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31 March 1967

LMSS EARTH ORBIT

TEST OBJECTIVES

(PRELIMINARY)

RELEASED PROVISIONARY

SUBJECT TO CHANGE

PENDING NASA REVISION

OF MISSION OBJECTIVES OR REQUIREMENTS

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1.1 This document defines the earth orbit test objectives for the Payload Module (PM) of the Lunar Mapping and Survey System (LMSS). The overriding requirement for this test is to validate those LMSS subsystem interfaces and flight operational procedures necessary for the success of either the contingency site certification mission in 1968 or the AAP scientific survey missions in 69-71. To accomplish this, the earth orbit test mission, will to the maximum possible degree, simulate those aspects of the LMSS Lunar missions which will significantly increase confidence in the overall performance potential of the system, including the development of effective command, control, and astronaut participation techniques.

1.2 The earth orbit LMSS test will allow system optimization prior to the actual Lunar mission. The LMSS E.O. test mission will include exercising and verifying: MCC-H command and control; MSFN command/telemetry transmission and processing; astronaut activities; and CSM and PM system and subsystem operations. While all of the PM subsystems have received acceptance testing, it should be noted that these subsystems have not received testing in a combined PM flight environment; nor has the astronaut/CSM/PM combination undergone a system level flight test. The primary purpose of the earth orbit mission is to verify, prior to the actual lunar mission, these operational interfaces and test as a complete system the LMSS.

1.3 In the event the contingency mission is flown prior to the E.O. test mission, the requirement for the E.O. Test mission will be re-evaluated.

1.4 There is no identified requirement for docking the PM to the AAP orbital workshop as an element of the E.O. test mission.

2. BASIC OBJECTIVES

The detailed mission objectives are identified and defined to accomplish the following basis objectives of the LM&SS earth orbit test mission:

2.1 Pefform thorough end-to-end validation of complete LM&SS.

2.2 Verify PM design and associated subsystem elements comprising the LMSS including the Rack, Docking Adapter, and CSM modifications.

2.3 Verify adequacy of factory-to-launch operations, ASE and testing.

2.4 Verify adequacy of MSFN, computer programs and operational procedures.

2.5 Confirm and improve operational procedures, including command philosophy, for lunar missions.

2.6 Verify, as much as possible, the adequacy of LMSS for lunar missions.

2.7 Verify Astronaut/PM interfaces and capabilities.

3. GENERAL FLIGHT PLAN

3.1 The PM/Rack/CSM will be launched by a Saturn 1B into a 120-150 nm earth orbit with a nominal inclination of 35°. After injection, the CSM will separate from the SLA and dock with the PM. After hard-docking and manual connection of CSM/PM umbilicals, the CSM/PM extracts from the SLA and Rack. Calibration of the Roll alignment is performed.

The LMSS vehicle is then ready for orbital operations. The test described later in this plan are programmed as subsequently defined by mission planning activities. Photographic tests will, in general, require attitude control of the PM as in the lunar mission. Command telemetry will be from the MSFN via the CM RF links. Data returned will consist of stor and real time data returned via telemetry, and payload data retrieved by the astronauts. Upon completion of the tests, the astronauts will separate the CSM from the PM, leaving the PM in orbit. No further testing will be possible since the PM is without command and telemetry.

4. MISSION OBJECTIVE

4.1 Primary Objective

The primary objectives of LMSS earth orbit test are listed below. Preflight malfunctions of spacecraft or launch vehicle system, ground equipment or instrumentation which would result in failure to meet these objectives will be cause to hold or cancel the mission until the malfunction has been eliminated.

4.1.1 Demonstrate PM Survival of Launch Environment

PM survival of the acoustical, vibration, and acceleration environment is to be evaluated by analysis of tape recorded data during powered flight, on orbit TM data, and recovered film. No special instrumentation is required.

4.1.2 Demonstrate Hard-Dock at the CSM and PM and Extraction of the PM from the SLA

Astronaut performance, commentary, photographs, and TM will be used to evaluate the docking maneuver. Evaluation of tasks associated with tunnel hardware and mating PM electrical connectors will also be based upon astronaut observations.

4.1.3 Demonstrate Roll Alignment Readout Accuracy

Accuracy is to be evaluated by analysis of stellar film to establish bias error estimate.

4.1.4 Demonstrate PM Operations for Lunar Mission

The EO test should simulate a 14-day lunar mission to the maximum extent practicable. Operational sequences should be of the same type, distribution, and duration, (TBD) as planned for the lunar mission in order to demonstrate operational life capability of the PM subsystems. Because of the EO test constraints, some photographic sequences may have to occur in darkness in order to satisfy this objective.

4.1.5 Demonstrate Adequacy of Command Generation and Transmission to PM

To the extent possible the lunar mission software is to be demonstrated with MSFN. Manual procedures as well as software are to be demonstrated. Command generation software is to be evaluated for its adequacy of optimization logic, flexibility, and reliability. Command transmission and verification is to be evaluated on the basis of MCC/MSFN command data, examination of confirming PM TM data, and payload record indicating executed functions. The remote stations shall provide RF attenuators to stimulate FR propogation losses for lunar distances.

4.1.6 Verify CSM G & N Functions Peculiar to LM&SS

Demonstrate the capability of the CSM guidance and navigation system including the ACC software modifications to perform within specifications for the LM&SS mission. Verify planned RCS propellant consumption for docking, roll, stabilization, etc. Demonstrate effectiveness of differential jet firings.

4.1.7 Verify PM Thermal Control System

Detailed analysis of PM TM thermal data and thermal control system data will be used to verify the thermal control system performance.

