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Volume IV

Final Report

September 1972

Program Development Requirements

# Astronomy Sortie Missions Definition Study





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# ASTRONOMY SORTIE MISSION DEFINITION STUDY

## ASTRONOMY SORTIE PROGRAM PROGRAM DEVELOPMENT REQUIREMENTS

Prepared for:

National Aeronautics and Space Administration
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## FOREWORD

This document is submitted in accordance with the Data Procurement Document Number 282, Data Requirement Number MA-04 under the George C. Marshall Space Flight Center Contract NAS8-28144.

This is the fourth of four folumes of the Astronomy Sortie Missions Definition Study Final Report. This volume contains the program development requirements.

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## PREFACE

The realization of a fully operational Space Shuttle will open the door for unparalled research opportunities in space astronomy. One mode of operation currently envisioned for the Space Shuttle is the short-duration sortie mission. The sortie mission would consist of a low earth orbit of approximately seven days' duration. During this seven days, research would be conducted by an experiment crew utilizing a scientific payload located in the Space Shuttle cargo bay.

For research in astronomy, the Space Shuttle sortie mission offers significant advantages. Several of the more important are (1) the ability to escape the Earth's atmosphere and, therefore, open up the entire electromagnetic spectrum to research, (2) the elimination of atmospheric pertubations and, thus, the ability to use the spatial resolution of the telescopes, which is currently limited to approximately one-half arc-second for ground-based telescopes, and (3) the ability to continually observe the sun during the seven-day mission without obscurations. Combining these scientific advantages with the large payload capability of the Space Shuttle, the low-cost operation of the Space Shuttle, the availability of an experiment crew on-orbit with the experiments, the frequent space flight opportunities, and the ability to return the experiment to Earth for refurbishment and retrofit offer the scientific community a unique opportunity for further research in the field of astronomy.

While the opportunities for advances in space astronomy research are clear, it is evident that significant planning is required by NASA to ensure an orderly and timely program that not only satisfies the astronomy objectives but also provides the most return for the smallest investment. The primary purpose of this study was to provide NASA with an overview of the astronomy sortie mission requirements.

The specific objectives of the study were to:

1) Evaluate the responsiveness of the sortie mission concept to stated scientific objectives;

2) Develop conceptual designs and interfaces for sortie missions including telescopes, mounts, controls, displays, and support equipment;

3) Develop a system concept encompassing the sortie mission from mission planning through postflight engineering and scientific documentation;

4) Provide funding estimates, development schedules, and supporting research and technology requirements for Shuttle sortie hardware.

The approach used in performing the study consisted of the following sequence:

1) Analyzing and conceptually designing the alternative candidate astronomy sortie mission program that maximized the utilization of common features;

2) Analyzing the astronomy sortie mission program to ensure compatibility between interfacing systems, evaluating overall performance and ensuring mission responsiveness, and developing a complete mission profile;

3) Analyzing the support subsystems to a depth sufficient to establish feasibility, compatibility with other subsystems, adequate performance, physical characteristics, interface definition, reliability level, and compatibility with manned operations;

4) Conceptually designing the selected astronomy sortie mission program, which included defining the significant design features, dimensions and interfaces on layout drawings, and defining the telescope system physical characteristics and support requirements;

5) Providing funding estimates, development schedules, and supporting research and technology requirements.

The final report of the study is contained in four volumes of which this volume is Volume II, Book 1. They are:

Volume 1 - *Astronomy Sortie Missions Definition Study Final Report: Executive Summary*

This volume summarizes the significant achievements and activities of the study effort.

Volume II - *Astronomy Sortie Missions Definition Study Final Report:*

Book 1 - *Astronomy Sortie Program Technical Report*

Book 1 of this volume includes the definition of telescope requirements, preliminary mission and system definitions, identification of alternative sortie programs, definition of alternative sortie programs, evaluation of the alternative sortie programs, and selection of the recommended astronomy sortie mission program. This volume identifies the various concepts approached and documents the rationale for the concept and approaches selected for further consideration.

Volume II - *Astronomy Sortie Missions Definition Study Final Report:*

Book 2 - *Appendix*

Book 2 of this volume contains the *B*aseline *E*xperiment *D*efinition *D*ocuments (BEDDs) that were prepared for each of the experiments considered during the study.

Volume III - *Astronomy Sortie Missions Definition Study Final Report:*

Book 1 - *Design Analyses and Trade Studies*

Book 1 of this volume includes the results of the design analyses and tradeoff studies conducted for candidate concepts during the selection of recommended configurations as well as of the design analyses and tradeoff studies conducted for the selected concept.

Volume III - *Astronomy Sortie Missions Definition Study Final Report*

Book 2 - *Appendix*

Book 2 of this volume contains the backup or supporting data for the design analyses and tradeoff studies that are summarized in Volume III, Book 1.

**Volume IV** - *Astronomy Sortie Missions Definition Study Final Report: Program Development Requirements*

This volume contains the planning data for subsequent phases and includes the gross project planning requirements; schedules, milestones, and networks; supporting research and technology; and cost estimates.

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## INTRODUCTION

Program development requirements for the selected Astronomy Sortie missions concept were generated and are presented in this volume in four parts as follows: Part I identifies the gross planning requirements that must be considered in subsequent phases of the project; Part II presents the schedules and logic networks for the design, development, and operation of the overall project; Part III identifies the supporting research and technology required to support the project; and Part IV presents the cost estimates of the selected concept, including development and the 12-year operations program.

Data reported in each part includes the appropriate rationale with explanations of the guidelines and assumptions that were used in the analyses and estimates.

# I. PROJECT PLANNING REQUIREMENTS

## A. INTRODUCTION

The gross planning requirements for subsequent phases of the Astronomy Sortie mission (ASM) project are presented here. The requirements were derived in five areas: (1) engineering and manufacturing; (2) testing; (3) quality and reliability assurance; (4) facilities; and (5) project management.

These requirements are not intended to limit future analyses in either scope or depth. Rather, these requirements are the essential elements that must be considered (or provided) to synthesize an effective program that satisfies the objectives economically and on schedule.

## B. ENGINEERING AND MANUFACTURING

The ASM telescopes and arrays are one-of-a-kind experiments that impose unique standards on design, fabrication, and acceptance for flight. Further, these telescopes and arrays will be used over a period of up to 12 years for several missions each. Thus, it is desirable that the telescopes and arrays be capable of accommodating new detectors, filters, cameras, and systems to exploit scientific advances developed during the operations phase of the project. The total number of seven-day Sortie missions for each experiment is shown in the following tabulation.

| Telescopes | Number of Flights | Arrays | Number of Flights |
|---|---|---|---|
| IR | 31 | Large Area X-Ray Detector | 13 |
| Stratoscope III | 24 | Wide Coverage X-Ray | 55 |
| Photoheliograph | 26 | Large Modulation Collimator | 14 |
| X-Ray Telescope | 26 | Narrow Band Spectrometer Polarimeter | 14 |
| XUV Spectroheliograph | 26 | Collimated Plane Crystal Spectrometer | 13 |
| Coronagraphs | 26 | Gamma-Ray Spectrometer | 14 |
| | | Low Background Gamma-Ray Detector | 14 |

Subsystems are needed for each Sortie Lab and pallet payload, requiring the use of several flight units and spares to support the 12-year operations phase. Provision must be made for initial fabrication of spares whenever possible, since it is impractical to maintain manufacturing capabilities over long periods of time. Engineering considerations must include the requirements of long-term storage of spares, allowing for the performance degradation effects of time and maintaining cleanliness, configuration control, and production acceptance status.

## C. TESTING

The overall test program will verify the compatibility of Astronomy Sortie payloads with the Shuttle interfaces and will validate the design and development of the payloads, assuring reliable experiments that fulfill their Sortie mission objectives. Testing (and analyses) during the design development phases will accurately predict and verify failure modes as well as the stress levels at which failures occur. Stress levels refer to the intensity and duration of any parameter that affects the ability of a component, system, or complete payload to perform its design function, and includes both imposed environments and self-induced conditions.

Development and test of experiments, subsystems, and payloads will fully exploit existing space-qualified hardware, military-qualified hardware, and commerical airline hardware, giving consideration to the individual Sortie mission duration, the number of missions in the program (for that payload or experiment), and the maintenance and refurbishment that is possible between missions. Validation of hardware capabilities to meet payload objectives will require extensive systems engineering analysis, previous test results, and previous use. The inherent capabilities of hardware will be determined by thorough examination of systems design, failure mode and effects analyses, and demonstrated performance under imposed environments. Capabilities will then be compared with operating requirements and environments for these Sortie missions. Additional testing will be concentrated on resolving those uncertainties that systems design and previous test analyses have not satisfied.

Performance that requires verification over the complete mission environments of temperature, vacuum, acceleration, vibration, and acoustics will be certified by methods other than test wherever possible. Methods will consist of one or a combination of the following items.

1. <u>Similarity</u>

Testing will be waived if it can be demonstrated that the item is similar or identical in design and manufacturing processes to another article that has previously been tested to equal or more stringent limits.

2. <u>Analyses</u>

Analytical techniques will be used in lieu of testing to certify compliance with specified requirements. Analyses may include systems engineering studies, statistics, qualitative reviews, and computer assisted modeling and simulations.

3. <u>Demonstration</u>

Some features of payloads or experiments, such as access for servicing or adjustment, and human engineering factors, will be certified by demonstrating that the payload or experiment operates properly.

4. Test Exercises

Tests will verify proper operation of payload or experiment equipment not certified by similarity, analyses, or demonstration. Tests will be run (when required) on hardware that has satisfactorily passed requirements for acceptance. Tests will include exposure to environments or loads in excess of those maximums expected in a mission, or for durations longer than expected to certify that critical systems will not impose any detrimental effect on the Orbiter or crew. Noncritical systems will be tested to limits as required by the detail specifications.

## D. QUALITY AND RELIABILITY ASSURANCE

1. Quality Assurance

The ASM project includes experiment hardware developed by experiment contractors and principal investigators not always experienced in the fabrication and integration of space hardware. Further, the program provides for return of payloads from orbit, permitting refurbishment and modification of experiments on the ground prior to a later mission. These project requirements will be extended over the 12-year duration of operations, plus the preoperational phases, and impose the need for a comprehensive and continuing quality assurance program.

It is intended that established quality techniques, methods, and management will be used to ensure that the engineering, hardware, and operations support from the different experiment contractors are integrated to provide a flight-ready payload at the PIC-MSFC and at the launch site so that maximum mission success is achieved within cost and schedule constraints. Contamination control of the experiment hardware will be a major challenge to the quality assurance program for the design and hardware phases of the program.

2. Reliability

The reliability program will place primary emphasis on the identification of all single failure points in the payloads that are critical to crew safety and/or mission success. The most cost-effective means of eliminating or reducing the effects of these critical failures will be determined. The basic reliability program philosophy will be to require redundancy only for safety-critical items or where the cost of incorporation into the design is very low. Inflight maintenance, degraded modes of operations, or return to earth for maintenance will be evaluated for all other cases. The reliability program will require the evaluation of all experiment hardware, support hardware, and interfaces that make up the payload. In addition, this program will consider the effects that integrating the hardware at the PIC-MSFC, transportation to the launch site, and installation in the Orbiter may have on mission reliability.

## E. FACILITIES

Existing Government or contractor facilities will be used as much as possible to minimize modification and construction of new buildings, laboratories, clean rooms, test chambers, etc.

The telescopes and arrays will be developed and built by principal investigators or experiment contractors and will be provided to NASA in a flight-ready condition for integration into the Sortie Lab and pallet. Facilities necessary for experiment integration will be identified and coordinated with facility requirements for other project phases.

The subsystems will be developed and fabricated by the contractor and will be integrated into the Sortie Lab and pallet at the PIC-MSFC. Facilities necessary for development, manufacture, and acceptance for integration, as well as those required for integration of the subsystems into the Sortie Lab and pallet will be identified and coordinated for time-phased needs, candidate existing installation, and interference with other projects.

Facilities planning must cover the 12-year operations period for all phases of the missions. Of particular concern is the refurbishment phase in which capabilities to support the telescopes and arrays as well as the subsystems must be provided at the PIC-MSFC. Storage and control of subsystem spares for the duration of this project may impose unique requirements that must be identified for analysis of the impact on facilities.

## F. PROJECT MANAGEMENT

Project management requirements for ASM include defining subsequent phase study tasks, objectives, and schedules. These tasks must be coordinated with the Shuttle studies in progress and with other experiment and payload studies on a continuing basis.

Coordination of the project with the astronomy scientific community is necessary and requires liaison to identify objectives and define methods of performance.

Program control, progress reporting, and problem solving require definition of milestone objectives that may be statused periodically. Control techniques must be imposed on subcontractors with effective communications.

The changing depths of analyses in subsequent phases of the program require review of responsibilities and manpower skills applied to the tasks. Management must develop a logical sequence of work to ensure synthesis of the concepts into systems characteristics definition.

## II. SCHEDULES, MILESTONES, AND NETWORKS

### A. INTRODUCTION

All elements of the work breakdown structure (WBS) for the ASM program are included in the total program schedules presented here. Schedules were developed for the total system, identifying individual schedules for each flight hardware item at levels 5 and 6 on the WBS.

### B. PROGRAM MILESTONE SCHEDULE

The program schedule shown in Fig. II-1 begins with the issuance of the RFP for a Phase B study. This program schedule is based on the program flight schedule shown in Fig. II-2 for the baseline payload combinations. During the Phase B study period, authorization to proceed for long-lead-time (LLT) development of telescopes and arrays are scheduled. The ASM program contract award is scheduled for January 1975 with the first flight, a solar mission, scheduled in the first quarter of 1979.

The telescopes, arrays, and subsystems will be accepted for integration at the contractor that develops and builds them and will be delivered to MSFC for integration into the Sortie Lab and pallet. Six months of integration and test activity for the first solar flight is scheduled. The totally integrated Sortie Lab and pallet, with subsystems and experiments, is then loaded in the Super Guppy and delivered to the launch site for three months of prelaunch operation before the first flight.

Eighty-one flights, beginning in the first quarter of 1979 and ending in 1990, are planned. The first flights of the three basic configurations are:

Solar (26 flights), 1st quarter 1979;

IR (31 flights), 4th quarter 1979;

Stratoscope III (24 flights), 1st quarter 1982.

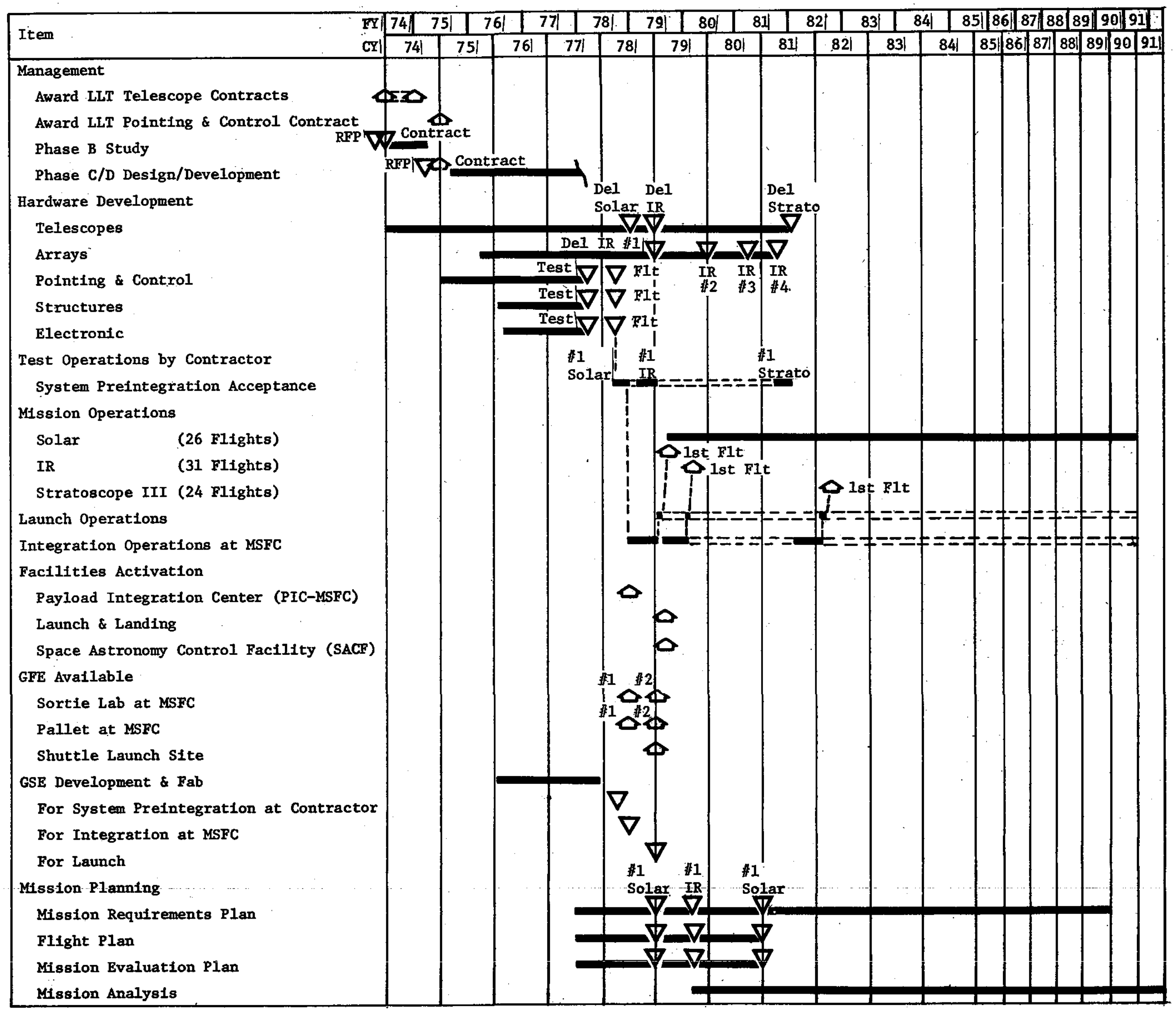


*Fig. II-1 Program Milestones Schedule*

| Payload | | Calendar Year 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar 1-2 | | X | XX | XXX | XXX | XXX | XX | XX | XX | XX | XX | XX | XX | 26 |
| Strato-scope III | 3AB | | | | X | | X | X | | X | X | X | | 6 |
| | 3AC | | | | | | X | X | X | | X | X | X | 6 |
| | 3AD | | | | | X | X | | X | X | X | | X | 6 |
| | 3AE | | | | | X | | X | X | X | | X | X | 6 |
| IR | 4AB | | X | | X | X | | X | X | | X | X | X | 8 |
| | 4AC | X | | | X | X | X | | X | X | X | | X | 8 |
| | 4AD | | | X | X | | X | X | | X | X | X | X | 8 |
| | 4AE | | | X | | X | X | X | X | X | | X | | 7 |
| Total | | 2 | 3 | 5 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 81 |

*Fig. II-2 Program Flight Schedule*

The payloads are returned after each flight. The Sortie Lab and pallet with experiments is then shipped to the Payload Integration Center (PIC) at MSFC, the experiments are removed, and the Sortie Lab and pallet are refurbished to receive other experiments. After integration of other telescopes and arrays, the integrated payload is tested and accepted as flight-ready. The payload is then shipped to the launch site for another Sortie flight.

Flight paylaods do not pass through the Space Astronomy Control Facility (SACF). Film exposed in missions will be returned to the SACF for processing, and scientists there must have communications with the flight (through mission control), but the payload handling capabilities necessary at the PIC-MSFC and at launch site are not needed at SACF. The overall turnaround time for a payload to complete one flight and be refurbished ready for another flight, is ten weeks, as shown in Fig. II-3. To meet the flight schedule of 81 flights during the 12-year period, two complete Sortie Labs and pallets are required.

## C. FACILITIES AND GSE

The primary facilities to be activated are the PIC-MSFC, the launch and landing site, and the SACF (Fig. II-4). These facilities will be outfitted with GSE developed concurrently with the flight hardware by the hardware manufacturer, and payload handling and support equipment GSE developed by the program contractor.

## D. LAUNCH, MISSION, AND RECOVERY/REFURBISHMENT OPERATIONS

Eighty-one flights, each lasting one week, are scheduled beginning early in 1979 and ending in 1990 as shown in Figure II-5. The reusable flight hardware is planned to be refurbished on a ten-week turnaround period with refurbishment operations performed at the PIC-MSFC.

