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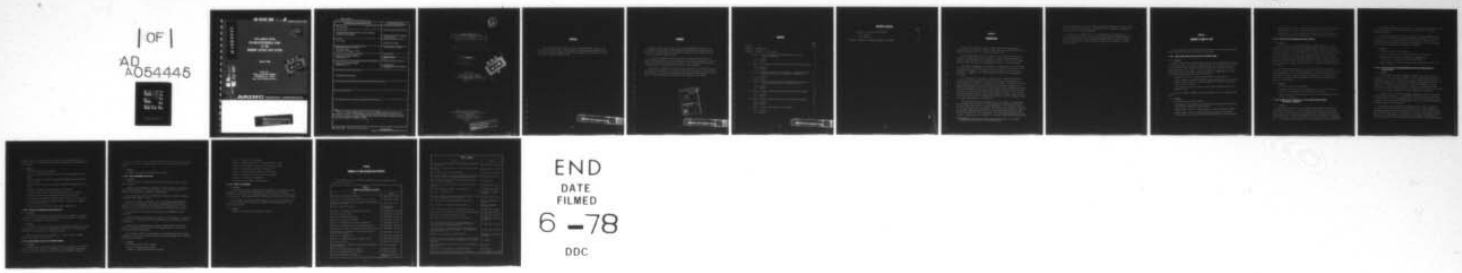

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SYSTEM-EFFECTIVENESS STUDY OF THE AIRBORNE TACTICAL DATA SYSTEM

January 1969

Prepared for
NAVAL AIR SYSTEMS COMMAND
WASHINGTON, D.C. 20360
under Contract N00019-68-C-0152

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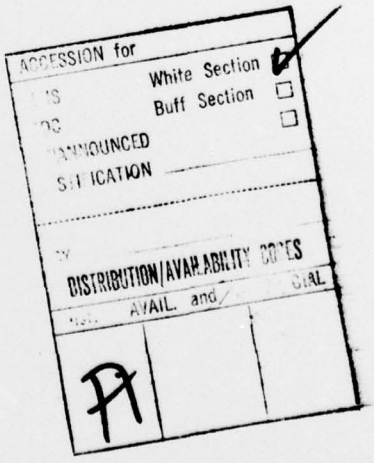
SUMMARY

This is a final summary report on the system-effectiveness study of the E-2A Airborne Tactical Data System performed by ARINC Research Corporation for the Naval Air Systems Command under Contract N00019-68-C-0152 during the period 1 July 1967 through 31 December 1968.

The work was completed under the direction of Code AIR-5102C within the scope of the tasks defined in the contract. As each task was completed, a special report was prepared and transmitted to NAVAIR. Each of these reports presented conclusions and recommendations pertinent to the task performed.

This report is organized to facilitate the association of work performed with work areas as described in the contract. Details of the results of work performed are provided in the special reports referenced under each task described. A summary of the items delivered is presented in the appendix to the report.



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CHAPTER 1

INTRODUCTION

This is a final summary report on work performed by ARINC Research Corporation for the Naval Air Systems Command under Contract N00019-68-C-0152 during the period 1 July 1967 through 31 December 1968.

The work was completed under the direction of Code AIR-5102C within the scope of the tasks defined in the contract. As each task was completed, a special report was prepared and transmitted to NAVAIR. Each of these reports presented conclusions and recommendations pertinent to the task performed.

This report is organized to facilitate the association of work performed with work areas as described in the contract. Details of the results of work performed are provided in the special reports referenced under each task described. A summary of the items delivered is presented in the appendix to the report.

The objective of the contract is described as "a System-Effectiveness Study for the Airborne Tactical Data System".* This descriptive phrase is a convenient way to indicate the nature of the contract. In practice, a single system-effectiveness study is not feasible for a system as complex as the Airborne Tactical Data System in the E-2A aircraft, which comprises an Airborne Early Warning System for detecting hostile aircraft and controlling inteceptor aircraft at a considerable distance from an aircraft carrier. It is the airborne extension of the Naval Tactical Data System, the carrier-based, carrier-controlled network under the command of the Officer in Tactical Command, relaying tactical data directly to his monitors.

The work performed actually comprises a set of studies, each undertaken for a specific useful purpose. In this program the studies performed were directed toward such goals as continued improvement of the mission reliability of the ATDS, reduced cost of ownership, and reduced turn-around time. There is an important additional application of the knowledge gained through studies of the operational E-2A in the procurement of substantially improved follow-on aircraft. This application consists of the review of procurement specifications

* The Airborne Tactical Data System is described in detail in the NAVAIR 01-85WBA-2 Series Maintenance Instruction Manuals.

and other documentation to assure that quantitative requirements (1) are realistic, (2) represent a significant improvement over the existing configurations, and (3) are worth the money expended.

