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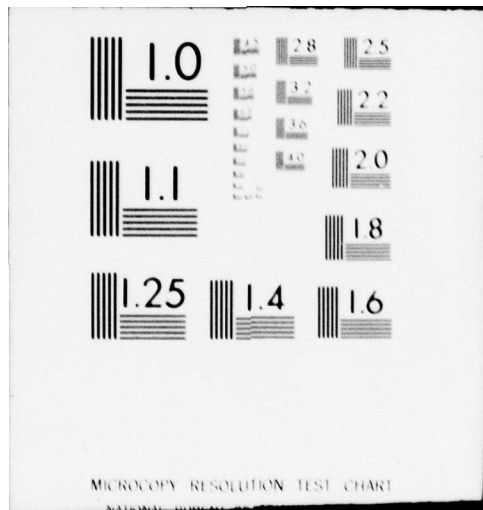
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PHASE II USER EQUIPMENT

June 1978

Prepared for

NAVSTAR GLOBAL POSITIONING SYSTEM
JOINT PROGRAM OFFICE
SAMSO, Los Angeles AFS, CA 90009

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ABSTRACT

→ Activities performed by ARINC Research Corporation relating to the integration of NAVSTAR Global Positioning System user equipment with host vehicles are summarized. These tasks were conducted for the GPS Joint Program Office, Air Force Space and Missile Systems Organization, Los Angeles, California, during the period 1 September 1976 through 30 June 1978 under Contract F04701-76-C-0273.

SUMMARY

This report summarizes the GPS Phase II user equipment integration support activities performed by ARINC Research Corporation for the GPS Joint Program Office at the Space and Missile Systems Organization, Los Angeles Air Force Station. The work was performed from 1 September 1976 through 30 December 1978 in accordance with the requirements of two contractual tasks - User Equipment ICD Development (Task 1) and GPS Phase II Testing (Task 2).

The results of the work performed under Task 1 were provided to the GPS Joint Program Office in the form of interface control documents (ICDs) for seven Navy host vehicles scheduled for Phase II Initial Operational Test and Evaluation (IOT&E). Also provided was an interim report, publication 1191-01-1-1688. The results of the work performed under Task 2 were provided to the GPS JPO in the form of an Air Force integration management plan guidebook, engineering notes, meeting minutes, and answers to questions raised by user equipment development contractors concerning the ICDs.

Meetings were held with SAMSO/YEO and SAMSO/YEUS on a regular basis during the contract period to discuss, coordinate, and review the work effort to ensure timely submittal of task results in support of Phase II program planning activities.

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INTRODUCTION

This final report summarizes the work performed and submittals made by ARINC Research Corporation for the NAVSTAR Global Positioning System (GPS) Joint Program Office (JPO) under Contract F04701-76-C-0273 during the period 1 September 1976 through 30 June 1978. The work was initially performed under the technical direction and guidance of SAMSO/YEO and later transferred to SAMSO/YEUS when that directorate was formed to handle engineering tasks related to host vehicle integration. The report provides a description of the background for the work, the contractual tasks, and a summary of the work performed and submittals delivered to SAMSO/YE.

1.1 BACKGROUND

The NAVSTAR GPS program is divided into three phases: Concept Validation (Phase I), Full-Scale Development (Phase II), and Production (Phase III). The work performed under this contract was in support of Phase II planning activities for user equipment development, integration, and testing.

A major objective of the GPS JPO during Phase II is the competitive development of prototype user equipment sets in accordance with specification requirements to verify the performance capability of those sets and the system in a variety of different host vehicles before committing the program to Phase III production. In compliance with this objective, the JPO selected four development contractors during Phase II to identify and define design requirements for user equipment integration into 17 service-unique host vehicles. These host vehicles are as follows:

<u>Air Force</u>	<u>Navy</u>	<u>Army</u>
F-16A*	P-3C	AH-1S*
B-52G/H*	A-6E*	Tank*
C-141A	RH-53D	Manpack*
HH-53B/C	Fast frigate	OV-1D
T-38A	Submarine*	Jeep
	Aircraft carrier*	
	Minesweeper	

*Indicates primary service vehicles, i. e., those designated for Initial Operational Test and Evaluation (IOT&E) during Phase II.

