This memo includes a detailed description of 16 level 6 digital simulation tests which fall into the following general categories:

6.1.0 RENDEZVOUS
6.2.0 ABORTS FROM DESCENT
6.3.0 LUNAR SURFACE OPERATIONS, ALIGNMENTS, ASCENT
6.4.0 LANDING ON LUNAR SURFACE
6.5.0 SPECIAL TESTS

The test initialization listed below apply to all the tests and any special initial conditions will be indicated in the particular test.

(1) 1σ IMU, Radar, State Vector Errors.
(2) Normal Astronaut interface from Apollo 15 Data File.
(3) Apollo 15 Operation Trajectory.
(4) Apollo 15 Erasable Load.
(5) 71/72 Ephemeris.
(6) 0 TLOSS.
(7) LM-10 Vehicle.
I. Test Objective

This test is made to verify the nominal LM Active Short Rendezvous Program Sequence.

II. Test Description

Timeline

<table>
<thead>
<tr>
<th>TPI -38</th>
<th>TPI +45</th>
</tr>
</thead>
</table>

Program Sequence

<table>
<thead>
<tr>
<th>P00</th>
<th>LGC Idling</th>
</tr>
</thead>
<tbody>
<tr>
<td>P20</td>
<td>Rendezvous Navigation</td>
</tr>
<tr>
<td>P34</td>
<td>Transfer Phase Initiation (TPI)</td>
</tr>
<tr>
<td>P42</td>
<td>APS</td>
</tr>
<tr>
<td>P35</td>
<td>Transfer Phase Midcourse (TPM)</td>
</tr>
<tr>
<td>P41</td>
<td>RCS</td>
</tr>
<tr>
<td>P35</td>
<td>Transfer Phase Midcourse (TPM)</td>
</tr>
<tr>
<td>P41</td>
<td>RCS</td>
</tr>
<tr>
<td>P00</td>
<td>LGC Idling</td>
</tr>
<tr>
<td>P47</td>
<td>Thrust Monitor</td>
</tr>
<tr>
<td>P00</td>
<td>LGC Idling</td>
</tr>
</tbody>
</table>

Extended Verbs

<table>
<thead>
<tr>
<th>V47</th>
<th>Initialize AGS (R47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V48</td>
<td>Start DAP Data Load (R03)</td>
</tr>
<tr>
<td>V63</td>
<td>Start RR/LR Self Test Routine (R04)</td>
</tr>
<tr>
<td>V64</td>
<td>S-Band Antenna Routine (R05)</td>
</tr>
<tr>
<td>V67</td>
<td>W Matrix RMS Error Display</td>
</tr>
<tr>
<td>V80</td>
<td>Enable LM State Vector Update</td>
</tr>
<tr>
<td>V82</td>
<td>Request Orbit Param Display (R30)</td>
</tr>
<tr>
<td>V83</td>
<td>Request Rendezvous Param Display (R31)</td>
</tr>
<tr>
<td>V93</td>
<td>Enable W Matrix Initialization</td>
</tr>
<tr>
<td>V95</td>
<td>No Update of Either State Vector</td>
</tr>
</tbody>
</table>
III. Test Initialization

1. 10% TLOSS during powered flights.
I. Test Objective

Verify proper operation and ascertain performance of the DPS Abort Program P70 in Luminary revision 210.

II. Test Description

This test is run with ABORT discrete present before entering P63.

Program Sequence

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P00</td>
<td>Idle Program</td>
</tr>
<tr>
<td>V48</td>
<td>DAP Data Load, Set Abort Backup</td>
</tr>
<tr>
<td>V64</td>
<td>S-Band Antenna Routine (R05)</td>
</tr>
<tr>
<td>P63</td>
<td>Braking Phase Program</td>
</tr>
<tr>
<td>V57</td>
<td>State Vector Update Routine; LR Update (R12)</td>
</tr>
</tbody>
</table>

Manual Throttle to 99% and ABORT at 33K ft.

