable the entire electronics module to be accommodated in a small space under the keyboard.

AN INTEGRATED INFORMATION DISSEMINATION SYSTEM

One of the major cost factors in the administration of any large corporate organisation is to be found in the dissemination of relevant information to its components. Traditionally such information has been disseminated by the circulation of general notices, periodical reports, minutes, etc. Apart from the evident ecological consequences of using such a paper-bound scheme, there are a number of other disadvantages. The delays which occur in copy production, transportation and delivery obviously do not enhance productivity. And, from the initiator's point of view, there can be no guarantee that his communication has reached its intended destination.

When (and if) the communication has been received and processed, it is either discarded or transferred to a file for subsequent reference. The retrieval of a filed communication poses a whole range of problems in itself!

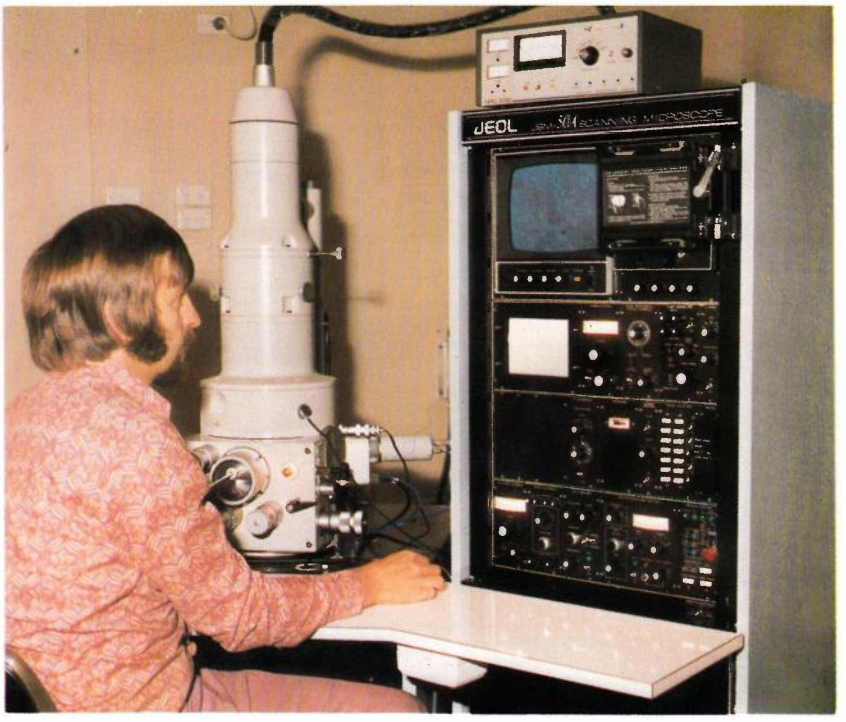
It is in the light of these considerations that the RINSY (an acronym for Research INformation SYstem) has been developed in the Research Laboratories. This system uses a central computer for the storage and dissemination of a wide range of textual transactions. Users' access to the system is by means of typewriter keyboards connected into conventional television sets able to display up to 24 lines of 72 characters. It is intended that this same terminal device will also be used for the facsimile reception/display of diagrammatic material, and for video-telephone communications.

System software is being implemented in a modular fashion. Services already available include a management information facility, a news service, conference/exhibition information service, and a generalised message service. The first-mentioned of these services is able to provide management with up-to-date progress and expenditure reports on any Laboratories' project; various such reports on selected cases can be viewed (and, by injection of a pass-number, modified) as desired through the entry of appropriate mnemonic directives at the keyboard. In a similar fashion, users of the conference/exhibition and news services can selectively view any conference notices, news items, etc, of interest to them, calling for extra details (by mnemonic directive) from the Laboratories' Library as required.

The message service enables a user to transmit minutes, notices, etc., to any other user (or mnemonically-designated group of users), these communications being saved by the computer until such time as the intended recipient has viewed them; they may then be discarded, or filed in the computer (disc) memory for future reference. Each message is automatically tagged with its originator's name and its date of insertion; an automatic acknowledgement is generated upon reception. A number of users can participate in a real-time on-line conference, with the computer saving each participant's remarks until viewed by all of those involved.

In the event that a user of the system requires a hard-copy print-out of any textual material appearing on his display, he has only to enter a PRINT directive, and that material will be tagged with his name to facilitate delivery, and routed automatically to a printer.

New Laboratory Facilities



The Research Laboratories' scanning electron microscope

INTRODUCTION

Staff salaries represent over half the total operating costs of the Research Laboratories. It is therefore essential that every effort is made to encourage a high level of productivity by equipping the Laboratories with first class, up to date tools. In this context the term "tools" refers to a very wide range of scientific and engineering instruments and devices, ranging from precision machine tools, through to the most advanced electronic and scientific test and measuring instruments, and reference standards.

Some types of instruments are in regular use in a number of Laboratories areas, for example digital multimeters and oscilloscopes. On the other hand there may be only one instrument of a particular type, used by a small group of specialists. In some instances the particular item may be unique to Telecom Australia, and hence could be widely used for tests on plant and materials from many areas.

So that users will have confidence in their measuring and test equipment, it is necessary to provide a comprehensive maintenance and calibration facility to ensure proper performance. This is no easy task with the range and complexity of equipment now in use.

Two major items of equipment which have recently been commissioned, and which are already proving extremely valuable, are described herein.

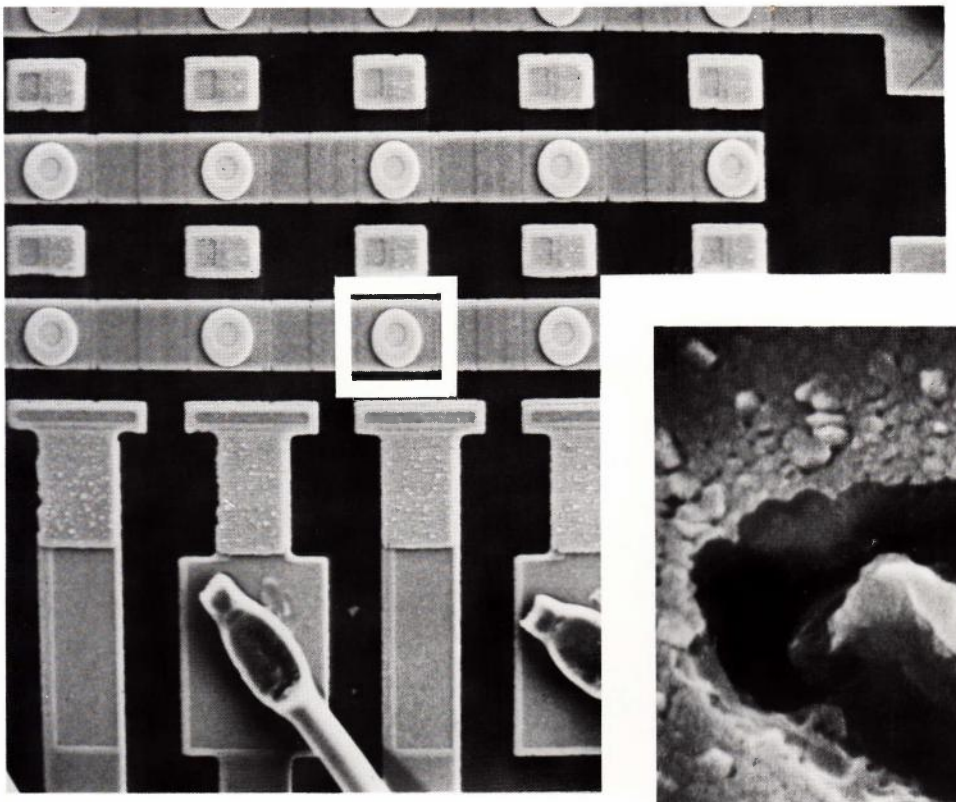
SCANNING ELECTRON MICROSCOPY

The analytic capability of the Research Laboratories of Telecom Australia have been greatly extended with the installation of a scanning electron microscope (SEM). This article outlines its operation and highlights some of the current investigations.

The SEM has many inherent features that set the instrument apart from other analytical techniques. These include

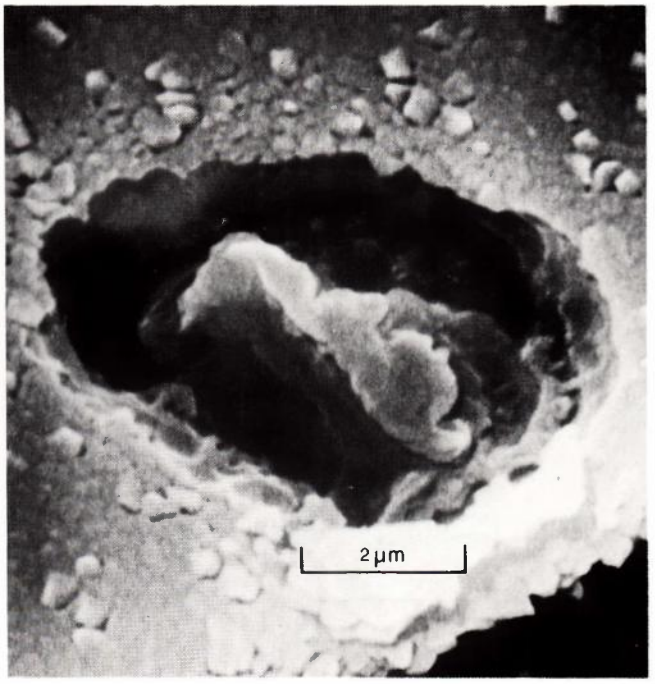
- direct observation of images at high magnification
- wide range of magnification
- great depth of focus
- real time imaging to permit dynamic observations
- direct compositional analysis
- ease of operation and sample preparation.

