The Australian East-West Radio Relay System Revisited

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Abstract: The *Journal* revisits an historic paper from 1971 by R. W. Richards and J. Donovan of GEC-AEI Telecommunications on the prime contractor's role in the delivery of the Australian East-West radio relay system from Northam in Western Australia to Port Pirie in South Australia.

Keywords: History of Australian Telecommunications, East-West Radio Relay System, GEC Australia, GEC-AEI Telecommunications, John A. Lush

Introduction:

Today Australians are largely immune to the challenges that "the tyranny of distance" presented to their forebears only a generation ago. The inability to access telecommunications services due to terrestrial isolation has largely been overcome with technological advances. Now there is an insatiable appetite for bandwidth everywhere in Australia and the optical fibre systems installed between Perth and Adelaide are capable of supporting millions of equivalent voice circuits.

Until the late 1960s, the East-West link between Adelaide and Perth used voice frequency telegraphy and HF transceivers to provide a limited number of voice circuits across the Nullarbor Plain. The Postmaster General's Department (now Telstra) called for world-wide tenders closing in January 1966 (Figure 1), for the supply and installation of a broadband communication system linking the broadband networks of Eastern and Western Australia ("Broadband Communications System", 1965).

The tender schedule specified a microwave radio system, but also set out the requirements for a co-axial cable system as an alternative. Furthermore, the tender invited other system solutions that the tenderer might consider suitable. The route distance was around 2,400 kilometres and most terrestrial sites would be off the mains power grid. Therefore, reliability

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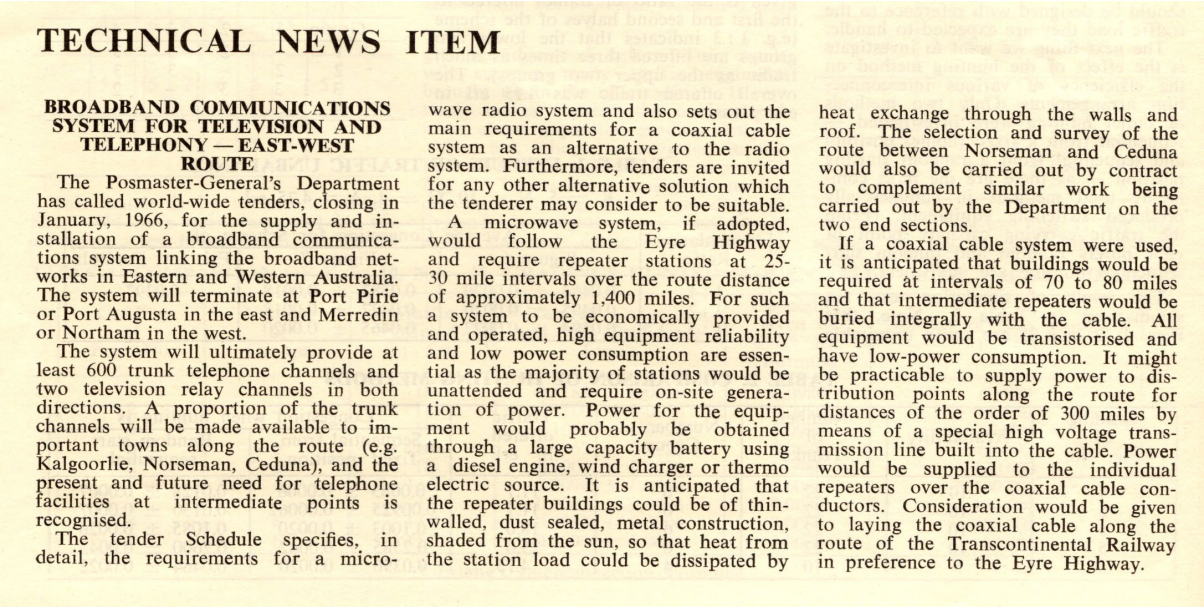
in passively cooled equipment shelters and low power consumption were prime considerations.

Twenty-eight companies were invited to tender for a 60-hop system from Northam in Western Australia to Port Pirie in South Australia. They were to provide 1+1 both-way, 600-circuit telephony bearers, capable of carrying television on the standby bearer on an occasional basis. The system had to cater for the possible expansion of up to six radio bearers in either direction, which influenced the design of tower, shelter and power requirements.



