Classified progress report no. 40: January-March 1965

National Research Council of Canada. Radio and Electrical Engineering Division

Report (National Research Council of Canada. Radio and Electrical Engineering Division : ERA); no. ERA-368, 1965-03

ERA-368

SECRET

COPY NO. 37

NATIONAL RESEARCH COUNCIL OF CANADA

RADIO AND ELECTRICAL ENGINEERING DIVISION

CLASSIFIED PROGRESS REPORT NO. 40
JANUARY - MARCH 1965

OTTAWA

MARCH 1965

NRC # 35368

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 Co-ordinating 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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COUNTER MORTAR RADAR (AN/MPQ-501)

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

Period under review: January-March 1965

RECEIVER

The modified receiver, which included a new hybrid junction mixer and a revised i-f input circuit, was fitted to Radar No. 105. However, this receiver, which had a noise figure of 9 db during bench tests without the duplexer, offered very little improvement over the existing receiver. As production tests had indicated that the noise figures lay between 11.5 and 12.5 db, the reasons for this discrepancy were studied.

It was found that there is a marked difference between the readings obtained during bench tests and those obtained with the built-in noise monitor, the readings of the latter being higher and less accurate. These errors are caused by saturation which occurs in the main amplifier prior to the point at which the noise sample is taken. By taking the noise sample from an earlier stage, the accuracy of the noise monitor may be improved considerably.

Drawings of the modified receiver and a recommendation for modification of the noise monitor have been forwarded to the Army.

TRANSMITTER

Further attempts to locate a higher-power magnetron have been unsuccessful. A spin-tuned magnetron was investigated as a matter of curiosity and we were informed that an existing 200 kw X-band unit would probably be modified for our frequency, but that the power would then be reduced to about that of the present magnetron. It seems that a fundamental limitation, based on wavelength, has been reached.

VIDEO STORAGE UNIT

The present design has been taken to the point where further advance would require a considerable increase in complexity. The recent design improvements have made available 3 to 5 db more sensitivity in the storage role with respect to the performance demonstrated in field trials at Shilo, while at the same time control has been simplified.

The registration error in the experimental model is not greater than ± 0.05% of the range interval of up to 20 km and ± 1 mil in azimuth. The errors in coordinate extraction have not been quantified, but they are less than those present in normal operation.

COMPUTER SERVO AMPLIFIERS

An investigation of commercially available amplifiers and motors to replace those components now in use indicates that suitable items can be readily obtained for use in future production runs. For equipments already in the field, replacement of the servoamplifier only, with matching transformer, is suggested as the best solution. Meanwhile the breadboard model has been packaged in a size and shape similar to that of the commercial amplifier now in use.

SCANNER

A test setup to investigate scanner wear due to the pawls riding on it, showed that this operation does produce an appreciable quantity of aluminum particles and is a source of the particles reported in the horns. Methods of alleviating the situation are being studied.

IMPROVEMENTS TO GROUND RADARS

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

Period under review: January-March 1965

DISTANCE-MEASURING EQUIPMENT

A new coding control box was constructed and installed. This allows the use of all codes in modes I, II, and III. Previously, many of the codes in mode II operation could not be used.

The error in range measurement was determined. It was found to vary from -148 feet to +50 feet in the range interval 700 feet to 200 nautical miles.

A report on the equipment is in preparation.

LONG-PULSE DISCRIMINATOR (LPD)

Before procuring these units for the AN/FPS-507 and AN/FPS-508 radars, the RCAF agreed that further tests were necessary. Tests were carried out at the DRB/DRTE laboratories using their AN/FST-2 simulator. It was found that the LPD degraded the MDS of a logarithmic receiver by 2 db, which agrees with the results of other agencies. Its super-clutter visibility, i.e., the ratio of the signal strength of a pulse of optimum duration (5 μseconds) to that of a pulse of 15 μseconds duration, was also determined. This ranged from 8 db for a 15-μsecond pulse 5 db above thermal noise, to 16 db for a 15-μsecond pulse 40 db above thermal noise. Its super-clutter visibility, except at the leading edge of the clutter pulse, is therefore worse than that of an FTC circuit.

NRC recommended and the RCAF have agreed that LPD's should not be installed on the search and height-finding radars because both the super-clutter visibility and maintenance problems of the LPD are worse than for an FTC circuit. In a Sage environment, the cost of additional delay lines to provide equal delays in all receivers also prohibits the LPD's addition to the search radar.

VARIABLE VELOCITY NOTCH MOVING TARGET RECEIVER (VVNMTR)

The Service Test Model of the single-sideband version for the AN/FPS-508 was given a preliminary test during the period under review. Complete cancellation of the chaff by the VVNMTR was not achieved until late in the trial. Incomplete cancellation could have been due to errors by the operator or to the high wind shear which existed. The winds varied from 100 knots, 260° at 30,000 feet to 20 knots, 240° at 5,000 feet. Late in the trial, some precipitation echoes appeared and these were successfully cancelled.