The basic principle behind the SEM is the irradiation of the specimen by a finely focused electron beam. This releases secondary electrons, backscattered electrons, x-rays and light from a small surface volume, and gives information relating to the topography and composition of the specimen. The desired signal is amplified and displayed on a cathode ray tube so that an image of the specimen surface is mapped onto the screen. Further information can be obtained from the absorbed electron current and the induced currents and voltages within the specimen, the latter being of great significance in semi-conductor device technology. The var-



Typical read mostly ovonic device

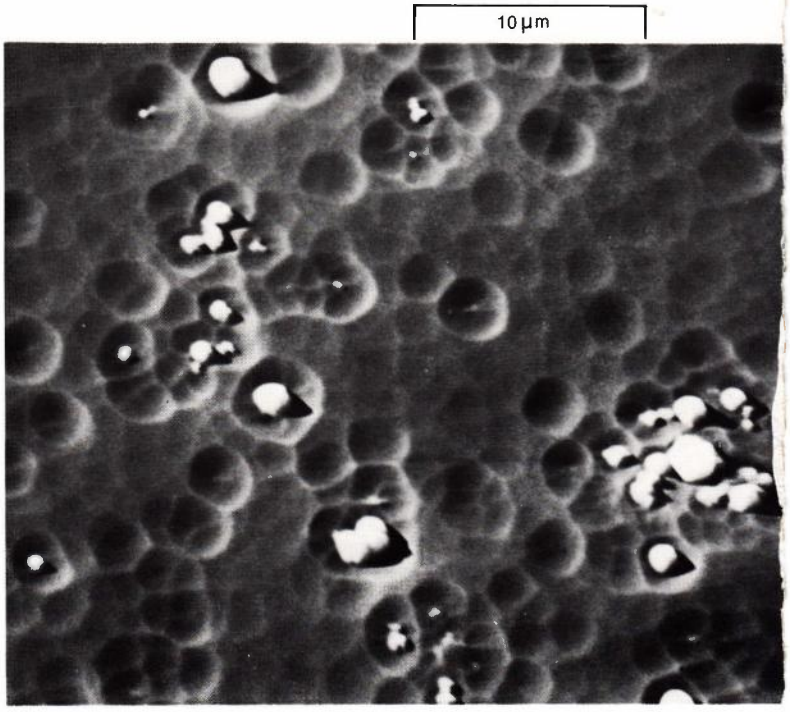
Inset: Rupture of a circuit element at a magnification of 10,000x



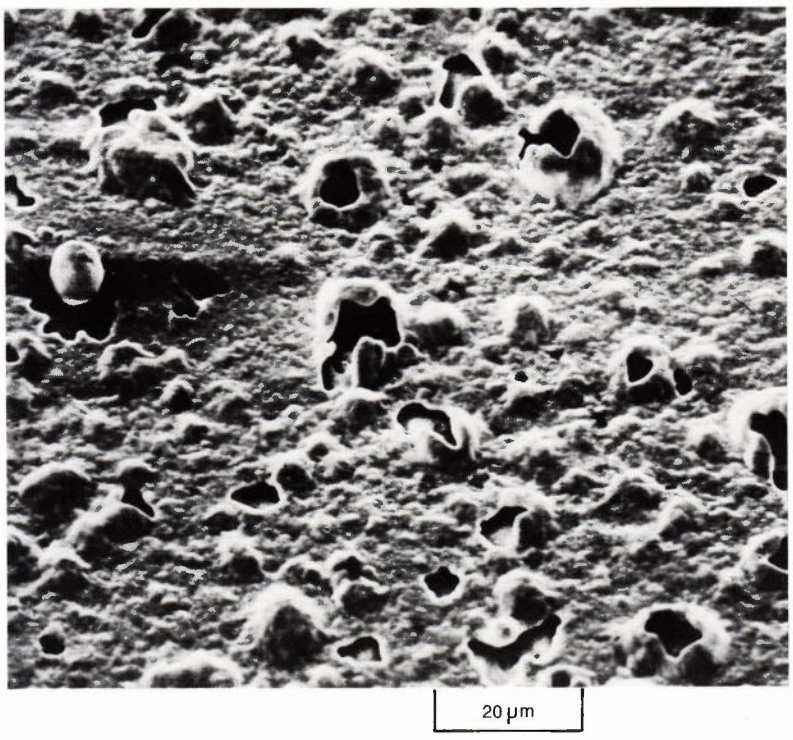
iety of signal types and the facility for electronic signal processing are two additional features that contribute to the outstanding analytical flexibility of the SEM.

The micrographs illustrate some of the current investigations utilising the SEM facility. The Laboratories are investigating the fabrication and characteristics of gallium arsenide light emitting diodes as sources for optical communications systems. The initial stages of device fabrication require stringent sample cleaning prior to sputtering the masking silica layer. A sputter etching technique had been used for the final cleaning procedure, but appeared to cause considerable surface damage to the gallium arsenide substrate. The high magnification available on the SEM enabled the observation of sub-micron foreign particles which were shown to cause the surface disfigurement. The cleaning procedures have since been modified and the source of contamination eliminated.

The study of microwave devices in one of the Laboratories' sections is heavily dependent on the deposition of gold onto the alumina substrates used for the microwave circuits. Film adhesion was low, so the vacuum deposited and baked films were examined in the SEM. The gold films showed bubbling, and high resolution imaging identified the bubbles to be sited above



Particle contamination causing surface damage to sputter etched gallium arsenide ▶



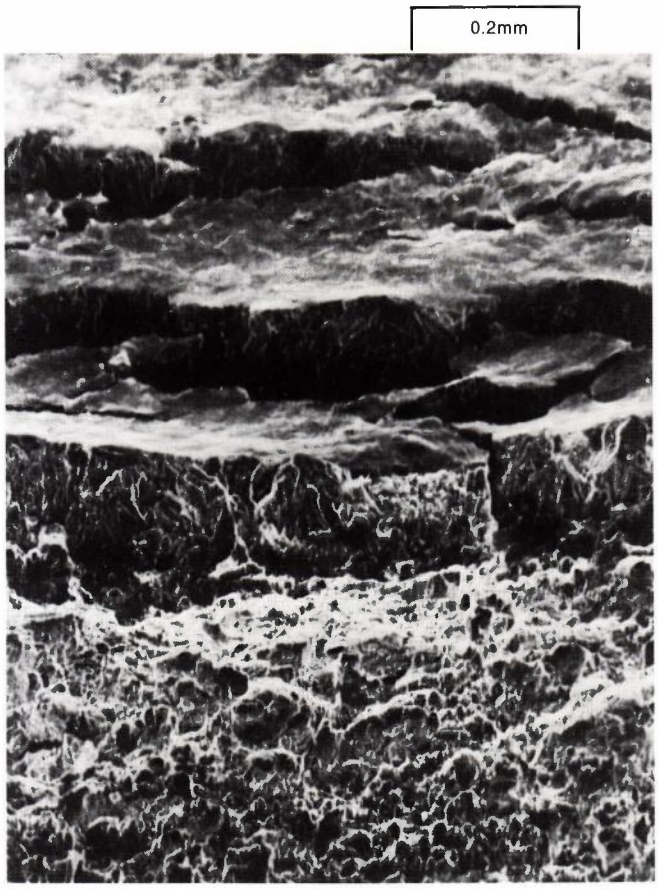
Bubbling of a gold film on an aluminium substrate

pores in the alumina substrate. This indicated outgassing from the sample, so the deposition procedure was modified to include a prebake and the problem was eliminated.

Recent applications of the SEM in the electrochemistry and metallurgy field have included the examination of metal fractures and the investigation of foreign deposits on telephone relay contacts. The cause of metal failure can be determined by examining at high magnification the contours of fractured surfaces. This technique has been applied to a failed stainless steel band which had been subjected to a highly stressed state in a marine environment. Examination in the SEM confirmed that failure had occurred by the process of stress corrosion cracking.

Telephone relay contacts which had exhibited open circuit failures were found to have deposits of foreign material on the mating surfaces. The SEM allows characterisation and identification of the material so that the source can be located in the exchange and either eliminated or the relays suitably protected.

To summarise, the variety of imagining modes and display techniques available on the SEM have already proven essential to many investigations within the Research Laboratories. The inclusion of full wavelength dispersive x-ray microprobe facilities will further extend the utility of the instrument. Application of the SEM to the fabrication and study of semiconductor devices, and investigations in the fields such as metallurgy and electrochemistry depend only on the imagination of the investigator.



Stress corrosion cracking of a stainless steel band

Central Processor Unit and peripherals — Gerber IDS-2

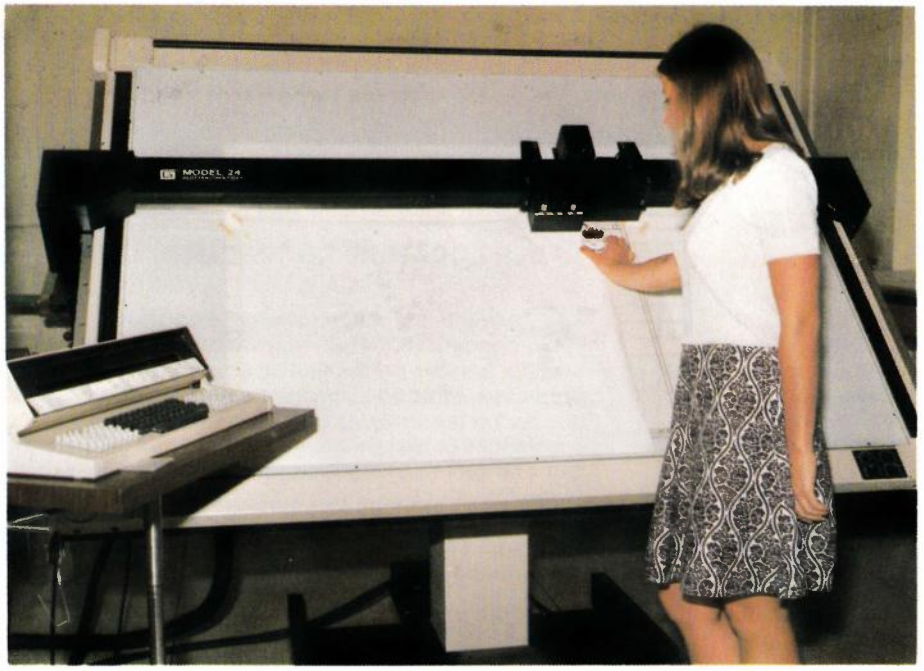
INTERACTIVE GRAPHICS SYSTEM FOR ELECTRONIC CIRCUIT LAYOUT

Printed wiring boards are used extensively in the Research Laboratories for interconnection of electronic components. The usual method for the preparation of printed wiring board artwork is to convert the schematic wiring drawing into a suitable layout and then, using adhesive backed tapes, pre-cut patterns, and a clear plastic backing sheet, the artwork is prepared at four times full size. The resulting pattern is then reduced to its final size on photographic film, which is used as a tool for manufacturing the required printed wiring board. Accuracy thus obtained is limited by the fact that the tapes and the pre-cut patterns are manually placed on the backing sheet.

With the present day requirements for complex printed wiring boards and in particular multilayer boards and micro-electronic circuits, a method of meeting the increased accuracy requirement was needed. An interactive graphics system was purchased to satisfy this demand. The equipment contains several minicomputers to manipulate and store information and finally to drive a photoplotter which plots the required pattern directly on photographic film. Far greater accuracy can be achieved in this way than can be achieved manually.

