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FINAL REPORT
SYSTEM DESIGN OF THE PIONEER VENUS SPACECRAFT

VOLUME 13
PRELIMINARY DEVELOPMENT PLANS

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By
M. S. MIXON
ET AL.

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July 1973

Prepared Under
Contract No. [redacted] NAS2-7250

By
HUGHES AIRCRAFT COMPANY
EL SEGUNDO, CALIFORNIA

For
AMES RESEARCH CENTER
NATIONAL AERONAUTICS AND
SPACE ADMINISTRATION

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PREFACE

The Hughes Aircraft Company Pioneer Venus final report is based on study task reports prepared during performance of the "System Design Study of the Pioneer Spacecraft." These task reports were forwarded to Ames Research Center as they were completed during the nine months study phase. The significant results from these task reports, along with study results developed after task report publication dates, are reviewed in this final report to provide complete study documentation. Wherever appropriate, the task reports are cited by referencing a task number and Hughes report reference number. The task reports can be made available to the reader specifically interested in the details omitted in the final report for the sake of brevity.

This Pioneer Venus Study final report describes the following baseline configurations:

- "Thor/Delta Spacecraft Baseline" is the baseline presented at the midterm review on 26 February 1973.
- "Atlas/Centaur Spacecraft Baseline" is the baseline resulting from studies conducted since the midterm, but prior to receipt of the NASA execution phase RFP, and subsequent to decisions to launch both the multiprobe and orbiter missions in 1978 and use the Atlas/Centaur launch vehicle.
- "Atlas/Centaur Spacecraft Midterm Baseline" is the baseline presented at the 26 February 1973 review and is only used in the launch vehicle utilization trade study.

The use of the International System of Units (SI) followed by other units in parentheses implies that the principal measurements or calculations were made in units other than SI. The use of SI units alone implies that the principal measurements or calculations were made in SI units. All conversion factors were obtained or derived from NASA SP-7012 (1969).

The Hughes Aircraft Company final report consists of the following documents:

Volume 1 - Executive Summary - provides a summary of the major issues and decisions reached during the course of the study. A brief description of the Pioneer Venus Atlas/Centaur baseline spacecraft and probes is also presented.

Volume 2 - Science - reviews science requirements, documents the science peculiar trade studies and describes the Hughes approach for science implementation.

Volume 3 - Systems Analysis - documents the mission, systems, operations, ground systems, and reliability analysis conducted on the Thor/Delta baseline design.

Volume 4 - Probe Bus and Orbiter Spacecraft Vehicle Studies - presents the configuration, structure, thermal control and cabling studies for the probe bus and orbiter. Thor/Delta and Atlas/Centaur baseline descriptions are also presented.

Volume 5 - Probe Vehicle Studies - presents configuration, aerodynamic and structure studies for the large and small probes pressure vessel modules and deceleration modules. Pressure vessel module thermal control and science integration are discussed. Deceleration module heat shield, parachute and separation/despin are presented. Thor/Delta and Atlas/Centaur baseline descriptions are provided.

Volume 6 - Power Subsystem Studies

Volume 7 - Communication Subsystem Studies

Volume 8 - Command/Data Handling Subsystems Studies

Volume 9 - Altitude Control/Mechanisms Subsystem Studies

Volume 10 - Propulsion/Orbit Insertion Subsystem Studies

Volumes 6 through 10 - discuss the respective subsystems for the probe bus, probes, and orbiter. Each volume presents the subsystem requirements, trade and design studies, Thor/Delta baseline descriptions, and Atlas/Centaur baseline descriptions.

Volume 11 - Launch Vehicle Utilization - provides the comparison between the Pioneer Venus spacecraft system for the two launch vehicles, Thor/Delta and Atlas/Centaur. Cost analysis data is presented also.

Volume 12 - International Cooperation - documents Hughes suggested alternatives to implement a cooperative effort with ESRO for the orbiter mission. Recommendations were formulated prior to the deletion of international cooperation.

Volume 13 - Preliminary Development Plans - provides the development and program management plans.

Volume 14 - Test Planning Trades - documents studies conducted to determine the desirable testing approach for the Thor/Delta spacecraft system. Final Atlas/Centaur test plans are presented in Volume 13.

Volume 15 - Hughes IR&D Documentation - provides Hughes internal documents generated on independent research and development money which relates to some aspects of the Pioneer Venus program. These documents are referenced within the final report and are provided for ready access by the reader.

Data Book - presents the latest Atlas/Centaur Baseline design in an informal tabular and sketch format. The informal approach is used to provide the customer with the most current design with the final report.

