<table>
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<th>Cryogenic usage</th>
<th>Cryogenic remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\text{H}_2$, lb</td>
<td>$\text{O}_2$, lb</td>
</tr>
<tr>
<td></td>
<td>$\text{H}_2$, lb</td>
<td>$\text{O}_2$, lb</td>
</tr>
<tr>
<td>Total loaded</td>
<td>58.6</td>
<td>660.2</td>
</tr>
<tr>
<td>Usable</td>
<td>56.2</td>
<td>647.2</td>
</tr>
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<td>Residual</td>
<td>2.4</td>
<td>13.0</td>
</tr>
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<td>Gauging error</td>
<td>1.5</td>
<td>17.5</td>
</tr>
<tr>
<td>Available for mission planning</td>
<td>54.7</td>
<td>629.7</td>
</tr>
<tr>
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<td></td>
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<td>Prelaunch</td>
<td></td>
<td></td>
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<tr>
<td>T - 28.5 hr to T - 6 hr at 40A</td>
<td>2.38</td>
<td>18.4</td>
</tr>
<tr>
<td>6-hr built in hold at 40A</td>
<td>.63</td>
<td>4.9</td>
</tr>
<tr>
<td>T - 6 hr to T - 2 hr at 40A</td>
<td>.42</td>
<td>3.3</td>
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<td>ECS requirements from crew</td>
<td>--</td>
<td>.7</td>
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<td>ingress (T - 3 hr)</td>
<td>.39</td>
<td>3.1</td>
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<td>T - 2 hr to T (hr) at 75A</td>
<td>3.82</td>
<td>30.4</td>
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<td>EPS</td>
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<td>ECS</td>
<td>--</td>
<td>98.4</td>
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<td>Uncertainties</td>
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<td>4.5 launch window at 75A</td>
<td>.87</td>
<td>7.8</td>
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<td>5% EPS uncertainty</td>
<td>1.83</td>
<td>13.7</td>
</tr>
<tr>
<td>Margin</td>
<td>11.62</td>
<td>206.2</td>
</tr>
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</table>
FIGURE 5-5  CSM O₂ PROFILE (ONE TANK)
FIGURE 5-6 CSM H₂ PROFILE (ONE TANK)
FIGURE 5-7 CSM CURRENT PROFILE
LM EPS ANALYSIS

GROUND RULES AND ASSUMPTIONS

1. The descent state batteries go on the line 30 minutes prior to earth liftoff.

2. A 3.6-hour checkout was assumed for lunar orbit.

3. Ascent and descent batteries were paralleled for the powered descent burn and prior to liftoff from the lunar surface.

4. The S-band equipment was assumed on 100 percent from initial activation in lunar orbit until completion of the mission.

5. The rendezvous radar electronics was assumed to be operational for the period of time dictated by the current G Mission flight plan.

6. The primary navigation and guidance subsystem (PGNCS) was left in the operate mode for the entire lunar stay.

7. The forward window heaters were left off for the lunar stay.

<table>
<thead>
<tr>
<th>TABLE 12 SUMMARY FOR DESCENT STAGE EPS ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total load = 1600 A-h</td>
</tr>
<tr>
<td>Total unusable for premission planning = 131 A-h (8.2%)</td>
</tr>
<tr>
<td>Total used = 1243.0 A-h (77.7%)</td>
</tr>
<tr>
<td>Usable remaining at liftoff = 226 A-h (14.1%)</td>
</tr>
<tr>
<td>Figure 5-8 presents the descent power profile</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>TABLE 13 SUMMARY FOR THE ASCENT STAGE EPS ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total loaded = 592.0 A-h</td>
</tr>
<tr>
<td>Total unusable for premission planning = 31.0 A-h (5.2%)</td>
</tr>
<tr>
<td>Total used = 326.0 A-h (55.1%)</td>
</tr>
<tr>
<td>Usable remaining at completion of crew transfer = 235.0 A-h (39.7%)</td>
</tr>
<tr>
<td>Figure 5-9 presents the ascent power profile</td>
</tr>
<tr>
<td>Figure 5-10 presents the descent &amp; ascent current profile</td>
</tr>
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</table>

