~~TOP SECRET~~

HANDLE VIA BYEMAN CONTROL SYSTEM

BAFA2

~~(S)~~ NATIONAL RECONNAISSANCE OFFICE
WASHINGTON, D.C.

OFFICE OF THE DIRECTOR

February 25, 1969

MEMORANDUM FOR THE DEPUTY SECRETARY OF DEFENSE

SUBJECT: HEXAGON Program Options

In accordance with your request, we have examined a program option for HEXAGON which would include development and procurement of one system, but would postpone procurement of subsequent vehicles until results of the first system flight were obtained. This program is reflected in the cost figures in Attachment 1 (Case B - Option 1), which indicate that FY-1969/1970 funding would have to be increased by $35M, and FY-1969 through 1974 costs would increase by $126M in relation to the currently approved HEXAGON program. These increases result from the fact that additional CORONA and GAMBIT vehicles would have to be procured in the time frame in which the remaining $105M of HEXAGON development funding would also be required. In costing this option, it has been assumed that no improvements or changes in the current CORONA J-3 camera system would be undertaken, and that the new 12" Stellar Index (mapping) Camera which cannot be accommodated on current CORONA vehicles, would neither be considered for launch on an "Improved" CORONA, nor programmed for separate launch. (The current HEXAGON program includes integration of the 12" S/I Camera in development and incorporation of the camera in the system beginning with the seventh vehicle. This 12" S/I camera is to meet DOD large scale mapping requirements and was approved by Mr. Nitze following review by the USIB (which declared that it supported the requirement but that the DOD should validate the value of meeting the requirement in relation to cost); the value to the DOD of meeting the requirement was established by an OSD/DIA committee chaired by the Office of the Assistant Secretary of Defense (Administration). It is

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further assumed in these figures that there would be at least a 30-month gap between the launches of HEXAGON vehicles 1 and 2, and that no significant expenditures would be made to shorten lead time and reduce this gap.

A second option presented in Attachment 1, Case B - Option 2, reflects similar assumptions, except that a separate 12" S/I Camera program, to be launched on Thorad/Agena, is costed for 6 launches to fill the gap until the HEXAGON system incorporating the camera would become operational, indicating that FY 1969/1970 funding would have to be increased by $44M, and FY 1969 through 1973 costs would increase by $188M. A footnote further indicates that if an "Improved" CORONA were also approved along the lines of proposals previously made, the added FY 1969 through 1974 costs would approximate $269M more than the current approved program.

Attachment 2 presents cost data on the option of terminating HEXAGON as of March 1, 1969 (Case B'- Option 1), as discussed at the February 19th meeting with the Bureau of the Budget. It is indicated that, under the stated assumptions, a $98M reduction in the FY 1970 budget could be effected, with a total reduction of $280M for FY 1968 through 1974. However, if, as is likely, there were generated requirements for improving our search system capability by modifying or replacing the CORONA J-3 camera and if, as is also likely, the requirement for flying the 12" S/I Camera were to remain, the resulting impact could result in an increase rather than a decrease in NRP costs over the next five years. Case B' - Option 2, illustrates that, to provide an "Improved" CORONA with a 32" focal length sensor, launched on a Titan 3B/Agena, and carrying a 12" S/I Camera, would cost an additional $13M in the FY 1970 budget, and a total increase of $133M for FY 1970 through 1974. Thus it appears that, in the event the HEXAGON program were terminated, the resulting effect on the NRP budget, depending program decisions on CORONA improvements and the 12" S/I Camera, could fall between a $280M reduction and a $138M increase.

It is apparent that delaying the HEXAGON program at this time does not offer attractive opportunities for budget reductions. This is because planning for reductions in the HEXAGON and GAMBIT programs and phaseout of the CORONA program have been on the basis of HEXAGON availability approximately on the present schedule and also because substantial commitments and expenditures have already been incurred, not only for the HEXAGON development, but on HEXAGON hardware for the first six to ten flight vehicles. To have achieved any early program cost savings from a prototype program approach such as Case B - Option 1, the approach should have been implemented much earlier in the program than the stage at which we are now in the HEXAGON program.

