DEPARTMENT OF THE AIR FORCE
WASHINGTON 20330

OFFICE OF THE SECRETARY

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APR 30 1969

MEMORANDUM FOR THE DEPUTY SECRETARY OF DEFENSE

SUBJECT: MOL FY 70 Program Options

I understand that week before last, you reviewed a draft memorandum to the President on MOL. Although that particular paper was prepared by Dr. Foster's people, much of the data and information it contained was the result of a collaborative effort by the DDR&E and MOL staffs on an earlier version.

I have no particular quarrel with the data and general information in that draft, although the considerations on GAMBIT-3 did not seem to be particularly pertinent to a choice between MOL and the MOL camera system for an unmanned application.

I believe the attached draft version of a memorandum to the President -- although excessively long -- does bring into sharper focus than the original draft the various facts, factors, and intangibles which should be considered prior to deciding whether to continue the present MOL Program, continue only the camera system in FY 70, or terminate the total activity.

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ROBERT C. SEAMANS, Jr.

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28 April 1969
Draft #3

MEMORANDUM FOR THE PRESIDENT

SUBJECT: Manned Orbiting Laboratory (MOL)

Your expressed desire, as reported by Mr. Mayo, that we fund MOL at less than the $525 million now requested of the Congress for FY 70 has resulted in our making a careful reappraisal of the program. I conclude that we either should fund MOL at a level commensurate with reasonable progress for the large amounts involved, or terminate the overt manned MOL Program and continue only the covert very high resolution (VHR) camera system toward future use in an unmanned satellite.

Before the March reductions in the DoD budget, the MOL Program included development of both manned and unmanned versions, with emphasis on the manned system. In early March, we revised the program to defer further development of the unmanned version and added a fourth manned reconnaissance mission in lieu of the previously-planned two unmanned flights -- the fourth manned flight being added to defer the necessity for any follow-on considerations until the FY 72 budget. We then reduced the January budget request from $576 to $556 million, and later to the present $525 million.

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Our recent reappraisal included the following program options:

1. The previous MOL Program which included both manned and unmanned versions (the unmanned capability has never been publicly announced).

2. Our revised MOL Program of proceeding at this time with only the manned version.

3. A possible satellite system, using the MOL camera, optimized to be unmanned (the planned unmanned version of MOL was a minimum-modification of a manned spacecraft).

4. Cancellation of all activities.

We also considered two other options but rejected these as too expensive in the long run. One of these would slow down the present manned program to a sustaining level in order to reduce FY 70 costs. The other would proceed first with the unmanned version of MOL and maintain the option for subsequent development of the manned system.

By the end of the current fiscal year, approximately $1.23 billion will have been expended in the MOL Program since engineering development began in September 1966. If all activities, including the camera system, were cancelled on

May 1, about $25 million more than is now available to MOL would be needed to complete termination close-out. If a total termination decision were made in July, up to $143 million FY 70 funds would be needed for program close-out.

The following table summarizes pertinent cost and time data for the three program options -- other than termination -- which were considered in our reappraisal.

Item	Option 1 Previous Manned and Unmanned MOL	Option 2 Present Manned-only MOL	Option 3 MOL Camera in Optimized Unmanned Vehicle
o Cost-to-go R&D	$1236M	$1045M(1)	$680M(2)
o Cost per Launch			
Manned	$130-140M	$130-140M	-
Unmanned	$110M	-	$67-73M
o Launches per year	2	2	2
o First Opn'l Launch	Apr 1972	Jan 1972	Jan 1973
o Mature Opn'l System	Oct 1974	Jul 1973	Jul 1975
o FY 70 Funding	$576M	$590M(3)	$175M

Footnotes:
(1) Includes $30 million one-time R&D costs to increase orbital lifetime from 33 to 45 days on the fourth or fifth system.
(2) Assumes few spacecraft modification/camera integration problems.
(3) At the present $525 million level, the first operational launch will take place in mid-CY 1972; a mature operational capability is estimated in January 1974; and the R&D cost-to-go total will be increased $100 million or more.

The following sections briefly discuss:

- o The three options listed above;
- o Manned and unmanned system considerations;
- o The need for VHR photography;
- o The contractors and communities affected by MOL termination;
- o And an overall summary and recommendation.

OPTION 1 - PREVIOUS MANNED AND UNMANNED MOL PROGRAM

In the previous MOL Program, which included both manned and unmanned versions, the manned system was planned for flight first to assure achieving the [redacted] resolution goal and a useful intelligence product at the outset; and to mature the automatic (i.e. "hands-off") camera system for possible unmanned use at an earlier date than probably otherwise would occur.

