

COMMUNICATIONS RESEARCH CENTRE

ANNUAL REPORT 1973-1974



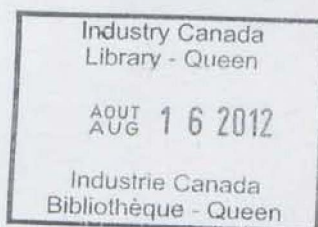
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COMMUNICATIONS RESEARCH CENTRE
OTTAWA

ANNUAL REPORT
1973 - 1974

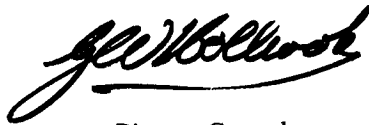


Dr. J.H. Chapman,
Assistant Deputy Minister (Research)

Dear Sir:

I have the honour to submit to you the Annual Report
of the activities of the Communications Research Centre for the
fiscal year 1973/74.

Yours faithfully,

A handwritten signature in black ink, appearing to read "J.C. McAllister", with a horizontal line drawn underneath the signature.

Director-General

1-7-74

TABLE OF CONTENTS

FOREWORD	1
HIGHLIGHTS OF ACTIVITIES, 1973 – 74	9
RADIO RESEARCH DIRECTORATE	12
COMMUNICATIONS SYSTEMS DIRECTORATE	17
SATELLITE COMMUNICATIONS SYSTEMS DIRECTORATE	23
COMMUNICATIONS TECHNOLOGY SATELLITE	28
INFORMATIQUE DIRECTORATE	30
ADMINISTRATION DIRECTORATE	34
APPENDIX A – CRC Project Fiscal Year 1973/74	40
APPENDIX B – CRC Operational Plan – Fiscal Year 1973/74	41
APPENDIX C – Summary of Computer Costs for Computing Services	42
APPENDIX D – Programs With Other Departments and Agencies	43
APPENDIX E – Services Provided to Industry FY 72/73 and FY 73/74	45
APPENDIX F – Industrial Contracts	46
APPENDIX G – University Research Contracts	48
APPENDIX H – Seminar Committee Guest Speakers	50
APPENDIX I – Patents	51
APPENDIX J – Research Laboratory Reports and Proposed Publications Cleared by the CRC Document Review Panel	53
APPENDIX K – CRC Liaison Officers	65
APPENDIX L – Major Construction Status Report	66

FOREWORD

The research centre's four years of existence as the Communications Research Centre, rather than the Defence Research Telecommunications Establishment, is a relatively short period of time in terms of developing research programs. Programs which were in hand in 1969/70 are now receiving less emphasis and a profusion of new projects, relevant to the Department of Communications rather than the Defence Research Board, is emerging. The Centre is gradually approaching and assuming its new and wider mandate of research in the whole field of communications, both military and civilian, and a broader aspect of radar research.

OBJECTIVES

The roles of the Communications Research Centre (CRC), as established by the Assistant Deputy Minister for Research (ADMR), are based upon the current objectives of the Department which are: —

1. To foster the orderly development and operation of communications for Canada in domestic and international spheres.
2. To foster, develop and introduce new communications systems, facilities and resources.
3. To foster, develop and extend telecommunications services in order to obtain optimum benefits for Canada both immediately and over the long term.
4. To protect and sustain Canadian interests in international telecommunications systems, services and undertakings.
5. To improve and extend the utilization of the radio frequency spectrum to permit the development and growth of radio communications.
6. To study the legal and economic aspects of communications and to systematically amend or develop the regulatory processes.
7. To study the impact of new communications systems on society. During the 1973/74 fiscal year, the wider responsibility of CRC to undertake research in communications, radar and space technology was examined in depth. The result of this examination has led to the more precise definition of the role of each directorate, within the Centre, in terms of primary and secondary responsibilities for various topics within these fields. These definitions are reflected in the roles of each of the programs within each directorate.

ROLES AND ORGANIZATION

CRC is organized into four research directorates and a directorate of administration as shown in Figure 1 and implements the roles of CRC by:

1. Providing data and expert advice within the field of Communications at both the national and international level, for:

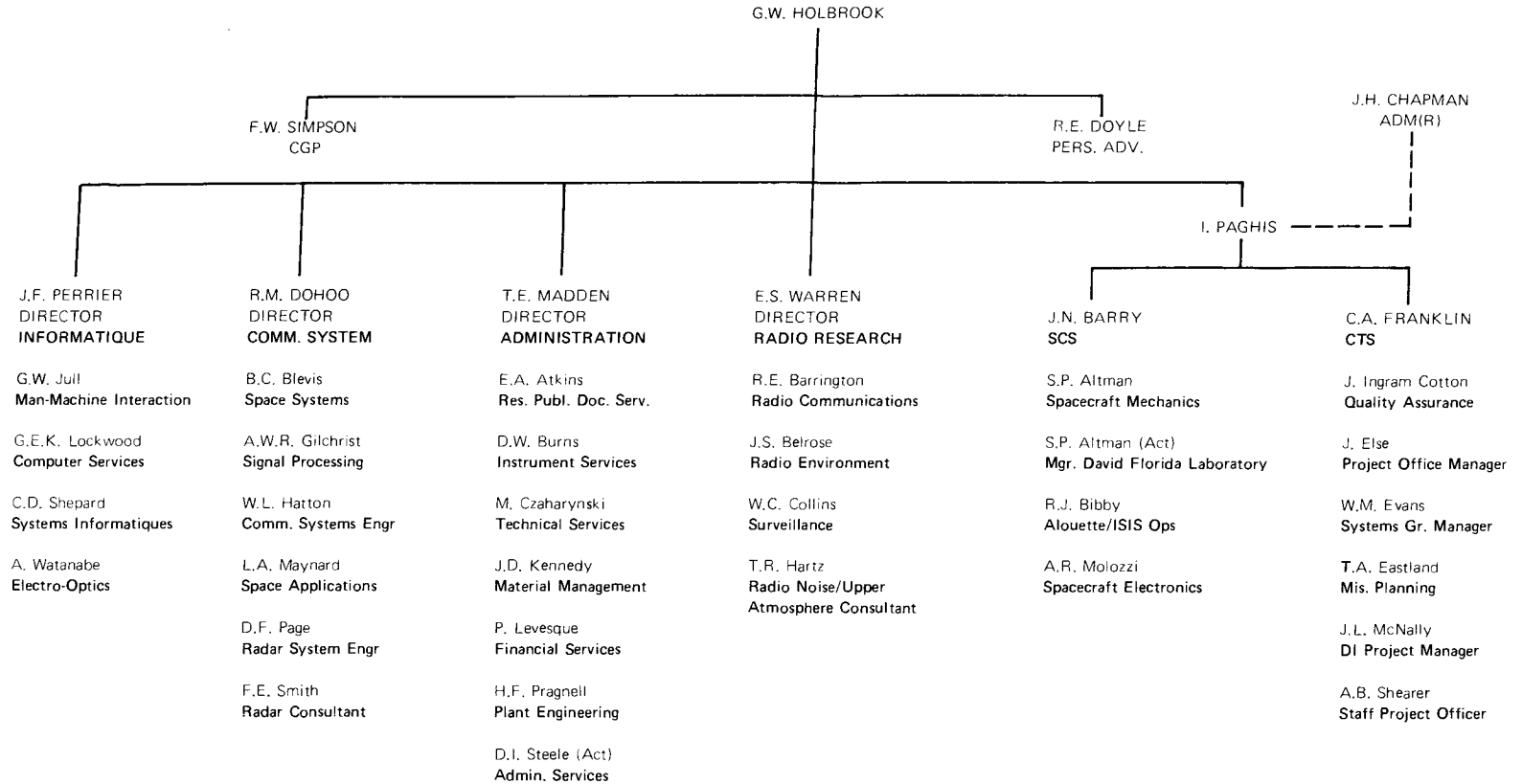


Figure 1. CRC Organization

- (i) Department of Communications
 - (ii) Other government departments and agencies
- 2. Conducting in-house research and development, and managing research and development contracts in Canadian universities and industry in support of:
 - (i) The objectives of DOC
 - (ii) Other government departments and agencies, in areas where CRC possesses unique personnel resources or physical facilities.
- 3. Maintaining liaison with, and providing information to, Canadian universities in matters related to (1) and (2) above.
- 4. Providing technical and scientific assistance to Canadian industry in matters related to (1) and (2) above.

Each research directorate is composed of three or more programs. The program manager's office is a financial responsibility centre and is considered to be the lowest level of permanent structure within the Centre. Each program manager's office is responsible for a defined area of research responsibility and these are described in this report. This responsibility is met by a number of research projects which will vary in size and content from time to time. Two exceptions to this situation presently exist and these are reflected in two of the major project offices:

- (a) Communications Technology Satellite – Spacecraft managed by Dr. Franklin who is directly responsible to Dr. Paghis the Director of Satellite Communications Systems. For this particular project, Dr. Paghis is directly responsible to ADMR.
- (b) Communications Technology Satellite – Communications Experiments managed by Dr. Blevis who is directly responsible to Dr. Dohoo, the Director of Communications Systems.

Both of these project offices will be discontinued on the completion of their projects and the personnel absorbed into other continuing programs on new and special projects. In 1973/74 CRC was involved in approximately 50 research projects which are described in their respective Project Approval Documents. The list of these projects is contained in Appendix A.

FUNCTIONAL RESPONSIBILITIES

CRC has attempted to coordinate internal projects, encouraging a productive overlap between responsibility areas of the directorates while eliminating any unnecessary duplication of effort.

Figure 2 represents the functional responsibilities of the four research directorates in terms of the interface between man and a communications system. As the communications link between man and man increases in sophistication, more directorates must be involved in the process of contributing to the solution of the problems that arise in establishing that link. Simplistically speaking, and only considering examples, Informatique Directorate would be concerned with communications by computer systems; Communications System Directorate would also participate if the system included communications by telephone or other line networks; Radio Research Directorate with communications by terrestrial radio systems; and Satellite Communications Systems Directorate with communication by satellite.

The Administration Directorate provides all the administrative and technical support for the Centre. Since there is no cost accounting to the research projects for the technical services performed, this directorate assumes a significant portion of the indirect cost of the projects. This is the basis for the resources distribution shown graphically in Appendix B.

The computing service for the Centre is handled in-house by the Informatique Directorate. Again, no cost accounting is made to the projects, although an experiment involving "paper dollars" was conducted throughout the 1973/74 fiscal year. A summary of costs incurred by each directorate is shown in Appendix C.

COORDINATOR GOVERNMENT PROGRAMS

A considerable share of the present research effort is directed towards the support of other government departments. Since this work is distributed within the four research directorates, Mr. Frank Simpson, has been appointed Coordinator Government Programs and reports directly to the Director General. The CGP office is responsible for the planning, coordination and overall management of activities and programs for other Government departments at CRC.

CRC/DND PROGRAM

By agreement DOC/DND, CRC undertakes R & D programs for DND. Projects and tasks are negotiated and funding recovered. Individual programs can be supported by additional funds from NDHQ directorates.

In FY 1973/74 agreed commitments of effort were met. Sixty man years were provided. Recoverable funds were \$2.48 million and supplementary funding of \$590 thousand was provided. The work comprised 45 short and longer term tasks. Results were reported directly to the client by specific communication and all programs were reported quarterly and annually to DRB. Consultation, advice, briefings to military units and visitors, etc., were also provided. Senior DND staff attended CRC annual program reviews.

The recoverable program for FY 1974/75 was planned and agreed by DOC and DRB. It comprises 57 man years of effort and total funding of \$2.2 million based upon up-dated CRC salary and overhead rates.

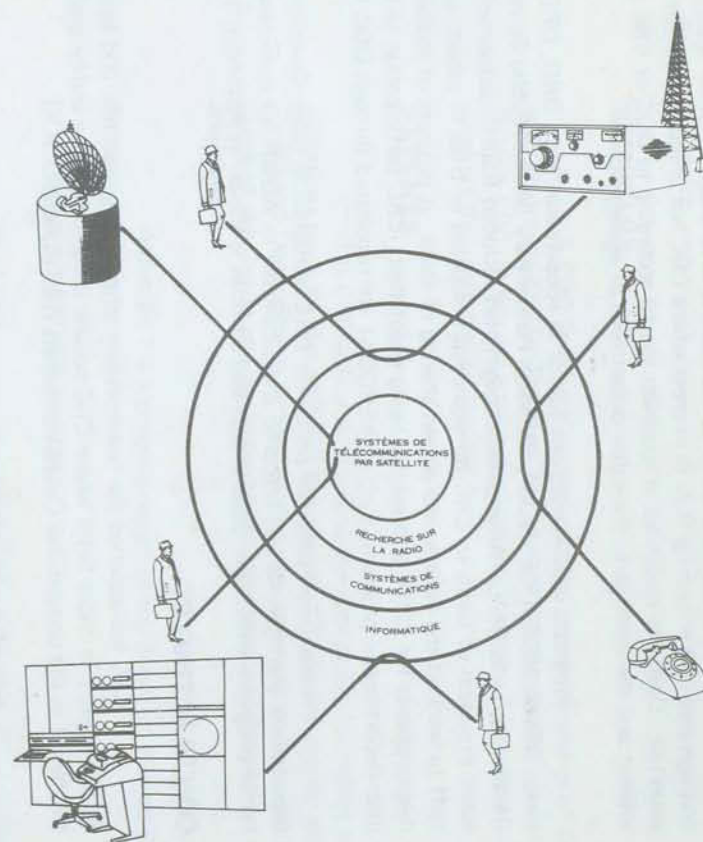
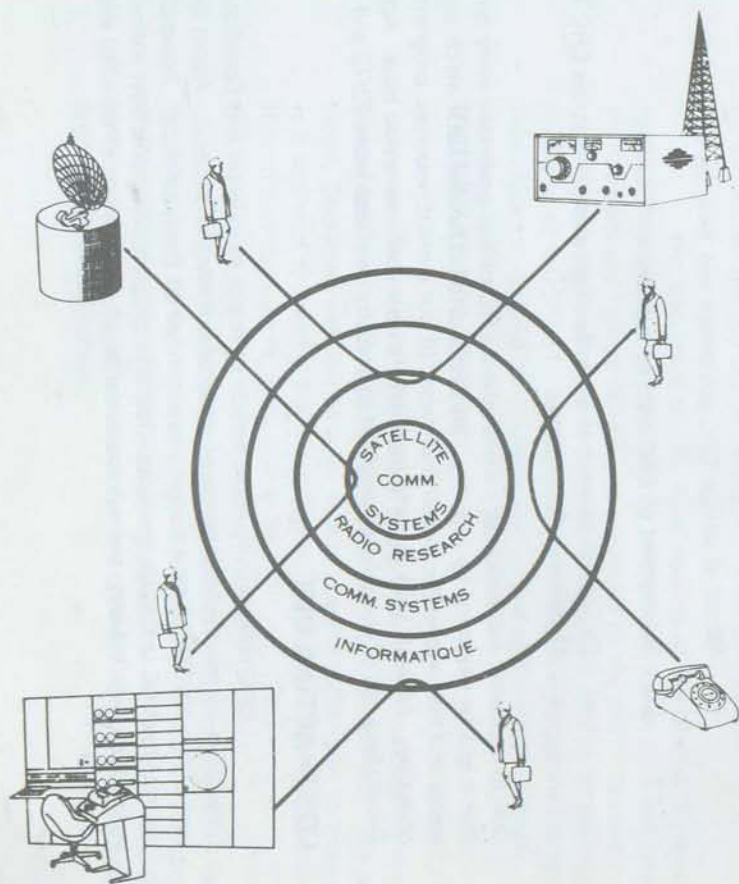


Figure 2.

OTHER GOVERNMENT DEPARTMENTS AND AGENCIES

Under the defined goals of the Centre, CRC supports other departments and agencies by performing R & D in areas where CRC has unique capabilities or expertise. Costs are recovered or expenses shared according to DOC or CRC self interest and the benefits to the other department or agency.