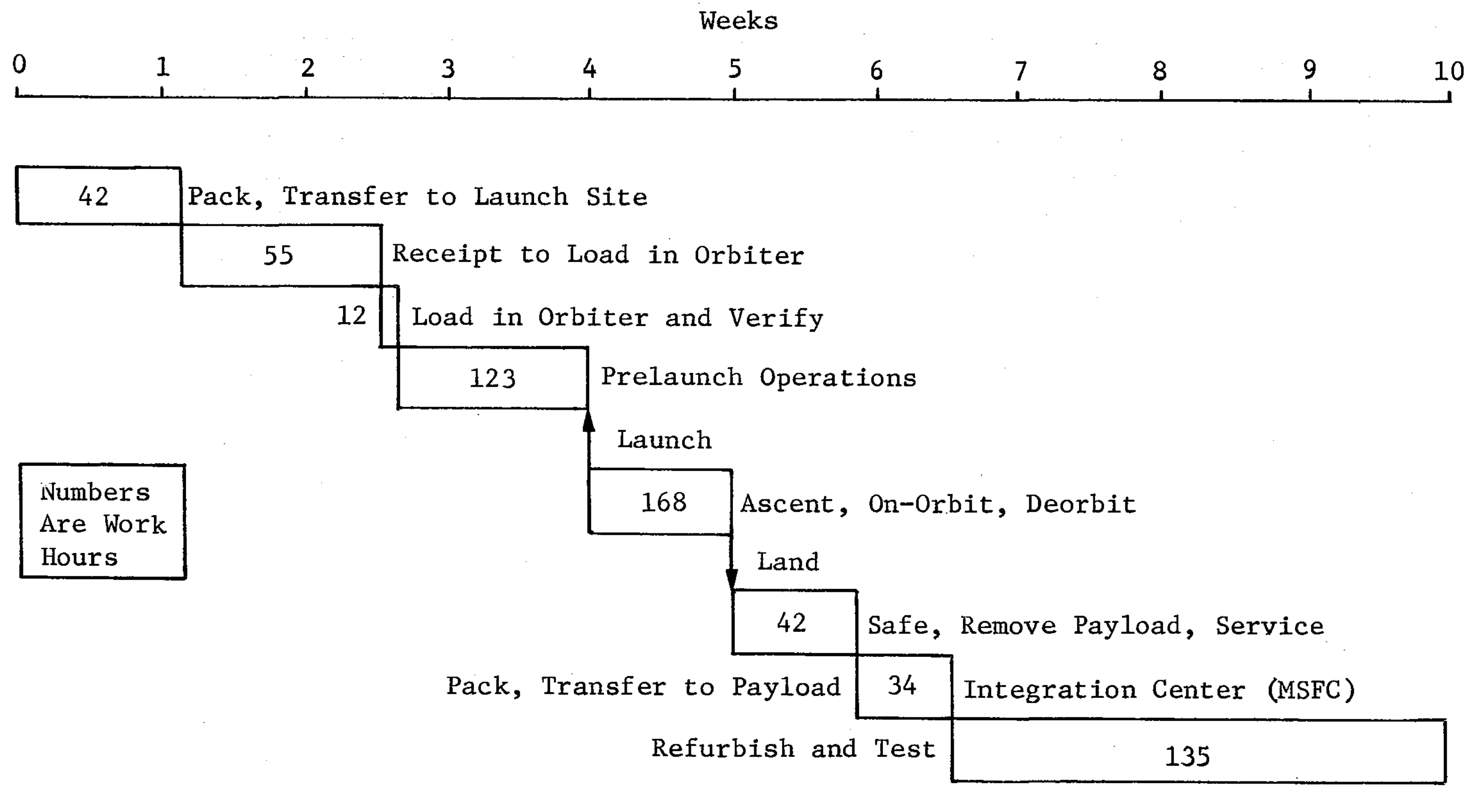


*Fig. II-3 Turnaround Schedule*

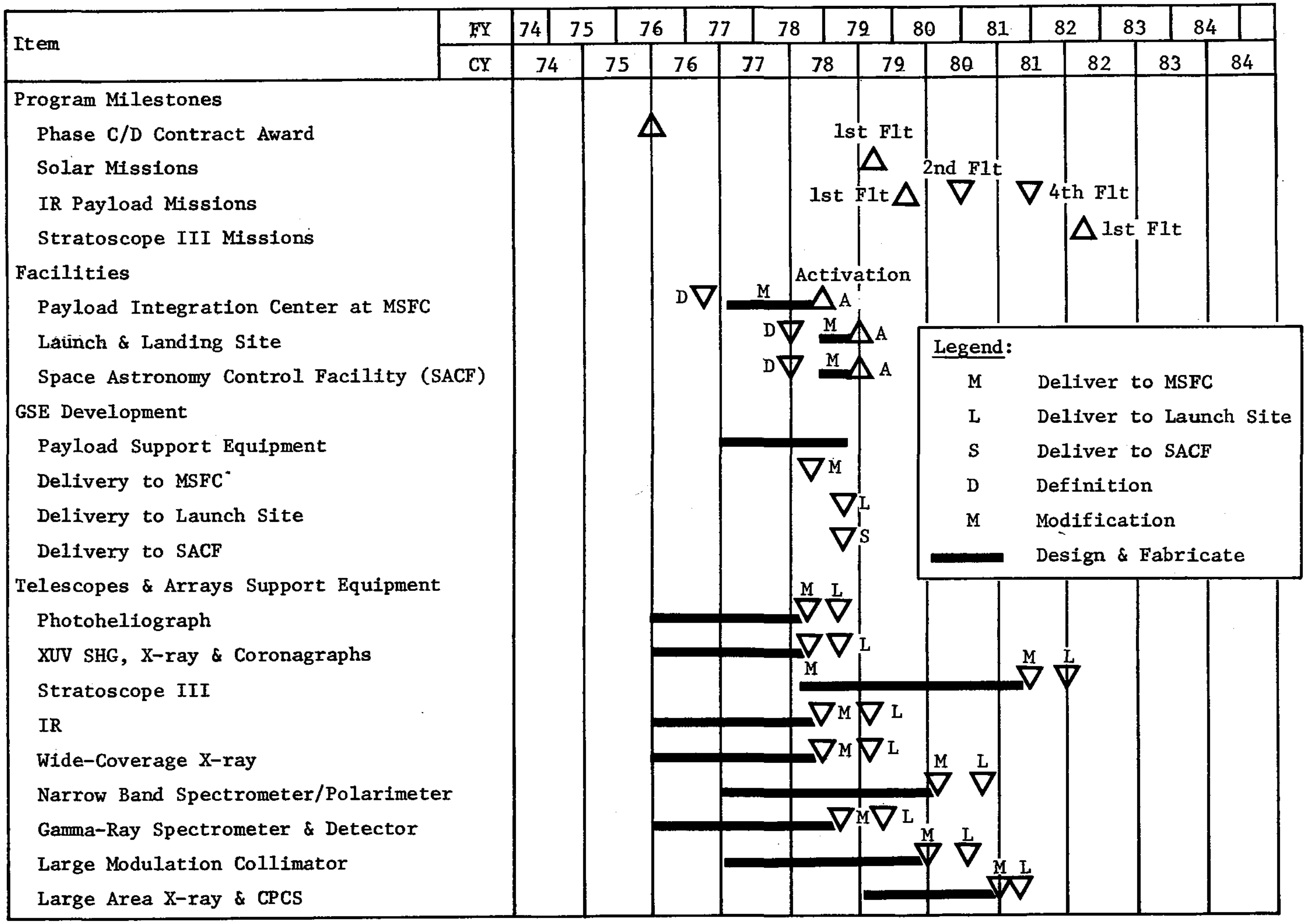


*Fig. II-4 Facilities and GSE Schedule*

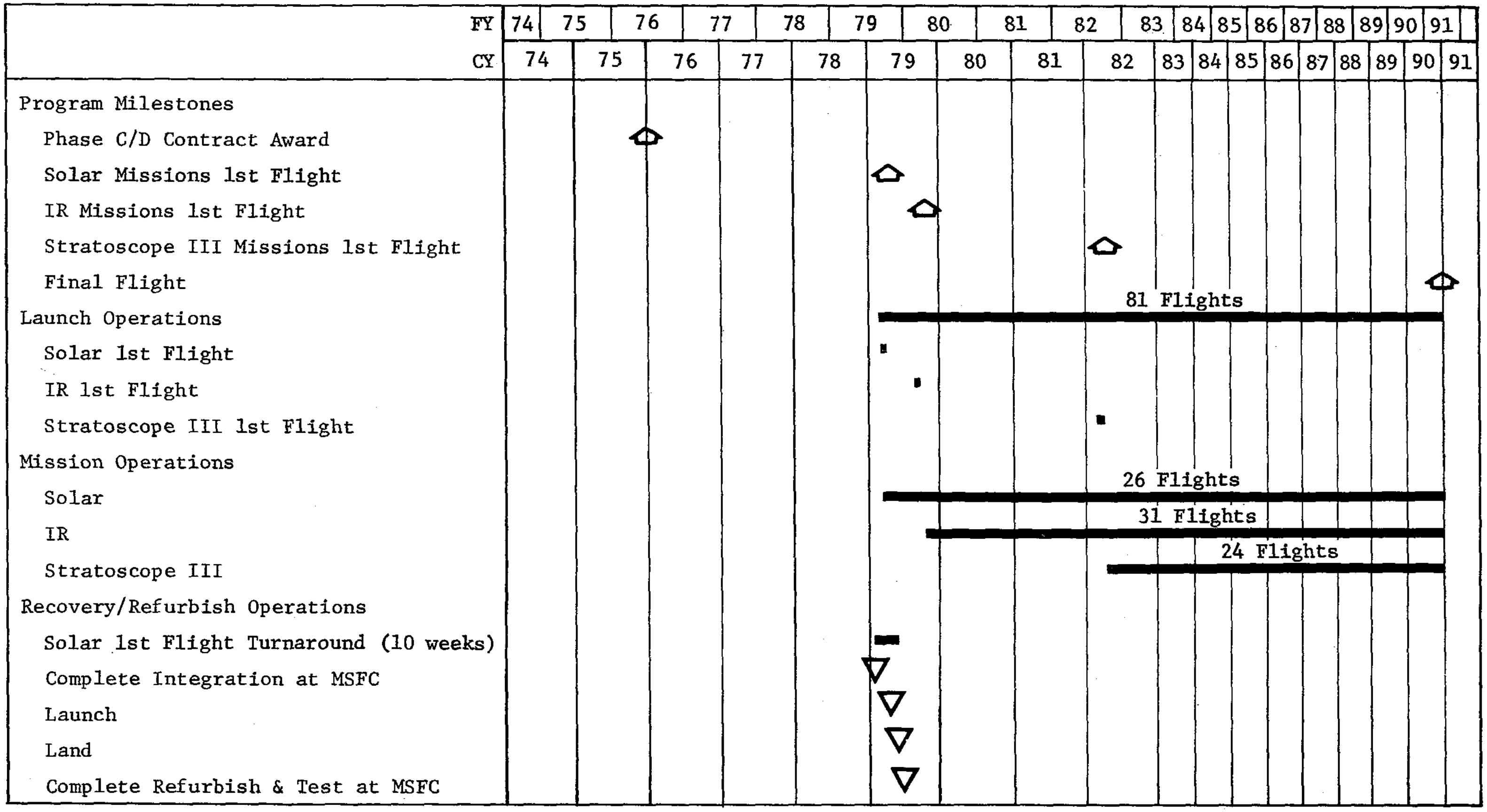


*Fig. II-5 Launch, Mission, and Recovery/Refurbishment Operations Schedule*

## E. TELESCOPES AND ARRAYS

These experiments will be built using a single article approach in which the flight unit will be subjected to any development tests after which it will be modified and serviced for flight acceptance. It is expected that each telescope and arry will be contracted for individually by NASA and provided to this project. In some cases schedule dates shown in Fig. II-6 and II-7 require ATP before Phase C/D contract award to meet integration, checkout, and the first Astronomy Sortie flight.

## F. POINTING AND CONTROL, STRUCTURES, ELECTRONICS, AND THERMAL SUBSYSTEMS

Test and flight articles are required for these subsystems (see Fig. II-8). The test article will be used by the project contractor in conducting systems tests (structural loading, dynamic, natural environments, and limited function) at the contractor's plant. The flight unit will undergo pre-integration acceptance tests before shipment to the PIC-MSFC where integration with the Sortie Lab and pallet is performed. The pointing and control system is the long-lead time development item and will require authorization to proceed concurrently with the Phase C/D program contractor award.

## G. MILESTONE LOGIC NETWORK

Using the schedules as a guide, the logic network shown in Fig. II-9 was developed. No prerequisite event problem areas appear in either project development or operations. However, SRT tasks need to be started in early calendar year 1973 to support the subsystems DDT&E.

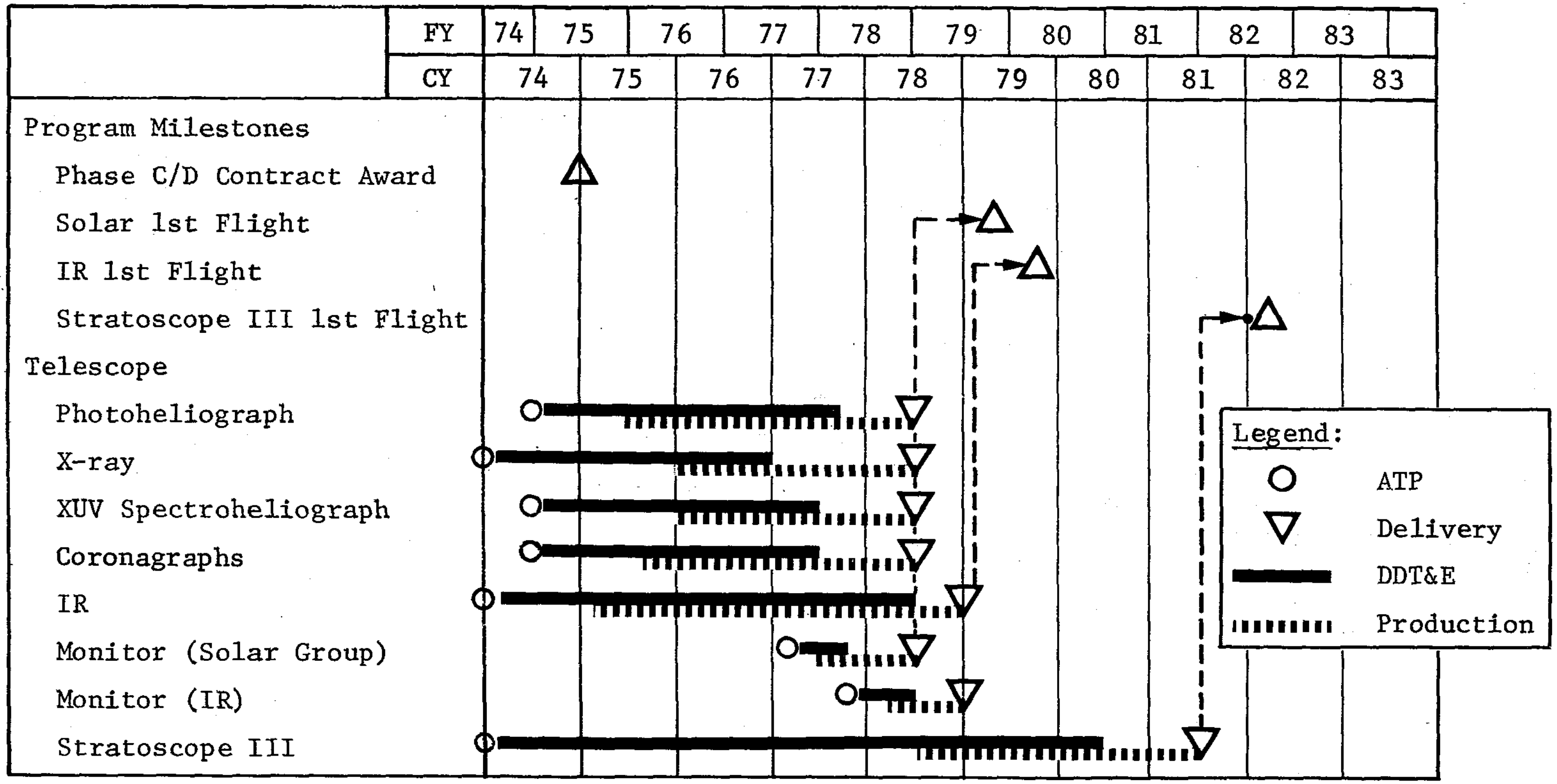


*Fig. II-6 Telescopes Schedule*

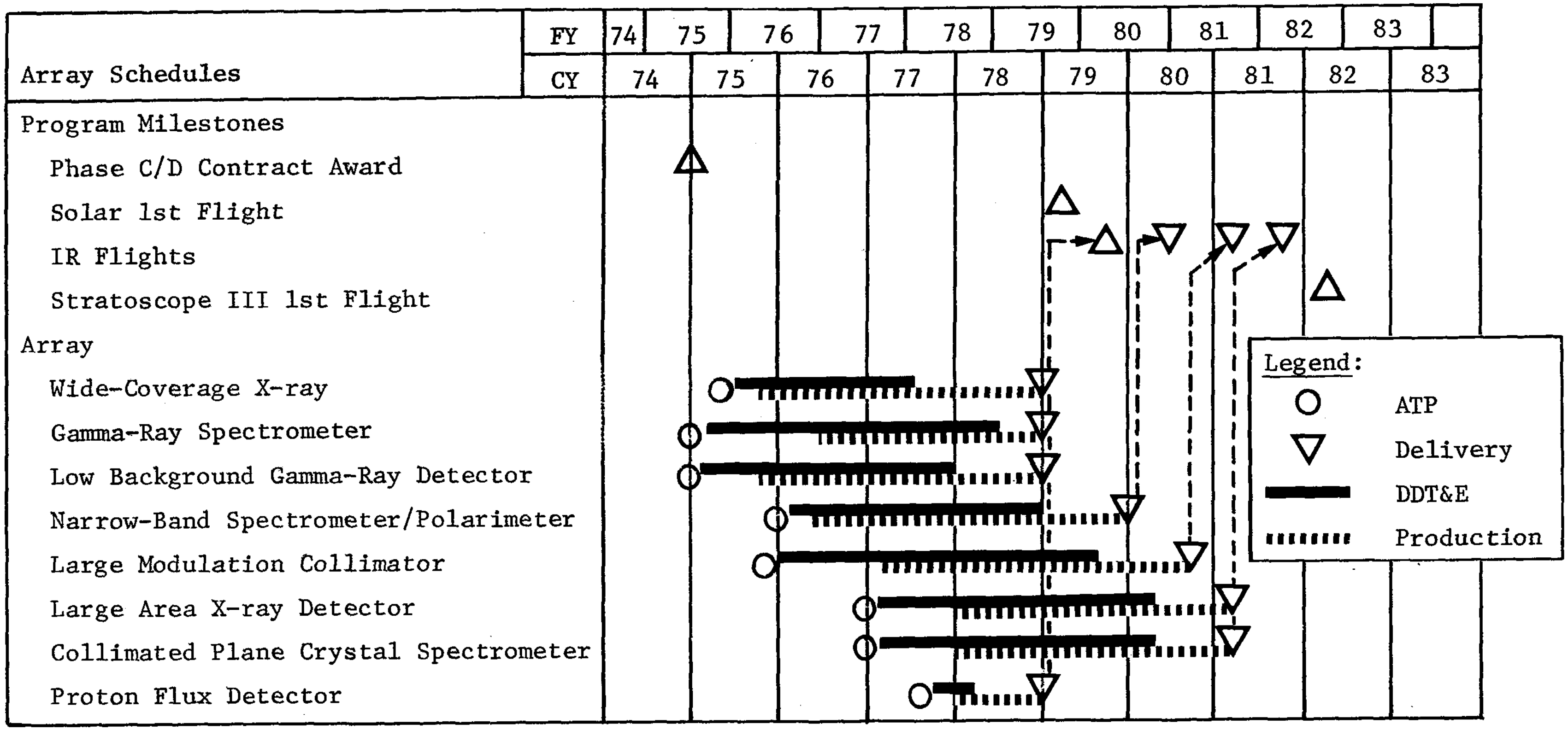


*Fig. II-7 Arrays Schedule*

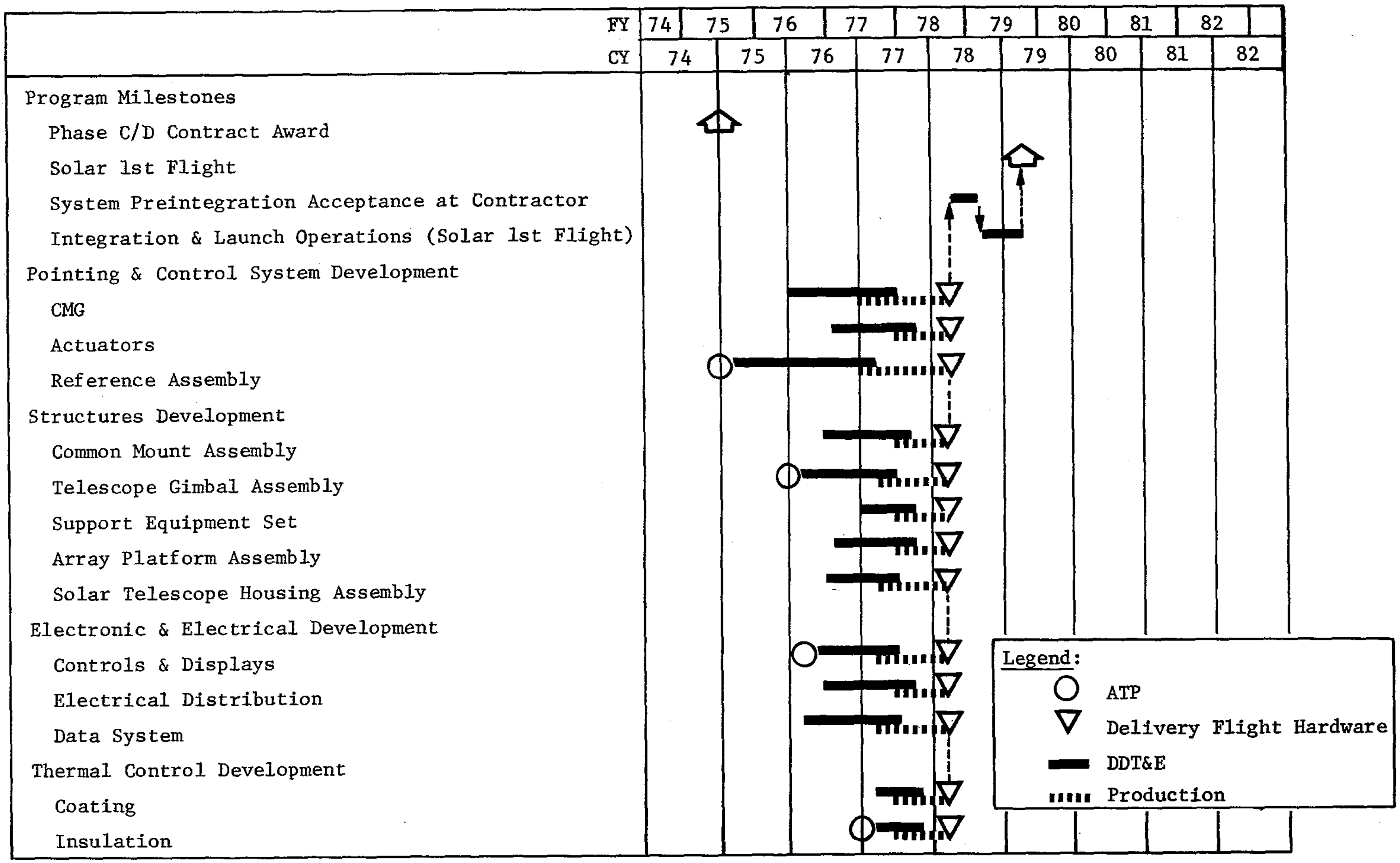


*Fig. II-8 Pointing and Control, Structures, Electronics, and Thermal Subsystems Schedule*

