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LUMINARY MEMO #247

To: Distribution
From: D. Millard
Date: 1 September 1972
Subject: Level 6 Test Description for Mission 17 (PRELIMINARY)

This memo provides a description of the LUMINARY Level 6
Digital Performance Testing currently planned for Mission 16. 7
Included are comments on test initialization and a detailed description
of the digital simulation tests which fall into the following general
categories.

6.1.0 ASCENT AND RENDEZVOUS
6.2.0 ABORT FROM DESCENT
6.3.0 LUNAR SURFACE OPERATION AND ALIGNMENTS
6.4.0 LUNAR LANDING
6.5.0 ERASABLE MEMORY PROGRAMS
6.6.0 SPECIAL TESTS

The test initialization listed below applies to all the tests and any
special initial conditions will be specified in the detailed test description.

1) 1σ IMU, Radar, State Vector Errors   *Flight*
2) Normal Astronaut Interface from Apollo 17 Data File
3) Apollo 17 Operational Trajectory
4) Apollo 17 Erasable Load
5) 71/72 Ephemeris
6) 10% TLOSS
7) LM12 Vehicle

Typical 1σ initialization errors are given on page 2.

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TYPICAL 1 SIGMA INITIALIZATION ERRORS

IMU ERRORS

	X	Y	Z
Misalignment (milliradians)	1.0	1.0	1.0
Bias Drift (MERU)	2.00	2.00	2.00
Input Axis Drift (MERU/G)	8.00	-8.00	8.00
Spin Axis Drift (MERU/G)	-5.00	5.00	-5.00
PIPA Bias (CM/SEC^2)	.20	.20	.20
PIPA Scale Factor (PPM)	-116	-116	-116

STATE VECTOR ERRORS AT PDI IGNITION

	ALTITUDE	CROSS-RANGE	DOWN-TRACK
POSITION (ft.)	-1410	1080	-4220
VELOCITY (fps.)	4.3	1.28	-1.38

RENDEZVOUS RADAR ERRORS

	BIAS	RANDOM
RANGE (ft.)	800 if R > 50.8 N.M. 80 if R ≤ 50.8 N.M.	.3% R
RANGE-RATE (fps)	.3	.4% Ṙ (MINIMUM .0044 fps)
SHAFT/TRUNNION (Mr.)	15.0	1.0

LANDING RADAR ERRORS

	RANDOM	MINIMUM
ALTITUDE (ft.)	.5%	5
VX (fps)	.5%	.8
VY (fps)	.7%	.8
VZ (fps)	1.0%	.8

6.1.0 ASCENT AND RENDEZVOUS

The following applies to all tests in this section unless stated otherwise in the test description.

a) The SLOSH environment is not simulated.
b) The FAST IMU environment is used.

6.1.1 · ASCENT AND RENDEZVOUS

I. Test Objective

Demonstrate LM Ascent from the lunar surface and LM active short Rendezvous.

II. Test Description

The LM is tilted approximately 10° on the Lunar Surface.

Program Sequence

P57	AT-3 to Landing Site
P00	
V48	DAP Data Load
V41N72	Position RR
P12	Ascent
V64	S-Band Antenna
V82	Orbital Parameter Display (R30)
P00	
V48	DAP Data Load
P20	Rendezvous Navigation
V80	Enable LM State Vector Update
P34	Transfer Phase Initiation (TPI)
V83	Rendezvous Parameter Display (R31)
N52	Display LM Central Angle
N59	Display Delta LOS Vel.
V48	DAP Data Load
P42	APS
V82	Orbital Parameter Display (R30)
P35	Transfer Phase Midcoarse (TPM)
V67	W-Matrix Display
V48	DAP Data Load
V83	Rendezvous Parameter Display (R31)

P41	RCS
V82	Orbital Parameter Display
P35	Transfer Phase Midcourse (TPM)
V93	Enable W-Matrix Initialization
P41	RCS
V82	Orbital Parameter Display
P00	
V48	DAP Data Load
P47	Thrust Monitor
P00	

6.2.0 ABORTS FROM DESCENT

The following applies to all tests in this section unless indicated differently in test description.

a) The LM is yawed left 70 degrees at PDI-3 mins.
   The 70 degrees yaw is removed at PDI +3 mins. This maneuver is done in the AUTO mode.
   manually

b) The AUTO throttle and ABORT back up discretes are set.

c) The abort switch is failed ON.

d) The SLOSH environment model is not simulated.

e) The environmental FAST IMU is used.

f) Abort sequence:
   Switch to ATTHOLD
   Full Throttle
   ABORT or ABORT STAGE
   V22N46 ENTER ENTER
   Switch to AUTO

g) Terrain slope error of -1 degree.