Programs were carried out for, or in cooperation with, DND, DRB Establishment, DEMR, MOT, DOE, RCMP, Canadian Penitentiary Service, Public Service Commission, and DITC. Arrangements negotiated included full reimbursement in some cases; provision of funds to CRC for equipment, supplies or trials in others; posting of staff to work at the Centre; and agreed sharing of costs. A program of radiometric measurements for COTC is presently being negotiated. CRC participation in large inter-departmental programs such as AEROSAT are negotiated through DOC HQ.

A discussion paper on policy for CRC assistance to other Government departments and agencies was prepared and submitted to ADMR for consideration. A list of programs with other departments and agencies is shown in Appendix D.

CONTRACTING IN

CRC has assumed the responsibility of providing scientific and technical aid to industry in those fields where CRC possess unique expertise and/or equipment not found in the competitive Canadian market. For example:

- (a) Consulting Services
- (b) Test, design and/or assembly of hardware using CRC staff, laboratories and facilities.
- (c) Rental of unique CRC equipment and facilities to industry.
- (d) Secondment of CRC staff to industry.
- (e) Circulation of a list of all unclassified publications, the CRC Index of Research Publications.

Due to economic and personnel consideration, CRC cannot undertake every service that might be requested by industry. We attempt to undertake work which complements and falls within the overall framework of our current resources, programs and objectives. All such work is performed strictly on a cost-recoverable basis. Appendix E includes a list of the services provided to industry for fiscal years 72/73 and 73/74.

CONTRACTING OUT

CRC relies heavily upon outside contracts to industry and Canadian universities for the implementation of many of our research projects. About 80 per cent of the 1973/74 Capital budget was expended on these contracts. Appendix F summarizes CRC industrial contracts. The CTS program depends almost entirely on contractual with industry and represents the largest single input to the CRC industrial contracts.

The university program was carried out mainly in two ways: some projects were sponsored by CRC and financed by the departmental research committee; other projects were sponsored and financed by CRC. Appendix G lists university contracts by topics.

SEMINARS

A CRC Seminar Committee under the chairmanship of Dr. K.O. Hill was organized in 1973/74. The main function of this committee is to invite speakers from outside CRC, to talk on a subject of general interest. Appendix H lists the guest speakers that were invited to CRC.

PATENTS

It is CRC policy to promote the application for patent to cover new inventions made by the staff. In this respect, CRC works closely with the Canadian Patent and Development Limited so that new ideas can be patented to protect the rights of the Crown and the individual(s) concerned and licensed to industry to be exploited.

Appendix I is a progress report of the invention notices filed by CRC during the past fiscal year.

DOCUMENT REVIEW PANEL

The publication and distribution of CRC documents results in the formal commitment of the Establishment to the information and opinions thus circulated outside. The final responsibility for ensuring that all CRC formal documents meet appropriate standards rest with the Director General. Without formal approval on his behalf, documents will not be released for external distribution.

The Document Review Panel consists of the Director General, the four research Directors and Mr. E.A. Atkins and reviews, for security and related considerations, papers and reports written and submitted by the staff. Appendix J lists the research laboratory reports and proposed publications cleared by the CRC document review panel in 1973/74. A CRC Index of Research Publications listing all unclassified publications is updated continuously and circulated throughout Canada.

EXTERNAL RELATIONS

The roles of CRC include a responsibility for cooperating with the research elements of Canadian industry and Canadian universities. This activity is closely associated with the directive to buy research rather than to make it in-house. It is also vital to meeting the wider responsibility of undertaking research in the total field of communications, radar and space.

To meet these responsibilities, CRC must have a solid information base not only of the current research programs of both industry and universities but also of the research potential of individual organizations. At the same time CRC must keep industry and the universities informed of the on going and proposed research program of the department.

While it is appreciated that there is a significant and very useful informal liaison existing at the working level it is also evident that this liaison is uncoordinated and that the information generated is not integrated into a cohesive bank of knowledge. In order to formalize and to coordinate liaison with outside agencies, responsibilities have been delegated as follows: --

- (a) Coordinator of CRC relationships with Canadian manufacturing industries working in or having potential for working in the fields of communications and space -- Mr. R.M. Dohoo
- (b) Coordination of CRC relationships with Canadian Universities which have viable graduate or research programs in the fields of communications and space -- Dr. E. Warren
- (c) Coordination of CRC relationships with the common carriers -- Dr. J.F. Perrier

Each of these coordinators has or is in the process of appointing individual liaison officers to carry out this function with either an industry or a university. The names of the current appointees to these liaison roles are shown in Appendix K. It is appreciated that the function represents an expenditure of time on the part of both the individual liaison officers and the coordinators, however it is anticipated that there will be a tangible return in terms of mutual exchange of information and the establishment of good will.

PERSONNEL ADVISER

The office of the Personnel Adviser, reporting to the Director General, CRC, underwent considerable expansion in staff, both as more functions were delegated from Headquarters and as fundamental and far-reaching changes in personnel policy, such as staffing of bilingual positions and replacement of staff on language training, were introduced. With the exception of the classification function, all fields of personnel work, including allied areas such as compensation and benefits, are carried out at CRC by a staff of fifteen professional and support personnel. A variant on the classification function is proposed for CRC, and this is classification by committee rather than classification by a personnel officer.

The staff expansion noted above underscores the heavy workload undertaken by Personnel. In addition to an marked increase in staffing activity, more emphasis was placed on manpower planning, training and development and staff relations.

BILINGUALISM

The role of the bilingualism division at CRC is to provide services and special programs which respond to the particular needs of CRC. In 1972/73, the emphasis was placed on offering linguistic services to the employees. In 1973/74, these services were continued, but the emphasis shifted to make people more aware of and convey more information about bilingualism in the Public Service.

Amongst our programs, the bilingualism division was responsible for providing the following:

- language training services such as Berlitz, Intext, Voix et Images de France
- special courses such as basic courses for secretaries, French and English administrative courses
- coordination of language training with the Language Bureau
- complementary instruction service with monitors
- language testing
- circulation of information concerning bilingualism
- control of the utilization of additional resources
- the official Language administrative system

This year the main activity was the organization of a plan to administer the Official Languages Act. This task necessitated several meetings with managers, language coordinators and groups of employees. All CRC positions were identified and given a designation date if identified bilingual.

HIGHLIGHTS OF ACTIVITIES 1973/74

Dr. Maxwell Yalden, newly appointed Deputy Minister, visited CRC several times to familiarize himself with the staff, facilities and programs at CRC. The briefing schedule was as follows:

June — first visit to CRC. Briefings were given by:

Dr. Chapman on the Research Branch
 Dr. Holbrook on the Centre
 E. Madden on Administration Directorate
 Dr. Paghis and associates on CTS.

July — two visits to CRC. Briefings given by:

R.M. Dohoo on Communications Systems Directorate
 Dr. J.F. Perrier on Informatique Directorate

October — one visit to CRC. Briefing given by:

Dr. J.N. Barry on Satellite Communications Systems Directorate

November — briefing given at DOC headquarters by:

Dr. E.S. Warren on Radio Research Directorate.

In December, Dr. Yalden met at headquarters with the Director General and the CRC Directors to review the important aspects of briefings given to him by each directorate and visits he made to CRC during the summer. Some of the subjects discussed were the structure of CRC, the research scientist classification, the planning in the research division, the make or buy research, work performed by CRC for other departments, participation at conferences and the space problem at CRC.

In January, CRC briefed the members of the DOC Research Committee and other guests from DOC headquarters on the proposed CRC operational plan for the new fiscal year.

In March, the Honorable James Richardson, Minister of National Defence, announced that the entire CRC military radar research program, presently a staff of 29 with an annual budget of around \$1.2 million, will be transferred to the new \$11.5 million research facility being built in Winnipeg by the Defence Research Board. The strong DOC presence in the west should stimulate growth of high-technology secondary industry and strengthen research in communications.

In September, the Honourable Jeanne Sauve, Minister of State for Science and Technology, presented a model of the Alouette I Satellite built at CRC to the Chinese Academy of Science in Peking on the occasion of the visit of the Canadian Scientific Delegation to the People's Republic of China.



A Model of the Alouette I Satellite Built at CRC and Presented to the Academy of Science in Peking.

In June, The Director General of CRC addressed the Canadian Telecommunications Carriers Association at their annual meeting in Harrison Hot Springs, B.C. and talked about R & D as it pertains to telecommunications as the 70's progress and more specifically about the government laboratory view of the Make or Buy policy and its interface with industrial research. In September, he attended the Product Innovation Canada Seminar in Muskoka, Ontario. In October he visited, along with Dr. Perrier, Director, Informatique, Maritime Telephone and Telegraphs and New Brunswick Telephone to acquaint these companies with the on-going research programs at CRC, to establish a rapport between the firms and their operational needs and to identify any courses of action related to their needs.

At the end of October, he visited the Queen Charlotte Islands to attend a conference on rural health delivery. The conference objective was to propose a model applicable to localities in British Columbia and elsewhere in Canada. During the year, he also visited the University of Western Ontario to review and assess the interdisciplinary centre for Radio Science and McMaster University as a member of the National Research Council Grant Review Committee.

In August, the largest Red Cross blood donor clinic ever was held at CRC with one hundred and seventy-three (173) voluntary blood donors being registered far surpassing the previous record of one hundred and twenty-five (125) in October 1965. Again this year the employees contributed generously the sum of \$7306.90, or 99 percent of their set objective, to the Public Service United Appeal Campaign.

CONCLUSION

During the fiscal year of 1973/74, CRC has achieved a broader interest in and a stronger commitment to subjects which are of vital importance to the department. It has also accepted an increased responsibility in its second major role of undertaking work for other government departments in areas where it possesses special facilities or expertise. It will be appreciated that the CTS program, involving both the space and the terrestrial segments, is the single largest project at CRC and one which will continue to dwarf any other project until at least 1976. However, the size and complexity of this project should not be allowed to overshadow the other significant, though smaller programs which are in hand. The roles of the other programs are outlined in the reports of the four directorates which together, with the highlights of the year and the attached appendices reveal the scope of the overall work of the Centre.

I wish to thank my colleagues, both at CRC and at DOC/HQ, for the support that I have received throughout the year in implementing the role of the Centre in the form of our current program.

RADIO RESEARCH DIRECTORATE

ROLE

The subject area of the directorate consists of the diverse influences of the geophysical environment upon the propagation of radio waves and the consequence of these influences on the use of the radio spectrum.

The scope of the Radio Research activity includes the investigation and measurement of man-made and natural interferences; the interaction between physical media and radio waves; and the potential and restrictions that such interactions, interference and natural noise imply for radio systems. It also includes the devising of techniques for the solution of the related practical problems.

HIGHLIGHTS

During the year Radio Research expanded its interests into the higher portions of the radio spectrum and initiated a program of propagation research at microwave frequencies in support of terrestrial communications. Radio climatology studies were begun at the request of the CRTPB; these include the preparation of atlases of microwave refractivity and of microwave attenuation resulting from rainfall precipitation. Other propagation studies were undertaken, through the contracting-out process, of the literature on anomalous propagation, of microwave ducting, and of communications to off-shore oil-drilling rigs.

Research activities have continued at HF, though with some shift of emphasis. The HF prediction service, developed at CRC, has been transferred to Telecommunications Regulations, and the provision of seminars on the optimum use of the HF spectrum to interested groups is being discontinued at CRC and is to be a Regional responsibility. The provision of advice to other agencies on the special technical problems encountered in the use of the spectrum has continued: several research projects were carried out under DRB support, some studies were conducted for NRC, and a series of HF communications trials were conducted between Ottawa and MOT ice-breakers operating in northern waters.

The research on the natural environment has continued to be productive. Progress has been made on studies of electron production rates in the D-region, on the generation of noise emissions or 'hiss' in the high-latitude ionosphere, on the physics of hot plasmas, and on natural processes in the Magnetospheric Cleft region. The ISIS satellites continue to produce very good data and the various experimenters involved in that program have continued their systematic, multi-experimental studies of ionospheric features and phenomena. New insights have been obtained concerning noise generation and concerning the structure and behaviour of the ionosphere in the polar and equatorial regions.

RADIO COMMUNICATIONS PROGRAM

ROLE

The role of the Radio Communications program is to perform propagation research and to assemble propagation data into readily usable formats for applications by radio engineers. The program consists of the acquisition of basic data on radiowave propagation at frequencies throughout the entire radio spectrum, from other agencies

where possible and by experimentation where necessary; the processing, analysis, and presentation of this data in a form convenient for use. These activities include development of ionospheric radio propagation predictions and forecasting techniques; provision of radio climatology charts for tropospheric refractivity and for radio wave attenuation due to rain; development of radio techniques for remote sensing; collecting statistics on ducting, scatter, and other propagation phenomena, and studies of the propagation factors that determine the extent of the usable radio spectrum.

HIGHLIGHTS

In the past few years, exploratory offshore drilling for oil and gas has increased off Canada's Atlantic coast, and some difficulties have been experienced with communications between shore station and drilling vessel.

Solutions to such problems have implications for the management of spectrum usage and are therefore of concern to CRC and the Department. Accordingly, agreement was reached with the Eastcoast Petroleum Operators Association for a jointly funded study to investigate the existing communications systems, to determine the problems and to recommend solutions. A contract was let to Petrie Telecommunications Ltd. for a study conducted in cooperation with CRC. This study was completed in February 1974. It is anticipated that the results will lead to the improvement of offshore communications for the oil industry and will also be useful to other groups with similar requirements.

A 10 GHz radiometer was developed and calibrated for use at Queen's University in experiments on the biological effects of non-ionizing radiation. CRC technicians assisted in the experiments at the University in which rabbits and other biological subjects were irradiated with microwave radiation, and their body temperature monitored in the post-radiation phase by the radiometer. The results showed that the body temperature was depressed by exposure to the radiation, but recovered to normal within a period of a few minutes. Repeated exposures to microwave radiation tended to reduce the magnitude of the response. These tests demonstrated the value of the radiometer as a tool for exploring the interaction of biological subjects of increasing concern in many countries as the sources of microwave radiation proliferate, and, particularly in the urban environment, humans are exposed to ever increasing intensities of such radiation.

RADIO ENVIRONMENT PROGRAM

ROLE

The role of the Radio Environment program is to identify and measure the properties of the material and electromagnetic environments that interact with radio systems. The emphasis is on research that will provide background knowledge. However, limited studies of a more applied nature are also undertaken. The work includes determining the structure and radio properties of the ionospheric layers; the properties of electromagnetic noise and interference; and the relation of solar activity to terrestrial radio phenomena. Also included are electromagnetic probing of the atmosphere, ionosphere, earth and ocean; ionospheric modification by addition of chemicals or energy; and the implications of phenomena such as refraction, reflection, scatter, scintillation, wave-interaction, time and frequency dispersion, and attenuation, for communications.

HIGHLIGHTS

The current Radio Environment research program includes the investigation and measurement of man-made and natural interference and investigations of the upper and lower ionosphere. The interaction between the physical media and radio waves and radio interference and noise impose limitations on the performance of systems involving transmission of radio waves. The research involves probing of the earth's atmosphere by radio waves, and observations of the effect of the medium on the ionospheric propagation of these waves, and is therefore primarily concerned with the employment of waves of frequencies less than 30 MHz; but research done co-operatively with the Telecommunications Regulation Branch has been concerned with spectrum usage in the VHF land mobile bands and with noise and interference extending into the lower UHF band. The objective of the research is to improve our knowledge of the radio environment and provide observational data needed by scientists and engineers concerned with optimizing communications and navigation systems using ionospheric propagation.