4.1.8 Determine RCS Contamination Effects

Analysis of payload mecord and thermal data throughout the mission will be used to indicate RCS contamination effects on the thermal controled surfaces. This test requires RCS propellant expenditures comparable to anticipated RCS consumption during the lunar mission. The time required to accomplish this test is TBD.

4.1.9 Determine the Validity of Planned Astronaut Timelines

Astronaut functions associated with PM operations will be detailed at the timeline level to provide necessary information for planning mission operations. Timelines are required for the following tasks:

(1) Transpoàition, docking and Separation
(2) Electrical and Mechanical PM Mating
(3) Roll Calibration of PM
(4) IMU Alignment
(5) G&N Telescope Sightings
(6) Data Retrieval
(7) Data Stowage
(8) Tunnel Hardware Stowage

The preliminary timelines will be based upon one "G" and zero "G" tests. The earth orbit-test of these funcgions will verify that the astronauts can peform the tasks satisfactorily in the allotted times.

4.1.10 Establish Value of Astronaut Telescope Sightings

The purpose of astronaut telescope sightings is to augment tracking data for a more accurate and more timely determination of the orbit. Of particular value is improvement of the altitude profile. Selected sighting targets must be comparable in size, contrast, etc. as lunar objects, i.e., natural instead of man-made. Sightings must take place during daylight with good visibility conditions. The selected sighting targets must be of known geodetic location in order to establish accuracy of data generated by this technique. Telescope sightings should take place only after orbit determination by normal tracking has converged, probably after the first day on orbit. Detailed analysis of the telescope sighting data, determined orbit, and vehicle attitude data are required to establish the accuracy of the telescope sighting data and its value in augmenting tracking data. The number and frequency of sightings is TBD.

4.1.11 Establish Astronaut Movement Restrictions for PM Operations

The purpose of this test is to determine if restrictions on astronaut movements are required by the PM. Baseline data for astronaut initiated perturbations will be established by recording the CM Telemetry during typical astronaut functions such as the following:

(1) No Movement
(2) Typical control panel arm movements
(3) Food preparation
(4) Waste disposal
(5) Couch rotation
(6) G & N telescope sighting operations
(7) Suit donning/doffing
(8) Miscellanceous stowage
(9) Experimemt activities

Voice annotation of astronaut activities will be recorded for subsequent correlation with telemetry data. Each of the typical astronaut functions will be recorded at least three times and preferably nine times during the mission. These data will be used to determine the validity of a specified regimen of astronaut movements which will be required to be performed to obtain standard test conditions.

A series of seven simple movements which are components of the typical astronaut functions identified above and a no astronaut movement condition will be required to be performed in each of eight combinations of astronauts/locations for a total of 64 test trials.

PM data will be obtained during the standardized movements. Each test trial should take less than five seconds. Because of the small amount of time required to conduct the complete test series, the entire sequence could be performed 10 to 15 times. Astronaut preflight training will be required to insure proficiency in formal standarized movements required during the second part of the test.

The test data will consist of CM attitude telemetry data and PM data recorded during the standardized astronaut movements. A dynamics model will be used to relate the attitude data sensed in the CM to perturbations experienced in the PM while in the docked CM/PM configuration. The effects of the astronaut movement conditions on PM data will be evaluated by performing a relative comparison of the data obtained during the various trial conditions. These analyses will provide a basis for determining the requirements for, and identifying movement components associated with, restrictions on specific types of astronaut movements.

4.1.12 Demonstrate Record Cut and Cassette Retrieval

Astronaut observation will be used to evaluate design and procedures for cassette retrieval and stowage. Film cut will occur at the termination of the photographic mission in lieu of film run out.

4.2 Secondary Objectives

Preflight malfunctions of spacecraft or launch vehicle systems, ground equipment or instrumentation which would result in failure to meet these objectives may be cause to Hold or cancel the mission until the malfunction has been eliminated.

4.2.1 Verify Adequacy of PV Interface with All Lunar Piggyback Experiments

The adequacy and compatibility of the mechanical, electrical, and operational requirements and interfaces of all lunar piggyback experiments will be verified during the PM EO Test Mission.

4.2.2 Verify Open and Closed Loop V/H Sensor Operation

Both modes of V/H sensor operations are to be demonstrated. Accuracy determination of sensor operation requires activation over a cloud free area during daylight. Software flexibility for change from one operating mode to the other is to be demonstrated. The time required to perform the earth orbit V/H sensor verification is TBD.

4.2.3 Determine Capability of Astronaut to Detect Unprogrammed Targets of Opportunity

This test involves determining the capability of the astronaut to provide sufficient information to the ground to permit reprogramming to obtain PM data from a particular area considered to be of interest based upon astronaut observation. The earth orbit test will determine if the astronaut can detect large visual targets located in a geographic area containing natural reference points and identify the coordinates of these targets with sufficient accuracy to enable ground reprogramming. The maps used will simulate the anticipated scale of lunar maps and charts.

4.2.4 Verify Factory-to-Launch Sequency

The EO test mission will demonstrate the adequacy of PM ground handling procedures, facilities, and schedules throughout the manufacturing, check-out, transportation, stowage, preparation for launch and launch sequence.

4.2.5 Simulate Various Failure Modes

Operational procedures to circumvent or minimize failure modes are to be demonstrated. Simulated failure modes will be entered during the mission to exercise contingency operator procedures and software capabilities. The adequacy of system response to failures will be evaluated in post test critiques.

4.2.6 Demonstrate Adequacy of TM Processing and Display

A post mission operations critique should be held to evaluate the adequacy of PM TM processing and display coupled with operations procedures whereby analysis of these data are fed into the operations decision making loop.