CENTRAL INTELLIGENCE AGENCY
WASHINGTON, D.C. 20505

EARLY ON
C PROGRAM
REVISION #1

BYE-7517-69
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16 JUL 1969

MEMORANDUM FOR : Comptroller, National Reconnaissance Office

SUBJECT : FY 70 Financial Program for Electro-Optical Imaging

1. Submitted herewith is the subject Program including cost projections through FY 75.

2. This document details The Program Plan with a four-year cycle to Initial Operational Capability. The elements of the Plan and the costs are as discussed with the Director, National Reconnaissance Office on 16 May 1969. Detailed discussions have been held with contractors, and schedule and cost estimates were generated for each item as well as for the overall plan.

3. The FY 71 through 75 cost data have been developed as upper limit budgetary estimates. The system development costs are based on costing separately each of the major sub-system elements. The total system as compiled in this way has been compared with actual cost experience on current satellite reconnaissance systems.

4. An essential feature of the overall acquisition plan discussed in the attached documents is the competitive system definition phase to be conducted during FY 70. The program funding for FY 70 will permit detailed system design (on a competitive basis) during FY 70. Therefore, by the end of

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SUBJECT: FY 70 Financial Program for Electro-Optical Imaging

FY 70 and prior to the final selection of contractor teams, credible program and cost data will be available.

5. This FY 70 Financial Program submission is intended as an alternative to the Electro-Optical Imaging portion of the May 1969 CIA submission for Applied Research/Advanced Technology (BYE-6414-69). However, the STX, STX Readout, and Vidicon portions of the May 1969 plan remain unchanged and therefore are not included in this alternative submission. The FY 70 funding required in these categories is as follows:

STX Sensor

STX Readout

Return Beam Vidicon

6. The total FY 70 funding requested in this submission is [redacted] The three line items mentioned above will require an additional [redacted] for an FY 70 total of [redacted] of initial FY 70 releases (BYE-12934-69) applies against this total FY 70 requirement, leaving an additional [redacted] needed for FY 70.

7. Work is continuing to refine the plans, and changes will be incorporated as they evolve.

Earl A. Myers

EARL A. MYERS
Comptroller
Directorate of
Science and Technology

Att: FY 70 Financial Program
for Electro-Optical Imaging

cc: D/NRO
DD/NRO

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SUBJECT: FY 70 Financial Program for Electro-Optical Imaging

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ELECTRO-OPTICAL IMAGING

FY 70 FINANCIAL PROGRAM

I. INTRODUCTION

The Program objective is to develop a reconnaissance satellite providing a continuous and timely flow of imagery to the Intelligence Community. Strategic intelligence applications include improved efficiency and flexibility in target surveillance, strategic warning/indications support, and crisis management support.

Key technology has been developed to the point that specific system design can begin. The Program looks to System Definition in FY 70, System Development in FY 71-73, and first launch in FY 74. The Master Schedule is shown in Appendix I. System performance goals are summarized in Appendix II.

Detailed definitive proposals have been received for three of the four solid state transducers, and two specific proposals for an optical design and fabrication program have also been prepared. Extensive discussions have been conducted with appropriate contractors concerning system definition and total program costs and schedules. Each major system element has been examined, including principal subsystems for the imaging satellite, the relay satellite, the ground receiving facility, and the ground operations/processing facility.

The preliminary system concept comprises three major elements - the imaging satellite, two synchronous relay satellites, and CONUS ground facilities. The imaging satellite will provide continuous on-orbit availability with minimum life expectancy of one year. The relays will provide continuous communications capability between the imaging satellite and ground facilities. The latter will deliver near real-time readout. Alternate system concepts (store/forward and store/relay configurations) have been studied. They will be preserved as options until all major subsystems have been carefully evaluated in a systems context and final engineering trade-off studies can be made.

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SUBJECT: Electro-Optical Imaging FY 70 Financial Program

II. PROGRAM PLAN

The Electro-Optical Imaging Program is laid out in four phases:

Technology Phase, FY 67 - FY 69

System Definition Phase, FY 70

System Development Phase, FY 71 - FY 73

Initial Operational Phase, FY 74

A. Technology Phase

For the past three years, the Program has been in the Technology Phase. The strategy has been to push the state-of-the-art in key areas and to maintain parallel efforts to insure that viable options are available at critical points in the Program. Thus at the present, it is possible to select the solid state array transducers as the candidates for System Definition. Similarly, work in optics, data handling, image reconstruction, and engineering studies has been phased to allow an orderly definition and selection of subsystems to proceed.

