



HUNTSVILLE, ALABAMA

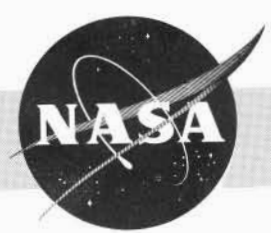
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DIGEST OF
FY-66 FUNDED ADVANCED STUDIES
NOVEMBER 1966

National Aeronautics and Space Administration



GEORGE C. MARSHALL SPACE FLIGHT CENTER

DIGEST OF
FY-66 FUNDED ADVANCED STUDIES

NOVEMBER 1966

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FOREWORD

This publication is one of a series summarizing the advanced study program, sponsored by the Advanced Systems Office, for each fiscal year beginning with FY-61. The purpose of these documents is to provide management with quick reference information which should be helpful in planning future study programs.

The FY-66 funded studies, which are under contract as of the date of this publication or are approved by NASA Headquarters and are in the procurement cycle, are covered by this document. The investigations are covered in five major sections: Launch Vehicle Studies, Earth Orbital Studies, Lunar Studies, Planetary/Nuclear Studies, and Project Definition Studies. The information presented on each study includes a brief statement of the objectives and pertinent contractual data. In cases where the study contract has not been awarded, obviously certain contractual data such as funds, contractor, period of performance, etc., can not be included.

SECTION I. LAUNCH VEHICLE STUDIES

A. ASSESSMENT OF TEST PROGRAM ALTERNATIVES: LARGE BALLISTIC LAUNCH VEHICLE RECOVERY AND REUSE

Objectives

The purpose of this effort is to investigate available and future test program alternatives that could provide technical data and initial feasibility demonstrations pertinent to large ballistic launch vehicle recovery programs. Both solids and liquids will be investigated with emphasis on the S-IC stage.

Contract Data

1. Contractor: Lockheed
2. Contract No.: NAS8-20294
3. Period of Performance: Oct. 66 - Jan. 67
4. Contract Amount: \$250,000
5. Code: 981-40-10
6. COR: G. Detko, R-AS-VG

B. SATURN IMPROVEMENT STUDIES: UPDATED SATURN IB PRELIMINARY PROGRAM DEFINITION (Phase III)

Objectives

This effort is directed at investigation of methods by which performance capabilities of the Saturn IB can be increased. The study will determine design changes necessary, performance gains attainable, impact upon facilities and ground support equipment, and the effects upon costs and schedules. This task is a follow-on to a FY-65 funded study.

Contract Data

1. Contractor:
2. Contract No.:
3. Period of Performance:
4. Contract Amount:
5. Code: 981-40-10
6. COR: M. Page, R-AS-VG

C. APPLICATION OF LARGE SOLID MOTORS FOR EARTH ORBITAL MISSIONS

Objectives

The purpose of this study is to examine launch vehicle configurations employing large advanced solid propellant motors to determine vehicle influences and desires for such applications to be used as guidance for the propulsion technology effort.

Contract Data

1. Contractor:
2. Contract No.:
3. Period of Performance:
4. Contract Amount:
5. Code: 981-40-10
6. COR: M. Page, R-AS-VG

D. ANALYSIS OF INSTRUMENT UNIT REQUIREMENTS FOR UPDATED SATURN IB CONFIGURATIONS

Objectives

The purpose of this effort is to analyze the necessary modifications to the astrionics systems required for the improved or updated Saturn IB launch vehicles which are identified in the Saturn IB Improvement Studies.

Contract Data

1. Contractor:
2. Contract No.:
3. Period of Performance:
4. Contract Amount:
5. Code: 981-40-10
6. COR: R. Coulter, R-ASTR-A

E. RECOVERY, REUSABILITY, AND ASSESSMENT OF TEST PROGRAM ALTERNATIVES FOR 260-INCH SOLID ROCKET MOTOR

Objectives

The purpose of this study is to investigate and identify the best non-winged recovery method for the 260-inch solid propellant rocket motor.

The study will determine experimental alternatives, including supporting analysis, to verify recovery concepts and to reduce uncertainties. The study shall define the data required and the best method of obtaining the data needed.