Various reasons have been cited for also including the unmanned, minimum-modification version of MOL -- possible international objections or foreign threat to manned overflight; possible physiological barriers to 30 day or longer manned spaceflight; the anticipated lower cost of an unmanned system when a reliable automatic camera was available; "insurance" against the possible long delay following a manned flight disaster, etc.

In our March review, we decided to defer any further development activity toward an unmanned version of MOL both to reduce cost and for the following reasons:

o The possibility of serious foreign threat or strong international objections to MOL flights is difficult to assess. There have been no objections to Soviet manned spacecraft traversing much of the Northern Hemisphere (NASA flights have not overflown Russia at low orbital altitudes). If the future MOL situation is similar to our unmanned reconnaissance satellites, a recent special NIE stated that physical interference was unlikely except as a prelude to general war and noted that the Russians stopped objecting to US reconnaissance satellites once they started their own program.

o Experience in the Gemini and Apollo flights, added to extensive earth-bound testing, indicates that there are no physiological barriers to 45-60 day flights.

o It is not necessary to fly the MOL camera system unmanned to demonstrate its capability for automatic operation.

o If unmanned flights are contemplated over an extended period, the unmanned MOL, as a minimum-modified manned spacecraft, is not an optimized system from a design or cost-effectiveness standpoint.

o The "insurance" against delay following a manned spaceflight disaster is a fallacy unless one is willing to pay the "premium". On the other hand, if an urgent need for VHR photography existed, a disaster would probably not be sufficient cause to delay a subsequent manned flight.

For those reasons, we deferred further development activity toward the unmanned version of MOL; however, we directed that the design of the MOL spacecraft retain those basic characteristics which would permit future modification to an unmanned configuration. . . . I recommend that no further consideration be given at this time to resurrecting the previous manned/unmanned MOL Program.

OPTION 2 - PRESENT MANNED-ONLY MOL PROGRAM

The only major extension of technology in the MOL Program has always been the camera system. Many elements of the system -- the Gemini B and Titan IIIM, for example -- are low risk modifications of reliable NASA and Air Force systems. The spacecraft follows standard aerospace design and construction practices; and many critical systems -- the fuel cells, environmental control and attitude control systems, etc. -- are modified versions of those developed for the Gemini and Apollo Programs.

The MOL camera, on the other hand, is a huge and complex device. Not only must it be manufactured with great precision, but several technically difficult-to-achieve on-orbit functions must also be performed with great precision. These functions involve automatic devices which either have never before been used or else represent large extrapolations in technology or operation.

The proper functioning of all of these automatic devices will make possible "hands-off" photography, and are essential if the MOL camera is to be used successfully in an unmanned satellite. In the MOL, the astronauts can, in most cases, also manually "fine-tune" them or substitute a completely manual mode of operation for failed or grossly malfunctioning subsystems.

Some of the astronaut capabilities on-orbit directly associated with the primary objective are:

o To verify alignment and/or realign the optical elements, as necessary.

o To make corrections as necessary in the automatic focus system.

o To correct or refine pointing errors by centering the target in the optical field of view. Since the MOL camera photographs a circle only about 1½ miles in diameter on the ground, accurate pointing is essential. The pointing accuracy necessary for MOL represents almost a three-fold improvement over current capabilities.

o To cancel out tracking errors, as necessary, in the camera system pointing mirror. Unless the target is tracked with great precision, smear will result and degrade the photography by a factor of up to 2. Simulations have shown that the astronauts will be able to provide much finer control than the automatic device -- even when the latter is operating perfectly -- by viewing through the camera optics and tracking manually.

o To determine the amount of haze, shadow, or scene brightness and set the most desirable film exposure time. This can provide up to a 20% improvement in resolution under certain conditions.

Additionally, once the automatic devices are working reasonably well and do not require repeated adjustment or extended manual operation, the MOL astronauts are expected to increase the quantity and quality of photography accomplished through the selection of cloud-free alternate targets and/or alternate targets which have a momentarily increased intelligence value -- for example, a missile in a silo or a space vehicle on a launching pad versus a nearby but empty facility. In comparison with an unmanned satellite using the MOL camera, the manned MOL system is expected to acquire 20-25 percent more cloud-free targets and up to three times as many time-sensitive targets per day on orbit.

The selection of cloud-free alternate targets and/or targets of momentarily increased intelligence value will be accomplished by the MOL flight crew via individual Acquisition and Tracking Scopes. These viewing telescopes have variable magnifications and fields of view and can be operated independently of or slaved-to the camera pointing and tracking mirror, and pointed automatically or manually.