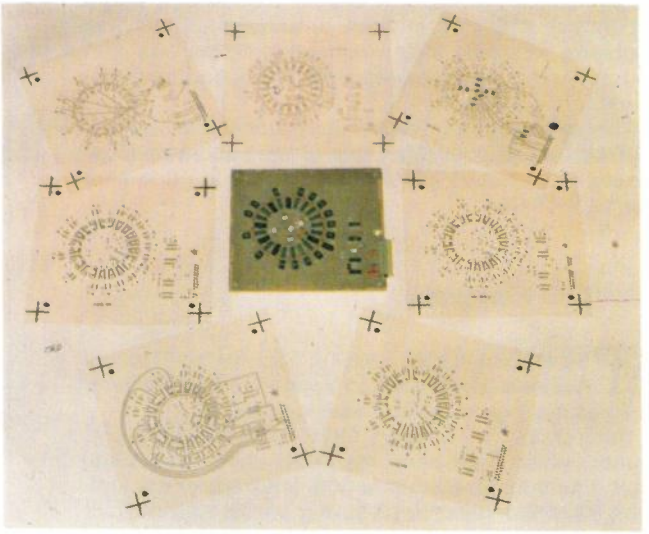
Designed and manufactured by the Gerber Scientific Instrument Co., U.S.A., and called "Interactive Design System — 2 axis" (IDS — 2), the equipment consists of four basic units:

Visual Display Unit and Keyboard — Gerber IDS-2



Digitizer/Plotter and Keyboard — Gerber IDS-2

Photographic films for multilayer printed wiring board ▶



- A Central Processing Unit which controls the overall operation of the system and the input—output facilities. Peripheral devices include:
  - A standard teletype
  - Magnetic disc drive
  - Reel-to-reel magnetic tape unit
- A Digitizer/Plotter Table which has a working area of 1220 mm X 920 mm (48" X 36") with Keyboard and Display, and a Terminal Control Computer. This terminal is used for digitizing and producing a hard copy output of the work.
- A Visual Display Unit which is a storage oscilloscope of 200 mm X 150 mm (8" X 6") with Keyboard and Display and a Terminal Control Computer. This terminal is used for editing and for digitizing simple jobs. The Visual Display Unit has a much faster response time than the Digitizer/Plotter Table but does not provide hard copy.
- A Photoplotter which exposes photographic film to produce a very accurate pattern of the layout. The Photoplotter has a plotting area of 510 mm x 410 mm (20" X 16").

Further photographic reduction of patterns for microelectronic layouts can be obtained using the existing precision camera.

To work with the IDS-2 the operator is not required to write computer programs. Instead he pushes buttons on the keyboard which command the computer to perform certain actions. The subsequent alternative steps of each command are usually displayed on an 80 character opto-electronic display. The operator can choose from options presented on the display to complete the particular operation. The equipment is "interactive", meaning that the computer responds to the operator as fast as he can respond to it. Hence the design procedure consists of a dynamic interchange of responses between the operator and the computer.

In the case of a printed wiring board, the layout which has been sketched manually is digitized on the Digitizer/Plotter Table. The graphical data thus converted into digital form is stored in the computer's storage system and is then available for output on the photoplotter. If future modifications are required, the information in the storage system can be retrieved and then edited using the Visual Display Unit and re-photoplotted.

Consultative Activities

INTRODUCTION

The diverse skills and knowledge in the engineering and scientific disciplines, which reside in the Research Laboratories by virtue of their more significant R & D projects and specialist activities, are often drawn upon as a source of consultative assistance with the less significant day-to-day problems met in the operational network. Assistance is given through informal consultations between Laboratories' staff and the staff of a large number of the engineering Branches in both the Headquarters and State Administrations of Telecom Australia. Assistance is also given to industrial and research organisations outside Telecom Australia, although less frequently.

This consultant role of the Laboratories is regarded as an important one, even though it might be seen to lack the "prestige" often attributed to a larger R & D project, it provides a valuable outlet for knowledge which is a by-product of the larger R & D projects. It helps solve minor network problems efficiently, and it enables R & D staff to become acquainted with the problems faced by their engineering colleagues who are concerned more closely with the operational network.

This section of the Review illustrates the scope and diversity of the consultant role of the Laboratories by means of the following brief outlines of tasks performed during 1975/76.

PAINTED FINISHES

The distinctive gold colour chosen for the Telecom Australia symbol when applied to architectural finishes has presented formulating problems.

Such paints in Telecom Gold based on lead pigments, while possessing many desirable properties, were found to contain up to 30% lead. Under the Uniform Paint Standard, paint having a total lead content of greater than 1% of the dried film, is required to be labelled as a Schedule 1 Paint. The use of these paints on a building or structure, as for example a public telephone booth, would contravene State Health Acts, so lead pigmented paints were clearly unsuitable.

Suitable paints in Telecom Gold have now been obtained with lead contents considerably lower than 1%.

The Laboratories have prepared specifications and have established colour standards for these paints.

The Laboratories have been consulted by the Radiocommunication Construction Branch, Engineering Department, in the preservation of radio towers and masts. Paint systems and repair procedures have been recommended for towers in widely differing climatic environments such as Waterhouse Point, Tasmania, coastal regions of southern Queensland and the dry inland areas of south west New South Wales.

CABLE LOCATION TECHNIQUES

Conventional cable location techniques utilising configurations of alternating magnetic fields used for locating cables and pipes buried in the ground or housed within building structures, suffer from errors due to the presence of other conducting or magnetic substances or current carrying conductors. Mathematical and technical assistance has been given to the Lines Construction Branch, Engineering Department, at Headquarters in setting up models to calculate field distortion, and hence location errors, for various situations found in the field location of cables and pipes.

CONDITION OF TELEPHONE RECEIVERS

Visits have been made to the Sydney Workshops of Telecom Australia, to investigate and assess a program for reconditioning telephone receivers, type 4T. The program promises to result in annual savings in receiver costs amounting to tens of thousands of dollars.

NEW ELECTRODE FOR TELEPHONE TRANSMITTERS

Because of the detailed knowledge of the performance of carbon microphones gained through telephone standards measurements over many years, the Laboratories were able to render consultant advice to Amalgamated Wireless (Australasia) Ltd., to assist in the development of gold plated electrodes for such microphones. The gold electrodes are being developed as an alternative for graphite electrodes normally used in this country.

SOLID STATE ERLANG-HOUR METER

Erlang-hour meters provide a means of measuring telephone traffic and revenue on STD routes by integrating a current over a period of time.

Previous erlang-hour meters have been multi-ranged and are inadequate for revenue recording. The Development Division of the Engineering Department designed an electronic erlang-hour meter having good accuracy on a single range. The Research Laboratories have tested these prototypes and made recommendations to the designers, and last year evaluated and found satisfactory, the first production units.

The electronic meter has made traffic and revenue studies easier and more accurate than with the older meters.

CALIBRATION AND MAINTENANCE OF TELEPHONE EFFICIENCY TESTERS

For many years the Research Laboratories have maintained a centralized calibration and maintenance service for telephone efficiency testers (a comprehensive system for electro-acoustic measurements on telephone instruments). During 1975 this service was taken over by the South Australian administration, and during the current year Laboratories' staff have provided consultative services to the South Australian staff to permit them to meet the initial problems of operating the service.

ECHO CANCELLATION ON LONG DISTANCE TELEPHONE CIRCUITS

Over the past few years, the Laboratories have been working on sophisticated echo control equipment for trunk network transmission systems. Based on this work Telecom Australia was successful in winning a development contract with Intelsat in March, 1975, to study problems of echo cancellation associated with frequency offset in telephone circuits with unsynchronised carrier equipment; and to design and develop an echo canceller which would cope with the frequency offset condition.

RETRIEVAL OF ARCHIVAL PROGRAMS (CDC 160A) FROM MAGNETIC TAPE

As part of the service to the other departments of Telecom Australia the Research Laboratories are often required to act as a service bureau. One example of this is work recently carried out to recover archival programs for the Broadcasting Branch of the Engineering Department.

A suite of programs were written which carried out recovery of the programs and as well, where possible, converted the non-ANSI Research Fortran to ANSI compatible Fortran suitable for use on a large batch machine.

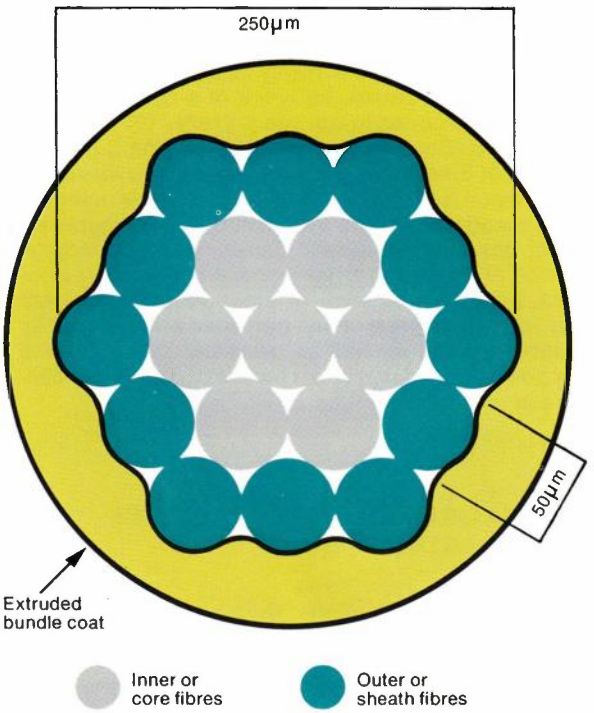
BI-DIRECTIONAL BUFFER

Incremental magnetic tape recorders and control equipment are used for computer aided analysis of telephone exchange traffic. The electrically noisy environment of most exchanges results in a tape that is difficult to read. .

Hence, a processor has been designed by the Research Laboratories using two tape transports, and a control unit, which allows synchronous transfer of data between transports and asynchronous writing onto or reading from tape. The latter have application in the servicing of the traffic equipment.

The processor enables the user to completely control the data flow rate from one source to another.

Arrangement of fibre strands in a multi-fibre bundle



COATING OF AN OPTICAL FIBRE BUNDLE

Two branches of the Research Laboratories jointly developed facilities for applying a plastics coating to a single strand optical fibre. C.S.I.R.O., who have the fibre drawing facilities, requested our co-operation in forming a graded index optical fibre by bundling nineteen 50 μm diameter fibre strands.

The core fibres, of the same refractive index, are surrounded by fibres of a different refractive index, simulating a tube. The extruded coat ensures compactness and completeness of the bundle and relative ease of handling of the completed fibre.

Several lengths have been provided for evaluation by the C.S.I.R.O.

FORMULATION FOR PVC SHEATHING AND INSULATION

Sub-standard, internal plant, PVC insulated wire and cable sheath has recently been detected in exchanges, and subsequent investigations by the Research Laboratories of how this material had come to be accepted, revealed deficiencies in both the manufacturing procedures, and the specification to which such wires and cables are made.

