# MAN IN MOL

## MANNED ORBITING LABORATORY PROGRAM

MARCH 28, 1969

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## PREFACE

This document is one of three brief summaries prepared for the purpose of providing Government executives a reasonably detailed insight into the Manned Orbiting Laboratory (MOL) Program.

MAN IN MOL discusses why man has been included as an integral part of the MOL system and the benefits expected from his presence as MOL performs its very high resolution photographic reconnaissance mission.* It assumes the reader is familiar with the elements and operation of the MOL system, the program plan, etc.; if not, the companion MOL PROGRAM SUMMARY is recommended reading. The third document -- MISSION VALUE -- discusses the value of very high resolution imagery to DoD decisions and operations.

These summaries are up-dated semi-annually. Suggestions toward increasing their usefulness are welcome at any time.

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*NOTE: All reconnaissance aspects of the MOL system are sensitive national security information and are handled only in the limited access BYEMAN Security System.

# INDEX

## I. INTRODUCTION

The MOL camera is a highly complex system. Not only must it be manufactured with great precision, but several technically difficult-to-achieve functions must be performed on orbit also with great precision. In fact, at the time the very high resolution photographic reconnaissance mission for MOL was originally proposed, it was believed that the necessary precision could only be achieved manually (particularly, the pointing and tracking functions).

It later became apparent that it was technically feasible to operate the MOL camera system in a completely automatic (i.e., "hands-off") mode. The decision was then made to incorporate a completely automatic camera system in the MOL so that the camera, when mature, would be suitable for use in future unmanned reconnaissance satellites if desired. At the same time, while the camera is operated in the automatic mode, man is freed from the routine manual tasks that had been considered originally as mandatory for him. Thus the MOL Program could begin to look beyond the original use of man toward other more encompassing roles for him which would exploit his unique qualities, that of a broad-banded multiple sensor, systems manager and psychomotor performer of multiple gross and fine manual tasks.

Automatic operation of the MOL camera system, however, involves several devices or techniques which either never before have been employed in orbit or else represent large extrapolations in precision, accuracy, or other capabilities. The proper functioning of <u>all</u> of these automatic devices would be essential for successful use of the MOL camera system in any future unmanned program. In MOL, although capable of "hands-off" photography using the automatic devices, the flight crew can, in most cases, also manually adjust them to peak performance or substitute a completely manual mode of operation for failed or grossly malfunctioning subsystems.

Man's roles in the operation of the MOL system will assure achievement of the primary objective (very high resolution photography), assure a useful reconnaissance product at the outset, and mature the automatic camera system operation at a much earlier date than probably otherwise would occur. When the automatic camera system is functioning properly, the flight crew is expected to enhance the quantity and quality of the photography and to accomplish certain additional tasks not now feasible or practical for any but a manned system.

This summary deals only with man-in-MOL. The sections which follow discuss and describe man's role in assuring early achievement of the reconnaissance objective, his enhancement of the quantity and quality of the intelligence information acquired, and other missions and capabilities unique to the manned system. The reader interested in more comprehensive and detailed treatment of the topics presented is referred to the MOL Program Office Document "The Roles of Man in MOL," Volumes I and II (SAFSL BYE 68431-68).

## II. THE IMPORTANCE OF MAN

The primary reason for a manned MOL reconnaissance system is that man's presence will virtually guarantee achievement of a [redacted] resolution photographic capability with the MOL camera/optical system at the outset of the program.

Early success is assured because man can: (1) point the camera at and track the target with the very high precision required, (2) manually adjust critical operating system parameters so as to insure the peak overall system performance necessary to achieve the resolution goal, and (3) diagnose and repair or compensate for many system malfunctions which would otherwise either result in serious mission degradation or premature termination. These critical contributions of man are discussed in the following subsections:

### a. Pointing

The field of view of the MOL optical system is very small, compared to other satellite reconnaissance systems. As illustrated in Figure 1, the MOL field of view, which covers approximately a 9,000-foot-diameter circle on the ground, is considerably smaller than the 10 nautical mile wide swath covered by the earlier KH-7 system or the 5 nautical mile swath covered by the KH-8. Thus, the requirement for accurate pointing with the MOL system is very stringent.

The automatic pointing system goal for MOL is to place the optical axis within 1500-1900 feet of the desired target 95 percent of the time. In most cases, therefore, the target will be located somewhere in the 9,000-foot-diameter circle contained in the MOL photograph. In other cases, however, the target will be outside the 9000 foot circle and would not appear in the photograph unless a manual correction was made.

The inherent ability of man to perform the pointing task is reflected in his ability, as demonstrated in earth-based simulations, to point the system manually to within 30-40 feet of the desired aiming point from the 80 nautical mile orbital altitude.

Man's capability to point the system with virtually perfect accuracy is critical to mission accomplishment for two reasons: (1) regardless of the source of automatic pointing system error (e.g., ephemeris location error, geodetic position uncertainty of the target, malfunction of the automatic pointing system) the flight crew will be able to point the system directly on target whenever required, and (2) since approximately 10-15 percent better resolution imagery is obtained for those objects in the scene directly on axis, man can be called upon for pin-point precision pointing accuracy whenever the best possible resolution photography is desired, even when the automatic pointing system is performing within its nominal limits.

b. Tracking

Any apparent scene motion will result in a blurred -- i.e., resolution-degraded -- image on the MOL photograph. Since the ground is sweeping by underneath the MOL vehicle at about 18,000 miles per hour, it is necessary to null the relative motion of the target by swiveling the large flat tracking mirror at a very precise rate. To obtain [redacted] resolution-quality photographs, the tracking system must reduce the relative motion between MOL and the target from the orbital velocity of 18,000 miles per hour to not more than about 14 miles per hour.