TECHNICAL NEWS ITEM

BROADBAND COMMUNICATIONS SYSTEM FOR TELEVISION AND TELEPHONY — EAST-WEST ROUTE

The Posmaster-General's Department has called world-wide tenders, closing in January, 1966, for the supply and installation of a broadband communications system linking the broadband networks in Eastern and Western Australia. The system will terminate at Port Pirie or Port Augusta in the east and Merredin or Northam in the west.

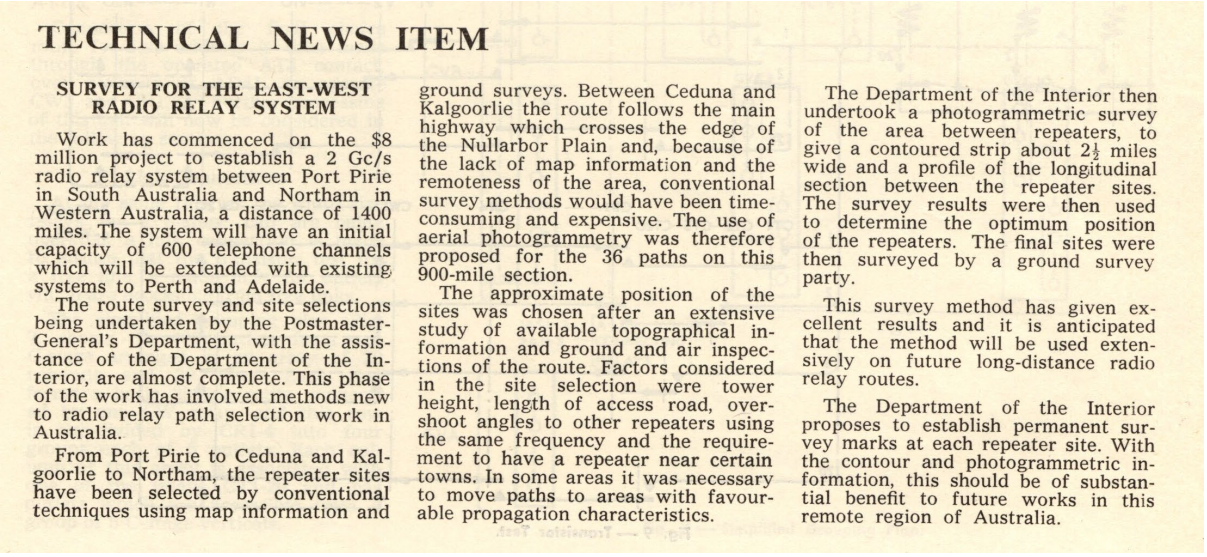
The system will ultimately provide at least 600 trunk telephone channels and two television relay channels in both directions. A proportion of the trunk channels will be made available to important towns along the route (e.g. Kalgoorlie, Norseman, Ceduna), and the present and future need for telephone facilities at intermediate points is recognised.

The tender Schedule specifies, in detail, the requirements for a microwave radio system and also sets out the main requirements for a coaxial cable system as an alternative to the radio system. Furthermore, tenders are invited for any other alternative solution which the tenderer may consider to be suitable.

A microwave system, if adopted, would follow the Eyre Highway and require repeater stations at 25-30 mile intervals over the route distance of approximately 1,400 miles. For such a system to be economically provided and operated, high equipment reliability and low power consumption are essential as the majority of stations would be unattended and require on-site generation of power. Power for the equipment would probably be obtained through a large capacity battery using a diesel engine, wind charger or thermo electric source. It is anticipated that the repeater buildings could be of thin-walled, dust sealed, metal construction, shaded from the sun, so that heat from the station load could be dissipated by heat exchange through the walls and roof. The selection and survey of the route between Norseman and Ceduna would also be carried out by contract to complement similar work being carried out by the Department on the two end sections.

If a coaxial cable system were used, it is anticipated that buildings would be required at intervals of 70 to 80 miles and that intermediate repeaters would be buried integrally with the cable. All equipment would be transistorised and have low-power consumption. It might be practicable to supply power to distribution points along the route for distances of the order of 300 miles by means of a special high voltage transmission line built into the cable. Power would be supplied to the individual repeaters over the coaxial cable conductors. Consideration would be given to laying the coaxial cable along the route of the Transcontinental Railway in preference to the Eyre Highway.