B. System Definition Phase

This phase is detailed by category in the FY 70 Financial Plan, below, and presented graphically in Appendix III. The overall objective of the FY 70 Program Plan is to develop the design, schedule, and cost data necessary to support a detailed program review prior to committing to system development. The FY 70 cost of achieving this objective will be less than five percent of the total system development cost. In order to preserve a competitive posture until definitive cost and Program data can be developed, at least two contractor teams for each major system element will be carried through the FY 70 System Definition.

SUBJECT: Electro-Imaging FY 70 Financial Program

Because the initial system definition work is required to select the overall concept, it is planned that subsystem tasks will be phased to conduct analyses and order long-lead equipment first. After the selection of key parameters such as altitude, specific designs will be started, and all activities will be focused in support of detailed system definition.

The System Definition Program will consist of the following major elements:

1. Imaging Satellite

a. Imaging Satellite - System Definition RFP's to five contractors, preliminary design by three, detailed design by two (selection of one to be made in FY 71);

b. Transducers - Prototype design, fabrication, and test of three of the four solid state arrays (selection of one to be made late in FY 70);

c. Transducer Evaluation Facility - Design and fabrication for use in the engineering development program;

d. Telescope - Design, fabrication of prototype optical elements, and interface studies by two contractors;

e. Digital Tape Recorder - Completion of breadboard;

f. [redacted] - Analysis, design, and prototype fabrication;

g. RF Power tube - Analysis, design, and breadboard.

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2. Relay Satellite

Six month government configuration study and System Definition Studies by two contractors. It is anticipated that the basic spacecraft design generated on other programs can be utilized, and the primary effort will be in the payload area.

3. Operations/Processing Facility

a. Facility - System Definition RFP's to four contractors, selection of two, and ten months design and breadboard/test;

b. Image Processing - Analysis and eight months laboratory tests.

Based on the foregoing, the System Development Phase will take approximately three years. Schedule Milestones are shown in Appendix I. It is now premature to specify the contractual relationships that should be utilized. However, contingent upon results of the System Definition Phase, current thinking calls for three prime contractors, one for each of the main system segments - imaging satellite, relay satellite, and operations/processing facility. The imaging contractor would have responsibility for overall system integration.

III. FY 70 FINANCIAL PROGRAM

The summary of the Financial Plan is submitted on the following page. Supplementary projections, FY 71 - FY 75, are attached. A breakdown of nonrecurring/recurring costs, which form the basis for the FY 71 - FY 75 spread, is contained in Appendix IV. The estimates include procurement imaging satellites, three relay satellites (including one reserve), the necessary ground facilities (receiving facility and operations/processing facility), and

FY 70 FINANCIAL PROGRAM RECOMMENDATIONS FOR ELECTRO-OPTICAL IMAGING PROGRAM

SUMMARY

	($ millions)
I. IMAGING SATELLITE	
A. System Definition (including RF ground receiving equipment design)	
1. Phase I	
2. Phase II	
B. Transducers	
C. Transducer Evaluation Facility	
D. Telescope	
E. Digital Tape Recorder	
F.	
G. RF Power Tube	
TOTAL	
II. RELAY SATELLITE	
III. OPERATIONS/PROCESSING FACILITY	
A. System Definition (including design and breadboard)	
B. Image Processing Techniques	
TOTAL	
TOTAL - FY 70	

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FY 70 FINANCIAL PROGRAM RECOMMENDATIONS

ELECTRO-OPTICAL IMAGING PROGRAM

I. IMAGING SATELLITE ($ millions)

A. System Definition

1. Phase I

Phase I will occur during the first half of FY 70. RFP's will be sent to the five candidate contractors in early FY 70. Before the end of first quarter, three will be selected to define alternative overall system configurations within general system specifications and to develop preliminary design concepts for those configurations. This work will include the following tasks:

a. Identification of the major subsystems in each of the system segments of the system configuration.

b. Identification of the functional requirements for each major subsystem.

c. Identification of the major trade-offs between the controlling subsystems.

d. Determination of technology boundaries which constrain the preliminary design trade-offs.

e. Formulation of performance estimates for each of the system segments and major subsystems of the system configuration.

f. Estimate of the performance, cost, development schedule, technical risk, reliability, and growth potential of the system configuration.