Contract Data

1. Contractor:
2. Contract No.:
3. Period of Performance:
4. Contract Amount:
5. Code: 731-21-01
6. COR: R. Davies, R-AS-VG

SECTION II. EARTH ORBITAL STUDIES

A. HUMAN ENGINEERING DATA FOR MAINTENANCE AND REPAIR OF ADVANCED SPACE SYSTEMS

Objectives

The objectives of this study include performing a literature search to obtain available data on zero and 1/6th G pertinent to human factors with emphasis on maintenance and repair. This effort is required to produce human engineering data and principles required by designers in designing maintainability and repairability into advanced space systems. The data will be provided in an easy to use form.

Contract Data

1. Contractor: General Electric
2. Contract No.: NAS8-18177
3. Period of Performance: Aug. 66 - Aug. 67
4. Contract Amount: \$98,647
5. Code: 127-51-04
6. COR: J. Hilchey, R-AS-VO

B. MANNED ASTRONOMY SUPPORT FACILITY

Objectives

The purpose of this study is to derive a manned orbital astronomy support facility concept capitalizing on the established Manned Space Flight capability for advancing the objectives of an astronomy/astrophysics experiment program in Earth orbit.

Contract Data

1. Contractor:
2. Contract No.:
3. Period of Performance:
4. Contract Amount:
5. Code: 981-10-10
6. COR: G. Olivier, R-AS-VO

C. UTILIZATION OF SPENT SATURN S-IVB STAGE IN EARTH ORBIT

Objectives

The purpose of this study is to determine the uses of a spent S-IVB stage in Earth orbit by investigating the alternative methods which are within specified constraints. Configurations and uses will be considered for the 1968-1972 time period.

Contract Data

1. Contractor:
2. Contract No.:
3. Period of Performance:
4. Contract Amount:
5. Code: 981-10-10
6. COR: C. Darwin, R-P&VE-A/W. Perry, R-AS-VO

D. EXPERIMENTS FOR SATELLITE AND MATERIAL RETURN FROM ORBIT

Objectives

The objectives of this study are to define an early series of three experiments that will lay the groundwork for an EVA program that will lead to the development of a long range capability for rendezvous, capture, retrieval, and repair of objects from Earth orbit.

Contract Data

1. Contractor: Ball Brothers
2. Contract No.: NAS8-18119
3. Period of Performance: June 66 - Feb. 67
4. Contract Amount: \$149,985
5. Code: 981-10-30
6. COR: W. Stafford, R-AS-VO

E. LARGE SPACE STRUCTURES EXPERIMENTS FOR AAP

Objectives

The purpose of this effort is to define EVA procedures and systems design techniques required to deploy, couple, assemble, erect, align, and support large antennas and telescopes in Earth orbit. The study will include investigation of three orbital experiments through which the evaluation of various systems design techniques and the concurrent development of required EVA operational capabilities may be accomplished.

Contract Data

1. Contractor: General Dynamics/Convair
2. Contract No.: NAS8-18118
3. Period of Performance: Sept. 66 - Aug. 67
4. Contract Amount: \$275,000
5. Code: 981-10-30
6. COR: W. Carey, R-AS-VO

F. EVEA PROGRAM REQUIREMENTS WITH EMPHASIS ON EARLY EXPERIMENTS

Objectives

This study will identify and formulate: an early EVEA program and requirements; specific design features for scientific equipment; data for design of support equipment; early experiments in sufficient detail to allow program definition; and the RDT&E program including costs for each experiment.

Contract Data

1. Contractor:
2. Contract No.:
3. Period of Performance:
4. Contract Amount:
5. Code: 981-10-30
6. COR: W. Whitacre, R-AS-VO

G. SPECIAL PROJECT

Contract Data

1. Contractor: Scheldahl; NAS8-20669;
July 66 - Dec. 66; \$40,000; 390-00-00;
J. Kingsbury, R-P&VE-ME
2. Contractor: Goodyear; NAS8-20668;
July 66 - Dec. 66; \$75,000; 390-00-00;
J. Kingsbury, R-P&VE-ME
3. Contractor: Westinghouse; NAS8-20666;
July 66 - Nov. 66; \$125,000; 390-00-00;
A. Kromis, R-P&VE-A
4. Contractor: Boeing; NAS8-20667;
July 66 - Nov. 66; \$125,000; 390-00-00;
A. Kromis, R-P&VE-A

SECTION III. LUNAR STUDIES

A. IMPROVED LUNAR CARGO AND PERSONNEL DELIVERY SYSTEM

Objectives

This effort includes the evaluation of the most promising concepts for increasing the number of personnel that could be delivered to the lunar surface, and definition of a direct flight, manned and unmanned delivery system.