To permit cable production to proceed, advice was tendered on the reformulation necessary for an improved PVC compound, and subsequently a new specification was developed in co-operation with the Engineering Department, Telecom Australia, containing more stringent requirements and improved test methods, which should result in an upgraded quality.

INSECT RESISTANT CABLES

The development of highly insect resistant plastic sheathed cables, by virtue of a nylon 11 or 12 jacket, was reported in last years' (1974/1975) Review of Activities. Co-operative research with the C.S.I.R.O. Division of Entomology to find a less expensive substitute to nylon is in progress. Nylon jacketting is now generally recognized as the best method yet perfected for insect protection of plastic cables, and as a consequence of the Laboratories' experience in its development, and the evaluation of other possible materials and modes of protection, our advice is frequently sought by local, as well as overseas, manufacturers and authorities on all matters pertaining to insect resistance of plastics.

NEUTRALISATION AND DISPOSAL OF TOXIC WASTES

At the request of the Melbourne Workshops, Telecom Australia, a comprehensive summary has been prepared of methods of disposal of cyanide plating wastes. Samples of wastes have been analysed, and neutralised, using the recommended method of oxidation by calcium hypochlorite.

TELEPHONE MICROPHONE CONSTRUCTION

A number of suggestions by the Melbourne Workshops of Telecom Australia, to modify the construction of telephone microphones have been examined and assessed at their request. The modifications are expected to yield a more reliable product with a reduced probability of failure in service, together with a slight reduction in manufacturing cost.

TWO-TONE FREQUENCY DISTRIBUTION SYSTEM FOR INDONESIA

A request was received from the Australian Trade Mission (Foreign Affairs Department), in Indonesia, for a means of calibrating the carrier oscillators at the Jakarta terminal of the Trans Sumatra Microwave System, against a caesium beam frequency standard located at the Perumtel Research Laboratories in Bandung. It was decided to use the two-tone system of standard frequency distribution, designed in the Research Laboratories and already proven in the Australian network. Two-tone transmitting and receiving equipment was therefore constructed for installation at Bandung and Jakarta respectively.

A saw-tooth beat frequency comparator was also designed to allow rapid frequency comparison and easy setting of the oscillator, the direction of the sawtooth giving the sign of the frequency error. The equipment has been installed in Indonesia and is functioning satisfactorily.

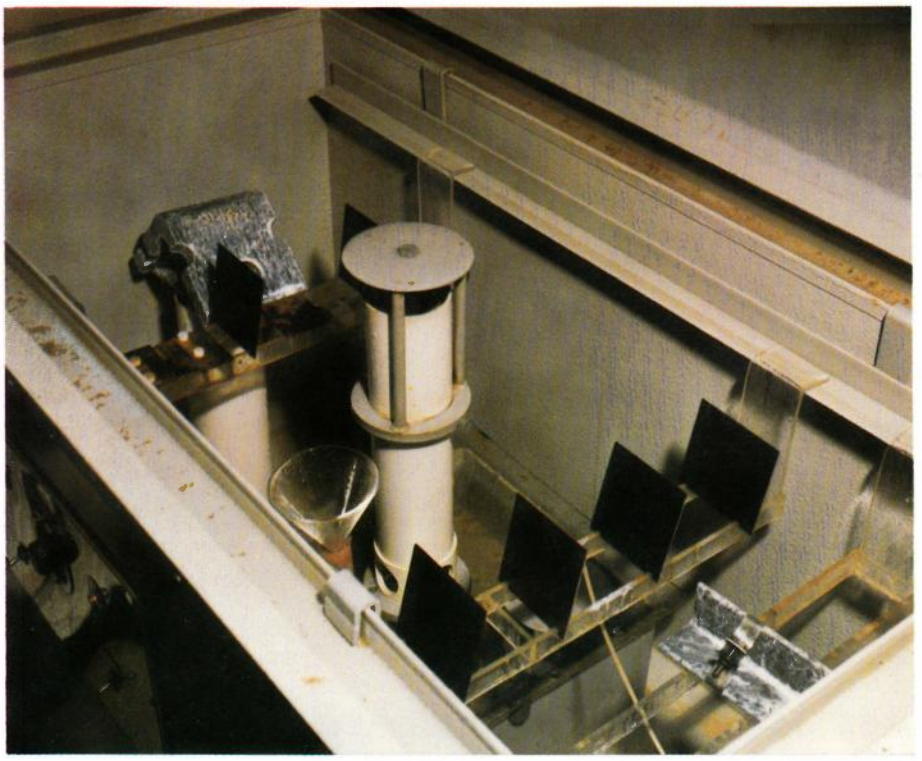
CALIBRATION OF RESISTANCE STANDARD

In keeping with the terms of the registration of the Electrical Standards Section, Research Laboratories, by the National Association of Testing Authorities, Australia (N.A.T.A.); and in furthering our aims of propagating electrical standards, the Section recently calibrated a resistance standard for the C.S.I.R.O. Division of Atmospheric Physics, which they require for their registration by N.A.T.A.

OFFICE AND BUILDING ACOUSTICS

General assistance has been given to the Buildings Branch, Engineering Department, at Headquarters in the assessment of acoustical parameters for the design of office accommodation. Specific assistance has been given in the preparation of specifications for noise conditioning installations for new buildings recently occupied by Telecom Australia, and in the construction, modification, testing and calibration of specialised instrumentation associated with optimising the adjustments for these noise conditioning projects.

Corrosion of crimped connectors in a telephone plug and socket caused by total immersion in water



Accelerated corrosion testing of metal finishes in a salt fog cabinet

ANTENNA DIPLEXER DESIGN

Diplexers are used in radio transceiving equipment where it is necessary or more convenient to have only one aerial for transmitting and receiving. Every year the Research Laboratories receive two to three verbal enquiries about diplexers, and spends about one man-year each year, working on new diplexer designs. This work assists the preparation of design specifications for vital elements of future mobile radiotelephone systems by the Engineering Department at Headquarters.

ELECTRICAL CONTACT PROBLEMS

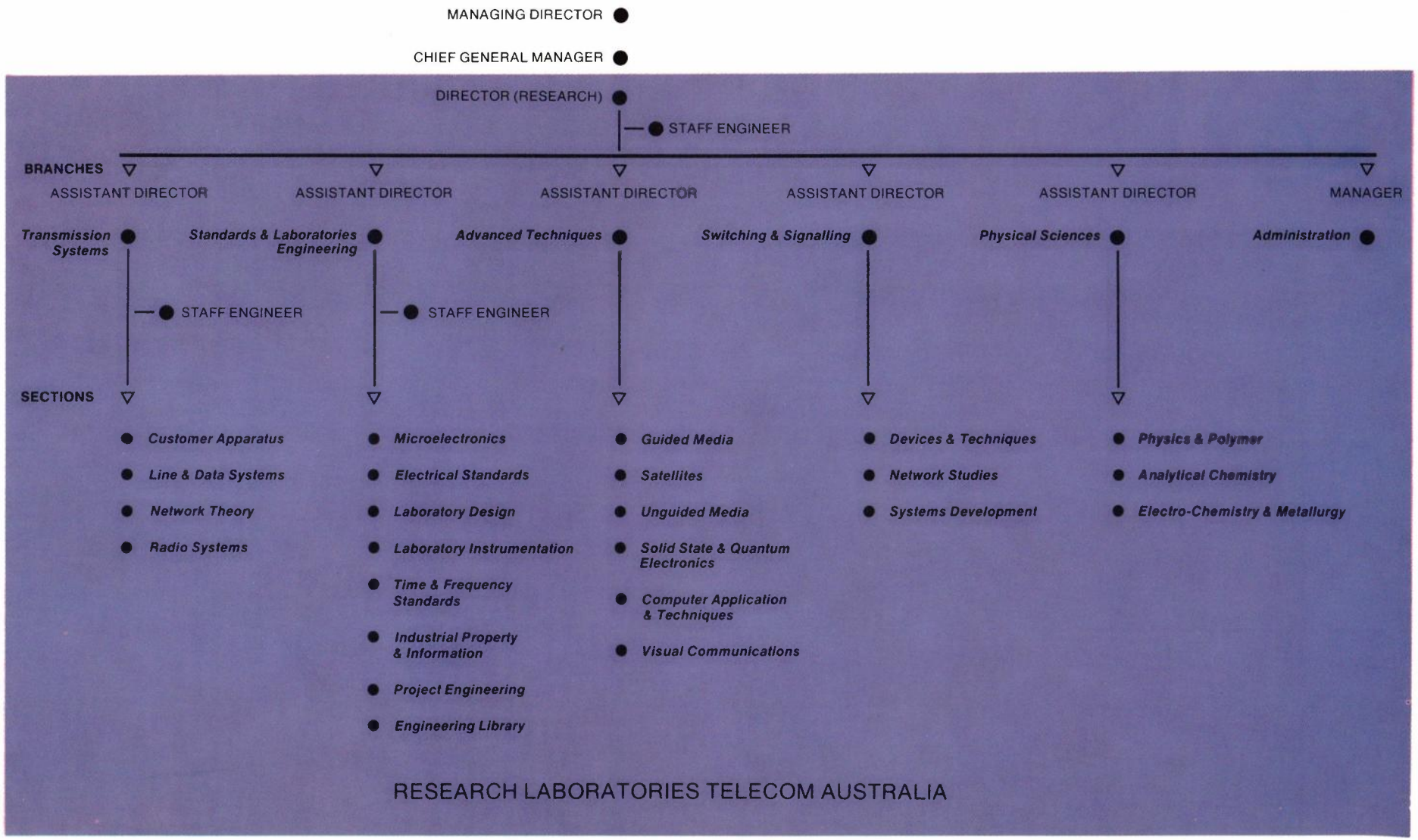
Electro-mechanical contacting devices are prone to various modes of failure and degradation, such as erosion, wear, contamination by insulating films and dust. The telecommunication network contains a multiplicity of electrical contacts (i.e. relays, crossbar, plugs and sockets, wire connectors etc.) and many of these types have been studied and evaluated over the years, thus creating a large volume of experience in analysing causes of failure. As a consequence the Laboratories are frequently called upon to find the reasons for malfunctioning, and to advocate remedial measures. Such advice is sought not only from within Telecom Australia, but at times private industry who, faced with a difficult contact problem will request assistance, and pay for such service.

TESTING OF COAXIAL CABLES

Field prototypes of the carrier burst test set are in use by Lines Construction Branch Telecom Australia, and the Olex and Austral Cable manufacturing companies. Designed and constructed in the Research Laboratories, these sets are used for high resolution measurement of structural return loss in coaxial cables.

