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23 June 1964

MEMORANDUM FOR: Deputy Director of Central Intelligence

THROUGH : Executive Director-Comptroller

SUBJECT : Project FULCRUM

1. This memorandum contains a recommendation for your approval. Such recommendation is contained in paragraph 5.

2. The attached history of Project FULCRUM traces the sequence of the studies, experiments and determinations which have culminated in the proposal for developing a three foot resolution satellite photographic system with large swath width coverage.

3. To develop a complete satellite system and commence operational procurement will require $54.3 million in Fiscal Year 1965 and between $124 and $157 million in FY 1966, depending upon booster costs and availability of launch facilities. The Agency has prepared an addendum to its NRO budget to accommodate the costs reflected above, however, we can commence this program immediately should sufficient year-end funds be available to the Agency.

4. Specifically, we propose that $50,000 be granted to commence detailed lens design, and additional $800,000 be earmarked to produce detailed design and actual brassboard working models of two separate film drive systems. One model will move film at a constant rate now estimated at 155 inches per second, the other model will allow exposure of the film frame after frame but necessitate storage of film loops to account for the periods during which no exposure is made. The Itek Corporation will be the contractor for both the lens and film drive efforts.

BYE-0152-64

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5. It is recommended that you approve the expenditure of the $850,000 of Fiscal Year 1964 funds as stated above for Project FULCRUM.

(Signed)
ALBERT D. WHEELON
Deputy Director
for
Science and Technology

CONCUR:

X
Executive Director-Comptroller

APPROVED:

(Signed) Lyman Kirkpatrick
(for) Deputy Director of Central Intelligence

Attachment:
History of Project FULCRUM

PROJECT FULCRUM

In May 1963 the Director of Central Intelligence convened a panel of scientific and technical experts, chaired by Dr. Edwin Purcell, to determine the future role and posture of the United States Reconnaissance Program. By June of the same year, the Panel had submitted its report which, among several recommendations, suggested that an improvement program be undertaken in the CORONA Project to optimize the performance of that system throughout the duration of a mission. A study was conducted to identify measures which could be taken to improve CORONA; however, there was little effort made to solicit Agency participation or advice. Shortly thereafter, the Agency independently prepared its own critique of the Air Force's CORONA improvement plan and this critique led to the establishment of the Drell Committee which again reviewed measures to improve CORONA, but this time with joint Agency/Air Force membership. Action on the Drell Report was delayed when the National Reconnaissance Office proposed to refer the Drell recommendations to yet another committee.

Shortly thereafter, the Agency independently generated internal efforts to assess the United States satellite reconnaissance needs. In cooperation with various Agency components, the DD/S&T reviewed the type and characteristics of USIB reconnaissance targets and requirements and the kinds of coverage necessary to satisfy our intelligence needs.

A rather detailed experiment was conducted with twenty-five photo interpreters from the National Photographic Interpretation Center to ascertain the resolution required to identify the various targets comprised in the USIB requirements. During the experiment, targets were interpreted under varying resolution from [redacted] to ten feet. The pure analysis of a photographed target was considered also against the type of target, the number of targets, weather conditions, the weight of payloads and finally boosters, economically available.

The result of this experiment demonstrated that the majority of targets could be properly identified with resolution in the two to four foot category. It was also

evident that with booster capabilities economically limiting payload to the five-thousand pound, or that of the Atlas/ Agena or Titan II, the camera system had to provide for large swath width coverage.

To augment the in-house CIA effort then underway, a study with the Itek Corporation was initiated in February 1964 to determine the feasibility and potential intelligence value of using various individual sensors or combinations thereof in a satellite system. Heretofore, little attention had been devoted in the exploration of sensing devices other than with a black and white film system. Under this study, titled Project FULCRUM, Itek analyzed the various sensing techniques such as infra-red, ultra-violet, color, microwave, etc. and evaluated each by itself and in combination with one another, against performance capabilities, environment, size and cost, processing and interpretation, and atmospheric limitations.

The Itek study concluded that black and white photography can still satisfy the majority of USIB reconnaissance requirements, but to do so properly, efficiently and economically, large swath width coverage with at least four foot resolution would be required. It was obvious to the Agency that the next satellite system, although presently limited by state of the art developments to black and white photography, should possess the inherent potential to accommodate technological advancements in color photography, infra-red, image intensifiers and readout capabilities.

