SECTION 1 - FLIGHT PLAN NOTES

FLIGHT PLAN NOTES

I. Crew

A. Crew designations are as follows:

Designation	Prime	Backup
Commander (CDR)	Young	Haise
Command Module Pilot (CMP)	Mattingly	Roosa
Lunar Module Pilot (LMP)	Duke	Mitchell

B. The nominal CM couch positions are:

Activity	Left	Center	Right
Launch thru TLI	CDR	CMP	LMP
T&D thru Entry	CMP	CDR	LMP

C. The PGA's are worn as shown in Table 2-1.

D. The crew biomedical harness and sensor wearing schedule is shown in Table 2-2.

E. A crew status report containing the following information for each crewman is voiced to MCC-H after each crew sleep period:
1. Radiation - Personal Radiation Dosimeter (PRD) readout.
2. Food - all menu items not consumed and all pantry snack items eaten.
3. Sleep - estimated sleep quantity and quality.
4. Medication - All medications taken.
5. Medical Observation - commentary solicited on health status, adaptation to spaceflight, medical hardware performance, etc.

F. Negative reporting is used in reporting completion of each checklist.

G. All onboard gauge readings are read directly from the gauges with no calibration bias applied.

II. CSM Systems

A. Communications

1. The preferred S-Band communication modes are:
   (a) Uplink Mode 6 (Voice, PRN, and Updata)
   (b) Downlink Mode 2 (Voice, PRN, TLM-HBR)

2. VHF Duplex B is used for launch, and Simplex A is used for earth-orbit operations.

3. Table 2-3 summarizes the MSFN coverage available for the CSM.

4. Table 2-4 contains a summary of the scheduled CSM & LM TV transmissions.

5. MCC-H switches OMNI antennas during TLC PTC periods, OMNI and HGA during TEC PTC periods. The crew manages antenna operations during all other TLC and TEC periods.

6. The HGA will be managed by the crew and MCC-H in order to minimize SIM bay experiment data loss at AOS and LOS while in lunar orbit during awake periods. Data System will be controlled by MCC-H after the initial turn-on during TLC.

B. DSE

1. During the earth-orbit phase, the CSM LBR data is recorded when the CSM is not within MSFN coverage. The DSE is dumped during the pass over the US prior to TLI if possible.

2. CSM LBR data will be recorded during all P24 landmark tracking.

3. CSM HBR will be recorded during Launch, TLI, SIVB/CSM SEP, TD&E, all CSM SPS maneuvers, Sim Door Jettison, docking, undocking, and LM Final Separation.

4. LM LBR data will be recorded during MSFN LOS periods between LM comm activation and PDI.

5. All entry data will be recorded in HBR during the blackout.

C. Electrical Power

1. The CSM normally remains powered up throughout the mission.

2. Table 2-5 lists the fuel cell purges.

3. Based on cryo purity and performance, the time between fuel cell O_2 purges may be increased to coincide with water dump times. The O_2 purge at 11 hours allows a judgement to be made on the defined purge schedule.

4. The cryogenic heaters are managed such that the planned usage is obtained out of each O_2 tank. The H_2 fans are operated manually for one minute before and after each sleep cycle.

5. Table 2-6 contains the battery charge schedule.

D. ECS and Water Management

1. Potable water is chlorinated once a day after the eat period prior to each sleep period.

2. Waste water dump and fuel cell purge scheduling criteria:

(a) Table 2-5 contains the scheduled fuel cell purges, urine dumps and waste water dumps

(1) Approximately once during each 24 hours following the initial dump and purge when three crewmen are in the CSM. Reduce interval to 22 hours when one crewman is in the CSM.

(2) H_2 fuel cell purges are scheduled at every other O_2 fuel cell purge after the first O_2 fuel cell purge

(b) The most opportune times to perform waste water dumps and fuel cell purges are as follows:

(1) Immediately after the sextant star check in maneuver preparation or cislunar navigation

(2) Behind the moon, with completion of dump or purge before AOS

(3) At least three hours prior to SIM Bay photography and laser altimeter operation

(c) If possible, dumps and purges are not scheduled during the following periods:

(1) Ten hours before MCC-2

(2) Eight hours before MCC-5

(d) Dumps and purges are <u>not</u> scheduled during the following MSFN tracking periods:

(1) Between MCC-4 and LOI

(2) MSFN coverage in lunar orbit

(3) Ten hours before MCC-7 until entry

(e) All waste water dumps are manual.

3. Only one CO_2 absorber filter (LiOH canister) is changed at a time. Table 2-7 lists the LiOH canister change schedule. There are 26 filters on board, with 24 stowed at launch, only 23 are required.