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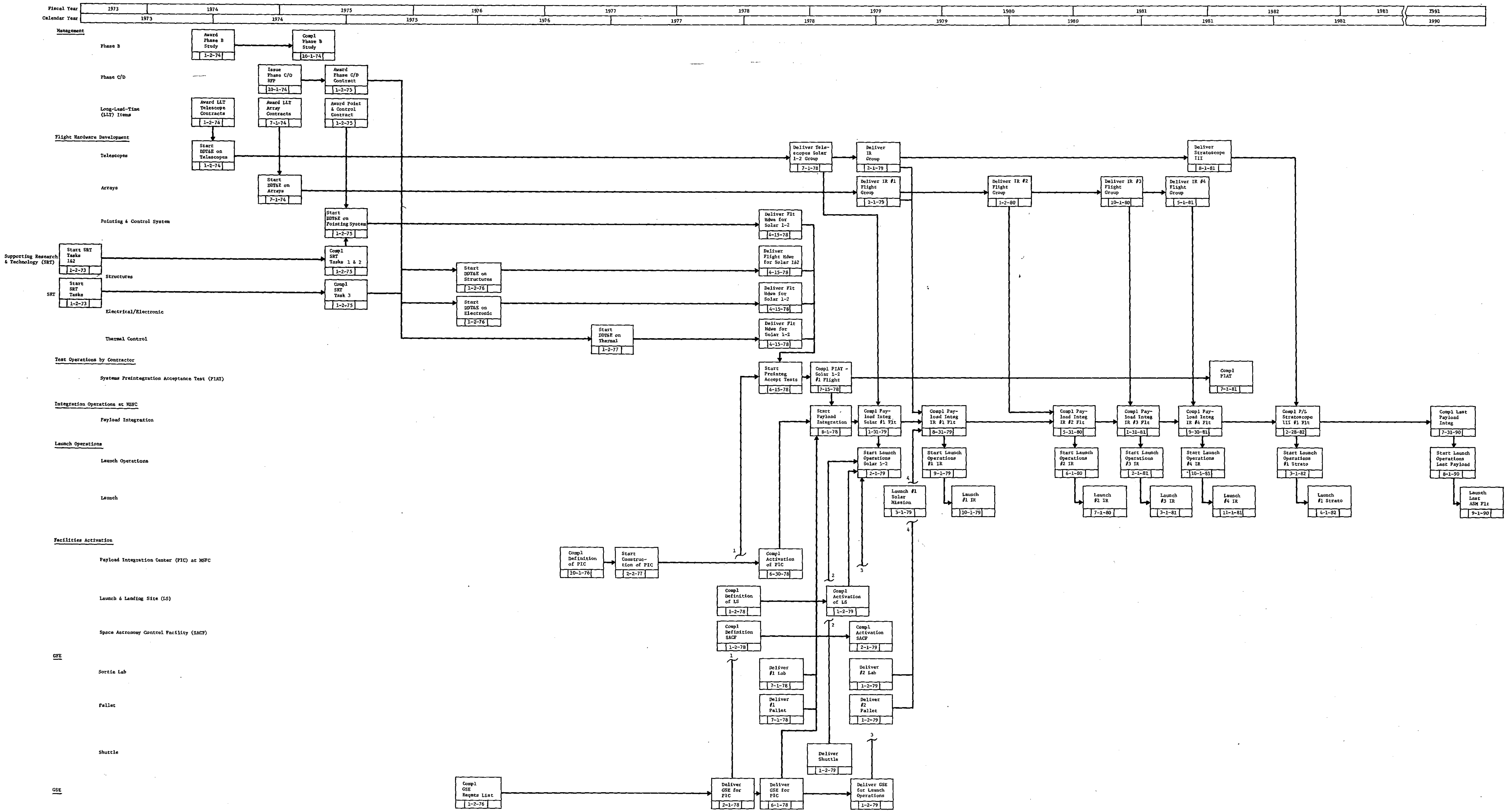



Fig. 11-9 Milestone Logic Network

# III. SUPPORTING RESEARCH AND TECHNOLOGY

## A. INTRODUCTION

Supporting research and technology has been defined for the subsystems, assemblies, and components. Detailed requirements are presented in Section B of this part.

In the telescopes and arrays, some technology requirements have been identified by title, but detailed definitions have not been made. The following items are examples of these requirements:

1) Aspheric grating for the XUV spectroheliograph;

2) IR detector compatible with the 2°K operating temperature;

3) Cooling equipment systems for the IR telescope, requiring 30°K, and for the IR detector, which should be cooled to 2°K;

4) Equipment systems for controlling contamination of critical surfaces of telescopes.

## B. SUPPORTING RESEARCH AND TECHNOLOGY (SRT) REQUIREMENTS

Three SRT tasks for the subsystems have been identified. They are: (1) telescope fine stabilization actuators; (2) precision star trackers; and (3) contamination control and countermeasures.

### 1. SRT Requirement No. 1

a. *Title* - Telescope Fine Stabilization Actuators

b. *Status* - The external stability design goals for the ASM telescopes are 0.5 μrad (0.1 $\widehat{sec}$) in azimuth and elevation and 25 μrad (5 $\widehat{sec}$) in roll. The selected concept for the pointing and control system includes two separate subsystems to provide the external stabilization for the telescopes: (1) a double gimbal CMG subsystem to stabilize the Shuttle Orbiter in an X-POP attitude; and (2) a fine external telescope stabilization subsystem using flex-pivots to stabilize the telescopes in azimuth and elevation and a servoed roll ring to stabilize them in roll.

The flex-pivot actuators capable of providing these stability requirements have not been developed.

c. *Justification* - The state of the art for stabilizing telescopes attached to manned spacecraft is Skylab. The projected stabilization capability of this Skylab system as determined by computer simulation is 10 μrad (2 $\widehat{sec}$) in azimuth and elevation.

The ASM external telescope stabilization goal of 0.5 μrad (0.1 $\widehat{sec}$) is 20 times better than that of Skylab. Even this stringent ASM stability goal is not sufficient for the photoheliograph and Stratoscope III, however, and these two telescopes will augment the external stabilization systems using internal image motion compensation to meet their final required stability. Considering these requirements, and to account for stabilization errors due to thermal flexing of the telescopes, an improvement factor over Skylab of approximately 50, or a stability of 0.2 μrad (0.04 $\widehat{sec}$), may be a justifiable goal. The baseline stability goal of 0.5 μrad (0.1 $\widehat{sec}$) is beyond that of the present verified state of the art; however, and does meet ASM scientific requirements. Systems to provide this capability should be developed.

d. *Technical Plan*

*Objectives* - The objective of this task is to develop fine stabilization actuators, which, when integrated with reference assembly optics and electronics, will provide a stability of 0.5 μrad (0.1 $\widehat{sec}$) in elevation and azimuth and 25 μrad (5 $\widehat{sec}$) in roll.

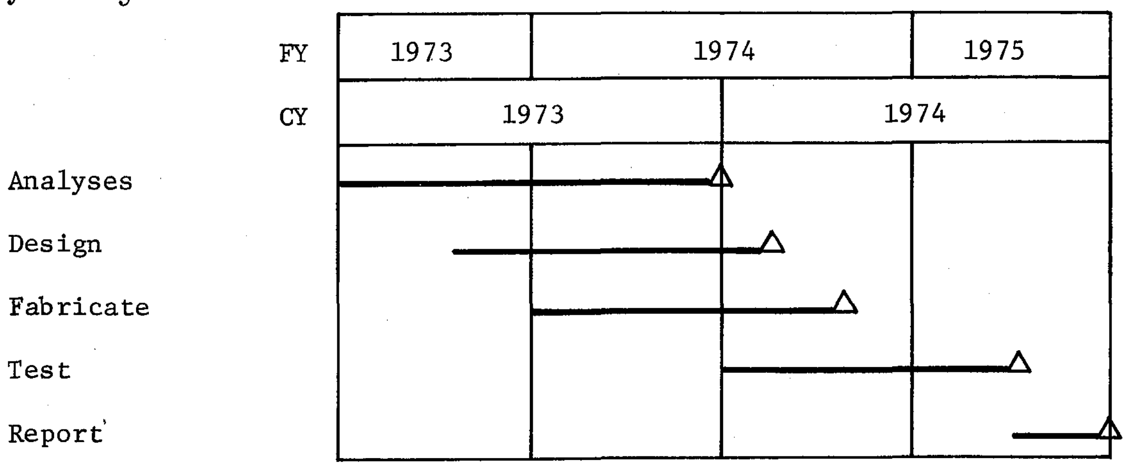
*Technical Approach* - Feasibility analyses are required to determine systems interfaces and establish specific performance requirements. These analyses should produce preliminary design requirements from which shop drawings suitable for fabrication of initial engineering test units may be prepared. Engineering test units will be fabricated and operated under suitable environmental conditions and appropriate loads to evalute the designs.

The results of these development tasks will be reported to the ASM project as requirements and preliminary specifications for use in design, development, test, and evaluation (DDT&E) of azimuth and elevation actuators for fine stabilization of the telescopes.

*e. Resource Requirements*

| | FY 1973 | FY 1974 | | FY 1975 |
|---|---|---|---|---|
| CY | 1973 | | 1974 | |
| Manpower | 2.5 | 5.0 | 6.0 | 4.0 |
| Computer Hours | 200 | 215 | | |
| Fab Shop | | | | |
| Test Lab | | | | |
| Funding | $211,000 | $518,000 | | $97,000 |

*f. Target Schedule*




2. <u>SRT Requirement NO. 2</u>

*a. Title - Precision Star Tracker*

*b. Status* - To properly guide the high-resolution ASM telescopes, an absolute angular measurement (pointing) accuracy of ±5 μrad (±1 sec) is required. An angle resolution (stability) of 0.5 μrad (0.1 sec) is required. These are considered design goals for the pointing and control system.

Precision star trackers capable of providing these requirements (when operated with appropriate actuators) have not been developed. Current state-of-the-art equipment achieves about ±25 μrad (±5 $\widehat{\text{sec}}$) absolute angle measurement accuracy with resolution of 10 μrad (2 $\widehat{\text{sec}}$) according to developer's claims.

*c. Justification* - Several of the ASM telescopes require orienting of their optical axes to specific astronomical sources of interest to within ±10 μrad (±2 $\widehat{\text{sec}}$). This uncertainty is total system error and includes reference measurement errors and instrument-to-reference alignment errors.

Those ASM telescopes with resolution capability of 0.5 μrad (0.1 $\widehat{\text{sec}}$) will additionally require further control of the image within the instruments.

The required accuracy and resolution are not available from any form of "strapdown" (nongimbaled) tracker system of reasonable size. The sensor field of view required for high probability of encountering stars of adequate brightness is far too large. Even for a gimbaled star tracker, with wide range of freedom for selecting reference stars, and limited instantaneous field of view, comparatively large (>20 cm diameter) primary objective apertures will be required to gather enough light energy from the brighter stars $(m_v < +4.5)$ to provide star tracker system bandwidths higher than 10 Hz together with resolution of 0.5 μrad (0.1 $\widehat{\text{sec}}$).

*d. Technical Plan*

*Objective* - Development of a star tracker system capable of defining the orientation of the instrument platform with an absolute accuracy of ±5 μrad (±1 $\widehat{\text{sec}}$) relative to specified stars. The tracker bandwidth must be at least 10 Hz; the angular resolution performance must be 0.5 μrad (0.1 $\widehat{\text{sec}}$) or better.

*Technical Approach* - The development of telescope fine stabilization actuators (SRT Requirement No. 1) is a related requirement that must be accomplished concurrently with this star tracker task. In addition to these actuators, three specific items may be identified that require fundamental development effort:

Angular measuring devices (e.g., autosyns, optical encoders, optosyns, etc) with absolute accuracy of ±2.5 μrad (±0.5 $\widehat{\text{sec}}$) over the full angular range of more than 0.52 radians (> 30 deg) and resolution of 0.5 μrad (0.1 $\widehat{\text{sec}}$) or better;

Compact optical systems with high transmission efficiency and diffraction-limited performance to minimize the weight and size of the sensor unit;

Adaptation of electro-optical sensing or detection devices for star tracker use, to achieve maximum sensitivity (quantum efficiency) and low inherent noise.

Each of these component development areas requires engineering analysis and study to establish preliminary design requirements from which shop drawings suitable for fabrication of test units may be prepared.

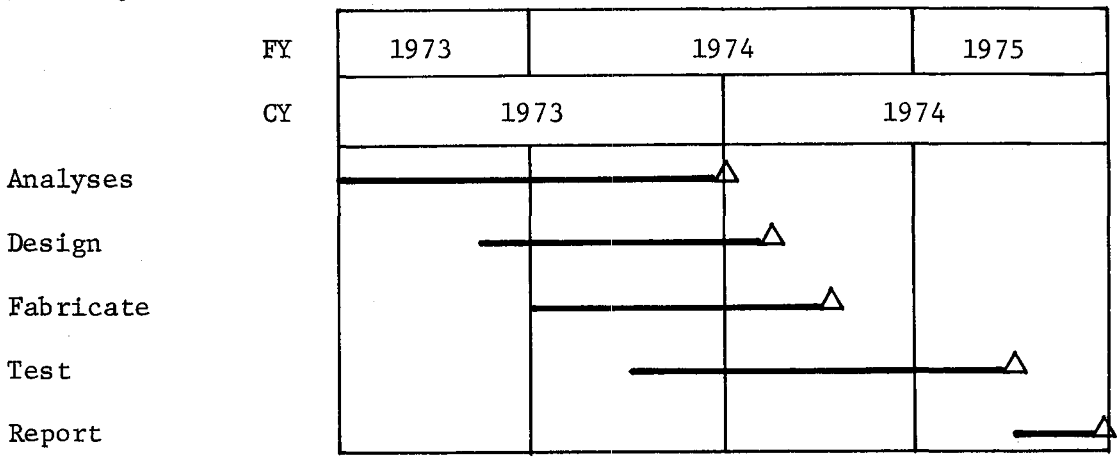
Engineering test units will be fabricated and operated under suitable environmental conditions and appropriate loads to evaluate the designs. Engineering tests will be conducted as much as possible at the adapted star tracker level at which the optical and angular measuring devices are integrated.

The results of these development tasks will be reported to the ASM project as requirements and preliminary specifications for use in design, development, test, and evaluation (DDT&E) of the precision star trackers.

*e. Resource Requirements*

| | | | | | |
|---|---|---|---|---|---|
| | FY | 1973 | 1974 | | 1975 |
| | CY | 1973 | | 1974 | |
| Manpower | | 3.0 | 6.0 | 8.0 | 6.0 |
| Fab Shop | | | ├──── | ────┤ | |
| Test Lab | | | ├── | ──── | ──┤ |
| Funding | | $89,000 | $441,000 | | $194,000 |

*f. Target Schedule*




3. SRT Requirement No. 3

*a. Title* - Contamination Control and Countermeasures

*b. Status* - Known cleanliness requirements such as Class 100,000 clean assembly and servicing areas for ASM payloads/telescopes, and arrays have been identified. Class 10,000 clean tents have been specified for control of certain critical components when unprotected or unpackaged. Environmental cover and control units that provide inert gas blankets have been identified to protect the payloads during transport between facilities. During pre-launch, provision has been made for maintaining the inert gas blankets after installation of payloads in the Orbiter. Ground operating techniques have been specified to prevent condensation on cooled surfaces.

During the missions, the Orbiter and Sortie Lab are expected to be significant sources of contaminants. The nature and rates of deposit of detrimental contamination from these sources have not been defined. Equipment to reduce or eliminate "harmful" contaminants or countermeasures to disperse or prevent their deposition may be necessary.

*c. Justification* - The scientific fields that are involved in contamination phenomena are essentially:

1) Theory of adhesion;

2) Theory of valences, molecular structure, and H-bonds;

3) Surface catalysis;

4) Surface mobility and diffusion of absorbed molecules;

5) Theory of nucleation.

Ground work has been laid in these scientific fields to explain observed phenomena, and no new concepts (or theories) have to be developed. It is necessary, however, to perform experiments to predict the extent of the threat of detrimental contamination. The results of these tests will be used to develop equipment to control the emission of contaminants or to disperse emissions without harmful deposition.

The required experiments can be carried out in a laboratory, because a zero-gravity environment is not important for the deposition of matter from the vapor phase. Depending on test results, control equipment to limit emissions or dispersal equipment (or both) must be developed to achieve maximum scientific objectives.

*d. Technical Plan*

*Objectives* - To determine the temperatures and contaminant concentration ranges at which detrimental deposition on a given surface can be expected; and to develop equipment concepts for controlling emissions or dispersing those that are detrimental.

*Technical Approach* - A study of the total problem and an appropriate experimental procedure has been developed and can be applied to provide the test data. The experiments consist of the determintion of a dividing line temperature $T_c$ (P) in a (P,T) diagram that divides the area with a deposition rate $r = \frac{dm}{dt} 0$ from the area where $r \leq 0$. $T_c$ (P) is to be determined in the dark and under the UV-light level as experienced in space. P in this context is related to the particle stream of the contaminant under investigation while T is the absolute temperature.

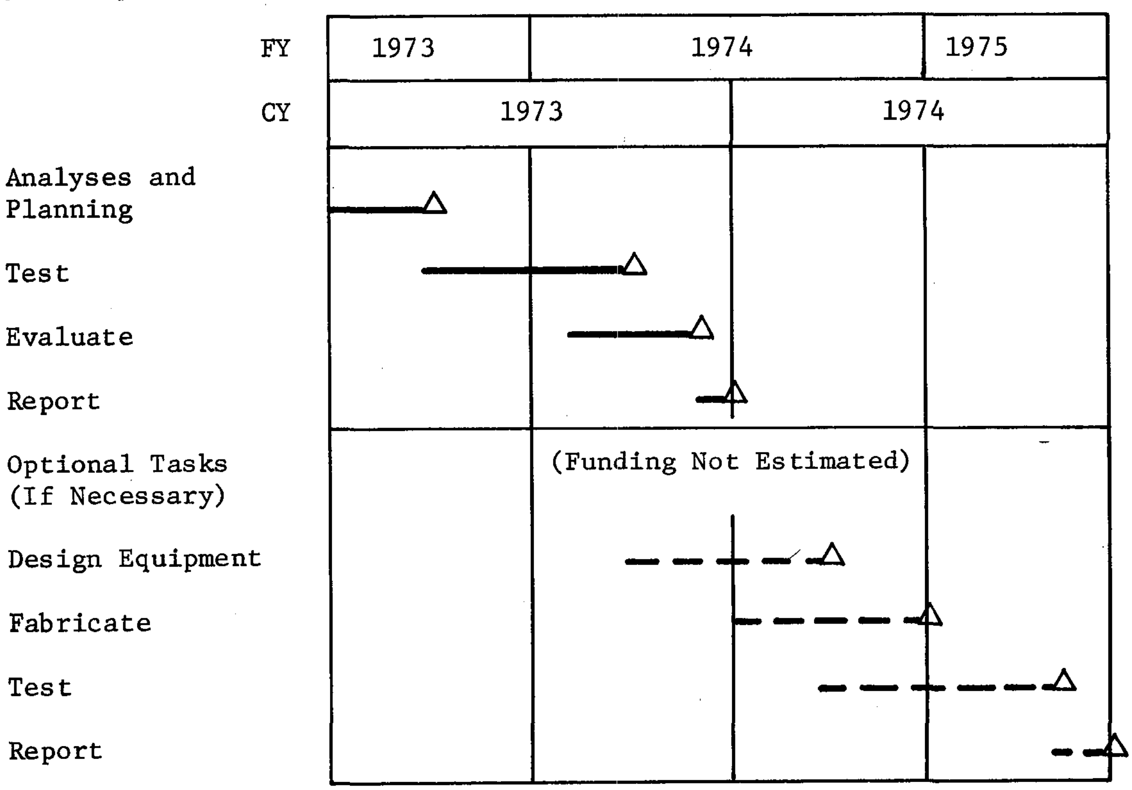
The approach is based on the fact that a surface contamination is "detrimental" only if it is at least a sufficient number of atom layers thick. In this case the influence of the substrate is no longer felt and the contaminant deposits on itself. In the presence of other contaminants and UV light, however, the creation of nucleation centers and the observation of incubation time effects can be expected.

The experiments will give insight into how the deposition of harmful contamination may be avoided. Equipment concepts, procedures, and materials (agents) will be identified and recommended for development as ASM systems if they are required.

*e. Resource Requirements*

| FY | 1973 | 1974 | | 1975 |
|---|---|---|---|---|
| CY | 1973 | | 1974 | |
| Manpower | $49,600 | $49,600 | (Funding Not Estimated) | |
| Test Equipment and Facilities | 8,900 | 8,900 | | |
| Materials | 2,700 | | | |
| Funding | $61,200 | $58,500 | | |

*f. Target Schedule*



# IV. COST ESTIMATES

## A. COSTING APPROACH, METHODOLOGY, AND RATIONALE

Parametric costing using cost estimating relationships (CERs), cost ratios, and factors in conjunction with detailed estimates was used to price the baseline configuration. Generally, subsystem hardware was priced using CERs, software elements such as project management using cost ratios/factors, and operations elements using detail estimates. Estimates were derived for design, development, test and evaluation (DDT&E), production, and operations. The CERs, cost ratios, and factors used here were developed from Martin Marietta experience on programs such as Skylab and Viking, and from data bank information of other industry programs.

A work breakdown structure (WBS) containing the necessary cost elements as defined by the data requirements (DR) is presented in Fig. IV-2 (in Section F of this part). The cost elements of this WBS will be used in Section B to present nonrecurring (DDR&E) and recurring (production and operations) costs. A definition of the effort encompassed by each WBS cost element is provided by the WBS Dictionary, Table IV-2 (in Section F).

The general ground rules and assumptions used in this pricing are:

1) Fiscal 1973 costant dollars;

2) Sortie Lab and Pallet are GFE;

3) NASA center cost excluded;

4) Experiment and subsystem configurations remain fixed;

5) No contingencies or discounts;

6) Shuttle operations cost excluded;

7) Costs include 10% profit.

The Astronomy Sortie DDT&E cost assumes that the telescopes and arrays are developed by various industry/university sources with the cost of instrument definition and contractor selection a NASA Center responsibility. The remaining cost elements are carried out by a single industry contractor.