About 99 percent of the correction will be provided by on-board computer commands to the tracking-mirror drive mechanism. The remaining correction will be provided by an Image Velocity Sensor (IVS) which will generate the necessary vernier commands for the tracking mirror. In addition, an Across-the-Format Image Motion Compensator (X-Format IMC) is provided in the MOL camera to compensate for residual image motion of objects not located at the center of the camera/optical axis. Residual image motion occurs off-axis because the IVS-generated rate commands to the tracking mirror compensate for relative motion of the axis line of sight only; the scene geometry is such that the system cannot simultaneously compensate perfectly for all points in the field of view.

The quality of photography obtained with the automatic system is directly dependent on the accuracy and reliability of the IVS and (to a lesser extent) the X-Format IMC devices. Although it is anticipated that both will mature into accurate and reliable devices, there is some development risk involved -- particularly for the IVS -- and, accordingly, these devices may malfunction frequently during early flights.

Man will serve in a backup capacity to perform the tracking task. Earth-based simulations have demonstrated that man can perform the tracking task several times better than the automatic system. Thus, his presence will guarantee that the requirement for highly precise tracking will be met whenever automatic system performance is not within nominal limits.

c. Adjustment of Critical System Components

In addition to the requirement for extremely precise pointing and tracking, achievement of [redacted] resolution-quality photography requires that several camera/optical system components perform within very precise limits. Although such parameters as optical alignment, focus, and exposure setting can and will be controlled automatically, man can monitor operation of the automatic processes and intercede to control them manually whenever tolerance limits are exceeded or malfunctions occur. In addition, he can apply very fine vernier adjustments to various critical components on those occasions when absolutely peak overall system resolution is required for particular intelligence targets. Some examples follow:

The optical elements require precise realignment in the zero-g environment, after having been subject to an initial alignment in the one-g field on earth, and to the dynamic thermal, acoustical, and thrust environment of launch. They also require periodic realignment in orbit during the stresses encountered during each revolution and/or orbit adjust maneuvers.

Maximum allowable misalignment among elements in the optical train is specified as 14 arc seconds (four-thousandths of a degree). The sensitivity of resolution achieved to misalignment of optical elements is evidenced by the fact that an additional excursion of five-thousandths of a degree will result in a 5 percent loss of resolution.

Man will monitor and check operation of the automatic alignment system using direct visual sightings and displays, and will control the alignment process himself whenever necessary.

Man will perform a similar role with respect to focus. Allowable mismatch between the film emulsion plane and plane of best focus is [redacted] inch. Excursions outside this limit cause relatively rapid degradation in resolution as focus error increases (see Figure 2). For example, a [redacted] inch focus error will result in an approximate ten percent loss in resolution. Man will contribute to establishing the best focus position for the camera by relaying information to the ground based on his observation of ground-scene content during focus-sensor operations of the camera/optical system.[1] In addition, man can develop exposed film periodically, using the on-board processor, check the quality of the imagery and, if necessary, manually control the focus setting.

MOL photographs are taken using a pre-computed exposure setting, which is based on many variables, e.g., target location and time of day and year (which determine sun angle), target reflectance characteristics, atmospheric transmittance, haze, etc. Since some of the variables cannot be predicted with perfect accuracy, the nominal exposure setting set into the camera will not always be optimum. In such cases, man will adjust the pre-selected exposure setting to compensate for the particular lighting or target conditions existing at the time of photography. The effect of exposure on resolution is significant. As shown in Figure 3, an error of one stop will result in about a 20 percent degradation in resolution.

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[1]In current unmanned satellite operations focus-sensing data read out to the ground is difficult to assess because of lack of knowledge of precise scene content viewed by the sensor during the focus-sensing operation. (Focus-sensing data is used by the ground to determine an optimum focus setting, which is subsequently transmitted to the system during command upload).

Although it is not anticipated that man will be required to adjust exposure settings very often, his ability to do so, together with his ability to insure accurate alignment and precise focus of the optical system, over a 30-day period will result in a significant increase in the total number of photographs having highest resolution quality.

d. Diagnosis

Man's expected ability to diagnose the cause of out-of-specification performance and malfunctions of various subsystems is key to early achievement of a mature operational capability. Although diagnostic techniques have been applied very successfully with unmanned systems, the process is time consuming and frequently involves considerable "down time" of the orbiting vehicle, during which valuable opportunities to conduct mission operations are lost. In MOL, man will be on board the vehicle and will have the capability to diagnose the operation of various systems, subsystems, and components. This capability will permit rapid assessment of many malfunctions and out-of-tolerance conditions, leading quickly either to restoration to normal operation conditions or to manual operation, if necessary.

A malfunction alarm system has been incorporated in the MOL. It monitors approximately 100 laboratory and 100 mission-payload segment parameters, provides aural and visual warning signals and displays which contain information concerning out-of-tolerance conditions. In the event of malfunction, the alarm system also immediately initiates automatic recording of data from several hundred instrumentation points for later transmission to the ground or call-up by the crew. In many instances, the crew is expected to perform immediate diagnosis and to take corrective action. In complex cases, in which immediate corrections are not possible, the crew can provide supplementary data to the ground, thereby assisting in the isolation of sources of off-nominal performance.

An illustration of the application of diagnostic technique by the flight crew, in conjunction with the ground, is shown in Figure 4, which depicts the diagnostic logic which might be followed for the problem of targets not being centered in the MOL photographs. As shown, the process involves checks of various possible sources of pointing error bias, with ultimate resort to manual pointing should automatic pointing system accuracy not be able to be re-established. This decision network is typical of other diagnostic procedures which may be applied to other malfunctions.