ATTITUDE HOLD

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P70</td>
<td>DPS Abort Program, Switch to AUTO</td>
</tr>
<tr>
<td>P00</td>
<td>LGC Idling Program</td>
</tr>
<tr>
<td>V64</td>
<td>S-Band Antenna Routine (R05)</td>
</tr>
<tr>
<td>V82</td>
<td>Orbital Parameters Display Routine (R30)</td>
</tr>
<tr>
<td>V83</td>
<td>Rendezvous Parameter Display Routine (R31)</td>
</tr>
<tr>
<td>P20</td>
<td>Rendezvous Navigation Program</td>
</tr>
<tr>
<td>P32</td>
<td>Coelliptic Sequence Initiation Program</td>
</tr>
</tbody>
</table>

While in P70 the following exercises will be performed:

I. Manual yaw maneuver to observe vehicle attitude control response to ACA when mode control is AUTO.

II. Monitor N76, N77, N85 via V16.

III. Test Initialization

1. Environment initialization
   A. Terrain profile with +1° errors.
   B. 10% TLOSS

2. CHANBKUP abort discrete set in P00.
TEST 6.2.2 ABORT AT 7K FT.

I. Test Objective

Verify operation and ascertain performance of the APS Abort Program (after DPS depletion in the DPS Abort Program) in Luminary revision 210.

II. Test Description

This test is run with the ABORT discrete present

Program Sequence

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P00</td>
<td>Idle Program</td>
</tr>
<tr>
<td>V48</td>
<td>DAP Data Load</td>
</tr>
<tr>
<td></td>
<td>Set Abort Backup</td>
</tr>
<tr>
<td>V64</td>
<td>S-Band Antenna Routine (R05)</td>
</tr>
<tr>
<td>P63</td>
<td>Braking Phase Program</td>
</tr>
<tr>
<td>V57</td>
<td>State Vector Update Routine; LR Update (R12)</td>
</tr>
<tr>
<td>P64</td>
<td>Approach Phase Program</td>
</tr>
</tbody>
</table>

Manual Throttle to 99% and ABORT at 7K ft.
ATTITUDE HOLD

P70 | DPS Abort Program
    | Switch to AUTO
ABORT STAGE at DPS depletion
ATTITUDE HOLD

P71 | APS Abort Program
    | Switch to AUTO

P00 | LGC Idling Program
V64 | S-Band Antenna Routine (R05)
V82 | Orbital Parameters Display Routine (R30)
V83 | Rendezvous Parameters Display Routine (R31)
P20 | Rendezvous Navigation Program
P32 | Coelliptic Sequence Initiation Program

While in P70, the following exercise will be performed (until DPS depletion):

I. Monitor N76, N77, N85 via V16.
While in P71, the following exercises will be performed:

I. Manual yaw maneuver to observe vehicle attitude control response to ACA when mode control is ATTHOLD.

II. Monitor N76, N77, N85 via V16.

III. Test Initialization

1. Environment Initialization

   A. Terrain profile with $+1^\circ$ errors.
   B. 10% TLOSS

2. CHANBKUP abort discrete set in P00.
I. Test Objective

Verify operation and ascertain performance of the APS Abort Program (after a nominal Lunar Landing) in Luminary revision 210.

II. Test Description

This test is run with the ABORT present.

Program Sequence

P00  Idle Program
V48  DAP Data Load Routine (R03)
     Set abort channel backup
P63  Braking Phase Program
V57  State Vector Update Routine; LR Update (R12)
P64  Approach Phase Program
P66  Vertical Phase Program (R, O, D. -Auto)

ABORT STAGE at touchdown
ATTITUDE HOLD
P71  APS Abort Program
     Switch to AUTO

P00  LGC Idling Program
V64  S-Band Antenna Program (R05)
V82  Orbital Parameters Display Routine (R30)
V83  Rendezvous Parameters Display Routine (R31)
P20  Rendezvous Navigation Program
P32  Coelliptic Sequence Initiation Program

While in P71, the following exercises will be performed:

I. Manual yaw maneuver to observe vehicle attitude control response to ACA when mode control is ATTHOLD.
II. Monitor N76, N77, N85 via V16.
III. Test Initialization

1. Environment Initialization

   A. Terrain profile with $+1^\circ$ errors
   B. 10% TLOSS

2. CHANBKUP abort discrete set in P00
TEST 6.3.1 LUNAR SURFACE OPERATIONS

I. Test Objective

This test is made to demonstrate the LM IMU alignment capability for a nominal program sequence during the lunar surface stay.

