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Astrometric Telescope Facility: Preliminary Systems Definition Study
Volume III: Cost Estimate

July 1987

National Aeronautics and Space Administration

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Edited by Charlie Sobeck, Ames Research Center, Moffett Field, California

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National Aeronautics and
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PREFACE

This report documents the results of the Astrometric Telescope Facility (ATF) Preliminary System Definition Study conducted in the period between March and September 1986. The main body of the report consists primarily of the charts presented at the study final review which was held at NASA Ames Research Center on July 30 and 31, 1986. The charts have been revised to reflect the results of that review. Explanations for the charts are provided on the adjoining pages where required. Note that charts which have been changed or added since the review are dated 10/1/86, unchanged charts carry the review date 7/30/86. In addition, the report contains a narrative summary of the study results and two appendices. The first appendix is a copy of the ATF Characteristics and Requirements Document generated as part of the study. The second appendix shows the inputs to the Space Station Mission Requirements Data Base submitted in May 1986.

The report is being issued in three volumes. Volume I contains an executive summary of the ATF mission, strawman design, and study results. Volume II contains the detailed study information. Volume III contains the detailed ATF cost estimate, and will have limited distribution.

The study and report presented here are the result of a team effort including personnel from the University of Arizona, the Allegheny Observatory, the University of California at San Diego, and the Ames Research Center. Members of the team were:

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COST ESTIMATE

Approach

The initial Astrometric Telescope Facility (ATF) cost estimate has been based on a combination of two different techniques:

1. The ATF management, science support, and operations costs were estimated using Ames Research Center's (ARC) historical data from space projects, including Pioneer Venus, Galileo, the Infrared Astronomy Satellite (IRAS), and the Space Infrared Telescope Facility (SIRTF).

2. The ATF hardware costs were estimated using the RCA PRICE™ model. This model estimates the costs at the unit level based on mass, volume, and complexity. Complexity of design and manufacture are considered as separate elements in the estimating process.

Significant portions of this estimate were verified by Science Applications International Corporation, in an independent review of the ATF cost estimate sponsored by NASA Headquarters. All costs are in constant 1986 dollars.

Assumptions

Five basic assumptions were used in the cost estimate (All five assumptions are based upon the results of the technical study documented in volume II):

1. The ATF strawman design can be implemented without new technology development.

2. The ATF will be based on a protoflight concept as described in volume II, section 1.6.2. This approach was selected to save costs and is consistent with ARC's experience on other programs (Pioneer Venus, IRAS, and Galileo). Further, the protoflight concept should be particularly applicable to Space Station payloads because the hardware is accessible should a problem arise.

3. The ATF will be provided with Standard Space Station services (e.g., power, data-link, etc.) and in particular, this cost estimate assumes that one of the station-funded Coarse Pointing Systems will be dedicated to ATF use throughout the program.

4. The ATF will use station electronic unit designs with only minor modifications, resulting in significant reductions in development and qualification costs.

5. The ATF program could be completed on a 4-yr schedule from phase C/D contract signing to launch. This tight schedule appears achievable because of the high-heritage, low-technical risk approach to the hardware design. Furthermore, cost optimal unit development schedules predicted by the RCA PRICE™ model are well matched to an overall 4-yr program.

Overall Program Costs

Table 1 gives a breakdown of the cost estimates for the overall ATF program, which include development and operational costs.

Project Management and Science Support

Project Management costs are divided, as shown in table 2, between the project office at ARC and the University of Arizona technical support estimated to be approximately six people at $100 K/person/yr.

The Science Working Group estimate is based on eight part-time people at $24 K/person/yr to cover time and travel.

Hardware Development Costs (Contract)

The hardware development costs estimates as calculated by the RCA PRICE™ model are show in table 3 by subsystem. Detail unit costing was achieved using the model.

Included in this cost estimate are costs of spare units and appropriate engineering and test models.

Operations Costs

The operations costs estimates provided in table 4 are based on historical data from Pioneer operations and the projected SIRTF expenses. These estimates reflect the ATF operations approach outlined in volume II, section 9.0, and provide for round the clock operations for the receipt and logging of ATF data, with scheduling and sequence generation activities limited to single shift, 5-day/wk operation.