Figure 1. Notice of the call for tenders ("Broadband Communications System", 1965)



TECHNICAL NEWS ITEM

SURVEY FOR THE EAST-WEST RADIO RELAY SYSTEM

Work has commenced on the $8 million project to establish a 2 Gc/s radio relay system between Port Pirie in South Australia and Northam in Western Australia, a distance of 1400 miles. The system will have an initial capacity of 600 telephone channels which will be extended with existing systems to Perth and Adelaide.

The route survey and site selections being undertaken by the Postmaster-General's Department, with the assistance of the Department of the Interior, are almost complete. This phase of the work has involved methods new to radio relay path selection work in Australia.

From Port Pirie to Ceduna and Kalgoorlie to Northam, the repeater sites have been selected by conventional techniques using map information and ground surveys. Between Ceduna and Kalgoorlie the route follows the main highway which crosses the edge of the Nullarbor Plain and, because of the lack of map information and the remoteness of the area, conventional survey methods would have been time-consuming and expensive. The use of aerial photogrammetry was therefore proposed for the 36 paths on this 900-mile section.

The approximate position of the sites was chosen after an extensive study of available topographical information and ground and air inspections of the route. Factors considered in the site selection were tower height, length of access road, overshoot angles to other repeaters using the same frequency and the requirement to have a repeater near certain towns. In some areas it was necessary to move paths to areas with favourable propagation characteristics.

The Department of the Interior then undertook a photogrammetric survey of the area between repeaters, to give a contoured strip about 2½ miles wide and a profile of the longitudinal section between the repeater sites. The survey results were then used to determine the optimum position of the repeaters. The final sites were then surveyed by a ground survey party.

This survey method has given excellent results and it is anticipated that the method will be used extensively on future long-distance radio relay routes.

The Department of the Interior proposes to establish permanent survey marks at each repeater site. With the contour and photogrammetric information, this should be of substantial benefit to future works in this remote region of Australia.

Figure 2. Notice of commencement of work ("Survey", 1967)

Survey work on the route began in 1967 (Figure 2). The General Electric Co. of Australia Ltd (GEC Australia) (Figure 5) won the tender. The historic paper (Richards & Donovan, 1971) describes how GEC Australia enlisted the help of GEC-AEI Telecommunications Ltd to

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prepare the tender submission, manage the UK post-contract organisation, and to liaise with GEC Australia on the Australian post-contract organisation, delivery and commissioning.

At the time, it was the largest broadband microwave project ever undertaken by the Postmaster General's Department. The total cost of the system was around $11 million which is equivalent to $140 million today (March 2024).

The historic paper is unique in that it provides details on project management that would normally be kept confidential to the tenderer. Aspects such as pre-tender investigations, post-contract organisation, communications and training are discussed in depth. This is typical of times when technical achievements were shared amongst the industry and before competitive advantage closed the door to publication in journals such as this.

I would also like to draw the reader's attention to the other excellent technical papers on the East-West Radio Relay System which appeared in this Special Issue (Figure 3) of Volume 21, Number 1, 1971 of the *Telecommunication Journal of Australia*, as follows (Figure 4):

- A.P.O. Project Management – pp. 8–15
- Testing the Prototype Equipment – pp. 16–23
- The Design and Development of the Radio and Associated Equipment – pp. 24–52
- Installation and Commissioning Requirements – pp. 53–58
- Stressed Rock-Anchor Antenna-Support Towers – pp. 59–62
- Thermal Design of Naturally Cooled Repeater Shelters – pp. 63–64
- Environmentally Controlled Equipment Shelters – pp. 66–71
- Antennas and Feeders – pp. 72–79
- Power Plant – pp. 80–94
- Service Aspects of the Radio System – pp. 95–98
- Operations and Maintenance – pp. 99–100

Dedication

This historic paper reprint is dedicated to John A. Lush (18 February 1947 – 28 December 2023) who came to Australia in 1969 as part of the GEC East-West project team. John settled in Australia and went on to a distinguished career in telecommunications at Telecom Australia, Andrew Antennas and LSE Technology.

References

"Broadband Communications System". (1965). "Broadband Communications System for Television and Telephony — East-West Route". Technical News Item, *Telecommunication Journal of Australia*, *15*(2), 124.

