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RADIO AND ELECTRICAL ENGINEERING DIVISION

CLASSIFIED PROGRESS REPORT NO. 36

(JANUARY - MARCH 1964)

OTTAWA

MARCH 1964 NRC # 35442

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 1964

WAVEGUIDE WINDOW

A number of ceramic discs were fired using Wesgo A1-300 alumina for the blanks. Considerable distortion occurred during firing because of the thin sections involved. One disc was successfully produced; however, because the radial shrinkage is less than the shrinkage in thickness, the final dimensions were incorrect. The shrinkage factors determined in these tests will be used in calculating the appropriate dimensions required for the unfired blanks.

Further work on this project is being postponed until other projects are completed.

TRANSMITTER

A new magnetron, Ferranti type-1018 (VF25), has been received from the manufacturer and is being fitted.

PRODUCTION RADAR FOR TESTING

One complete system (serial 105) was received for installation in the Radio and Electrical Engineering Building. The antenna has been mounted on the roof, and the console and control units in a laboratory on the third floor. This equipment will facilitate testing of items being developed under the improvement program, and permit investigation of any problems arising in the field.

Until the manufactured extension cables are received, the equipment will be partially operable with temporary cables.

IMPROVEMENTS TO GROUND RADARS

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

Period under review: January-March 1964

VARIABLE VELOCITY NOTCH MTI

By shifting the frequency of the coherent oscillator in a coherent MTI system, the blind speeds of the radar's MTI can be shifted. If the radar is the AN/FPS-508 with a PRF of 360 c/s and is operating at L-band, the first blind speed can be altered from zero nautical miles/hour to 80 nautical miles/hour by shifting the frequency of the coherent oscillator by 360 c/s. Thus, selective cancellation can be carried out; e.g., wind-blown chaff can be eliminated, leaving aircraft targets.

One method of shifting the frequency of the coherent oscillator is to use single-sideband modulation. A Wien-bridge audio oscillator was employed. The dual capacitor in its frequency-determining network was driven by a servomechanism synchronized with the rotation of the radar antenna. The variation about the center frequency of the oscillator (2.16 kc/s) was proportional to the wind velocity and to the cosine of the angular difference between the wind and antenna direction. Thus, if the wind speed and direction were constant over the whole of the radar coverage, chaff would be simultaneously eliminated in all parts of the cover. The center frequency of 2.16 kc/s (6 times the PRF) was chosen to provide a useful range for the variable-frequency oscillator from 1.44 to 2.88 kc/s; thus, the maximum wind velocity that can be cancelled would be about 160 knots.

For the single-sideband modulation technique a pair of beam-deflection tubes is used, fed by suitably phased signals from the 30 mc/s coherent oscillator and the audio signal generator. Provision was made in the experimental model for gating either the input coherent signal or the single-sideband-modulated signal to the output of the unit. This will allow the use of normal MTI from zero range out to the limits of the radar permanent echoes and VVNMTI from that point to the maximum radar range. Unlike an earlier model of the VVNMTI [1], a single set of delay line components suffices for both types of MTI.

Another advantage of the newer model is that the operator can preset the wind velocity and wind direction controls from meteorological data. If diplex operation of the AN/FPS-508 is employed, both channels can use the same audio signal generator with its single set of controls.

In early March, the experimental model was tested at RCAF Station Foymount. Unfortunately, the weather at ground level was poor, and the Department of Transport ordered the cessation of chaff dropping after seven bundles had been dropped. However, these bundles covered a large enough sector of the radar's coverage to show that this VVNMTI was significantly better than the earlier model in the sector width that it was capable of cancelling. The RCAF will ask the Napkin Committee to produce a Service Test Model.

DISTANCE-MEASURING EQUIPMENT

The RCAF have experienced difficulty in obtaining accurate range measurements of ECM aircraft from the Napkin ECM monitor van during experiments. The measurements were derived from plots taken at nearby radar stations. The Directorate of Electronic Warfare requested our aid in developing a simple system to overcome this problem. A proposal was submitted and accepted.

