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HEADQUARTERS
SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Air Force Unit Post Office, Los Angeles, California 90045

REPLY TO ATTN OF: SSMM

2 Dec 1964

SUBJECT: Gemini/MOL Experiments

TO: SSG-1

1. (U) In response to Mr. Preston's inquiry on 23 November 64 regarding NASA/DOD Gemini and DOD/MOL Experiments, the attached material is forwarded to help clarify the differences between the two programs.

2. (S) In defining the NASA/DOD Gemini experiments, the basic objective was to identify those elements of participation which contribute to the following mission objectives:

a. [redacted]

b. Observation of surface activities to provide intelligence, warning and targeting data.

c. Retaliation from a space platform by bombardment or by other forms of attack of hostile activities.

d. Development of protective measures to safeguard satellite activities from hostile action and other developments of reliable space hardware through in-space experiments conducted under active manned control.

The selection of experiments was tempered by several factors:

(1) The Gemini Program schedule and essential objectives of Manned Lunar Landing Program must not be jeopardized.

(2) The weight, volume, power required to perform the experiment must be consistent with the restricted capabilities of Gemini.

(3) The experiments must be performed within the time and schedules available.

(4) Modifications to the Gemini spacecraft must be kept at a minimum.

(5) Funding limitations.

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Downgraded at 12 year
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These factors limited the experiments to those which could collect a bare minimum of data over short periods of time and could use and evaluate man's utility only in very fundamental terms.

While limited in scope, the experiment selection will contribute to the solution and evaluation of defense problems, provide a nucleus of trained and experienced Air Force personnel in manned spacecraft activities, and minimize duplication of activities within the national space program. The experience to be gained through these Gemini experiments is directly applicable to MOL experiments and future military missions.

3. (U) Similarly the same basic mission objectives were considered in defining a MOL experiments program with emphasis on establishing a qualitative and quantitative measure of man's usefulness in space for performing these military tasks. As you know, MOL was conceived to serve as a test bed for experiments, and as such, has ample ability to support a total task without concern for program or physical constraints. The experiments selected are those which cannot be achieved in any other way and which will make maximum use of ground tests, simulation, aircraft tests and existing space programs such as Gemini for testing wherever possible. These experiments are divided into two areas: (1) Primary - which assesses man's utility and his physiological and psychological well-being, and (2) Secondary - to advance technology and acquire scientific data of national importance. As you will see, many of these MOL experiments are planned extensions of the Gemini Program.

4. (U) In the near future, we expect to complete the initial definition of MOL experiments. At that time, as a part of the status report to DOD, we will include a discussion of the current DOD Gemini experiments and those recommended for test on MOL. Attachment 1 provides a preliminary comparison of the Gemini and MOL experiments and shows that while they appear outwardly similar there is a significant difference in the approach, the equipments, and the quality and quantity of data to be acquired on man's utility.

5. (U) In summary, we believe that this early and fundamental data to be derived from the Gemini Program will contribute limited, but valuable data to MOL, as well as future military missions regarding man's utility. Through a program such as that defined for MOL, we will be able to accumulate the qualitative and quantitative measurements of man's utility in space for performing military tasks.

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6. (U) Should additional information be desired, please contact this office.

WILLIAM D. BRADY
Colonel, USAF
System Program Director for MOL

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Rpt, "Comparison of Gemini/
MOL Experiments (S)

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COMPARISON OF GEMINI/MOL EXPERIMENTS

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INTRODUCTION

A preliminary prerequisite comparison of Gemini versus MOL experiments is made in this attachment. To avoid repetition of many long titles in the text of this comparison, only experiment numbers are used. In order to clearly identify the experiment being discussed the number, title and a very brief description of both the Gemini and MOL experiments is given.

NASA/DOD GEMINI EXPERIMENT SYNOPSIS

D-1 [redacted]

D-2 [redacted]

[redacted]

D-3 Mass Determination
To investigate techniques of determining mass of an orbiting object.

D-4 Radiometric Background Measurements
Spectral analysis of earth and space backgrounds and particular objects in space.

D-5 Star Occultation Measurements for Spacecraft Navigation
To investigate feasibility and operational worth of star occultation measurements for spacecraft navigation.

D-6 Photographic Definition of Terrestrial Features
To gain further insight into the problems of acquiring, tracking, observing and photographing from a manned spacecraft.

D-7 Radiometric Measurement of Objects in Space
Spectral analysis of earth and space backgrounds [redacted]

[redacted]

D-8 Radiation
To determine spatial distribution of radiation dose-rate in spacecraft and to augment NASA's radiation measurements.

D-9 Manual Measurement Techniques for Spacecraft Navigation
To explore visual sighting techniques for development of an autonomous manual navigation system.