Richards, R. W., & Donovan, J. (1971). The Prime Contractor's Role in Project Management. *Telecommunication Journal of Austr*alia, *21*(1), 4–7.

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"Survey". (1967). "Survey for the East-West Radio Relay System". Technical News Item, *Telecommunication Journal of Australia*, *17*(2), 132.

Figure 3. The cover of the TJA special issue on the East-West Microwave link, February 1971

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Figure 4. The Table of Contents of the TJA special issue on the East-West Microwave link, February 1971

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The Historic Paper

THE PRIME CONTRACTOR'S ROLE IN PROJECT MANAGEMENT

*R. W. RICHARDS AND J. DONOVAN**

INTRODUCTION

In any large project there is much liaison and co-ordination effort required on equipment and services which are not normally part of a prime contractor's manufacturing capability, but nevertheless form part of his contractual responsibility. GEC-AEI Telecommunications Limited (the UK-based company responsible for the telecommunications activities of The General Electric Company Limited, of England) was well equipped to act as the essential keystone vital to the success of any large telecommunications project. The East-West system is a typical application of this expertise.

A UK-based project management team, unique to the project, was appointed as soon as the 'Invitation to Tender' was issued, and later supplemented by a Melbourne-based team to ensure maximum communication between customer and suppliers. This article presents the scope of the problem and illustrates the means subsequently used to co-ordinate all aspects of the Contract. Particular reference is made to one contractual responsibility; that of training A.P.O. engineers and technicians in the operation and maintenance of the advanced and sophisticated all-semiconductored equipment supplied.

THE INVITATION TO TENDER

GEC (Australia) Pty Ltd was one of 28 companies invited to tender for the 2400 km (1500 mile) Northam to Port Pirie Microwave radio system for trunk-telephone and television transmission (Fig. 1). The 60-hop system was to provide 1 + 1 bothway 600-circuit telephony bearers between Northam and Port Pirie, capable of carrying television over the standby channel on an occasional basis. A unidirectional television channel was required between Northam and Kalgoorlie. In addition, 'wayside' telephone channels were to be provided for settlements along the Eyre Highway. The requirement for space diversity operation over particularly difficult sections of the route was known, although the details were finalized later. The invitation to tender also