Paralleling the Itek effort, the Space Technology Laboratories under Agency contract explored the feasibility of spin stabilizing satellites, thereby permitting fixed optics to sweep or pan the entire earth's surface beneath, or in effect produce an horizon-to-horizon swath. In spinning the entire spacecraft, STL felt that it could be feasible to permit total target area coverage in low resolution with a payload system in the five-thousand pound category.

In essence then, each effort, the Agency's as well as Itek's and STL's, independently concluded that we needed CORONA-type coverage with consistent GAMBIT-type resolution.

During the latter half of May, the DD/S&T decided to prepare a proposal for a satellite which could demonstrate

the technical feasibilities of developing a 5000-pound payload package which could provide large swath width coverage with four foot or better resolution, thereby replacing the present CORONA and GAMBIT programs with a single system.

Under DD/S&T direction, the Itek Corporation and STL joined forces to demonstrate with sufficient engineering design and computations the feasibility of such a system. The system devised employed two Itek cameras in an STL stabilized spacecraft with a simple recovery system and placed in orbit by a modified Titan II booster. The camera optics suggested are a relatively simple Maksutov reflective system F-3 lens with 60-inch focal length employing a corrective lens, beryllium mirror and eggcrate quartz main plate. The cameras are designed to allow the addition of image intensifiers and a readout system and are so mounted to permit one to look 15° forward of the nadir and the other 15° aft, thereby producing stereo photography. The cameras spin within the spacecraft counter to one another along the flight axis over a 120° scan angle with a swath width of 360 nautical miles and resolution from 2.7 to 4 feet from 100 miles altitude. Lower orbits would improve the resolution proportionately but reduce swath coverage. As now proposed, the film will be moved at a constant rate of 155 inches per second. Since the camera will be looking inside of the spacecraft during 2/3 of its revolution, the film, because of its continuous movement, will only be exposed for 1/3 of the time. As a result, the film passes through the camera system three times during each mission, exposing 1/3 of the film each time. Upon completion of the mission, the film will then be fed by a leader from the camera into the spool in the recovery vehicle. The spacecraft used for housing the payload and performing attitude and program control can be one of straightforward design employing hardware from the Vela Hotel, POGO and OGO programs. The cameras will each carry 34,000 ft. of seven-inch film producing 11.6 million square miles of stereo photography or about 23 times the amount of all the film carried in the GAMBIT system.

Conservative estimates suggest a twenty-four month development program with first operational flight some twenty-seven months following program go-ahead. Based upon this schedule, and assuming a July 1964 go-ahead, a

five-year program of 34 operational launches is as follows:

FY 65	54.3	
FY 66	156.9 #	
	124.2	
FY 67	148.8	3 test and 10 ops launches
	130.8	
FY 68	149.0 #	12 ops launches
	128.6	
FY 69	66.5 #	12 ops launches
	60.6	

Depends upon booster costs and modifications. (5.2 vs. 3.5 for each Titan II)

Cumulative costs over the five-year period should run between $498.5M and $575.5M, depending upon booster costs. By replacing the CORONA and GAMBIT programs at their current launch rate mid-way through FY 67, FULCRUM is projected as amortizing its own development costs by the turn of FY 68-69 and actually saving the Government at least $100 to $177 million by the end of FY 69.

Detailed Fiscal Year 1965 and 1966 Summary:

		FY 65	FY 66
a.	Camera		
	Design & Dev.	$15.8	$10.6
	Production	-0-	12.8
	Facilities	3.0	-0-
		$18.8	$23.4
b.	Spacecraft		
	Design & Dev.	$17.0	$38.0
	Facilities	.5	2.5
	Production	-0-	27.0
		$17.5	$67.5
c.	Booster		
	Modification & Design	$ 8.0	$21.2
	Production & Launch	-0-	24.0
		$ 8.0	$45.2

d.	Recovery Vehicle		
	Design & Development	$ 5.0	$ 6.0
	Production	-0-	4.0
		$ 5.0	$10.0
e.	Launch Facilities		
	Modification Construction and Equipment	$ 4.0	$ 7.0
f.	Engineering for Assembly, Integration and Checkout	$ 1.0	$ 2.8
g.	Film	$ -0-	$ 1.0
	GRAND TOTAL	$54.3	$156.9