DEVELOPMENT OF JELLY FILLED CABLES

The development of a jelly filled cable suitable for Australian conditions has been the subject of Telecom Australia developmental contracts with two cable manufacturers, one local and one in Japan. Polymer chemists of the Laboratories have been closely involved in the production of the cable specification and test methods for these contracts, and together with Telecom Australia cable design engineers have been monitoring the progress of this development. At various stages of the contracts critical decisions have had to be made regarding optimum polymer/filler combinations, stabilizing systems, material performance and reliability, which also required two overseas visits as well as close and frequent contact with Australian raw material manufacturers. One of the contracts has now been successfully concluded, and trial quantities of jelly filled cable are soon to undergo field evaluation.



THE 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 24 scientific and engineering sections which are grouped into five branches and an administrative section. The sections comprise professional, technical and administrative staff, with each section possessing expertise in particular areas of the engineering and scientific fields.

Overall Objectives of the Laboratories

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

PROFESSIONAL AND SENIOR STAFF

The names given below are those of the actual occupants of the positions (appointed or acting) at 30 April, 1976.

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

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

TRANSMISSION SYSTEMS BRANCH

Branch Objectives

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

ASSISTANT DIRECTOR: S. Dossing, M.Sc.E.E.(Hons.), M.E.E., F.I.E.Aust.

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

Customer Apparatus Section

Section Functions

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

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

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

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

ENGINEERS:
D. M. Blackwell, B.E.(Elec.)
G. M. Casley, B.E.(Elec), M.Eng.Sc., D.I.C., Ph.D., M.I.E.Aust., M.I.E.E.
J. P. Goldman, Assoc. Dip.Rad.Eng., Assoc.Dip.Comm.Eng., Grad.I.E.Aust.
D. J. Kuhn, B.E.(Elec), M.Eng.Sc.
B.E. Snedden, B.E.(Elec.)
P. W. Wellby, B.E.(Hons.), B.Sc.

SENIOR TECHNICAL OFFICERS:
S. G. Beadle
T. R. Long
R. J. Wood

Line and Data Systems Section

Section Functions

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

SECTION HEAD: R. Smith, B.E.(Hons.), M.E., M.I.E.E., M.I.R.E.E.

PRINCIPAL ENGINEEERS:
A. Domjan, B.E.E., A.M.I.E.Aust.
A. J. Gibbs, B.E.(Elec.), M.E., Ph.D., M.I.R.E.E.

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

ENGINEEERS:
J. A. Bylstra, B.Sc.(Hons.), M.Sc., M.I.E.E.E., M.I.E.Aust.
R. J. Dempsey, B.E.(Elec.)
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.
A. Y. C. Quan, B.E.(Hons.), M.E., A.M.I.E.E.
R. P. Coutts, B.Sc., B.E. (Hons.)

SENIOR TECHNICAL OFFICERS:
J. Gillies
J. L. Kelly
W. Yelverton

Network Theory Section

Section Functions

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

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

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

ENGINEEERS:
F. G. Bullock, B.E.(Hons.), Grad.I.E.Aust.
J. L. Snare, B.E.(Hons.)
O. Tenen, Dip.Rad.Eng., M.I.E.Aust.

SENIOR TECHNICAL OFFICER: R. Owers

Radio Systems Section

Section Functions

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

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

SENIOR ENGINEER: I. C. Lawson, B.E.E.

ENGINEERS:
R. A. Court, B.E.(Hons.), B.Sc., M.Eng.Sc., M.I.E.E.E.
R. W. Harris, B.Sc.(Hons.), B.E.(Hons.)
P. R. Hicks, B.E.(Elec.), B.Sc., M.I.E.E.E.
J. Steel, B.E.(Hons.), Ph.D.
E. Vinnal. B.E.(Hons.)

SENIOR TECHNICAL OFFICERS:
F. Temby
D. J. Thompson

STANDARDS AND LABORATORIES ENGINEERING BRANCH

Branch Objectives

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

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

STAFF ENGINEER: J. M. Warner, B.Sc., M.I.E.E.

Microelectronics Section

Section Functions

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

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

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

ENGINEERS:
A. Brunelli, Dip.Electron.Eng., B.E.(Comm.).
R. J. Day, Dip.Elec.Eng., Dip.Mech.Eng., M.I.E. Aust.
G. Heinze, Dip.Electron.Eng., B.E.(Elec.).
B. A. Wickham, B.Sc., B.E., M.I.E.Aust., M.I.R.E.E., M.I.E.E.E.

SENIOR TECHNICAL OFFICER: C. D. Barling

Electrical Standards Section

Section Functions

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

SECTION HEAD: E. Pinczower, Dip.Elec.,Eng., M.I.E.Aust.

SENIOR ENGINEER: R. W. Pyke, B.E.(Elec.), Dip.Elec.,Eng., Grad.I.E.Aust.

ENGINEER: J. B. Keeble, B.E.(Elec.)

SENIOR TECHNICAL OFFICER: J. B. Erwin

Industrial Property and Information Section

Section Functions

- Maintain an industrial property advisory service and information dissemination service in scientific and technological fields of interest to the Commission.
- Develop and exploit the Commission's portfolio of patents and registered designs, and protect the Commission's interests in industrial property aspects of contracts and licensing arrangements.
- Edit and control standards of technical publications and technical manuscripts emanating from the Laboratories.

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

ENGINEER: P. C. Hey, Dip.Elec.Eng., Dip.Mech.Eng.

SENIOR TECHNICAL OFFICERS:
A. K. Mitchell
W. W. Staley

Laboratory Design Section

Section Functions

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

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

SENIOR TECHNICAL OFFICER: N. G. Chandler

Laboratory Instrumentation Section

Section Functions

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

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

ENGINEERS:
R. E. Proudlock, B.E.(Elec.)
M. J. J. Valk, B.E.(Comm.)

SENIOR TECHNICAL OFFICERS :
P. S. Dawson
H. B. FitzSimons
R. R. Jepson
B. J. McEwen

Time and Frequency Standards Section

Section Functions

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

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

SENIOR ENGINEER: G. M. Willis, Fell.Dip.Comm.Eng, Grad.I.E.Aust., Grad.I.R.E.E.

ENGINEERS:
B. R. Ratcliff, Assoc.Dip.Comm.Eng.
A. A. Townsend, B.E.(Elec.), M.I.E.E.

SENIOR TECHNICAL OFFICERS:
J. Freeman
V. E. Thomas, A.M.I.R.E.E.
R. Yates

Project Engineering Section

Section Functions

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

SECTION HEAD: R. L. Kilby, Assoc.Dip.Elec.Eng., Grad.I.E.Aust.

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.
C. Mangalore, B.E.(Mech.), Grad.I.E.Aust.

SENIOR TECHNICAL OFFICERS:
C. V. Eyre
R. J. Mackin

Engineering Library Section

Section Functions

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

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

LIBRARIANS:
Mrs. S. M. Peters, B.A., B.Sc., Dip.Ed., Dip.Lib., A.L.A.A.
Mrs. S. E. Roberts, B.Soc.Sc.(Lib.), A. L.A.A.
Mrs. H. M. Wisdom, B.A., A.L.A.A., Dip.Lib.
Mrs. A. F. Parkhowell, B. A., Dip.Lib. A.L.A.A.

ADVANCED TECHNIQUES BRANCH

Branch Objectives

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

ASSISTANT DIRECTOR: A. J. Seyler, Dip.Ing.(Hons.), M.E.E., D.App.Sc., F.I.R.E.E.

Computer Applications and Techniques Section

Section Functions

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

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

SENIOR ENGINEER: N. Demytko, B.E.(Elec.)(Hons.), B.Sc.

ENGINEEERS:
K. S. English, B.E.(Elec.)(Hons.)
I. Jenkins, B.E.(Elec.)(Hons.)
R. A. Seidl, B.E.(Elec.)(Hons.), Ph.D.
P. J. Tyers, B.E.(Hons.), B.Sc., M.I.E.E.

SENIOR TECHNICAL OFFICER: I. J. Moran

Guided Media Section

Section Functions

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

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

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

ENGINEERS:
J. P. Colvin, B.E.(Elec.), Dip.Elec.Eng.
L. A. Denger, E.N.S.E.M.N., M.I.E.E.E., M.Soc.Fr.de Phys., M.Soc.Fr.de Elec., Grad.I.E. Aust.

Satellites Section

Section Functions

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

SECTION HEAD: E. R. Craig, B.Sc.(Hons.), M.I.E.E.

PRINCIPAL ENGINEER: G. F. Jenkinson, B.Sc., M.I.R.E.E.

SENIOR ENGINEERS:
R. K. Flavin, B.Sc., M.Sc., M.I.E.Aust.
S. E. Howard, B.E.(Elec.), Grad.I.R.E.E.

Solid State and Quantum Electronics Section

Section Functions

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

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

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

SENIOR ENGINEERS:
L. W. Cahill, B.E.(Elect.), M.Eng.Sc., Ph.D., M.I.E.E.E, M.I.R.E.E.
P. V. Sabine, B.Sc., B.E.(Elec.)(Hons.), Ph.D.

ENGINEERS:
J. Hubregtse, Fell.Dip.Comm.Eng., Grad.I.R.E.E.
E. Johansen, B.E.(Hons.)
G. K. Reeves, B.Sc.(Hons.), Ph.D., M.I.E.Aust.
G. O. Stone, B.E.(Elec.), M.Eng.Sc., Ph.D., M.I.E.E.E., M.I.R.E.E.

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

Unguided Media Section

Section Functions

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

SECTION HEAD: J. H. Reen, B.E.E., M.I.E.Aust.

PRINCIPAL ENGINEER: S. Sastradipradja, B.E.(Elec.)

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

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

SENIOR TECHNICAL OFFICERS:
R. J. Francis
J. E. W. Lucas

Visual Communications Section

Section Functions

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

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

SENIOR ENGINEERS:
W. J. Lavery, B.E.(Hons.), M.Eng.Sc.
M. Subocz, B.E.(Elec.), M.I.E.Aust.

ENGINEERS:
R. Ayre, B.E.(Elec.)(Hons.), B.Sc.(Hons.)-Eng.Sc.,
J. K. Craick, B.E.(Elec.)(Hons.), B.Sc.
A. M. Duncan, B.Sc., B.E.(Elec.)(Hons.)
D.Q. Phiet, B.E.(Elec.)(Hons.), Ph.D.

SENIOR TECHNICAL OFFICER: G. W. Quirk

SWITCHING AND SIGNALLING BRANCH

Branch Objectives

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

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

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

SECTION HEAD: I. P. Macfarlane, B.E.(Elec.), A.R.M.T.C.

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

ENGINEER: J. B. Wise, B.E.