The capability of man in MOL to monitor "hands-off" operation of the automatic system, to assist in diagnosing malfunctions, particularly for those devices which are critical (for example, the IVS), and to perform key tasks manually whenever required, will not only expedite the maturing of a reliable operational system but also permit acquisition of valuable operational intelligence photography at the same time.

Although man's inclusion in the system is considered mandatory to assure early success, there are other significant benefits which will be derived from his presence. Key among these is the enhancement of the quantity and quality of the total intelligence product of the MOL system, which is discussed in the following section.

## III. MAN'S ENHANCEMENT OF PHOTOGRAPHIC QUANTITY AND VALUE

In the first few manned flights, man may be preoccupied for the most part in performing those tasks, discussed earlier, which are related to insuring that the system performs reliably and consistently within specifications. However, when the system performs nominally, man will turn his attention to enhancement of the mission product. His capabilities here are quite significant, and the system has been designed to permit him to make a maximum contribution to product enhancement.

Provision has been made to exploit man's capabilities by incorporation of an Acquisition Telescope System (ATS) in the MOL.

The ATS is depicted in Figure 5, which shows the location of the two telescopes in the crew compartment, one for each astronaut. Each ATS is independently mounted and operated, and may be pointed automatically or manually controlled. The astronaut may select various degrees of magnification, with corresponding field of view and ground resolution, from among the range of values indicated in the table on the following page. For comparative purposes, the corresponding figures are also shown for the fields of view and resolutions available to the astronaut through the camera optical system (Visual Optics).

Acquisition Telescope and Main Optics Nadir Performance

| Magnification (Power) | Field of View (Diameter) | Resolution |
|---|---|---|
| **ATS** | | |
| 16X | 5.6 N.M. | 15.3 Ft. |
| 32X | 2.8 N.M. | 11.5 Ft. |
| 64X | 1.4 N.M. | 5.7 Ft. |
| 127X | .7 N.M. | 3.3 Ft. |
| **Visual Optics** | | |
| 125X | 2,720 Ft. | 30.0 In. |
| [redacted] | | |

The displays and controls used by the crew in operating the ATS and in performing various mission functions are depicted in Figure 6. Identification of the key displays and controls are outlined in white.

Operation of the ATS to enhance the MOL intelligence product is reflected in Figure 7, which depicts operation of the system during a payload pass. As shown, the camera/optics system is photographing a target in a completely automatic operating mode. If uninterrupted by the astronauts, the camera system will automatically and successively point to, track, and photograph the preselected targets along the ground track of the orbiting vehicle. The astronauts' role during mission operations is to inspect targets out in front of the vehicle while the camera/optical system is photographing the target selected for photography in the previous cluster. Using the ATS the astronaut role is to inspect each target area for the presence or absence of clouds. If the target is cloud-free, he then checks whether or not the target is "active," that is, whether or not there is any indication of high value activity at the target (e.g., new construction, presence of a new type aircraft at an airfield, loading or unloading of an ICBM into a silo, presence of a space vehicle on a launching pad, etc.). The information concerning weather and activity on each target viewed is fed to the on-board computer which, by pre-programmed decision logic, commits the camera/optical system to that target in the cluster which has the highest intelligence value. As the target selected is being photographed, the crew can verify camera operation by viewing through the visual optics. If the camera is operating properly, the crew will view the targets in the next cluster, repeating the operation wherever alternate targets are available.

The number of alternate targets that may be viewed for weather and/or high intelligence value will depend on the geographic dispersion of targets, the time required to view each scene and make inputs (votes) to the computer, etc. Simulations and geometric time-space analyses indicate that the two astronauts, together, will be able to view, on the average, the primary and five alternate targets prior to each photographic sequence.

Thus, for each target that could be photographed by an unmanned system using the MOL camera system, the MOL crew will view several alternate targets for possible substitution in place of the predesignated primary target. With the astronauts performing an alternate-target inspection role, the probability will be greatly increased that the MOL camera/optical system will be pointed at the right target at the right time, based on a last-minute, real-time appraisal of the actual conditions at each of the candidate target locations. It is anticipated that both the number of high resolution photographs and their intelligence value will be considerably enhanced as the result of man's mission enhancement activity.

The quantity will increase for two reasons. First, man can verify that cloud-free photographs have been obtained of particular targets, simply by observing that the target was, in fact, cloud-free during the photo sequence. On early subsequent passes over the same area other alternate targets may be photographed. In contrast, because of uncertainty as to the precise weather conditions at the time of photography, present unmanned systems are frequently committed to the same target on several successive passes, so as to provide a high probability that the target has been photographed in the clear, before the system is committed to other targets having lower priority on subsequent passes over the area.

Closely related to verification that clear photographs have been achieved is man's role in selecting a cloud-free alternate target for photography when the designated primary target is cloud-covered. By evaluating actual cloud cover at the primary and alternate he can select a target for photography which is cloud-free (or can inhibit photography if all are cloud-covered). He can follow up by verifying that cloud-free photography has been accomplished, thus releasing the camera/optical system to photograph other targets on the next pass over the same area.

Analyses based on past experience with average weather conditions over the Sino-Soviet land mass indicate that the MOL system will produce approximately 20-25 percent more clear photographs per day on orbit than an unmanned satellite using the MOL camera system. This difference is directly attributable to man's ability to perform the cloud-avoidance and verification roles.

There is very high confidence that in addition to the increase in quantity of clear, cloud-free photographs, a significantly greater number of high-value photographs will be taken with the MOL system as compared to that achieved by an unmanned satellite using the MOL camera system. The superiority will result because of man's ability to inspect both primary and alternate targets for unusual activity prior to camera operation, to substitute color or other special films into the camera in place of the standard black and white film, and to record verbal intelligence reports on tape, based on visual observations through the ATS and Visual Optics.