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31 August 1964

MEMORANDUM FOR : Director of Central Intelligence

THROUGH : Deputy Director of Central Intelligence

SUBJECT : Conduct of the FULCRUM Program

REFERENCE : a. DDCI Memorandum to DD/S&T, 27 Aug. 1964
b. DCI Memorandum to DD/S&T, 14 Aug. 1964

1. Purpose - The following basic paper has been prepared in response to recent guidelines (Ref. a and Ref. b) for the conduct of the FULCRUM Satellite Reconnaissance Program by CIA under NRO aegis. It confirms the terms of reference you have established and advances a specific management plan for Phase I FULCRUM development for your approval.

2. Background - The FULCRUM concept grew out of CIA/DD/S&T in-house studies and a small CIA funded ($115,000) effort at ITEK, designed to explore the potential improvement of broad area, general search photographic satellite reconnaissance systems. These studies were conducted primarily during the second half of fiscal year 1964. During May of 1964 a specific system proposal was put forward for realizing remarkable resolution improvement over the present search system (CORONA) while retaining its broad area coverage feature. The basic concept is to exploit the TITAN II booster to place a 5,500 pound photographic payload directly into low earth orbit without the use of additional rocket stages. The payload would consist of two rotating 60 inch focal cameras to give stereo coverage at a nadir ground resolution of 2 to 4 feet across a strip 360 miles wide. The spacecraft would carry enough film (68,000 ft. of 7 inch EK type 4404) to photograph approximately eleven million square miles each mission, at a cost of approximately $10 million per launch. A new reentry vehicle must be developed to return this enormous amount of film.

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This concept was examined critically in June 1964 by a non-government committee under Dr. Edwin Land, who reported that the concept held real promise. He recommended that it should be vigorously explored as to its detailed technical reliability in a Phase I effort during the first half of FY 1965. He and his Panel identified four specific areas that must be demonstrated or analyzed in enough depth to support an all out development and flight program:

a. Feasibility of moving the film rapidly and accurately through the cameras.

b. Stability and noise of the rotating camera bearing system.

c. Compatibility of the all-up payload weight (i.e., cameras, film, re-entry vehicle, spacecraft) with the lifting capability of the TITAN II booster.

d. Composition, coupling, and control of the several components of angular momentum associated with the rotating camera and the high speed film supply.

Dr. Land urged the DCI to move ahead rapidly in exploring these problems in a Phase I feasibility effort.

Subsequent conversations between Mr. Vance and the Director have established FULCRUM as a proper part of the National Reconnaissance Program, to be conducted by the CIA under NRO aegis. They have directed that the TITAN III be considered as a backup to the TITAN II, and that its additional payload capability be explored to see how the FULCRUM concept might be enhanced thereby. With NRO concurrence, CIA made $850,000 of FY 1964 year-end money available to start the program.

3. Terms of Reference - Reference b delineates guidelines for the conduct of the Phase I FULCRUM program and was coordinated with Mr. Vance. This guidance was as follows:

a. There shall be no commitment made to the contractors to proceed past the phase I feasibility effort.

b. CIA is to employ contractors and engineers to the fullest possible extent, avoiding unnecessary expansion of the DD/S&T staff.

c. CIA is to reserve as an "in-house" responsibility the supervision and guidance of the contractors and engineers.

d. Employment of a systems engineering contractor responsible for: (i) developing plans, specifications, etc., for all phases of the project on an integrated basis, and (ii) performing such other functions as DD/S&T may direct. The systems engineer could, under DD/S&T direction, assume a coordinating and supervision function, but should not act as a prime contractor for the other contract efforts. The selection of this contractor need not be made competitively.

e. Competitive contracts with two or more contractors to study and demonstrate the film transport mechanism.

f. Contract for camera design and feasibility demonstration, which probably should go to ITEK because of their own input to the basic FULCRUM concept.

g. Competitive selection of a spacecraft design study contractor.

h. Subsequent instructions included competitive selection of a re-entry vehicle design study contractor.