DDT&E cost for each subsystem was estimated by the application of the following logic:

BASIC DEVELOPMENT + TEST ARTICLES + TESTING = DDT&E

Cost estimating relationships (CERs) are used at the component level (WBS Level 6 and 7) to build up the basic development cost. Basic development encompasses basic engineering analysis, design, specification preparation, tooling design and fabrication, test criteria, etc.

Development of each telescope and array requires producing one unit, using the unit for tests and checkouts, and updating the same unit for flight. The subsystems are composed of assemblies and components that, in some cases, are qualified and are available off-the-shelf, and in other cases, require extensive development including recommended supporting research and technology (SRT). The inherent project advantages of returning each payload from orbit and the relatively short on-orbit stay times for each flight were considered in recommending limited development tests requiring only one test article in most cases. Conformance with Orbiter certification level requirements for qualification is planned for all "critical" components.

Test article cost is the first unit cost obtained from CERs times the number of test articles computed on a 90% improvement curve. In most instances, the number of test articles is one.

Component and subsystem development testing is estimated at a fixed percentage (22%) of the test article cost.

No spares were specifically allocated to the DDT&E cost category. Spares quantities for the operational phase are scheduled to be built to enable their use during the DDT&E phase, and therefore provide a program cost savings.

Development of GSE, production GSE, and GSE spares is included in the DDT&E phase. GSE development is estimated as a percentage (29%) of the total subsystem development cost, and an operational production set of 116% of the subsystems first unit cost. Two sets of operational GSE were included. GSE spares for the operational phase are priced at 25% of the operational hardware.

The facility cost estimate assumes no new facilities (contractor or government) and the maximum use of existing facilities. Contractor facility cost will be primarily for minor modifications to existing facilities to be used for manufacturing, test, and integration. The estimate is derived from historical experience on programs of a similar nature.

System support and project management costs are estimated as fixed percentages (11% and 7.6%, respectively) of program DDT&E cost. These relationships have been developed from previous contract history.

Production costs for the flight hardware were estimated by using cost estimating relationships. Costs were estimated at the component or subassembly level. This was required to enable a consistent application of a 90% improvement curve due to the variable quantity of each item required for DDT&E, production, and operations (spares). This estimating process for a typical component is as follows: determine the first unit cost using applicable CER; compute DDT&E cost on a 90% curve for units 1 and 2; compute production cost for six units (on a 90% cureve - units 3-8); and compute operations cost (spares) for six units (on a 90% curve - units 9-14).

System support and project management costs are estimated at 11% and 7.6 respectively, of the production cost.

The 12-year project duration requires the operation and coordination of activities between three active centers of responsibility: PIC-MSFC; the launch and landing site; and the Space Astronomy Control Facility (SACF).

Each telescope and array will be accepted for integration at the developer's facility and will then be transferred to the Payload Integration Center at MSFC (PIC-MSFC) for integration into the Sortie Lab and pallet, which has been outfitted with the appropriate subsystems. The integrated payloads are tested and checked out to establish flight acceptance at the PIC-MSFC. Support equipment and ground operations are provided to maintain flight readiness with minimum checkout at the launch site.

In addition to initial payload integration, the PIC-MSFC is responsible for refurbishment of the telescopes, arrays, Sortie Labs, and pallets. The refurbished items are subsequently integrated again for a later flight.

The Shuttle launch and landing site is responsible for payload installation into the Orbiter and for prelaunch and postlanding servicing. The PIC-MSFC transient crew provides support for these operations.

The SACF is the scientific center for Astronomy Sortie missions, including principal investigator support of ground and on-orbit operations and problem resolution. The payloads themselves are not handled, serviced, or operated at SACF, but scientific data are processed, stored, analyzed, and disseminated from this center.

Cost estimates for the launch, mission, support, and recovery/refurbishment functions just described were based on the engineering, technical, and administrative manpower level required to sustain the baseline flight schedule. These cost estimates assume the functions are accomplished by the contractor at three separate locations. They further assume that government facilities such as buildings, utilities, office equipment, transportation, gases, and fluids are available at each location at no cost to the contractor.

## B. SUMMARY COST PRESENTATIONS

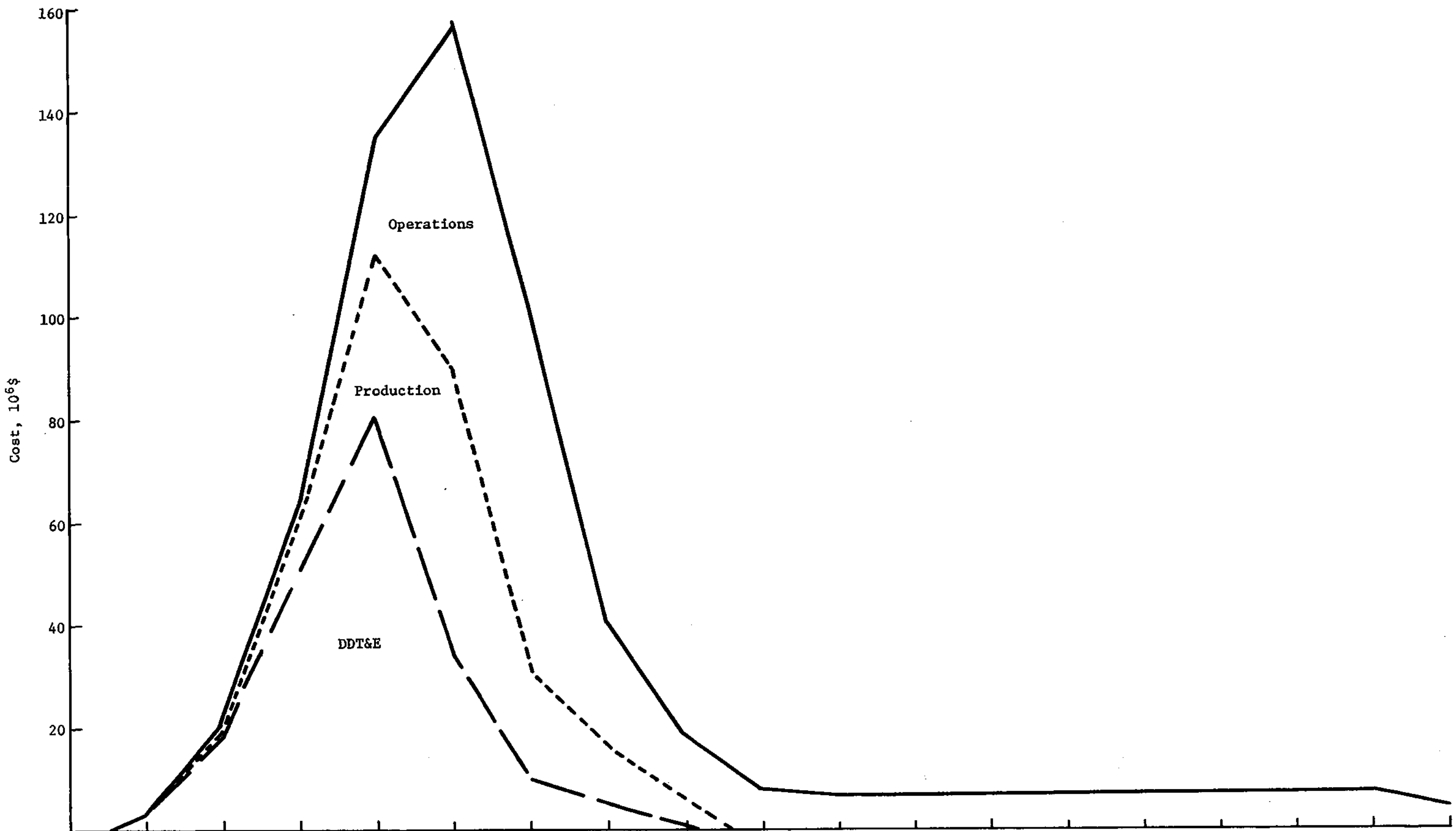
The detailed costs of the Astronomy Sortie missions are summarized in Table IV-1. The table shows total project costs by major hardware item and operations functions in the categories of nonrecurring DDT&E, recurring production, and recurring operations, as well as the total costs. Notice that in developing the GSE (DDT&E), units were fabricated that will satisfy the operations requirements. Therefore, production costs are avoided.

The facilities cost shown in Table IV-1 is for modification of existing facilities to manufacture the subsystems. The costs of facilities for developing the telescopes and arrays, and for operations were not estimated in this study.

*Table IV-1 Astronomy Sortie Mission Costs ($10^6$ $)*

| | DDT&E | Production | Operations | Total |
|---|---|---|---|---|
| Telescopes | $ 47.04 | $ 36.98 | $ 37.17 | $121.19 |
| Arrays | 39.40 | 47.32 | 72.11 | 158.83 |
| Pointing and Control | 18.16 | 10.53 | 20.10 | 48.79 |
| Structures | 29.78 | 12.52 | 12.14 | 54.44 |
| Electronics | 11.32 | 4.09 | 12.91 | 28.32 |
| Thermal Control | 2.32 | 0.43 | 0.27 | 3.02 |
| Ground Support Equipment | 21.37 | -- | 3.73 | 25.10 |
| Facilities | 0.25 | -- | -- | 0.25 |
| System Support and Integration | 18.66 | 12.31 | 23.77 | 54.74 |
| Project Management | 14.31 | 9.44 | 18.22 | 41.97 |
| Launch Operations | -- | -- | 14.79 | 14.79 |
| Mission Operations | -- | -- | 7.95 | 7.95 |
| Support Operations | -- | -- | 16.06 | 16.06 |
| Recovery & Refurbishment | -- | -- | 18.84 | 18.84 |
| Total | $202.61 | $133.62 | $258.06 | $594.29 |

Figure IV-1 shows the total funding requirements in each fiscal year of the ASM project by nonrecurring DDT&E, recurring production, and recurring operations categories. The total cost of $594.3 million for the project requires a peak expenditure of $156.1 million in fiscal year 1978.




| Fiscal Year | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DDT&E | 3.6 | 18.5 | 51.5 | 80.1 | 33.8 | 9.7 | 4.8 | 0.6 | | | | | | | | | | | 202.6 |
| Production | | 0.7 | 10.1 | 31.8 | 54.9 | 20.4 | 10.9 | 4.8 | | | | | | | | | | | 133.6 |
| Operations | | | 2.3 | 22.6 | 67.4 | 71.8 | 23.7 | 13.6 | 7.0 | 5.8 | 5.8 | 5.8 | 5.8 | 5.9 | 5.9 | 5.9 | 5.9 | 2.9 | 258.1 |
| Total | 3.6 | 19.2 | 63.9 | 134.5 | 156.1 | 101.9 | 39.4 | 19.0 | 7.0 | 5.8 | 5.8 | 5.8 | 5.8 | 5.9 | 5.9 | 5.9 | 5.9 | 2.9 | 594.3 |

*Fig. IV-1 Astronomy Sortie Mission Funding Summary*

## C. COST ESTIMATES BY WBS ELEMENT

Estimates were prepared for nonrecurring (DDT&E) on Cost Data Form - A(1), for recurring (production) on Cost Data Form - A(2), and for recurring (operations) on Cost Data Form - A(3). These data are presented here at WBS level 4, 5, 6 or 7.

A description of the contents of each column of the form follows:

1) Identification Number - The 13-digit WBS number of the item of cost.

2) WBS Identification - The alphanumeric nomenclature of the item from the WBS (not limited in length).

3) WBS Level - The level at which the element is carried.

4) Expected Cost - The cost estimate for the WBS item. For production and operations items, the WBS item cost will be the total cumulative cost for the number of units quantified in the "Number of Units" column.

5) Number of Units - The quantity of units for each WBS item used in the production and operations phases of the program.

6) Reference Unit - The production sequence number of the first unit that is used in the recurring phase of the program.

7) Reference Unit Cost - The cost of the reference unit.

8) Learning Index - A numerical index of a learning rate related to the recurring cost.

9) $T_d$ - The time (months) to design and develop or produce a WBS item. For nonrecurring category, $T_d$ is the cost duration of the DDT&E activity. For the production and operations activities, $T_d$ is the cost duration of only the reference unit.

10) $T_s$ - The lead time (months) measured from the start of cost accrual for the item to the launch milestone. For the production and operations activities $T_s$ will be given for the reference unit.

11) Spread Function - An index number representing a cost distribution curve that the estimator recommends for the time phasing of costs over $T_d$. Standard distributions from Figure 8 of the *Phase A and Phase B Studies Cost Estimates Document* No. MF-030A, were used in some cases. Other distributions were used where applicable.

12) Launch Milestone Date - The date used in conjunction with $T_s$.

13) Confidence Rating - A value of 1 through 4 representing the estimator's confidence in the estimate shown in WBS item cost column. The values were obtained by reviewing the criteria presented in the *Phase A and Phase B Studies Cost Estimates Document*, DRD No. MF-030A, Table 1, "Confidence Level Groups for Cost Estimates," and selecting the value most applicable.

14) First Unit Cost - The cost to produce theoretical first item. This is the intercept of the learning cure on a log-log plot.

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
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## COST DATA FORM – A(1)
## NON-RECURRING (DDT&E)

DATE SEPT 1972
PAGE 1 OF 8

| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | EXPECT. COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT. |
|---|---|---|---|---|---|---|---|
| 01-001-00-00-00-00 | ASTRONOMY SORTIE | 3 | 202.61 | | | | |
| | MISSION PROJECT | | | | | | |
| 01-001-01-00-00-00 | PROJECT MANAGEMENT | 4 | 14.31 | 4 | 81 | 96 | 50/60 |
| 01-001-02-00-00-00 | SYSTEM SUPPORT & | 4 | 18.66 | 4 | 81 | 96 | 50/60 |
| | INTEGRATION | | | | | | |
| 01-001-03-00-00-00 | FACILITIES | 4 | .25 | 3 | 12 | 51 | – |
| 01-001-04-00-00-00 | GROUND SUPPORT | 4 | 21.37 | 3 | 21 | 27 | 50/80 |
| | EQUIPMENT | | | | | | |
| 01-001-05-00-00-00 | PAYLOADS | 4 | 148.02 | | | | |
| 01-001-05-01-00-00 | TELESCOPES | 5 | 47.04 | | | | |
| 01-001-05-01-01-00 | IR TELESCOPE | 6 | 10.50 | 2 | 54 | 69 | – |
| 01-001-05-01-02-00 | STRATOSCOPE III | 6 | 8.40 | 2 | 48 | 63 | – |
| 01-001-05-01-03-00 | PHOTOHELIOGRAPH | 6 | 5.16 | 2 | 39 | 57 | – |
| 01-001-05-01-04-00 | X-RAY TELESCOPE | 6 | 17.65 | 2 | 54 | 66 | – |
| 01-001-05-01-05-00 | XUV SPECTRO- | 6 | 2.15 | 2 | 39 | 57 | – |
| | HELIOGRAPH | | | | | | |
| 01-001-05-01-06-00 | CORONAGRAPHS | 6 | 2.98 | 2 | 39 | 57 | – |

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## COST DATA FORM – A(1)
## NON-RECURRING (DDT&E)

DATE SEPT 1972


| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | EXPECT. COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT. |
|---|---|---|---|---|---|---|---|
| 01-001-05-01-07-00 | MONITORS | 6 | .20 | 3 | 15 | 30 | – |
| 01-001-05-02-00-00 | ARRAYS | 5 | 39.40 | | | | |
| 01-001-05-02-01-00 | LARGE AREA X-RAY | 6 | 4.95 | 2 | 39 | 57 | – |
| | DETECTOR | | | | | | |
| 01-001-05-02-02-00 | WIDE COVERAGE | 6 | 2.25 | 2 | 27 | 54 | – |
| | X-RAY DETECTOR | | | | | | |
| 01-001-05-02-03-00 | LARGE MODULATION | 6 | 6.95 | 2 | 48 | 66 | – |
| | COLLIMATOR | | | | | | |
| 01-001-05-02-04-00 | NARROW BAND | 6 | 6.30 | 2 | 36 | 54 | – |
| | SPECTRO/POLARIM | | | | | | |
| 01-001-05-02-05-00 | COLLIMATED PC | 6 | 5.10 | 2 | 42 | 57 | – |
| | SPECTROMETER | | | | | | |
| 01-001-05-02-06-00 | GAMMA RAY | 6 | 7.30 | 2 | 42 | 57 | – |
| | SPECTROMETER | | | | | | |
| 01-001-05-02-07-00 | LOW BACKGROUND | 6 | 6.50 | 2 | 36 | 57 | – |
| | X-RAY DETECTOR | | | | | | |
| 01-001-05-02-08-00 | PROTON FLUX | 6 | .05 | 3 | 6 | 18 | – |
| | DETECTOR | | | | | | |
| | | | | | | | |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
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## COST DATA FORM – A(1)
## NON-RECURRING (DDT&E)

DATE SEPT 1972
PAGE 3 OF 8

| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | EXPECT. COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT. |
|---|---|---|---|---|---|---|---|
| 01-001-05-03-00-00 | POINTING & CONTROL | 5 | 18.16 | | 33 | 51 | 50/60 |
| | SYSTEM | | | | | | |
| 01-001-05-03-01-00 | CMG ASSEMBLY | 6 | .91 | | | | |
| 01-001-05-03-01-01 | DOUBLE GIMBAL | 7 | .77 | 4 | | | |
| | CMGs | | | | | | |
| 01-001-05-03-01-02 | INVERTERS | 7 | .14 | 4 | | | |
| 01-001-05-03-01-03 | IMU | 7 | | | | | |
| 01-001-05-03-02-00 | COMMON MOUNT | 6 | 1.32 | | | | |
| | ACTUATORS | | | | | | |
| 01-001-05-03-02-01 | AZIMUTH | 7 | .65 | 3 | | | |
| | POINTING | | | | | | |
| 01-001-05-03-02-02 | DEPLOYMENT | 7 | .67 | 3 | | | |
| 01-001-05-03-03-00 | TELESCOPE | 6 | 2.16 | | | | |
| | GIMBAL ACTUATORS | | | | | | |
| 01-001-05-03-03-01 | ELEVATION | 7 | .89 | 1 | | | |
| | POINTING & | | | | | | |
| | STABILITY | | | | | | |
| 01-001-05-03-03-02 | AZIMUTH | 7 | .51 | 1 | | | |
| | STABILITY | | | | | | |

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## COST DATA FORM – A(1)
## NON-RECURRING (DDT&E)

DATE SEPT 1972


| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | EXPECT. COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT. |
|---|---|---|---|---|---|---|---|
| 01-001-05-03-03-03 | ROLL | 7 | .37 | 3 | | | |
| 01-001-05-03-03-04 | PITCH & YAW | 7 | .39 | 3 | | | |
| | (CORONAGRAPHS) | | | | | | |
| 01-001-05-03-04-00 | ARRAY PLATFORM | 6 | .57 | | | | |
| | ACTUATOR | | | | | | |
| 01-001-05-03-04-01 | ELEVATION | 7 | .57 | 3 | | | |
| | POINTING | | | | | | |
| 01-001-05-03-05-00 | REFERENCE ASSEMBLY | 6 | 13.20 | | | | |
| 01-001-05-03-05-01 | STRAPDOWN | 7 | 1.96 | 1 | | | |
| | STAR TRACKERS | | | | | | |
| 01-001-05-03-05-02 | TELESCOPE IMU | 7 | 2.72 | 3 | | | |
| 01-001-05-03-05-03 | FINE SUN SENSOR | 7 | .90 | 4 | | | |
| 01-001-05-03-05-04 | BORESIGHTED | 7 | 2.13 | 3 | | | |
| | STAR TRACKER | | | | | | |
| | PRECISION | | | | | | |
| 01-001-05-03-05-05 | CORRELATION | 7 | 5.49 | 3 | | | |
| | TRACKER | | | | | | |
| 01-001-05-04-00-00 | STRUCTURES | 5 | 29.78 | | 21 | 39 | 50/60 |
| | | | | | | | |

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## COST DATA FORM – A(1)
## NON-RECURRING (DDT&E)

DATE SEPT 1972
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| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | EXPECT. COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT. |
|---|---|---|---|---|---|---|---|
| 01-001-05-04-01-00 | COMMON MOUNT | 6 | 7.05 | | | | |
| | ASSEMBLY | | | | | | |
| 01-001-05-04-01-01 | AZIMUTH TABLE | 7 | 1.73 | 3 | | | |
| 01-001-05-04-01-02 | AZIMUTH YOKE | 7 | 2.71 | 3 | | | |
| 01-001-05-04-01-03 | DEPLOYMENT | 7 | 1.20 | 3 | | | |
| | YOKE | | | | | | |
| 01-001-05-04-01-04 | DEPLOYMENT | 7 | 1.06 | 3 | | | |
| | GEARMOTORS | | | | | | |
| | & LAUNCH LOCKS | | | | | | |
| 01-001-05-04-01-05 | JETTISON | 7 | .35 | 3 | | | |
| | EQUIPMENT | | | | | | |
| 01-001-05-04-02-00 | TELESCOPE GIMBAL | 6 | 6.84 | | | | |
| | ASSEMBLY | | | | | | |
| 01-001-05-04-02-01 | OUTER GIMBAL | 7 | 1.62 | 3 | | | |
| | RING | | | | | | |
| 01-001-05-04-02-02 | OUTER ROLL | 7 | 2.16 | 3 | | | |
| | RING | | | | | | |
| 01-001-05-04-02-03 | INNER ROLL | 7 | 1.37 | 3 | | | |
| | RING | | | | | | |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
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## COST DATA FORM – A(1)
## NON-RECURRING (DDT&E)

DATE SEPT 1972


| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | EXPECT. COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT. |
|---|---|---|---|---|---|---|---|
| 01-001-05-04-02-04 | ROLL GEAR | 7 | .10 | 3 | | | |
| 01-001-05-04-02-05 | TELESCOPE P&C | 7 | .48 | 3 | | | |
| | PLATFORM | | | | | | |
| 01-001-05-04-02-06 | GIMBAL GEAR- | 7 | 1.11 | 3 | | | |
| | MOTORS & LAUNCH | | | | | | |
| | LOCKS | | | | | | |
| 01-001-05-04-03-00 | ARRAY PLATFORM | 6 | 4.77 | | | | |
| | ASSEMBLY | | | | | | |
| 01-001-05-04-03-01 | ARRAY MOUNT | 7 | 3.89 | 3 | | | |
| 01-001-05-04-03-02 | PLATFORM GEAR- | 7 | .88 | 3 | | | |
| | MOTORS & | | | | | | |
| | LAUNCH LOCKS | | | | | | |
| 01-001-05-04-04-00 | SUPPORT EQUIPMENT | 6 | 4.15 | | | | |
| | SET | | | | | | |
| 01-001-05-04-04-01 | CMG SUPPORT | 7 | .39 | 3 | | | |
| | STRUCTURES | | | | | | |
| 01-001-05-04-04-02 | WC X-RAY | 7 | 1.47 | 3 | | | |
| | DETECTOR | | | | | | |
| | SUPPORTS | | | | | | |