TEST 6.2.1 ABORT AT 33 K. FT.

I. Test Objective

   Demonstrate DPS Abort from descent.

II. Test Description

   ## Program Sequence

P00	
V48	DAP Data Load
V64	S-Band Antenna Routine (R05)
P63	Braking Phase Program
V57	LR Update (R12)

ABORT sequence at 33 K ft. altitude.

P70	DPS Abort Program
N76	Monitor Desired HVEL, RVEL, Crossrange
N77	Monitor TTOGO, VGY, ABVEL
N85	Monitor VG
P00	LGC Idle Program
V64	S-Band Antenna Routine (R05)
V82	Orbital Parameter Display Routine (R30)
V83	Rendezvous Parameter Display Routine (R31)
P20	Rendezvous Navigation Program
P32	Coelliptic Sequence Initiation Program

TEST 6.2.2 ABORT AT 7 K. FT.

I. Test Objectives

Demonstrate DPS and APS Abort from descent.

II. Test Description

The abort switch is failed OPEN requiring the astronaut to select
P70 via DSKY.

[handwritten annotation: peep to reep the ABORT backup dioute is set]

Program Sequence

P00	
V48	DAP data load
V64	S-Band Antenna Routine (R05)
P63	Braking Phase
V57	LR Update (R12)
P64	Approach Phase
	ATTHOLD at 7 K ft.
	Full throttle
	V22N46 EE
P70	DPS Abort select by Astronaut
	AUTO mode

ABORT STAGE at DPS depletion

P71	APS Abort
N76	Monitor Desired Horizontal, Radial Vel, Crossrange
N77	Monitor TTOGO, VGY, ABVEL
N85	Monitor VG
P00	
V64	S-Band Antenna Routine (R05)
V82	Orbital Parameter Display (R30)
V83	Rendezvous Parameter Display (R31)
P20	Rendezvous Navigation
P32	Coelliptic Sequence Initiation

TEST 6.2.3 ABORT AFTER TOUCHDOWN

I. Test Objective

   Demonstrate APS (T1) Abort

II. Test Description
    The Auto Throttle is failed off.

   Program Sequence

P00

V48   DAP Data Load

V64   S-Band Antenna Routine (R05)

P63   Braking Phase

V57   LR Update Enable

P64   Approach Phase

P66   Vertical Phase

ABORT Sequence at Lunar Surface Touchdown

P71   APS Abort

P00

V64   S-Band Antenna Routine (R05)

V82   Orbital Parameter Display (R30)

V83   Rendezvous Parameter Display (R31)

P20   Rendezvous Navigation

P32   Coelliptic Sequence Initiation

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6.3.0 LUNAR SURFACE OPERATION AND ALIGNMENTS

TEST 6.3.1 LUNAR SURFACE OPERATIONS

I. Test Objective

Demonstrate LM IMU Lunar Surface alignments and operations.

II. Test Description

The LM is tilted approximately 10° on the Lunar Surface.

Program Sequence

P68	Lunar Surface Confirmation Program
P00	
P12	Ascent Program
P57	AT-3 Lunar Surface Alignment to REFSMMAT
	Recycle Gravity Determination
V47	AGS Initialization
V41N20	Park IMU
	Coarse align IMU to parking gimbal angles
P06	LGC Power Down Program
	LGC Power Up
P57	AT-3 Lunar Surface Alignment to Landing Site
	4 Star sightings
V63	RR Self test
P22	Lunar Surface Navigation (No Update Mode)
P57	AT-3 Lunar Surface Alignment to Landing Site
V47	AGS Initialization
V48	DAP Data Load
V82	Orbital Parameter Display
P12	Ascent Program to TIG
P00	

6.4.0 LUNAR LANDING

The following applies to all tests in this section unless indicated differently in test description.

a) The LM is yawed left 70 degrees at PDI -3 mins.
    The 70 degree yaw is removed at PDI +3 mins. This maneuver is done in the AUTO mode.

b) The AUTO throttle and ABORT back up discretes are set.

c) The abort switch is failed ON and the auto throttle failed OFF.

d) The SLOSH mode is not simulated.

e) The environmental FAST IMU is simulated.

f) Terrain slope error -1 degree

TEST 6.4.1 LUNAR LANDING - AUTO (ERROR FREE)

I. Test Objective

   Demonstrate LM automatic landing.

II. Test Description

   This test contains no initialization errors.