D-10 Spacecraft Attitude Determination for Navigation Purposes
To investigate determination of spacecraft attitude in yaw and pitch from measurement of ion flow variations.

D-11 Astronaut Extravehicular Chest Unit
Operational test of extravehicular life support system to be used with MAMU (D-12).

D-12 Modular Astronaut Maneuvering Unit
To demonstrate feasibility of man to maneuver and perform useful functions in free space.

D-13 Astronaut Visibility
To determine man's capability to see objects on the surface of the earth from an earth-orbiting vehicle.

D-14 UHF, VHF Polarization Measurements
To develop data applicable to communication and control systems operating through the ionosphere.

D-15 Low Light Level Television
Operational test of low light level TV system to aid man in night observation of sea and terrestrial features.

D-16 Minimum Reaction Power Tool Evaluation
To determine man's ability to perform maintenance in free space.

MANNED ORBITING LABORATORY (MOL) EXPERIMENT SYNOPSIS

P-1 Acquisition and Tracking of Ground Targets
Measures man's ability to acquire and track pre-assigned ground targets under varying conditions.

P-2 [redacted]

P-3 Direct Viewing for Ground Targets
Measures man's ability to detect surface targets of opportunity and to make cursory intelligence assessments.

P-4 Electromagnetic Signal Detection
Measures man's ability to make semi-analytical decisions and adjustments based on information from electromagnetic emitters.

P-5 In-Space Maintenance
Measures the crew member's ability to perform in-space maintenance as applied to present and future manned space missions.

P-6 Extravehicular Activity
Determines what functions man can perform outside the spacecraft and what tools he will require for these functions.

P-7 Remote Maneuvering Unit

Measures crew member's ability to control a maneuvering unit by remote control.

P-8 Autonomous Navigation and Geodesy

Measures man's ability to navigate in space and to perform geodetic survey of uncooperative targets.

P-10 Multiband Spectral Observations

Determines the crew member's ability to operate radiometric and related equipment in the completion of military and scientific activities.

P-11 General Human Performance in Space

Measures the day-to-day general performance capabilities of the crew members.

P-12 Biomedical and Physiological Evaluation

Measures the physiological and biomedical factors of the crew members under conditions of long-term orbit and weightlessness.

P-13 Ocean Surveillance

Evaluates the capability of man to control, coordinate, and use a system consisting of various sensors and subsystems to detect, track, classify, and catalog sea targets.

COMPARISON OF GEMINI/MOL EXPERIMENTS

GEMINI/DOD (USAF) EXPERIMENTS D-1, D-2 and D-6

[redacted] Currently, human performance is in this case shown to be competitive with the state-of-the-art in vehicle servo control system design. Experiments, P-2, P-3 and D-1, D-3 can be similarly compared to show that the MOL experiments can qualitatively exceed those of Gemini by two magnitudes.

While an accurate quantitative comparison is not possible a rough estimate is provided. Let us assume that the average Gemini mission duration is seven days, that only one (1) astronaut can operate the equipment and that he has two hours per day available to conduct the experiment and that only two missions are possible per experiment. For MOL the equipments would be available on six (6) missions spread over the four natural seasons, the mission duration is 30 days, two (2) space crewmen can operate the equipment, and that each has two hours per day available to conduct the experiment.

GEMINI		MOL
7 Days		30 Days
1 Astronaut		2 Space Crewmen
7		60
2 Hours/Day		2 Hours/Day
14 Hours		120 Hours
2 Missions		6 Missions
28 Hours of Data		720 Hours of Data

$\frac{720}{28}$ = ~26X as much data as can be acquired in MOL compared to Gemini

Gemini must bring back photos for analysis while MOL can analyze them in space within minutes after exposure.

GEMINI/DOD (USAF) EXPERIMENT D-3

This experiment is intended to evaluate a procedure for mass determination which involves the transfer of energy and the resultant measurement of the affect. A candidate secondary experiment contained in MOL would further study the energy transfer technique, but using pellets or nets instead of vehicle propulsion and physical contact.

GEMINI/NASA (USAF) EXPERIMENTS D-4 and D-7

The Gemini Experiments D-4 and D-7 come very close to meeting the primary objective of MOL Experiment P-10, in that both of them have as their objective the assessment of man's ability and utility in military space tasks and will provide significant radiometric data which will have military and scientific value. Table A is included to show the comparative factors of the equipments associated with these experiments. A review of these factors shows that the P-10 equipments are able to provide considerably more qualitative data than that which can be obtained with the Gemini equipments. The prime difference to be noted is that Gemini collects radiometric data while MOL additionally collects extensive data on man's functions.

Quantitatively the P-10 data will be collected over approximately a 2400-minute period as compared with Gemini which would be limited to about 208 minutes; thus, the quantity of data available from the Gemini Program will be one-tenth that derived from MOL.