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

SENIOR TECHNICAL OFFICER: B. C. Gilbert

Network Studies Section

Section Functions

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

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

SENIOR ENGINEERS:
A. Even-Chaim, B.Sc.
N. N. Grubb, B.Sc.(Eng.)
P. Reid, B.E.(Comm.)

ENGINEER: M. R. O'Keefe, B.E.(Hons.), M.Eng.Sc.

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

SENIOR TECHNICAL OFFICERS:
H. G. Fegent
W. McEvoy

Systems Development Section

Section Functions

- Develop switching and signalling systems and equipment using new techniques and/or principles, or to meet new requirements.
- Develop and arrange production of equipment for field trials, arrange installation, and conduct of trials.

SECTION HEAD: E. A. George, A.S.T.C., M.I.E.

PRINCIPAL ENGINEER: A. M. Fowler, M.I.E.Aust., M.I.R.E.E.

SENIOR ENGINEERS:
G. J. Champion, B.E.
M. A. Hunter, B.E.(Hons.), A.M.I.E.E.
F. Mazzaferri, B.E.(Hons.)

ENGINEERS:
M. C. Chan, B.E.(Hons.)
J. L. Collins, Dip.Elec.Eng., B.E.
J. Hont, B.E.(Hons.), Grad.I.E.Aust.
Mrs. S. M. Jong, B.E.(Elec.)

PRINCIPAL TECHNICAL OFFICER: K. Curley

SENIOR TECHNICAL OFFICERS:
D. Duckworth
A. Romagnano
N. Wolstencroft

PHYSICAL SCIENCES BRANCH

Branch Objectives

- Provide services to the Commission in the fields of Physics, Chemistry and Metallurgy.

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

Physics and Polymer Section

Section Functions

- Conduct exploratory research and investigation in the field of Physics and Polymer to the depth necessary to enable this scientific knowledge to be applied to the solution of telecommunications problems.
- Conduct scientific studies into the electrical, magnetic, mechanical, optical and thermal attributes of new materials and components.
- Carry out scientific studies into polymeric materials and develop methods for their application within the Department. Develop polymer materials with special properties for particular applications as required.
- Conduct research into the nature and simulation of the effects of the natural and man made environment on plant and staff, and where necessary devise means of protection from any deleterious influences.
- Investigate and develop new techniques in X-radiation, colour measurement photometry, spectroscopy and other methods of instrumental analysis directed at facilitating an understanding of the composition or physical structure of materials.

SECTION HEAD: G. Flatau, F.R.M.I.T.(App.Phys.)

PRINCIPAL PHYSICIST: D. McKelvie, B.Sc.(Hons.)

SENIOR PHYSICISTS:
I. A. Dew, B.Sc., M.Sc., M.A.I.P.
G. W. Goode, B.Sc.

PHYSICISTS:
E. J. Bondarenko, Dip.App.Phys., B.App.Sc., F.R.A.S.
Miss S. J. Charles, Assoc.Dip.App.Phys., B.App.Sc.
I. J. Lloyd, B.Sc.(Hons.), M.Sc., Ph.D.
B. A. MacLennon, B.Sc.
G. G. Mitchell, B.Sc.(Hons.), M.Sc.
A. J. Murfett, B.Sc.(Hons.)
N. J. Sadler, B.Sc., F.R.A.S., M.I.R.E.E.
I. K. Stevenson, B.App.Sc., A.R.M.I.T., Grad.A.I.P.

PRINCIPAL CHEMIST: H. J. Ruddell, Dip.App.Chem., A.P.I.A.

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

CHEMISTS:
D. J. Adams, Dip.App.Chem.
D. T. Miles, M.R.S.H., F.C.S., A.R.I.C.

SENIOR TECHNICAL OFFICERS:
R. J. Boast, Dip.App.Chem., Grad.R.A.C.I.
D. M. Clancy
M. Hooper
E. L. Wallace, A.R.M.I.T.(App.Phys.)

Analytical Chemistry Section

Section Functions

- Conduct exploratory research and investigations in the field of chemistry to the depth necessary to enable this newly acquired scientific knowledge to be applied to the solution of telecommunications engineering problems.
- Conduct chemical studies into materials and develop methods for their application within the Commission. Develop materials with special properties for particular applications as required.
- 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 materials and consumer products.
- Carry out scientific studies involving chemical phenomena in such fields as microelectronics and printed circuitry and exploratory development and fabrication of such devices.

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

CHEMISTS:
I. Cederholm, M.Sc., A.R.A.C.I.
S. Georgiou, B.App.Sc.
F. M. Petchell, Dip.App.Chem.
R. J. Western, Dip.App.Chem.

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

Electro-Chemistry and Metallurgy Section

Section Functions

- Conduct exploratory research and investigation in the fields of electro-chemistry and metallurgy to the depth necessary to enable the newly acquired scientific knowledge to be applied to the solution of telecommunications engineering problems.
- Perform scientific studies involving electrochemical phenomena in such fields as corrosion, protection and electrical power sources, and exploratory development and fabrication of such devices.
- Investigate metallographic and crystallographic techniques and apply these to studies related to the functions, properties and composition of materials and equipment.
- Investigate, develop and adopt methods of non-destructive testing.
- Investigate theoretical and practical aspects of surface protection and electrodeposition and development of practices for the satisfactory and economic protection of equipment and plant.

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

SENIOR CHEMIST: J. Der, B.Sc., A.R.A.C.I.

CHEMISTS:
P. J. Gwynn, Dip.App.Chem.
Z. Slavik, Dip.Eng., A.R.A.C.I.

SENIOR METALLURGIST: T. J. Keogh, Assoc.Dip.Sec.Met.

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

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

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EXECUTIVE ASSISTANT: A. B. Conroy

SENIOR PLANNING OFFICER: J. F. Reid

OFFICE MANAGER: T. H. Brown

BUDGETS OFFICER: E. J. Scates

EQUIPMENT OFFICER: M. R. Shanahan

BRANCH ADMINISTRATIVE OFFICERS:
C. J. Chippindall
M. A. Chirgwin
T. W. Dillon
Ms D. Forster
J. S. Sergeant

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 regularly contribute articles to Australian and overseas technical journals and present papers to learned societies.

PAPERS

Balderston, M.	"An Historical Survey of Communication Satellite Systems", The Telecommunication Journal of Australia. Part i Vol. 25 No. 1 1975 Part ii Vol. 25 No. 2 1975 Part iii Vol. 25 No. 3 1975
Bennett, J. A.	"A Concise Helmholtz type Representation for Waves in Inhomogenous Dispersive Anisotropic Multiply Refracting Media", Australian Telecommunication Research Vol. 9, No. 2, 1975.
Cassidy, M.	"100 Years After Bell", Issue of the Journal of The Institution of Engineers, March 1976.
Craig, E. R.	"Telecommunications by Satellite — An APO Study", Paper for Special Satcom Issue of the British Interplanetary Society Journal.
Dempsey, R. J.	"Transmission Aspects of a TV Telephone Network", The Telecommunication Journal of Australia, Vol. 25, No. 1, 1975.
Demytko, N. & Mackechnie, L. K.	"Performance of High-Speed Adaptive Echo Canceller", 3rd International Conference on Digital Satellite Communication, November 1975, in Kyoto, Japan.
Denger, L. A.	"Evaluation of Approximation of Coupled Differential Equations in Multi-Modal Transmission", Electronics Letters, Vol. 11, No. 12, June 1975.
Duc, N. Q.	"Line Coding Techniques for Baseband Digital Transmission", Australian Telecommunication Research, Vol. 9, No. 1, 1975.
Even-Chaim, A.	"Some Switching, Signalling and Synchronisation Techniques in Satellite Communication Systems", The Telecommunication Journal of Australia, Vol. 25, No. 3, 1975.
Flatau, G. & McKelvie, D.	"Physists in the Australian Post Office Research Laboratories", The Australian Physicist, July 1975.
Flavin, R. K.	"Radiometer Microwave Receiver for the Measurement of Atmospheric Attenuation at 11 & 14 GHz", IREE Proceedings, November 1975.
Gale, N. J.	"Application of State Transition Diagrams to Systems Independent Specification of Telephone Facilities and Systems", Australian Telecommunication Research, Vol. 9, No. 2, 1975.
Gibbs, A. J.	"SSB Modulator for Data Signals using Binary Transversal Filters", IEEE, October 1975.
Gibbs, A. J.	"Binary Transversal Filter Hilbert Transformers", Australian Telecommunication Research, Vol. 9, No. 1, 1975.
Gibbs, A. J. & Duc, N. Q.	"Digital Transmission over Standard Coaxial Cables", Journal of Asia Electronics Union, Vol. 7, No. 2, 1974.
Ja, Y. H.	"Holographic Reconstruction of Source Distribution from Microwave Height Gain Curves", IEEE Trans. Antennas & Propagation, Vol. AP-24, No. 1, January 1976.
Ja, Y. H.	"Measurement of Angles of Arrival of Waves by Microwave Holographic Technique", Communication — IEEE Trans. on Antennas and Propagation, Vol. AP-23, September 1975.
Ja, Y. H.	"Phase Information on Microwave Holographic Recordings", Proc. IREE Aust. Vol. 36, No. 6, June 1975.
Jenkinson, G. F.	"Tropical Rain Attenuation at 11 GHz — A Study of 18 Months' Measurements at Innisfail Queensland", Australian Telecommunication Research, Vol. 9, No. 1, 1975.
Jones, P. S.	"Digital Code Conversion for Telephony", Australian Telecommunication Research, Vol. 9, No. 2, 1975.
Keogh, T. J.	"Some problems encountered with Metal Finishes in the Telecommunications Industry", The Australian Institute of Metal Finishing, Brisbane Branch, March 1976.

Kidd, G. P.	"Liquid-Core Optical Fibres for Communications Systems", The Telecommunication Journal of Australia, Vol. 25, No. 3, 1975.
Kidd, G. P. (with Nicol, D. R. & Ogilvie, G. J.	"Liquid Core Optical Fibres", Australian Telecommunication Research, Vol. 9, No. 2, 1975.
McLeod, N. W.	"A Clock Averaging Circuit", Electronics Letters, Vol. 11, No. 18, September 1975.
Murphy, J. V.	"A Simple Approximation to Intersymbol Interference Error Rate for Low SNR", IEEE Trans. on Information Theory, November 1975.
Rosman, G., Doan, H. B., Hullet, J. L.	"A Modified Receiver for Optical Transmission Systems", IEEE Trans. on Communications December 1975.
Sabine, P. V. H.	"Mode Locked Lasers for Digital Optical Fibre Communications", Australian Telecommunication Research, Vol. 9, No. 1, 1975.
Sabine, P. V. H.	"Stress Induced Light Guiding in Embossed Waveguides", Electronic Letters, October 1975.
Sabine, P. V. H.	"Loss Measurements in Stress-Induced Optical Waveguides fabricated by an Embossing Process", Electronics Letters, March 1976.
Seyler, A. J.	"Communication by Recorded Information — A need for Changing Technology", IEEE Trans. on Communications, Vol. 23, No. 10, October 1975.
Western, R. J.	"Thermoplastic Polyester Protects Optic Fibres", Plastic News, November 1975.