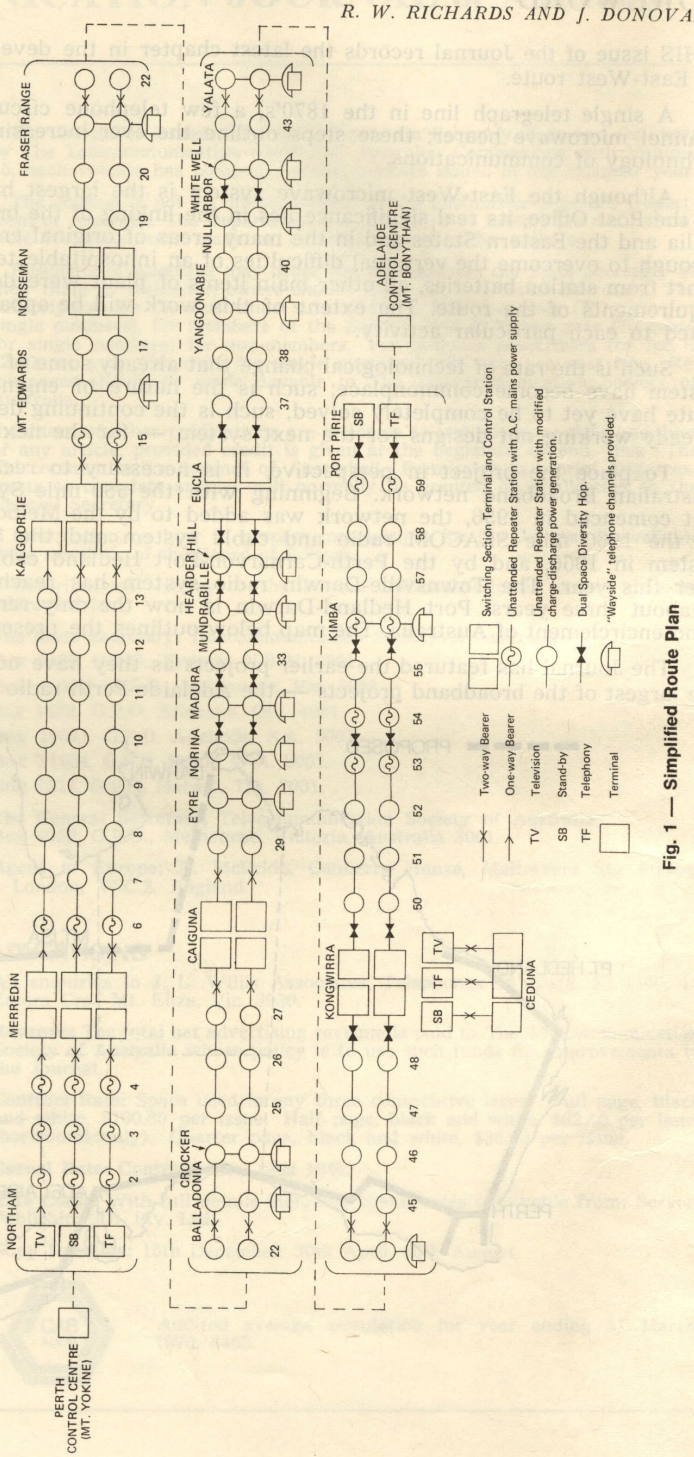

Fig. 1 — Simplified Route Plan

* Mr Richards is U.K. Project Manager and Mr Donovan is Australian Project Manager, East-West Project, for GEC-AEI Telecommunications Ltd, England

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specified the requirements for shelter and tower foundations, towers, equipment shelters for 51 unattended repeater stations, power-generation plant, antennae and feeders, and the supervisory and control scheme to be operated from control centres near Perth and Adelaide; intermediate control and switching stations were to be provided at Merredin, Kalgoorlie, Norseman, Caiguna, Eucla, and Kongwirra.

1 + 2 bothway telephony and television bearers between the satellite earth station at Ceduna and the adjacent intermediate control station at Kongwirra were added later.

The system had to take into account future expansion of the system up to a maximum of 6 radio bearers in each direction. For example, this influenced the shelter, tower and power generation considerations.

In addition to the technical requirements, the invitation to tender offered a wealth of information on the environment and discussed the problems with which a contractor was likely to be faced, and formed a sound foundation for the resulting tender.

PRE-TENDER INVESTIGATIONS

GEC (Australia) Pty Ltd enlisted the aid of GEC-AEI Telecommunications Ltd, who accepted responsibility for preparing a tender for submission to the A.P.O.

As soon as the invitation to tender was issued a project manager and a team of systems-planning, contract-engineering, and installation and commissioning experts, who were responsible for the complete preparation of the tender working in close co-operation with their colleagues in the Australian company, were appointed.

GEC experts visited Australia to make a comprehensive appraisal of potential subcontractors needed for the supply of ancillary equipment. Due account was taken of the local expertise that would be required, as well as transport considerations and freight economy, and it was decided that towers, shelters, and prime-power generation equipment should be manufactured in Australia. The team of experts also visited the repeater sites proposed by the A.P.O. to elaborate on the information provided in the invitation to tender, thus giving first-hand knowledge of site-access, environmental, and logistics problems.

Information obtained during the investigations, and from concurrent discussions with the A.P.O., was fed back to the U.K. for inclusion in the GEC proposals.

The project team was responsible for the collation of all incoming information and for the co-ordination of all the design and development activities. It was also responsible for co-ordination and liaison between all internal departments, subcontractors, the GEC teams in Australia, and the customer.

As an example of the co-ordination problem involved, it became obvious that all means possible would have to be used to reduce the overall prime power requirement, with minimum degradation of system performance. A.C. mains supply is not available at most of the unattended repeater stations, and these stations would normally be totally dependent on diesel generators. The route is effectively only accessible from the ends, therefore fuel transport costs are high. These factors led to the proposal of a low-power consumption version of the GEC 2 GHz radio system in which the total power consumption of a 1 + 1 bothway unattended repeater, with subtrafficband access, was reduced to about 500 W. This drastically altered the approach to shelter and power-generation design and gave rise to the shelter design that did not need powered equipment to control its environment and the modified charge-discharge system of power generation, the principles of which are described in individual articles.