The initial effort will be examination of overall system concepts to determine altitudes to be used, types of orbits,

numbers of satellites, and other key parameters which will define overall system capability. A complete analysis will be made of the implementation and deployment plan for the electro-optical imaging system. A detailed review will be made of this work, and one system concept will be selected.

The contractors will then define alternative imaging satellite and RF receiving facility configurations, including subsystems, within the constraints of their EOI system configurations. Each contractor will submit a preferred imaging satellite configuration candidate for detailed design during Phase II. The selection criteria will be based on factors including performance, technical risk, cost, schedule, reliability, and growth capability.

2. Phase II

Based on firm specifications for the selected configuration from Phase I, two of the three contractors will be selected to develop a specific imaging satellite and RF ground facility design. These will be in sufficient detail, including equipment and interface specifications, to establish a firm and realistic system baseline. Planning shall be focused to permit initiation of a well-defined development program early in FY 71. Drawings and documentation shall be sufficient to conduct a system PDR in early FY 71. All subsystems and subcontractors shall also be identified in detail. Alternate transducers will be considered until the end of Phase II since there are no major system consequences from the specific selection. Contractor submissions will include firm cost/schedule proposals for imaging satellite development.

B. Transducers

The FY 69 Technology Program included study and breadboard activities on four alternative solid state array transducers: The Fairchild Quasi-Linear Phototransistor

array; the TRW Polytransistor Array; the Westinghouse Photodiode Array; and the Westinghouse Photocathode Array. Design studies and breadboard fabrication have been completed for the Quasi-Linear Array and the Polytransistor Array. Both Westinghouse transducer activities were started later in FY 69 and lag the other two programs, but plans include increased effort to improve the schedule.

Prototype development, fabrication, and test programs will be conducted in FY 70 for three of the four solid state transducers.

The prototype arrays will include a minimum of [redacted] elements and all associated on-board readout and processing electronics. The design, fabrication, and packaging of the prototype devices will be consistent with the requirements for flight hardware. Each of the prototypes will be thoroughly tested for all important characteristics. In addition, the practical imaging properties of these devices will be evaluated in a quantitative sense. Prototype fabrication and test programs will be supported by engineering design analysis and fabrication technology development programs. The objective of this activity is to obtain sufficient quantitative specification and performance information, along with supporting engineering feasibility information, so that one of the transducers can be selected by late FY 70 for system development.

The prototype device development activities will be closely coordinated with spacecraft data-link and optical system design studies. Particular emphasis will be placed on definition of the interfaces between the solid state transducers and the closely related vehicle subsystems.

C. Transducer Evaluation Facility

A test facility for evaluation of transducer prototypes will be designed and fabricated during FY 70. It will enable all candidate transducers to be tested and evaluated under identical conditions. The facility will include a simulated ground scene, appropriate optical systems, and a breadboard data processing/image reconstruction system. The data processing and image reconstruction portions of this test facility are not intended to function as a ground facility prototype but, rather, will be specifically designed to meet the specific objectives of transducer imaging testing.

D. Telescope

Studies of the optics required by an EOI System have been conducted in FY 69. Tasks in FY 70 will include system design and fabrication and testing of elements. Analysis will be undertaken to identify interface requirements and to provide inputs to the system development effort. Detailed study will include image motion compensation, focusing, filters, mass properties, and thermal control tolerances.

E. Digital Tape Recorder

Design and development will be initiated in FY 70 on a breadboard digital tape recorder. The current concept is that four recorders and one backup unit may be used if desired to store the formatted serial data from the transducer prior to transmission. Techniques developed here will also be used for the necessary wide bandwidth digital tape recorders required at the various ground sites. (The question of storage backup will be resolved during the System Definition Phase.)

F. [redacted]

The attitude control system (ACS) will use [redacted] simulation studies are necessary to establish the performance capabilities of the configuration concepts. The results of these studies will assist in selecting a [redacted] configuration and in establishing an ACS design. A prototype unit will be built to verify performance projections and provide data for flight design units.

G. RF Power Tube

The imaging satellite to relay satellite data link requires wide-band transmission capability. The frequency bands under consideration are in the region from [redacted] An analysis of the requirements will provide preliminary specifications, and a breadboard and engineering model will be fabricated. Laboratory testing will be conducted to produce data for the design of prototype/flight units.

TOTAL - IMAGING SATELLITE [redacted]

II. RELAY SATELLITE

The critical relay satellite requirements will be examined by a government study in early FY 70. The results of that study and of communication link analyses conducted in Phase I of the imaging satellite work will be used to issue RFP's and to choose two contractors to work during the final half of FY 70 on developing preliminary design within overall system specifications.