LECTURES AND TALKS

Baker, F. C.	"Role of Analytical Chemistry in Telecom Materials Technology", 3rd Australian Symposium on Analytical Chemistry, May 1975.
Bylstra, J.	"Synchronisation of Digital Networks", IREE Aust. Convention, Sydney, August 1975.
Cahill, L. W.	"Radiation Patterns of Gallium Arsenide Injection Lasers", IREE Aust. Convention, Sydney, August 1975.
Cassidy, M.	"Cable T.V. and Visual Communication Systems", 18th Biennial Conference Library Association of Australia, Melbourne, August 1975.
Davies, W. S.	"Determination of Ray Diffusion and Loss Parameters for Liquid-filled Optical Fibres", IREE Aust. Convention, Sydney, August 1975.
Domjam, A.	"Power Feeding and Supervision of a Digital Coaxial Cable Transmission", IREE Aust. Convention, Sydney, August 1975.
Duc, N. Q.	"Line Coding Techniques for Baseband Digital Transmission, IREE Aust. Convention, Sydney, August 1975.
Duc, N. Q. & Gibbs, A. J.	"Digital Transmission over Single Quad Carrier Cable", IREE Aust. Convention, Sydney, August 1975.
Flavin, R. K.	"Radiometer Microwave Receiver for the Measurement of Atmospheric Attenuation at 11 & 14 GHz", IREE Aust. Convention, Sydney, August 1975.
Flavin, R. K.	"Broadband Parametric Amplifiers for Small Earth Stations", IREE Aust. Convention, Sydney, August 1975.
Hont, J.	"A General Purpose Programmable Sequential Controller"; IREE Aust. Convention, Sydney, August 1975.
Horton, R.	"Transistor Amplifier Design up to 12 GHz", IREE Aust. Convention, Sydney, August 1975.
Horton, R. (with Foreword, K. E., Monash University)	"New Trends in GaAs FETS", IREE, Melbourne Division, February 1976.
Horton, R.	"Low noise Solid State Integrated Pre-Amplifiers", Engineering Planning Research Symposium, May 1975.
Howard, S. E.	"Satellite Communication Studies Effects of Tropical Rain on 11 GHz and 14 GHz Signals", IREE Aust. Convention, Sydney, August 1975.
Hubregtse, J.	"R.F. Sputtering of $Si_2$0. Thin Film on to Gallium Arsenide", IREE Aust. Convention, Sydney, August 1975.

Johansen, E.	"Liquid Phase Epitaxy", IREE Aust. Convention, Sydney, August 1975.
Kidd, G. P.	"Influence of Fibre and Device Parameters on Systems Specifications", IREE Aust. Convention, Sydney, August 1975.
Latoszynski, P. & Pierson, R.	"Some Problems in the Application of Pyrolysis G.L.C. for the Characterisation of Polymers used in Telecommunications", Second Australian Conference on Science Technology, Adelaide, August 1975.
Macfarlane, I. P.	"State of the Art in Digital Electronics", South Australian branch of IREE and IEE Aust. August 1975.
Miles, D. T. & Flatau, G.	"Selection of Telecommunications Materials", Sydney Branch of Australian Institute of Metals, September 1975.
Miles, D. T.	"A Novel Thin Layer Chromatographic Technique for the Analysis of Anti-oxidants in Polyolefins", 3rd Australian Symposium on Analytical Chemistry, May 1975.
Morgan, R. J.	"The Influence of Fibre Parameters on Analogue Transmission for Liquid Core Fibres", IREE Aust. Convention, Sydney, August 1975.
Murphy, J.V. & Burton, J. M.	"Tropospheric Multipath Propagation Analysis using a Microwave Holographic Array", Weapons Research Establishment Symposium, Adelaide, September 1975.
Murphy, J. V.	"High Resolution Analysis of Multiple Signals", Open Symposium on Non-Stationary Signal Analysis, UR51 General Assembly, Lima, Peru, August 1975.
Park, J. L. & Quan, A. Y. C.	"Design Considerations for a High Speed Digital Regenerative Repeater", IREE Aust. Convention, Sydney, August 1975.
Quan, A. Y. C.	"An Experimental High Speed Baseband Digital Coaxial Link", IREE Aust. Convention, Sydney, August 1975.
Reeves, G.	"The Fabrication and Operation of Gunn Effect Digital Devices", IREE Aust. Convention, Sydney, August 1975.
Sabine, P. V. H.	"Loss Measurements in Embossed Optical Waveguides", IREE Aust. Convention, Sydney, August 1975.
Sabine, P. V. H.	"Mode-Locked Lasers for Optical Communications", IREE Aust. Convention, Sydney, August 1975.
Sabine, P. V. H. & Cahill, L. W.	"High Speed Laser Pulses for Optical Fibre Communications", IREE Melbourne, June 1975.
Seyler, A. J.	"Teleconferencing — A New Phase in Telecommunications", IREE Aust. Convention, Sydney, August 1975.
Seyler, A. J.	"Man Technology Interface Problems in Telecommunications", University of Adelaide, June 1975.
Slade, R. D.	"The Use of Standards in Metal Finishing Industry", The Australian Institute of Metal Finishing, Adelaide, October 1975.
Stone, G. O.	"Integration of High Power Impatt Sources", IREE Aust. Convention, Sydney, August 1975.
Teede, N. F.	"Electro-optical Sources for Fibre Transmission Systems", IREE Aust. Convention, Sydney, August 1975.
Teede, N. F.	"Semiconductor Crystals — their Preparation and Application to Lasers", The Australian Institute of Metals, Melbourne, July 1975.
Teede, N. F. & Cahill, L. W.	"Optical sources for Fibre Transmission Systems", Research Laboratories Colloquia, Melbourne, March 1976.
Williamson, W. J.	"Variations in the Surface Brightness Distribution in LEDs for Optical Fibres", IREE Aust. Convention, Sydney, August 1975.
Williamson, W. J.	"Solid State Sources for Optical Fibre Communication Systems", Department of Electrical Engineering, University of Newcastle, March 1975.
Davies, W. S.	"Transmission Characteristics of Optical Communication Fibres".*
Kidd, G. P.	"Optical Fibre Principles".*
Kidd, G. P.	"Optical Fibre Transmission Systems".*
Morgan, R. J.	"Fibre System Aspects".*
Teede, N. F.	"Sources for Optical Communications".*

*Continuing Education Course 22/75, Optical Fibre Communications, RMIT, September 1975.

RESEARCH LABORATORIES REPORTS

Report No.	Author	Title
6710	R. E. Proudlock	A BCD Output Code Tester
6738	F. R. Wylie	Time Delay Cut-Out for Battery Operated Equipment
6808	O. F. Lobert & V. K. Sargeant	A Compact Electric Field Strength Reference System for Laboratory Use
6831	A. N. Hamilton	A VLF Calibration System
6832	R. W. Ayre	Television Converters Using Line Storage Techniques
6837	A. N. Hamilton	Programmable/Automatic Updating Voltage Supply for Ageing Compensation of VCOs
6839	M. Belfer	ANT — An Alpha-Numeric Text Generator for the A.P.O. Conference Facility
6852	G. J. Semple	A Technique for Evaluating the Retiming Operation of a Primary PCM Regenerator
6854	F. R. Wylie	A General Purpose Cable Identification Set
6864	P. J. Tyers	A Program for Digitized Recording of Analogue Information
6875	R. W. Ayre & G. Ardern	Subjective Evaluation of Digital TV Error Concealment Techniques
6877	N. F. Teede	Electroluminescent Diode Sources for Optic Fibre Communications
6878	D. Q. Phiet	A Subjective Comparison of Techniques for Concealing Data Lost by Buffer Overflow in Variable Length TV Transmission
6894	R. Horton	Microcircuit Design at Microwave Frequencies
6903	P. V. H. Sabine	Laser Mode-Locking Techniques for Communications Applications
6904	R. Horton	The Microwave MESFET and its Applications
6915	W. J. Williamson	Measurements of the Outer Dimensions of Optical Fibres
6920	P. H. Gerrand	Evaluation of State Transition Diagrams & Functional Flow Charts as Methods of Specification & Description of SPC Telephone Exchanges
6926	G. J. Semple	Windsor/Malvern PCM Bearer Error Rate/Crosstalk Noise Margin Measurements
6929	J. V. Murphy	Simple Approximations to Digital Error Rate Due to Intersymbol Interference Gaussian Noise
6930	G. J. Semple	A Prototype Primary Level PCM Regenerator Threshold Level Tester
6935	W. S. Davies & G. P. Kidd	Impulse Response & Bandwidth Results for Medium Length Liquid Filled Optical Fibres
6940	I. J. Lloyd	Lightning Impulse Propagation Along Underground Cables in Subscribers' Circuits
6942	G. F. Jenkinson	Tropical Rain Attenuation at 11GHz — Analysis of Results to April, 1974
6947	L. W. Bourchier G. J. Semple	A Test Instrument for Measuring the Retiming Performance of Primary Level PCM Regenerators
6949	M. F. Lane	Crystal Oscillator Design Employing Digital Integrated Circuits as the Active Element
6950	A. A. R. Townsend	A Phase Locked Loop Unit with Store and Synthesiser.
6952	M. Balderston	System Calculations for an Australian Nation Satellite Study
6953	S. J. Charles	A Light Obscuration Meter
6955	N. Q. Duc	Digital Transmission over Single-Quad Carrier Cable
6959	B. C. Gilbert	Line Driving & Receiving, and Self Generated Noise in Digital Systems
6966	L. A. Denger	Computation of Characteristic Values of Non-Symmetric Matrices
6972	A. Domjan, N. Q. Duc & A. Y. C. Quan	A 4B-3T Encoder/Decoder for High-Speed Baseband Digital Transmission Systems
6973	R. A. Court	A Survey of Distribution Links for Stereophonic Sound
6982	J. A. Bylstra	A Technique for Smoothing Justification Jitter in Digital Systems with Low Justification Rates
6986	J. L. Park	Clock Generation for a 4B-3T Decoder Using Phase-Locked Loop
7011	G. K. Jenkins	A Versatile Scanning System for Optical Character Recognition Studies
7013	L. A. Denger	Coupled Differential Equations & Their Application to Overmoded Transmission Systems
7014	G. J. Semple	Transmission of Non-Telephony Signals over Tandem PCM Carrier Derived VF Circuits
7017	R. A. Court	A Review of Integrated Television Sound Broadcasting
7021	A. Y. C. Quan	Digital Circuitry for a 140 Mbit/s Regenerative Repeater
7025	G. K. Jenkins	Research Information System — The News Service
7026	G. K. Jenkins	Some Useful Time-Share Utility Programs
7028	G. K. Jenkins	A Time-Shared Assembler for Nova & Nova-Compatible Minicomputers
7029	G. K. Jenkins	Paper Tape Facilities for CDC 6000/7000 Cyber Computers
7030	A. Y. C. Quan & J. L. Park	Peak Signal Power Levels for High-Speed Baseband Digital Transmission Systems

In addition 42 other reports were distributed on a limited basis.