In general, when considering complex satellite reconnaissance systems, it must be kept in mind that the reliability and effectiveness of the system depends in large measure on fabrication, inspection, test, checkout, launch and operational control procedures used on each vehicle. Such vehicles are not manufactured and stored but depend on stepwise preparation and are validated for flight in the flow from factory to launch pad.

In this respect, procurement of reconnaissance satellites differs markedly from procurement of reusable vehicles for the force inventory. Experience has shown that reliability and consistency of performance depend as much on the continuity and repetitive exercising of all necessary controls and disciplines in the factory-to-orbit sequence as it does on the specific hardware design. Thus the satisfactory flight performance of one prototype vehicle would not provide sufficient assurance of system reliability to obviate the need for overlap of a new system with its predecessor. Even with the relatively mature system with substantial flight experience behind it, great emphasis must be kept on procedural controls and disciplines in order to insure continuing reliability and performance. During the life of the GAMBIT - 1 system (launched every month) during a period of no significant hardware changes the initial favorable flight success history degraded such that the six month running average of success ratio became an unacceptable four-tenths when procedural controls and disciplines were allowed to lapse; stringent attention to this problem resulted in restoration of the success ratio to .9.

You indicated some concern about the technical status of HEXAGON with particular reference to the film transport system development. Attachment 3 provides a brief summary of the current status. The feasibility of development of the HEXAGON camera film transport system and the intricate servo controls associated with this system was a fundamental issue in the initial decision to proceed with this system. The judgements of the best and most experienced satellite camera experts in the Government were sought on this question and the system was also reviewed by the President's Scientific Advisory Committee Panel on the NRP, headed by Dr. Edwin H. Land. All agreed that basically the film transport concept was feasible for engineering implementation but that rigorous attention to engineering design and testing would be necessary to insure development of a successful system. Such rigorous attention has been given to the development of the HEXAGON film transport system since program initiation. Results, as evidenced by successful test demonstrations of the system engineering model, further described in Attachment 3, have indicated that the basic mechanical and servo system designs are sound and meet program objectives. Detailed engineering problems relating to integration of the camera into the satellite vehicle and operation in the vehicle environment are still being worked on, but this is normal for a program of this kind at the current stage of development.

In order to allow ample time for solution of camera development problems, we initially deferred lower-risk portions of the HEXAGON vehicle system until progress in camera development warranted further commitment. I believe that the current schedule is reasonable, although tight, and that a marginally adequate overlap with CORONA exists. While no development as ambitious and significant as the HEXAGON effort is without risk, I do not feel that the program risks are appreciably different than those we accepted when we successfully introduced GAMBIT-3 into the NRP. We must, of course, continue to maintain a high level of program surveillance and management attention in order to insure program success, but on the basis of demonstrated results to date, I believe that we can have reasonable confidence that the HEXAGON system can be brought into operational use within the currently planned schedule constraints.

Alexander H. Flax

3 Attachs

Comparative Costs for Alternative Courses of Action – HEXAGON Program
(Million Dollars)

	FY 68	FY 69	FY 70	FY 71	FY 72	FY 73	FY 74
Case A: Continue HEXAGON on Present Program							
Hexagon:							
Launches	–	–	–	4	4	4	4
Costs	$207	$203	$182	$193	$203	$181	$178
Gambit:							
Launches	8	8	7	5	5	4	4
Costs	$193	$162	$167	$147	$122	$112	$112
Corona:							
Launches	8	7	6	4	–	–	–
Costs	$ 75	$ 49	$ 27	$ 17	$ 2	–	–
TOTAL COSTS	$475	$414	$376	$357	$327	$293	$290

Case B: Develop HEXAGON and Buy One System, but Postpone Buy of Follow-On Systems until First Launch Results Obtained

Option 1: (Assumes no changes in CORONA J-3 configuration, no 12" Stellar Index Camera for mapping and charting, and no increase in costs for other systems where the same companies are involved, other than the Titan Boosters)