4. Reference a provides that:

a. Command, control, supervision and direction of the entire FULCRUM Phase I program is assigned to DD/S&T.

b. Coordination, liaison, project integration and engineering support will be provided to DD/S&T by the systems engineering contractor, who will have direct access to all other contractors.

c. DD/S&T will keep NRO fully and completely informed of its progress through regular monthly progress reports and/or briefings, and will provide

information copies of contractor work statements to NRO.

d. DD/S&T will act as the sole point of contact and direction in the government for the FULCRUM contractors.

e. Additional funds up to $4.5 million may be committed against the DD/S&T plan, as approved by the DDCI. As in any such program, the contractors will be reimbursed by CIA as the work progresses, subject to the satisfaction of the CIA as to its quality. The NRO will reimburse the CIA for funds expended in the FULCRUM program in accordance with previous agreements between Mr. Vance and the Director.

f. A specific unit will be established in DD/S&T reporting directly to the DD/S&T to manage the FULCRUM and other satellite programs. In consonance with the Director's discussions with the PFIAB and Secretary McNamara, it should be no larger than 20 or 30 technical people depending on the impact of other programs, but may utilize covert support capabilities elsewhere in DD/S&T to accomplish its assigned mission.

5. DD/S&T Organization - I have created a Special Projects Group within DD/S&T to handle all CIA satellite reconnaissance programs, viz., FULCRUM, [redacted], ZOSTER, and eventually CORONA. This group reports directly to me and is headed by Mr. J. D. Maxey. His group now consists of 11 CIA staff technical professionals and 6 support people, most of whom have been previously involved but are now being brought together in one unit. In addition, we have 4 technical professionals now in our recruiting pipeline who will be assigned to this group. However, only 8 technical people are focused on the FULCRUM project per se, so that we are well within the Director's guidelines to hold down the in-house personnel build up. If anything, we are somewhat light compared with comparable activities, and we will probably eventually grow to fill the 20-30 authorization mentioned by the Director to the PFIAB. Covert support will be provided by the Office of Special Activities, for the time being, and Mr. John McMahon

has been assigned to the Special Projects Group to ensure that contracts, security, and communications support are adequate to the need.

6. The Special Projects Group will be responsible for the prosecution of the Phase I FULCRUM program, subject to my guidance and supervision. They will act as the single point of contact within the Government for the FULCRUM contractors, They will exercise command, control, and supervision over the entire program and, with me, will be responsible for the decisions and actions that only the Government can take. This group will prepare all progress reports for the NRO and yourself. It will be responsible for the preparation of contractor work statements, evaluation of proposals and funded efforts, and the final presentation of the integrated FULCRUM system concept. In this role, they will be heavily supported so far as is proper by the systems engineering contractor (see below) who will report directly to them.

7. The Special Projects Group will be expected to examine the technical progress and financial expenditures of each contractor at least once per month so as to ensure that the program promptly and decisively settles the fundamental questions relating to the FULCRUM feasibility. This group will be responsible for approving all contracts and authorizing the release of funds and payment for satisfactory work. It will approve the need-to-know for security access within the contractor structure and will recommend, for my approval, FULCRUM clearances for other portions of Government. It will also be responsible for establishing appropriate contact with the Space Systems Division of the Air Force Systems Command, who are presumably the logical supplier for booster and launch facility information relevant to the basic system design and feasibility demonstration.

8. Contracts and Schedules - General - The Phase I FULCRUM program will last approximately six months and could begin on a broad front on the first of September. This program is designed to provide in February 1965 all analysis and the working demonstrations needed to establish the feasibility of FULCRUM and support a decision to proceed with its development. However, no contractor will be given any basis for assuming that a Phase II program is

authorized or should be expected: all work statements for Phase I will carry an explicit warning to this effect. On the other hand, if it becomes clear as the program progresses that it either is or is not likely to carry forward, authorization will be sought from the Director and Mr. Vance to so advise the contractors so that they will not dissolve prematurely or continue unnecessarily the unusually well qualified design teams who will be engaged in Phase I. A detailed funding and scheduling breakdown is attached.

9. The contractual structure is divided into the components discussed in the Director's guidelines:

a. Camera design.

b. Film handling.

c. Spacecraft.

d. Re-entry vehicle.

e. Systems engineering.

The substance of the effort to be conducted under each component and their general terms of reference is outlined below, together with the proposed contractors and the anticipated funding level.