The basic unit will be a commercially available Time Interval Unit which provides a readout suitable for the monitor van's recording equipment. This will record the time taken for a beacon mounted in the aircraft to reply to a coded pulse from the ground transmitter, using the SIF beacon system available from RCAF Stores. The only modification will be to tune it to new frequencies in its operating band, in order to improve interference rejection from other SIF equipments operating in the vicinity. The only electronic construction necessary will be small units that may be required to match various trigger and video levels between the beacon system, Time Interval Unit, and the recording equipment. Since the azimuth of the ECM aircraft is known in advance, a fixed antenna will be used with horizontal and vertical beamwidths of approximately 20° each. A corner-reflector antenna designed and built by NRC will be used. The aircraft will employ one of the normal airborne SIF antennas.

The Time Interval Unit has a built-in 10 mc/s crystal-controlled clock, and it is estimated that the system will provide range accuracy of ± 250 feet at 100 miles.

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1. F.R. Hunt, "Variable Velocity Notch Moving Target Indication", NRC Report ERB-628, April 1963 (Confidential)

C.W. INTERCEPT RECEIVER

Reference: Army, Navy. Napkin project

Period under review: January-March 1964

This equipment, which is a light-weight intercept receiver operating in the X-band region, is based upon a proposal of Canadian Arsenals Limited and is being built with the assistance of DRB/DRTE. The system comprises a horn antenna, a waveguide varactor-diode modulator, a waveguide detector, an amplifier tuned to the modulating frequency, a synchronous detector, and audio output stages.

The modulating frequency is 100 kc/s and is obtained from a very stable oscillator which utilizes a magnetostrictive filter having a bandwidth of 6 c/s. A similar filter of matched characteristics is used in the amplifier to produce the very narrow bandwidth required for high sensitivity. Because very high gain is required to amplify the thermal noise in a 6 c/s bandwidth up to a useable level, amplifier stability is a serious problem. For this reason, a heterodyne system has been used, part of the amplifier being tuned to 92 kc/s, while the remainder operates at 100 kc/s. Conversion between the two frequencies is accomplished with an auxiliary 8 kc/s oscillator.

During the period under review, all components of the receiver have been developed and tested. A case has been fabricated from Fiberglas laminate, and the assembly of the receiver completed.

Laboratory tests indicate that the sensitivity is between -60 and -65 dbm at X-band. Field testing is under way. The initial results indicate that the over-all sensitivity is about 4 db less than the anticipated value, and that some problems of amplifier stability remain. Circuit changes designed to improve stability are being made.

RADAR PERFORMANCE EVALUATION

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

Period under review: January-March 1964

Balloons have been received from a second manufacturer and are undergoing laboratory tests. These balloons are made of 1 mil aluminized Mylar and are 4 feet in diameter. Half of them have pressure-relief valves supplied and installed by the manufacturer, and half have necks to receive the NRC pressure-relief valves.

Orders have been placed with two manufacturers for large balloons to carry the 4-foot balloons to high altitude. One manufacturer is supplying 25-foot-diameter spheres complete with pressure-relief valves. The other manufacturer is supplying tetrahedrons with an altitude of 42 feet per side which have a neck to receive the NRC valve. Both types are made of 1 mil clear Mylar. Delivery of both orders has been promised for March 31. Arrangements are being made with the RCAF to test these balloons operationally.

A simple method of checking for leaks in balloons is being tested. A small amount of freon 12 is mixed with the helium and the leak is detected with a halide leak detector.

X-BAND GROUND SCATTER MEASUREMENTS

Reference: RCAF. No project number

Period under review: January-March 1964

The RCAF has made a proposal for an electronic airborne jammer which would combine the masking properties of a conventional jammer with the main advantage of a decoy, i.e., the possibility of diverting the interceptor from the target to the decoy. Briefly, the airborne jammer feeds a directional antenna, with very low side lobes, directed at the ground below the jamming aircraft. To an interceptor the jamming appears to come from the ground rather than from the aircraft. At the same time, the jamming is strong enough to mask active radar returns from the jamming aircraft, even though the jamming is entering through the side lobes of the interceptor's radar antenna.

Two flights were made in February over the snow-covered flat farming land and tree-covered hills where measurements were made last summer [1]. Thus, the effect of snow on the scatter-loss factor $S(\theta)$ will be determined. $S(\theta)$ is defined as the scattering cross section divided by the area in which scattering takes place, times a constant. The results will be analyzed as soon as the flight data is complete.

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1. F.R. Hunt, "Bistatic Scattering Measurements at X-band", NRC Report ERB-651, November 1963 (Secret)

SOUND-RANGING COMPUTER

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

Period under review: January-March 1964

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.