	FY 68	FY 69	FY 70	FY 71	FY 72	FY 73	FY 74
Hexagon:							
Launches	–	–	–	1*	–	1	4
Costs	$207	$203	$ 95	$110	$ 87	$153	$178
Gambit:							
Launches	8	8	7	7	7	6	4
Costs	$193	$162	$187	$177	$143	$122	$112
Corona: (J-1, J-3)							
Launches	8	7	7	6	7	6	–
Costs	$ 75	$ 66	$ 92	$ 98	$ 92	$ 27	$ 4
Impact on Other Titan Boosters:							
Costs	–	–	$ 20	$ 20	$ 20	$ 15	–
TOTAL COSTS	$475	$431	$394	$405	$342	$317	$294
FY Cost							
Difference	–	+ 17	+ 18	+ 48	+ 15	+ 24	+ 4
Cumulative	–	+ 17	+ 35	+ 83	+ 98	+122	+126

* A more practical and realistic way to plan the program would be to provide 1 HEXAGON for launch, plus 1 HEXAGON back-up system which could be launched in FY 1971 in the event the first vehicle failed in such a catastrophic way that it would prevent the acquisition of test data. This would involve an additional cost of about $45M for hardware, split $30 in FY 1970, and $15M in FY 1971.

Option 2: (Assumes no changes in CORONA J-3 configuration, but that the 12" Stellar Index Camera would be flown separately until Hexagon could carry)

	FY 68	FY 69	FY 70	FY 71	FY 72	FY 73	FY 74
Hexagon:							
Launches	-	-	-	1	-	1	4
Costs	$207	$203	$ 95	$110	$ 87	$153	$178
Gambit:							
Launches	8	8	7	7	7	6	4
Costs	$193	$162	$187	$177	$143	$122	$112
Corona: (J-1, J-3)*							
Launches	8	7	7	6	7	6	-
Costs	$ 75	$ 66	$ 92	$ 98	$ 92	$ 27	$ 4
Separate 12" S/I Camera Program:							
Launches	-	-	-	-	3	3	-
Costs	-	-	$ 9	$ 14	$ 32	$ 7	-
Impact on Other Titan Boosters:							
Costs	-	-	$ 20	$ 20	$ 20	$ 15	-
TOTAL COSTS	$475	$431	$403	$419	$374	$324	$294
FY Cost							
Difference	-	+ 17	+ 27	+ 62	+ 47	+ 31	+ 4
Cumulative	-	+ 17	+ 44	+106	+153	+184	+188

*If the Corona J-3 system were replaced with an Improved Corona, with a 32" focal length sensor, the additional FY 1969 thru 1973 costs would approximate $181M, beyond the preceding cumulative $188M.

Comparative Costs for Alternative Courses of Action - HEXAGON Program
(Million Dollars)

	FY 68	FY 69	FY 70	FY 71	FY 72	FY 73	FY 74
Case A: Continue HEXAGON							
Hexagon:							
Launches	-	-	-	4	4	4	4
Costs	$207	$203	$182	$193	$203	$181	$178
Gambit:							
Launches	8	8	7	5	5	4	4
Costs	$193	$162	$167	$147	$122	$112	$112
Corona:							
Launches	8	7	6	4	-	-	-
Costs	$ 75	$ 49	$ 27	$ 17	$ 2	-	-
TOTAL COSTS	$475	$414	$376	$357	$327	$293	$290

Case B: Terminate HEXAGON (Assumes 1 Mar 69 notice to terminate)

Option 1: (Assumes no changes in CORONA J-3 configuration, no 12" Stellar Index Camera for mapping and charting, and no increase in costs for other systems where the same companies are involved, other than the Titan Boosters.)