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## COST DATA FORM – A(1)
## NON-RECURRING (DDT&E)

DATE SEPT 1972


| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | EXPECT. COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT. |
|---|---|---|---|---|---|---|---|
| 01-001-05-04-04-03 | γ-RAY SPECT | 7 | 2.29 | 3 | | | |
| | HOUSING & EXT | | | | | | |
| | MECH. | | | | | | |
| 01-001-05-04-05-00 | SOLAR TELESCOPE | 6 | 6.97 | | | | |
| | HOUSING ASSY | | | | | | |
| 01-001-05-04-05-01 | TUBULAR | 7 | 4.47 | 3 | | | |
| | STRUCTURE | | | | | | |
| 01-001-05-04-05-02 | BULKHEADS | 7 | 1.96 | 3 | | | |
| 01-001-05-04-05-03 | SUNSHIELD – | 7 | .45 | 3 | | | |
| | FIBERGLASS | | | | | | |
| 01-001-05-04-05-04 | APERTURE DOORS | 7 | .06 | 3 | | | |
| 01-001-05-04-05-05 | DOOR ACTUATORS | 7 | .03 | 3 | | | |
| 01-001-05-05-00-00 | ELECTRONICS | 5 | 11.32 | | 18 | 36 | 50/60 |
| 01-001-05-05-01-00 | CONTROL & DISPLAY | 6 | 7.71 | 3 | | | |
| 01-001-05-05-02-00 | ELECTRICAL | 6 | 2.29 | | | | |
| 01-001-05-05-02-01 | LOAD CENTER | 7 | .10 | 3 | | | |
| | SWITCH | | | | | | |
| 01-001-05-05-02-02 | FEEDER CABLES | 7 | 2.00 | 3 | | | |
| 01-001-05-05-02-03 | JUNCTION BOX | 7 | .19 | 3 | | | |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## COST DATA FORM – A(1)
## NON-RECURRING (DDT&E)

DATE SEPT 1972
PAGE 8 OF 8

| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | EXPECT. COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT. |
|---|---|---|---|---|---|---|---|
| 01-001-05-05-03-00 | DATA | 6 | 1.32 | | | | |
| 01-001-05-05-03-01 | DATA BUS INTER- | 7 | .06 | 3 | | | |
| | FACE UNIT | | | | | | |
| 01-001-05-05-03-02 | COAX DATA BUS | 7 | .16 | 3 | | | |
| 01-001-05-05-03-03 | PALLET | 7 | .55 | 3 | | | |
| | INSTRUMENTATION | | | | | | |
| | BOX | | | | | | |
| 01-001-05-05-03-04 | DATA PROCESSOR | 7 | .55 | 3 | | | |
| 01-001-05-06-00-00 | THERMAL CONTROL | 5 | 2.32 | 3 | 9 | 27 | 50/60 |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## COST DATA FORM - A(2)

## RECURRING (PRODUCTION)

DATE: SEPT 1972


| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | NO. OF UNITS | 1st UNIT COST $T_1$ | EXPECTED COST | REF. UNIT | REF. UNIT COST | CONFID. RATING | $T_d$ | $T_S$ | SPREAD FUNCT | LEARN INDEX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-001-00-00-00-00 | | 3 | | | 133.62 | | | | | | | |
| 01-001-01-00-00-00 | PROJ. MGMT. | 4 | NA | NA | 9.44 | NA | NA | 4 | 72 | 81 | 50/60 | NA |
| 01-001-02-00-00-00 | SYS. SUPT. | 4 | NA | NA | 12.31 | NA | NA | 4 | 72 | 81 | 50/60 | NA |
| 01-001-03-00-00-00 | FACILITIES | 4 | | | | | | | | | | |
| 01-001-04-00-00-00 | GRD. SUPT. EQUIP. | 4 | | | | | | | | | | |
| 01-001-05-00-00-00 | PAYLOADS | 4 | | | 84.30 | | | | | | | |
| 01-001-05-01-00-00 | TELESCOPES | 5 | | | 36.98 | | | | | | | |
| 01-001-05-01-01-00 | IR TELESCOPE | 6 | 1 | 12.00 | 12.00 | 1 | 12.00 | 2 | 45 | 54 | | 90% |
| 01-001-05-01-02-00 | STRAT III | 6 | 1 | 7.20 | 7.20 | 1 | 7.20 | 2 | 36 | 45 | | 90% |
| 01-001-05-01-03-00 | PHOTOHELIOGRAPH | 6 | 1 | 4.61 | 4.61 | 1 | 4.61 | 2 | 36 | 45 | | 90% |
| 01-001-05-01-04-00 | X-RAY TELE | 6 | 1 | 8.20 | 8.20 | 1 | 8.20 | 2 | 30 | 39 | | 90% |
| 01-001-05-01-05-00 | XUV SPECT | 6 | 1 | 1.00 | 1.00 | 1 | 1.00 | 2 | 30 | 39 | | 90% |
| 01-001-05-01-06-00 | CORONO | 6 | 1 | 1.95 | 1.95 | 1 | 1.95 | 2 | 33 | 42 | | 90% |
| 01-001-05-01-07-00 | MONITORS | 6 | 1 | 2.02 | 2.02 | 1 | 2.02 | 3 | 15 | 30 | | 90% |
| 01-001-05-02-00-00 | ARRAYS | 5 | | | 47.32 | | | | | | | |
| 01-001-05-02-01-00 | LG. AREA X-RAY | 6 | 1 | 4.58 | 4.58 | 1 | 4.58 | 2 | 33 | 45 | | 90% |
| 01-001-05-02-02-00 | WC X-RAY | 6 | 1 | 7.80 | 7.80 | 1 | 7.80 | 2 | 39 | 48 | | 90% |
| 01-001-05-02-03-00 | LG. MOD. COLL | 6 | 1 | 5.18 | 5.18 | 1 | 5.18 | 2 | 36 | 48 | | 90% |
| 01-001-05-02-04-00 | NAR. BD SPECT | 6 | 1 | 10.20 | 10.20 | 1 | 10.20 | 2 | 36 | 48 | | 90% |
| | | | | | | | | | | | | |

STUDY TITLE ASTRONOMY SO... E MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## COST DATA FORM - A(2)

## RECURRING (PRODUCTION)

DATE: SEPT 1972


| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | NO. OF UNITS | 1st UNIT COST $T_1$ | EXPECTED COST | REF. UNIT | REF. UNIT COST | CONFID. RATING | $T_d$ | $T_S$ | SPREAD FUNCT | LEARN INDEX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-001-05-02-05-00 | COLL P.C. SPECT | 6 | 1 | 7.30 | 7.30 | 1 | 7.30 | 2 | 36 | 45 | | 90% |
| 01-001-05-02-06-00 | $\gamma$-RAY SPECT | 6 | 1 | 4.50 | 4.50 | 1 | 4.50 | 2 | 30 | 39 | | 90% |
| 01-001-05-02-07-00 | LOW BACK X-RAY | 6 | 1 | 7.30 | 7.30 | 1 | 7.30 | 2 | 36 | 48 | | 90% |
| 01-001-05-02-08-00 | PROTON FLUX | 6 | 1 | .46 | .46 | 1 | .46 | 3 | 6 | 24 | | 90% |
| 01-001-05-03-00-00 | POINT & CONT. | 5 | | | 10.53 | | | | 15 | 27 | 50/60 | |
| 01-001-05-03-01-00 | CMG ASSY | 6 | | | 3.25 | | | | | | | |
| 01-001-05-03-01-01 | DB. GIMB. CMG | 7 | 6 | .63 | 2.65 | 2 | .50 | 4 | | | | 90% |
| 01-001-05-03-01-02 | INVERTER | 7 | 6 | .06 | .25 | 2 | .05 | 4 | | | | 90% |
| 01-001-05-03-01-03 | IMU | 7 | 2 | .26 | .35 | 5 | .18 | 3 | | | | 90% |
| 01-001-05-03-02-00 | COMMON MT. | 6 | | | .85 | | | | | | | |
| 01-001-05-03-02-01 | AZ POINT | 7 | 4 | .16 | .47 | 2 | .13 | 3 | | | | 90% |
| 01-001-05-03-02-02 | DEPLOY | 7 | 4 | .13 | .38 | 2 | .10 | 3 | | | | 90% |
| 01-001-05-03-03-00 | TELE. GIMB. ACT | 6 | | | 1.37 | | | | | | | |
| 01-001-05-03-03-01 | ELE POINT. | 7 | 4 | .22 | .64 | 2 | .64 | 1 | | | | 90% |
| 01-001-05-03-03-02 | AZ STAB | 7 | 4 | .13 | .38 | 2 | .10 | 1 | | | | 90% |
| 01-001-05-03-03-03 | ROLL | 7 | 4 | .08 | .23 | 2 | .06 | 3 | | | | 90% |
| 01-001-05-03-03-04 | PITCH & YAW | 7 | 2 | .08 | .12 | 2 | .06 | 3 | | | | 90% |
| 01-001-05-03-04-00 | ARRAY PLAT. | 6 | 4 | .14 | .41 | 2 | .11 | 3 | | | | 90% |
| 01-001-05-03-05-00 | REF. ASSY. | 6 | | | 4.98 | | | | | | | |
| 01-001-05-03-05-01 | STAR TRACK | 7 | 12 | .34 | 2.65 | 2 | .27 | 1 | | | | 90% |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## COST DATA FORM - A(2)

## RECURRING (PRODUCTION)

DATE: SEPT 1972


| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | NO. OF UNITS | 1st UNIT COST $T_1$ | EXPECTED COST | REF. UNIT | REF. UNIT COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT | LEARN INDEX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-001-05-03-05-02 | TELE. IMU | 7 | 3 | .26 | .58 | 2 | .58 | 3 | | | | 90% |
| 01-001-05-03-05-03 | SUN SENS. | 7 | 1 | .74 | .59 | 2 | .59 | 4 | | | | 90% |
| 01-001-05-03-05-04 | STAR TRACK | 7 | 1 | .28 | .22 | 2 | .22 | 3 | | | | 90% |
| 01-001-05-03-05-05 | CORR TRACK | 7 | 1 | .76 | .61 | 2 | .61 | 3 | | | | 90% |
| 01-001-05-04-00-00 | STRUCTURES | 5 | | | 12.52 | | | | 12 | 24 | 50/60 | |
| 01-001-05-04-01-00 | COMM. MOUNT | 6 | | | 4.83 | | | | | | | |
| 01-001-05-04-01-01 | AZ. TABLE | 7 | 4 | .37 | 1.08 | 2 | .30 | 3 | | | | 90% |
| 01-001-05-04-01-02 | AZ. YOKE | 7 | 4 | .58 | 1.69 | 2 | .46 | 3 | | | | 90% |
| 01-001-05-04-01-03 | DEPLOY. YOKE | 7 | 4 | .26 | .76 | 2 | .21 | 3 | | | | 90% |
| 01-001-05-04-01-04 | GEAR & LOCK | 7 | 8 | .21 | 1.10 | 3 | .16 | 3 | | | | 90% |
| 01-001-05-04-01-05 | JETT EQUIP | 7 | 4 | .07 | .20 | 2 | .06 | 3 | | | | 90% |
| 01-001-05-04-02-00 | TELE GIMB. ASSY | 6 | | | 3.65 | | | | | | | |
| 01-001-05-04-02-01 | OUT. GIMB. | 7 | 3 | .35 | .78 | 2 | .28 | 3 | | | | 90% |
| 01-001-05-04-02-02 | OUT. ROLL | 7 | 3 | .47 | 1.05 | 2 | .38 | 3 | | | | 90% |
| 01-001-05-04-02-03 | INNER ROLL | 7 | 3 | .30 | .67 | 2 | .24 | 3 | | | | 90% |
| 01-001-05-04-02-04 | ROLL GEAR | 7 | 3 | .02 | .04 | 2 | .02 | 3 | | | | 90% |
| 01-001-05-04-02-05 | P&C PLAT. | 7 | 3 | .10 | .22 | 2 | .08 | 3 | | | | 90% |
| 01-001-05-04-02-06 | GEAR & LOCK | 7 | 6 | .22 | .89 | 3 | .16 | 3 | | | | 90% |
| 01-001-05-04-03-00 | ARRAY PLAT ASSY | 6 | | | 1.93 | | | | | | | |
| 01-001-05-04-03-01 | ARRAY MT. | 7 | 2 | .84 | 1.29 | 2 | .67 | 3 | | | | 90% |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## COST DATA FORM - A(2)

## RECURRING (PRODUCTION)

DATE: SEPT 1972


| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | NO. OF UNITS | 1st UNIT COST $T_1$ | EXPECTED COST | REF. UNIT | REF. UNIT COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT | LEARN INDEX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-001-05-04-03-02 | GEAR & LOCK | 7 | 4 | .22 | .64 | 2 | .18 | 3 | | | | 90% |
| 01-001-05-04-04-00 | SUPT. EQUIP. | 6 | | | .88 | | | | | | | |
| 01-001-05-04-04-01 | CMG SUPT | 7 | 6 | .06 | .23 | 4 | .04 | 3 | | | | 90% |
| 01-001-05-04-04-02 | W.C. MT. | 7 | 1 | .32 | .26 | 2 | .26 | 3 | | | | 90% |
| 01-001-05-04-04-03 | γ-RAY HOUS. | 7 | 1 | .49 | .39 | 2 | .39 | 3 | | | | 90% |
| 01-001-05-04-05-00 | SOL. TELE. HOUS | 6 | | | 1.23 | | | | | | | |
| 01-001-05-04-05-01 | TUB. STRUCT | 7 | 1 | .97 | .78 | 2 | .78 | 3 | | | | 90% |
| 01-001-05-04-05-02 | BULKHEADS | 7 | 1 | .42 | .34 | 2 | .34 | 3 | | | | 90% |
| 01-001-05-04-05-03 | SUNSHIELD | 7 | 1 | .10 | .08 | 2 | .08 | 3 | | | | 90% |
| 01-001-05-04-05-04 | APER. DOOR | 7 | 6 | .006 | .02 | 2 | .005 | 3 | | | | 90% |
| 01-001-05-04-05-05 | DOOR ACT. | 7 | 6 | .004 | .01 | 2 | .003 | 3 | | | | 90% |
| 01-001-05-05-00-00 | ELECTRONICS | 5 | | | 4.09 | | | | 12 | 24 | 50/60 | |
| 01-001-05-05-01-00 | CONT. & DISP. | 6 | 2 | 1.57 | 2.42 | 2 | 1.26 | 3 | | | | 90% |
| 01-001-05-05-02-00 | ELECTRICAL | 6 | | | .81 | | | | | | | |
| 01-001-05-05-02-01 | LOAD SW. | 7 | 12 | .03 | .22 | 2 | .02 | 3 | | | | 90% |
| 01-001-05-05-02-02 | CABLES | 7 | 1 | .50 | .50 | 1 | .50 | 3 | | | | 90% |
| 01-001-05-05-02-03 | JUNC. BOX | 7 | 2 | .06 | .09 | 2 | .05 | 3 | | | | 90% |
| 01-001-05-05-03-00 | DATA | 6 | | | .86 | | | | | | | |
| 01-001-05-05-03-01 | INTER. UNIT | 7 | 8 | .02 | .10 | 2 | .02 | 3 | | | | 90% |
| 01-001-05-05-03-02 | COAX | 7 | 2 | .04 | .07 | 1 | .04 | 3 | | | | 90% |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## COST DATA FORM - A(2)

## RECURRING (PRODUCTION)

DATE: SEPT 1972


| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | NO. OF UNITS | 1st UNIT COST $T_1$ | EXPECTED COST | REF. UNIT | REF. UNIT COST | CONFID. RATING | $T_d$ | $T_S$ | SPREAD FUNCT | LEARN INDEX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-001-05-05-03-03 | INSTRU. BOX | 7 | 2 | .10 | .15 | 2 | .08 | 3 | | | | 90% |
| 01-001-05-05-03-04 | DATA PROCES. | 7 | 8 | .10 | .54 | 2 | .08 | 3 | | | | 90% |
| 01-001-05-06-00-00 | THERMAL CONT. | 6 | 2 | .38 | .43 | 2 | .30 | 3 | 6 | 18 | 50/60 | 90% |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## COST DATA FORM – A (3)

RECURRING (OPERATIONS)

DATE SEPT 1972
PAGE 1 OF 5

| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | NO. OF UNITS | EXPECT COST | REF. UNIT | REF UNIT COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT | LEARN INDEX |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-001-00-00-00-00 | | 3 | | 258.06 | | | | | | | |
| 01-001-01-00-00-00 | PROJ. MGMT. | 4 | N.A. | 18.22 | N.A. | N.A. | 4 | 168 | 27 | 50/50 | N.A. |
| 01-001-02-00-00-00 | SYS. SUPT & INTEG | 4 | N.A. | 23.77 | N.A. | N.A. | 4 | 168 | 27 | 50/60 | N.A. |
| 01-001-03-00-00-00 | FACILITIES | 4 | | | | | | | | | |
| 01-001-04-00-00-00 | GR. SUPT. EQUIP. | 4 | N.A. | 3.73 | N.A. | N.A. | 3 | 24 | 15 | 50/60 | N.A. |
| 01-001-05-00-00-00 | PAYLOADS | 4 | N.A. | 109.28 | N.A. | N.A. | | | | | N.A. |
| 01-001-05-01-00-00 | TELESCOPES | 5 | N.A. | 37.17 | N.A. | N.A. | | | | | N.A. |
| 01-001-05-01-01-00 | IR TELESCOPE | 6 | .6 | 5.76 | 1.6 | 5.76 | 2 | 57 | 48 | | 90% |
| 01-001-05-01-02-00 | STRAT III | 6 | 1.1 | 6.26 | 1.1 | 5.22 | 2 | 48 | 39 | | 90% |
| 01-001-05-01-03-00 | PHOTOHELIOGRAPH | 6 | 2.6 | 9.04 | 2 | 3.69 | 2 | 48 | 39 | | 90% |
| 01-001-05-01-04-00 | X-RAY TELE | 6 | 2 | 12.62 | 2 | 6.56 | 2 | 42 | 32 | | 90% |
| 01-001-05-01-05-00 | XUV SPECT | 6 | 2 | 1.54 | 2 | .80 | 2 | 42 | 32 | | 90% |
| 01-001-05-01-06-00 | CORONO | 6 | 1.2 | 1.95 | 2 | 1.56 | 2 | 45 | 36 | | 90% |
| 01-001-05-02-00-00 | ARRAYS | 5 | N.A. | 72.11 | N.A. | N.A. | | | | | N.A. |
| 01-001-05-02-01-00 | LG. AREA X-RAY | 6 | 2 | 7.05 | 2 | 3.66 | 2 | 51 | 39 | | 90% |
| 01-001-05-02-02-00 | W.C. X-RAY | 6 | 2 | 12.00 | 2 | 6.24 | 2 | 51 | 42 | | 90% |
| 01-001-05-02-03-00 | LG. MOD. COLL | 6 | 2 | 7.97 | 2 | 4.14 | 2 | 54 | 42 | | 90% |
| 01-001-05-02-04-00 | NAR. BD. SPECT | 6 | 2 | 15.70 | 2 | 8.16 | 2 | 54 | 42 | | 90% |
| 01-001-05-02-05-00 | COLL P.C. SPECT | 6 | 2 | 11.23 | 2 | 5.84 | 2 | 51 | 39 | | 90% |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## COST DATA FORM – A (3)
RECURRING (OPERATIONS)

DATE SEPT 1972
PAGE 2 OF 5

| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | NO. OF UNITS | EXPECT COST | REF. UNIT | REF UNIT COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT | LEARN. INDEX |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-001-05-02-06-00 | γ-RAY SPECT | 6 | 2 | 6.93 | 2 | 3.60 | 2 | 42 | 33 | - | 90% |
| 01-001-05-02-07-00 | LOW BACK γ-RAY | 6 | 2 | 11.23 | 2 | 5.84 | 2 | 51 | 42 | - | 90% |
| 01-001-05-03-00-00 | POINT & CONT | 5 | | 20.10 | | | | 27 | 21 | 50/60 | |
| 01-001-05-03-01-00 | GMG ASSY | 6 | | 3.96 | | | | | | | |
| 01-001-05-03-01-01 | DB GIMB CMG | 7 | 9 | 3.33 | 8 | .39 | 4 | | | | 90% |
| 01-001-05-03-01-02 | INVERTER | 7 | 5 | .18 | 8 | .04 | 4 | | | | 90% |
| 01-001-05-03-01-03 | IMU | 7 | 3 | .45 | 15 | .15 | 3 | | | | 90% |
| 01-001-05-03-02-00 | COMMON MT | 6 | | 2.14 | | | | | | | |
| 01-001-05-03-02-01 | AZ POINT | 7 | 18 | 1.66 | 6 | .10 | 3 | | | | 90% |
| 01-001-05-03-02-02 | DEPLOY. | 7 | 6 | .48 | 6 | .09 | 3 | | | | 90% |
| 01-001-05-03-03-00 | TELE GIMB ACT. | 6 | | 4.77 | | | | | | | |
| 01-001-05-03-03-01 | ELE POINT. | 7 | 18 | 2.28 | 6 | .14 | 1 | | | | 90% |
| 01-001-05-03-03-02 | AZ STAB. | 7 | 18 | 1.35 | 6 | .09 | 1 | | | | 90% |
| 01-001-05-03-03-03 | ROLL | 7 | 18 | .83 | 6 | .05 | 3 | | | | 90% |
| 01-001-05-03-03-04 | PITCH & YAW | 7 | 6 | .31 | 4 | .06 | 3 | | | | 90% |
| 01-001-05-03-04-00 | ARRAY PLAT | 6 | 18 | 1.45 | 6 | .09 | 3 | | | | 90% |
| 01-001-05-03-05-00 | REF ASSY | 6 | | 7.78 | | | | | | | |
| 01-001-05-03-05-01 | STAR TRACK. | 7 | 24 | 4.27 | 14 | .19 | 1 | | | | 90% |
| 01-001-05-03-05-02 | TELE IMU | 7 | 6 | .95 | 7 | .17 | 3 | | | | 90% |
| 01-001-05-03-05-03 | SUN SENS | 7 | 2 | 1.07 | 3 | .55 | 4 | | | | 90% |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## COST DATA FORM – A (3)

