THE UNIVERSITY OF MICHIGAN

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FINAL REPORT ON CONTRACT AF 19(604)-1949

by

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This contract started on 1 October 1956 and ended with the publishing of this final report on 31 July 1959.

The major effort was the writing of an instruction manual (Ref. 1). The purpose of this manual is to tell engineers, mathematicians, and physicists (with only an undergraduate course in electromagnetic theory and the usual undergraduate courses in applied mathematics) how to compute the radar cross sections of aircraft and missiles. Different methods presented are dependent upon whether the ratio of the major dimensions of the scatterer are large or small with respect to the wavelength. This manual contains many examples and these examples should suffice for the many aircraft and missile shapes with which a member of the aircraft and/or electronics industry may be involved. With average judgement on methods to use, the inexperienced engineer should be able to reproduce the radar cross section of an aircraft within 6 db. When the missile dimensions are small with respect to the wavelength, the calculated cross section should agree within three db of the measured return. When the wavelength is small with respect to all radii of curvature of the missile again the cross section as calculated should agree very well with experiment. When the missile is long and thin and when the wavelength is large in respect to the radius of curvature in the front and rear but less than the missile's dimensions then much more experience and judgement are required to compute the cross section. In that case it is necessary to determine the reflection coefficient at the rear of the missile in order to determine the nose-on cross section. This is described in Reference 1 and utilized in Reference 2.

Other major efforts on this contract include the following reports:

1. Dr. T. B. A. Senior's report (Ref. 3) which gave the exact solution for the imperfectly conducting wedge.

2. Dr. R. Goodrich's report (Ref. 4) which describes and applies Fock theory. He describes and uses this method to solve both two dimensional and three dimensional problems.

3. Dr. F. Sleator applied the variational technique to obtain the scalar solution for a prolate spheroid at long wavelengths (Ref. 5).

4. Prof. R. Ritt and Prof. N. Kazarinoff analyzed the scalar scattering from a prolate spheroid at small wavelengths (Ref. 6).

Information and knowledge gained on this contract allowed us to contribute all or part of the journal articles listed in References 7-18.

Information and knowledge gained under this contract allowed us to perform more efficiently on many other United States Air Force contracts such as AF 30(602)-1808, AF 33(616)-5585, AF 33(600)-36793, AF 30(602)-1853, AF 19(604)-4993, AF 30(602)-1982, AF 19(604)-5470, AF 19(604)-5553, and AF 33(600)-39476.

At the termination of some contracts we are aware of partial contributions which will be or have been completed under other contracts. Examples of such contributions are included in References 19-25, for this contract.

One major effort is still not completed and should play an important role in Contract AF 19(604)-4993. This effort was by Professor D. Darling (Refs. 26 and 27) and shows how to solve exactly (but presently mainly in potential theory) the Dirichlet and Neumann problems for a shape which is made up of surfaces which have the following property: Each surface is part or all of a surface obtained for a coordinate system for which Laplace's equation separates and one of the coordinates is set equal to a constant. Methods are known for using these solutions to obtain solutions to Maxwell's equations

when the wavelength is large with respect to the dimensions of the body. This method is important in that it applies to homogeneous surfaces for all values of dielectric constant and permeability. Thus ablating warhead's cross sections can now be found exactly in the long wavelength region. This will be an example of basic research performed under one contract leading to important applications on another contract.

We desire to take this opportunity to thank P. Blacksmith for the excellent cooperation we have received during the course of this effort. His efforts undoubtedly doubled our efficiency in performance under this contract.

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