Because of the dynamic status of the E-2A program, its importance in military operations, and the status of procurement of major modifications and new versions, many of the investigations were performed on a "crash" schedule. Thus many special and informal reports were delivered to NAVAIR on a "quick reaction" basis.

CHAPTER 2

SUMMARY OF WORK BY TASK

The work performed is summarized below according to contractually specified tasks. Shortened task titles are given in each case.

2.1 TASK 1: IDENTIFY PROBLEM AREAS EXISTING IN ATDS AND ITS SUPPORTING ELEMENTS

2.1.1 Activity

Liaison between ARINC Research field engineers and USN maintenance personnel at North Island Naval Air Station (NORIS) and the study of failure reports from the Navy 3M system were the basic elements employed in a continuing review of problem areas in the E-2A/ATDS. This review consisted partly of a search for new problem areas not previously reported to NAVAIR by ARINC Research. Three new problems investigated concerned the following:

- Undesirable locking of landing flaps and aileron droop system
- A high incidence of Combined Hydraulic System failures in the C-2 aircraft, which could be a prelude to similar problems in the identical configuration in the E-2 aircraft
- A high failure rate of the pilot's 5-inch self-contained Vertical Gyro Indicator (VGI)

Problems of support equipment were also reviewed (these are reported under Task 4).

2.1.2 Reports

The following reports were prepared:

- Investigation of Problems in E-2A Landing Flap and Aileron Droop System, ARINC Research Publication 563-01-1-855
- Special Report (letter) - Investigation of E-2A/C-2 Hydraulic Systems
- Special Report (letter) - History and Current Status of Activities Concerning Use of the Five-Inch Self-Contained VGI in the E-2A Aircraft

- Special Report (letter) - Progress Report on Investigation of Potential Replacements for the Pilot's Five-Inch VGI in the E-2A Aircraft
- Special Report (letter) - Additional Findings in the Investigation of the Pilot's Five-Inch VGI Problem in the E-2A aircraft (in process).

2.2 TASK 2: INVESTIGATE SELECTED PROBLEM AREAS PREVIOUSLY IDENTIFIED

2.2.1 Activity

During the contract period ARINC Research was provided with a large volume of raw (unprocessed) 3M data on magnetic tape. These data provided a broader statistical base for problem analyses than was available during E-2A developmental stages. It was decided that all problem areas previously reported should be reviewed in the context of this body of data. It was found that several problems previously reported had diminished in importance because of increased maintenance experience and engineering changes. Some bias may also have been involved in earlier decisions since the number of equipments available for survey was limited; however, many of the previously reported problems still exist.

A detailed investigation of the current reliability and maintenance problems of the Air Data Computer was completed. This system has had a history of high maintenance costs. It was found that the present reliability of the system does not unduly jeopardize mission reliability, and that maintenance costs will be reduced through new maintenance procedures established at the Naval Air Rework Facility.

2.2.2 Reports

The following reports were prepared:

- Preliminary Analysis of Current Reliability and Cost of Maintenance Data on Air Data Computer Set A/A24G-13 (letter report)
- Current Status of Problem Areas in the E-2A Avionics Subsystem (letter report, in process)

2.3 TASK 3: DETERMINE THE COST OF OWNERSHIP OF THE ATDS, INCLUDING SUPPORTING ELEMENTS, WITH EMPHASIS ON MAINTENANCE

2.3.1 Activity

ARINC Research performed a cost-of-maintenance analysis using 3M data from NORIS-based aircraft. A second analysis, started late in the contract period, was concerned with the cost of maintenance of deployed aircraft only. It was planned that a comparative analysis of these two operational and maintenance environments would be performed to provide further guides to minimizing costs. The contract period ended before this second report could be completed.

As mentioned previously (see Section 2.2), the cost of maintenance for the Air Data Computer was resurveyed to provide current inputs to a planned improvement program.

As a subtask of Task 3 the status of repairable versus consumable items was reviewed. It was determined that significant progress has been made in revising the list of material identified as consumable in order to meet the objective of reducing aircraft downtime and maintenance costs. Some suggestions for further improvement were presented to NAVAIR.

2.3.2 Reports

The following reports were prepared:

- Study of Consumable E-2A Avionics Components (letter report)
- Maintenance Cost Analysis E-2A/ATDS (U), ARINC Research Publication 563-01-2-888, June 1968.(CONFIDENTIAL)
- Special Report on Breakdown of Maintenance Man-Hours per Flight Hour (letter report)

2.4 TASK 4: ANALYZE AND EVALUATE THE GENERAL MAINTENANCE PRACTICES AND PROCEDURES EMPLOYED BY THE ATDS ACTIVITIES

2.4.1 Activity

The ATDS standard and special support equipment was studied. It was found that, with few exceptions, equipment of both classes was adequate and in good supply. Two notable exceptions are the ground air-conditioning units, which are inadequate, and defective ground-power extension-cable fittings. The report lists 27 support items that can be considered significant from the standpoints of design adequacy, quantity available, or spare-parts support. The effect of these on ATDS availability is estimated, and the items are listed in the order of their importance to aircraft-availability improvement.