TOTAL - RELAY SATELLITE [redacted]

SUBJECT: FY 70 Financial Program Recommendations

III. OPERATIONS/PROCESSING FACILITY

A. System Definition

Preliminary design concepts will be developed for the facilities and system definition RFP's issued in early FY 70. Two contractors will be selected by the end of the first quarter to begin detailed preliminary design and breadboard/test work. The work will include definition of the equipment and interface specifications. Designs will be in sufficient detail to enable development work to be initiated in early FY 71 by one selected contractor.

B. Image Processing Techniques

Image processing as used in this context applies to all those image data handling functions which affect image quality and to those system characteristics that contribute to estimation of system performance. Those functions include the following areas:

1. Video Signal Formatting
2. Signal Processing
3. Video Data Storage
4. Image Reconstruction
5. Two Dimensional Image Data Processing

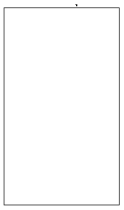
The FY 70 Program Plan for this area of activity is divided into two tasks. The first is preliminary design activity with the objective of identifying the major trade-offs available in image data handling between the ground facility and the imaging satellite. A major portion of the effort will be concerned with developing the appropriate methodology for characterizing the performance of the image data handling subsystems so that quantitative trade-off studies can be conducted.

SUBJECT: FY 70 Financial Program Recommendations

The second task area is concerned with those ground facility data handling functions which are essentially independent of the particular imaging satellite configuration. This task will be concerned with developing alternative approaches to the video data storage function and the image reconstruction function. In addition, the feasibility of mechanizing generalized two dimensional image processing will be studied.

TOTAL - GROUND FACILITIES

TOTAL - EOI - FY 70



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COST PROJECTION FY 71 - FY 75

ELECTRO-OPTICAL IMAGING PROGRAM

($ millions)

DEVELOPMENT PROGRAM	FY 71	FY 72	FY 73	FY 74	FY 75	TOTAL
Imaging Satellite						
Nonrecurring						
Relay Satellite						
Nonrecurring, plus three flight units, including one backup						
Ground Facilities						
Nonrecurring						
TOTAL						
OPERATIONS						
Launch Support, plus two years' operations						

FOLLOW-ON PROCUREMENT

Launch Vehicle/LVI costs are not shown since it is assumed that they will be budgeted and funded by SAFSP. The costs are estimated at [redacted] spread FY 72 through FY 75.

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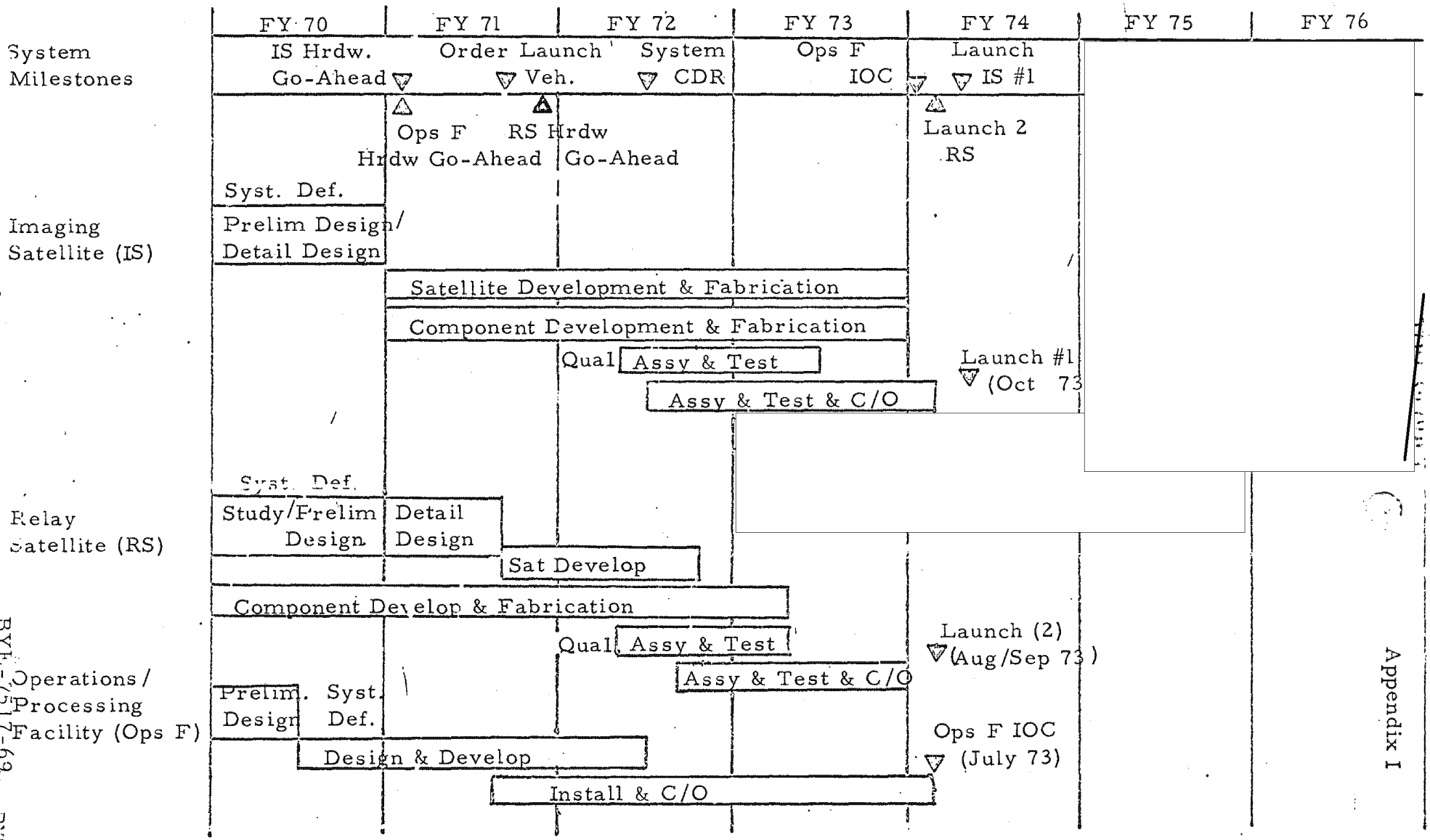
ELECTRO-OPTICAL IMAGING PROGRAM