GEMINI/DOD (USAF) EXPERIMENTS D-5 and D-9

MOL Experiment P-8 is similar in name only to D-5 and D-9. Again due to the limited space in Gemini, D-5 and D-9 do not have the intrinsic accuracy associated with P-8. They will probably provide position accuracies of about 50 n mi which would be useful for emergency deorbit, but little else. Contrast this with P-8 where positional accuracies equal to our best ground tracking system can be achieved in a manner of a few orbits and updated at will. By using P-8 in combination with other experiment equipments, it is possible to determine the MOL vehicle position to within a few hundred feet. Even more important from a military mission standpoint the P-8 equipments should be able to determine geocentric coordinates of targets such as ballistic missile sites to within 600' of the absolute location on earth.

GEMINI/DOD (USAF) EXPERIMENT D-8

The two Gemini flights which are expected to reach altitudes above 160 n mi will carry Experiment D-8 to measure charged particle radiation rates. Total flight time is limited to about six days, and because of weight limitations, only seven sensors are included. All MOL flights, as a part of Experiment P-12, will include many sensors to make more complete surveys inside and outside of the spacecraft with total exposure times of 120 days. The MOL Experiment P-12 is thus a much more thorough extension to the Gemini D-8 concentrating on radiation in the 140 to 160 n mi altitude range.

GEMINI/DOD (USAF) EXPERIMENTS D-11 and D-12

The Astronaut Extravehicular Chest Unit and the Modular Astronaut Maneuvering Unit are used together to perform the D-12 experiment. Experiment D-11 is a NASA hardware item modified to add displays and controls for the D-12 experiment. The MOL P-6 experiment is an extension of and supplementary to Gemini D-12, using more sophisticated life support and maneuvering systems combined with more complicated astronaut maneuvers and tasks.

GEMINI/DOD (USAF) EXPERIMENT D-10

We consider Experiment D-10 to be a sufficient test of the technology associated with the ion sensor phenomena and do not plan to extend the study to tests in MOL.

GEMINI/DOD (USN) EXPERIMENT D-13

No additional MOL experimenting is planned in this area, but data from MOL Experiments P-1, P-2 and P-3 will be used to supplement data obtained in Gemini Experiment D-13.

GEMINI/DOD (USN) EXPERIMENT D-14

No MOL experiments are planned in this area.

GEMINI/DOD (USN) EXPERIMENT D-15

Currently two methods of low light level target sensing techniques are under consideration. The P-10 experiment study has considered and can accommodate the inclusion of the TV system as a part of the optics design. Another competitive concept of image intensification using optics could be made a part of P-1. If the TV system were finally selected, then it would be an improved version of the Gemini equipments with similar test objectives as those in Gemini.

GEMINI/DOD (USAF) EXPERIMENT D-16

This experiment will evaluate the astronaut's ability to perform extravehicular operations of a minimum reaction power tool. While MOL does not have any plans to extend tests of this specific tool, it is considering numerous similar type activities that might be associated with in-space maintenance; the specifics of which are at this time undefined.

COMPARATIVE FACTORS

	MOL EXPERIMENT P-10	GEMINI EXPERIMENTS D-4 and D-7
A. EQUIPMENT		
Types	(1) Spatial Radiometer (2) Spectral Radiometer	(1) Spatial Radiometer (2) Michelson Interfometer
Sensitivity	10^{-11} to 10^{-13} Watts/Cm^2 μ	10^{-7} to 10^{-10} Watts/Cm^2 μ
Telescope Aperture	15"	4"
Detectors	PM, PbS, InSb, Ge(Cu)	PM, PbS, Bolometer, Ge(Hq)
Spectral Coverage	.2-15μ (Includes Visible Region)	.2-13μ (Excludes Visible Region)
Tracking Capability	Yes	No
Mounting	Gimballed	Body-mounted
B. ASTRONAUT FUNCTIONS		
	• Visual Observation and Selection of Adverse Backgrounds • Target Acquisition • Data Editing and Evaluation • Calibration • Manual Pointing and Tracking	• Calibration • Maneuvers Vehicle to Point Sensor
C. MEASUREMENTS		
1. Background	• Earth, with Special Emphasis on Absorption Bands and Adverse Areas	• Earth, with Special Emphasis on Cloud Free Areas • Sky: Stars of Magnitude of Less Than 3
2. Target Acquisition and Tracking	• Missiles in Launch, Mid-course and Re-entry Phases	• Missiles in Boost Phase Only (will be tracked only within Gemini maneuvering capability)
3. Thermal Mapping	• Ground, Sea and [redacted]	• None
4. Horizon Sensing	• Radiance Profile of Earth's Horizon	• None

[redacted]