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1.0 SYNOPSIS

PROGRAM DEVELOPMENT PLAN

The Program Development Plan will be submitted with the proposal presently being prepared in response to the RFP. The Plan will be presented in three volumes as shown below.

VOLUME I — TECHNICAL DEVELOPMENT PLAN

1.0 ORGANIZATION — Presents the Hughes Pioneer Venus program organization including all staff functions, and the responsible engineering activities. Key individuals are identified.

2.0 PROGRAM TASKS AND SCHEDULE — Presents the Master Phasing Schedule, the Work Breakdown Structure and the performing Pioneer Venus Program organizational elements. A cross-reference between the WBS and the Statement of Work included in the RFP is presented.

3.0 SUBSYSTEM DEVELOPMENT PLAN — Presents a task description cross-referenced to the RFP Statement of Work, the development schedule and manpower spread, the development testing, flight hardware testing, hardware deliverables (including all development hardware), development problems and proposed approach for resolution, and finally a description of the approach to a low cost program. All of the above are presented for each of the following subsystems:

Probe Vehicles
Command and Data Handling
RF
Antenna
Attitude Control and Mechanisms
Power
Probe Bus and Orbiter Structures and Thermal
Propulsion and Orbit Insertion Motor

4.0 SUBCONTRACTS — Identifies all hardware items that will be subcontracted (excluding parts and materials), the basis for the decision to buy rather than make, the name of the selected subcontractor, and the competition list for each subcontracted item with bid price for each competitor.

5.0 DELIVERABLE ITEMS — Presents in tabular form the spacecraft flight hardware to the unit level, the quantities, and the required delivery dates. In addition, this section identifies all Ground Support Equipment by item and

required delivery dates; the Government Furnished Equipment, required delivery dates, and cognizant contract number; and finally the deliverable computer software items.

6.0 DEVELOPMENT PLAN APPENDICES — This section presents a number of the development plans in summary form, which will be provided during the execution phase of the program in detail. The intent here is to demonstrate an understanding of the requirements, and this contractor's approach, rather than define the detail procedures involved with each plan. The specific plans covered in this section are:

System Engineering Plan
Science Instrument Integration Plan
EMI Control Plan
Magnetic Control Plan
Configuration Management Plan
Manufacturing Plan
Safety Plan
Facilities Plan
Contamination Control Plan

In general, each plan presents the organization and management of the tasks, applicable documents, proposed plan for implementing the RFP requirements, and this contractor's approach to reducing costs in the specific area being treated.

VOLUME II — INTEGRATION, TEST AND LAUNCH SUPPORT PLAN

1.0 INTEGRATED TEST PLAN — Presents all tests to be performed, including development, unit flight hardware, and system level testing. Environmental test requirements, test sequences, and test equipment and facilities are defined. System level test schedules are presented in some detail and the system test organization is also described. This contractor's approach to a low cost program in the test area is also presented. And finally, a task description is provided with cross-reference to the RFP Statement of Work.

2.0 LAUNCH OPERATIONS — Presents the activities to be performed at the Eastern Test Range, the organization devoted to this activity, and the test sequences and schedules. A task description with cross-reference to the RFP Statement of Work is presented. This contractor's approach to a low cost program in this area is also presented.

3.0 GROUND SUPPORT EQUIPMENT — Defines all mechanical and electrical ground support equipment to be developed on this program. Utilization of this equipment is presented. A task description with cross-reference to the RFP Statement of Work is included as is this contractor's recommended low cost approach.

4.0 TEST SOFTWARE PLAN — All computer software to be used during system level testing is defined in this plan. In addition, the computer complex recommended for this program is defined.

VOLUME III – RELIABILITY AND QUALITY ASSURANCE PLAN

1.0 RELIABILITY PLAN – The tasks to be performed are described together with a cross-reference to the RFP Statement of Work. Procedures for selection and control of parts, materials and processes to be used on this program are defined. Parts screening requirements are also covered in this section. Failure reporting and procedures for disposition of failures are presented. Subcontractor control in the areas of parts, materials and processes, and failure reporting are also covered, and finally the organization and management of this task is covered. Low cost approaches are identified as in previous sections.

2.0 QUALITY ASSURANCE PROGRAM PLAN – Procedures for manufacturing control, including inprocess inspection and spacecraft assembly inspection are presented. The procedures for review and disposition of material nonconformances are covered for both in-house and subcontracted manufacturing. Quality records and traceability requirements are defined. As in previous sections, this contractor's recommendations for a low cost program in this area are presented.

2.0 PROGRAM DEVELOPMENT PLAN

DETAILED OUTLINE

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