The camera system in the manned MOL also includes a secondary shutter and film supply which will be used by the astronauts both to verify camera performance on-orbit (by developing and viewing film on-board) and also to expose color and/or other special films in those particular cases where this will yield new or additional intelligence information.

[redacted]

All of the critical technical milestones necessary to the success of the manned MOL camera system have already been achieved -- for example, special test and manufacturing facilities and equipment; new optical materials; the precision drive and control mechanism for the pointing and tracking mirror, etc. Not yet demonstrated is the capability to point and track with sufficient precision for unmanned operation; however, these are relatively simple tasks for the astronauts to do with great precision.

The MOL Program to-day is dollar-paced and has been in this situation for the past two years. At the $525 million level in FY 70, the first manned launch in the present program will be about 2½ years later than the first overly-optimistic goal. The program will cost about $1 billion more than the initial estimates. At least half of the delay and perhaps half of the cost increase can be attributed to development stretchouts because of inadequate funding -- for various reasons, not now pertinent -- in FY's 68, 69, and planned for FY 70.

The MOL Program development status today is such -- with sizable quantities of test hardware flowing between contractors; initial flight hardware in fabrication; approximately 80 percent of peak contractor manpower on board, etc. -- that what seem to be relatively minor fund reductions result in disproportionately large development stretchouts and unreasonably large net increases in total cost . . . . In retrospect, because of the many major variations between planned and allocated funds, not all of the approximately $1.23 billion which will have been expended by end FY 69 has been used as effectively as it could have been.

In order to minimize past development stretchouts and the related net increases in total cost, the program has gradually moved toward an expenditure funding basis and all possible non-critical work (from a technical difficulty standpoint) has been deferred as far as possible into the future. As a result, there is no financial flexibility whatsoever in the program; and the planned future work is not as orderly and sequential as it could have been to minimize the risk of additional development delays and cost increases.

To illustrate the funding sensitivity at this point in time, a difference of about $75 million funding in FY 70 (and appropriate follow-on levels in FY 71 and 72) results in a five months difference in first manned launch date and -- <u>more important</u> -- a difference of perhaps $150 million in total cost. I find we could spend approximately $350 million in FY 70 and virtually stand still, increasing the total cost at least that much. I conclude, if we proceed with the manned

MOL Program, that prudent management dictates it be funded at a level commensurate with the large annual investment which must be made in any event.

Besides the implicit value of a military manned space program, another aspect of MOL is worth noting. The performance of the reconnaissance mission by the crew will constitute a real-life experiment for the analysis of human capacities, capabilities, and reactions in a relatively long-duration space flight. The data collected in the MOL flights is expected to constitute a worthwhile contribution to national manned space flight knowledge because the "automatic" characteristics of the camera will permit direct comparison of manned and unmanned satellites. Such data must be collected during the course of the normal reconnaissance mission to anlayze both the camera system and to insure maximum performance by man, and thus, in a sense, is a "bonus" feature. Such information would be of greatest interest to the defense establishment. Since most military space missions can be performed unmanned, we must insure that man has unique or very valuable contributions before we pay the price of sustaining him in space.

OPTION 3 - OPTIMIZED UNMANNED SATELLITE WITH MOL CAMERA

Studies have been made in the past toward the possible incorporation of the MOL camera system into the HEXAGON spacecraft (the medium resolution search system now under development), and certain modifications were made in the basic HEXAGON design to preserve this option. Such a system, using a Titan IIID for the booster, would have a potential on-orbit lifetime of 50 days or more. Film would be returned at intervals via four film reentry capsules and air-caught near Hawaii (the technique used since 1960 for all National Reconnaissance Program unmanned photo satellites).

Although somewhat constrained in scope and depth, these earlier studies do provide a basis for rough estimates of the one-time R&D cost-to-go and the recurring costs of a MOL camera/HEXAGON spacecraft combination. It has been estimated that six spacecraft might be developed, produced, and launched via a Titan IIID from the HEXAGON facility at Vandenberg AFB for as little as $230 million. That total does not include any of the much-more expensive camera system costs and assumes little or no integration problems; problems in the latter regard might easily increase the total cost $200 million or more. The first launch should be possible within three years or less after go-ahead.

The estimated recurring launched-cost of the MOL camera/ HEXAGON spacecraft combination is about half that of the manned MOL system ($70 vs $130-140 million).