The probability of obtaining photographs of a target in a time-sensitive, high-intelligence value state is quite low (approximately three percent), based upon experience with unmanned systems to date and is for the most part strictly a matter of chance. In the MOL case, the probability of photographing an active target is still relatively low, but considerably increased by virtue of man's ability to inspect several alternates, any one of which may be substituted in place of the primary.

Simulations and analyses have been made to assess man's ability, using the ATS, to detect indicators of activity and to assess their significance correctly, and to quantify the benefits to be derived. Results of the studies indicate that man can see and correctly identify the significance of activity and that because of his ability to do so, two-to-three times as many photographs of "active" targets will be obtained per day on orbit than would be acquired through an unmanned system using the MOL camera system.

Although the precise intelligence value of an "active" target photograph versus that of an "inactive" target is difficult to quantify, it is clear, to cite an obvious example, that a photograph of an ICBM silo with the door open and a missile being lowered into it has considerably more intelligence information than a "buttoned-up" silo with no activity in the vicinity. More importantly, man's ability to search for particular objectives at specific locations (e.g., an exposed nuclear warhead at a nuclear storage site), will greatly enhance MOL system capability to meet specific intelligence objectives of current, high-priority interest.

The quality of the intelligence product obtained with the MOL will be further enhanced by man's ability to insert special film in the alternate camera when appropriate -- a capability exceedingly difficult to achieve with sufficient flexibility or reliability in any current unmanned systems. Examples of beneficial use of color and other special films include:

[redacted]

Man will also contribute to the value of the total intelligence product of the MOL system through voice-recorded comments concerning scenes being photographed, and by reporting intelligence information on targets viewed through the ATS for which a voice report is sufficient, for example: an estimate of the number of aircraft at an advanced staging base, or other air, ground, or naval order-of-battle intelligence.

Although man's mission enhancement role is secondary to his primary role of insuring proper operation of the overall MOL system so as to achieve the [redacted] resolution photographic reconnaissance objective, as the automatic devices perform more and more reliably and consistently, man will be able to devote increasingly more time to his mission enhancement role.

## IV. MANNED MISSION FLEXIBILITY & SYSTEM GROWTH POTENTIAL

Because of man's inate capability and versatility, he adds a measure of mission flexibility and growth potential to the MOL system which is unmatched by any unmanned vehicle attempting to perform the MOL mission. This section deals with [redacted] (including a limited astronomical capability), crisis reconnaissance, and short and long term growth potential of the MOL system.

a. [redacted]

[redacted]

[redacted]

b. Crisis Reconnaissance

A high premium may be attached to the acquisition of real-time accurate, credible, and relevant intelligence information in times of international crisis, for example: the Arab-Israeli War of 1967, and the Pueblo and Czechoslovakian crises of 1968. Although not specifically designed for such purpose, the MOL system provides a limited, but potentially significant capability to acquire intelligence information pertinent to any crisis which may occur, anywhere on the globe, during a period when MOL is in orbit.

MOL can be launched in such a manner and its orbit adjusted so as to pass over any geographic area once each day during sunlit conditions, permitting acquisition of very high resolution photographs. Man's role in a crisis management situation would be to relay near-real-time intelligence information to the U.S., based on his ability to observe targets in the crisis area visually, to develop and interpret photographs on board, and to report all pertinent information to the ground by encrypted voice when within range of ground stations.

Should it be desired to incorporate a provision to return actual photographic imagery to the ground rapidly (in the current baseline system photographs will not be returned to the ground until mission termination after 30 days), an on-board read-out capability can be added to the MOL system. If so, man would have the additional role, after developing the photographs, of "cropping" those portions of the photograph which contain vital intelligence imagery, which would subsequently be scanned electronically (or by laser-beam) and transmitted to a ground station.

c. Growth Potential

Studies now underway indicate that MOL camera resolution can be improved in follow-on models from the basic [redacted] norm to an approximately [redacted] capability. The best possible resolution norm from 80 nm altitude appears to be about [redacted] This might be achieved by the addition of a series of relay and magnifying lenses which could be mechanically inserted into the center of the optics light path whenever ultimate resolution was desired; however, this higher resolution would be achieved at the expense of a reduced field of view. This penalty, in turn, would require even higher precision pointing than is necessary with the present baseline system. The option to achieve the best possible camera resolution appears feasible for the foreseeable future only through the use of man -- man can manually point with the accuracy required.

The possible future use of MOL as an orbital test-bed to develop new military equipments and mission capabilities is an explicit secondary objective of the MOL program.

The discretionary payload of the manned MOL is considerable. Removal of the photographic reconnaissance mission equipment from the vehicle would make available approximately 230 cubic feet of pressurized volume, 2800 cubic feet of unpressurized volume, five tons of payload weight, and an average of 700 watts of electrical power (2.5 kw-peak power), etc.

The discretionary payload capability could be utilized for any number of military or civilian scientific purposes. On the military side there are such potential missions as ocean surveillance, multi-sensor reconnaissance, [redacted] etc. On the scientific side the MOL, sans the camera payload, could easily be adapted as a general-purpose near-earth scientific space laboratory. The astronauts could play the same roles in development test of new equipment and conduct of new missions as they will play in the current program, i.e., system operator, system manager, diagnostician, etc., in expediting maturation of system operational capability.

## V. ASSESSING MAN'S CAPABILITIES IN SPACE

The MOL reconnaissance mission uniquely lends itself to providing quantitative data on man's capabilities in space. It will exercise maximally all of his physical and mental faculties, repetitively, and over a sufficiently long period to permit the establishment of statistical validity of the assessment. In this regard it will be responsive to the recommendations of the President's Scientific Advisory Committee.