II. Test Description

Program Sequence

P68 Lunar Surface Confirmation Program
P00
P12 Ascent Program
P57 AT=1 Lunar Surface Alignment to REFSMMAT
   (Recycle Gravity Determination)
   (Reject Noun 93)
V41N72 Radar Designate
P57 AT-2 Lunar Surface Alignment to REFSMMAT
   (Star and Planet)
P57 AT-2 Lunar Surface Alignment to REFSMMAT
   (2 stars)
V47 AGS Initialization
P06 LGC Power Down Program
P00
P57 AT-3 Lunar Surface Alignment to Landing Site
   (1 star, Spiral-Cursor marks)
V64 S-Band Antenna Routine
V63 Radar Selftest
P22 Lunar Surface Navigation (No Update Mode)
V48 DAP Data Load
P57 AT-3 Lunar Surface Alignment to Landing Site
   (1 star)
V47 AGS Initialization Routine
V48 DAP Data Load
V82  Orbital Parameter Display
P12  Ascent Program
     (Terminate at TIG -5)
P00
TEST 6.3.1.1 INFLIGHT ALIGNMENTS

I. Test Objective

This test is made to demonstrate the LM IMU alignment capability for a nominal program sequence using the P57 sighting mark procedure and normal inflight mark procedure.

II. Test Description

Program Sequence

P00
V48 DAP Data Load
V41N72 RADAR Designate
P52 Alignment to REFSMMAT
   Select P57 Sighting Procedure
      (star-planet, Cursor-Spiral marks)
V48 DAP Data Load
P52 Alignment to REFSMMAT
   (2 stars, normal X-Y marks)
P52 Alignment to REFSMMAT
   (Sun-Planet, normal X-Y marks)
P00

III. Test Initialization

1. IMU errors to reflect docked coarse aligned IMU.
TEST 6.3.2 ASCENT FROM LUNAR SURFACE

I. Test Objective

This test is made to verify LM performance for a nominal program sequence for Ascent from the Lunar Surface.

II. Test Description

Program Sequence

<table>
<thead>
<tr>
<th>P68</th>
<th>Lunar Surface Confirmation</th>
</tr>
</thead>
<tbody>
<tr>
<td>P00</td>
<td></td>
</tr>
<tr>
<td>V48</td>
<td>DAP Data Load</td>
</tr>
<tr>
<td>P12</td>
<td>Ascent</td>
</tr>
<tr>
<td></td>
<td>Target for 1 n.m. out-of-plane</td>
</tr>
<tr>
<td>V64</td>
<td>S-Band Antenna Routine</td>
</tr>
<tr>
<td>V83</td>
<td>Request Rendezvous Parameter Display</td>
</tr>
<tr>
<td>P00</td>
<td></td>
</tr>
<tr>
<td>V82</td>
<td>Request Orbital Parameter Display</td>
</tr>
<tr>
<td>P20</td>
<td>Rendezvous Navigation</td>
</tr>
<tr>
<td></td>
<td>No state vector update</td>
</tr>
<tr>
<td>V83</td>
<td>Request Rendezvous Parameter Display</td>
</tr>
<tr>
<td>P34</td>
<td>TPI</td>
</tr>
<tr>
<td>P00</td>
<td></td>
</tr>
</tbody>
</table>

III. Test Initialization

1. 10% TLOSS
TEST 6.4.1 LUNAR LANDING

I. Test Objective

This test is made to verify LM performance during an automatic landing program sequence.

II. Test Description

This test will exercise the landing site redesignation option prior to PDI to update targeted landing site. The abort discrete is failed throughout the landing. The LM is yawed left 50 degrees at PDI -3 min. The 50 degrees is removed at PDI +3 min.

Program Sequence

P00
N69 Landing Site Redesignation at PDI -10 min.
   Down track -6865 ft.
   Cross track +417 ft.
   Altitude +380 ft.
V48 DAP Data Load
   Set ABORT Backup Discrete
P63 Braking Phase at PDI -5 min.
V57 LR Enable
N69 Landing Site Redesignation at PDI +5 min.
   Down track +653 ft.
   Cross track +662 ft.
N68 Monitor range, TGO, Velocity
N92 Monitor throttle CMD, HDOT, H
P64 Approach Phase
P66 Vertical Phase
P68 Lunar Surface confirmation
P00

III. Test Initialization

1. Terrain profile (+10°) error
TEST 6.4.2.1 LUNAR LANDING

I. Test Objective

This test is made to verify LM performance during a nominal landing program sequence.