In addition to these vehicles, the contractors are to also consider the interface and integration requirements for other service vehicles that will be in the inventory when GPS becomes fully operational. From the results of the four contractors' studies, two contractors will be selected to fabricate prototype user equipment sets for integration and test in the designated IOT&E vehicles.

To coordinate effectively the development and integration effort of so many different integrated configurations, the JPO has identified Interface Control Documents (ICDs) and service-peculiar integration management plans as the means by which the effort will be documented, managed, and controlled. Therefore, for each IOT&E host vehicle, an ICD had to be prepared that describes the functional, physical, electrical, and environmental interfaces between the UE and the vehicle. For each major service involved in GPS, an integration management plan is required that will provide an organized and timely approach to managing the integration and vehicle modification requirements during Phase II.

1.2 CONTRACTUAL TASKS

To support the GPS JPO in developing integration criteria and management data, ARINC Research was contracted to perform the two tasks described in the following paragraphs. Results of these tasks are summarized in Section 2.

1.2.1 User Equipment ICD Development (Task 1)

Task 1 was to perform systems and engineering analysis associated with integrating the GPS user equipment into the following host vehicles: P-3C (Update II), RH-53, A-6 or EA-6, CVA, FF, MSO, and SSN. The work was to include the analysis necessary to define the Navy GPS user equipment configurations to the LRU level; trade studies of alternative GPS UE configurations; environmental envelopes for the GPS user equipment relative to the host vehicles; and the definition of common and unique GPS UE/host vehicle interfaces leading to a minimum number of integration modules.

1.2.2 GPS Phase II Testing (Task 2)

Task 2 was to assist in the development of a management plan to facilitate Phase II IOT&E user equipment integration and testing. This plan will identify the scope of the effort and tasking to accomplish the integration; provide a technical/management approach and assessment; present a detailed work breakdown structure;

define how and specify who will perform the required integration efforts; show the interrelationship between the various contractors and activities that will be involved; and provide an estimate of cost and schedules to accomplish the integration of user equipment to satisfy the IOT&E objectives and requirements. Following the preparation of the Air Force management plan, it was to be coordinated with the Joint Program Office, NADC, and AVRADA; and published as a final integration management plan. Also part of Task 2 was to conduct essential liaison with user equipment contractors and update ICDs as required during the contract performance period.

SUMMARY OF INTEGRATION SUPPORT ACTIVITIES

The work performed and the submittals made under the contract are summarized below for each assigned task.

2.1 TASK 1 - USER EQUIPMENT ICD DEVELOPMENT

The following activities and documented deliveries were made in accordance with Task 1 requirements.

2.1.1 Activities

The ICD development effort consisted of analyzing GPS UE integration/interface requirements for the seven Navy IOT&E host vehicles. The analysis included identifying and defining an integrated UE/weapons system functional and physical configuration for each vehicle, determining the interface requirements for this configuration, and recording the results of the analysis in an approved Interface Control Document format. The interface requirements presented in the ICDs have been categorized as functional, physical, electrical, and environmental. The material used in formulating the ICDs was obtained from Navy publications, equipment specifications, and military specifications; and through user and equipment manufacturer consultation. Support was also provided by the Naval Air Development Center (NADC) and through a series of Interface Working Group (IWG) meetings with platform sponsors and users. Results of the ICD development effort are summarized in an interim report (see Section 2.1.2.2), which also compares the interface requirements between host vehicles in order to determine if the number of unique interface modules can be minimized.

2.1.2 Submittals

2.1.2.1 Interface Control Documents

ICDs specifying functional, physical, electrical, and environmental integration requirements for various host vehicles were submitted as follows:

- a. ICD-GPS-051, GPS Phase II User Equipment Interface Requirements for the P-3C Update II Aircraft, 1 September 1977.