The tasks performed by man during a typical mission pass over Russia permit a discrete, programmed, quantitative testing of all of man's unique capabilities as a broad-band multiple sensor, information integrator, and decision maker. It will also permit assessment of his abilities to continue to act in a coordinated psychomotor manner while performing tasks ranging from gross manipulation to those requiring fine finger dexterity. Man's performance during flight will be compared to his baseline performance acquired during ground training and testing.

Mission requirements dictate that vast amounts of data be recorded and transmitted to the ground, e.g., health status of the vehicle, its systems, man, and the crew assessment of the last photographic sequence. Since the crew plays a key role in the photographic operations, information concerning their decisions on weather avoidance, selection of targets of transient value, crew inputs to pointing and tracking, voice comments on the targets, etc., will be recorded and will be of special value in assessing the crew's contribution to the mission during flight. Crew comments, telemetry on mission equipment operation and the resulting photographic product will permit postflight reconstruction of mission events and the part that the equipment and the crew played during the mission event.

The MOL mission equipment will be operated in automatic, manual and various combinations of automatic/manual modes. Thus, mission results due to man's performance and contributions will be able to be compared to those achieved by the completely automatic camera operation.

The MOL reconnaissance mission offers a unique opportunity to evaluate man's utility, capability and contributions to a demanding military mission. It will complement other crew performance data now being accumulated by the NASA manned space program. Further, it will be of sufficient duration and magnitude to make a major contribution to the scientific data base needed to extrapolate and project man's capabilities in extended space flights of increased duration.

## VI. SUMMARY

Man has been included as an integral part of the MOL system because his presence is critical to accomplishment of the principal program objective, i.e.: an early operational capability to acquire [redacted] resolution photographs of significant targets in denied areas of the world for technical intelligence on strategic and tactical weapon systems. In particular, his presence guarantees that the pointing and tracking tasks necessary to achieve [redacted] resolution photography will be performed with the required precision. In addition, his capability to monitor and manually adjust critical system components, to diagnose difficulties, and to improvise as necessary will insure acquisition of a useful photographic product at the very outset of the flight program and will, at the same time, insure early maturation of the MOL very high resolution camera system.

In the long run, it is believed that man's ability to enhance the quantity and intelligence value of the photography will prove to be his more important contribution, particularly as the automatic camera devices mature, permitting him to devote increasing time to the mission enhancement task. Man's versatility in performing the target coverage verification and cloud-avoidance roles, in inspecting alternate targets for activity, in using special films whenever appropriate, in making and reporting visual observations, and in [redacted] provides a very sophisticated intelligence collection capability, not previously available to the intelligence community.

A final, significant product of manned MOL reconnaissance operations will be the acquisition of valid, statistically reliable data on man's performance in space while operating complex equipment, in a demanding operational task, over extended periods of time. This information, which will be unique, will provide significant information both to the military and scientific communities.

The MOL system has been designed for maximum operational capability through exploitation of the inherent attributes of man. Program progress to date reinforces the belief that MOL will more than live up to the potential originally envisioned.

LIST OF FIGURES

[redacted]