The CRC and Regulations Branch have been co-operating for several years in radio interference studies. The interests of the Regulations Branch is primarily spectrum occupancy and usage; that of CRC is evaluation of the influence of interference and noise upon the performance of systems. Accomplishments during the year include further testing and evaluation of the laboratory designed and built HF Environmental Monitor System, a sophisticated computer-controlled receiver and antenna system that can be used to automatically measure radio noise and interference in the frequency range 2 – 30 MHz; and test and evaluation of a prototype amplitude probability distribution meter, which was developed in the USA. A similar equipment is presently under construction and when completed it will be an invaluable addition to the measurement capability of the Group for identifying and classifying various types of radio noise. The measurement of the base noise level against which the degree of man-made noise and interference can be judged at the CFS Mill Cove, N.S. receiver site this year has been completed. Measurements were made in four seasons. Similar noise measurements are being made at several sites in the Ottawa area and advice on experience gained in the course of this work is being given to other government departments.

The Upper Ionosphere Group has continued its co-operative investigations with experimenters from other agencies in the analysis of Alouette-ISIS satellite data. Accomplishments during the year include studies of field-aligned ducted echoes; and studies of strong narrow bands of radio noise at frequencies near 2 and 4 MHz and of discrete noise bands at VLF frequencies named V's or saucers because of the shape of their signature in a frequency-time record. Investigations of these naturally occurring radio noise signals lead to insight into non-linear interactions, possibly involving the conversion of electrostatic waves to propagating ordinary mode waves, and to effects of vertical currents and precipitating energetic electrons to the generation of noise in the upper ionosphere. Studies of the mid-latitude ionospheric structure during the great magnetic storm of August 1972, a storm of almost unprecedented magnitude; and of the distribution of electron density over the polar cap employing almost simultaneous topside sounder data from two or three satellites (Alouette II and ISIS I and II) is near completion.

The Lower Ionosphere Group has also made considerable advances in various aspects of their research program. A review paper was prepared, and presented at the COSPAR Conference on Lower Ionosphere Structure, May 1973 at Konstanz, FRG, on the use of long-wave waves as a probe to measure electron density height profiles in the ionosphere. This paper, while it was a general review of the work in this area, work which has just recently begun to make progress but which is now suspended due to change in program within the Radio Research Directorate. The re-evaluation of the partial reflection experiment is now complete. This work began last year with the addition of differential phase measurements to complement the differential amplitude measurements; research which provided conclusive evidence for a $\Delta N/N$ being responsible for the partial reflection (irregularities in electron density). The work this year has been concerned with an investigation into the effects of limited height resolution in the differential phase, differential absorption partial reflection experiments. Modifications to the partial reflection sounder system at Ottawa, rather extensive modifications, to improve the reliability of the experiment and to extend its usefulness as an EM probe to study the lower ionosphere are well underway. The purpose of this work is to utilize the partial reflection sounder to study fading, direction of arrival, measurement of both phase and amplitude in order to better understand the nature of the ionization irregularities responsible for the partial reflection of radio waves from the D-region; and to study the bulk movement of the background ionization densities. Experimental observations are expected to begin in the third quarter of next fiscal year. In the meantime current research into the electron density changes over dawn, and during absorption disturbances continued (disturbances associated with high energy particles).

SURVEILLANCE PROGRAM

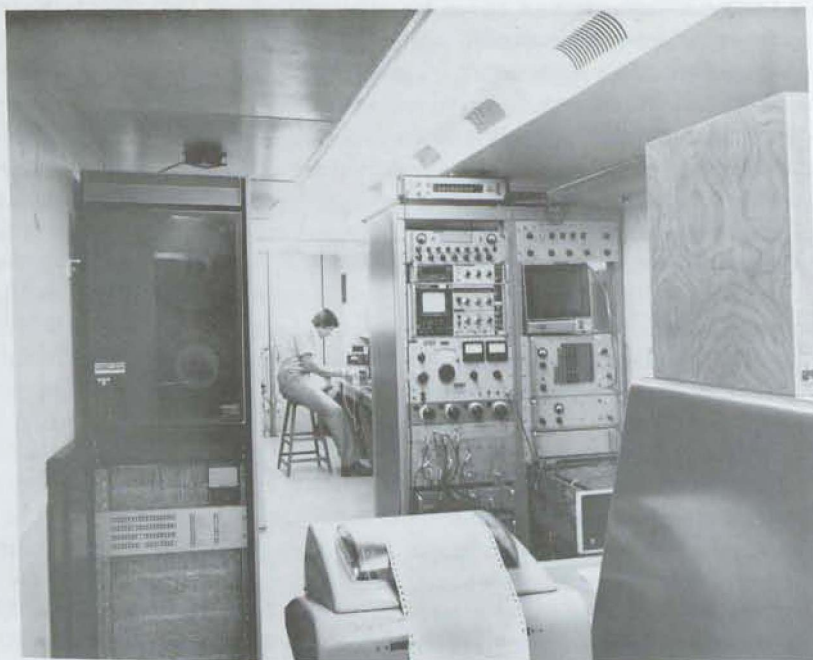
ROLE

The role of the Surveillance program is to apply propagation and environmental research knowledge and techniques to the optimization of specific radio systems. The program includes the improvement of the performance of radio direction finding systems, navigation, remote sensing and radio communications in these problem areas for which the major obstacle to improved performance consists of radiowave interaction with the environment. This work includes both long-term optimization work at the CRC and short-term activities at other locations for system improvements.

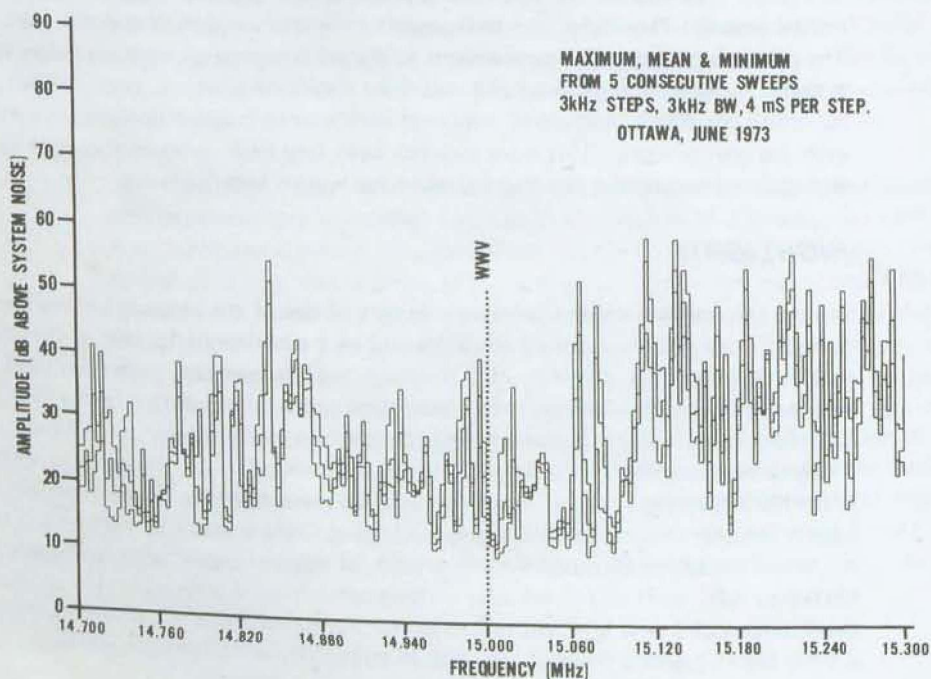
HIGHLIGHTS

Antenna studies carried on as part of one of the projects for the Canadian Armed Forces has led to new knowledge and new applications for one of the oldest and simplest antenna elements, "the Beverage". These elements have been used in two large arrays for high-frequency over-the-horizon radar studies at Cambridge Bay in the Canadian Arctic. One installation is a wide-aperture (4000') linear array having about a 1 degree beam width for the study of ionospheric irregularities; the other is a circular array (800' diameter) for the investigation of spurious side-lobe signals from the main radar. Another circular array is being installed at Ottawa where it will be used to test a simple inexpensive direction-finding system for which a patent application was submitted by CRC staff late in the year. These antenna studies have also led to the development of a new low cost technique for measuring antenna patterns by means of a small high-frequency receiver mounted in an aerodynamically-stable plastic sphere which can be towed behind a light aircraft.

RADIO RESEARCH DIRECTORATE



View of mobile high frequency environmental monitoring system (HFEMS). The HFEMS is a sophisticated computer-controlled receiver which can be used for spectrum monitoring. It also supplies information on the modulation characteristics and transmission loss of radio signals for statistical studies aimed at improvement of radio systems.



A sample sweep of a part of the HF spectrum showing some possibilities for measurement of spectrum occupancy. The recording was made on the afternoon of 12 June, 1973 in Ottawa employing an omnidirectional 25 foot vertical antenna.

COMMUNICATIONS SYSTEMS DIRECTORATE

ROLE

The Communications Systems Directorate is responsible for systems (rather than device) research and development. The directorate is responsible for the recommendation, management and implementation of research programs of the Communications Research Centre in telecommunications, terrestrial and space communication systems, radar and remote sensing systems and their application. It also actively participates in National and International committees in these areas and it maintains liaison and coordinates with other telecommunications research centres and provides advice and assistance to the Department as required.

HIGHLIGHTS

During 1972/73 R.M. Dohoo (D/CS) was appointed to coordinate the development of liaison with the manufacturing industries. In order to encourage liaison with industries more geographically remote from Ottawa he made several visits, in the company of Mr. R. H. Tanner (DIP). In May 1973 he visited industries in the prairie provinces and in British Columbia and in October 1973 he visited several companies in Nova Scotia.

In January and February 1974 R.M. Dohoo was seconded to Headquarters to serve on Working Group Number 22 of the Computer/Communications Coordinating Committee which, under the leadership of W. Pajor of the Treasury Board Staff, studied the role of the Federal Government in the regional development of EDP.

COMMUNICATION SYSTEMS ENGINEERING PROGRAM

ROLE

The aim of this program is to develop the tools and methodology of systems research and to carry out research in the fields of network and communication systems evaluation, synthesis and optimization. Activities in this program include the monitoring of national and international trends in technology, policy and costs of communications; research into the nature and scope of future communication services likely to be required in the national interest and the effect such services would have on the communities affected; modelling, analysis and simulation of systems and subsystems from both the technological and economic points of view; and synthesis and evaluation of technological options to meet needs in light of existing and future environments.

In line with the above objectives, the following projects were pursued in 1973:

- (a) The Data Terminal Research Project,
- (b) The Integrated Data Communications Systems Project, and
- (c) The Domestic Long Distance Communication Network Study.

The Data Terminal Research Project is a new project begun this year.

HIGHLIGHTS

In the Data Terminal Research Project the use of product research and development in support of policy was explored by a study of the feasibility of developing a data communication terminal which will meet existing user needs and also encourage the development of a coherent data communication system for Canada.

In co-operation with the Informatique Directorate, a number of studies have been carried out by industrial contract. Woods, Gordon & Co. carried out a User Requirement and Market Survey Study. Urwick, Currie and Partners Ltd. studied the state of the Canadian data communication terminal industry. They also completed a study of the present and future technology for data terminal equipment. DCF Industries carried out a study of standards and protocols for data terminals.

As a result of these studies it appears likely that it is feasible to support policy by the development of a data communications terminal. Early in 1974/75 recommendations will be made on follow-on program which will include the development in industry of a data terminal for a specific application which has been identified as having the greatest opportunity to meet the project's aims.

The development of a new distributed switch system for a transaction oriented data communication system was completed this year under the Integrated Data Communication Systems Project. The system, which was designed and built for CRC by Edmund Newhall Associated Ltd., was installed and successfully tested at CRC (and demonstrated at the computer show in Toronto). A more extensive system is now being developed to link E. Newhall Associates, the University of Toronto, the University of Waterloo, and CRC in a hierarchy of distributed switch loops.

In the Domestic Long Distance Communication Network Study, the development was completed of computer programs that make practical a study of how satellite communications can best fit into a mix of terrestrial and satellite facilities. These programs are now ready to be applied to the evaluation and analysis of the cost/ effectiveness of various mixes of space and terrestrial sub-systems to meet predicted communication requirements.

SPACE SYSTEMS PROGRAM

ROLE

The Space Systems Program is concerned with the requirements, technology, design and impact of space communications systems to satisfy a variety of communications needs and with the study of interference between space and terrestrial systems sharing the same frequency bands. Three projects are being carried out within the Program. The largest is the CTS Communications Experiments Project; the others are the Microwave Propagation Project and a Systems Technology Project carried out as part of a joint DOC/CBC study of satellite broadcasting. The Microwave Propagation Project will be transferred to the Radio Research Directorate in April 1974.

HIGHLIGHTS

The general objectives of the CTS Communications Experiments Project are to define, plan, co-ordinate and implement, in co-operation with other Canadian organizations, an integrated set of communications experiments using the SHF transponder in the CTS satellite and the preparation of specifications for, and procurement of, all the ground terminal facilities required to carry out the various Canadian experiments.

Following the October 1972 CTS meeting in Winnipeg, where potential experimenters were briefed on the status of the CTS project and the possibilities of its use for their experiments, a total of 49 proposals for communications experiments were received by the department. These proposals were reviewed in 1973 with the various organizations involved in order to define experiments that would be compatible with CTS and the proposed ground terminals. An independent Evaluation Committee appointed by the Minister of Communications met in April and July 1973 to make interim recommendations on the proposals. The Evaluation Committee will meet in April 1974 to make final recommendations to the Minister on those experiments which should be accepted. The time available to Canada for communications experiments will be a limiting factor in acceptance of experiments.

Specifications for ground terminals, to be provided by DOC to approved experimenters, were prepared during the year. Requests for Proposals were issued for Transportable Transmission and Voice Network Control Terminals, and for smaller Remote User Experimental Terminals. Bids were received for the Transportable Transmission and Voice Network Control Terminals and a contract should be let in May 1974. A contract for the Remote User Terminals should be let in the third quarter of 1974. Refurbishment of the 30-foot Communications Control Terminal at Ottawa, for operation with CTS, was begun this year.

Planning for communications experiments to be conducted by CRC in the area of propagation and systems was continued. A contract for electronics equipment for a Time Division Multiple Access Experiment will be let in April 1974.

In order to determine margins necessary for satellite communications systems operating in the SHF bands, the Microwave Propagation Project began measurements in early 1973 of the statistics of attenuation due to precipitation at seven locations across Canada. These locations are representative of different Canadian climatic regions. Radiometers, which provide a simple indirect measurement of atmospheric attenuation, were installed at Mill Village, N.S., Ottawa, Ontario, Allan Park, Ontario, Fort Smith, N.W.T., Thunder Bay, Ontario, Melville, Saskatchewan and Lake Cowichan, B.C. Records from these installations are being analysed at Ottawa to provide the required statistical information.

During the past two years, DOC and the CBC have co-operated in a Satellite Broadcasting System Study. The Systems Technology Project at CRC has provided a technical input to this study on satellite system models and their costs. Under contract, Bell Northern Research carried out modelling studies to define five system models which were the basis for subsequent cost-benefit analysis carried out by another group. The final report of the System Technology Project has been incorporated in an overall Study Report which was submitted to DOC and CBC senior management in March 1974.

RADAR SYSTEMS ENGINEERING AND SIGNAL PROCESSING PROGRAM

ROLE

The role of this program is to foster and maintain a research base of Canadian Government expertise in radar; to provide radar and signal processing consultation services and advice to DOC and to other Departments of Government; to carry out system studies and applied research to meet objectives mutually agreed between DRB and CRC relating to Canadian Forces requirements; and to satisfy the growing requirements for CRC radar expertise in civilian radar applications, as agreed between CRC and other Departments. This program is the major source of Canadian expertise to meet international defence commitments in the areas of radar and signal processing. Activities in this program include system studies aimed at improving the operation of radar systems in difficult clutter environments; radar research and studies in support of the Armed Forces, including studies and projects to solve existing radar problems; research and technological studies in the use of computers for radar detection and identification; studies on the application of microwave solid state technology to radar; and on the application and development of radar systems for remote sensing of earth resources.