We have examined several alternatives in this regard -- ranging from starting the spacecraft effort promptly, to deferring it until FY 71. If we deferred start of the spacecraft until FY 71, the time between now and then could be devoted toward achieving more technical confidence in our ability to operate the camera completely unmanned and also to the evaluation of competitive spacecraft designs to insure that HEXAGON is, in fact, the best approach. Further, it would reduce FY 70 expenditures from about $300 million to perhaps $175 million.

If this option is adopted, I recommend that we proceed at the slower pace in FY 70.

<u>MANNED/UNMANNED COMPARISONS</u>

The ability to both point and track the MOL camera system with acceptable accuracy for unmanned operation might not be clearly established until the system is flown.

Key to achieving the required pointing accuracy is the performance of a Low-G Accelerometer [redacted] If the Low-G

Accelerometer does not prove out, there are other possible approaches (SPARS, Dopler, TRANSIT, etc.). Key to tracking is the performance of an on-board image Velocity Sensor (IVS) which will provide the final vernier rate corrections to the pointing and tracking mirror. The difficulty of ground-simulating the varied scenes that the IVS will view <u>from orbital altitudes through the MOL optics</u> may preclude verifying the full-range adequacy of this device before flight test. The IVS is <u>essential</u> to acceptable automatic camera operation.

There is no question of the <u>technical feasibility</u> of pointing and tracking with sufficient accuracy for an unmanned system. The implicit risk in an unmanned satellite using the MOL camera is that failure to achieve early and reliable performance for these and other automatic camera system functions (for example, alignment) could lead to a much later and more costly operational capability than would otherwise have been possible. In the manned MOL system, as noted earlier, pointing, tracking, and various other camera functions can be performed by the flight crew with greater precision than the automatic devices even when the latter are working perfectly.

The one-time R&D and recurring costs of an unmanned system will always be considerably lower because the spacecraft does not need to contain the life-support systems and redundancy necessary to sustain and safeguard the flight crew. The weight saved can be converted either to increased orbital lifetime or to the utilization of a smaller booster. . . . On the other hand, since the life support systems are largely extensions of aircraft experience, and have been proven highly reliable in the NASA programs, the on-board presence of the MOL flight crew greatly increases the probability that the camera will operate successfully and also offers certain unique capabilities and operational flexibility.

The following table compares the expected annual costs and very high resolution photography results from two <u>mature</u> MOL system missions and two <u>mature</u> unmanned MOL camera/HEXAGON system missions:

Item	MOL System	MOL Camera/ HEXAGON System
o Number of Launches	2	2
o Cost	$270M	$140M
o Expected Days on Orbit	84	82
o Targets VHR Photographed		
In Sino-Soviet Bloc(1)	7300	5650
Hi-value, time sensitive(2)	725	225
[redacted]	[redacted]	[redacted]
o Cost per VHR Bloc Photo	$37K	$25K

Footnotes:
(1) Present experience indicates about 10% additional photography will be taken outside Sino-Soviet Bloc
(2) Missile on launch pad, being loaded in silo, etc.

To determine the real worth of the $270 million and $140 million annual expenditures cited in the above table, a value judgment must also be assigned to other aspects of the two systems such as:

- [redacted]
- Ten percent or more better average resolution of the manned system (more accurate pointing, tracking, etc.);
- The option in the manned system of exposing both color and black & white film against the same target;
- Approximately 25 daily verbal reports by the flight crew of visual reconnaissance of targets not photographed with the VHR camera system (These could be recorded at 3-4 foot resolution via an auxiliary 70 mm camera, if desired);
- The return of exposed film at the end of the mission in the MOL system vs each 10-12 days in the unmanned system.

Although the costs, targets photographed, etc., can be determined with reasonable precision, we have not been able to arrive at quantitative values for the non-comparables and thus establish a high-confidence real worth of the expenditures.

IS VHR PHOTOGRAPHY WORTHWHILE?

The value of the increased intelligence information from MOL-like photography over that available from improved models of our current high resolution satellite system has been the subject of considerable study both in the DoD and, to a lesser extent, the CIA.

The Director of Defense Research and Engineering and the Director, DIA believe that a VHR photographic capability via either the manned MOL system or an optimized unmanned system is important to defense decisions. This resolution will provide critical fine detail which will allow the determination of important performance characteristics of emerging Sino-Soviet weapons systems well in advance of operational tests, field deployment, or public display in parades or shows.

I agree with Mr. Helms that the increased information expected from MOL photography, while worthwhile, probably is not worth the cost for broad national intelligence estimate purposes alone; however, the technical intelligence acquired should provide very valuable information toward multi-billion dollar DoD force structure and employment decisions. Further if a strategic arms limitation agreement is achieved, the same information will either greatly increase our confidence that the agreement is being observed or identify suspicious activity at an early date.