Contract Data

1. Contractor:
2. Contract No.:
3. Period of Performance:
4. Contract Amount:
5. Code: 981-20-30
6. COR: G. Woodcock, R-AS-VL

B. DESIGN REQUIREMENTS FOR REACTOR POWER SYSTEMS FOR LUNAR EXPLORATION

Objectives

The objectives of this study are to: Develop guidelines for on-going reactor power system technology programs based on potential manned lunar surface missions use; evaluate the capabilities of the hardware and technology to be derived from the SNAP-8 program for manned lunar surface use; and identify and evaluate mission requirements that influence reactor power system design and operation.

Contract Data

1. Contractor: Lockheed
2. Contract No.: NAS8-20377
3. Period of Performance: June 66 - Aug. 67
4. Contract Amount: \$150,000 (FY-66); \$200,000 total
5. Code: 120-27-06
6. COR: G. Woodcock, R-AS-VL

SECTION IV. PLANETARY/NUCLEAR STUDIES

A. MISSION ORIENTED STUDY OF ADVANCED NUCLEAR SYSTEMS

Objectives

This is a continuation of previous study. The objective is to identify and define the essential design requirements for a nuclear rocket propulsion system based on the PHOEBUS 2 reactor concept. Primary emphasis is on optimizing the engine design characteristics to obtain the best overall system performance for the manned Mars stopover mission and other selected missions during the 1975-1990 time period.

Contract Data

1. Contractor: TRW
2. Contract No.: NAS8-5371, Mod 7
3. Period of Performance: April 66 - April 67
4. Contract Amount: \$122,766 (FY66), Total Contract \$675,179
5. Code: 789-30-01
6. COR: R. Harris, R-AS-VP

B. MODULAR NUCLEAR VEHICLES

Objectives

Mod 3 - This is a continuation of a previous study contract. The objective of this modification to the contract is to provide a meaningful effective comparison and evaluation of the destruct auxiliary thrust system counter-measure as applied to nuclear rocket vehicle flight operations.

Mod 4 - This effort is a result of Phase I which indicates that further investigation is necessary to broaden the scope of the investigation, to verify design concepts, to evaluate design alternatives, to update nuclear flight safety analyses, and to establish supporting technological requirements.

Mod 5 - The objectives of this modification to the study contract are to perform a safety analysis evaluating the Auxiliary Thrust System (ATS) counter-measure; establish the relative range safety of the direct injection mode; analyze and perform preliminary design of the ATS counter-measure system and define program planning and schedule requirements for its development; determine safety effects and constraints imposed upon nuclear vehicles by man-rating; and provide general support for the ROVER Flight Safety Panel activity responsibilities of MSFC.

Contract Data

1. Contractor: Lockheed
2. Contract No.: NAS8-20007, Mod 3, Mod 4, and Mod 5
3. Period of Performance: Mod 3, Dec. 65 - March 66;
Mod 4, March 66 - Dec. 67;
Mod 5, April 66 - Dec. 67
4. Contract Amount: Mod 3, \$44,000 (FY 66); Mod 4, \$317,000 (FY 66)
Mod 5, \$104,000 (FY 66); Total Contract,
\$837,336.
5. Code: Mod 3, 122-05-00; Mod 4, 121-30-04; Mod 5, 122-05-00.
6. COR: D. Saxton, R-AS-VP

C. STUDY OF NUCLEAR PROPULSION FOR UNMANNED SOLAR SYSTEM PROBES

Objectives

(Work statement has not been prepared)

Contract Data

1. Contractor:
2. Contract No.:
3. Period of Performance:
4. Contract Amount:
5. Code: 789-30-01
6. COR: W. Jordan, R-AS-VP

D. MANNED PLANETARY FLYBY MISSIONS BASED ON SATURN/APOLLO SYSTEMS

Objectives

This study will investigate the feasibility of, and establish overall requirements for, performing manned Mars and Venus flyby missions using Saturn/Apollo systems with minimum modification. Areas to be investigated include vehicles, systems, operations, utility, experiments, schedules, and costs.