Thus it will be appreciated that the early appointment of a centralized management team, can provide invaluable liaison and co-ordination between customer and suppliers.

Shortly before the tender was submitted by GEC (Australia) Pty Ltd, the project manager visited Melbourne to co-ordinate the activities of potential subcontractors and compile the comprehensive tender documents.

POST-CONTRACT ORGANIZATION

GEC retained two design consultants, Ove Arup and Partners for towers and foundations, and D. S. Thomas and Partners for the equipment shelters. The companies to whom GEC awarded the various subcontracts were Electric Power Transmission Pty Ltd for foundations and towers, Signal Industries Pty Ltd for equipment shelters, McColl Electric Works Pty Ltd for power equipment, and Andrews Antennas Pty Ltd for antennae and waveguide.

A team was set up in Australia, based in Melbourne, to prepare detailed information on such matters as station layout, site and foreground clearance. The role of the U.K. project management team changed from one of contract negotiation to one of co-ordination of design, manufacture, and supply. At this stage, the final format of the project management teams came into operation. A simplified liaison-path diagram of the Anglo-Australian partnership set up by the company is shown in Fig. 2.

The Project Manager in the U.K. had to ensure that each factory department, and U.K. supplier, received sufficient information on planning and progress associated with both U.K. and Australian phases of the project in order that all the committments could be met. He was also responsible for the commercial decisions necessary to maintain close control over the project. He was able to draw on the specialist expertise available at Coventry.

The GEC Project Manager at Melbourne, assisted by a project co-ordinator, was responsible for the co-ordination of all aspects of the project in Australia. Their team included a financial controller, specialist project engineers, field contract controller, sub-contractor's factory inspectors, and field surveillance engineers. The respective responsibilities are shown in Fig. 3.

COMMUNICATIONS

Telex and telephone communications were maintained between the UK-based GEC company, the Melbourne office, the field contract-control office (initially in Adelaide, later moved to Perth), and the field support centres at Ceduna and Northam (later moved to Norseman).

An appraisal of existing means of communication along the route indicated that the increased telephone activity would not overload the local public telephone network at the end sections, but that the public system would not cope on the centre section — the only communication with Eucla was a single-wire earth-return circuit which followed the original telegraph route of 1875.

These facilities were augmented by a temporary HF mobile radio network with base stations at the two field support centres and 21 mobile sets for the teams.

As each microwave radio-relay station became operational, additional communication was provided back to the terminal stations via the supervisory engineers' order wire circuit.

TRAINING

The contract included comprehensive instruction on all aspects of the system and its constituent equipments for the 45 A.P.O. maintenance technicians who were to be assigned to the route. A training establishment was set up at Whyalla (station 59) to

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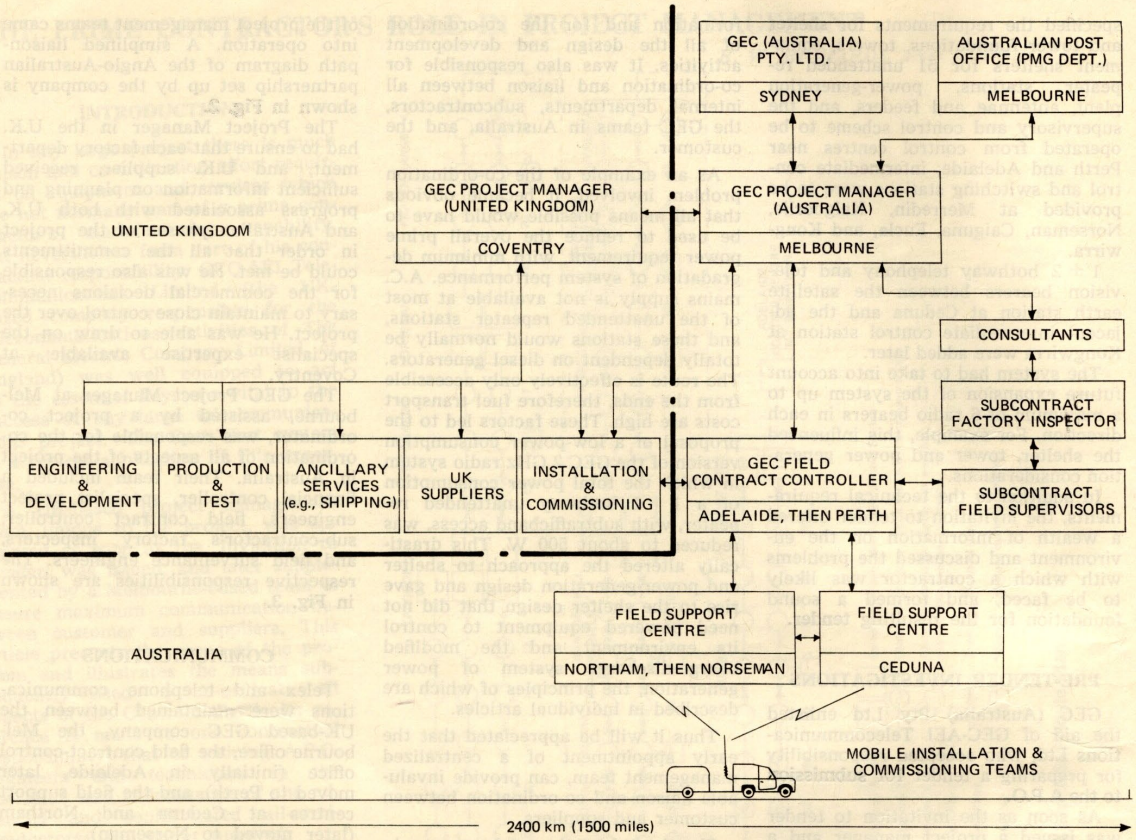