The Task 2 work on the Air Data Computer included a review of the maintenance procedures followed. The significant finding was that the procedures followed resulted in high maintenance costs and long turn-around time, and that a change to the use of local Navy maintenance in lieu of contractor facilities produces savings of time and funds.

Investigations were made into provisioning for the Computer Indicator AN/ASA-27 and the Radar AN/APS-96. One objective was to assure adequate CI spares provisioning during the transition to the E-2B. This problem is somewhat unusual because some of the material will be used as Government-furnished material by the modification contractor, and two different configurations, E-2A and E-2B, will have to be provisioned for a number of years in a constantly

changing ratio. The APS-96 has been subject to spare-parts shortages; the studies resulted in recommendations for revising allowances and quantities to be purchased.

2.4.2 Reports

The following reports were prepared:

- Report of Operational Problems of the E-2A Support Equipment (letter report)
- AN/ASA-27 Computer Indicator Provisioning Requirements Investigation (letter report)
- AN/ASA-27 Computer Indicator Assembly Purchase Recommendations (letter report)
- AN/APS-96 Provisioning Investigation (letter report)
- E-2A/ATDS Summary Report on Provisioning Studies (letter report)
- AN/ASA-27 Assets and Recommended Disposition (letter report)
- Justification for AN/APS-96 Reprovisioning Disposition (letter report)
- E-2A/ATDS Provisioning Investigation Report, CP-413/ASA-27 Computer Detector (letter report)
- AN/APS-96 Listing of ARA's by Serial Number (NORIS Memo)

2.5 TASK 5: EVALUATE SELECTED ENGINEERING CHANGE PROPOSALS (ECP)

2.5.1 Activity

Eleven ECPs were reviewed -- some only briefly, to determine their correlation with E-2A specifications; and others in greater depth, to determine if they were addressed to the real problem.

2.5.2 Reports

The results of the study of eight ECPs were reported informally to NAVAIR. The following letter report was prepared for ECPs 49 and 48: Evaluation of Adaptation of Automated Control and Landing System.

Comments on ECP 376 were incorporated in a report on Task 1 (ARINC Research Publication 563-01-1-855).

2.6 TASK 6: MONITOR PROGRESS AND RESULTS OF IMPROVEMENT PROGRAMS

2.6.1 Activity

No actual Mod Ax (E-2B) changes have been made to aircraft; thus results cannot be monitored. However, the progress of the modification schedule is being monitored, and assistance is being provided to NAVAIR in planning,

acquiring, and delivering avionics GFE on schedule at lowest cost, and in assuring adequate provisioning support for both E-2A and E-2B during the changeover period.

2.6.2 Reports

No reports were prepared specifically for Task 6.

2.7 TASK 7: ASSIST IN PROCUREMENT OF NEW SYSTEM

2.7.1 Activity

The E-2C Technical Development Plan was revised several times to reflect current changes.

Grumman Aircraft Engineering Corporation (GAEC) reliability and maintainability specifications for the E-2C (USCZ2A, B, and C) were reviewed, and revisions were submitted to NAVAIR for consideration.

The purchase request (PR) for JIFDATS was reviewed for possible technical implications with respect to ATDS.

As an aid to NAVAIR, a comparison chart of performance characteristics of E-2A and E-2C was prepared. This chart included SOR and TDP numerical values for the E-2C and procurement numerical values specified for the E-2A. These data provided guidance for the refinement of ATDS procurement planning.

GAEC specification RC-123CS-4A was reviewed and a simplifying change recommended.

Extensive assistance was provided to NAVAIR in the preparation of technical requirements to be included in E-2C Procurement Request 9-8-090-06, including the R&D brief.

Several special investigations were made to supply NAVAIR with timely reliability and maintainability data on the deployed E-2A's to be used as a guide in procurement negotiations.

Other documents related to procurement of new configurations were studied and commented on to provide NAVAIR with expert technical opinion from the system-effectiveness standpoint.

2.7.2 Reports

The following reports were prepared:

- TDP-31-20 Revisions (master copy)
- Comments on Specification USCZ2A (informal)

- Comments on JIFDATS P/R (informal)
- Comments on GAEC specification CC-123CS-4A (letter report)
- Material for Procurement Request 9-8-090-06 (master copy)
- Review of R&M specification USCZ-2B (informal)
- Review of R&M specification USCZ-2C (letter report)
- Comments on Reliability Report MS 2685-8 (informal)
- Comments on MSSR-423-68-1 (informal)
- Tabulation of Performance Characteristics

2.8 TASK 8: GENERAL TASK ASSIGNMENTS

2.8.1 Activity

Two ARINC Research field engineers were stationed at NAS, NORIS, San Diego, California. These engineers provided direct contact with the operating environment and obtained the unique data required to perform the tasks required by this program. They prepared several of the reports listed under these tasks.

