GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

PROJECT INITIATION

Date: June 14, 1974

Project Title: Consulting Services in Support of DG/AEGIS Electromagnetic Effectiveness Analysis Program

Project No.: A-1611

(S)

Project Director: Dr. C. E. Ryan

Sponsor: Atlantic Research Corporation; Alexandria, Virginia

Effective February 22, 1974 Estimated to run until June 30, 1974 (Work Period)

Type Agreement: Subcontract No. 98666 under U.S. Govt. Prime N00024-74-C-1110 Amount: $ 5,098

Reports Required: Monthly Activity Reports; Final Summary Reports.

Sponsor Contact Person (s):

Technical Matters	Contractual Matters
John Dodge	Glen T. Newman
Technical Manager	Contract Administrator

Atlantic Research Corporation
5390 Cherokee Avenue
Alexandria, Virginia 22314

Phone: (703) 354-3400

DEFENSE PRIORITY RATING: DO-A7 under DMS Reg. 1.

Assigned to _____ RADAR _____ Division

COPIES TO:

- ☐ Project Director
- ☐ Director
- ☐ Assistant Director
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RA-73

GEORGIA INSTITUTE OF TECHNOLOGY
Engineering Experiment Station

Posted 9/25

M-251

PROJECT TERMINATION

9/6/74

Date _____

PROJECT TITLE: Consulting Services in Support of DG/AEGIS Electromagnetic EffectivenessAnalysis Program

PROJECT NO: A-1611

PROJECT DIRECTOR: Dr. C. E. Ryan

SPONSOR: Atlantic Research Corporation; Alexandria, Virginia

TERMINATION EFFECTIVE: 7-22-74 (Final report submitted)

CHARGES SHOULD CLEAR ACCOUNTING BY: 7-31-74

Contract Closeout Items Remaining: Final Invoice & Closing Doc.'s.
Final Report of Inventions
Gov't. Property Inventory & Cert.
Classified Material Cert.

Radar Division

COPIES TO:

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ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

1 April 1974

Atlantic Research Corporation
5390 Cherokee Avenue
Alexandria, Virginia 22314

Attention: Mr. N. J. Schairer

Reference: Subcontract No. 98666 under Prime Contract N00024-74-C-1110

Title: "Consulting Services in Support of DG Aegis Electromagnetic Effectiveness Analysis Program"

Subject: Monthly Progress Report No. 1

Gentlemen:

A summary of the progress on the referenced contract for the period 25 February through 31 March 1974 follows:

A. Progress Made and Milestones Reached

A preliminary estimate of the effects of the exhaust stack upon the AN/SPY-1 antenna was performed, and the results were forwarded to Mr. Richard Bertram of Atlantic Research Corporation. A final estimate for the AN/SPY-1 gain loss due to exhaust stack blockage will be made when the final topside design is specified.

Information on the modelling of ship radar cross section was sent to Dr. Harlowe Judson of the Autonetics Division of North American Rockwell Corporation as requested by Mr. Richard Bertram.

B. Problems Encountered and Action Taken

No problems were encountered during this reporting period.

C. Areas of Potential Difficulty

The preliminary estimates of the blockage-gain loss for the MK-99 and AN/SPS-49 antenna which were reported on 14 December 1973, prior to the

initiation of this subcontract, assumed a typical configuration for the open masts. Further data on the proposed mast construction are required in order to update these estimates.

D. Activities Forecast

During the next month the blockage-gain estimates for the MK-99 and AN/SPS-49 antennas will be reviewed, and other tasks will be performed as requested.

Respectfully submitted,

Charles E. Ryan, Jr.
Project Director

Approved:

Fred L. Cain
Technical Area Manager
EM Effectiveness

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

3 May 1974

Atlantic Research Corporation
5390 Cherokee Avenue
Alexandria, Virginia 22314

Attention: Mr. N. J. Schairer

Reference: Subcontract No. 98666 under Prime Contract N00024-74-C-1110

Title "Consulting Services in Support of DG Aegis Electromagnetic Effectiveness Analysis Program"

Subject: Monthly Progress Report No. 2

Gentlemen:

A summary of the progress on the referenced contract for the period 1 April through 30 April 1974 follows:

A. Progress Made and Milestones Reached

Data on the proposed mast construction were received and reviewed. These data will be used to update the blockage-gain loss estimates for the MK-99 and AN/SPS-49 antennas during the next month.

B. Problems Encountered and Action Taken

No problems were encountered during this reporting period.

C. Areas of Potential Difficulty

No areas of potential difficulty are anticipated at this time.

D. Activities Forecast

During the next month the blockage-gain estimates for the MK-99 and AN/SPS-49 antennas will be reviewed. Other tasks will be performed as requested.