Fig. 2 — Simplified Liaison-Path Diagram of Project Organisation

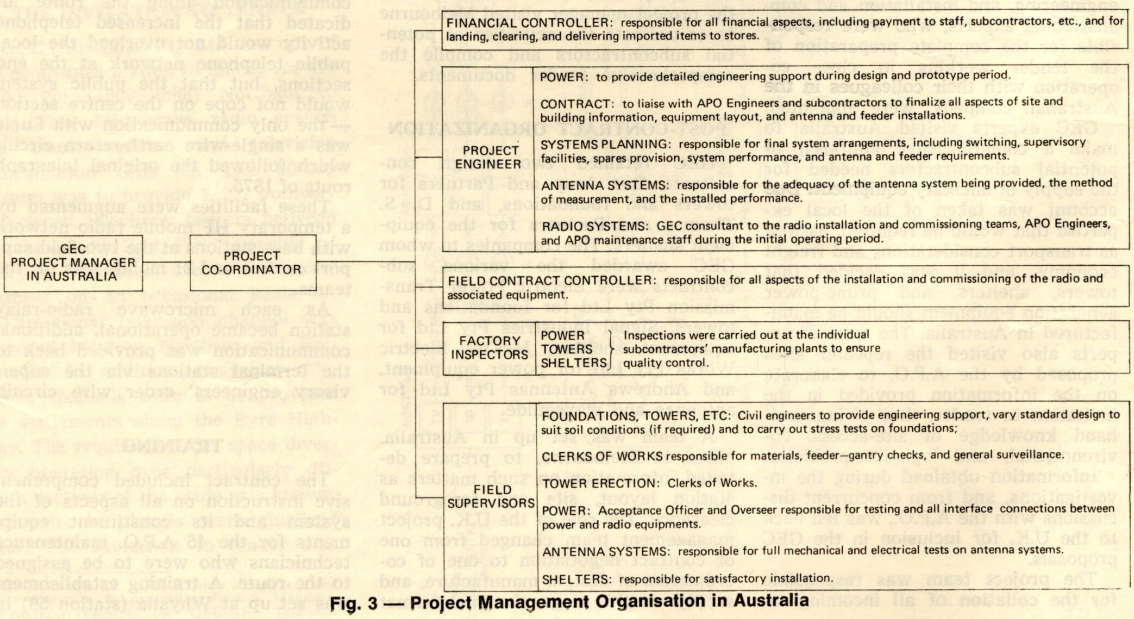

Fig. 3 — Project Management Organisation in Australia

RICHARDS & DONOVAN — Prime Contractors Role

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simulate a switching-section terminal, and provision was made to transmit to the next repeater along the route (Broadbents Hill) and back. GEC specialists, in co-operation with A.P.O. training officers, conducted two four-week courses in the theoretical and practical aspects of the system, its operation, and its maintenance. Instruction on the power equipment was given by McColl Electric engineers.