HIGHLIGHTS

A major research project, concerned with the application of electronically-steered phased array antennas to radar systems was defined this year. Agreement was obtained from DND for supplying man-year resources and from the Royal Radar Establishment, U.K., for supplying a suitable antenna, in what would be a cooperative research program between DOC, DND and RRE in the U.K. Unfortunately, losses of staff and program uncertainties, caused by the announcement of the move of the program to Winnipeg in three years, has necessitated a re-evaluation of the project definition.

Work was completed for the Canada Centre for Remote Sensing, in the modification and commissioning of their dual-polarized, microwave scatterometer. It remains to assist them, in the coming year, to plan a schedule of activity for the instrument and to assist in developing a data analysis facility.

In co-operative winter experiments with the Department of the Environment on Lake Ontario and the St. Lawrence and Ottawa Rivers, a wide-band, impulse radar technique was demonstrated to be capable of measuring accurately fresh-water ice thickness of greater than 6 inches, from several hundred feet altitude. This work will be extended for sea ice experiments next winter.

In cooperative studies with CCRS, Barringer Research Ltd., and the Geological Survey of Canada, a GSC scientist was seconded to our program for the purpose of exploring techniques for remotely measuring soil moisture. This work will be extended to the remote measurement of permafrost properties in 1974.

SPACE APPLICATIONS PROGRAM

ROLE

The objectives of this program are to define and conduct research activities relating to small terminal satellite communication systems for use with large numbers of low cost terminals in remote regions and/or mobile platforms on board aircraft and ships, to provide research and development support, consultative services, and advice to other Government Departments and Agencies, especially to the Department of National Defence on Military Satellite Communications research, and to the Ministry of Transport in relation to both Maritime Satellite Systems and Aeronautical Satellite Systems. Activities in this program include studies of communications requirements, various aspects of system design, prototype development of specialized system components including modems and communications control units and the proving and testing of these systems components and concepts on existing space systems.

HIGHLIGHTS

Several co-operative experiments were carried out with Telesat Canada during the year. These experiments included the transmission of voice and teletype signals from Allen Park, via the ANIK I and II satellites, to the transportable DND/CRC earth station, which consists of a six-foot parabolic antenna with associated electronic equipments housed in a military vehicle. Preparations were made this year to continue these co-operative experiments with a series of low angle satellite propagation measurements to be taken at Eureka, N.W.T. in July 1974. The transportable terminal was made available, in September, for the official opening of the Ottawa United Appeal Campaign. The Hon. Jean-Pierre Goyer opened the campaign with a message transmitted via the Anik satellite and received by the transportable terminal located in Confederation Square.

A high quality voice delta codec suitable for use in small satellite ground terminal systems was produced in May 1973 through the combined efforts of CRC and industry.

It is expected that the co-operative effort of CRC and industry during this year on digital modulation techniques will produce Canadian-developed and manufactured channel units in 1974. Concurrent research was continued in the area of demand assignment techniques required for the development of hardware sub-systems which would be used with these channel units.

A Memorandum of Understanding was tentatively approved for the establishment of an experimental co-operative International Aeronautical Satellite program by Canada, the United States and the European Space Research Organization. In support of this program, CRC is undertaking research and development work on a wide range of communication techniques to provide efficient use of this facility for air traffic control in the North Atlantic. The work begun this year includes the development of ground station facilities which interface with existing air traffic control facilities, and the preparation of experiments to evaluate communication reliability between satellites and aircraft, using the NASA Applications Technology Satellites.



A transportable terminal located in Confederation Square Ottawa and employed to transmit a message via the Anik Satellite during the official opening of the Ottawa United Appeal Campaign.

SATELLITE COMMUNICATIONS SYSTEMS DIRECTORATE

ROLE

The prime objectives of the Satellite Communications Systems Directorate are to implement or support national and international experimental space programs, emphasizing applications to satellite communications systems, and to provide specialized consultative support towards development of related Government policies.

This objective is pursued through management of specific space programs through in-house development and testing of hardware and software subsystems for current and future space missions, through development and operation of satellite ground control and telemetry stations, through management of the National Spacecraft Assembly and Test Facility (the David Florida Laboratory), and through the conduct of programs of research and experimental development in electrical and mechanical engineering.

HIGHLIGHTS

In 1973/74 important accomplishments were achieved or milestones reached in all of the subject areas under investigation. Most of these areas bear a direct relation to the Communications Technology Satellite Program, support of which is currently the top priority in the Directorate.

SPACECRAFT ELECTRONICS PROGRAM

ROLE

The role of this program is to conduct and promote R & D on electronic materials, devices, and related physical phenomena, microwave technology, and instrumentation required for communication and aerospace systems. A particular aim of the program is to contribute expert technical judgement to the government program and to develop the national industrial R & D capability in electronics. The following technical activities are identified as areas of prime responsibility and include the direction of R & D contracts; electronic materials; solid state devices and integrated circuits; solid state circuit design; antenna theory and design (Microwave frequencies); instrumentation for space and ground segments of space missions; energy conversion and storage; reliability analysis of electronic components and materials; effects of space environment on electronic materials and devices.

HIGHLIGHTS

A large proportion of the program resources were assigned directly and indirectly to CTS supportive tasks. This is in keeping with the build-up of tempo of that project. Major tasks included provision of SHF Beacon flight hardware, parts procurement consultation both in the field and in the reliability analysis of received parts and data, and late in the year, the undertaking, on an emergency basis, of the design and construction of an amplifier for the on-board transponder. The latter equipment utilizes a newly emerging microwave amplifying device: the gallium arsenide field effect transistor shown on this page. This device can be expected to have considerable impact on future communications equipment in the 5 — 20 GHz frequency region.

Research and development activity in the program has produced a number of noteworthy spin-offs into industry. A high accuracy attitude sensing system of the type required for operation on direct broadcast satellites using microwave principles had been conceived and prototype equipment developed. Because of CTS weight limitations, flight tests cannot be conducted on CTS. Accordingly, the technology has been transferred to Canadian Patents and Development Limited who in turn have licensed its use on the Japanese Broadcast Satellite scheduled for launch in 1977.

Research into failure mechanisms in today's microscopic yet extremely sophisticated electronic circuits and devices, poses requirements for new techniques and equipment with which to perform failure and reliability analysis. In particular, the need to magnify relatively large areas of a micro-circuit led to an innovation whereby the area viewed by a scanning electron microscope (SEM) was extended 25 fold. The importance of this technology was recognized by a Canadian company, SEMCO, who obtained a license through SP & DL to pursue the development. In order to maintain the momentum of the work and to effect maximum efficiency in transfer of information, eight technical personnel concerned with the work resigned to join SEMCO.

SPACECRAFT MECHANICS PROGRAM

ROLE

The role of this program is to conduct and promote R & D in the fields of dynamics, controls, and applied mechanics as applied to aerospace technology. In addition, it provides support to other DOC programs which require specialized consultative services. A particular aim of this program is to stimulate and co-ordinate the development of a strong national capability in space mechanics. Specific technical roles of this program include spacecraft flexible body dynamics; spacecraft attitude dynamics; spacecraft attitude determination; orbital dynamics, orbit determination; orbital environment phenomena; spacecraft attitude controls; aerospace navigation and guidance; spacecraft subsystem controls, aerospace control computers and programming; spacecraft thermal systems; aerospace fluid mechanics; spacecraft aeromechanics; aerospace metallic, organic and inorganic materials; spacecraft system analysis and simulation; spacecraft machine elements and processes; spacecraft electro-mechanical sensors and drive devices; acoustic and fluid wave propagation theory.

HIGHLIGHTS

During this fiscal year, this program's activities were very heavily oriented to CTS related tasks. From September through December 1973, Spacecraft Mechanics personnel conducted a series of tests on the CTS Attitude Control Subsystem (ACS) to obtain performance data for the nonspinning on-orbit operational configuration of the ACS. The purposes of this work were to determine or validate component transfer functions, to validate ACS simulation models, to acquire data for subsequent analysis, and to assist in determining test philosophy, policy, and programs required with particular regard to the CTS ACS Experiment.

A full size model (51" wide x 550" long) representative of one half of the complete solar array for the CTS, was fabricated by Spacecraft Mechanics for Dynamic Testing in a 10' diameter x 30' high vacuum chamber at CRC. The testing of the extended model array included low frequency mechanical excitation from 0.1 Hz to 3.0 Hz, the sweep duration was a nominal 2 hours, in vacuum, (1×10^{-3} TORR). The test objective, to support the development of analytical models by demonstrating that predictions are in accord with the ground test results, was fully met when the test results agreed closely with the predictions for: natural frequencies, associated mode shapes, and damping coefficients. The photograph shows the Spacecraft Mechanics Program fabricated model array suspended in the 10' x 30' vacuum chamber, before out of plane excitation begins.

The Deployable Solar Array (DSA) structure and panel of the CTS satellite were subjected to pre-qualification vibration test in two different test run sets: first in January 1974, and then in March 1974. These tests are designed to prove the DSA design suitable to perform as required after being subjected to the vibrations encountered by CTS during launch and second-stage thrust firings. The vibration tests were successfully completed, even though they were extremely complex and extensive. Essential modifications of the DSA are being accomplished as the result of test evaluations and inspection of the DSA components after test.

SATELLITE GROUND CONTROL OPERATION

ROLE

The role of this operation is to develop and provide the facilities necessary for the in-orbit management, scheduling control, data acquisition and processing functions for spacecraft and programs, national and international, sponsored by DOC. Activities in this program include spacecraft operational scheduling and management; spacecraft ground station, development and operation; ground control measurement equipment, instrumentation systems, and ground support systems, spacecraft in-orbit control; satellite data acquisition and distribution; spacecraft telemetry, tracking and commands; co-ordination with Canadian and international program participants.

HIGHLIGHTS

In mid 1973 an experiment was begun with the Alouette II satellite to determine if the satellite could be semi-mothballed, i.e. if it could be accessed at progressively less frequent intervals. The objective of the experiment was to determine if one of the ISIS satellites, also in orbit, could be mothballed until 1977. By the end of fiscal year 1973/74 the experiment with Alouette II had been entirely satisfactory. The satellite status is now verified only once every month. No apparent degradation of the satellite has set in as a result of this infrequent attention as shown by a temporary reactivation in February for a special event. It is therefore believed that, should it become necessary, one of the ISIS satellites could be put into a similar state of storage.

DAVID FLORIDA LABORATORY

ROLE

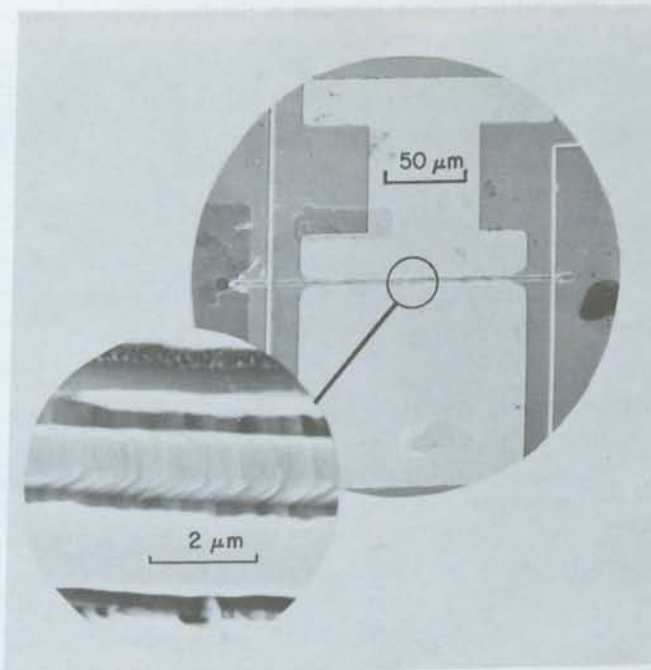
The role of the lab is to support national and international aerospace projects as the national Canadian technical facility for assembly, test and integration of aerospace systems and subsystems. Features of the laboratory include planning of test and assembly (T & A) schedule, management and direction of T & A; ground support systems for spacecraft integration and acceptance testing; thermal-vacuum space simulation for testing large systems; vibration testing, controls system test facility; antenna field pattern, boresight line and environment testing; RF anechoic test facilities; processing and reduction of customers' test data; environmental test engineering.

HIGHLIGHTS

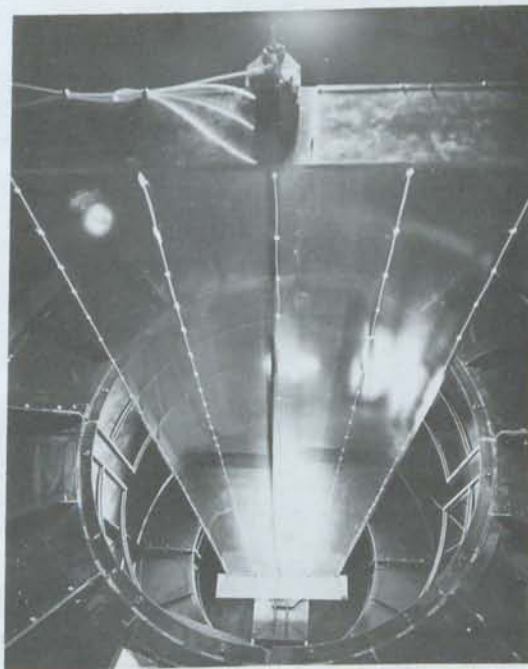
1973/74 marked the beginning of the environmental testing and assembly of the Communications Technology Satellite. Final shake-down tests of the environmental test facility was completed in December 1973 and full-scale testing under thermal-vacuum and vibrations begun. A heavy schedule of testing was followed in the antenna range and the anechoic chamber and with prospects for continued activity at a high level through fiscal year 1974/75. In all instances, the laboratory has been able to meet expectations both as to quality and quantity of testing and other services.

Late in the year, the department made a commitment to the National Research Council to support environmental and assembly testing for a project currently being proposed by a consortium of Canadian companies. The project, a Remote Manipulator System (RMS) to be developed and flown on the NASA Space Shuttle, is still awaiting final go-ahead in the general government.

SATELLITE COMMUNICATIONS SYSTEMS DIRECTORATE



A top view of a GaAs FET illustrating its microscopic size. The critical parameter is the gate width, 1 μm in this example, which has to be accurately placed in a 4 μm gap 125 μm long.



Full size model representative of 1/2 of the complete solar blanket for CTS is set up in CRC's 10' x 30' vacuum chamber, to undergo Dynamic's Test.

COMMUNICATIONS TECHNOLOGY SATELLITE

The Communications Technology Satellite (CTS) is a joint Canadian/USA program designed to produce advances in Satellite Communications Technology in the 12 to 14 GHz frequency range. Canada designed, and will build and operate the CTS spacecraft. The USA provides some advanced components and pre-launch testing, and will launch the spacecraft in late 1975 or early 1976. The European Space Research Organization (ESRO), comprising ten countries, is also participating by providing several components of spacecraft subsystems. The DOC Communications Research Centre (CRC) manages the Canadian portion of the program and is the design authority for the Spacecraft.