II. Test Description

This test sequence exercises the landing site redesignation option in P63. The abort discrete is failed in P63, P64, P66. LM is yawed left 50 degrees at TIG -3 min. The 50 degrees is removed at TIG +3 min.

Program Sequence
P00
V48    DAP Data Load
      Set ABORT BACKUP
P63    Braking Phase
N69    Landing Site Redesignation at TIG +30 sec.
      Down range 10 K ft.
      Cross range 5 K ft.
P64    Approach Phase
P66    Vertical Phase
      Entered at 700 ft. - Attitude Hold and ± ROD switch
P00

III. Test Initialization

1. Terrain profile (+1°) error.
I. Test Objective

This test is made to verify LM performance using nominal program procedures.

II. Test Description

This test sequence exercises the landing site redesignation options in P63 and P64. The abort discrete is failed prior to P63. LM is yawed left 50 degrees at TIG -3 min. The 50 degrees is removed at TIG +3.

Program Sequence

P00
V48 DAP Data Load
   Set ABORT Backup
P63 Braking Phase
N69 Land Site Redesignation at TIG +30 sec.
   Downtrack 20 K ft
   Crosstrack 20 K ft
P64 Approach Phase
   ACA: 2(-EL), 2(+AZ)
P66 Vertical Phase
   Enter at 700 ft. manually
P00

III. Test Initialization

1. 10% TLOSS
2. Terrain profile (+1°) error.
I. Test Objective

This test is made to verify LM performance using nominal program procedures.

II. Test Description

This test sequence exercises the landing site redesignation option in P64. LM is yawed left 50 degrees at TIG -3 min. The 50 degrees is removed at TIG +3.

Program Sequence

P00
V48 DAP Data Load
Set ABORT BACKUP
P63 Braking Phase

V57 LR Enable
N68 Monitor Range, TGO, VI
N92 Thrust Monitor
P64 Approach Phase
Redesignate ACA: 2(EL), 2(-AZ)

P66 Vertical Phase
Entered at 700 ft. Attitude Hold and ± ROD increments

III. Test Initialization

1. Terrain profile (±1°) error.
I. **Test Objective**

Verify proper operation and ascertain performance of the Erasable Memory RCS Guided Burn for LM Deorbit (P99) in Luminary revision 210.

II. **Test Description**

The procedure followed is that enumerated in Luminary Memo #211 Rev. 1.

The following sequence is used in the test:

- **P00** LGC Idling Program
- **V82** Orbital Parameters Display Routine (R30)
- **V48** DAP Data Load Routine (R03)
- **P30** External ΔV Targetting Program
- **V48** DAP Data Load Routine (R03)
- **V96** Extended Verb to Interrupt Integration and GOTOPOOH
- **V71** Universal Update - Block Address
- **V71** Universal Update - Block Address
- **V71** Universal Update - Block Address
- **V71** Universal Update - Block Address
- **V72** Universal Update - Single Address
- **V5N26** Verification of P99 address
- **V30** Request executive; call P99
- **V82** Orbital Parameters Displays Routine (R30)
- **P00** LGC Idling Program

In the above sequence, the astronaut egresses from the LM after V96; so that the ground continues at the uplink sequence, V71.

III. **Test Initialization**

1. Approved procedure and uplink for P99 as enumerated in Luminary Memo #211 Rev. 1.
2. **Environment Initialization**
   - **A.** CG and mass (fuel loadings, etc.) as agreed upon with MPAD; Guidance and Performance Division.
I. Test Objective

Verify operation and ascertain performance of the APS Abort Program (after a nominal Lunar Landing) in Luminary revision 210.

II. Test Description

The Auto Throttle Backup discrete is set during test sequence. The Abort Backup discrete is clear.