FIGURE 1

DORIAN

HANDLE VIA
BYEMAN/TALENT-KEYHOLE
CONTROL SYSTEMS JOINTLY

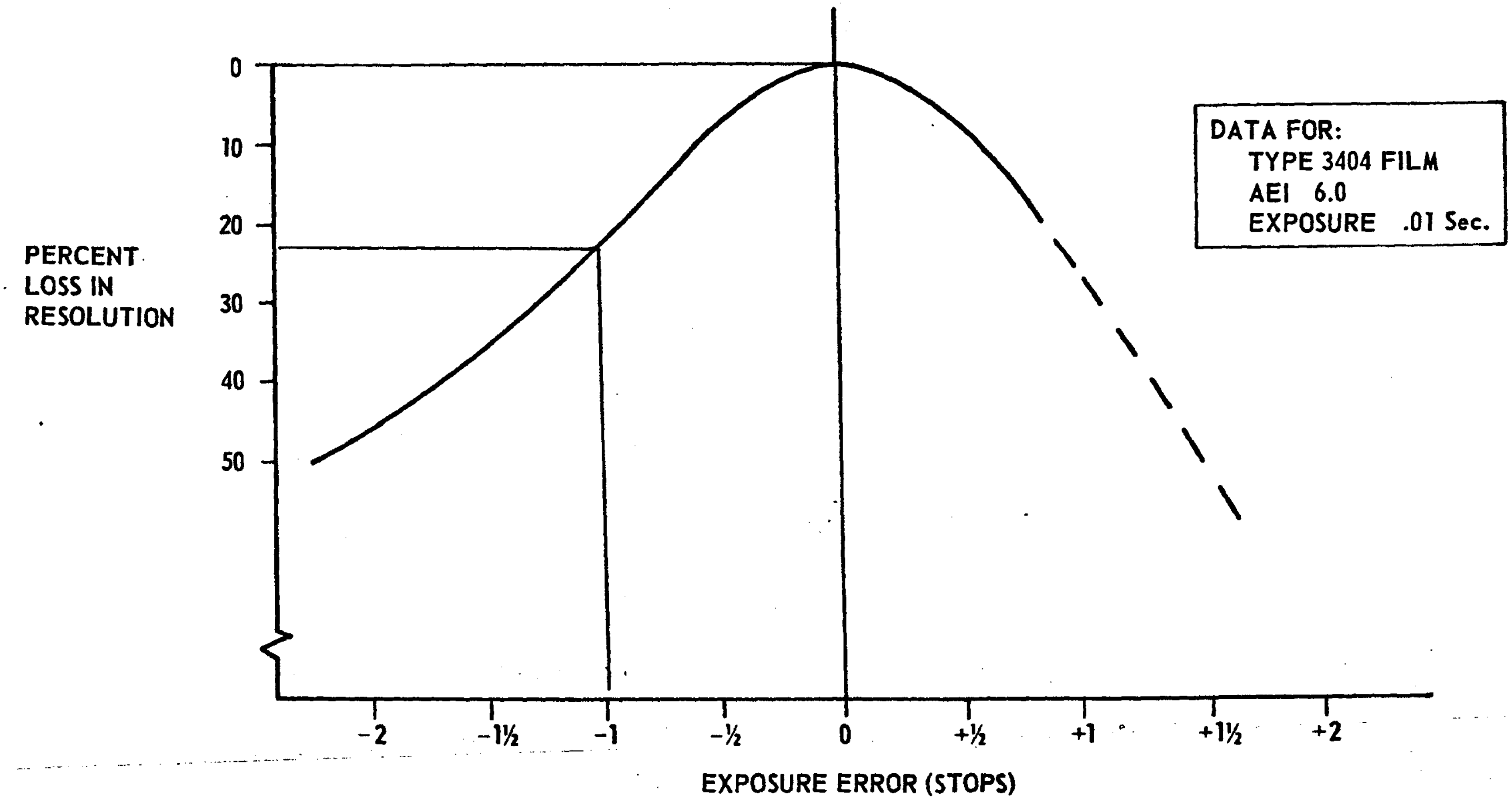
GEOMETRIC
MEAN
RESOLUTION

LINES
PER
MM

[redacted]

[redacted]

FIGURE 2




MOL SYSTEM PHOTOGRAPHY RESOLUTION LOSS
AS FUNCTION OF EXPOSURE - SETTING ERROR

FIGURE 3

~~TOP SECRET~~



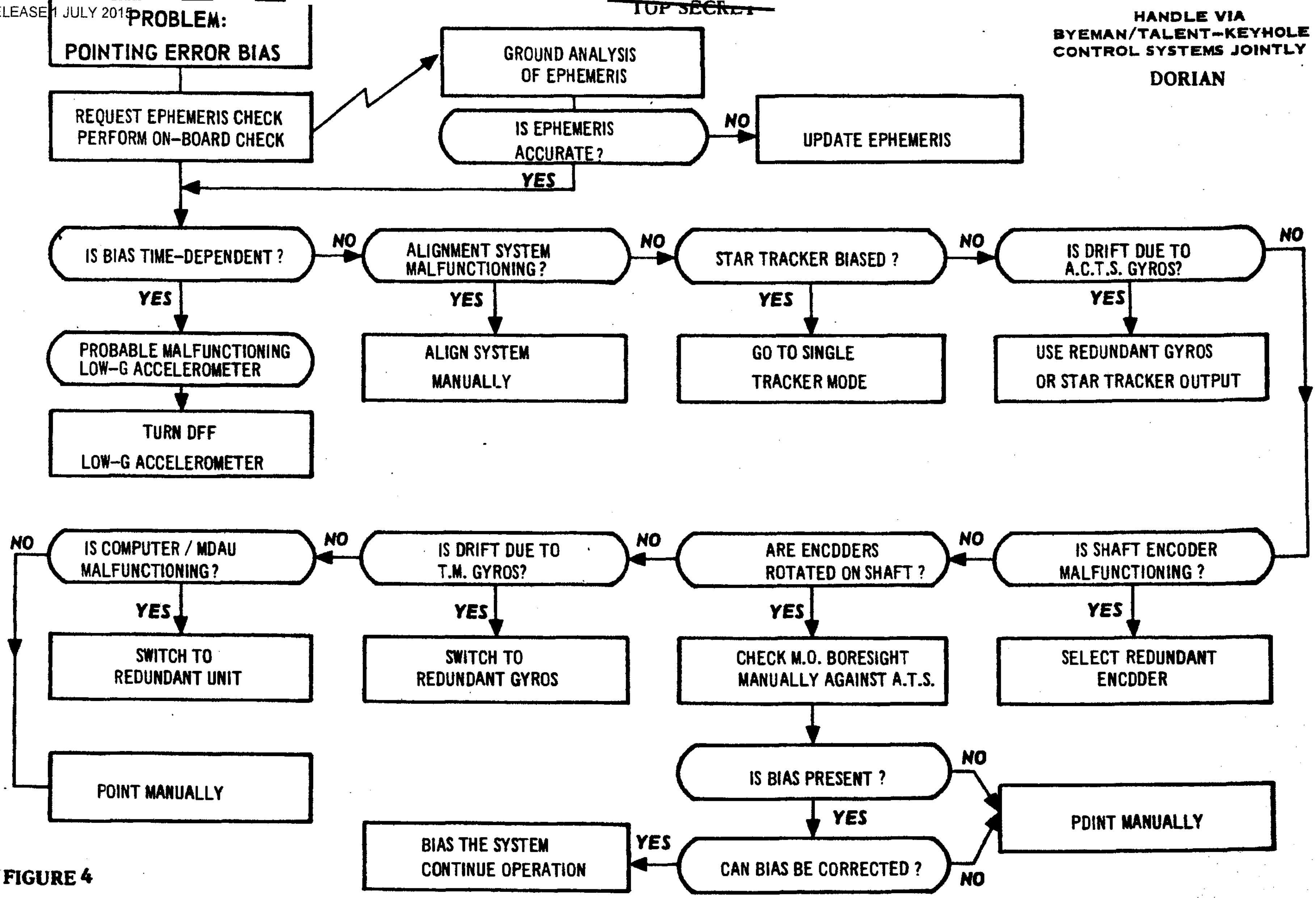
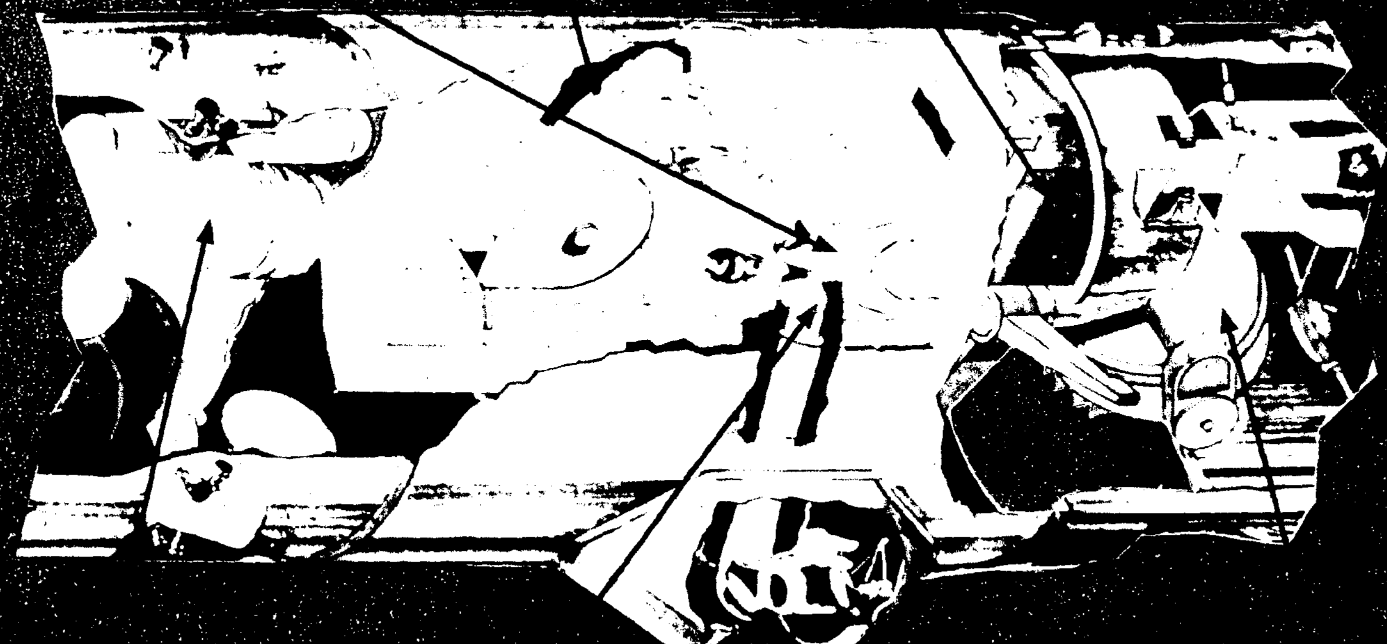