   ## Program Sequence

P00

V48	DAP data Load
V64	S-Band Antenna Routine (R05)
P63	Braking Phase
V57	LR Update Enable
N68	Monitor Range, TGO, Velocity
N92	Monitor THROTTLE CMD, HDOT, H
P64	Approach Phase
P66	Vertical Phase
P68	Lunar Surface Confirmation

P00

TEST 6.4.2 LUNAR LANDING - AUTO

I. Test Objective

Demonstrate LM automatic landing.

II Test Description

This is the same as TEST 6.4.1 (ERROR FREE) except that it contains a -1 degree terrain slope error.

TEST 6.4.3 LUNAR LANDING - NOMINAL

I. Test Objection

Demonstrate LM automatic landing.

II. Test Description

This test exercises landing site redesignation option at PDI -10 mins. to correct propagated state vectors errors; at PDI +5 mins. to correct IMU errors and at PDI +8 mins. to correct altitude errors.

Test Sequence

P00	
N69	Landing Site Redesignation at PDI -10 mins.
	Downtrack
	Crosstrack
V48	DAP Data Load
V64	S-Band Antenna Routine (R05)
P63	Braking Phase
V57	LR Update Enable
N69	Landing Site Redesignation at PDI +5 mins.
	Downtrack
	Crosstrack
N69	Landing Site Redesignation at PDI +8 mins.
	Altitude
P64	Approach Phase
	LPD ACA: AZ, EL
P66	Vertical Phase
P68	Lunar Surface Confirmation
P00	

TEST 6.4.4 LUNAR LANDING - MAX DOWNRANGE N69

I. Test Objective

Demonstrate LM nominal landing to offset landing site.

II. Test Description

This test exercises the landing site redesignation option N69 at PDI +2 and LPD during P64. The N69 redesignation offsets the actual landing site.

Program Sequence

P00	
V48	DAP Data Load
P63	Braking Phase
N69	Landing Site Redesignation at PDI +2 mins.
	Downtrack
P64	Approach Phase
	LPD ACA: AZ, EL
P66	Vertical Phase
	Entered manually at 700 ft.
P68	Lunar Surface Confirmation
P00	

6.5.0 ERASABLE MEMORY PROGRAMS

Only those EMPs specified in the flight plan for a nominal mission will be reported on.

EMP 99 LM DEORBIT   TEST 6.5.1

TEST 6.5.1 LM DEORBIT

I   Test Objective

Demonstrate LM deorbit using Erasable Memory
Program 99.

II   Test Description

Test Sequence

P00

Load EMP 99

V48   DAP Data Load

V47   AGS Initialization

P30   External Delta-V

Verify Noun 26

V62   Display Total Attitude Errors

V30   Activate EMP 99

6.6.0 SPECIAL TESTS

The following applies to all tests in this section unless otherwise indicated in the test description.

a) The SLOSH environment is not simulated.

b) The FAST IMU environment is used.

6.6.1A DOI2 - ERROR FREE

I.   Test Objectives

        Demonstrate the DOI2 burn with no initialization errors.

II.   Test Description

        The LM is yawed left 70 degrees after DOI2.
        The simulation is terminated at throttle up in P63.

        ### Program Sequence

P00	
V48	DAP data load
V82	Orbited Parameter Display (R30)
P30	External Delta V targetting
P41	RCS Burn
V82	R30
V64	S-Band Antenna Routine (R05)
V48	DAP data load
P27	SV Update
P63	Braking Phase

6. 6. 1B DOI2

I.   Test Objective

Demonstrate the DOI2 burn with 1σ errors.

II.   Test Description

This is the same as TEST 6. 6. 1A except that it is initialized with 1σ errors.

6. 6. 1C   DOI2

I.   Test Objective

Demonstrate the DOI2 burn with 1σ errors.

II.   Test Description

This is the same as TEST 6. 6. 1B except that the 1σ state vector errors are reversed.

6.6.3 TEI Using DPS

I.   Test Objective

        Demonstrate the TEI burn using the LM DPS.

II.   Test Description

        Program Sequence

        P00
        V48   DAP Data Load
        V82   Orbital Parameter Display (R30)
        P30   External Delta V Targeting
        P40   DPS Burn
        V82   R30

6.6.4 LOI Using DPS

I.   Test Objective

Demonstrate the LOI burn using the LM DPS.

II.   Test Description

Program Sequence

P00

V48   DAP Data Load

V82   Orbital Parameter Display (R30)

P30   External Delta V targetting

P40   DPS Burn

V82   R30