Costs for archiving ATF data, or spares maintenance/servicing support, have not been estimated, and therefore are not included in the present figures. Data archiving costs will be strongly affected by the choice of storage medium, degree of access required, and commonalty with other archiving tasks. It is currently anticipated that the ATF will use the same data archiving techniques which will be developed by the Space Station Program for the archiving of Space Station data. Spares maintenance/servicing support will be dependent upon the level of direct commonalty with Space Station hardware. Therefore, although the annual ATF operating costs will increase somewhat above the $7.2 million/yr figure cited in table 4 because of these tasks, it is felt that these costs will be minimized because of the redundancy built into the system and the fact that the ATF measurements are not timecritical in nature.

Cost Risk Assessment

A review of the elements in the strawman design shows that most of the electronics are based on flight proven designs with minor modifications, or Space-Station-Program-developed designs with minor modifications. Therefore, the cost risk associated with the electronics is judged to be low.

Some applied development will be required for the Vibration Isolation/Vernier Pointing System and the Ronchi ruling assembly. Vibration isolation systems with much more severe requirements than the ATF are under development and are in the brass-board demonstration phase at this time. Therefore, it appears that the technology will be well developed to meet ATF schedules. The ruling drive mechanism will require new development as a system. However, it appears it can be designed using existing components. Based on this, neither of these mechanisms is judged to represent major cost risks. Similarly, the structure and optics are new configurations, but are based on existing designs, and therefore, do not appear to represent major cost risks.

Operations for the Planetary Detection program consist of repetitive operations using a single instrument. Although the operations for astrophysics measurements have not been defined, they are similarly constrained by a single instrument, and therefore, should represent no major cost risk. This

belief has been verified by experience with astrophysics investigations using ground-based astrometric facilities. As noted earlier, costs associated with a spares maintenance/servicing support effort have not yet been estimated. This area is an uncertainty at this time and therefore may represent a significant unknown.

Future Refinements

It should be understood that the costs presented in this volume are preliminary estimates only. Effort will continue on the refinement of the cost-model input parameters and verification of its predictions through independent means.

The cost of Space-Station-developed items was estimated through the RCA PRICE™ model. These estimates could be greatly refined if the off-the-shelf purchase price (a model input parameter for modified items) were determined for these units.

Costs associated with data archiving and spares maintenance/servicing support will be addressed in the future.

TABLE 1. - OVERALL PROGRAM COSTS

TASKS	MILLION DOLLARS*
ATF Development Program	
Project Management	2.0
Science Support	3.2
Operations Development	16.6
Hardware Development Costs	159.4
Software Development Costs	12.6
Subtotal	193.8
Contingency (20%)	38.8
Total Development Costs	232.6
ATF Operations (20 yr at $7.15 million/yr)	143.0

*Constant Fiscal Year 1986 Dollars.

TABLE 2. - PROJECT MANAGEMENT AND SCIENCE SUPPORT

	Million Dollars*
Project Management	
ARC (20-man staff)	2.0
Science Support	
University of Arizona Technical Support	2.4
Science Working Group	0.8

*Constant Fiscal Year 1986 Dollars.

TABLE 3. - HARDWARE DEVELOPMENT COSTS (CONTRACT)

TASKS	MILLION DOLLARS*
Hardware Development	
Telescope	58.1
Command and Data	25.6
Pointing and Control	36.8
Power and Harness	0.6
Launch Support Structure	5.0
System Level Contractor Activities	33.3
Total Development Costs	159.4

*Constant Fiscal Year 1986 Dollars.

TABLE 4. - OPERATIONS COSTS

TASK	MILLION DOLLARS*
ATF Operations**	
Mission Operations Staff (38 people @ $100K/yr)	3.8
Hardware Maintenance	0.2
Science Planning Support	0.2
Data Analysis	3.0
Total Recurring Costs	7.2
Total Mission Costs (20 yr)	143.0

*Constant Fiscal Year 1986 Dollars.
**Data archiving and spares maintenance/servicing support cost not included.

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16. Abstract

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