The potential value of very high resolution photography is sufficient that we should continue to pursue this capability either in the MOL or an unmanned satellite using the MOL camera.

OTHER CONSIDERATIONS

If we select the unmanned option, a number of MOL contractors will have to lay off sizable numbers of people. I have listed below the major contractors, their roles, and the probable lay-offs which would result. An additional consequence is that overhead costs on other Defense contracts will increase.

There are currently four major contractors working on MOL:

o McDonnell-Douglas is developing the basic spacecraft in Huntington Beach and the Gemini B astronaut recovery system in St. Louis. Respectively, 4300 (of 4800 working on MOL) and 1200 people would be lay-offs at those locations.

o Martin, in Denver, and several associate contractors are developing the TITAN III-M booster. 2600 people would be laid-off.

o General Electric in Valley Forge, Pennsylvania is developing the camera controls for both manned and unmanned systems. 1000 of 2400 now working on MOL would be laid-off.

o Eastman Kodak in Rochester, New York is developing the camera and optics. This is a covert activity. About 300 of 1800 now working on MOL would be laid-off.

Additionally, perhaps 2500 lst-tier Sub-contractor personnel in various areas of the country would be terminated. In all, about 12,000 people would be laid off. The greatest impact probably would be on McDonnell-Douglas in Huntington Beach and General Electric in Valley Forge where there is little other Air Force or NASA space activity to take up the slack.

The estimated future costs of an unmanned system using the MOL camera assume a decision on 1 May. Currently, approximately $45 M per month is being spent on the MOL program. If we later decide to continue only the camera toward a future unmanned application, the "savings" will have eroded at a rate of more than $1 million per day after May 1. In the interim, however, progress is being made on both the camera system and the MOL spacecraft.

SUMMARY AND RECOMMENDATION

Viewing the MOL Program purely as a means to achieving a very high resolution photographic satellite capability, the following is pertinent:

o The manned MOL system provides high confidence in achieving the [redacted] resolution goal; returning a useful intelligence product at least one year sooner than an unmanned satellite using the MOL camera; a mature system some 2-2½ years sooner; and offers added operational flexibility and certain unique capabilities not now practical for inclusion in an unmanned system.

o The MOL Program could cost from approximately \$165 to \$465 million more in one-time R&D costs and almost twice as much in annual recurring costs (complete, launched operational systems) as an unmanned system using the MOL camera. Over the next five Fiscal Years, this adds up to a sizable difference. For example, assuming a MOL Program funded at \$525 million in FY 70, vs an unmanned program at \$175 million, and continuing VHR operations through FY 77 (two launches per year for either system), the MOL Program would cost approximately \$2.14 billion from FY 70 through FY 74 vs an unmanned system (using the MOL camera) estimated cost of \$1.14 to \$1.34 billion. Note: These cost comparisons include the one-time R&D costs plus the recurring costs for four MOL launches vs three unmanned launches through end-FY 74, plus the appropriate FY 73/74 lead-time funding for the partial production of systems to be launched in the FY 75-77 period.

o For various reasons, the MOL Program is at the development stage where more than half-billion dollar annual investments must be made to provide reasonable progress. As much as $350 million could be invested in FY 70 and virtually no schedule progress made toward the first manned launch.

o If there is a likelihood of reaching a strategic arms limitation agreement with the Soviets in the next few years, it can be rationalized that we should pursue the MOL at a vigorous pace and pay the higher price to insure a VHR photographic capability in the early 1970's. Likewise, an argument can be made for the MOL if we believe the Soviets or the Chinese will continue or accelerate the development of new and advanced strategic and tactical weapon systems.

o On the other hand, if the <u>calculated risk</u> that early unmanned flights with the MOL camera might not be productive and a national need for VHR photography will not exist until 1975 or later <u>is acceptable</u>, then a good argument can be made that we should pursue only the MOL camera system toward an unmanned satellite application to save both sizable dollars in FY 70 and over the long term.

Although appropriate value consideration should be attached to the probable higher confidence in the early successful operation of the camera system in the MOL, the probable ten percent or more better average resolution of the MOL system, the added flexibility and unique capabilities of the manned system, the utility of the information to be acquired on the extent of man's capabilities in space for military purposes, the possible economic and political ramifications of terminating MOL, etc., the fundamental issues are whether or not the US needs a very high resolution photographic satellite capability and, if so, when.

In light of all of the foregoing, I recommend . . . . .

MELVIN R. LAIRD