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
VICTORIA INSTITUTE OF COLLEGES	
Academic Committee — Engineering	M. Cassidy
MONASH UNIVERSITY	
Faculty of Engineering	A. J. Seyler
ADELAIDE UNIVERSITY	
Electrical Engineering Department — Hon. Consultant for Post Graduate Studies	A. J. Seyler
UNIVERSITY OF NEW SOUTH WALES	
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FOOTSCRAY INSTITUTE OF TECHNOLOGY	
Course Advisory Committee	H. S. Wragge
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
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Capital Funds Committee	M. Cassidy
Course Advisory Committees	M. Cassidy
	R. D. Slade

NATIONAL PROFESSIONAL BODIES

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RADIO RESEARCH BOARD	E. F. Sandbach
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Australian Electrotechnical Committee	E. F. Sandbach
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Plastics Industry Standards Board	R. D. Slade
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• Tensile Testing of Metals	K. G. Mottram
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• Pressure Sensitive Adhesive Tapes	G. Flatau
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	
• Methods of Testing Plastics	G. Flatau
• Outdoor Weathering of Plastics	G. W. Goode
• Polytetrafluoroethylene	B. A. Chisholm
• Flammability of Plastics	H. J. Ruddell
SAFETY STANDARDS	
• Industrial Safety Gloves	F. C. Baker
TELECOMMUNICATIONS AND ELECTRONICS INDUSTRY STANDARDS	
• Capacitors and Resistors	G. Flatau D. McKelvie
• Printed Circuits	D. E. Sheridan
• Wires and Cables	G. Flatau
• Semi-Conductors	I. P. Macfarlane
• Environmental Testing	G. Flatau
• Reliability of Electronic Components and Equipment	G. Flatau
• Electro-Acoustics and Recording	E. J. Koop
NATIONAL ASSOCIATION OF TESTING AUTHORITIES (N.A.T.A.)	
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Assessor for Aerial Equipment and Measurements	O. F. Lobert
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International Bodies

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

- the International Telephone and Telegraph Consultative Committee (C.C.I.T.T.)
- the International Radio Consultative Committee (C.C.I.R.)
- the Australian and New Zealand Association for the Advancement of Science (A.N.Z.A.A.S.)
- the Bureau International de l'Heure (B.I.H.)
- the International Electro-Technical Commission (I.E.C.)
- the International Standards Organisation (I.S.O.)
- the Asia Electronics Union (A.E.U.)
- the International Federation of Documentation, Committee for Asia and Oceania (F.I.D./C.A.O.)

INDUSTRIAL PROPERTY

It is a policy of the Commission 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 the Commission 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 the Commission. The property includes applications for letters patent and registered designs.

PATENT APPLICATIONS AND PATENTS

Subject	Inventor	Patent or Patent Application Number	Country
Method and Apparatus for Testing Subscribers Telephone Instrument in situ under Service Conditions	J. F. M. Bryant (Research Labs) R. W. Kett (Research Labs)	286,959 3,261,926	Australia U.S.A.
Self Adaptive Filter and Control Circuit Therefor	L. K. Mackechnie (Research Labs)	448,805 P20 63 183.8 1,334,250 45-115560 70-18580 913,733 70-45859 362,763 3,732,410	Australia Germany Britain Japan Netherlands Italy France Sweden U.S.A.
Public Telephone Installation (Vandal Proof)	K. B. Smith (Engineering Dept., Headquarters) A. A. Rendle (Engineering Dept., Headquarters)	424,305 1,217,291 718,886	Australia Britain Japan
Vibrating Cable Plough (Dual Tine)	E. W. Corless (Engineering Dept., Headquarters)	450,397 1,292,844 69/7565	Australia Britain South Africa
Dual Speed Ratio Automatic Telephone Dial	R. J. W. Kennell (private inventor — rights assigned to Telecom Australia)	264,679	Australia
Tip Welding Means	E. J. Bondarenko (Research Labs)	455,004 1,287,873 3,657,512	Australia Britain U.S.A.
Analogue Multiplier	H. Brueggemann (Research Labs)	414,207 1,271,813 P19 45 125.3 728,044 3,629,567	Australia Britain Germany Japan U.S.A.
Analogue Multiplier	H. Brueggemann (Research Labs)	GbmH 6934984.4 (Utility or Model Patent)	Germany
Apparatus for Routing Discrete Telecommunication Signals	A. Domjan (Research Labs)	448,958 756684 12968-70 70-14122 70-35267 1,326,626 P20 46 069.9 83533-70	Australia Belgium Sweden Netherlands France Britain Germany Japan
Digitally Tuned Detector (Petra)	J. A. Lewis (Research Labs)	458,997 1,359,508 7107445.4	Australia Britain Sweden
Improved Hybrid Network	E. M. Cherry (Monash University — rights assigned to Telecom Australia)	451,292	Australia
Edge Triggered Pulse Generator	I. P. Macfarlane (Research Labs)	465,242	Australia
Faulty Circuit "Executioner"	N. W. McLeod (Research Labs)	466,670 1,362,707 3,745,418 71-28121 P21 36 516.2 56442-71	Australia Britain U.S.A. France Germany Japan
Polarization Diversity in Domestic Radio Receivers	D. G. Rodoni (Engineering Dept., Headquarters) T. Van Bemmel (Electronic Inst. Pty. Ltd.)	56341/73 14672 1,411,704 137070 61018/73	Australia Philippines Britain India Japan
Broadband VHF Antennas	R. P. Tolmie (Queensland Admin.)	49340/72	Australia

Subject	Inventor	Patent or Patent Application Number	Country
Cable Pair Identifier	C. G. Devey (Victorian Admin.)	52281/73 11338/73 170022	Australia Britain New Zealand
Smoke Detector (Nephelometer)	L. Gibson (Victorian Admin.) D. R. Packham (CSIRO)	56513/73 564,238 1,419,146 63703/73 3,874,795	Australia Switzerland Britain Japan U.S.A.
Detection of Digitally Encoded Frequency Signals	A. D. Proudfoot (Research Labs)	59138/73 3,882,283 803494 P23 40 672.6 73-11093 73-29439 11603/73 73/109209 38106/73 1955402/26.9 2012118/26.9 178402 48/89385	Australia U.S.A. Belgium Germany Netherlands France Switzerland Sweden Britain U.S.S.R. Canada Japan
Methods of Bonding	H. J. Ruddell (Research Labs) R. J. Western (Research Labs)	62568/73	Australia
Improved Integrating Current Meter	J. R. McIntyre (Engineering Dept., Headquarters)	77537/75	Australia
Time Delay Cut-Out for Battery Operated Equipment	F. R. Wylie (Research Labs)	PC 1281/75	Australia
Optical Fibre Terminations	G. P. Kidd (Research Labs)	PC 1194/75	Australia
Improved Electrical Connector	C. R. Bomball (Engineering Dept., Headquarters) B. C. Bladier (Engineering Dept., Headquarters) T. E. Woodward (Engineering Dept., Headquarters)	PC 1618/75	Australia
Nephelometer — Improved Light Trap	R. C. Huxtable (Victorian Admin.) D. R. Packham (CSIRO)	84529/75 36650/75 234977 611774 11677/75 108596/75	Australia Britain Canada U.S.A. Switzerland Japan
Nephelometer — Photo Detector	E. H. S. Foot (Victorian Admin.)	84530/75 36635/75 234976 611773 11676/75 108597/75	Australia Britain Canada U.S.A. Switzerland Japan
Improvements to Smoke Detector (Nephelometer)	L. Davidovits (Research Labs)	PC 4285/75	Australia
Laser as Light Source for Smoke Detector	L. Davidovits (Research Labs)	PC 4286/75	Australia
Plastic Coupling for Rigid and Semi-Rigid Pipes	A. D. Pontin (Engineering Dept., Headquarters)	PC 4019/75	Australia
Stress-Induced Optical Waveguides Fabricated by an Embossing Process	P. V. H. Sabine (Research Labs) P. S. Francis (Research Labs)	PC 4499/75	Australia

Registered Designs

Subject	Designer	Number	Design Class	Country
Case for a Wall Telephone	B. T. Burland (Engineering Dept., Headquarters)	50863 50864 11973	1 3	Australia Australia New Zealand
Table Top Switchboard	B. T. Burland (Engineering Dept., Headquarters)	63002 63003	1 2	Australia Australia

VISITORS TO THE LABORATORIES

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

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

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

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 program of overseas visits each year during which members of staff interchange experience, technical knowledge, opinions and ideas. The visits are normally to other administrations, universities and industry, as well as to international forums and conferences of world telecommunications bodies and related organisations.

The following staff members have travelled overseas during the past year:

G. J. Barker
E. R. Craig
N. Demytko
G. Flatau
A. M. Fowler
D. A. Gray
R. Horton
I. P. Macfarlane
B. M. Smith
R. Smith
H. S. Wragge

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 of 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.

The following professional staff have been encouraged to engage in postgraduate studies or to seek wider professional experience during the past year:

N. Q. Duc, Syracuse University, Syracuse, New York
N. J. Gale, University Soins, Malaysia
H. Junghams, Siemens Industries, Munich
G. P. Kidd, B.P.O. Research Laboratories, U.K.
J. V. Murphy, Latrobe University, Melbourne
F. J. W. Symons, Essex University, U.K.
N. F. Teede, Electrotechnical Laboratory, Tokyo, Japan

SPONSORED EXTERNAL RESEARCH AND DEVELOPMENT

The Commission 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 research on the topics below:

- Interdependence of the Physical and Chemical Properties of Plastics with Insect Resistance
- Transmission Equalisers for TV-Telephones
- Transmission Characteristics of Trunk Waveguide Systems
- Solid State Technology for Circular Design in Microstrip Form
- Electrical Discharges and Plumes on High Power HF Antennas
- Computer Based Correlator for Broadband System Transfer Function Measurements
- Assignment of Tolerance to Minimum Sensitivity Networks
- Theoretical Studies of Optical Fibres
- Channel Capacity of Stepped-Index Optical Fibre Systems
- Active Devices for Integrated Optics

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