Respectfully submitted

Charles E. Ryan, Jr.
Project Director

Approved:

Fred L. Cain
Technical Area Manager
EM Effectiveness

CER/ja

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

12 June 1974

Atlantic Research Corporation
5390 Cherokee Avenue
Alexandria, Virginia 22314

Attention: Mr. N. J. Schairer

Reference: Subcontract No. 98666 under Prime Contract N00024-72-C-1110

Title: "Consulting Services in Support of DG AEGIS Electromagnetic Effectiveness Analysis Program"

Subject: Monthly Progress Report No. 3

Gentlemen:

A summary of the progress on the referenced contract for the period 1 May through 7 June 1974 follows:

A. Progress Made and Milestones Reached

As requested by Mr. Richard Bertram of ARC in a telephone conversation on 21 May, work was initiated on evaluation of blockage gain loss for the two alternate DG AEGIS topside configurations. The results of this investigation for the "Split" and "U-shaped" deckhouse configurations were mailed to Mr. Richard Bertram on 7 June 1974.

B. Problems Encountered and Action Taken

No problems were encountered during this reporting period.

C. Areas of Potential Difficulty

No areas of potential difficulty are anticipated at this time.

D. Activities Forecast

No future activities are anticipated, and the technical effort on this program has been expended.

Respectfully submitted,

Charles E. Ryan, Jr.
Project Director

Approved:

Fred L. Cain
Technical Area Manager
EM Effectiveness

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

2 July 1974

Atlantic Research Corporation
5390 Cherokee Avenue
Alexandria, Virginia 22314

Attention: Mr. N. J. Schairer

Reference: Subcontract No. 98666 under Prime Contract N00024-72-C-1110

Title: "Consulting Services in Support of DG AEGIS Electromagnetic Effectiveness Analysis Program"

Subject: Monthly Progress Report No. 4

Gentlemen:

A summary of the progress on the referenced contract for the period 7 June 1974 through 30 June 1974.

A. Progress Made and Milestones Reached

During the last month the evaluation of the blockage gain loss for the alternate DG AEGIS configuration was completed. This evaluation completed the technical effort on this program.

B. Problems Encountered and Action Taken

No problems were encountered during this reporting period.

C. Areas of Potential Difficulty

No areas of potential difficulty are anticipated.

D. Activities Forecast

A summary report of activities on this program will be prepared and submitted within the next month.

Respectfully submitted,

Charles E. Ryan Jr.
Project Director

Approved:

Fred L. Cain
Technical Area Manager
EM Effectiveness

CONSULTING SERVICES IN SUPPORT OF THE DG-AEGIS ELECTROMAGNETIC EFFECTIVENESS ANALYSIS PROGRAM

FINAL REPORT

C. E. Ryan Jr.

15 July 1974

Prime Contract No. N00024-72-C-1110
Subcontract No. 9866

for

Atlantic Research Corporation
EMM Department

by

Radar Division
Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30032

FOREWORD

The consulting efforts on this program were carried out by personnel of the Radar Division of the Systems and Techniques Department, Engineering Experiment Station at the Georgia Institute of Technology, Atlanta, Georgia 30032. Dr. C. E. Ryan Jr. served as the Project Director. The program was sponsored by Atlantic Research Corporation under Subcontract No. 9866 (Prime Contract No. N00024-72-C-1110), and was designated by Georgia Tech as Project A-1611. This Final Report covers the technical efforts for the period 25 February 1974 through 30 June 1974.

The work performed was made possible by the combined efforts of the staff of Atlantic Research Corporation and the Radar Division at Georgia Tech. The contributions of Richard Bertram of ARC and of F. L. Cain of Georgia Tech are gratefully acknowledged.

Charles E. Ryan, Jr.
Project Director

Approved:

F. L. Cain
Technical Area Manager
Electromagnetic Effectiveness

ABSTRACT

The objective of the consulting efforts on this project was to assess the effects of proposed DG-AEGIS topside configurations on the performance of the directive radar antennas. These assessments concerned the antenna gain loss due to blockage effects as a function of antenna look angle. This report describes the consulting activities performed during the contract period.

TABLE OF CONTENTS

SECTION I

INTRODUCTION

This report summarizes the consulting activities of the Radar Divison of the Systems and Techniques Department of the Engineering Experiment Station at Georgia Institute of Technology in support of the DG-AEGIS Electromagnetic Effectiveness Analysis Program. The tasks assigned to the Radar Division are listed in Section II and concerned the assessment of the effects of the ship topside structure on the performance of the directive radar antennas. The effects of the ship topside structure upon the antenna gain were estimated by using available measured data and by standard theoretical techniques in cases where measured data were not available. The estimation techniques which were employed are described in Reference 1.

The detailed estimates of the directive radar antenna performance are contained in the technical letters submitted during the contract. These letters are listed in Section III of this report.