RECURRING (OPERATIONS)

DATE SEPT 1972


| INDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | NO. OF UNITS | EXPECT COST | REF. UNIT | REF UNIT COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT | LEARN INDEX |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-001-05-03-05-04 | STAR TRACK | 7 | 2 | .40 | 3 | .21 | 3 | | | | 90% |
| 01-001-05-03-05-05 | CORR TRACK | 7 | 2 | 1.09 | 3 | .56 | 3 | | | | 90% |
| 01-001-05-04-00-00 | STRUCTURES | 5 | | 12.14 | | | | 24 | 18 | | |
| 01-001-05-04-01-00 | COMM MOUNT | 6 | | 2.71 | | | | | | | |
| 01-001-05-04-01-01 | AZ TABLE | 7 | 2 | .48 | 6 | .24 | 3 | | | | 90% |
| 01-001-05-04-01-02 | AZ YOKE | 7 | 2 | .75 | 6 | .38 | 3 | | | | 90% |
| 01-001-05-04-01-03 | DEPLOY. YOKE | 7 | 2 | .34 | 6 | .17 | 3 | | | | 90% |
| 01-001-05-04-01-04 | GEAR & LOCK | 7 | 8 | .96 | 11 | .12 | 3 | | | | 90% |
| 01-001-05-04-01-05 | JETT EQUIP. | 7 | 4 | .18 | 6 | .05 | 3 | | | | 90% |
| 01-001-05-04-02-00 | TELE GIMB ASSY | 6 | | 5.32 | | | | | | | |
| 01-001-05-04-02-01 | OUT. GIMB | 7 | 6 | 1.33 | 5 | .24 | 3 | | | | 90% |
| 01-001-05-04-02-02 | OUT. ROLL | 7 | 6 | 1.79 | 5 | .32 | 3 | | | | 90% |
| 01-001-05-04-02-03 | INNER ROLL | 7 | 6 | 1.14 | 5 | .20 | 3 | | | | 90% |
| 01-001-05-04-02-04 | ROLL GEAR | 7 | 6 | .08 | 5 | .01 | 3 | | | | 90% |
| 01-001-05-04-02-04 | P&C PLAT | 7 | 3 | .20 | 5 | .07 | 3 | | | | 90% |
| 01-001-05-04-02-06 | GEAR & LOCK | 7 | 6 | .78 | 9 | .13 | 3 | | | | 90% |
| 01-001-05-04-03-00 | ARRAY PLAT ASSY | 6 | | 1.72 | | | | | | | |
| 01-001-05-04-03-01 | ARRAY MT | 7 | 2 | 1.16 | 4 | .59 | 3 | | | | 90% |
| 01-001-05-04-03-02 | GEAR & LOCK | 7 | 4 | .56 | 6 | .14 | 3 | | | | 90% |
| | | | | | | | | | | | |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## COST DATA FORM – A (3)
RECURRING (OPERATIONS)



| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | NO. OF UNITS | EXPECT COST | REF. UNIT | REF UNIT COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT | LEARN INDEX |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-001-05-04-04-00 | SUPT EQUIP. | 6 | | 1.24 | | | | | | | |
| 01-001-05-04-04-01 | CMG SUPT | 7 | 2 | .07 | 10 | .04 | 3 | | | | 90% |
| 01-001-05-04-04-02 | WC MOUNT | 7 | 2 | .46 | 3 | .24 | 3 | | | | 90% |
| 01-001-05-04-04-03 | X-RAY HOUSING | 7 | 2 | .71 | 3 | .36 | 3 | | | | 90% |
| 01-001-05-04-05-00 | SOL TELE HOUS | 6 | | 1.15 | | | | | | | |
| 01-001-05-04-05-01 | TUB. STRUCT | 7 | 1 | .72 | 3 | .72 | 3 | | | | 90% |
| 01-001-05-04-05-02 | BULKHEADS | 7 | 1 | .31 | 3 | .31 | 3 | | | | 90% |
| 01-001-05-04-05-03 | SUNSHIELD | 7 | 1 | .07 | 3 | .07 | 3 | | | | 90% |
| 01-001-05-04-05-04 | APER DOOR | 7 | 6 | .02 | 13 | .003 | 3 | | | | 90% |
| 01-001-05-04-05-05 | DOOR ACT. | 7 | 12 | .03 | 13 | .002 | 3 | | | | 90% |
| 01-001-05-05-00-00 | ELECTRONICS | 5 | | 12.91 | | | | 24 | 18 | | |
| 01-001-05-05-01-00 | CONT & DISPLAY | 6 | 12 | 11.62 | 4 | 1.10 | 3 | | | | 90% |
| 01-001-05-05-02-00 | ELECTRICAL | 6 | | .64 | | | | | | | |
| 01-001-05-05-02-01 | LOAD SWITCH | 7 | 12 | .20 | 14 | | 3 | | | | 90% |
| 01-001-05-05-02-02 | CABLES | 7 | 1 | .40 | 2 | .40 | 3 | | | | 90% |
| 01-001-05-05-02-03 | JUNC BOX | 7 | 1 | .04 | 4 | .04 | 3 | | | | 90% |
| 01-001-05-05-03-00 | DATA | 6 | | .65 | | | | | | | |
| 01-001-05-05-03-01 | INTER UNIT | 7 | 8 | .09 | 10 | .01 | 3 | | | | 90% |
| 01-001-05-05-03-02 | COAX | 7 | 1 | .03 | 3 | .03 | 3 | | | | 90% |
| 01-001-05-05-03-03 | INSTRU BOX | 7 | 1 | .07 | 4 | .07 | 3 | | | | 90% |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
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## COST DATA FORM – A (3)

RECURRING (OPERATIONS)

DATE SEPT 1972
PAGE 5 OF 5

| IDENTIFICATION NUMBER | WBS IDENTIFICATION | WBS LEVEL | NO. OF UNITS | EXPECT COST | REF. UNIT | REF UNIT COST | CONFID. RATING | $T_d$ | $T_s$ | SPREAD FUNCT | LEARN INDEX |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 01-001-05-05-03-04 | DATA PROCESS | 7 | 8 | .46 | 10 | .06 | 3 | | | | 90% |
| 01-001-05-06-00-00 | THERMAL CONT | 6 | 1 | .27 | 4 | .27 | 3 | 21 | 12 | | 90% |
| 01-001-06-00-00-00 | LAUNCH OPERATIONS | 4 | NA | 14.79 | NA | NA | 3 | 168 | 27 | | NA |
| 01-001-07-00-00-00 | MISSION OPERATIONS | 4 | NA | 7.95 | NA | NA | 3 | 168 | 27 | | NA |
| 01-001-08-00-00-00 | SUPPORT OPERATIONS | 4 | NA | 16.06 | NA | NA | 3 | 168 | 27 | | NA |
| 01-001-09-00-00-00 | RECOV & REFURB OPS | 4 | NA | 18.84 | NA | NA | 3 | 168 | 27 | | NA |

## D. TECHNICAL CHARACTERISTICS DATA

Technical Characteristics Data (TCD) Form B sheets were prepared for each of the telescopes, arrays, and subsystems at WBS levels 5 and 6. The TCDs are arranged here in order of increasing number. The data were used in estimating costs of each item. A description of the information in each column of the TCD form is as follows:

1) WBS Identification Number - The 13-digit WBS code number of the item.

2) WBS Identification - The alphanumeric nomenclature of the item from the WBS.

3) Quantity or Value - The numerical quantity or value of the characteristic (Column 5) under consideration; where no characteristic is identified, quantity refers to the WBS item and identification number.

4) Units of Measure - The identification of the units of measure associated with the characteristics (Column 5) under consideration; where no characteristic is identified, units of measure applies to the WBS item and identification number.

5) Characteristics - The identification of the technical property under consideration.

6) Notes - Comments or explanations to clarify any of the information presented.

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 5

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-01-00-00 | TELESCOPES | 1 | UNIT | 1-m INFRARED TELESCOPE | |
| | | 1 | UNIT | 1.2-m STRATOSCOPE III | |
| | | 1 | UNIT | 1-m PHOTOHELIOGRAPH | |
| | | 1 | UNIT | 0.32-m X-RAY TELESCOPE | |
| | | 1 | UNIT | 0.25-m X UV SPECTROHELIOGRAPH | |
| | | 1 | UNIT | CORONAGRAPH ASSEMBLY (2.5-cm AND 4.0-cm CORONAGRAPHS) | |
| | | 4 | UNITS | MONITORS | |

STUDY TITLE ASMPS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-01-01-00 | INFRARED TELESCOPE | 1.0 | m | PRIMARY APERTURE | CASSEGRAIN OPTICS |
| | | 5.0 | min (arc) | FIELD OF VIEW | |
| | | f/10 | | SYSTEM F NUMBER | |
| | | 0.7-1000 | MICRONS | WAVELENGTH RANGE | |
| | | 1 | UNIT | INTERFEROMETER | |
| | | 1 | UNIT | LINEAR DETECTOR ARRAY | |
| | | 3.2X1.6D | m | SIZE | |
| | | 1600 (3525) | kg (LB) | TOTAL WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

## TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-01-02-00 | STRATOSCOPE III | 1.20 | m | PRIMARY APERTURE | RITCHEY-CHRETION |
| | | 6.0 | MIN | FIELD OF VIEW | (WITH 2X RELAY) |
| | | 1.1 | - | PRIMARY f NUMBER | |
| | | 1.2 | - | SYSTEM f NUMBER | |
| | | 900 TO 20,000 | ANG-STROMS | SPECTRAL RANGE | |
| | | 2 | UNIT | FIELD CAMERAS | 2 OR 3 SENSORS PER MISSION |
| | | 2 | UNIT | SPECTROGRAPHS | |
| | | 1 | UNIT | POLARIMETER | |
| | | 1 | UNIT | FIELD VIEWING MONITOR | |
| | | 1 | UNIT | INTERNAL CLOSED-LOOP GUIDING SYSTEM | |
| | | 4.2X1.9D | m | SIZE | |
| | | (5.9X 1.9D) | (m) | (SUN SHADE EX-TENDED) | |
| | | 1800 (3962) | kg (lb) | TOTAL WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-01-03-00 | PHOTOHELIOGRAPH | 1.0 | m | PRIMARY APERTURL | GREGORIAN OPTICS |
| | | 3.0 | MIN | FIELD OF VIEW | |
| | | 3.85 | - | PRIMARY f NUMBER | |
| | | 50.0 | - | OVERALL f NUMBER | |
| | | 2000 TO 7000 | ANG-STROMS | SPECTRAL RANGE | |
| | | 3 | UNIT | FILM CAMERAS | |
| | | 1 | UNIT | SPECTROGRAPH | |
| | | 1 | UNIT | INTERNAL FINE POINTING AND STABILITY SYSTEM | THE INTERNAL POINTING AND STABILIZATION SYSTEM WILL BE A SIGNIFICANT DE-VELOPMENT ITEM |
| | | 4.6X1.9 X1.42 | m | SIZE | |
| | | 570 (1260) | kg (1b) | TOTAL WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

## TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-01-04-00 | X-RAY TELESCOPE | 32 | cm | APERTURE | GRAZING INCIDENCE |
| | | 10 | MIN | FIELD OF VIEW | |
| | | 10 | | OVERALL f NUMBER | |
| | | 2 TO 100 | ANGSTROMS | SPECTRAL RANGE | |
| | | 1 | UNIT | IMAGING SYSTEM | |
| | | 1 | UNIT | CRYSTAL SPECTROMETER | |
| | | 1 | UNIT | PROPORTIONAL COUNTER | |
| | | 1 | UNIT | FILM CAMERA | |
| | | 4.6X0.7D | m | SIZE | |
| | | 392 (862) | kg (lb) | TOTAL WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-01-05-00 | XUV SPECTROHELIOGRAPH | 25 | cm | APERTURE | CONCAVE GRATING-COLLECTING OPTICS |
| | | 32 | $\widehat{\text{MIN}}$ | FIELD OF VIEW | |
| | | 12 | - | SYSTEM f NUMBER | |
| | | 170 TO 650 | ANG-STROMS | SPECTRAL RANGE | |
| | | 1 | UNIT | FILM CAMERA | |
| | | 3.4X1.3 X0.76 | | | |
| | | 430 (948) | kg (lb) | TOTAL WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-01-06-00 | CORONAGRAPHS | IC / OC | | | |
| | IC-INNER CORONAGRAPH | 2.45/4.0 | cm | APERTURE(S) | REFRACTIVE OPTICS |
| | OC-OUTER CORONAGRAPH | | | | |
| | | 3.25/15 | deg | FIELD OF VIEW | |
| | | 12.9/ 2.25 | - | SYSTEM f NUMBER | |
| | | 4000 TO 7000 | ANG-STROMS | SPECTRAL RANGE | |
| | | 2 | UNIT | FILM CAMERAS | |
| | | 3.8X1.2X 0.7 | m | SIZE | |
| | | 430 | kg | TOTAL WEIGHT | |
| | | (947) | (lb) | | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6



| WBS IDENTIFICATION NUMBER (1) | WBS IDENTIFICATION (2) | QUANTITY OR VALUE (3) | UNITS OF MEASURE (4) | CHARACTERISTICS (5) | NOTES (6) |
|---|---|---|---|---|---|
| 01-001-05-01-07-00 | MONITORS | 1 | UNIT | XUV MONITOR OPTICAL-MECHANICAL ASSEMBLY | SOLAR TELESCOPE GROUP |
| | | 1.43X.26 X.24 | m | SIZE | |
| | | 45.3 (100) | kg (lb) | WEIGHT | |
| | | 2 | w | POWER | |
| | | 1 | UNIT | CONTROL UNIT | |
| | | 10 | w | POWER | |
| | | 37X37X 16 | cm | SIZE | |
| | | 11 (24) | kg (lb) | TOTAL WEIGHT | |
| | | 1 | UNIT | XRT MONITOR | SOLAR TELESCOPE GROUP |
| | | 20DX 122L | cm | SIZE | |
| | | 45.3 (100) | kg (lb) | TOTAL WEIGHT | |
| | | 1 | UNIT | H-ALPHA MONITOR | SOLAR TELESCOPE GROUP |
| | | 15 | W | POWER | |
| | | 160X35.5 X25.4 | cm | SIZE | |
| | | 56 (124) | kg (lb) | TOTAL WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-01-07-00 (CON'T) | MONITORS (CON'T) | 1 | UNIT | FIELD VIEWING | IR TELESCOPE (ONLY) |
| | | 30 | w | POWER | |
| | | 15X15X 94 | cm | SIZE | |
| | | 48 (106) | kg (lb) | TOTAL WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 5



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-02-00-00 | ARRAYS | 1 | UNIT | LARGE AREA X-RAY DETECTOR | |
| | | 1 | UNIT | WIDE COVERAGE X-RAY DETECTOR | |
| | | 1 | UNIT | LARGE MODULATION COLLIMATOR | |
| | | 1 | UNIT | NARROW BAND SPEC-TROMETER/POLARI-METER | |
| | | 1 | UNIT | COLLIMATED PLANE CRYSTAL SPECTRO-METER | |
| | | 1 | UNIT | GAMMA-RAY SPECTRO-METER | |
| | | 1 | UNIT | LOW BACKGROUND GAMMA-RAY DETECTOR | |
| | | 1 | UNIT | PROTON FLUX DETECTOR | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-02-01-00 | LARGE AREA X-RAY DETECTOR | 0.1 TO 100 | KEV | ENERGY BAND | |
| | | 1.15 | deg | FIELD OF VIEW | |
| | | 6 | UNIT | DETECTOR MODULES | |
| | | 1 | UNIT | DATA PROCESSOR | |
| | | 2.4X1.8 X0.5 | m | SIZE | |
| | | 315 | kg | TOTAL WEIGHT | |
| | | (695) | (1b) | | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-02-02-00 | WIDE COVERAGE X-RAY DETECTOR(S) | 2 TO 200 | KEV | ENERGY BAND | |
| | | 180 | deg | FIELD OF VIEW | |
| | | 154 | UNIT | DETECTOR | DIVIDED INTO TWO QUARTER-SPHERES FOR HEMISPHERICAL COVERAGE |
| | | 1 | UNIT | DATA PROCESSOR | |
| | | 1.2X2D | m | SIZE | |
| | | 250 (550) | kg (lb) | TOTAL WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-02-03-00 | LARGE MODULATION COLLIMATOR | 0.1 TO 100 | KEV | ENERGY BAND | |
| | | 2.9 | deg | FIELD OF VIEW | |
| | | 6 | UNIT | DETECTOR MODULES | |
| | | 1 | UNIT | DATA PROCESSOR | |
| | | 1 | UNIT | GAS SUPPLY | ARGON/CARBON DIOXIDE |
| | | 2.9X2.3 X0.85 | m | SIZE | |
| | | 375 (826) | kg (lb) | TOTAL WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-02-04-00 | NARROW BAND SPECTROMETER/ POLARIMETER | 5.94 TO 8.37 | KEV | ENERGY BAND | (NINE SPECIFIC EMISSIONS) |
| | | 1.0 | deg | FIELD OF VIEW | |
| | | 9 | UNIT | DETECTOR MODULES | |
| | | 1 | UNIT | DATA PROCESSOR | |
| | | 2.5X2.5 X0.6 | m | SIZE | |
| | | 543 (1197) | kg (lb) | TOTAL WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-02-05-00 | COLLIMATED PLANE CRYSTAL SPECTROMETER | 0.5 TO 10 | KEV | ENERGY BAND | |
| | | 30 | deg | FIELD OF VIEW | |
| | | 3 | UNIT | DETECTOR MODULES | |
| | | 1 | UNIT | DATA PROCESSOR | |
| | | 1.22X 1.33X 1.84 | m | SIZE | |
| | | 260.8 | kg | TOTAL WEIGHT | |
| | | (574) | (lb) | | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-02-06-00 | GAMMA RAY SPECTROMETER | 0.06 TO 10 | MEV | ENERGY BAND | |
| | | 72 | deg | FIELD OF VIEW | |
| | | 1 | UNIT | DETECTOR | |
| | | 1 | UNIT | CRYO REFRIGERATOR | |
| | | 1 | UNIT | DATA PROCESSOR | |
| | | 0.34X 0.34X x 0.7 | m | SIZE | |
| | | 155 | kg | TOTAL WEIGHT | |
| | | (341) | (lb) | | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-02-07-00 | LOW BACKGROUND GAMMA RAY DETECTOR | 0.3 TO 10 | MEV | ENERGY BAND | |
| | | 110 | deg | FIELD OF VIEW | |
| | | 4 | UNIT | DETECTOR MODULES | |
| | | 1 | UNIT | DATA PROCESSOR | |
| | | 1.4X1.4 X0.5 | m | SIZE | |
| | | 994 | kg | TOTAL WEIGHT | |
| | | (2190) | (lb) | | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-02-08-00 | PROTON FLUX DETECTOR | - | - | HIGH ENERGY ALERT | WARNS OF SOUTH ATLANTIC ANOMALY |
| | | 90 | deg | FIELD OF VIEW | (TWO 45° CONES) |
| | | 0.4X0.4 X0.4 | m | SIZE | |
| | | 13.5 | kg | TOTAL WEIGHT | |
| | | (30) | (lb) | | |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
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# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 5 & 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-03-00-00 | POINTING & CONTROL SYSTEM | 1 | UNIT PER PAYLOAD | | |
| 01-001-05-03-01-00 | CMG ASSEMBLY | 1 | ASSEMBLY PER PAY-LOAD | 3 DG CMGS<br>3 INVERTERS<br>1 IMU | |
| 01-001-05-03-02-00 | COMMON MOUNT ACTUATORS | 2 | UNITS PER PAYLOAD | AZIMUTH POINTING<br>DEPLOYMENT | |
| 01-001-05-03-03-00 | TELESCOPE GIMBAL ACTUATORS | 1 | UNIT PER PAYLOAD | ELEVATION POINTING & STABILITY<br>AZIMUTH STABILITY<br>ROLL | |
| | | 1 | UNIT PER SOLAR PAYLOAD | ELEVATION POINTING & STABILITY AZI-MUTH STABILITY<br>ROLL<br>PITCH & YAW (COR-ONAGRAPHS) | |
| 01-001-05-03-04-00 | ARRAY PLATFORM ACTUATORS | 1 | UNIT PER STELLAR PAYLOAD | ELEVATION POINTING | |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 5 & 6