Although the trial was successful, it was suggested that the RCAF install the receiver at a site for a period of one month. Two or three chaff drops should be arranged during this period. The trial period will allow an evaluation of the new receiver's operational and maintenance characteristics. Comparison with the earlier VVNMTR at the same time would indicate whether the newer unit shows any significant improvement.

The earlier VVNMTR was described in Communications and Electronics Digest, April 1964, pp. 14 to 16, "A simple variable velocity notch MTI for the AN/FPS-508" (Confidential) and in NRC Report ERB-628, "Variable velocity notch moving target indication", April 1963 (Confidential), both by F.R. Hunt.

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

Reference: Army, Navy. Napkin Project

Period under review: January-March 1965

An extension of the intercept receiver development work carried out jointly by DRTE and this Division has been arranged. The purpose of the current development is to investigate receiver techniques which are of use for a light-weight hand-held receiver that is to be responsive to both pulsed and c.w. radar transmissions, and to extend the present frequency coverage.

The required test gear has been acquired, and various special-purpose diodes for use as modulators and detectors have been purchased.

Initial efforts have been directed toward investigation of various circuits for the receiver. Preliminary results indicate that significant improvement in sensitivity can be made without the use of the narrow-band filter previously employed.

RADAR PERFORMANCE EVALUATION

Reference: RCAF. DND Project 098-38-02-09

Period under review: January-March 1965

The balloon trial results have been plotted. Reports are being prepared.

X-BAND GROUND SCATTER MEASUREMENTS

Reference: RCAF. No project number

Period under review: January-March 1965

Analysis of the results obtained from the flights over water was continued on a low priority basis during the period under review. The transmitting antenna mount was modified to allow measurements to be made with the angle of illumination off the vertical.

SOUND RANGING

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

Period under review: January-March 1965

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.

COMPUTER

The initial two-point approximation to the sound-velocity structure, used in the computation of meteorological corrections based on the Goodwin Method, gave results which were unsatisfactory; in most cases the location accuracy was worsened over that obtained using the correction based on a weighted wind and 500-foot temperature. To permit a more satisfactory representation of the sound-velocity structure, a computer program was written which permits the fitting of a polynomial of maximum order five to the sound-velocity and wind-velocity structures. Using a second-order curve fit, several series have been reprocessed, and a significant improvement in location accuracy has been obtained. Location errors have been reduced by as much as 50 percent. All locations made with this correction method have been fired under conditions of high winds with a positive velocity gradient. Locations made under conditions of lower winds are currently being examined.

To determine the effect on the correction to the sound-arrival-time data of changes in the meteorological structure, corrections have been calculated from meteorological data obtained by means of a linear interpolation between two measurements. Corrections were computed for three locations (at ranges of 13,700, 16,300, and 18,800 metres) using the Goodwin integral and a second-order curve fit to the meteorological data. Changes in correction, over a 15-minute interval, as high as 33 milliseconds were indicated for a 2000-metre sub base. This results in a change in bearing of approximately 5 mils.

This would indicate there is some improvement to be obtained in location accuracy by interpolating between meteorological messages, possibly making use of surface measurements to give a more valid interpolation.

MODEL ANTENNA STUDIES FOR RCN

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

Period under review: January-March 1965

HF ANTENNAS

i) DE205

A report on the antenna evaluation trials carried out on HMCS Ottawa, Esquimalt, has been prepared jointly by DGFE/RCN and NRC.

ii) DE257

Owing to lack of space on the superstructure of the DE257, DGFE/RCN has decided to abandon the use of the broad-band 5 to 30 mc/s discage antenna in favor of two tuned 35-foot whips. Receiving fan antennas similar to those installed on HMCS Ottawa are being fitted on the 1/20 scale mock-up, and impedance and coupling measurements are under way.

iii) DDH (destroyer helicopter carrier)

Discussions with DGFE/RCN on the communications antenna system for the new helicopter-carrying destroyer escort are progressing.

iv) CNAV Laymore

Laymore is an RCN auxiliary vessel which is being converted to an oceanographic research ship for the Department of Transport. An HF communication antenna system has been proposed, suitable to DOT requirements. It is expected that no model measurements of the antenna system will be required.

v) Oberon Submarine

A report summarizing the radiation pattern evaluation of the proposed ALN2 HF whip antenna for HMCS Ojibwa has been prepared.

Jezebel Antenna

Preliminary radiation pattern measurements on a 1/3 scale mock-up of the two-element dipole array for the proposed Jezebel antenna system have been completed. Impedance measurements on the array are being carried out.

ECM Antennas

Development of an X-band conical-spiral antenna and waveguide-to-coaxial transition is being continued. A second antenna has been built which provides both improved azimuthal and elevation patterns.

Construction of a 10-foot 100 to 300 mc/s conical-spiral antenna has been started in our Model Shops.