4. At lift-off, the cabin contains 60% O_2 and 40% N_2. The CM is purged after launch. The purge is terminated prior to LM pressurization after TLI. After the LM is configured for ejection, it is isolated and the CM is purged for eight more hours.

5. CSM O_2 pressurizes the LM after transposition and docking; and repressurizes the LM before TLC LM entry, MCC-4 and LM activation.

E. Guidance and Navigation

1. REFSMMAT Definitions

(a) The "Launch Pad" REFSMMAT is used for launch, TLI, and TD&E. This REFSMMAT places the IMU X-axis along the launch azimuth at the pad and the Z-axis along the negative radius vector. The FDAI, at launch, will display roll 162° (launch azimuth +90°), pitch 90°, and yaw 0°.

(b) The "PTC" REFSMMAT is used for all midcourse maneuvers (except MCC-7) and for other operations during TLC and TEC. This REFSMMAT places the X-axis in the ecliptic plane and perpendicular to the earth-moon line projection in the ecliptic plane at the average time of transearth injection for the monthly launch window and azimuth range. The Z-axis is perpendicular to the ecliptic and directed south. At the beginning of the PTC Mode the spacecraft maneuvers to an FDAI display of pitch 90° or 270°.

(c) A "Preferred" REFSMMAT is used by the CSM for LOI, Lunar-Orbit Plane Changes, and TEI. The CSM IMU X-axis aligns normally with the spacecraft X-body axis at the vehicle attitude for ignition with the thrust directed through the center of gravity. At burn ignition, the FDAI displays roll 0°, pitch 0°, and yaw 0°, except roll 180° for TEI.

(d) The "Landing Site" REFSMMAT is used for DOI, PDI, landing, and CSM lunar orbit activities up to the first plane change. This REFSMMAT places the CSM and LM IMU X-axis along the positive lunar radius vector at the landing site at the predicted landing time and places the Z-axis in the direction of flight parallel to the CSM orbital plane. At nominal touchdown, the LM FDAI displays roll 0°, pitch 0°, and yaw 0°.

(e) The "Lift-Off" REFSMMAT is used for all lunar activities after plane change 1, except plane change 2, and until transearth injection. This REFSMMAT places the CSM and LM IMU X-axis along the positive lunar radius vector at the landing site at predicted lift-off time, with the Z-axis down range parallel to the CSM orbital plane. At nominal lift-off time, the LM FDAI displays roll 0°, pitch 0°, and yaw 0° with slight differences reflecting actual touchdown yaw and slope tilt angles.

(f) The "Entry" REFSMMAT aligns the IMU X-axis in the local horizontal plane in the direction of flight at entry interface. The entry REFSMMAT is used for MCC-7 and all remaining activities. The Z-axis is down along the negative radius at entry interface. At entry interface, with wings level, local horizontal, heat shield forward, inplane, lift up, heads down, the FDAI displays roll 0°, pitch 180°, and yaw 0°.

2. The CSM external lighting is operated during the rendezvous from lift-off to docking. The running lights only are on from CSM/LM separation to PDI.

3. The time tags on attitude maneuvers in Section 3 indicate the be-there-by time unless otherwise stated. All maneuver angles are the angles read on the FDAI after the maneuver has been completed.

4. CSM/LM and CSM attitude maneuvers are normally performed at the rate of 0.2°/sec unless other rates are required. LM maneuvers are normally performed at 2°/sec unless otherwise specified.

5. The SIM Bay RCS configuration provides single jet control authority in each axis to eliminate contamination of the SIM experiments. Table 2-8 identifies the periods when the CSM RCS is in an uncoupled configuration.

6. Undocking is done radially, CSM below, using the soft undocking procedure. The probe is extended its full length with the LM held on by the capture latches. When the rates are nulled, the CSM releases the LM. The separation maneuver is then performed immediately.

7. LM jettison is done radially, CSM below, with final sep pyros providing approximately 0.4 foot per second thrust radial. The separation burn is performed five minutes after jettison, providing 2 foot per second thrust posigrade.

8. The standard register load for nouns 78 and 70 for SIM bay experiment pointing using the Universal Tracking Program P20, option 5 is:

N78 (+090.00)
(+052.25)
(+180.00) +X-axis forward
or (+000.00) -X-axis forward
N70 (00050)

Only changes to this standard register load will be shown as required in Section 3 of the flight plan.

9. The SC RCS configuration and maneuver control is shown as a DAP LOAD code in the time column where applicable in Section 3. During passive thermal control the code is shown as a note indicating the status of the DAP.

F. Propulsion Systems

1. In order to conserve SM RCS, the SPS engine is used to "back-up" all LM rendezvous burns requiring a ΔV greater than 12 FPS. The SPS gimbal motors are not turned on during the normal maneuver preparation.