FIGURE 4



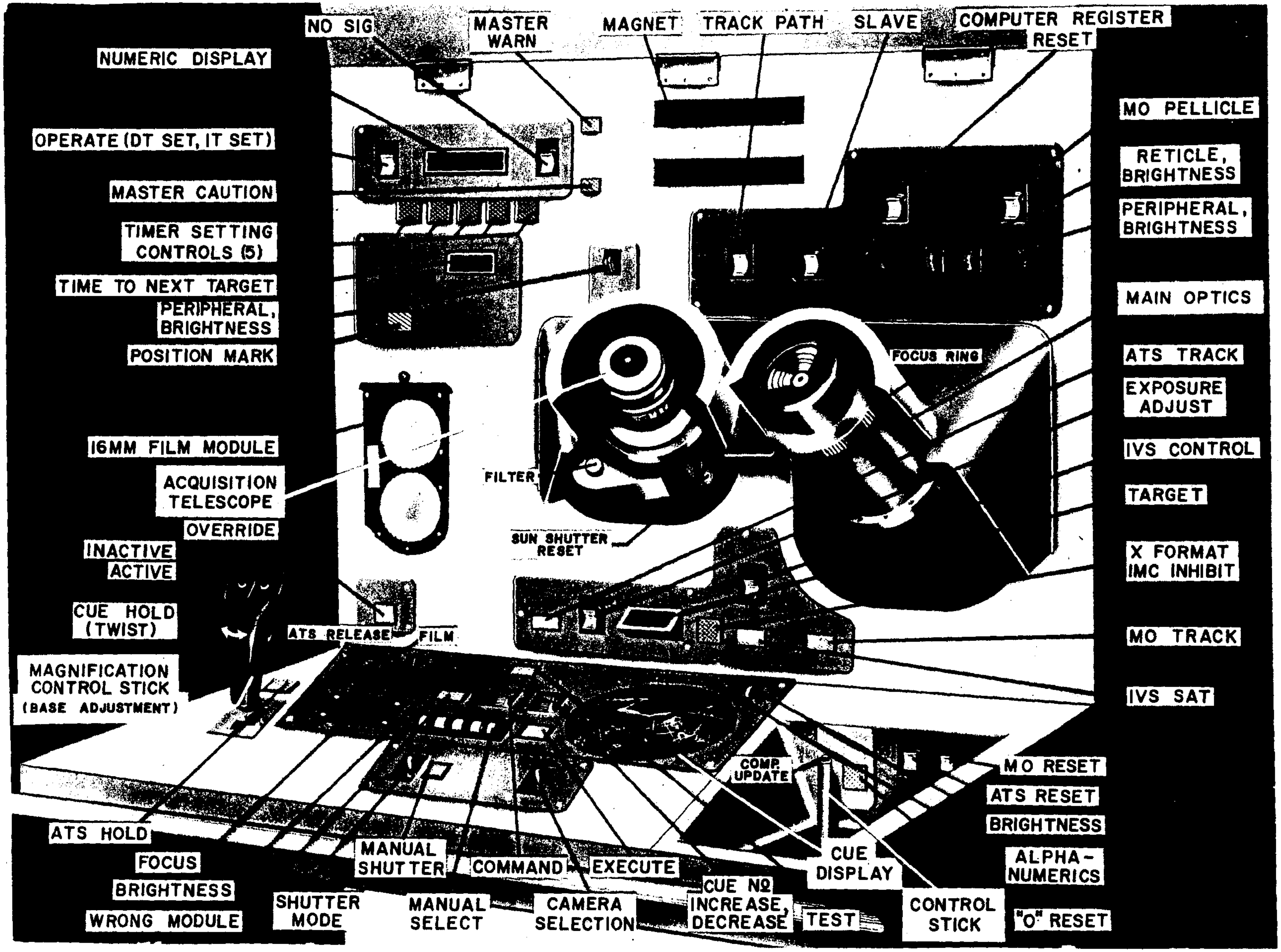
ILLUSTRATION OF MOL SYSTEM DIAGNOSTIC TECHNIQUE
PROBLEM: TARGETS NOT CENTERED IN PHOTOGRAPHS

