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National Research Council of Canada. Radio and Electrical Engineering Division

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NATIONAL RESEARCH COUNCIL OF CANADA
RADIO AND ELECTRICAL ENGINEERING DIVISION

CLASSIFIED PROGRESS REPORT NO. 44
JANUARY - MARCH 1966

Declassified to
original level
S. A. NATIJA

Authorized

NOV 26 1992

Date

OTTAWA

MARCH 1966

NRC # 35386

FOREWORD

This Classified Progress Report is intended to present a convenient quarterly summary of some of the classified aspects of the research and development program of this Division, for the information of the Services in Canada, the United Kingdom, and the United States, and of laboratories and other organizations in these countries which are engaged in work similar to ours and which have been supplying us with reciprocal information. Unclassified material, whether or not it is of Service interest, appears in our open publications and will not be covered here. The format of this report is such that the account of each project may be separated from the whole without loss of security grading. It is thought that this feature may be appreciated by some agencies, such as the Project Coordinating Centre of the Department of National Defence, where they may prefer to file the individual sheets according to their own systems. It also permits us to issue the separate sheets to persons who may have an interest in certain selected projects but who do not require the remainder of the report.

A list of classified reports issued by the Division each quarter is included. There is no automatic distribution for these reports — the circulation list for each is determined by the nature and interest of the work described. Requests for copies of these reports, to be directed to the Document Control Office of this Division, will be given every consideration, subject to security regulations. Recipients of these documents should note that Canadian approval is required for release to other persons, organizations, or governments of any classified information (including this Classified Progress Report) which may be issued by this Division.

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Reference: Army. DND Project B22-38-50-01

Period under review: January-March 1966

RANGE EXTENSION

As a part of the investigation of the requirements associated with range extension, it has been found that further reduction of PRF results in some change in the firing delay in the transmitter (actually, in the thyatron). The change is small, but is significant now that other sources of variable delay have been removed by modifications to the triggering circuits. These modifications were introduced some time ago as a part of the recent product improvement program. Examination of the ceramic hydrogen thyatron revealed that, though adequate mechanically, it failed to satisfy thermal requirements. Heat transfer to the mounting's cooling fins was negligible. An experimental mount was machined from an aluminum block. It reduced the firing delay variability with respect to repetition rate somewhat, but sufficient variability remains to justify further investigation.

RAIN-CLUTTER MONITOR

Rain-clutter data recorded during six rainstorms has been examined to determine the clutter cancellation capabilities of the radar polarizer. Thirty separate measurements of the mid-scan cancellation varied from 15 to 24 db (gross), with a mean of 19.9 db. This figure is in good agreement with several readings averaging 20 db taken earlier with a calibrated attenuator fitted to the radar receiver. The measurements taken so far show no clear evidence of dependence upon the rainfall rate which varied from less than 0.5 mm/hr to 5.5 mm/hr during the tests.

Measurements taken toward the edges of scan (at ± 160 mils from centre) show that the cancellation drops toward the left of the display (15.5 db averaged over 3 measurements), but holds up well toward the right edge (20.8 db averaged over 4 measurements).

For comparison, the cancellation provided by the prototype polarizer was measured at centre scan during storm only. Six readings produced an average of 19.0 db for this figure. Seven readings taken with the production polarizer during the same portion of the storm averaged 19.7 db.

Further study of the records will be undertaken to attempt to correlate the clutter return power with the rain-fall rate.

A non-degenerate parametric amplifier which was expected to be delivered early in the period under review has just been received. Delays are also being experienced in obtaining the pump klystron and power supply, as neither vendor has been able to meet promised delivery dates. A laboratory evaluation will be made when all necessary equipment has been delivered.

VIDEO RECORDING

A video tape recorder has been received and the radar video signals have been recorded with, and without target simulator signals. These have been played back onto a standard laboratory oscilloscope as a first step. The requirements for playback onto the radar are being studied.

SIGHTING TELESCOPE

A rifle telescope, with a zoom magnification range from 3 to 9, has been mounted on the antenna structure. Quick removal has been provided for by means of a mounting clamp, as used in mounting the telescope on a rifle. The magnification range allows a reasonably wide view for initial spotting of the sighting point and high power for accurate final setting.

PRESSURIZED ROTATING JOINT

Seals for the pressurized rotating joints in the scanner waveguide system have been under test. One was operated successfully for just over 1000 hours before being dismantled for examination. The condition of the carbon seal indicated that only a fraction of its probable life had been expended. A further report is expected from the manufacturer of the seal.

A seal from another manufacturer has operated successfully for over 600 hours so far and will be examined later.

LEVELING

Completion of the leveling investigation was delayed by non-delivery of the heating components.

IMPROVEMENTS TO GROUND RADARS

Reference: Navy, Army, RCAF. DND Project D48-38-03-27

Period under review: January-March 1966

KEYED-AGC MTI

A suggestion was made to the RCAF that a keyed-AGC MTI circuit would provide near CFAR action, and at the same time would not suffer loss of targets due to hard-limiting encountered in Dicke-MTI systems. This circuit had been referred to the contractor carrying out an ECCM study for the RCAF. The contractor built a breadboard model and carried out preliminary tests. Discussions were held with the RCAF and the contractor on these preliminary tests.