Contract Data

1. Contractor: North American Aviation
2. Contract No.: NAS8-18025
3. Period of Performance: Aug. 66 - Aug. 67
4. Contract Amount: \$400,000
5. Code: 981-30-20
6. COR: B. Noblitt, R-AERO-DP

E. FEASIBILITY OF MODIFYING THE S-II STAGE FOR MANNED FLYBY MISSIONS

Objectives

This effort is to determine the feasibility of modifying the S-II stage for use as an orbital injection stage for manned planetary flyby missions. The intent is to provide a realistic input into the flyby studies and gain further insight into the total requirements for such a mission in order to better guide and direct such efforts as AAP, AR&T programs, and the planetary effort in general.

Contract Data

1. Contractor: North American Aviation
2. Contract No.: NAS8-18031
3. Period of Performance: Aug. 66 - May 67
4. Contract Amount: \$100,000
5. Code: 981-30-20
6. COR: L. Allen, R-P&VE-A

F. FEASIBILITY OF MODIFYING THE S-IVB STAGE FOR MANNED FLYBY MISSIONS

Objectives

This effort is to determine the feasibility of modifying the S-IVB stage for use as an orbital injection stage for manned planetary flyby missions. The intent is to provide a realistic input into the flyby studies and gain further insight into the total requirements for such a mission in order to better guide and direct such efforts as AAP, AR&T programs, and the planetary effort in general.

Contract Data

1. Contractor: Douglas Aircraft Company
2. Contract No.: NAS8-18032
3. Period of Performance: Oct. 66 - April 67
4. Contract Amount: \$100,000
5. Code: 981-30-20
6. COR: L. Allen, R-P&VE-A

G. ALTERNATIVE MISSION MODES

Objectives

This study effort is to evaluate novel and previously unemphasized modes for accomplishing manned missions to Mars and Venus. A search will be made for modes with applications for Saturn/Apollo hardware extensions, as well as missions requiring more advanced technology.

Contract Data

1. Contractor: TRW
2. Contract No.: NAS8-18056
3. Period of Performance: Aug. 66 - Sept. 67
4. Contract Amount: \$200,000
5. Code: 981-30-10
6. COR: R. Austin, R-AS-VP

H. LOW ACCELERATION SPACE TRANSPORTATION SYSTEMS (SOLAR CELL)

Objectives

The purpose of this effort is to conduct analyses of solar arrays to determine control modes, dynamic responses, structural requirements, and control system requirements. An overall systems analysis will be performed of hybrid high-thrust/low-thrust vehicle systems. From this analysis will evolve conceptual designs for both nuclear-electric and solar electric systems that represent optimum designs based on realistic constraints.

Contract Data

1. Contractor: General Electric
2. Contract No.: NAS8-21030
3. Period of Performance: Oct. 66 - Oct. 67
4. Contract Amount: \$148,000
5. Code: 789-30-01
6. COR: J. Russell, R-AS-VP

I. LOW ACCELERATION SPACE TRANSPORTATION SYSTEM (TRAJECTORY MODEL)

Objectives

This is a continuation of a previous study to further develop and verify a simplified trajectory model for low acceleration space transportation systems, and to use the model to develop criteria and requirements for low acceleration propulsion systems for manned planetary missions.

Contract Data

1. Contractor: United Aircraft Corporation
2. Contract No.: NAS8-11309, Mod 4
3. Period of Performance: July 66 - Oct. 67
4. Contract Amount: \$73,000 (FY-66); Total Contract, \$205,432
5. Code: 120-26-07
6. COR: J. Russell, R-AS-VP

J. STUDY OF MODIFICATION OF S-IV/S-IVB TANKAGE FOR SMALL NUCLEAR
ROCKET STAGES

Objectives

(Work statement has not been prepared)

Contract Data

1. Contractor:
2. Contract No.:
3. Period of Performance:
4. Contract Amount:
5. Code: 121-30-04
6. COR: R. Harris, R-AS-VP

K. MISSION ENGINEERING STUDY OF ELECTRICALLY PROPELLED MANNED
PLANETARY VEHICLES

Objectives

This study will define the operational aspects of a electrically propelled vehicle for a Mars landing mission. The prime concern will be the mission operation and manning aspects. The interactions of the Earth launch vehicle, facilities, and spacecraft will be defined. The desired characteristics for electric thrusters, power conditioning reactors, and thermionic converters will be determined. Preliminary development schedule and cost data will be established.