- b. ICD-GPS-052, GPS Phase II User Equipment Interface Requirements for the A-6E/TRAM Aircraft, 1 September 1977.
- c. ICD-GPS-053, GPS Phase II User Equipment Interface Requirements for the RH-53D Helicopter, 1 September 1977.
- d. ICD-GPS-055, GPS Phase II User Equipment Interface Requirements for the FF-1052 Class Fast Frigate, 1 September 1977.
- e. ICD-GPS-056, GPS Phase II User Equipment Interface Requirements for the SSN 688 Class Submarine, 1 September 1977.
- f. ICD-GPS-057, GPS Phase II User Equipment Interface Requirements for the CV-59 Class Aircraft Carrier, 1 September 1977.
- g. ICD-GPS-058, GPS Phase II User Equipment Interface Requirements for the MSO-443 Ocean Minesweeper, 1 September 1977.

2.1.2.2 Interim Report

ARINC Research publication 1191-01-1-1688, NAVSTAR GPS Navy Phase II User Equipment Integration Support, December 1977, summarizes the results of the systems engineering analysis performed in producing the information contained in seven NAVY ICDs. It also provides a summary of the ICD contents and compares this data in order to reduce the number of unique interface requirements between host vehicles.

2.2 TASK 2 - GPS PHASE II TESTING

The following activities and documented deliveries were made in accordance with Task 2 requirements.

2.2.1 Activities

The activities under this task consisted primarily of developing an Air Force integration management strategy and documenting it in the form of a guidebook; developing integration issues and documenting them as engineering notes; and answering questions raised by Phase II UE development contractors. The Air Force integration management strategy was developed from the preparation of an integration work breakdown structure, task flow diagram, responsibility matrix, and time-line schedule of activities. Through these methods, the numerous integration and modification tasks were identified and consolidated in an understandable and usable form.

Issues of concern to the integration process were identified and expounded upon in detail in engineering notes. Each issue was coordinated with the GPS JPO and then researched to provide an orderly and timely answer to important integration planning activities primarily involving the F-16 and B-52 IOT&E host vehicles. Other timely issues were also researched and reported.

The preliminary ICDs produced under Task 1 of this contract, and under another contract for the Air Force host vehicles, were for use by the UE development contractors during Phase II. As a result, those contractors have asked questions relative to the ICD contents. ARINC Research was responsible for answering most of these questions, particularly the more technical ones, in a timely manner during the contractual performance period. Answers were generated and reported to the GPS JPO on formatted answer forms.

Other activities under this task included preparing briefing material for presentation at joint integration conferences and Interface Working Group meetings, participating in those meetings and preparing the minutes, and developing a user equipment development plan.

2.2.2 Submittals

The following submittals were made as a part of this task:

- a. Tech Note W78-1191-TN01, Air Force Integration Management Guidebook, 30 June 1978. This guidebook identifies and defines the integration and modification engineering tasks that must be performed during Phase II in order to integrate the prototype UE sets into the Air Force IOT&E host vehicles. It also assigns responsibilities and schedules to these tasks, identifies pertinent host vehicle data and points of contact, and provides other similar information relative to the integration management function of the UE development program.
- b. Engineering Note SAB/EN-26, Pressure Altitude Measuring Device Accuracy, October 1977. This engineering note identifies and defines the accuracy of various aircraft pressure altimeters, encoding altimeters, and air data computers in order to estimate their impact, when integrated with the user equipment, on the solution of the GPS navigation problem.