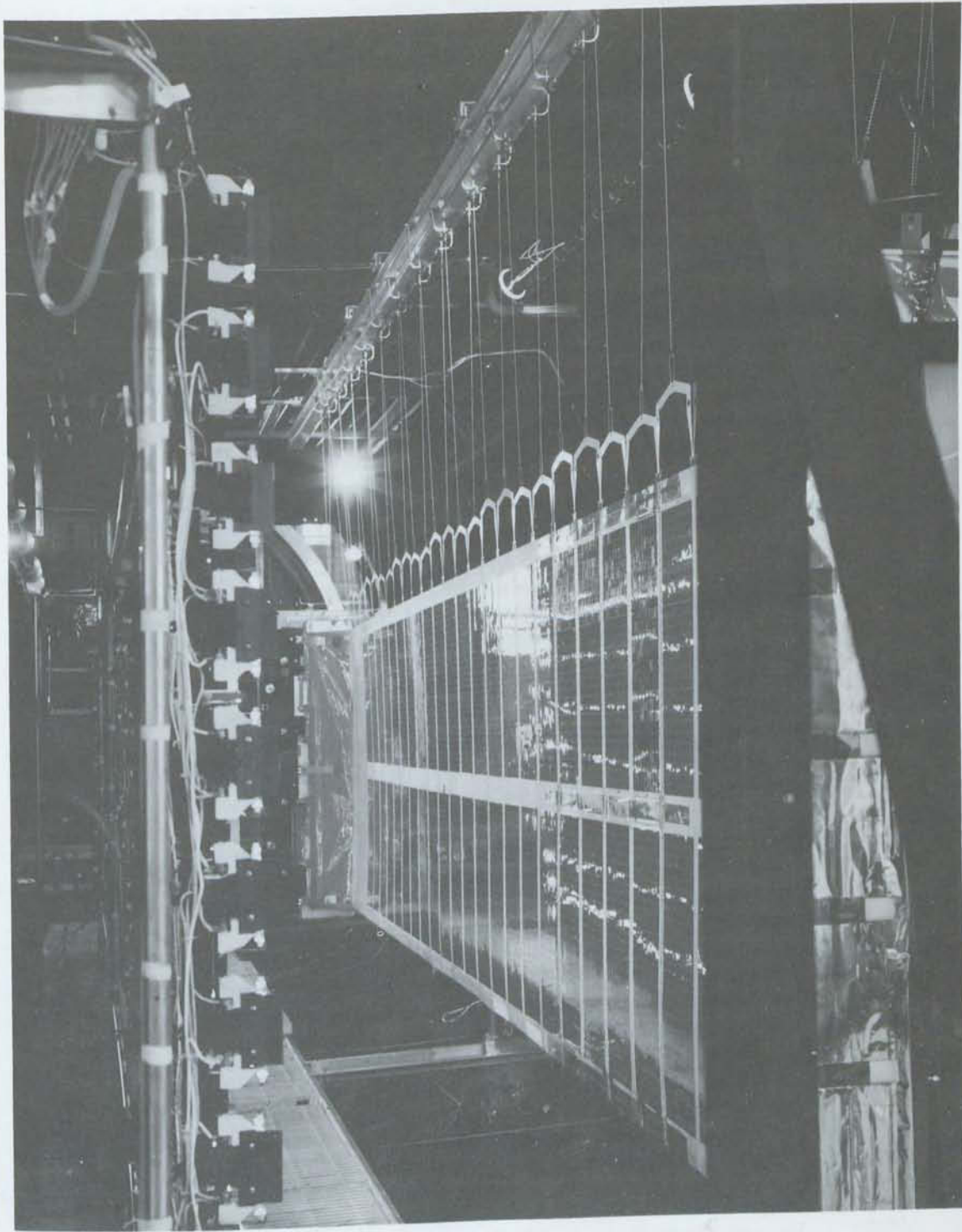
The CTS Program consists of four main elements:

The David Florida Laboratory	Design, construction and commissioning of a national spacecraft integration and test laboratory. (See under SCS Directorate).	1970-73
Ground Stations	Equipment and software design, development, construction and operation for satellite control and experimentation. (See under CS and SCS Directorates).	1970-77
Satellite	Design, construction, launch and operation of the CTS Spacecraft.	1970-77
Experiments	Planning and co-ordination of Canadian technological and communication experiments, including the provision of specified facilities to experimenters. (See under CS and SCS Directorates.)	1970-77

Phase D, the spacecraft manufacture, integration and test phase began in late 72 and continues through to launch. Testing of major spacecraft subsystems began in 1973, and integration of the Engineering Model Spacecraft at CRC in early 1974.

In September 1973 the second CTS Project Review was conducted at CRC, with representation from NASA, RCA, SPAR, SED Systems, TELESAT, DSS and DOC. A number of problem areas were identified, particularly in regard to the adequacy of documentation, and remedial measures were initiated.

Major milestones included completion of the spacecraft thermal design including a heat-pipe system for the 200 watt tube, integration of the first 200 watt tube package with the breadboard SHF Transponder, successful deployment of the developmental model Deployable Solar Array, and authorization of a development program for a Field Effect Transistor Amplifier (FETA) to be implemented at CRC with direct participation of RCAL staff. The FETA development became an urgent requirement when sub-contractors were unable to meet essential amplifier specifications for this portion of the SHF Transponder.



Deployed Engineering model solar array during preliminary thermal vacuum tests.

INFORMATIQUE DIRECTORATE

ROLE

The general area of the behaviour of the human being as he interfaces with computer and telecommunications systems and equipments. Specifically to extend the boundaries of knowledge in the following fields: data processing in general; computer/communications in particular; communications by means of glass fibre; human behaviour in situations where the generic type is the interaction between man and the machine.

HIGHLIGHTS

The main objectives of the Informatique Branch have not been met. This is largely due to the fact that it has been, and still is, very difficult to hire scientists in the field of informatique and psychology. It has therefore been impossible to develop a research project on computer/communication; in consequence, with the resources that are available to us, we have substituted to that project a research project on man/computer interaction to complement our general research on man/machine interaction. On the other hand, the shortage of psychologists has greatly slowed down the setting up of a multidisciplinary team, which is the basis of our research on man/machine interaction. With the exception of the research on data processing and on glass fibre communications, the results of the studies were very modest. Nonetheless, we were able during that period to develop research plans which, when our resources are permitting, will guide us in the setting up of our research programs.

The widening of the military sector of our researches, was undertaken during the year and has just been crowned with success. The military agreed to provide us with resources amounting to approximately \$135K for military oriented research in the field of electro-optics.

Our relations with the carriers have considerably improved. Our information exchange program with them has been so successful that they have begun to let us know their priorities as regards scientific research; this will be of great help to us in the development of our research plans to meet the needs of Canadians.

MAN/MACHINE INTERACTION PROGRAM

ROLE

To determine the usefulness of the practicability of various teleconference systems as a management and administration tool for the federal departments and agencies. The studies in this field are twofold: the study on behaviour in communications, and the study on image data processing.

HIGHLIGHTS

The studies made this year on behaviour enabled us to develop a knowledge of the efficiency with which various types of communications can be carried out by using teleconferencing as an interaction medium. These studies were made in cooperation with the utilizers of the Bell Canada Television Teleconference System, the Quebec University Audio System and the Department of Communications Audio-Graphic System. The results of these studies will be used to define the desirable characteristics of the future teleconference systems.

A laboratory was set up during the year to study the reaction of the users of various modes of teleconferencing. The laboratory is situated at the Development Center of the Public Service Commission at Carleton Place. The studies in the laboratory will begin in September 1974.

In the field of image data processing, an experimental device was set up in order to initiate the studies on various applications of image transmission in communications. The utilization of this apparatus for study purposes started this winter and the results will be submitted towards the end of May 1974.

ELECTRO-OPTICS PROGRAM

ROLE

To arrive at a sound understanding of the factors that affect the performance of the optical memories and to study the characteristics of the new materials used in the holographic recording systems in order to develop new modes of utilization.

To undertake a comprehensive study of glass fibre communications technology and to derive from this study applications for the communications systems of the future.

To obtain a more advance knowledge in the field of optical data processing.

HIGHLIGHTS

Without entering into the details of the research, the studies completed during the year were crowned with eight inventions and patents.

A report presented before the Canadian Cable Television Association on the application of the optical communications technology to cable television was very well received. The president of the CCTV requested that the presentation be repeated at Montreal on May 27 – 29 during the annual convention of the Association.

A demonstration on the applicability of the laser to detect the proximity of the ground, paid for the Leigh Instruments Company, was very successful. The results of that demonstration could be useful for the construction of a prototype for the marketing of that apparatus.

A development project for the construction of a experimental fibre glass communications system for the Forces, of a value of \$135K, has been approved. That project will be put into effect during the 1974/75 financial year.

COMPUTER SYSTEMS PROGRAM

ROLE

To undertake research work on man/computer interaction and support the research already being done in that field, and act as a consultant in the field of computer/communications.

HIGHLIGHTS

A study group (No.19) of the Interdepartmental Committee on Computer/Communication was set up in October 1973 to study a change in the technical plan of the CANUNET Project (Canadian Universities Computer Network) which advocates that the development and installation of switching systems be carried out by the organizations concerned rather than by the federal government. The work of this study group should be completed in October 1974.

Last year was mainly used to formulate a research plan and to obtain equipment. Certain preliminary studies were completed, the results of which will be utilized to construct the hardware and software components of a graphic interactive computer system during the 1974/75 financial year.

A series of studies have been completed under industrial contracts in the field of the computer/communication terminals in order to set up a technological information bank on these systems, which could be used to complement the research being done on the structure of the computer/communications systems and on the possibilities with regard to the modes of interaction between man and the computer.



CRC terminal of the DOC/HQ — CRC experimental teleconference link.



Man-computer interactive graphic system studies.



TV baseband transmission through optical fiber-waveguide bundle.

ADMINISTRATION DIRECTORATE

ROLE

Provides direction and control of administrative services, including financial management, for CRC in support of the Research Program. Ensures that the affairs of CRC are conducted in accordance with Treasury Board Regulations and that all Financial and Administrative Acts, Regulations and guidelines are adhered to. Directs and co-ordinates the preparation of the Program Forecast and Annual Budget for CRC amounting to approximately \$30,000,000. In general, it can be said that every activity in the Administration Directorate has a direct or indirect impact on the CRC Research Program. These activities are as follows: Research publications and documentation production including a research library; photography, graphic arts and technical electro-mechanical design; instruments information, control, quality, repair and calibration; design and manufacture mechanical components and specialized equipment; material management including inventory control, procurement, receiving, shipping, storing and issuing; computerized financial data reporting on budgets, commitments, expenditures and recoverable costs; design construction, maintenance of site facilities (including those of DREO). To provide steam, water, power, waste disposal, road and ground maintenance to CRC and DREO establishments at Shirley Bay; general administrative services include, motor transport pool, security, telecommunications, safety, fire prevention, equipment and supplies, mail and freight services, central registry, cafeteria, cleaning, parking, photocopying, conference arrangements and health services.

HIGHLIGHTS

During the fiscal year 73/74 several studies were undertaken, namely:

- (a) a study of accommodation requirements for the Communications Research Centre;
- (b) a study of the organization structure of the Communications Research Centre Administration Directorate;
- (c) a study of the Commitment Control System and Suppliers' Accounts processing.

The Bureau of Management Consulting, DSS, undertook the first two studies and at time of writing, both have been completed. The recommendations contained in BMC reports on the studies are currently being reviewed by Management. We hope as a result of implementing the recommendations to be able to make more efficient use of existing space and get approval for additional accommodation which is very obviously required. By adopting an improved organization for the Administration Directorate, a more efficient operation will result.

The study on Commitment Control and Suppliers' Accounts processing is being performed by DOC Management and Computer Services Branch. It was started toward the end of 73/74 and, at this time, is still in process. We are confident from what we have seen so far that the recommendations and proposals coming out of the study will result in more timely and efficient systems.

A submission to Treasury Board was instrumental in having the subsidy on the Voyageur Colonial Bus service to Shirley Bay extended until 31 August 1974. The original cut-off date was 31 December 1973. As of 1 September 1974 bus service to Shirley Bay is to be provided by the Ottawa/Carleton Regional Agency — OC Transpo.

A complete set of organization charts for CRC was prepared during the year. These are now officially up-dated on a quarterly basis.

Phase I of the addition to Building 34 was completed last summer and the Model Shop moved in from the basement of Building 2. Also, additional office space was made available in Building 34 for CTS personnel. Before the end of 73/74 Phase II of the addition to Building 34 was started. It is expected that this additional space will be available in September 1974 to accommodate Photography, Graphic Arts, Technical Electro-Mechanical Design and the Plating Laboratory.

RESEARCH PUBLICATIONS AND DOCUMENTATION SERVICES

A reorganization of this activity took place in mid-year, in order that the program resources could be more directly applied to the scientific information and documentation function. This change affected the printing operation, drafting, technical illustrations and photography, which had been component parts of the Publications and Documentation activity and which now provide a direct service to CRC under the Administration Services Program.

During the year a total of ninety-seven publications were approved for presentation at conferences, publication in the open scientific literature, or publication as formal CRC research documents. Copies of all research publications are distributed systematically to a specific and active list of domestic and foreign agencies and this list has been continuously reviewed and updated during the year. For example, the CRC library has distributed a total of 21,300 copies during the year under review. The distribution includes, in addition to the Department of Communications, 45 agencies and universities in Canada, 57 agencies in the Canadian industrial sector and 53 agencies in foreign countries, all of whom are directly involved in telecommunications or related research. National scientific and technical information centres of Canada and other countries are included in the distribution scheme and this ensures a further subsidiary distribution by means of the national networks unique to each country.

Both library activity and acquisitions were increased significantly during the year because of the broadening of the CRC research information base to include work in the fields of the behavioural sciences and operational systems research. The CRC library increasingly made use of the Shirley Bay computer to assist in day-to-day operations such as the revision of mailing lists and sources, and the assembly and publication of a list of current periodical holdings.

Cooperative working with the scientific information divisions of other Canadian agencies was further developed, and this included CRC participation with the National Research Council in their pilot study of a Canadian Scientific and Technical Information network.

ADMINISTRATIVE SERVICES

The Department of Public Archives conducted a comprehensive study of the Records Management System with a view to improve the services provided by the section. Three units namely Photography, Electro-Mechanical Design and Graphic Arts were added to the section from the Research Publications and Documentation Services and the Cleaning Services were transferred to Plant Engineering. An extension of the main guardhouse was constructed to house the new equipment for the Bell Telephone Centre System to be installed by March 1975. The fire alarm control panel was relocated in the guardhouse; the fire alarm are transmitted directly to the Dominion Electric Protection Co. who have assumed the responsibility to notify the Nepean Township Fire Department. A new emergency vehicle was purchased and fully equipped for emergency requirements.

FINANCIAL SERVICES

The format at the Commitment Control and Recovery Statement was modified to include allotments by project and to segregate recoverable from cash funds. The accounting system for man year utilization by directorate was improved considerably. A ledger to record personal service contracts was implemented, and an improved financial coding structure to be implemented next year was designed. The operational plan for 1974/75 and the program forecast were prepared and submitted.

INSTRUMENT SERVICES

The Components Information Unit became part of Instrument Services and a direct result was the distribution of an updated standard parts catalogue and a revised method of handling raw-data to avoid future slippage. Instrument Information produced a printout of an instrument selection catalog. This provides technical data on all electronic equipment at CRC and improves access to instrumentation particularly between scientific inventories. Rapidly increasing workloads forces us to devise methods of coping with the overload. The cost effectiveness of outside repair contracts was improved by the use of a three level quality control program. With this system it was possible to increase simultaneously the use of contracted repairs and reduce the amount of time spent on required incoming inspections for certain classes of instruments. For more critical instruments, a calibration update system was effective in ensuring that valid measurements were made in CTS related projects.

MATERIAL MANAGEMENT

In April, the manual cross-index file system was computerized and additional bits of information were added such as line object of expenditure, name of supplier, supplier's location, bring forward, follow-up on deliveries and contract amount. This system permitted us to answer inquiries much quicker and to follow up on deliveries more effectively. Special arrangements were made with the U.S. Embassy to have the specific attache sign all U.S. free entry certificates for the large volume of hand carried shipments of spacecraft components to various U.S. destinations.