Contract Data

1. Contractor: General Electric
2. Contract No.: NAS8-20372
3. Period of Performance: June 66 - May 67
4. Contract Amount: \$183,000
5. Code: 981-30-10
6. COR: J. Russell, R-AS-VP

SECTION V. PROJECT DEFINITION STUDIES

A. IN SITU LUNAR SAMPLE ANALYSIS

Objectives

The purpose of this study was to establish appropriate techniques for geochemically and petrologically analyzing lunar materials. Functional instrument prototypes were to be provided, and an instrument development program which would be compatible with AAP would be recommended.

Contract Data

1. Contractor: Goddard Space Flight Center
2. Contract No.: Sub-allotment
3. Period of Performance: April 65 - May 66
4. Contract Amount: \$200,000
5. Code: 908-40-13
6. COR: N. Costes, R-RP

B. LOCAL SCIENTIFIC SURVEY MODULE (LSSM)

Objectives

This is a continuation of previous studies to perform a preliminary design definition on the LSSM, which is a small lunar surface vehicle. The vehicle is to be capable of transporting an astronaut-scientist and at least 150 kg (330 lbs.) of equipment on trips of at least 16 km in traversed distance.

Contract Data

- ✓ 1. Contractor: Bendix
 - ✓ a. Contract No.: NAS8-20378
 - ✓ b. Period of Performance: June 66 - Jan. 67
 - c. Contract Amount: \$350,000
 - d. Code: 981-20-10
 - e. COR: L. Bradford, R-AS-P
- ✗ 2. Contractor: Boeing
 - a. Contract No.: NAS8-20340
 - b. Period of Performance: June 66 - Jan. 67
 - c. Contract Amount: \$350,000
 - d. Code: 981-20-10
 - e. COR: L. Bradford, R-AS-P

C. MOBILITY TEST ARTICLE (MTA)

Objectives

The purpose of these studies was to design, develop, and fabricate a model to serve as a 1/6 g Mobility Test Article for the mobility design concept of lunar surface vehicles. The MTA was to provide accurate simulation of the contractor's LSV concept and be flexible and adaptable to all subsystems and alternates which may be suitable for comprehensive LSV mobility system development testing. The MTA will provide a means of evaluating LSV surface mobility performance, maneuverability, stability, dynamic behavior, and overall performance. The FY-66 funds cover an overrun to the General Motors contract, engineering services from Bendix and General Motors, and testing services performed by the U.S. Army.

Contract Data

1. Contractor: General Motors
 - a. Contract No.: NAS8-20251 (Modification)
 - b. Period of Performance: Sept. 66 - Jan. 67 (FY-66 Funded extension)
 - c. Contract Amount: \$85,000 overrun plus \$25,000 for Engineering Services; Total FY-66, \$110,000; Total Contract, \$500,000 (FY-65 + FY-66)
 - d. Code: 981-20-10 (FY-66)
 - e. COR: H. Schaefer, R-AS-P

2. Contractor: Bendix
 - a. Contract No.: NAS8-20441
 - b. Period of Performance: Aug. 66 - Feb. 67
 - c. Contract Amount: \$25,000
 - d. Code: 981-20-10
 - e. COR: H. Schaefer, R-AS-P

3. Contractor: U.S. Army TECOM
 - a. Contract No.: H-13240
 - b. Period of Performance: June 66 - July 67
 - c. Contract Amount: \$275,000
 - d. Code: 981-20-10
 - e. COR: H. Schaefer, R-AS-P

D. LEM RELAY EXPERIMENT OPERATIONS TRACKING RELAY

Objectives

This experiment is to demonstrate feasibility and ascertain usefulness of a LEM in synchronous orbit as an operational communications and tracking relay between a manned spacecraft in a low altitude Earth orbit and the Manned Flight Network (MSFN).

Contract Data

1. Contractor:
2. Contract No.:
3. Period of Performance:
4. Contract Amount:
5. Code: 949-10-01
6. COR: Mr. Barr

E. MISCELLANEOUS HARDWARE PROCUREMENTS

1. Intercom System: ITT; Contract NAS8-16977; \$10,000;
908-40-22; Jan. 65 - Feb. 66; Mr. Bobbitt
2. Rechargeable Batteries: Eagle-Pitcher; Contract NAS8-17679;
\$14,000; 908-40-22; Jan. 66 - March 66;
H. Schaefer.