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-03-05-00 | REFERENCE ASSEMBLY | 1 | UNIT PER PAYLOAD | STRAPDOWN STAR TRACKERS | 2 SETS OF 4 FOR SOLAR PAYLOAD; 1 SET OF 4 FOR STELLAR PAYLOADS. |
| | | | | TELESCOPE IMU | 2 REQ'D FOR SOLAR 1 REQ'D FOR STEL-LAR |
| | | | | FINE SUN SENSOR | CORONAGRAPHS |
| | | | | PRECISION BORE-SIGHTED STAR TRACKER | IR TELESCOPE |
| | | | | CORRELATION TRACKER | SOLAR GROUP |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-03-01-00 | CMG ASSEMBLY | 1 | ASSEMBLY PER PAYLOAD | | |
| | | 150 | WATTS | AVERAGE POWER | |
| 01-001-05-03-01-01 | DOUBLE GIMBAL CMGS | 3 | UNITS | | SKYLAB TOTAL MOMENTUM OF 6900 ft-lb-sec |
| | | 2300 | ft-lb-sec | MOMENTUM CAPABIL-ITY PER CMG | |
| | | 191 (420) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-03-01-02 | INVERTERS | 3 | UNITS | | SKYLAB INCLUDES INVERTER HEATERS |
| | | 25 (55) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-03-01-03 | IMU | 1 | UNIT | | ELECTRONICS TO INTEGRATE RATE AND ATTITUDE DATA OF SHUTTLE |
| | | 6.8 (15) | kg (lb) | UNIT WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-03-02-00 | COMMON MOUNT ACTUATORS | 2 | UNITS PER PAYLOAD | | |
| 01-001-05-03-02-01 | AZIMUTH POINTING | 1 | UNIT | ROLLING ELEMENT BEARING TYPE | |
| | | 11 | ft-lb | STALL TORQUE | |
| | | 5 | sec | POSITION INDICATION ACCURACY | |
| | | 15.9 (35) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-03-02-02 | DEPLOYMENT | 2 | UNITS | ROLLING ELEMENT BEARING TYPE | |
| | | 90 | ft-lb | STALL TORQUE | |
| | | 30 | min | POSITION INDICATION ACCURACY | |
| | | 13.6 (30) | kg (lb) | UNIT WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-03-03-00 | TELESCOPE GIMBAL ACTUATORS | 1 (SEE NOTE) | SET PER PAYLOAD | USE FOR IR, S III, OR PHG | ADDITIONAL SET REQUIRED FOR SOLAR GROUP |
| 01-001-05-03-03-01 | ELEVATION POINTING & STABILITY | 2 | UNITS | ROLLING ELEMENT ELEVATION; FLEX PIVOT STABILIZATION | |
| | | 11 | ft-lb | STALL TORQUE ELEVATION | |
| | | 7 | ft-lb | STALL TORQUE STABILIZATION | |
| | | 5 | sec | POSITION INDICATION ACCURACY | |
| | | 28.1 (62) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-03-03-02 | AZIMUTH STABILITY | 2 | UNITS | FLEX PIVOT BEARING | |
| | | 7 | ft-lb | STALL TORQUE | |
| | | 5 | sec | POSITION INDICATION ACCURACY | |
| | | 15.9 (35) | kg (lb) | UNIT WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-03-03-03 | ROLL | 1 | UNIT | ROLLING ELEMENT BEARING | |
| | | 2.7 | ft-lb | STALL TORQUE | |
| | | 30 | min | POSITION INDICATION ACCURACY | |
| | | 8.6 (19) | kg (lb) | UNIT WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS Level 6 & 7

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-03-03-00 | TELESCOPE GIMBAL ACTUATORS | 1 (SEE NOTE) | SET | USE FOR SOLAR GROUP TELESCOPES | SEE OTHER SET REQUIRED FOR IR, SIII, OR PHG |
| 01-001-05-03-03-01 | ELEVATION POINTING & STABILITY | 2 | UNITS | ROLLING ELEMENT ELEVATION; FLEX PIVOT STABILIZATION | |
| | | 11 | ft-lb | STALL TORQUE ELEVATION | |
| | | 7 | ft-lb | STALL TORQUE STABILIZATION | |
| | | 5 | $\widehat{\text{sec}}$ | POSITION INDICATION ACCURACY | |
| | | 28.1 (62) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-03-03-02 | AZIMUTH STABILITY | 2 | UNITS | FLEX PIVOT BEARING | |
| | | 7 | ft-lb | STALL TORQUE | |
| | | 5 | $\widehat{\text{sec}}$ | POSITION INDICATOR ACCURACY | |
| | | 15.9 (35) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-03-03-03 | ROLL | 1 | UNIT | ROLLING ELEMENT BEARING | |
| | | 2.7 | ft-lb | STALL TORQUE | |
| | | 30 | $\widehat{\text{min}}$ | POSITION INDICATION ACCURACY | |
| | | 8.6 (19) | kg (lb) | UNIT WEIGHT | |

STUDY TITLE ____________
CONTRACT NO. ____________

## TECHNICAL CHARACTERISTICS DATA FORM B

WBS Level 6 & 7

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-03-03-04 | PITCH & YAW | 2 | UNITS | CORONAGRAPHS | |
| | | 9.1 | kg | UNIT WEIGHT | |
| | | (20) | (lb) | | |
| 01-001-05-03-04-00 | ARRAY PLATFORM ACTUATOR | 1 | SET | USE ON STELLAR PAYLOADS FOR ARRAYS | NOT REQUIRED FOR SOLAR |
| 01-001-05-03-04-01 | ELEVATION POINTING | 2 | UNITS | ROLLING ELEMENT BEARING | |
| | | 11 | ft-lb | STALL TORQUE | |
| | | 5 | sec | POSITION INDICATION ACCURACY | |
| | | 13.6 | kg | UNIT WEIGHT | |
| | | (30) | (lb) | | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-03-05-00 | REFERENCE ASSEMBLY | 1 (SEE NOTE) | UNIT | | SECOND UNIT WITH FINE SUN SENSOR & CORRELATION TRACKER REQUIRED FOR SOLAR |
| 01-001-05-03-05-01 | STRAPDOWN STAR TRACKERS | 4 | UNITS | OPTICS & ELECTRONICS | |
| | | 15 (33) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-03-05-02 | TELESCOPE IMU | 1 | UNIT | ELECTRONICS | |
| | | 6.8 (15) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-03-05-03 | FINE SUN SENSOR | 1 | UNIT | OPTICAL-MECHANICAL; PREAMP ASSEMBLY; SIGNAL CONDITIONER; CONTROL ELECTRONICS ASSEMBLY | REQUIRED FOR CORONAGRAPHS ONLY. ATM |
| | | 11 | watts | POWER | |
| | | 24.5 (54) | kg (lb) | UNIT WEIGHT | INCLUDES ELECTRONICS |
| 01-001-05-03-05-04 | PRECISION BORESIGHTED STAR TRACKER | 1 | UNIT | | REQUIRED FOR IR TELESCOPE ONLY |
| | | 11.3 (25) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-03-05-05 | CORRELATION TRACKER | 1 | UNIT | | REQUIRED FOR SOLAR GROUP ONLY |
| | | 25 | watts | POWER | |
| | | 54.5 (120) | kg (lb) | UNIT WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 5 & 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-04-00-00 | STRUCTURES | | | | |
| 01-001-05-04-01-00 | COMMON MOUNT ASSEMBLY | 2 | ASSEMBLIES PER PAYLOAD | 1 AZIMUTH TABLE<br>1 AZIMUTH YOKE<br>1 DEPLOYMENT YOKE<br>2 DEPLOYMENT GEARMOTORS & LAUNCH LOCKS<br>1 SET JETTISON EQUIPMENT | |
| 01-001-05-04-02-00 | TELESCOPE GIMBAL ASSEMBLY | 1 (SEE NOTE) | ASSEMBLY PER PAYLOAD | 1 OUTER GIMBAL RING<br>1 OUTER ROLL RING<br>1 INNER ROLL RING<br>1 ROLL GEAR<br>1 TELESCOPE P&C PLATFORM<br>1 SET GIMBAL GEARMOTORS & LAUNCH LOCKS | SOLAR PAYLOAD REQUIRES TWO ASSEMBLIES |
| 01-001-05-04-03-00 | ARRAY PLATFORM ASSEMBLY | 1 (SEE NOTE) | ASSEMBLY PER PAYLOAD | 1 ARRAY MOUNT<br>1 SET PLATFORM GEARMOTORS & LAUNCH LOCKS | REQUIRED FOR STELLAR PAYLOADS ONLY |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 5 & 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-04-04-00 | SUPPORT EQUIPMENT SET | 1 | SET PER PAYLOAD | 3 CMG SUPPORT STRUCTURES<br>1 SET WIDE COVERAGE X-RAY DETECTOR SUPPORTS<br>1 GAMMA RAY SPECTROMETER HOUSING AND EXTENSION MECHANISM | REQUIRED FOR ALL PAYLOADS<br>REQUIRED FOR STELLAR PAYLOADS ONLY<br>REQUIRED FOR STELLAR PAYLOADS ONLY |
| 01-001-05-04-05-00 | SOLAR TELESCOPE HOUSING ASSEMBLY | 1 | UNIT | 1 TUBULAR STRUCTURE<br>2 BULKHEADS<br>1 FIBERGLASS SUNSHIELD<br>6 APERTURE DOORS<br>6 APERTURE DOOR ACTUATORS | REQUIRED FOR SOLAR GROUP ONLY |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-04-01-00 | COMMON MOUNT ASSEMBLY | 2 | ASSEMBLIES PER PAYLOAD | | |
| 01-001-05-04-01-01 | AZIMUTH TABLE | 1 | UNIT | BASIC STRUCTURE WITHOUT ACTUATORS | |
| | | 0.69x 1.27x 1.27 | m | ENVELOPE SIZE | |
| | | 111 (244) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-04-01-02 | AZIMUTH YOKE | 1 | UNIT | BASIC STRUCTURE WITHOUT ACTUATORS | |
| | | 1.01x 2.54x 3.35 | m | ENVELOPE SIZE | |
| | | 172 (380) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-04-01-03 | DEPLOYMENT YOKE | 1 | UNIT | BASIC STRUCTURE WITHOUT ACTUATORS | |
| | | 0.31x 4.0 x 3.1 | m | ENVELOPE SIZE | |
| | | 76 (168) | kg (lb) | UNIT WEIGHT | |

STUDY TITLE ______
CONTRACT NO. ______

# TECHNICAL CHARACTERISTICS DATA FORM B



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-04-01-04 | DEPLOYMENT GEARMOTORS & LAUNCH LOCKS | 2<br>23.6<br>(52) | UNITS<br>kg<br>(lb) | UNIT WEIGHT | INCLUDES GIMBAL RING SUPPORTS |
| 01-001-05-04-01-05 | JETTISON EQUIPMENT | 1<br>20.4<br>(45) | UNIT<br>kg<br>(lb) | UNIT WEIGHT | |
| 01-001-05-04-02-00 | TELESCOPE GIMBAL ASSEMBLY | 1<br>(SEE NOTE) | ASSEMBLY PER PAY-LOAD | | SOLAR PAYLOAD RE-QUIRES 2 ASSEMBLIES |
| 01-001-05-04-02-01 | OUTER GIMBAL RING | 1<br>100<br>(220) | UNIT<br>kg<br>(lb) | ALUMINUM RING<br>UNIT WEIGHT | |
| 01-001-05-04-02-02 | OUTER ROLL RING | 1<br>133<br>(294) | UNIT<br>kg<br>(lb) | ALUMINUM RING<br>UNIT WEIGHT | |
| 01-001-05-04-02-03 | INNER TOLL RING | 1<br>84.3<br>(186) | UNIT<br>kg<br>(lb) | ALUMINUM RING<br>UNIT WEIGHT | |
| 01-001-05-04-02-04 | ROLL GEAR | 1<br>6.4<br>(14) | UNIT<br>kg<br>(lb) | UNIT WEIGHT | |
| 01-001-05-04-02-05 | TELESCOPE P&C PLATFORM | 1<br>30.4<br>(67) | UNIT<br>kg<br>(lb) | UNIT WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-04-02-06 | GIMBAL GEARMOTORS & LAUNCH LOCKS | 2 | UNITS | | |
| | | 24.5 (54) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-04-03-00 | ARRAY PLATFORM ASSEMBLY | 1 | ASSEMBLY | | REQUIRED FOR STELLAR PAYLOADS ONLY |
| 01-001-05-04-03-01 | ARRAY MOUNT | 1 | UNIT | BASIC STRUCTURE WITHOUT ACTUATORS | |
| | | 200 (440) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-04-03-02 | PLATFORM GEARMOTORS & LAUNCH LOCKS | 2 | UNITS | | |
| | | 24 (53) | kg (lb) | UNIT WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-04-04-00 | SUPPORT EQUIPMENT SET | 1 | SET PER PAYLOAD | | |
| 01-001-05-04-04-01 | CMG SUPPORT STRUCTURES | 3 | UNITS PER SET | BASIC STRUCTURE | |
| | | 14.7 (32.5) | kg (lb) | UNIT WEIGHT | INCLUDES INVERTER SUPPORT STRUCTURES |
| 01-001-05-04-04-02 | WIDE COVERAGE X-RAY DETECTOR MOUNT | 2 | UNITS PER SET | BASIC STRUCTURE | REQUIRED FOR STELLAR PAYLOADS ONLY |
| | | 77 (170) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-04-04-03 | GAMMA RAY SPECTROMETER HOUSING AND EXTENSION MECHANISM | 1 | UNIT | BASIC STRUCTURE | REQUIRED FOR STELLAR PAYLOADS 3AC & 4AC ONLY |
| | | 476 (1050) | kg (lb) | UNIT WEIGHT | |

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# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7

DATE 8/22/72
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| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-04-05-00 | SOLAR TELESCOPE HOUSING ASSEMBLY | 1 | ASSEMBLY | BASIC STRUCTURE | REQUIRED FOR SOLAR GROUP ONLY |
| 01-001-05-04-05-01 | TUBULAR STRUCTURE | 1<br>302<br>(290) | UNIT<br>kg<br>(lb) | BASIC STRUCTURE<br>UNIT WEIGHT | |
| 01-001-05-04-05-02 | BULKHEADS | 1<br>132<br>(290) | UNITS<br>kg<br>(lb) | BASIC STRUCTURE<br>UNIT WEIGHT | INCLUDES FITTINGS AND PARTITIONS |
| 01-001-05-04-05-03 | FIBER GLASS SUNSHIELD | 1<br>30.4<br>(67) | UNIT<br>kg<br>(lb) | UNIT WEIGHT | |
| 01-001-05-04-05-04 | APERTURE DOORS | 6<br>1.81<br>(4) | UNITS<br>kg<br>(lb) | BASIC STRUCTURE<br>UNIT WEIGHT | |
| 01-001-05-04-05-05 | DOOR ACTUATORS | 6<br>0.91<br>(2) | UNITS<br>kg<br>(lb) | ELECTRO-MECHANICAL<br>UNIT WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 5 & 6

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-05-00-00 | ELECTRONIC | | | | |
| 01-001-05-05-01-00 | CONTROL & DISPLAY | 1 | UNIT | 1 CB/DISTRIBUTOR PANEL<br>2 MULTIPURPOSE CRTs<br>1 SYMBOL GENERATOR<br>1 FUNCTION KEY-BOARD<br>1 ALPHANUMERIC KEYBOARD<br>2 KEYBOARD ENCODERS<br>1 MICROFILM VIEWER<br>1 EVENT TIMER<br>1 MISSION TIMER<br>1 THREE AXIS CONTROLLER<br>2 ANNUNCIATOR BANKS<br>1 RECORDER | EQUIPMENT IS INSTALLED IN SORTIE LAB FOR ALL PAYLOADS |
| 01-001-05-05-02-00 | ELECTRICAL | 1 | UNIT | 6 LOAD CENTER SWITCHES<br>- FEEDER CALBES<br>1 JUNCTION BOX | REQUIRED FOR ALL PAYLOADS |
| 01-001-05-05-03-00 | DATA | 1 | UNIT | 4 DATA BUS INTER-FACE UNIT<br>1 COAX DATA BUS<br>1 PALLET INSTR BOX<br>4 DATA PROCESSOR | REQUIRED FOR ALL PAYLOADS |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7

DATE SEPT 1972


| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-05-01-00 | CONTROL & DISPLAY | 1 | UNIT PER PAYLOAD | INTEGRATED CONCEPT | INSTALLED IN SORTIE LAB |
| | | 415 | W | POWER | |
| | | 149<br>(329) | kg<br>(lb) | UNIT WEIGHT | |
| 01-001-05-05-01-01 | CB/DISTRIBUTOR PANEL | 1 | UNIT | | |
| 01-001-05-05-01-02 | MULTIPURPOSE CRTs | 2 | UNITS | VIDEO | ALPHANUMERIC STATIC GRAPHIC |
| 01-001-05-05-01-03 | SYMBOL GENERATOR | 1 | UNIT | GENERATE SYMBOLS, CHARACTERS, VECTORS, RASTER VIDEO | |
| 01-001-05-05-01-04 | FUNCTION KEYBOARD | 1 | UNIT | FUNCTIONAL CATEGORY DATA | |
| 01-001-05-05-01-05 | ALPHANUMERIC KEYBOARD | 1 | UNIT | | |
| 01-001-05-05-01-06 | KEYBOARD ENCODERS | 2 | UNITS | | |
| 01-001-05-05-01-07 | MICROFILM VIEWER | 1 | UNIT | READ PROCEDURAL TYPE DATA | |
| 01-001-05-05-01-08 | EVENT TIMER | 1 | UNIT | | |
| 01-001-05-05-01-09 | MISSION TIMER | 1 | UNIT | | |
| 01-001-05-05-01-10 | THREE-AXIS CONTROLLER | 1 | UNIT | INSTRUMENT POINTING | |
| 01-001-05-05-01-11 | ANNUNCIATOR BANK | 2 | UNITS | VISUAL ALERTING | |
| 01-001-05-05-01-12 | RECORDER | 1 | UNIT | MULTI CHANNEL | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-05-02-00 | ELECTRICAL | | | | |
| 01-001-05-05-02-01 | LOAD CENTER SWITCH | 6 | UNITS | | |
| | | 10 x 5 x 20 | CM | SIZE | |
| | | | W | POWER | |
| | | 2.72 (6) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-05-02-02 | FEEDER CABLES | 70 (155) | kg (lb) | PAYLOAD WEIGHT SOLAR | |
| | | 60 (133) | kg (lb) | PAYLOAD WEIGHT STELLAR | |
| 01-001-05-05-02-03 | JUNCTION BOX | 1 | UNIT | | |
| | | 4.54 (10) | kg (lb) | WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 6 & 7



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-05-03-00 | DATA | | | | |
| 01-001-05-05-03-01 | DATA BUS INTERFACE UNIT | 4 | UNITS | REMOTE COMMAND & MULTIPLEXING | ALL PAYLOADS |
| | | 9.5 | W | POWER | |
| | | 10 x 8 x 18 | CM | EVNELOPE SIZE | |
| | | 1.81 (4) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-05-03-02 | COAX DATA BUS | 122 | M | LENGTH | ALL PAYLOADS |
| | | 9.1 (20) | kg (lb) | PAYLOAD WEIGHT | |
| 01-001-05-05-03-03 | PALLET INSTRUMENTATION BOX | 1 | UNIT | STATUS AND DYNAMIC ENVIRONMENT MONITOR | ALL PAYLOADS |
| | | 5.0 | watts | POWER | |
| | | 2.26 (5) | kg (lb) | UNIT WEIGHT | |
| 01-001-05-05-03-04 | DATA PROCESSOR | 4 | UNITS | | ALL PAYLOADS |
| | | 3.0 | watts | POWER | |
| | | 2.26 (5) | kg (lb) | UNIT WEIGHT | |

STUDY TITLE ASMDS
CONTRACT NO. NAS8-28144

# TECHNICAL CHARACTERISTICS DATA FORM B

WBS LEVEL 5 & 6



| (1) WBS IDENTIFICATION NUMBER | (2) WBS IDENTIFICATION | (3) QUANTITY OR VALUE | (4) UNITS OF MEASURE | (5) CHARACTERISTICS | (6) NOTES |
|---|---|---|---|---|---|
| 01-001-05-06-00-00 | THERMAL CONTROL | 1 | UNIT | | ALL PAYLOADS |
| 01-001-05-06-01-00 | THERMAL COATING | | | 293 TYPE WHITE PAINT | APPLIED TO ALL SURFACES OF DEPLOYMENT YOKE |
| | | 5.45 (12) | kg (lb) | PAYLOAD WEIGHT | |
| 01-001-05-06-02-00 | MULTILAYER INSULATION | | | PALLET EQUIPMENT | ALL PAYLOADS |
| | | 59 (130) | kg (lb) | PAYLOAD WEIGHT | |
| | | | | SOLAR TELESCOPE HOUSING | SOLAR PAYLOAD ONLY |
| | | 62.1 (137) | kg (lb) | PAYLOAD WEIGHT | |
| | | | | ARRAY PLATFORM | STELLAR PAYLOADS ONLY |
| | | 22.6 (50) | kg (lb) | PAYLOAD WEIGHT | |

## E. TOTAL PROGRAM FUNDING SCHEDULE

The time-phased estimates of the costs required to accomplish the total program are presented here on Data Form C. The WBS lower level cost estimates were time-phased by fiscal year against the proposed development or production schedule by estimated distribution of costs or by using the appropriate spreading function. Spreading functions were selected from those presented in *Phase A and Phase B studies Cost Estimates Document*, DRD No. MF-030A, Figure 8, "Idealized Cost Distribution Curves." The results were then summarized to develop the funding schedules of higher levels.