A total of 50 main inventories consisting of approximately 10,000 items and 156 tool kits were physically inspected and accounted for. The Plant Engineering stores stock-taking holdings of approximately 4900 line items was completed. Special arrangements were also made to engrave the serial numbers on the outside casing of approximately 110 Hewlett Packard pocket calculators. The maximum/minimum control system for all items held in Main Technical Stores was computerized. Several test runs were made and we should operate on a parallel manual-data processing base for 1974/75 with a full computerized operation by the end of the fiscal year.

TECHNICAL SERVICES

A colorful model of Alouette I, Canada's first venture into space, was built for the Ministry of State of Science and Technology for presentation to the Chinese Academy of Science in Peking on the occasion of the visit of the Canadian Scientific Delegation to China. A radio frequency window was built and installed in the David Florida Laboratory permitting the use of the anechoic chamber during inclement weather. This unique structure was composed of over 300 cubic feet of Styrofoam which was then tongued and grooved and assembled without the use of adhesives or fastenings of any kind.

PLANT ENGINEERING

This year the following construction projects were completed:

- (a) The Spacecraft Ground Control Centre to accommodate all staff and contract personnel responsible for the ISIS and CTS ground control operations;
- (b) The new directional tracking antenna for use with CTS;
- (c) The RF testing range tower and the anechoic chamber in the David Florida Laboratory;
- (d) The new central model shop facility in phase I of the Technical Services building.

Facilities maintenance and construction continued to be affected by the support of research activities. The work load was maintained at previous levels with 3,582 work requests processed and more than 100 projects completed during the year.

Engineering assistance was given to the DOC Ontario and Central regions in the design of new major antenna systems at Kenora, Ontario and Churchill, Manitoba. The extensive experience of Plant Engineering gained over several years of installing antennas for the various research programs proved to be helpful to DOC.

A progress report of major construction at CRC is contained in Appendix L.

ADMINISTRATION DIRECTORATE



A part of the reading room of the CRC Research Library.



This "Mock-Up" of the C.T.S. was made by Technical Services to check the effect of the spacecraft configuration on the Antenna Pattern of the SHF Beacon.



A specially made adjustable holding fixture designed and constructed by CRC Technical Services capable of locating and holding the CTS solar array for inspection and environmental testing purposes.



The assembly of 6 — 40 MHz log-periodic antenna by CRC Plant Engineering Services.

APPENDIX A

CRC PROJECT FISCAL YEAR 1973/74

A. Radio Research Directorate

- High Frequency Direction Finding
- Special Communications Tasks for DND
- Polar Cap III
- Upper Ionosphere Studies
- Lower Ionosphere Studies
- Radio Interference and Noise Measurements
- Radio Noise
- Radio Climatology of Terrestrial Paths
- Applied Propagation (VLF-VHF)
- Biological Effects of Non-Ionizing Radiation
- Applied UHF and Microwave Propagation

B. Communications Systems Directorate

- Data Terminal Research
- Integrated Data Communication Systems
- Domestic Long Distance Communication Network Study
- Communication Systems Engineering
- DOC/CBC Satellite Broadcast System Study
- CTS Communications Experiments
- Microwave Propagation Studies
- Support and Advice for Frequency Management
- Radar Consulting
- Basic Radar Studies
- Civilian Radar Applications
- Military Radar
- Radar Detection and Identification
- Tandem
- Small Terminal Satellite Communications
- Aeronautical Satellite Communications
- Military Communications Technology

C. Satellite Communications Systems Directorate

- Joint Dielectric Studies with EM&R and DOC
- Microelectronics
- Microwave Technology
- Reliability Analysis
- Semiconductor Material and Devices
- Microwave Instrumentation for Communication Satellites
- Ancillary Support
- Field Effect Transistor Amplifier
- Dynamics
- Control Systems
- Applied Mechanics
- Satellite Ground Control Operations
- David Florida Laboratory

D. Informatique Directorate

- Special Informatique Tasks
- Pattern Recognition
- Teleconferencing
- Data Terminals
- Computer Networks
- Computer Science
- Optical Data Storage and Processing
- Optical Communications
- Computing Services

APPENDIX B

CRC OPERATIONAL PLAN – FISCAL YEAR 1973/74

		Man Years 1	Salary	Goods & Services 2	Capital	Totals
Director General	Allocated	10	120.5	128.0	nil	148.5
	Expended			42.7	.8	164.0
Director, Radio Research	Allocated	66	976.8	512.0	115.0	1603.8
	Expended			456.3	101.5	1534.6
Director, Communications Systems	Allocated	91	1344.0	662.8	1262.0	3268.8
	Expended			411.2	661.5	2416.7
Director, Satellite Communications Systems	Allocated	82	1173.5	614.0	245.0	2032.5
	Expended			752.2	401.4	2327.1
Communications Technology Satellite	Allocated	23	(325.0 included in CTS budget)	nil	14540.0	14540.0
	Expended			—	16858.7	16858.7
Director, Informatique	Allocated	43	623.5	712.2	330.0	1665.7
	Expended			679.7	346.4	1649.6
Director, Administration	Allocated	207	2158.3	1480.4	2671.0	6309.7
	Expended			2261.2	1114.0	5533.5
CRC TOTALS	Allocated	522	6396.6	4109.4	19163.0	29669.0
	Expended			4603.3	19484.3	30484.2

Note 1: Thirteen additional man years were provided and paid for by headquarters for language training relief.

Note 2: Includes budgetary recoverables from other departments.

Note 3: Costs are in thousands of dollars.

APPENDIX C

SUMMARY OF COMPUTER COSTS FOR COMPUTING SERVICES

CLIENT		COMM		SAT COMM	RADIO	DOC		
MONTH	ADMIN.	INF.	SYSTEMS	SYSTEMS	RESEARCH	HQ	DREO	TOTALS
April 73	1.3	0.2	5.0	23.4	31.7	2.9	1.6	66.1
May	2.0	3.1	4.3	40.7	41.4	3.3	1.1	95.9
June	2.0	4.4	6.8	12.2	42.8	3.7	1.7	73.6
July	1.2	5.7	7.7	41.5	38.6	4.8	3.3	102.8
August	1.3	6.1	9.1	81.0	40.2	4.7	6.0	148.4
September	2.4	5.0	6.5	72.0	41.0	5.1	2.1	134.1
October	3.0	5.8	7.0	33.5	63.3	5.7	1.1	119.4
November	2.5	9.6	6.4	44.4	37.0	5.0	1.6	106.5
December	2.2	7.2	5.2	19.2	24.2	3.4	1.7	63.1
January 74	1.9	8.1	2.5	23.3	38.9	4.9	1.7	81.3
February	2.0	3.5	2.7	23.2	51.6	5.2	1.7	89.9
March	1.9	12.0	6.4	48.1	38.8	5.9	2.3	115.4
TOTALS	23.7	70.7	69.6	462.5	489.5	54.6	25.9	1196.5

Note 1: Costs are in thousands of dollars.

Note 2: These costs are pseudo charges. Actual cost of the complete operation is 800K. Revenues exceeded costs by 50 per cent because actual usage exceeded forecasted usage.

APPENDIX D

PROGRAMS WITH OTHER DEPARTMENTS AND AGENCIES

ITEM	DEPARTMENT	ACTIVITY
Military Programs	DND	Military tasks in telecommunications and radar and supporting activity. Recoverable and supplementary funding. Continuing.
AEROSAT	MOT	Earth terminal specification, testing and experimental program; accessing studies etc. Submission to T.B.
11/14 GHz Site Survey	COTC	Radiometric investigation. Recoverable funding. Being negotiated.
HF Prediction Information	DND & other Departments and Agencies	DND access CRC computer directly. Others provided with information. Continuing.
HF Circuit Tests	MOT	Tests of communications between CRC and MOT patrol ships in North. Complete.
Microwave Dielectric Materials	EMR	Materials for space electronics. Joint investigation. Near completion.
Airborne Scatterometer and Processing System	CCRS/EMER	Microwave sensor expertise provided. DM/EMR request to DOC.
Ice-Thickness Radar Techniques	DOE	Successful fresh water ice tests. Development for sea ice trials. DOE funding for equipment development and contract assistance.
Microwave Techniques for Sensing Geological and Permafrost Properties	GSC/EMR	GSC have posted a man to CRC and are providing material funds.
Radiometric Measurement of Sea Ice Thickness	MOT	MOT industrial contractor using CRC equipment for trial. Technical monitoring by CRC.
Radiometric Measurement of Salinity	DOE	Contractor to use CRC developed equipment for trials. CRC providing consultation to DOE.

Teleconferencing Research	Public Service Commission	Facility installed at BSDT Management School for joint experimental program DOC/PSC.
Soil Moisture Measurement	DEMR & AGR	Remote sensing by microwave. Joint program with CRC.
Microwave Landing Systems	MOT	CRC designed propagation measurement program.
MOT Data Link Project	MOT	CRC staff member participating in Project Committee.
Polar Continental Shelf Project	EMR	CRC providing consultation on propagation.
PAIT & DIP Programs	I, T&C	Project assessment.
DIR Grants	DRB/DND	Project assessment.
Maritime Satellite Communications	MOT & EA	Consultation provided.

APPENDIX E

SERVICES PROVIDED TO INDUSTRY FY 72/73 AND FY 73/74

Group Providing Service	Name of Company	Type of Service	Value	FY 72/73
Reliability Analysis	Bell-Northern Research	SEM Time	\$1,836.24	Oct. 72
Reliability Analysis	Raytheon Canada	Analysis Work	341.45	Oct. 72
Reliability Analysis	Bowmar Canada Ltd.	SEM Time	50.00	Feb. 73
Reliability Analysis	Leigh Instruments	SEM Time	50.00	Feb. 73
Reliability Analysis	Raytheon Canada	SEM Time	228.50	Feb. 73
Reliability Analysis	Bell-Northern Research	SEM Time	481.25	Feb. 73
Reliability Analysis	Bell-Northern Research	SEM Time	123.76	Mar. 73
TOTAL			<hr/> \$3,111.20	
				FY 73/74
Reliability Analysis	Leigh Instruments	Microprobe Analysis	900.00	May 73
Reliability Analysis	Garrett Mfg. Co.	Consulting Service	2,200.00	May 73
Reliability Analysis	Bowmar Canada Ltd.	SEM Time	180.00	June 73
Reliability Analysis	Bell-Northern Research	SEM Analysis	435.00	June 73
Reliability Analysis	Bell-Northern Research	SEM Work	1,340.00	Jan. 74
TOTAL			<hr/> \$5,055.00	

Note: The Reliability Analysis group also performs a number of small tasks requiring only a few hours of Scanning Electron Microscope at no charge for the Canadian industry.

APPENDIX F

INDUSTRIAL CONTRACTS

A. Contracts with individuals for personal services:

40 CTS Contracts	\$ 661,342.77
47 CRC Contracts	<u>183,598.61</u>
for a total of	844,941.38

B. Contracts with firms for personal services:

ADGA Ltd.	399,029.52
CAE Electronics Ltd.	15,170.73
Canadian General Electric	58,400.00
The Canada Systems Group (EST) Ltd.	32,000.00
Datacrown Ltd.	23,000.00
Digital Methods Ltd.	427,379.72
Foster Design Co. Inc.	59,900.00
Hitech Canada Ltd.	32,877.00
Ian Martin Associates Ltd.	86,405.20
I.P. Sharp Associates Ltd.	8,600.00
Petrie Telecommunications	20,884.00
Price Waterhouse Association	37,000.00
Quasar Systems Ltd.	41,400.00
Semco Instruments Co. Ltd.	20,000.00
Sharon Electronics Ltd.	64,950.00
Spar Aerospace Products Ltd.	127,194.34
Systems Concepts	15,416.00
T.C. York Consultants	4,200.00
United Aircraft of Canada	<u>10,210.00</u>
for a total of	1,484,016.51

C. Contracts with firms for required services:

ASDA Ltd.	4,000.00
Bell Canada Northern Electric	85,882.38
Carleton University	10,000.00
Computing Devices of Canada	50,243.28
DCT Systems Ltd.	18,000.00
EDA Electronics Ltd.	7,000.00
Edmunds-Newhall Associated Ltd.	102,600.00
F.A. Laurin Corp. Ltd.	18,000.00
Helmer, Tutton Architects	25,000.00
Hewlett Packard	1,932.00
Jamieson & Redford Consultants Ltd.	15,000.00
Industrial Research Institute	6,050.00
Iomec Inc.	1,800.00
MacGregor Industrial Elects.	10,000.00
McGill University	5,954.00
Microsystems International Limited	13,000.00
Petrie Telecommunications	15,000.00
Philco Ford of Canada	1,173,165.89
RMI Data Maintenance	1,500.00
RCA of Canada Ltd.	3,755,623.00
RCA Research Labs	37,804.23
SED Systems Ltd.	1,026,300.00
SPAR Aerospace Products Ltd.	4,041,587.00
Spectrolas	188,393.00
Texas Instruments Ltd.	14,850.00
T.D. Overhill Engineering Ltd.	10,000.00
TMC (Canada) Ltd.	2,000.00
University of Montreal	30,326.00
Urwick, Carrie & Partners Ltd.	91,980.00
Woods Gordon Co.	149,600.00
	<hr/>
	10,915,590.78

APPENDIX G

UNIVERSITY RESEARCH CONTRACTS

To augment its own capabilities, CRC has contracts with outside bodies, mainly universities, for research and development in specialized fields. The contracts for fiscal year 1973/74 are listed below, by titles, in two categories:-

(a) Contracts, approved by the Research Committee and funded by the Department:

Project	University	Amount
Digital Image Processing	Ottawa	11,000.00
Redundancy Removal in Binary Sources	Queens	11,000.00
Programming Systems for Unsophisticated Users	Queens	33,500.00
Simulation Study of Uses of a Computer Network	Waterloo	30,000.00
Special Purpose Signal Processing and Transformation Systems	Ecole Polytechnique de Montréal	23,000.00
Electron Beam Deflection Systems	Carleton	7,600.00
Propagation Characteristics of Optical Fibres Waveguides	McGill	9,500.00
Radio Wave Scattering in the Ionosphere	Western	14,300.00
Communications Theory, Information Theory and Signal Processing	Queens	9,500.00
Correlation of Alouette-ISIS Data and Magnetometer Data	Alberta	8,100.00
VLF/LF Propagation Studies	Nova Scotia Technical College	6,200.00
Satellite Charging, Satellite Antennas	Toronto	17,400.00
Vibration Damping and Attitude Control of the CTS using the Solar Radiation Pressure	U.B.C.	8,200.00
Dynamics and Control of Very Flexible Communications Satellites	Toronto	8,000.00
Acquisition, Attitude Control and Station Keeping of Communications Satellites	Saskatchewan	8,000.00
Thin Dielectric Films for Semi-Conductor Memories	U.B.C.	7,600.00
Research Study of the Application of New Numerical Analysis Techniques to the Solutions of Microstrip Problems	McGill	8,100.00
Analysis of a BARRITT as a Stable LO Microwave Oscillator Source	Carleton	4,800.00
Electroless Thin Films	Windsor	6,700.00
Conclusion of Work on Analysis of IMPATTS as Digitally Modulated Microwave Oscillator Service	Alberta	7,600.00

Delta Encoding of Data Signals	Sherbrooke	12,900.00
Precipitation Attenuation above 10 GHz for Various Elevation Angles	McGill	2,800.00
Microwave Semiconductor Electronics	Carleton	10,500.00
Protocol and Related Studies in Packet Switched Networks	Waterloo	9,500.00
Machine Intelligence Aspects of the Communication of Images	Western	22,000.00
The Application of Dynamic Modelling to the Study of Telecommunications Development in Canada	Queens	<u>37,000.00</u> 334,800.00

(b) Contracts, approved and funded by CRC but not processed by the Research Committee:

Transaction Oriented Data Communications Experiments and Studies	Waterloo	3,974.00
Thermal Analysis of Heat Pipes	Waterloo	5,429.08
Investigation of Articulation Index Measurement Techniques	Windsor	6,050.00
Investigation of the Flexibility of Constructing a Special Purpose Bubble Domain Optical Spatial Modulator	McMaster	4,496.63
Study of Various Radar Link Time Domain Pulsed Signal Spectra Containing Incidental F.M. and Related Phenomenon	McMaster	7,500.00
Study of Ducted Propagation	Western	14,000.00
Research into the Climatological Factors which Influence Radiowave Propagation through the Atmosphere	New Brunswick	16,114.54
Research on Biological Effects of Non-Ionizing Microwave Electro-Magnetic Radiation	Queen's	12,069.00
Survey and Assessment of Experimental Research of the Precipitation Attenuation Behaviour of Microwave Radio Relay Systems	Western	2,972.00
		<hr/> 72,605.61

APPENDIX H

SEMINAR COMMITTEE GUEST SPEAKERS

May	File Organization and Computer Networks: by Prof. W.M. Gentleman, Department of Applied Analysis and Computer Services, University of Waterloo.
July	Strategic Planning Study of a Multi-Purpose UHF Satellite Communications System: by O. Roscoe of DOC HQ. Microwave Applications: by Dr. V.P. Kodali, TATA Institute of Fundamental Research, Bombay, India, (three lectures).
August	A Contribution to Radar Superresolution Theory: by Dr. J. Stuller of the University of New Brunswick. Fibre Optical Waveguides and Antenna Research at Queen Mary College: by Prof. P.J.B. Clarricoats, University of London, (twelve lectures).
September	The Realities of Patents in Canada: by Ken Lund, Canadian Patents and Development Limited, Ottawa, Ontario.
October	Research Activities at Toshiba Research and Development Centre: by Kenji Kakizaki, Director Toshiba Research and Development Centre, Japan.
November	Copyright Legislation and Relevant Considerations: by A.A. Keyes, Property Rights Consultant, Bureau of Intellectual, Department of Consumer and Corporate Affairs, Ottawa, Ontario.
December	What Will The Christmas Monster Bring? : by Dr. Lorne Avery, Radio Astronomy Section, Radio and Electrical Engineering Division, National Research Council, Ottawa, Ontario. MOSST Science Policy: by Dr. A. Beaulnes. Secretary of State, Ministry of State for Science and Technology, Ottawa, Ontario.
January	Computers, Communication and Visual Literacy: by Gordon B. Thompson, Bell Northern Research, Ottawa, Ontario.
February	Organizational Climate Conditions for Effective Research Scientists Performance: by Dr. M.V. McCarry, Chief, Organizational Behaviour Research Division, Public Service Commission, Ottawa, Ontario.
March	Free Interspecies Communications With The Killer Whales: by Jim O'Donnell and Bruce Bott, Ocean Life Systems Society. Spacelab: by Dr. R.W. Johnson, Director, Experiment Accommodation Spacelab Program, NASA.

APPENDIX I

PATENTS

Title	Inventors	Status of Invention
Microwave Attitude Sensing System	R.W. Breithaupt W.E. Threinen	To be exploited on a know-how basis.
Microwave Circular Waveguide Mode Coupler	J.P. Legendre	No patent action to be taken.
Voltage Controlled Current Limiting Transistor	R.F. Haythornthwaite	No patent action to be taken.
Control for Automatic Closure of a Water Faucet to a Preset Flow Rate	N.S. Hitchcock	No patent action to be taken.
Couplers for Optical Communications System	E.H. Hara	Patent application to be filed by CP & DL.
Axially Inhomogeneous Index Couplers for Optical Communications System	M. Imai B. Kawasaki A. Watanabe	Patent application to be filed by CP & DL.
A Method of Contacting Silicon by Chemical Displacement	W.D. Edwards	No patent action to be taken.
Getter Pump	F. Bouchard D.S. James	No patent action to be taken.
A Rapid Azimuthal Determination of Radio Signals	J. Litva E.E. Stevens	Referred to DND.
Improvement to Avalanche Transistor Circuits	W.J. Chudobiak	Under investigation.
A 3-D Television System Compatible with currently used system.	K.O. Hill	No patent action to be taken.
Metallization Process for Silicon Devices	S. Bellier L.B. Ehlert	Under investigation.
Tandem Signal Processor	A.W.R. Gilchrist	Referred to DND.
Directly Heated LaB ₆ Filament for Scanning Electron Microscope	K. Ramachandran	No patent action to be taken.
Application of Bragg Imaging to Optical Signal Processing	E.B. Felstead	Under investigation.
A Binocular Infrared Communications System	H.C. Frayn E.H. Hara	To be exploited on a know-how basis.

Passive Frequency-Selective Interwaveguide Coupler	K.O. Hill M. Matsuhara A. Watanabe	Under investigation.
Active Frequency-Selective Interwaveguide Coupler	K.O. Hill A. Watanabe	Under investigation.
Acousto-optic Light Beam Scanner	E.B. Felstead	Under investigation.
A System for the Assignment of Satellite Communications Channels Upon Demand	M.A. Stott R. Campbell	No patent action to be taken by CP & DL. Referred to DND.
Voltage Contrast Detector System	D.A. Shaw T.M. Black	Patent application to be filed.

APPENDIX J

RESEARCH LABORATORY REPORTS AND PROPOSED PUBLICATIONS CLEARED BY THE CRC DOCUMENT REVIEW PANEL

This list does not include papers cleared for presentation only, without subsequent publication.

Reference No.	Title	Author	Remarks
Astronomy and Astrophysics			
73-516	A proposed experiment to determine (1) if field-aligned currents close by polarization currents and (2) the length of the flux tube involved.	G. Atkinson	Paper submitted for publication in Journal of Geophysical Research (Letters)
74-014	Energy flow and current closure in the magnetosphere.	G. Atkinson	Paper submitted for publication in Journal of Geophysical Research
Atmospheric Sciences			
73-526	A lunar effect on the occurrence of conjugate echoes on topside sounder ionograms.	R.P. Sharma D.B. Muldrew	Paper submitted for publication in Journal of Geophysical Research
73-555	Narrowband radio noise in the topside ionosphere.	H.G. James E.L. Hagg D.L.P. Strange	Paper submitted for presentation at AGARD/EPP XIX Meeting on Non Linear Effects Electromagnetic Wave Propagation Edinburgh, Scotland, 12 – 17 November 1973, and publication in Conference Proceedings
73-576	The distribution of ionospheric M.F. noise emissions relative to the cleft.	T.R. Hartz H.G. James	Abstract – proposed for presentation at AGU – Magnetospheric Cleft Symposium, Dallas, Texas 1 – 3 November 1973
73-579	Ionospheric Structure in the magnetospheric cleft.	J.H. Whitteker	Abstract – proposed for presentation at AGU – Magnetospheric Cleft Symposium Dallas, Texas, 1 – 3 November 1973
74-009	Very-low-frequency V's.	H.G. James	Abstract – proposed presentation AGU 55th Annual Meeting Washington, D.C. April 8 – 13 1974 – Publication program of meeting

Behavioral and Social Sciences

73-495	Audio-graphic teleconferencing system.	C.A. Billowes	Brochure-for publication as User Information Brochure
73-535	The impact of teleconferencing on organizational behaviour.	G.W. Jull	Paper — for presentation at Canadian Research Manager's Association Conference Toronto, Ontario May 7 — 8, 1973 no publication
74-008	Human and technical factors in teleconferencing services.	G.W. Jull C.A. Billowes	Paper — for presentation at International Symposium on Subscriber Loops and Services BNR, Ottawa, Ontario, May 20 — 23, 1974. Publication Conference Proceedings

Earth Sciences and Oceanography

73-519	UHF radiometry for remote sensing in maritime sciences in a northern environment	A.W. Adey G.N. Reed	Paper — submitted for publication in Journal of the Canadian Aeronautics and Space Institute
73-546	Radio-frequency radiometry as a remote sensing technique in Maritime reconnaissance and marine sciences in a northern environment	A.W. Adey G.N. Reed	Publication — CRC Technical Note 660
73-580	Snow and ice depth measurement by high range resolution radar	D.F. Page G.O. Venier	Paper (condensation of oral paper) for publication in CASI Journal (Special supplement — Proceedings of Aerospace Electronics Symposium)
73-583	Radar remote sensors for ice thickness and soil moisture measurements	W.J. Chudobiak R. Gray	Abstract — proposed for presentation at Second Canadian Symposium on Remote Sensing, Guelph, Ontario, 29 April — 1 May 1973
73-588	Wide-band radar techniques for remote sensing	W.J. Chudobiak R. Gray V. Makios	Abstract — proposed for presentation at the Aerospace Electronics Symposium, Victoria, B.C., February, 1974
74-025	Field trials of the CRC UHF radiometer at Churchill Falls and Lake Melville, Labrador	G.N. Reed R.E. Barrington	Publication — CRC Report 1252

Electronics and Electrical Engineering

73-491	Varactor-tuned microstrip impatt oscillators	W.J. Chudobiak V. Makios	Paper — submitted for publication in IEEE Transactions on Microwave Theory and Techniques
73-513	A simulator for a minicomputer in a spacecraft application	F.E. Guertin W.E. Threinen	Paper — submitted for presentation and publication in Conference Proceedings of Canadian Information Processing Society, "1973 Focus 20/20", Edmonton, Alta., June 20 — 22, 1973
73-520	Stability of highly- doped negative- conductivity diodes	A.B. Torrens	Paper — submitted for publication in Applied Physics Letters
73-540	Scanning Laser Topography	A.B. Torrens W.D. Edwards	Paper — submitted for publication in Canadian Research & Development
73-542	Applications of wide bandwidth varactor tuned MIC oscillators	W.J. Chudobiak V. Makios	Paper — for presentation at IEEE Electronics Conference, Toronto, Ontario October 1973, and publication in Conference digest
73-544	Experimental charac- terization of microstrip right-angle bends and their frequency dependent behaviour	R.J.P. Douville D.S. James	Paper — for presentation at IEEE Conference and Exposition, Toronto, Canada, October 1 — 3, 1973, and publication in Conference Digest
73-553	A surface controlled negative-impedance transistor	R.E. Thomas W. Chin R.F. Hay- thornthwaite	Abstract — proposed presentation at IEEE International Electron Devices conference, Washington, D.C., 3 — 5 December 1973
73-558	A crossed-slot belt array antenna for satellite application	R.W. Breithaupt B. Clarke D. Waung	Paper — submitted for presentation at AGARD XXIVth Meeting of the Avionics Panel Symposium on "Antennas for Avionics", Munich, Germany November 26 — 30, 1973, and publication in Conference proceedings
73-559	Excitation efficiencies of fundamental and higher- order modes in optical- fiber waveguides	M. Imai E.H. Hara	Paper — submitted for publication in Applied Optics

73-564	Sputtering techniques for microwave integrated circuit fabrication	F. Bouchard D.S. James	Abstract — proposed for presentation at Electromechanical Society meeting, Ottawa Chapter, Bell Northern Research, Ottawa, November 1973 no publication
73-573	Thick film multilayer circuitry-problem areas	M. Miller S. Hitchcock	Paper — proposed for presentation at IEEE Canadian Electronics Conference, Toronto, Ontario, 3 October 1973 no publication
73-581	A surface-controlled negative-impedance transistor	R.E. Thomas W. Chin R.F. Haythornthwaite	Paper/Extended Abstract — for presentation at IEEE International Electron Devices Conference, Washington, D.C., 3 — 5 December, 1973 and publication in Conference Digest
74-011	Small and quasi-neutral domain in negative-differential-conductivity materials	A.B. Torrens	Paper — publication in Journal of Applied Physics
74-015	Transhorizon interference measurements at 15.7 GHz	R.L. Olsen U.H.W. Lambers	Abstract — proposed presentation — USNC/URSI Meeting, Atlanta, Georgia, 11 — 13 June 1974
74-019	A 12 GHz field-effect transistor amplifier for communications satellite applications	D.S. James R.J.P. Douville R.W. Breithaupt A.L. VanKoughnett	Abstract and Summary — proposed presentation — Fourth European Microwave Conference, Montreux, Switzerland, September 10 — 13, 1974

Mathematical Sciences

73-537	Synthesis of networks with fixed and linear incremental link costs	G.A. Neufeld	Paper — submitted for publication in Operations Research
73-597	The planning of domestic communication networks	G.A. Neufeld R.R. Bowen A.R. Kaye	Publication — CRC Technical Note 663
74-028	Evaluating the effect of communication satellites on the Canadian long distance transmission network	A.R. Kaye G.A. Neufeld R.R. Bowen	Abstract — proposed presentation — Seventh Biennial Symposium on Communication, Queen's University, Kingston, Ontario, May 30 — 31 1974

Methods and Equipment

73-507	CTS Communications Experiments	R.M. Dohoo	Abstract — submitted for publication in Conference Record of the Data Processing Institute of the Federal Institute of Management, "Conference 73", Ottawa, Canada March 27, 1973
73-531	ERTS quicklook system at PASS	R.E. Barrington W. Rolfe J.S. MacDonald	Paper — submitted for publication in Journal of the Canadian Aeronautics and Space Institute
73-539	Reliability assurance of individual semiconductor components	R.F. Haythornthwaite A.R. Molozzi D.V. Sulway	Paper — for publication in Proceedings of the IEEE

Military Sciences

74-012	CRC Technical Note 665	A.W.R. Gilchrist	Document prepared for a client agency
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Navigation, Communications, Detection and Countermeasures

73-503	The effects of multipath on the design of ship board satellite communications antennas	J.L. Pearce H.L. Werstiuk	Paper — submitted for publication in ICC 1973 Record, International Communication Conference, Seattle, Washington June 11 — 13, 1973
73-509	The phase characteristics of ionospherically-propagated radio waves observed with a large, sampled-aperture antenna array	D.W. Rice	Paper — submitted for publication in Nature
73-524	CRC Technical Note No. 658	F.W. Symons	Document prepared for a client agency
73-528	Impulse interference measurements at 7.3 GHz	J. LeBel G.E. Poaps	Abstract — submitted for selective review to ARFA 2nd Biennial Radio Frequency Symposium, NATO HQ, Brussels Belgium, December 11 — 13, 1973

73-529 73-533	Performance and synchronization considerations	N.G. Davies	Paper – submitted for presentation and publication in NATO/AGARD Record, Lecture Series 58, "Spread Spectrum Communications", Bolkesjo, Norway, May 28 – 30, 1973
73-541	Influence of inter-modulation distortion on satellite communication systems (DRB Supported Work)	J.L. Pearce	Paper – presented at 15th Symposium of the NATO TACSATCOM Scientific Group, CRC, Shirley Bay, Ontario May 31, 1973, and publication in Conference Proceedings
73-547	A single hop demand assignment scheme using frequency division multiple access (DRB supported work)	R.J. Campbell J.D. Lambert	Paper – presented at 15th Symposium of the NATO TACSATCOM Scientific Group Ottawa, Ontario, 29 May – 1 June 1973, and publication in Conference Proceedings.
73-548	Simulation analysis of a pre-emptive demand assignment system (DRB supported work)	R. Theriault	Paper – presented at 15th Symposium of the NATO TACSATCOM Scientific Group Ottawa, Ontario, 29 May – 1 June 1973, and publication in Conference Proceedings
73-561	UHF linear phased arrays for aeronautical satellite communications (DRB supported work)	H.L. Werstiuk J.D. Lambert L.A. Maynard J.H. Chinnick	Paper – proposed for presentation at AGARD XXIVth Meeting of the Avionics Panel Symposium on "Antennas for Avionics", Munich, Germany, November 26 – 30, 1973
73-557	The determination of the impedance profile of a transmission line from frequency domain properties (DRB supported work)	B.J. Rook	Publication – CRC Report 1249
73-575	A method for determining the probability of interference for shared assignments in the HF band	U.I. Campbell E.D. DuCharme	Paper – for presentation at NATO/ARFA 2nd Biennial Radio Frequency Symposium, Brussels, 26 – 28 November 1973
73-577	An approach to radio environmental noise measurements in Canada	F.D. Green W.R. Lauber	Paper – for presentation at NATO/ARFA 2nd Biennial Radio Frequency Symposium, Brussels, 26 – 28 November 1973