2. The SPS always is started using a single bank, however, the other bank will be opened 2 to 5 seconds after ignition for burns longer than 6 seconds. DOI will be performed on a single bank.

3. Table 2-9 lists the CSM propulsion burns.

G. Scientific Instruments Module

1. The panoramic and mapping cameras will be placed in the boost and standby modes, respectively, during launch through TD&E, rendezvous, and all SPS thrusting maneuvers.

2. The following switches may be left in their command position between uses in order to keep track of SIM Bay experiment status:

   a) Mapping Camera Track
   b) Gamma Ray Boom Deploy
   c) Mass Spectrometer Boom Deploy
   d) Mapping Camera/Laser Cover
   e) Alpha/X-Ray Cover

   These switches will be in the OFF (center) position during SPS burns and all other events that may induce vibration or shock, i.e., undocking and rendezvous through LM jettison.

3. The SIM experiment status will be indicated in the upper right-hand corner of each page, or half page in the CSM flight plan, of Section 3. The first line will indicate the CSM attitude and experiments positions at the beginning of each hour or half-hour as applicable. The second line indicates the experiments' functional modes as previously set up. Page xxiv defines the SIM experiment position and mode status code.

4. The position of boom mounted experiments is indicated by the length of the boom measured from the fully retracted position.

III. LM Systems

A. Communications

1. The preferred S-Band communications are:
   (a) Uplink Mode 7 (Voice, Updata)
   (b) Downlink Mode 2 (Voice, TLM-HBR, PRN, BIOMED)

2. The LM DSEA schedule is shown in Table 2-10.

B. ECS

1. The LM contains ambient air at lift-off. During launch the pressure bleeds to zero psia. CSM O_2 pressurizes the LM after T&D. The LM is isolated after T&D and after each entry and allowed to bleed down via leakage. Before the first entry into the LM, the LM is vented to at least 2.7 PSID and repressurized with CSM O_2 in order to enrich the LM atmosphere. CSM O_2 is used to repressurize the LM for the second and third entries.

2. LM O_2 is used to pressurize the LM five times; after EVA-1, EVA-2, EVA-3, and two equipment jettison periods.

3. Table 2-7 lists the LiOH canister change schedule.

C. Guidance Systems

1. The LGC and CMC use the same landing site and lift-off REFSMMATS.

2. The AGS is placed in standby after the "GO" is given for lunar stay at T3.

3. The IMU platform is oriented so that all PIPA input axes are normal to the gravity vector, then powered down and the LGC placed in standby approximately 1 hour after TD until approximately 4 hours prior to lift-off. The LGC is placed in operate several times to update the computer clock and CSM State Vector.

4. To prevent overheating of the antenna, the rendezvous radar is pointed away from the sun and turned off when no functional use is required.

5. The LM tracking light is operated continuously in the S/C dark period during rendezvous.

D. Propulsion Systems

1. The APS/RCS interconnect is used during the lunar lift-off and ascent only.

2. Table 2-11 lists the LM propulsion burns.

E. Electrical Power System

1. The LM is powered down to a minimum level to conserve battery consumables on the lunar surface from PDI +1:00 to lift-off -4:00 hours.

2. LM battery management is scheduled on the lunar surface to equalize the usage of the five descent stage batteries. Table 2-6 contains the LM battery management schedule.

IV. Procedures

A. CSM - Crew procedures called out in the flight plan may be found in the following documents:

1. Apollo Operations Handbook - CSM 113 (AOH), Volume 2
2. Crew Checklists
3. CSM Rendezvous Procedures
4. Lunar Landmark Tracking Attitude Studies
5. Lunar Orbit Attitude Sequence for Mission J-2

B. LM - Crew procedures called out in the flight plan may be found in the following documents:

1. Apollo Operations Handbook LM-11, Volume 2
2. Crew Checklists
3. LM Rendezvous Procedures
4. LM Descent/Ascent Procedures
5. EVA Procedures
6. Lunar Surface Procedures

V. Synchronization of Ground Elapsed Time (GET)

The realtime GET is synchronized with the Flight Plan GET. In TLC, the GET is synchronized at 48:30 if the difference is more than ±1 minute. In lunar orbit the GET is synchronized at 81:35 and at 191:20 if the difference is more than ±2 minutes. The time changes are based on the expected difference between realtime and flight plan GET's at the start of lunar orbit revs. The synchronization is performed by a V70 uplink from the ground followed by the crew synchronizing the mission timer to the CMC clock.

VI. Miscellaneous

A. Table 2-12 contains a schedule of the return to earth block data updates.

B. Table 2-13 is the landmark tracking and landing site data.

C. Table 2-14 contains the cryo management schedule.

D. Table 2-15 contains the Apollo 16 Film Budget.