ARINC Research representatives attended numerous meetings at NAVAIR, NRL, and GAEC to provide expert assistance to NAVAIR in matters relating to ATDS system effectiveness.

2.8.2 Reports

No reports were prepared specifically for Task 8.

APPENDIX

SUMMARY OF ITEMS DELIVERED OR IN PROCESS

The contract items that have been delivered or are in preparation are summarized in Table A-1.

TABLE A-1

SUMMARY OF ITEMS DELIVERED OR IN PROCESS

Item	Status
Updating of E-2A Historical Data	To AIR-5102C 9/27/67
Tabulation of Performance Characteristics of E-2A	To AIR-5102C 8/20/67
Comments on Reliability/Maintainability Specification USCZ2A for the E-2B	To AIR-5102C 9/8/67
Revision Pages for TDP 31-20	To AIR-PMA-31 on several dates
Comments on Grumman Specification RC-123CS-4A	To AIR-PMA-31 10/23/67
New WUC Anomalies Chart	To AIR-PMA-31 10/23/67
Reliability-Data Presentation	To AIR-PMA-31 11/1/67
Comments on Eight E-2/C-2 ECPs	To AIR-5102C 11/6/67
Study of Consumable E-2A Avionics Components	To AIR-PMA-31 12/4/67
Comments on Requirement for Landing-Gear Testing	To AIR-5102C 11/22/67
Adaptation of ACLS to E-2/C-2 (ECP-415) (ECPs-45, 48)	To AIR-PMA-31 12/8/67
Investigation of Problems in E-2A Landing Flap and Aileron Droop System	To AIR-PMA-31 1/31/68
Comments on JIFDATS P/R	To AIR-5102C 12/27/67
Minutes of NAVAIR Meeting, 16 January on ACLS	To AIR-5102C 1/19/68
E-2C/ACLS Schedule	To AIR-5102C 1/19/68
Special Report on Breakdown of Maintenance Man-Hours per Flight Hour	To 5102C 2/20/68
Review of R&M Specification USCZ-2B	Informal to 5102C
Review of R&M Specification USCZ-2C	To 5102C 2/28/68
Procurement Request 9-8-090-06	Draft to AIR-5102C 2/28/68

TABLE A-1 (continued)

Item	Status
AN/ASA-27 Computer Indicator Provisioning Requirements Investigation	To AIR-411221 3/20/68
AN/ASA-27 Computer Indicator Assembly Purchase Recommendations	To AIR-411221 3/22/68
AN/APS-96 Provisioning Investigation	To AIR-411221 3/26/68
Preliminary Analysis of Current Reliability and Cost of Maintenance Data on Air Data Computer Set A/24G-13	To AIR-5102C 3/20/68
E-2A/ATDS Provisioning Investigation Report, CP 413/ ASA-27 Computer Detector	To AIR-411221
Report of Operational Problems of the E-2A Support Equipment	To AIR-51022C 5/8/68
AN/APS-96 Listing of ARAs by Serial Number	To AIR-411221 6/1/68
Comments on MSSR-423-68-1	Informal to NAVAIR 5/24/68
Review of Factors Related to E-2A Participation in the TACSATCOM Program (U) (Confidential)	To AIR-5102C 5/21/68
E-2A Hydraulic System Preliminary Field Review	Draft to AIR-5102C 5/23/68
Justification for AN/APS-96 Reprovisioning	Memo to NASCREPAC 5/24/68
E-2A/ATDS Summary Report on Provisioning Studies	To AIR-5102C 6/27/68
Maintenance Cost Analysis E-2A/ATDS (U) (Confidential)	To AIR-5102C 6/28/68
Hydraulic System Investigation E-2A/C-2	To AIR-5102C 7/31/68
AN/ASA-27 Assets and Recommended Disposition	To NASCREPAC Code 2314 9/17/68
Special Report - History and Current Status of Activities Concerning Use of the Five-Inch Self-Contained VGI in the E-2A Aircraft	To AIR-5102C 11/22/68
Special Report - Progress Report on Investigation of Potential Replacements for Pilots 5 Inch VGI in the E-2A Aircraft	To AIR-5102C 11/22/68
Comments on Reliability Report MS2685-8	Informal to AIR-5102C 11/21/68
Special Report - Additional Findings in the Investigation of the Pilots Five-Inch VGI Problem in the E-2A Aircraft	In process
Current Status of Problem Areas in the E-2A Avionics Subsystem	In review
Maintenance Cost Analysis E-2A/ATDS, Deployed	In process
Monthly and Quarterly Letter Reports on Progress	As required by contract