Program Sequence

- P00 LGC Idling Program
- V48 DAP Data Load Routine (R03)
  - Set Auto Throttle Backup discrete
- P63 Braking Phase Program
- V57 State Vector Update Routine; LR Update (R12)
- P64 Approach Phase Program
- P66 Vertical Phase Program (R.O.D. - Auto)

Abort Stage after Touchdown

- P71 APS Abort Program
- P00 LGC Idling Program
- V64 S-Band Antenna Routine (R05)
- V82 Orbital Parameters Display Routine (R30)
- V83 Rendezvous Parameter Display Routine (R31)
- P20 Rendezvous Navigation Program
- P32 Coelliptic Sequence Initiation Program

While in P71, the following sequences will be performed:

I. Manual yaw maneuver to observe vehicle attitude control response to ACA when mode control is ATTHOLD.

II. Monitor N76, N77, N85 via V16.
III. Test Initialization

1. Environment Initialization
   A. Terrain Profile with +1° errors.
   B. 10% TLOSS

2. CHANBKUP abort discrete not set (abort discrete not present)
I. Test Objective

Verify operation and ascertain performance of a lunar landing sequence in which P66 is entered at 700 ft. altitude and the landing proceeds from there.

II. Test Description

The Auto Throttle backup discrete is set.

Program Sequence

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P00</td>
<td>LGC Idling Program</td>
</tr>
<tr>
<td>V48</td>
<td>DAP Data Load Routine (R03) Set Auto Throttle Backup discrete</td>
</tr>
<tr>
<td>P63</td>
<td>Braking Phase Program</td>
</tr>
<tr>
<td>V57</td>
<td>State Vector Update Routine (LR Update; R12)</td>
</tr>
<tr>
<td>N69</td>
<td>Downtrack 10k ft, crosstrack 5k ft at TIG +5 min.</td>
</tr>
<tr>
<td>P64</td>
<td>Approach Phase Program</td>
</tr>
<tr>
<td>P66</td>
<td>Vertical Descent Program (R, O, D, -ATTHOLD)</td>
</tr>
<tr>
<td>P68</td>
<td>Landing Confirmation Program</td>
</tr>
<tr>
<td>P00</td>
<td>LGC Idling Program</td>
</tr>
</tbody>
</table>

III. Test Initialization

1. Environment Initialization

   A. Terrain profile with +1° error
   B. 10% TLOSS

2. CHANBKUP abort discrete not set (abort discrete not present)
I. Test Objective

Verify operation and ascertain performance of the plane-change burn while in the Docked Configuration.

II. Test Description

Program Sequence

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P00</td>
<td>LGC Idling Programs</td>
</tr>
<tr>
<td>V48</td>
<td>R03, DAP Data Load Routine; Load DAP for docked configuration</td>
</tr>
<tr>
<td>V62</td>
<td>Display Total Attitude Error</td>
</tr>
<tr>
<td>V77</td>
<td>Rate Command and Attitude Hold</td>
</tr>
<tr>
<td>P30</td>
<td>External Delta-V Targetting Program</td>
</tr>
<tr>
<td>P40</td>
<td>DPS Burn Program</td>
</tr>
<tr>
<td>V82</td>
<td>Orbital Parameter Display Routine (R30)</td>
</tr>
<tr>
<td>P00</td>
<td>LGC Idling Program</td>
</tr>
</tbody>
</table>

III. Test Initialization

1. State Vectors, TIG, ΔV required to be supplied by MPAD at NASA/MS

2. Environment Initialization:
   CG and Mass (fuel loadings, etc.) as given by MPAD at NASA/MSC.
TEST 6.5.6 DOCKED DPS TEI BURN

I. Test Objective

Verify operation and ascertain performance of the TEI burn while in the Docked Configuration.

II. Test Description

Program Sequence

<table>
<thead>
<tr>
<th>Program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P00</td>
<td>LGC Idling Program</td>
</tr>
<tr>
<td>V48</td>
<td>R03, DAP Data Load Routine; Load DAP for docked configuration</td>
</tr>
<tr>
<td>V62</td>
<td>Display Total Attitude Errors</td>
</tr>
<tr>
<td>V77</td>
<td>Rate Command and Attitude Hold</td>
</tr>
<tr>
<td>P30</td>
<td>External Delta-V Targetting Program</td>
</tr>
<tr>
<td>P40</td>
<td>DPS Burn Program</td>
</tr>
<tr>
<td>V82</td>
<td>Orbital Parameter Display Routine (R30)</td>
</tr>
<tr>
<td>P00</td>
<td>LGC Idling Program</td>
</tr>
</tbody>
</table>

III. Test Initialization

1. State vectors, TIG, ΔV as required to be supplied by MPAD at NASA/MSC.

2. Environment Initialization:
   CG and Mass (fuel loadings, etc.) as given by MPAD at NASA/MSC.