- c. Engineering Note 1191-78-1, GPS UE/F-16A Integration Analysis Tasks, March 1978. This engineering note describes the tasks required to perform a concise integration engineering analysis for integrating the GPS user equipment into the F-16A IOT&E host vehicle.
- d. Engineering Note 1191-78-2, F-16A Avionics Malfunction Analysis Scheme, March 1978. This engineering note provides an overview of the avionics malfunction scheme incorporated into the F-16A Weapons Control System that the UE development contractors must take into consideration in their UE designs.
- e. Engineering Note 1191-78-3, Specification of FAA Advisory Circular 90-45A Requirements, March 1978. This engineering note addresses the desirability of specifying the requirements of Federal Aviation Administration (FAA) Advisory Circular 90-45A, "Approval of Area Navigation Systems for Use in the U.S. National Airspace System", in GPS User System Segment Specification SS-US-200.
- f. Engineering Note 1191-78-4, Identification of F-16A Integration Issues, March 1978. This engineering note identifies issues concerned with the integration of the GPS UE into the F-16A aircraft that require further definition than provided in the F-16A Interface Control Document.
- g. Engineering Note 1191-78-5, GPS UE Integration Concepts for the F-16A and B-52G/H, April 1978. This engineering note presents the approved baseline concepts by which the GPS UE will be developed for integration into the F-16A and B-52G/H IOT&E host vehicles.
- h. Engineering Note 1191-78-6, Categorization/Prioritization of Contractor Questions, April 1978. This engineering note provides the method by which UE development contractor questions to the GPS JPO will be categorized and the answers prioritized.
- i. Engineering Note 1191-78-7, GPS UE Blanking Pulse Input Signal, April 1978. This engineering note presents a justification for eliminating the requirement for sending the GPS UE an interference blanking or suppression pulse signal from onboard aircraft transmitting equipment such as TACAN and IFF.
- j. Engineering Note 1191-78-8, B-52/GPS User Equipment Integration Analysis Tasks, April 1978. This engineering note identifies and describes tasks

required to perform a comprehensive integration engineering analysis on integrating the GPS UE into the updated B-52G/H IOT&E host vehicle.

- k. Meeting Minutes 1191-78-1, GPS Phase II Joint Integration Planning Conference, 20 April 1978. These meeting minutes summarize the joint integration planning conference meeting with GPS JPO Air Force and Army representatives to discuss their integration management approaches.
- l. Meeting Minutes 1191-78-2, GPS Phase II Joint Integration Planning Conference, 2 May 1978. These meeting minutes summarize the joint integration planning conference meeting with GPS JPO Air Force and Navy representatives to discuss their integration management approaches.
- m. UE Contractor Question, "Answers AR-1000 through AR-1004", April 1978. Answers are provided to a variety of UE development contractor questions concerning ICD information.
- n. UE Contractor Question, "Answers AR-1005 through AR-1012", 10 May 1978. Answers are provided to a variety of UE development contractor questions concerning ICD information.
- o. User Equipment Development Plan, 11 May 1978. This plan establishes and describes the approach that will be taken by the GPS JPO in managing the development, acquisition, test and evaluation, and planning for the initial deployment of the GPS User Equipment Segment of the NAVSTAR program.

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SUMMATION OF RESULTS

The work performed under this contract has resulted in the identification of Phase II user equipment interface requirements for Navy vehicles, and the formulation of Air Force integration management planning information.

The Navy interface requirements data will be used by the UE development contractors and vehicle integrators to define detailed interface design requirements for Phase II prototype set fabrication and installation. The interface/integration information presented in the ICDs forms a baseline set of requirements from which the contractors may develop more definitized requirements for control of each host vehicle-to-UE interface during the next phase of the integration process.

The Air Force integration management information identifies and defines the various phases of the integration process and who has responsibility for them. This information has been presented in a loose-leaf "guidebook" format so as to be easily expanded upon and/or modified in the future. The guidebook will be used by appropriate members of the GPS JPO to implement, manage, monitor, and control the UE interface design and host vehicle integration/modification process during Phase II. As such, it must be maintained current to be of maximum use on a day-to-day working basis.

The next phase of activities to be performed in the guidebook area will include expanding upon the material presented therein and maintaining its contents current. This will include reviewing the Army and Navy integration management plans to ensure interservice compatibility and, if required, modifying the Air Force guidebook accordingly. Once the integration plans of the three services have been completed, an overall plan that combines them into a single consolidated and coordinated element must be developed. Inconsistencies in schedules and UE contractor interfaces must be identified and resolved. Installation cost and budget information must also be developed and incorporated into the plans in order to ensure adequate out-year funding. Phase III installation/modification requirements must be taken into consideration during this effort.

Also during the next phase, as the UE development contractors and vehicle integrators get more involved in the required vehicle interfaces, additional integration issues will surface that will require analysis and resolution. The baseline ICDs will have to be updated to incorporate those resolved issues and any other detailed information that the contractors identify as relevant to interface design control.

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