MASTER SCHEDULE



EOI PROGRAM

SYSTEM PERFORMANCE GOALS

RESOLUTION	2'
FRAME SIZE	3 x 3 to 6 x 6 n.m.
ACCESS SWATH	600 n.mi.
FRAMES/DAY	
SATELLITE LIFE	
IMAGE RECOVERY	
GROUND FACILITY	CONUS
RELAY LIFE	

EOI COST PROJECTIONS, FY 71 - FY 75

($ millions)

	Non-Recurring	Recurring Unit	Recurring 3 Units
I. IMAGING SATELLITE (3)			
TOTAL, Non-Recurring			
II. RELAY SATELLITE (3 - including 1 reserve)			
TOTAL, Non-Recurring plus three flight units			
III. GROUND FACILITIES			
A. Receiving Facility -			
1. Site acquisition (50 acres), 4,000 sq. ft. building, foundations for three 85 ft. antennas, limited messing facilities, water, power. sewer, security fencing, design and administration fees			
2. Development/procurement of three antennas, receiving, demodulation, recording, and transmitting equipment			
TOTAL, RECEIVING FACILITY			

IV. OPERATIONS (continued) ($ millions)

B. Ground Facilities - Annual Cost

1. Receiving Facility - 24 personnel, engineering and support.

2. Operations/Processing Facility - 72 personnel, engineering and support.

TOTAL, ANNUAL OPERATING COST

V. LAUNCH VEHICLES/LVI

A. Relay Satellites - 3 Titan III B's including one reserve.

B. Imaging Satellites

C. LVI

TOTAL, LAUNCH VEHICLE/LVI

III. GROUND FACILITIES (continued) ($ millions)

B. Operations/Processing Facility - area, land and standard services availability

1. Building (15,600 sq. ft.), emergency power, design and administration fees.

2. Development/procurement of formatting, image processing, storage/retrieval, and display equipment. (IOC is assumed. Depending upon final concept, the estimate could range up to

3. Procurement of equipment for targeting, command generation, ephemeris generation, and engineering analysis.

TOTAL, OPS/PROCESSING FACILITY

C. Ground Facilities Data Link - assume coaxial cable, 100 miles

TOTAL, DEVELOPMENT

IV. OPERATIONS

Assume launch of two (2) relay satellites and one (1) imaging satellite in FY 74,

A. Launch Support (relay/imaging contractors)

1. 2 Relay Satellites

2. Imaging Satellites

TOTAL, LAUNCH SUPPORT

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