SECTION II

TASKS ASSIGNED TO GEORGIA TECH

Tasks were assigned to Georgia Tech via telephone conversations between Atlantic Research Corporation and Georgia Tech personnel. The following assignments were specified by Atlantic Research Corporation.

Date	Task
26 Feb. 1974	During a telephone conversation between Mr. Neil Schairer and Mr. Richard Bertram of ARC and Dr. C. E. Ryan Jr. of Georgia Tech, Georgia Tech was requested to perform an analysis of the effects of the exhaust stack on the AN/SPY-1 radar antenna. The analysis requested concerned the effect of exhaust stack height on antenna gain as a function of azimuth angle.
21 May 1974	During a telephone conversation between Mr. Richard Bertram of ARC and Dr. C. E. Ryan Jr. of Georgia Tech, Georgia Tech was requested to perform an estimate of the performance of the AN/SPS-49, AN/SPS-55 and MK-99 antennas for the alternate "Split" and "U-shaped" topside configurations. The estimates requested were for antenna gain loss as a function of azimuth angle for each antenna.

SECTION III

REPORTS

In response to the tasks assigned to Georgia Tech for consulting activities in support of the DG-AEGIS Electromagnetic Effectiveness Analysis Program, the following letter reports were submitted to the Atlantic Research Corporation. A brief description of the content of each report is given.

1. C. E. Ryan Jr., "Preliminary Estimates of the Effect of Exhaust Stack Height on the AN/SPY-1 Radar Antenna Coverage," 6 March 1974.

   This report presents the results of an assessment of the blockage effects of the exhaust stack on the AN/SPY-1 phased-array radar antenna as a function of exhaust stack height.

2. C. E. Ryan Jr., "Preliminary Antenna Blockage Estimates for the DG-AEGIS Split and U-Shaped Deckhouse Alternate Arrangement," 7 June 1974.

   This report includes antenna gain loss versus azimuth angle estimates for the AN/SPS-49, AN/SPS-55, and MK-99 radar antennas for both of the alternate deckhouse arrangements. The report supplements previous estimates discussed in Reference 2.

SECTION IV

SUMMARY

The techniques which were applied to estimate the effects of the ship topside structure are presently limited in their application. The specific limitations have been discussed in Reference 1. These limitations are due to the complexity of the ship topside structures and the large number of structures occurring on the ship. Also, these structures are typically located in the near zone of the antennas which further complicates the analysis or experimental characterization of their effects on antenna performance.

In the assessment of the directive radar antenna performance of the DG-AEGIS, both simple theoretical models and measured data for simple obstacles [3] have been used. At the present time, these techniques are limited due to the lack of comprehensive theoretical analyses or extensive measured data for near-zone scattering by complex obstacles. The gross estimates of the blocking effects of these complex obstacles are made by assuming that these effects are approximated by scattering due to relatively simple obstacles.

The approximate approaches are valuable for the assessment of the gross effects of the structures upon the antenna gain and sidelobe levels. If precise, high-confidence level assessments are required, additional research is needed to develop extended methods of assessment. A possible approach would utilize statistical methods to characterize the complex scatterers. A statistical approach would provide the analyst with the magnitude of the possible deviation of the performance from the mean value.

The assessments of the approximate antenna performance for the DG-AEGIS topside configuration are useful in modelling the electromagnetic effectiveness of the radar systems. In making the assessments, a pessimistic approach has been used so that an approximation to the "worst case" performance could be arrived at. In future programs, more accurate assessment techniques and measured data may permit optimum topside configurations to be derived. However, additional research is required before this goal can be attained.

In summary, the tasks assigned to the Radar Divison have been performed, and the results have been submitted as letter reports to Atlantic Research Corporation for use in the EM analysis.

REFERENCES

1. C. E. Ryan Jr. and R. D. Nevels Jr., "Final Report on Consulting Services in Support of the Patrol Frigate Electromagnetic Effectiveness Analysis Program", Final Report Project A-1460, Subcontract No. A2MV-568343 (Prime Contract No. N00024-72-C-1444) for Autonetics Division, Rockwell International Corporation by the Radar Division, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia 30032, 30 August 1973.

2. C. E. Ryan Jr., "Preliminary Antenna Blockage Estimates for the DG-AEGIS", private letter communication to Mr. Harlowe Judson, Autonetics Division of Rockwell International Corporation, 14 December 1973.

3. F. L. Cain, C. E. Ryan, C. P. Burns and B. J. Cown, "Near Field Obstacle Effects and Phased Array Studies", Final Report Project A-1301, Contract No. N00024-71-C-1120 prepared for the Naval Ship Engineering Center, Code 6174-D, Naval Ship Systems Command 03526, Washington, D. C. by the Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia 30032, 31 January 1972.