73-578	Impulse interference measurements at 7.3 GHz	J. LeBel G.E. Poaps	Paper — for presentation at NATO/ARFA 2nd Biennial Radio Frequency Symposium, Brussels, 26 — 28 November 1973
73-590	Calculations of inter-modulation noise due to hard and soft limiting of multiple carriers	C. Loo	Paper — for presentation at 1974 IEEE International Conference on Communications, (ICC 74), Minneapolis, Minnesota, 17 — 19 June 1974 and publication in Conference Record
73-593	CRC Report 1251	F.W. Symons	Document prepared for a client agency
73-594	CRC Technical Note 662	D.C. Barnes G.E. Haslam	Document prepared for a client agency
73-595	Transmission line low-profile antennas theory and experiment	J.S. Belrose	For publication in QST
74-003	Algorithm for a synchronization scheme for application in TDMA systems	P.P. Nuspl R. deBuda	Paper — for presentation at 1974 IEEE International Conference on Communications (ICC 1974), Minneapolis, Minnesota, June 17 — 19, 1974
74-004	HF Antenna handbook	J.L. Thomas E.D. Ducharme	Publication — CRC Report 1255
74-010	CRC Technical Note 664	F.R. Cross J.R. Lewis	Document prepared for a client agency
74-016	CRC Technical Note 666	R.W. Jenkins E.L. Hagg	Document prepared for a client agency
74-018	L'Apl en tant que générateur de séquences aléatoires de MOTS	E. Lambert	Summary — proposed presentation at 1974 IEEE Conférence canadienne sur les communications et l'énergie Montreal, Quebec, 7 — 8 November 1974
74-021	Signalling and channel assignment in FDMA, TDMA	P.P. Nuspl R.J. Campbell	Summary — proposed presentation IEEE Canadian Communications and Power Conference, Montreal, Quebec, 7 — 8 November 1974
74-022	Analyse du trafic d'un système de télécommunications par satellite opérant par affectation prioritaire des voies	R.R. Theriault	Summary — proposed presentation IEEE Canadian Communications Power Conference, Montreal Quebec, 7 — 8 November 1974

74-029	Radio communications used for off-shore oil explorations in a Canadian Maritime region	L.E. Petrie U.I. Campbell	Publication — CRC Report 1254
74-031	Communications Technology Satellite	B.C. Blevis	Paper — publication in Journal of the ITU Association of Japan (published in Japanese language)
74-032	Philosophy of audio system evaluation	E. Lambert	Abstract — proposed presentation Seventh Biennial Symposium on Communications, Queens University, Kingston, Ontario, May 30 — 31, 1974

Physics

73-499	An investigation into the height resolution of the differential-absorption partial-reflection experiment	T.N.R. Coyne J.S. Belrose	Paper — submitted for publication in Journal of Geophysical Research
73-508	Calculation of evanescent-wave gain in the TE_{0m} modes of an optical fiber	A. Watanabe K.O. Hill D. Mintz	Publication — CRC Report 1247
73-510	Bistatic measurement of meteorological and propagation parameters with a high resolution K _U -band scatter system	U.H.W. Lam- mers	Summary Paper — submitted for presentation and publication in the Program Digest, 1973 International IEE/G-AP Symposium, Boulder, Colorado, August 21 — 24, 1973
73-511	Interference measurements at 15.7 GHz over a long transhorizon path	R.L. Olsen U.H.W. Lam- mers	Paper — submitted for presentation and publication in Proceedings, NATO/AGARD Meeting on "Propagation Effects on Frequency Sharing", Rome, Italy, May 7 — 11, 1973
73-514	The measurement of slant path attenuation using radar, radiometers, and a satellite beacon	J.I. Strickland	Abstract — submitted for selective review to IUCRM Colloquim, Nice, France, October 23 — 31, 1973
73-515	Radar measurements of site diversity improvement during precipitation	J.I. Strickland	Abstract — submitted for selective review to IUCRM Colloquim, Nice, France, October 23 — 31, 1973

73-517	Investigation of soft x-ray absorption edge structure using an energy modulated electron beam	K.N. Ramachandran C.D. Cox	Paper — submitted for presentation and publication in Conference Proceedings, Twelfth Symposium on "Electron, Ion and Laser Beam Technology", M.I.T., Boston, Mass., May 21 — 23, 1973
73-530	One-dimensional optical fourier transforms of line tracings	E.B. Felstead K.O. Hill A.U. Tenne-Sens	Paper — submitted for publication in Optica Acta
73-532	Spectroscopic studies on rare-earth ions in aprotic solvent systems	A. Watanabe R.G. Lamont J.G. Chambers	Publication — CRC Report 1248
73-538	Microwave attenuation and scatter theory and measurement	B.C. Bleviss	Abstract — proposed for presentation at IUCRM Colloquim on Fine Scale Structure of Precipitation and EM Propagation, Nice, France, October 23 — 31, 1973
73-543	Evaluation of a new photopolymer hologram recording medium	R.I. MacDonald K.O. Hill	Publication — CRC Technical Note 659
73-545	On the interpretation of CW propagation data for long radio waves	J.S. Belrose B. Segal	Paper — for publication in proceedings of Symposium on Methods of Measurements and Results of Lower Ionosphere Structure, Konstanz, F.R.G., May 23 — 25 1973
73-550	Evanescent-wave amplification in asymmetric-slab waveguides	K.O. Hill R.I. MacDonald A. Watanabe	Paper submitted for publication in Journal of the Optical Society of America
73-551	Spectroscopic studies of Nd^{3+} ions in POCl_3	A. Watanabe	Publication CRC Technical Note 661
73-560	The coupling of light emitting diodes to optical fibers	D.C. Johnson B.S. Kawasaki	Abstract — proposed for presentation at Electro-Optics International '74, Brighton, England, March 12 — 21 1974
73-562	Microwave attenuation and scatter theory and measurement	B.C. Bleviss	Paper — proposed presentation at IUCRM Colloquim on Fine Scale Structure of Precipitation and EM Propagation, Nice, France, October 23 — 31 1973, and publication in Journal de Recherches Atmospheriques
73-565	Damage to GaAs LED's by 20 MeV protons	A.L. Barry R.H. Hum	Abstract — proposed for presentation at Electrochemical Society Meeting, Ottawa Chapter, Bell Northern Research, Ottawa, November 1973, no publication

73-566	The spectroscopy of Pr^{3+} ions in aprotic solvents	A. Watanabe	Paper — submitted for publication in Canadian Journal of Physics
73-571	The measurement of slant path attenuation using radar, radiometers, and a satellite beacon	J.I. Strickland	Paper — proposed for presentation at IUCRM Colloquim on Fine Scale Structure of Precipitation and EM Propagation, Nice, France, October 23 — 31, 1973, and publication in Journal de Recherches Atmospherique
73-572	Radar measurements of site-diversity improvement during precipitation	J.I. Strickland	Paper — proposed for presentation at IUCRM Colloquim on Fine Scale Structure of Precipitation and EM Propagation, Nice, France, October 23 — 31, 1973, and publication in Journal de Recherches Atmospherique
73-582	Holographic recording characteristics of diazo photosensitive films	K.O. Hill G.W. Jull	Paper — submitted for publication in Optica Acta
73-586	ELF Emissions observed near the plasmopause and plasma sheet	R.E. Horita B.P. Smith T. Watanabe R.E. Barrington F.H. Palmer	Paper — submitted for publication in Canadian Journal of Physics
73-589	The coupling of light emitting diodes into optical fibers	D.C. Johnson B.S. Kawasaki	Publication — CRC Report No. 1250
73-591	Aperiodic distributed-parametric waveguides for integrated optics	K.O. Hill	Paper — submitted for publications in Applied Optics
73-592	Numerical solution of the coupled mode equations of guided-wave optics	K.O. Hill	Abstract and Summary — proposed presentation at Optical Society of America, 1974 Spring Meeting; Washington, D.C., April 22 — 25, 1974. Summary for publication in October issue of J.O.S.A.
74-001	The effect of oxide films on thermal contact resistance	F.C. Yip	Paper — for presentation at AIAA/ASME Thermophysics Conference, Boston, Mass. July 15 — 17, 1974
74-005	Excitation of optical-fiber waveguide modes by misaligned Gaussian beams	E.H. Hara Masaaki Imai	Abstract and Summary — proposed presentation — VIII International Quantum Electronics Conference, San Francisco, California, June 10 — 13, 1974

74-007	Acceptance angle of axially graded index tapers	M. Imai A. Watanabe	Abstract and Summary — proposed presentation — Joint meeting of the Optical Society of America and the Americal Physical Society 1974 Spring Meeting, Washington, D.C., April 22 — 25, 1974
74-017	On charge decay in conducting media	J. Sarma	Paper — publication in Proceedings of IEEE (Letters)
74-023	The coupling of light emitting diodes to bulb ended optical fibers	D.C. Johnson B.S. Kawasaki	Paper — for presentation at Electro-Optics 74 International Conference, Brighton, England, March 19 — 21, 1974
74-026	Optical communications Research at CRC	D.C. Johnson	Abstract — proposed presentation Seventh Biennial Symposium on Communications, Queens University, Kingston, Ontario, May 30 — 31, 1973
74-027	Electron microscopy of Ti-Al thin films	M. Bouchard	Summary — proposed presentation Eighth International Congress on Electron Microscopy, Canberra, Aust. August 25 — 31, 1974 Publication Conference Proceedings
74-030	The coupling of curved transmission lines, and its application to optical directional couplers	M. Matsuhara	Paper — publication in IEEE Transactions on Microwave Theory and Techniques (special issue on Integrated Optics)

Propulsion, Engines, and Fuels

73-554	Monopropellant hydrazine reaction control subsystem for the Communications Technology Satellite	V.J. Sansevero C. Arvidson W.D. Boyce S.F. Archer	Paper — submitted for presentation at AIAA/SAE 9th Propulsion Conference, Las Vegas, Nevada, November 5 — 7, 1973 and publication as AIAA Preprint
73-568	The design, development and testing of a high performance apogee motor, utilizing a remote initiation system, for the Communications Technology Satellite (CTS)	F. Eshleman J. Edwards	Paper — proposed for presentation at 9th AIAA/SAE Propulsion Conference, Las Vegas, Nevada, November 5 — 7, 1973, and publication as AIAA Preprint

Space Technology

73-505	A microwave attitude sensing system for satellites angular relationships	R. Mamen	Publication – CRC Report 1245
73-570	Thin-walled beam theory generalized to include thermal effects and arbitrary twist angle	F.R. Vigneron	Abstract – proposed presentation – ASAA/ASME/SAE 15 Structures, Structural Dynamics and Materials Conference, Las Vegas, Nevada, April 1974
73-585	CTS spacecraft thermal and electrical conductivity	R. Buckingham R. deEdwardes R. Townsend	Abstract – proposed for presentation at AIAA 15th Structural Dynamics and Materials Conference, Las Vegas, Nevada, April 17 – 19, 1974
73-596	Communications Technology Satellite – the future for Canada	B.C. Blevis A.B. Shearer	Paper – for publication in DOC Quarterly Journal, 2nd issue 1974
74-002	The 14/12 GHz communications Technology Satellite	L.D. Braun	Abstract and Summary – proposed presentation – Fourth European Microwave Conference (Microwave 74) Montreux, Switzerland, September 1974
74-006	Communications Technology Satellite Project	W.M. Evans	Paper – publication IEEE Aerospace and Electronic Systems Group “Review of Communications Satellite Systems Technology”
n/a	Session 1: Aerospace power electronics applications (Session Chairman’s remarks)	C.A. Franklin	Paper – for presentation at IEEE Power Electronic Specialists Conference, June 11 – 13, 1974, Pasadena, California, and Publication in Conference Proceedings

APPENDIX K

CRC LIAISON OFFICERS

University Liaison

Dr. P.E. Allard — CRC	Dr. Yves Giroux — Université Laval
Mr. P.M. Boudreau — CRC	Mr. Roger Goulet — Université de Sherbrooke
Mr. W.L. Hatton — CRC	Dr. R.W. Donaldson — University of British Columbia
Mr. J.J. Rousseau — CRC	Mr. Pierre Dumas — Université du Québec
Dr. A. Torrens — CRC	Rene J.A. Levesque — Université de Montréal
Mr. F.E. Smith — CRC	Dr. J.E. Hogarth — Queen's University
Dr. T.R. Hartz — CRC	University of Saskatchewan
Dr. T.R. Hartz — CRC	Dr. Nelson Blair — University of Calgary
Mr. J. Craig — CRC	Mr. A. McFarlane — University of Western Ontario

Common Carriers Liaison

Mr. R.L. Hutchison — CRC	AGT — Mr. R. Taylor
Dr. G.W. Jull — CRC	Bell Canada — Mr. D.M. Atkinson
Dr. J.I. Strickland — CRC	B.C. Tel — Mr. G. Valde
Mr. E.A. Walker — CRC	CNT
Mr. E.A. Walker — CRC	CPT — Mr. R. Allen
Mr. R.L. Hutchison — CRC	Edmonton Telephones — Mr. J. Pulford
Mr. R.L. Hutchison — CRC	Island Telephone Co. (MIT)
Dr. A.R. Kaye — CRC	Manitoba Tel — Mr. G. Anderson
Mr. H.G. Bown — CRC	NB Tel — Mr. D.F. MacLennan
Mr. H.G. Bown — CRC	Newfoundland Tel
Dr. A.R. Kaye — CRC	Sask. Tel — Mr. Fraser Lee
Dr. B.C. Blevis — CRC	Telesat — Mr. John Almond
Mr. H.G. Bown — CRC	Maritime Tel & Tel (MIT) — Mr. A.J. Pothier
Dr. J.F. Perrier — CRC	Can. Tel. Carriers Association — Mr. J.L. Wilson

Industrial Liaison

Mr. R.M. Dohoo — CRC	BNR
Dr. A.W.R. Gilchrist — CRC	CDC

APPENDIX L

MAJOR CONSTRUCTION STATUS REPORT

PLANT ENGINEERING
REPORT No. 12.... DATE: 6 April 1974....

COMMUNICATIONS RESEARCH CENTRE

PROJ. No.	DESCRIPTION	SCHEDULE																								ALLOTMT.	COMMITTED TO DATE	COMPL. PERCENT	PROJECT DESIGN COST																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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		APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
7560	Central Heating and Cooling Plant																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

Costs in thousands of dollars.

APPENDIX L (CONTINUED)

PROJ. No.	ESTIMATED EXPENDITURES												PROJECT STATUS	CONTRACTOR	ARCHITECT	REMARKS
	1973-1974				1974-1975				1975-1976							
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th				
7560				16	100	100	100	125	250	375	300	300	With DPW for Design		Graneck Engineering	Schedule: Design start Jan. 1974
7559				10	50	60	100	200	200	200			With DPW for Design		Richardson Engineering	same as above
7872	30	50	23										COMPLETED	Normand & Flemming	Helmer & Tutton	Mechanical changes will be completed with Phase II Constr.
7870				65		185							Under construction	DOMCAT Ltd.	Helmer & Tutton	Schedule: Aug. 74 Completion
7862																Project will be re-scheduled for 1974 — 75
7861			55	55									COMPLETED	Concord	D.P.W.	Restore Grass surfaces — to be completed , Spring 1974
7868				85		35							Construction in progress	Muzzin Construction	Parkway	Project behind schedule, caused by contractor delay
7564			100	110	20								COMPLETED	DOMCAT Ltd.	Helmer & Tutton	Occupancy scheduled; 21 January 1974
7867																Project will be re-scheduled
7860a				60	30								Assembly in progress	Honeywell		
	30	50	178	401	200	380	200	325	547	575	450	300				
	TOTALS 659					1105										