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## FUNDING SCHEDULE DATA FORM C

X NON-RECURRING (DDT&E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

DATE SEPT 1972
PAGE 1 OF 3

| PROJECT WBS ITEMS | FY 74 | FY 75 | FY 76 | FY 77 | FY 78 | FY 79 | FY 80 | FY 81 | FY ___ |
|---|---|---|---|---|---|---|---|---|---|
| ASTRONOMY SORTIE MISSION | 3.58 | 18.51 | 51.46 | 80.10 | 33.79 | 9.72 | 4.80 | .65 | 202.61 |
| PROJECT MANAGEMENT | .31 | 1.98 | 6.03 | 4.16 | 1.16 | .54 | .11 | .02 | |
| SYSTEM SUPPORT & INTEG. | .40 | 2.58 | 7.87 | 5.42 | 1.52 | .70 | .14 | .03 | |
| FACILITIES | .05 | .20 | | | | | | | |
| GROUND SUPPORT EQUIP. | | | | 9.20 | 12.11 | .06 | | | |
| IR TELESCOPE | 1.25 | 3.00 | 2.65 | 2.25 | 1.35 | | | | |
| STRATOSCOPE III | | | | 1.10 | 2.60 | 2.40 | 1.70 | .60 | |
| PHOTOHELIOGRAPH | | 1.50 | 2.00 | 1.50 | .16 | | | | |
| X-RAY TELESCOPE | 1.57 | 3.73 | 5.90 | 4.50 | 1.95 | | | | |
| XUV SPECTROHELIOGRAPH | | .75 | .85 | .40 | .15 | | | | |
| CORONAGRAPHS | | .95 | .95 | .89 | .19 | | | | |
| MONITORS | | | | .05 | .15 | | | | |
| LARGE AREA X-RAY | | | | .80 | 1.78 | 1.52 | .85 | | |
| WIDE COVERAGE X-RAY | | .25 | 1.17 | .83 | | | | | |
| LARGE MODULATION COLLIM. | | | .80 | 1.65 | 2.15 | 1.95 | .40 | | |
| NARROW BAND SPECTRO/POLAR. | | | .90 | 2.35 | 2.20 | .85 | | | |
| COLLIM. P.C. SPECTROMETER | | | | .50 | 1.30 | 1.70 | 1.60 | | |
| GAMMA RAY SPECTROMETER | | .80 | 1.75 | 2.10 | 2.65 | | | | |
| LOW BACKGROUND X-RAY | | .90 | 2.10 | 2.40 | 1.10 | | | | |
| PROTON FLUX DETECTOR | | | | | .05 | | | | |
| POINTING & CONTROL | | 1.87 | 10.37 | 5.84 | .08 | | | | |
| STRUCTURES | | | 7.14 | 22.15 | .49 | | | | |
| ELECTRONICS | | | .98 | 10.05 | .29 | | | | |
| THERMAL CONTROL | | | | 1.96 | .36 | | | | |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

## FUNDING SCHEDULE DATA FORM C

DATE SEPT 1972
PAGE 2 OF 3

____ NON-RECURRING (DDT&E)
X RECURRING (PRODUCTION)
____ RECURRING (OPERATIONS)

| PROJECT WBS ITEMS | FY 75 | FY 76 | FY 77 | FY 78 | FY 79 | FY 80 | FY 81 |
|---|---|---|---|---|---|---|---|
| ASTRONOMY SORTIE MISSION | .70 | 10.14 | 31.75 | 54.89 | 20.42 | 10.91 | 4.81 |
| PROJECT MANAGEMENT | .02 | .27 | 2.12 | 3.81 | 2.05 | 1.03 | .14 |
| SYSTEM SUPPORT & INTEG. | .03 | .86 | 3.60 | 4.50 | 2.19 | 1.01 | .12 |
| IR TELESCOPE | .65 | 2.85 | 3.00 | 3.50 | 2.00 | | |
| STRATOSCOPE III | | | | | 2.00 | 2.50 | 2.70 |
| PHOTOHELIOGRAPH | | 1.26 | 1.75 | 1.60 | | | |
| X-RAY TELESCOPE | | .50 | 2.75 | 4.95 | | | |
| XUV SPECTROHELIOGRAPH | | .15 | .35 | .50 | | | |
| CORONAGRAPHS | | .45 | .65 | .85 | | | |
| MONITORS | | | | 1.78 | .24 | | |
| LARGE AREA X-RAY | | | | .63 | 1.58 | 1.92 | .45 |
| WIDE COVERAGE X-RAY | | 2.20 | 2.60 | 2.10 | .90 | | |
| LARGE MODULATION COLLIM. | | | .30 | 1.45 | 1.78 | 1.65 | |
| NARROW BAND SPECTRO/POLAR. | | | 2.80 | 3.70 | 3.70 | | |
| COLLIM. P.C. SPECTROMETER | | | | .80 | 2.30 | 2.80 | 1.40 |
| GAMMA RAY SPECTROMETER | | | 1.80 | 1.80 | .90 | | |
| LOW BACKGROUND X-RAY | | 1.60 | 2.40 | 2.70 | .60 | | |
| PROTON FLUX DETECTOR | | | | .28 | .18 | | |
| POINTING & CONTROL | | | 4.51 | 6.02 | | | |
| STRUCTURES | | | 2.35 | 10.17 | | | |
| ELECTRONICS | | | .77 | 3.32 | | | |
| THERMAL CONTROL | | | | .43 | | | |

STUDY TITLE ASTRONOMY SORTIE MISSION DEFINITION STUDY
CONTRACT NO. NAS8-28144

FUNDING SCHEDULE DATA FORM C

DATE SEPT 1972
PAGE 3 OF 3

___ NON-RECURRING (DDT&E)
___ RECURRING (PRODUCTION)
_X_ RECURRING (OPERATIONS)

| PROJECT WBS ITEMS | FY 76 | FY 77 | FY 78 | FY 79 | FY 80 | FY 81 | FY 82 | FY 83 | FY 84 | FY 85 | FY 86 | FY 87 | FY 88 | FY 89 | FY 90 | FY 91 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASTRONOMY SORTIE MISSION | 2.28 | 22.59 | 67.39 | 71.81 | 23.73 | 13.55 | 6.99 | 5.85 | 5.85 | 5.85 | 5.85 | 5.85 | 5.85 | 5.85 | 5.85 | 2.92 |
| PROJECT MANAGEMENT | .17 | 1.37 | 4.37 | 5.16 | 2.22 | 1.00 | .44 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .41 | .21 |
| SYSTEM SUPPORT & INTEG. | .60 | 2.62 | 6.28 | 5.74 | 2.30 | 1.08 | .56 | .54 | .54 | .54 | .54 | .54 | .54 | .54 | .54 | .27 |
| GSE | | | .70 | 2.75 | .28 | | | | | | | | | | | |
| IR TELESCOPE | .45 | 1.70 | 2.03 | 1.31 | .27 | | | | | | | | | | | |
| STRATOSCOPE III | .31 | 2.10 | 2.54 | 1.24 | .07 | | | | | | | | | | | |
| PHOTOHELIOGRAPH | .45 | 3.03 | 3.67 | 1.79 | .10 | | | | | | | | | | | |
| X-RAY TELESCOPE | | 3.03 | 5.98 | 3.40 | .21 | | | | | | | | | | | |
| XUV SPECTROHELIOGRAPH | | .37 | .73 | .41 | .03 | | | | | | | | | | | |
| CORONAGRAPHS | .03 | .59 | .86 | .45 | .02 | | | | | | | | | | | |
| LARGE AREA X-RAY | | | | 1.49 | 3.13 | 2.14 | .29 | | | | | | | | | |
| WIDE COVERAGE X-RAY | .13 | 2.90 | 4.75 | 3.45 | .77 | | | | | | | | | | | |
| LARGE MODULATION COLLIM. | | | .87 | 3.06 | 2.97 | 1.06 | .01 | | | | | | | | | |
| NARROW BAND SPECTRO/POLAR. | | .78 | 5.27 | 6.37 | 3.11 | .17 | | | | | | | | | | |
| COLLIM. P.C. SPECTROMETER | | | | 2.11 | 4.63 | 3.64 | .85 | | | | | | | | | |
| GAMMA RAY SPECTROMETER | | .45 | 2.86 | 2.88 | .74 | | | | | | | | | | | |
| LOW BACKGROUND X-RAY | .14 | 3.02 | 4.71 | 2.97 | .39 | | | | | | | | | | | |
| POINTING & CONTROL | | | 10.15 | 9.79 | .16 | | | | | | | | | | | |
| STRUCTURES | | | 4.67 | 7.33 | .14 | | | | | | | | | | | |
| ELECTRONICS | | | 4.97 | 7.79 | .15 | | | | | | | | | | | |
| THERMAL CONTROL | | | .06 | .20 | .01 | | | | | | | | | | | |
| LAUNCH OPERATIONS | | .24 | .48 | .55 | .61 | .94 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | .63 |
| MISSION OPERATIONS | | .15 | .30 | .33 | .35 | .65 | .65 | .65 | .65 | .65 | .65 | .65 | .65 | .65 | .65 | .32 |
| SUPPORT OPERATIONS | | .24 | .50 | .60 | .65 | 1.34 | 1.34 | 1.34 | 1.34 | 1.34 | 1.34 | 1.34 | 1.34 | 1.34 | 1.34 | .67 |
| RECOVERY & REFURB. OPS. | | | .64 | .64 | .42 | 1.53 | 1.59 | 1.65 | 1.65 | 1.65 | 1.65 | 1.65 | 1.65 | 1.65 | 1.65 | .82 |

## F. WORK BREAKDOWN STRUCTURE (WBS)

The final WBS dictionary and diagram are presented in this section. This WBS is compatible with the breakdown that was used in estimating costs.

The dictionary (Table IV-2) is a listing in numerical order of the functions and hardware which must be developed for the ASM project.

Figure IV-2 is the diagram showing the relationship of these elements in a family tree. In the dictionary, functions and support hardware shown only as level 4 on the diagram are further identified to level 5. Components and assemblies of the payloads (a level 4 item on the diagram) are identified to level 5 and 6 on the diagrams and in the dictionary. Further, the components and assemblies of subsystems are identified to level 7 in the dictionary.

*Table IV-2 WBS Dictionary*

| WBS IDENTIFICATION NUMBER | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LEVEL 2 | | LEVEL 3 | | | LEVEL 4 | | LEVEL 5 | | LEVEL 6 | | LEVEL 7 | | WBS IDENTICIATION |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | SHUTTLE SORTIE MISSION PROGRAM |
| 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | ATRONOMY SORTIE MISSION PROJECT |
| 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | PROJECT MANAGEMENT |
| 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | PROGRAM CONTROL |
| 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | CONFIGURATION MANAGEMENT |
| 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | CONTRACTUAL DATA MANAGEMENT |
| 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | SYSTEM SUPPORT & INTEGRATION |
| 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | SYSTEMS ANALYSIS |
| 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | PAYLOAD INTEGRATION |
| 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | PROGRAM INTEGRATION |
| 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | SAFETY AND RELIABILITY |
| 0 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 5 | 0 | 0 | 0 | 0 | QUALITY ASSURANCE |
| 0 | 1 | 0 | 0 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | FACILITIES |
| 0 | 1 | 0 | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | CONTRACTOR |
| 0 | 1 | 0 | 0 | 1 | 0 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | GOVERNMENT |
| 0 | 1 | 0 | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | GROUND SUPPORT EQUIPMENT |
| 0 | 1 | 0 | 0 | 1 | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | ELECTRICAL & ELECTRONIC |
| 0 | 1 | 0 | 0 | 1 | 0 | 4 | 0 | 2 | 0 | 0 | 0 | 0 | STRUCTURAL & MECHANICAL |
| 0 | 1 | 0 | 0 | 1 | 0 | 4 | 0 | 3 | 0 | 0 | 0 | 0 | OPTICAL |
| 0 | 1 | 0 | 0 | 1 | 0 | 4 | 0 | 4 | 0 | 0 | 0 | 0 | TRANSPORT & HANDLING |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | PAYLOADS |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 1 | 0 | 0 | 0 | 0 | TELESCOPES |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 1 | 0 | 1 | 0 | 0 | IR TELESCOPE |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 1 | 0 | 2 | 0 | 0 | STRATOSCOPE III |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 1 | 0 | 3 | 0 | 0 | PHOTOHELIOGRAPH |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 1 | 0 | 4 | 0 | 0 | X-RAY TELESCOPE |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 1 | 0 | 5 | 0 | 0 | XUV SPECTROHELIOGRAPH |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 1 | 0 | 6 | 0 | 0 | CORONAGRAPHS |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 1 | 0 | 7 | 0 | 0 | MONITORS |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 0 | 0 | 0 | ARRAYS |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 1 | 0 | 0 | LARGE AREA X-RAY DETECTOR |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 2 | 0 | 0 | WIDE COVERAGE X-RAY DETECTOR |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 3 | 0 | 0 | LARGE MODULATION COLLIMATOR |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 4 | 0 | 0 | NARROW BAND SPECTRO/POLARIM |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 5 | 0 | 0 | COLLIMATED PC SPECTROMETER |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 6 | 0 | 0 | GAMMA-RAY SPECTROMETER |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 7 | 0 | 0 | LOW BACKGROUND $\gamma$-RAY DETECTOR |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 2 | 0 | 8 | 0 | 0 | PROTON FLUX DETECTOR |

*Table IV-2 (cont)*

| WBS IDENTIFICATION NUMBER | | | | | | WBS IDENTIFICATION |
|---|---|---|---|---|---|---|
| LEVEL 2 | LEVEL 3 | LEVEL 4 | LEVEL 5 | LEVEL 6 | LEVEL 7 | |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 0 | 0 0 | POINTING & CONTROL SYSTEM |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 1 | 0 0 | CMG ASSEMBLY |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 1 | 0 1 | DOUBLE GIMBAL CMGs |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 1 | 0 2 | INVERTERS |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 1 | 0 3 | IMU |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 2 | 0 0 | COMMON MOUNT ACTUATORS |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 2 | 0 1 | AZIMUTH POINTING |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 2 | 0 2 | DEPLOYMENT |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 3 | 0 0 | TELESCOPE GIMBAL ACTUATORS |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 3 | 0 1 | ELEVATION POTING & STABILITY |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 3 | 0 2 | AZIMUTH STABILITY |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 3 | 0 3 | ROLL |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 3 | 0 4 | PITCH & YAW (CORONAGRAPHS) |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 4 | 0 0 | ARRAY PLATFORM ACTUATOR |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 4 | 0 1 | ELEVATION POINTING |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 5 | 0 0 | REFERENCE ASSEMBLY |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 5 | 0 1 | STRAPDOWN STAR TRACKERS |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 5 | 0 2 | TELESCOPE IMU |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 5 | 0 3 | FINE SUN SENSOR |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 5 | 0 4 | BORESIGHTED STAR TRACKER-PRECISION |
| 0 1 | 0 0 1 | 0 5 | 0 3 | 0 5 | 0 5 | CORRELATION TRACKER |
| 0 1 | 0 0 1 | 0 5 | 0 4 | 0 0 | 0 0 | STRUCTURES |
| 0 1 | 0 0 1 | 0 5 | 0 4 | 0 1 | 0 0 | COMMON MOUNT ASSEMBLY |
| 0 1 | 0 0 1 | 0 5 | 0 4 | 0 1 | 0 1 | AZIMUTH TABLE |
| 0 1 | 0 0 1 | 0 5 | 0 4 | 0 1 | 0 2 | AZIMUTH YOKE |
| 0 1 | 0 0 1 | 0 5 | 0 4 | 0 1 | 0 3 | DEPLOYMENT YOKE |
| 0 1 | 0 0 1 | 0 5 | 0 4 | 0 1 | 0 4 | DEPLOYMENT GEARMOTORS & LAUNCH LOCKS |
| 0 1 | 0 0 1 | 0 5 | 0 4 | 0 1 | 0 5 | JETTISON EQUIPMENT |

*Table IV-2 (cont)*

| WBS IDENTIFICATION NUMBER | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LEVEL 2 | | LEVEL 3 | | | LEVEL 4 | | LEVEL 5 | | LEVEL 6 | | LEVEL 7 | | WBS IDENTIFICATION |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 2 | 0 | 0 | TELESCOPE GIMBAL ASSEMBLY |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 2 | 0 | 1 | OUTER GIMBAL RING |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 2 | 0 | 2 | OUTER ROLL RING |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 2 | 0 | 3 | INNER ROLL RING |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 2 | 0 | 4 | ROLL GEAR |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 2 | 0 | 5 | TELESCOPE P& C PLATFORM |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 2 | 0 | 6 | GIMBAL GEARMOTORS & LAUNCH LOCKS |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 3 | 0 | 0 | ARRAY PLATFORM ASSEMBLY |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 3 | 0 | 1 | ARRAY MOUNT |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 3 | 0 | 2 | PLATFORM GEARMOTORS & LAUNCH LOCKS |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 4 | 0 | 0 | SUPPORT EQUIPMENT SET |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 4 | 0 | 1 | CMG SUPPORT STRUCTURES |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 4 | 0 | 2 | WC X-RAY DETECTOR MOUNT |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 4 | 0 | 3 | γ-RAY SPECT HOUSING & EXT MECH |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 5 | 0 | 0 | SOLAR TELESCOPE HOUSING ASSY |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 5 | 0 | 1 | TUBULAR STRUCTURE |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 5 | 0 | 2 | BULKHEADS |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 5 | 0 | 3 | SUNSHIELD-FIBERGLASS |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 5 | 0 | 4 | APERTURE DOORS |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 4 | 0 | 5 | 0 | 5 | DOOR ACTUATORS |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 0 | 0 | 0 | ELECTRONIC |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 0 | 0 | CONTROL & DISPLAY |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 0 | 1 | CB/DISTRIBUTOR PANEL |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 0 | 2 | MULTIPURPOSE CRT |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 0 | 3 | SYMBOL GENERATOR |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 0 | 4 | FUNCTION KEYBOARD |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 0 | 5 | ALPHANUMERIC KEYBOARD |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 0 | 6 | KEYBOARD ENCODER |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 0 | 7 | MICROFILM VIEWER |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 0 | 8 | EVENT TIMER |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 0 | 9 | MISSION TIMER |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 1 | 0 | THREE-AXIS CONTROLLER |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 1 | 1 | ANNUNCIATOR BANK |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 1 | 1 | 2 | RECORDER |

*Table IV-2 (concl)*

| WBS IDENTIFICATION NUMBER | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LEVEL 2 | | LEVEL 3 | | | LEVEL 4 | | LEVEL 5 | | LEVEL 6 | | LEVEL 7 | | WBS IDENTIFICATION |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 2 | 0 | 0 | ELECTRICAL |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 2 | 0 | 1 | LOAD CENTER SWITCH |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 2 | 0 | 2 | FEEDER CABLES |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 2 | 0 | 3 | JUNCTION BOX |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 3 | 0 | 0 | DATA |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 3 | 0 | 1 | DATA BUS INTERFACE UNIT |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 3 | 0 | 2 | COAX DATA BUS |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 3 | 0 | 3 | PALLET INSTRUMENTATION BOX |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 5 | 0 | 3 | 0 | 4 | DATA PROCESSOR |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 6 | 0 | 0 | 0 | 0 | THERMAL CONTROL |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 6 | 0 | 1 | 0 | 0 | THERMAL COATING |
| 0 | 1 | 0 | 0 | 1 | 0 | 5 | 0 | 6 | 0 | 2 | 0 | 0 | MULTILAYER INSULATION |
| 0 | 1 | 0 | 0 | 1 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | LAUNCH OPERATIONS |
| 0 | 1 | 0 | 0 | 1 | 0 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | PRELAUNCH |
| 0 | 1 | 0 | 0 | 1 | 0 | 6 | 0 | 2 | 0 | 0 | 0 | 0 | LAUNCH |
| 0 | 1 | 0 | 0 | 1 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | MISSION OPERATIONS |
| 0 | 1 | 0 | 0 | 1 | 0 | 7 | 0 | 1 | 0 | 0 | 0 | 0 | MISSION CONTROL |
| 0 | 1 | 0 | 0 | 1 | 0 | 7 | 0 | 2 | 0 | 0 | 0 | 0 | MISSION PLANNING |
| 0 | 1 | 0 | 0 | 1 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | SUPPORT OPERATIONS |
| 0 | 1 | 0 | 0 | 1 | 0 | 8 | 0 | 1 | 0 | 0 | 0 | 0 | EXPERIMENT CREW TRAINING |
| 0 | 1 | 0 | 0 | 1 | 0 | 8 | 0 | 2 | 0 | 0 | 0 | 0 | SUSTAINING ENGINEERING |
| 0 | 1 | 0 | 0 | 1 | 0 | 9 | 0 | 2 | 0 | 0 | 0 | 0 | GSE MAINTENANCE |
| 0 | 1 | 0 | 0 | 1 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | RECOVERY & REFURBISHMENT OPERATIONS |
| 0 | 1 | 0 | 0 | 1 | 0 | 9 | 0 | 1 | 0 | 0 | 0 | 0 | TELESCOPES |
| 0 | 1 | 0 | 0 | 1 | 0 | 9 | 0 | 2 | 0 | 0 | 0 | 0 | ARRAYS |
| 0 | 1 | 0 | 0 | 1 | 0 | 9 | 0 | 3 | 0 | 0 | 0 | 0 | SUBSYSTEMS |

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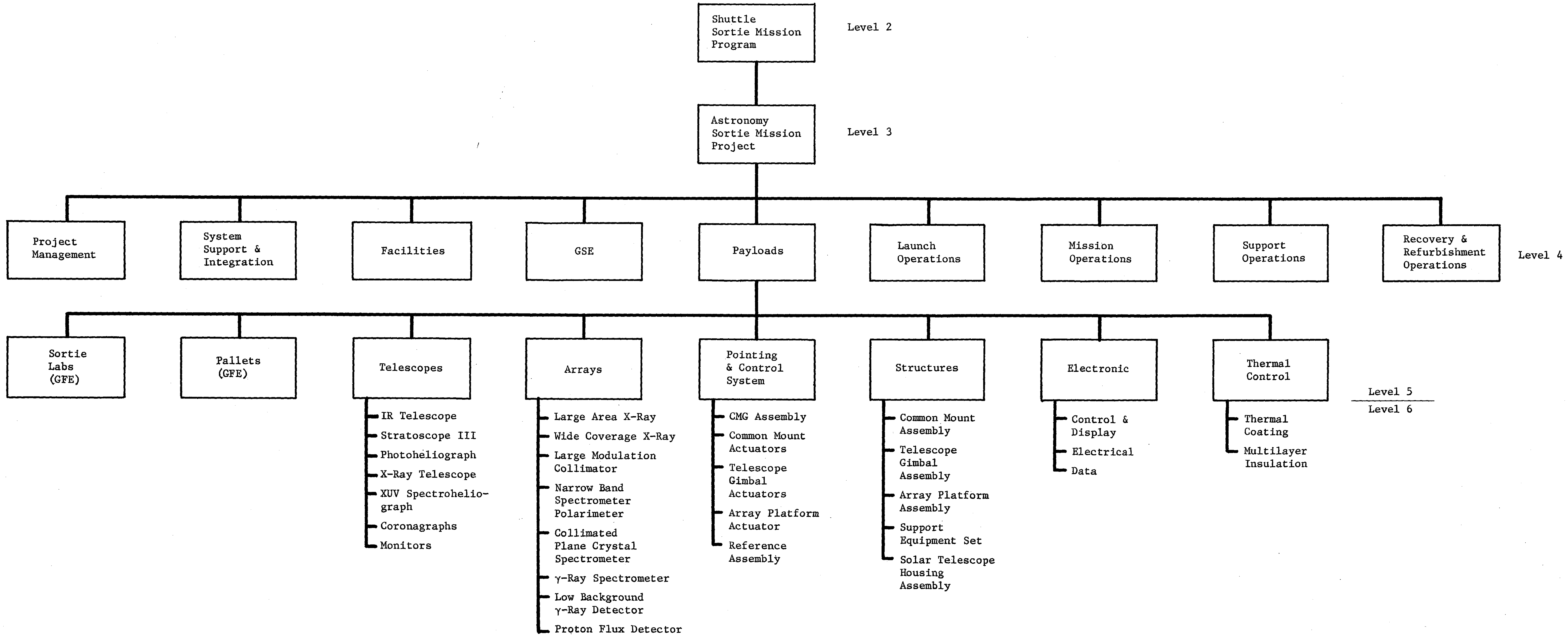


*Fig. IV-2 Work Breakdown Structure (WBS) Diagram*