CONCLUSION

The article has illustrated one means of contract co-ordination employed by a company that has experience of 'turnkey' contracts in many parts of the world. The diverse requirements of the contract, the high locally manufactured content, and the long distance between prime contractor and customer indicated that best co-ordination would be obtained by appointing two Project Managers, one in the United Kingdom and the other in Australia, with equal general authority but each with overriding authority in his own sphere of activities. This, in conjunction with the tightly knit communications complex between all teams, ensured smooth continuity from the Invitation to Tender stage to the hand over of the complete system to the A.P.O.

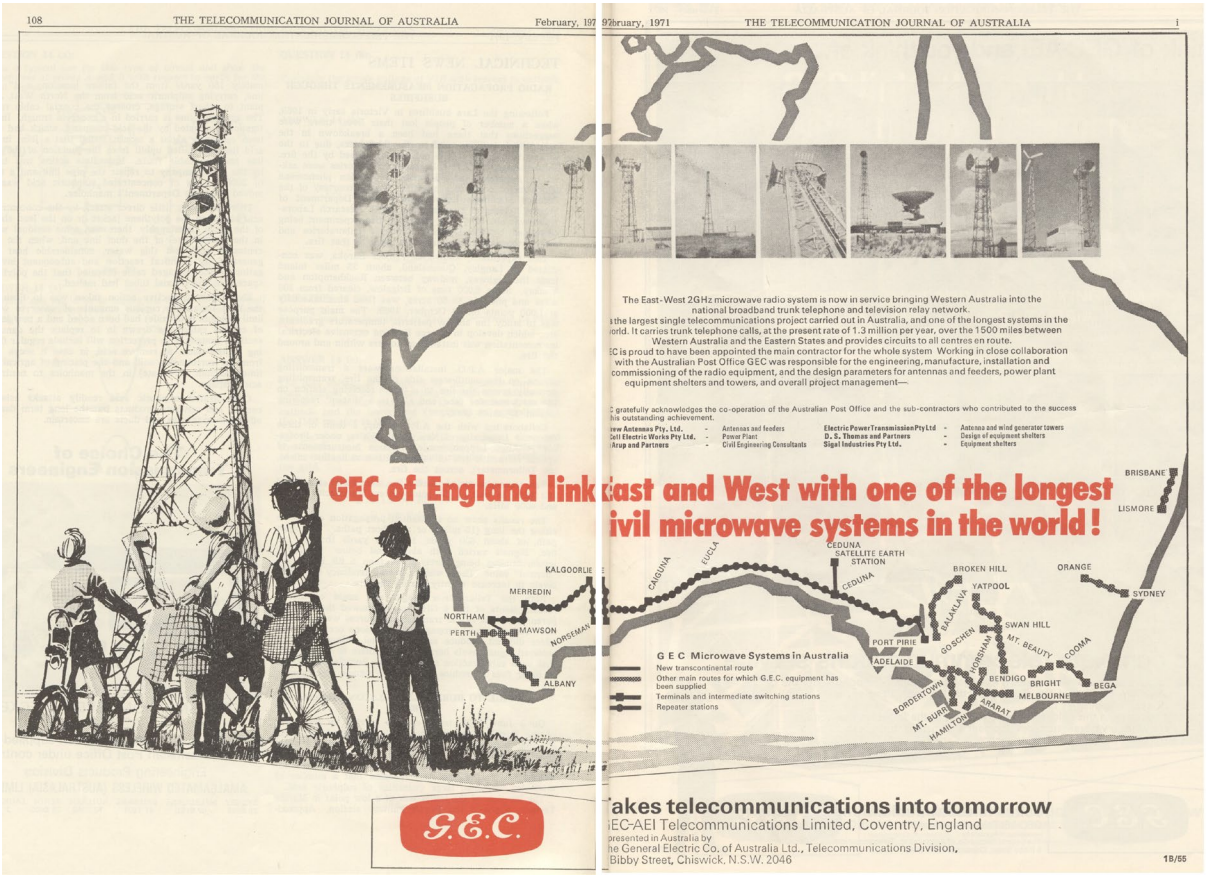

Figure 5. The GEC Australia advertisement that appeared in the TJA, *21*(1), February 1971, 108–109

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