	FY 68	FY 69	FY 70	FY 71	FY 72	FY 73	FY 74
Hexagon:							
Launches	-	-	-	-	-	-	-
Costs	$177	$184	-	-	-	-	-
Gambit:							
Launches	8	8	7	7	7	7	7
Costs	$193	$162	$187	$177	$152	$142	$142
Corona: (J-1, J-3)							
Launches	8	7	7	7	7	7	7
Costs	$ 75	$ 66	$ 98	$ 98	$ 98	$ 98	$ 98
Impact on Other Titan Boosters:							
Costs	-	$ 5	$ 20	$ 20	$ 20	$ 20	$ 20
TOTAL COSTS	$445	$417	$305	$295	$270	$260	$260
FY Cost							
Difference	- 30	+ 3	- 71	- 62	- 57	- 33	- 30
Cumulative	- 30	- 27	- 98	-160	-217	-250	-280

Option 2: (Assumes an Improved Corona would be required, as well as the 12" S/I Camera, and that there would be a 5% increase in costs for other systems where the same companies are involved.)

	FY 68	FY 69	FY 70	FY 71	FY 72	FY 73	FY 74
Hexagon:							
Launches	-	-	-	-	-	-	-
Costs	$177	$184	-	-	-	-	-
Gambit:							
Launches	8	8	7	7	7	7	7
Costs	$193	$162	$187	$177	$152	$142	$142
Corona: (Fly J-3's thru Dec 71, then fly Improved with 12" S/I Camera) (Assumes $105M development costs)							
Launches	8	7	7	7	7	7	7
Costs	$ 75	$ 78	$179	$165	$163	$138	$138
Impact on Other Titan Boosters:							
Costs	-	$ 5	$ 20	$ 20	$ 20	$ 20	$ 20
Impact on Other Systems Costs:							
Costs	-	$ 4	$ 14	$ 20	$ 22	$ 24	$ 24
TOTAL COSTS	$445	$433	$400	$382	$357	$324	$324
FY Cost Difference	- 30	+ 19	+ 24	+ 25	+ 30	+ 31	+ 34
Cumulative	- 30	- 11	+ 13	+ 38	+ 68	+ 99	+133

Technical Study of HEXAGON

In 1964 the United States Intelligence Board (USIB) asked the NRO to study a system which would deliver the resolution of the current spotting system (KH-7) while retaining the area coverage capability of the search system (KH-4). Preliminary designs and exploratory development of the optical system were carried out by both the Air Force and the CIA with two contractors and later a third. It was recognized early that the critical problem was the development of a film handling and drive system which would store a very large amount of film, transport it efficiently and drive it during exposure with great precision to compensate for image motion. The intensive design and prototype competition for the total optical system was carried out over more than two years with major emphasis on demonstrating the feasibility of meeting the performance specifications. At least two of the contractors (Itek and Perkin-Elmer) demonstrated feasibility with operating prototypes and the award was finally granted to Perkin-Elmer in March, 1967, largely on the basis of a better optical design and less risk in the film drive mechanism development. The contracts for the Satellite Basic Assembly to Lockheed was not awarded until July, 1967, when a critical review of Perkin-Elmer's effort indicated that progress was sufficient to warrant expenditures in other areas with confidence. The reentry vehicles and the mapping camera were not placed on contract until May, 1968, to minimize expenditures during the high risk portion of Perkin-Elmer's development.

At this time, approximately two-thirds of the Critical Design Reviews of the sensor subsystems are complete. A full flight load of film (105,500 feet) has been wound successfully. The spool has met vibration and shock loading tests. The engineering model camera has successfully met tests of the film drive mechanism and associated servos. The optical performance of the engineering model exceeds specifications. The large test facilities at Perkin-Elmer for thermal, vacuum and acoustic testing are either operational or have passed acceptance tests.

The Satellite Basic Assembly (the Lockheed built orbital vehicle) is judged to be a lower risk item and is not as far in the development cycle as the sensor subsystem, but engineering mockups, the dynamic test vehicle and the static test vehicles are in advanced buildup. A major review was recently completed of the general systems engineering by Aerospace Corporation for the Program Director. This review indicated that the total system was progressing adequately toward an October, 1970 launch date.

At this stage of development, although problems have and will arise, the technical confidence in the HEXAGON is comparable to that in previous programs, e.g., GAMBIT-3, at a similar stage.