C.W. INTERCEPT RECEIVER (AN/PSS-502)

Reference: Army, Navy. Napkin Project

Period under review: January-March 1966

The purpose of this project was to investigate techniques and to develop components and circuitry for a light-weight portable intercept receiver which is required to detect both pulse-modulated and c.w. radar emissions. The work, which has been carried out jointly by the National Research Council and the Defence Research Telecommunications Establishment, is an extension of earlier work on light-weight pulse and c.w. intercept receivers.

Under this project, three waveguide modulator-detector units covering the frequency range 8-37 Gc/s, have been made. Each comprises a waveguide structure on which is mounted a modulating diode and a detector diode. The circuitry previously used (see NRC Report ERB-675) has been modified to eliminate the gain control, the matched magnetostrictive filters, and the two-frequency (heterodyne) amplifier system. The receiver now employs a coherent detection system. Integrated circuits are being used. System feasibility has been demonstrated by operation of the Ku-band and Q-band modulator-detector units with the breadboard receiver. The results indicate that the system sensitivity varies between -58 and -65 dbm in the band 10.5 - 21.5 Gc/s, and between -55 and -63 dbm in the band 21 to 37 Gc/s. A slightly larger unit has been constructed for operation down to 8 Gc/s. Present coverage of this unit is 8 to 16.5 Gc/s.

In accordance with the arrangements made when this work was begun, responsibility for this project has now been transferred to DRTE. The Project Napkin contractor (Canadian General Electric) has initiated work on the complete receiver, using the components and techniques developed under this project.

Two of the modulator-detector units, along with various test sections and detailed drawings, have been sent to the contractor.

A report describing the various modulator-detector units is being prepared.

X-BAND GROUND SCATTER MEASUREMENTS

Reference: RCAF. No project number

Period under review: January-March 1966

In 1961, the Royal Canadian Air Force required data on bistatic scattering at X-band. Since no direct information was available in the literature, the RCAF requested the National Research Council to provide a suitable transmitting antenna and measuring equipment and to aid in the measurements and analysis of the results. The method used by us to determine the bistatic cross section per unit area (σ_0) at X-band is described in NRC Report ERB-725 (see p. 12).

Measurements were made over flat farming country, tree-covered hills, and water. It was found that a linear equation of the form $\sigma_0 = A_1 + A_2 \theta^\circ$ (db) adequately described the experimental results in all cases for $5^\circ < \theta^\circ < 80^\circ$, where θ is the angle with the horizontal made by the receiving beam. The constants A_1 and A_2 did not vary for different land terrains, even when snow-covered. They did vary for cross polarization, and when α , the angle with the horizontal made by the transmitting beam, was altered to 60° from 90° . The value for $\theta = \alpha = 90^\circ$ agreed with that obtained by others for monostatic measurements. A_1 and A_2 also varied for various sea states when parallel polarization was employed. It was found that the scattering power level from land or sea did not vary appreciably in intervals of 2 or 20 seconds (the latter represents approximately 0.7 miles distance).

The results obtained were sufficiently accurate for the practical application which required the measurements. Therefore, this project has now been terminated, as further measurements over the same types of terrain with the present equipment would not provide significantly better results. Also, the RCAF has disposed of one of the aircraft used for the project and a replacement has not yet been obtained. Recommendations were included in the report on the types of equipment (aircraft and electronic) if a new project were instituted to obtain statistically better results on an economic basis.

SOUND RANGING

Reference: Army. DND Project B105-38-50-08

Period under review: January-March 1966

PURPOSE

The purpose of this equipment is to provide a sound-ranging system which will reduce errors in film reading, in application of meteorological corrections, and in calculation of locations. It will provide equipment for magnetic storage of sound data, and facilities for computation of sound-source locations by means of a special digital computer.

METEOROLOGICAL CORRECTION PROGRAM

Processing of the meteorological data gathered during the Shilo sound-ranging trials in September and December 1965 is being continued. All of the wind data from the Phase I trials have been transcribed on to punched cards and a computer program for the reduction of radiosonde wind and temperature data has been written and is being used for processing. Some difficulty has been experienced in processing the magnetic tape recordings of the tower wind and temperature data gathered during the trials. Equipment failures resulted in record gaps being omitted, and in some cases, extra characters being inserted in the records. It will be necessary to edit the tapes before they can be processed on the IBM 360 computer. In the meantime, selected portions of the tower data are being examined using manual processing, but this is limited to extremely small portions of the record, owing to the extensive processing necessary to extract the wind and temperature data from the coded message.

A computer program using the Goodwin method of computing sound travel times has been written and is now running. Two versions of the program are currently being used. One uses meteorological data at discrete points, while the other uses a least-squares curve fit to the meteorological data and defines the velocity structure by means of three polynomials (sound velocity, and the X and Y components of the wind vector). Data from only four radiosonde ascents have been processed using these programs; however, results using the polynomial representation of the velocity structure

appear to be better than those obtained using the meteorological data at discrete points.