10. Camera Design - ITEK has already been given a contract to establish the basic feasibility of the FULCRUM camera design, which is now partially funded from a share of the $850,000 provided by the Director (the rest of this sum went to start the film handling work at ITEK). The camera system work has several separate tasks, all of which will run for the entire six months of Phase I.

a.	Optical Design	ITEK	515K
b.	Camera Dynamics	"	706
c.	Test Facility Design	"	50
d.	Camera Design	"	709
e.	Program Analysis	"	14
			1,994K

We are also sponsoring a small (85K) backup study at Perkin-Elmer to explore alternate optical/camera designs so that we will be sure that the eventual ITEK solution represents a true optimum. The total cost of the Phase I camera studies is therefore expected to be approximately $2,079,000.

11. Film Handling - We propose to sponsor two competitive design efforts whose purpose will be to demonstrate that seven inch film can be handled as rapidly and accurately as required by the FULCRUM camera. One of these efforts is now begun at ITEK and partially funded toward an expected total cost of $971,000. A second source with previously demonstrated capabilities in this field is STL and we propose to negotiate a parallel contract with them for $700,000 as soon as possible. Both efforts will attempt to produce an engineering prototype of the film drive, both of which are to be compatible with the camera design and either of which could be used. The total cost to the Government of this effort is estimated to be $1,671,000.

12. Spacecraft - We will conduct a funded competition lasting six weeks in order to provide an objective basis for selecting a spacecraft contractor to conduct preliminary design studies during Phase I and to ultimately build the spacecraft if FULCRUM becomes an approved Phase II program. Three contractors have demonstrated a genuine capability to design reliable spacecraft: Lockheed in CORONA/ARGON/LANYARD; General Electric in GAMBIT; and Space Technology Laboratories in Vela Hotel among others. Our plan is to give each of the three companies a funded proposal contract for $100,000 on 1 September. The detailed work statements and contractual letters are now prepared and ready for release. The results of these efforts will be evaluated during the last two weeks of October and a winner selected. By 1 November the winner will be awarded a $300,000 design study contract for the remaining three months of Phase I, working then as part of the FULCRUM team with DD/S&T and the systems engineering contractor. The total cost of the spacecraft design study would then be $600,000.

13. Re-entry Vehicle - A similar funded competition will be conducted between the two principal designers and

manufacturers of re-entry vehicles: General Electric and Avco. Each will be given a six weeks, $100,000 study proposal contract early in September, the work statements for which are now being drafted. After the results have been evaluated, the winner will be funded to the extent of $300,000 for continuing design studies as part of the FULCRUM team. Total cost to the Government is $500,000.

14. Systems Engineering - We are anxious to establish a systems engineering contract as soon as possible so as to assure maximum effectiveness throughout the entire program. This contractor would be responsible for providing general systems engineering and technical management support to the Special Projects Group of DD/S&T. Specifically, he would be responsible for the budgets governing weight, dynamic balance, electrical power, and expendables (i.e., gas). He would also provide interface control between the contractors and establish a quality and reliability engineering program. He will conduct analysis to determine what test, assembly, and checkout facilities will be required if the program proceeds into Phase II. He will also be responsible for generating and/or checking detailed launch vehicle performance criteria (payload, guidance accuracy, etc.) which in turn will be furnished to the Air Force. Should the program proceed into Phase II, the role of this contractor would broaden to include actual assembly and checkout of the various payloads as they arrive at the launch site from the contractors. The SE contractor will have full and continuing access to all phases of the FULCRUM efforts in the component contractor facilities.

15. We have estimated that this central systems engineering effort should consist of a full time effort by approximately 25 technically qualified people. With adequate computer/simulation support, this amounts to approximately $500,000 for the five month period between 1 September 1964 and the end of Phase I. We have examined the firms suitable for this role and feel that STL is almost uniquely well qualified. STL has by a wide margin the most systems engineering experience, dating back to the beginning of the ballistic missile program in 1954. They have already demonstrated an ability to function in a supporting technical management role to the

Government. We therefore propose to utilize the Director's provision for sole source in this crucial area and proceed as soon as possible to establish such a contract. This effort for $500,000 plus the costs listed above integrate up to $4,500,000 which is requested in addition to the $550,000 already provided.

16. Conclusion - Approval of the above terms of reference and program plan is requested.

(Signed)
ALBERT D. WHEELON
Deputy Director
for
Science and Technology

Approved:

Mr. McCone has read
and approved.

(signed) MSC

/s/ Marshall S. Carter date: 1 September 1964
DDCI