TRIAL RESULTS

All of the Phase I (June 1963) and approximately one-half of the Phase II (September 1963) tape recordings have been processed with the aid of army personnel. The sound time-arrival measurement method has been that which has produced the smallest estimate of probable error as given by the computer, but it is evident that in some cases, with the present system of meteorological corrections, this has contributed some rather erratic results. In other cases, where time-arrival measurements have been made with the emphasis on repeatability over a series of shots, the standard deviation of 10 locations at 7000 metres has been of the order of 10 metres, while relatively large bias errors were still retained, possibly because of the method of applying meteorological corrections. Investigations are being continued.

CIRCUITRY

Individual gain controls for each channel have been added at the data input to control recording levels.

COMPUTER

Trial results indicate that it would be desirable to have a more accurate asymptote display, with the asymptotes corrected

for meteorological effects, which would assist the operator in selecting the correct signal. It is planned to use the computer to generate the asymptotes, since this will result in improved accuracy and facilitate the inclusion of the meteorological correction. To test the feasibility of the system, a Charactron Model 70B display unit will be used to display the asymptotes. The required interface circuits have been designed, and printed-circuit drawings are currently being prepared.

MODEL ANTENNA STUDIES FOR RCN

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

Period under review: January-March 1964

HF ANTENNAS

Impedance measurements on the twin-fan antenna arrangement for the St. Laurent DE-205 conversion class described in the previous issue of this report were continued. Good results were obtained on a configuration consisting of a pair of fans (2 wires each) connected in parallel at the feed point and subtending an angle of about 30° with the foremast. Using an LC network, a VSWR of less than 3.5 to 1 was obtained over the 2 to 5 mc/s band.

A second configuration for exciting the foremast as a 2 to 5 mc/s antenna was investigated. The antenna arrangement consisted of 4 ungrounded guy wires which form a simulated cone around the foremast. The apex of the cone is fed by the center conductor of a coaxial feed and the outer conductor is grounded to the foremast. Good results were also obtained on the 1/20 scale impedance mock-up. The antenna is structurally simpler than the folded tetrahedron and twin-fan antennas, and will be adopted by the RCN as the 2 to 5 mc/s broadband antenna for the improved St. Laurent class.

The "monocone antenna", as it has been termed, was installed on HMCS Assiniboine at Halifax, and full-scale impedance measurements were carried out on the antenna by personnel of NRC and a staff member from DGFE/RCN. The full-scale and model impedance results will be used in the design of a diplexer unit for the antenna. A contract has been awarded to a private firm for the design of the unit.

Construction of a 1/48 scale model of the supply ship HMCS Provider has been commenced. It is planned to provide the ship with broadband HF antennas and the model will be used for radiation pattern studies.

UHF ANTENNAS

Calculations of the radiation pattern of a dipole antenna located near a conducting circular cylinder were carried out. The results are applicable for a UHF antenna located on a yard-arm near a ship's foremast.

ECM ANTENNAS

The 300 to 1100 mc/s spiral D/F antenna has been officially designated the "AS-5034 (XP-1)/UPR antenna" by DND. A contract demand for 2 units to be used for service evaluation has been given Treasury approval.

CLASSIFIED REPORTS ISSUED

Wong, J.Y.
and
Macpherson*, H.A.

Evaluation of UHF Antenna System (AS-1018/URC) for HMCS Assiniboine (ERB-655, Confidential)

HMCS Assiniboine has reported unsatisfactory, and in certain cases inadequate UHF communications. The antenna arrangement consists of an AS-1018/URC mounted inside the top section of the foremast. Impedance and pattern measurements were carried out on a full-scale mock-up and the pattern performance was found to be seriously degraded by the presence of the DAU antenna cables which run alongside the foremast. It is recommended that the cables be re-routed to follow the corner members of the foremast. A further improvement can be effected by the inclusion of a matching stub.

Lavrench, W.

X-band Antenna for CL-89 Drone Tracker (ERB-656, Confidential)

An X-band antenna producing a $\csc^2$ vertical radiation pattern to 45° has been designed and built for the CL-89 Drone Tracker. The antenna performance meets all requirements except that of horizontal beamwidth. The latter varies from 18° to 24° over the band, whereas the specification calls for 20°. This variation is caused by the existence of a higher mode in the pillbox antenna.

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*Lieutenant, DGFE/RCN