~~TOP SECRET~~




LOCATION OF ACQUISITION TELESCOPE SYSTEMS
IN MOL LABORATORY COMPARTMENT

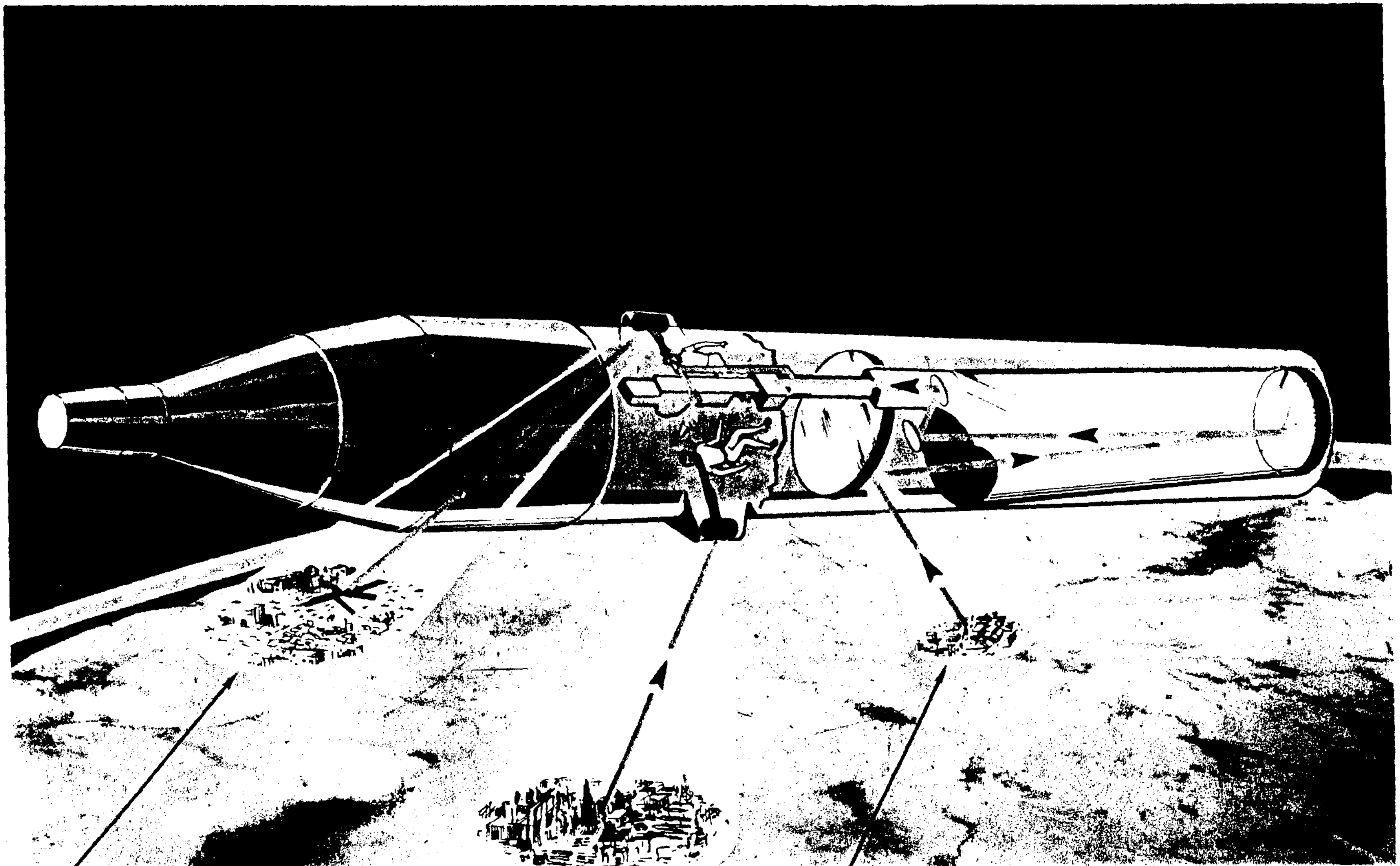
Figure 5






MOL MISSION CONSOLE (CURRENT CONFIGURATION)

FIGURE 6




FIGURE

ACQUISITION TELESCOPE SYSTEM OPERATING CONCEPT

[redacted]