THE UNIVERSITY OF MICHIGAN RADIATION LABORATORY

2455 Hayward Street
Ann Arbor, Michigan 48105

(313) 764-0500

14 August 1973

011764-5-L

Air Force Avionics Laboratory
Air Force Systems Command
4950 Test Wing (Technical)
ATTENTION: AFAL-WRP
Wright-Patterson AFB, Ohio 45433

SUBJECT	Monthly Progress Letter No. 5
PERIOD COVERED	15 July - 15 August 1973
CONTRACT NR, PROJECT and TITLE	F33615-73-C-1174, 7633 "Non-Specular Radar Cross Section Study"
CONTRACTING OFFICER	George E. Himes
REPORT SUBMITTED BY	Thomas B. A. Senior and E. F. Knott

DISTRIBUTION

AFAL/WRP (2)
ONRRR (1)
Hiatt/File
Knott
Senior

11764-5-L = RL-2233

This is the fifth monthly progress letter on Contract F33615-73-C-1174 and covers the period 15 July - 15 August 1973.

The streamlined edition of program RAM1B, designated RAMD, has been fully tested. For bare and loaded bodies with H polarisation, it duplicates results obtained with the less efficient RAM1B and also duplicates the E-polarisation bare body output of program REST. To the maximum extent possible, the subroutines in RAMD and REST are identical. The time required for the various computation steps involved in RAMD has been determined, and this indicates the possibility for an even more efficient version of the program. It is hoped to benefit from this knowledge in the extension of program TWOD. Because of the relatively large number of sampling points which TWOD may require, a number of 'capability' type runs have been made using programs REST and RAMD for a bare body with E-polarisation. The surface and back-scattered fields for ogival and wedge cylinders were computed for different sampling rates and on the premise that 16.7 points per wavelength gives 'exact' results, the errors produced by smaller sampling rates have been determined. As examples, 10 points/λ produces maximum errors which are of order 0.5 dB, rising to around 2 dB for 6 points/λ on a bare body and 4 dB on a loaded body.

The extension of program TWOD to handle magnetic materials as well as dielectric materials is now under way. Based on a scalar formulation of the problem, three coupled integral equations are obtained which embrace the equations employed by Northrop as a limiting case. These equations have kernels having at most first derivative singularities, in contrast to the second derivative kernels which a vector formulation produces. Although the vector formulation is, in some respects, a more natural one, we have so far found no way to reduce the equations that result to the form provided by a scalar treatment, and we are continuing to explore this problem. However, this has no direct effect on our extension of TWOD, and by assuming an impedance boundary condition at the surface of the body, the program we are developing will handle either polarisation by a simple exchange of parameters. Many parts of the computation have already been programmed and the subroutines tested, and we hope to have the complete program available for testing in the next few weeks.

Analyses of data produced by programs REST and RAM1B (or RAMD) are continuing, but there are still quite a few topics to be explored. The effects of impedance coatings adjacent to the front and/or rear ends of an ogival cylinder have been explored. For E-polarisation, a relatively small coverage of the surface adjacent to the front edge is very effective in reducing the scattering. The cross section reduction extends over an angular range of about 45^{o} about end on, and increases with the maximum impedance. The results for a linear impedance variation are not significantly different from those for exponential and s^2 law variations. The same treatment at the rear end has virtually no effect, and we therefore maintain the effectiveness of the treatment when both ends are covered. With H polarisation, the rear end of the body is the critical one. When the s^2 impedance variation found effective for E polarisation is also used for H polarisation, the traveling wave lobes are suppressed, though the actual end-on return is somewhat increased. The quantitative reasons for this have not yet been determined. Covering the front end as well as the rear diminishes, but only slightly, the cross section reductions which the rear-end coating provides.

Using program REST which, it will be recalled, makes use of resistive sheets strategically placed and, therefore, effective only for E-polarisation, a variety of types and placings of these sheets have been examined. The most effective of all appears to be a single sheet symmetrically placed and projecting from the front. For a linear variation of resistivity, the cross section reduction displays resonance effects as functions of the sheet length and maximum resistivity. More data are being acquired to pinpoint the sources of the interference. For a s^2 variation, most of the resonance disappears but we are not yet sure what the trade-offs are between sheet length and maximum resistivity.