A third version of the correction program which is currently being checked out, will permit data from up to three radiosonde ascents to be combined into a "running average". This will result in increased smoothing of the meteorological data and reduce the effect of random measurement errors.

MICROPHONES

The varistor filter which automatically raises its high-pass corner frequency in the presence of wind-noise has been tested and a report has been prepared. To demonstrate the action of the circuit, a wide-band (1-300 cps) sound-ranging recording with considerable randomly varying wind-noise was passed through the automatic filter at controlled levels of amplitude. The outputs show increased attenuation of wind-noise as the wind simulated-amplitude increases, with negligible degradation of normal gun-sound frequencies. Attenuation of wind frequencies in the region of 1-2 cycles/sec was about 15 decibels at the largest amplitudes.

MODEL ANTENNA STUDIES FOR RCN

Reference: Navy. DND Project A12-55-40-16

Period under review: January-March 1966

HF ANTENNAS

i) DDH 205 HMCS St. Laurent

Installation of a broad-band transmitting and receiving antenna on the destroyer escort HMCS St. Laurent, Halifax, was completed in early January. The system comprises a 2 to 6 MHz monocone antenna and two 2 to 30 MHz fan-type receiving antennas. Evaluation trials to assess the performance of the new system, in particular the Sinclair Radio 3-channel multicoupler, were carried out during the period 16 February to 2 March. A total of 12 trials were carried out jointly by RCN, NRC, and Sinclair Radio Laboratories, Toronto. A summary report of the trials is being prepared by the RCN.

ii) DDH 280

RCN has advised us of further structural changes to the foremast and mid-superstructure area of the DDH 280 destroyer escort. These modifications are being incorporated in our 1/20 scale impedance mock-up.

iii) Operational Support Ship

A complete set of drawings of the 1/48 scale model of the Operational Support Ship has been delivered to our Model Shops and construction of the model is well under way.

iv) HMCS Bonaventure

NRC Report ERB-728 has been prepared, describing a proposed receiving-fan antenna for HMCS Bonaventure. The new antenna, which will be used in conjunction with a multicoupler, is intended to replace the present island-mounted 28-foot whip.

VHF/UHF ANTENNAS

i) DDH 280

It was stated in the previous issue of this report that preliminary studies were being carried out to determine the feasibility of combining the VHF and UHF antennas on a single pole mast for the DDH 280 destroyer escort class. RCA in Montreal has been awarded a contract to design a service test model and our role will be to assist the RCN in monitoring the contract.

ii) HMCS Nipigon

Installation of the VHF communication system for HMCS Nipigon, which will enable the flight controller to communicate with the deck crew, is being considered. RCA in Montreal has been selected to supply the equipment and we are advising on the antenna problem and layout.

HELICOPTER ANTENNA STUDIES FOR RCN

Radiation pattern studies of the UHF blade antenna on the CHSS-2 helicopter have been completed and a brief report of the results was submitted to the Canadian Forces Headquarters.

ECM ANTENNAS

Canadian General Electric Co., Toronto, was awarded a contract to produce a service evaluation model of the NRC-designed 300-1100 MHz spiral D/F antenna. (Reference: Classified Progress Report, Jan. - Mar., 1964). During the period under review we have been assisting RCN in monitoring the contract. Environmental tests of the prototype antenna are scheduled for May.

CLASSIFIED REPORTS ISSUED

Akeroyd, J. Balloons for Radar Evaluation in S.A.G.E.
(ERB-726, Secret)

Plastic radar reflecting balloons are good targets for use in radar performance evaluation. This report contains the results of all trials using S.A.G.E., along with a brief discussion of results and of the usefulness of the balloons in S.A.G.E.

Hunt, F.R. X-band Bistatic Scatter Measurements (ERB-725,
Secret)

The method used by the National Research Council and the Royal Canadian Air Force to determine the bistatic scattering cross section per unit area (σ_0) at X-band is described. Measurements were made over flat farming country, tree-covered hills, and water. It was found that a linear equation of the form $\sigma_0 = A_1 + A_2 \theta^\circ$ (db) adequately described the experimental results in all cases for $5^\circ < \theta^\circ < 80^\circ$, where θ is the angle with the horizontal made by the receiving beam. The constants A_1 and A_2 did not vary for various land terrains even when snow-covered. They did vary for cross polarization and when α , the angle with the horizontal made by the transmitting beam, was altered to 60° from 90° . The value for $\theta = \alpha = 90^\circ$ agreed with that obtained by others for monostatic measurements. A_1 and A_2 also varied for various sea states when parallel polarization was employed. It was found that the scattered power level from land or sea did not vary appreciably in intervals of 2 or 20 seconds (the latter represents approximately 0.7 miles distance).

Classified Reports Issued (cont'd.)

Wong, J.Y.

A Proposed HF Receiving Antenna for
HMCS Bonaventure (ERB-728, Confidential)

A two-element co-phased fan-type receiving antenna located on the island structure has been developed for HMCS Bonaventure. The antenna which will be used in conjunction with a multicoupler is intended to replace the present 28-foot receiving whips.