5-38
FIGURE 5-8 LM DESCENT POWER PROFILE
FIGURE 5-9  LM ASCENT POWER PROFILE
5-40
FIGURE 5-10 LM TOTAL CURRENT PROFILE
5-41
LM ECS BUDGET

GROUND RULES AND ASSUMPTIONS

1. Cabin $O_2$ leakage rate was 0.1 lb/hr while pressurized.
2. Metabolic rates were varied according to Volume 2 of the Spacecraft Operational Data Book.
3. Metabolic $O_2$ consumed was $(1.643 \times 10^{-4}) \times$ (metabolic rate).
5. Cabin pressure regulator check requires 2.65 lb of $O_2$.
6. $H_2O$ consumed because of sublimator cooling was total heat removed divided by 1040 (Btu per lb) of $H_2O$.
7. $H_2O$ lost due to urination was 0.11 lb/hr per man.
8. Cabin temperature control was set to 72° F.
9. Average glycol flow rate was 250 lb/hr.

TABLE 5-14 LM ECS SUMMARY

(a) Descent stage

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<thead>
<tr>
<th>Description</th>
<th>$O_2$, lb</th>
<th>$H_2O$, lb</th>
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<tr>
<td>Loaded</td>
<td>48.00</td>
<td>210.6</td>
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<td>Unusable</td>
<td>3.40</td>
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<td>Available for mission</td>
<td>44.60</td>
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<td>Required for mission</td>
<td>21.81</td>
<td>140.61</td>
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<tr>
<td>Usable remaining in tanks</td>
<td>22.79</td>
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</table>

(b) Ascent stage

<table>
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<td>Loaded</td>
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<td>Unusable</td>
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<td>Available for mission</td>
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<td>Usable remaining in tanks</td>
<td>2.93</td>
<td>52.73</td>
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5-42
FIGURE 5-11  LM DESCENT $O_2$ PROFILE
FIGURE 5-12  LM ASCENT O₂ PROFILE
FIGURE 5-13 LM DESCENT $\text{H}_2\text{O}$ PROFILE
FIGURE 5-14  LM ASCENT \( \text{H}_2\text{O} \) PROFILE
MISSION G PLSS CONSUMABLE ANALYSIS

The results of the PLSS battery, oxygen, water and LiOH consumable analysis are summarized in the following figures:

- Figure 5-15: LMP and CDR PLSS battery profile
- Figure 5-16: CDR oxygen profile
- Figure 5-17: LMP oxygen profile
- Figure 5-18: CDR H₂O profile
- Figure 5-19: LMP H₂O profile
- Figure 5-20: LMP and CDR LiOH CO₂ profile
Figure 5-15 LMP and CDR - PLSS Battery

Nominal Lunar Surface EVA

Voltage and current readout is available on real time basis.

- Includes end-to-end TM error.

Power consumed 42 W/hr.

---

EVA 2+40 hours

Red line intersects at 5+40 hours.

PLSS checkout

Watt-hours

0 1+0 2+40

Red line

Hours plus minutes
NOTE A: BASED ON MINIMUM BOTTLE, 378 CU. IN. 1060 PSIA = 1.304

NOTE B: 85 PSIA ULLAGE
67 PSIA GAUGE INACCURACY
152 PSIA UNUSABLE

BASED ON PREDICTED METABOLIC RATE 1550 BTU/HR. PLUS PGA SPEC LEAKAGE .034 LBS/HR. O₂

OXYGEN READOUT IS AVAILABLE ON REAL TIME BASIS.
NOTE A: BASED ON MINIMUM BOTTLE, 378 CU. IN. 1060 PSIA = 1.304 LUS.

NOTE B: 85 PSIA ULLAGE 67 PSIA GAUGE INACCURACY 152 PSIA UNUSABLE

BASED ON PREDICTED METABOLIC RATE 1250 BTU/HR PLUS PGA SPEC. LEAKAGE .034 LBS/HR. O₂
OXYGEN READOUT IS AVAILABLE ON REAL TIME BASIS.
NOMINAL LUNAR SURFACE EVA

FIGURE 5-18 CDR - WATER

PREDICTED RATES IN BTU/HR.

A. METABOLIC HEAT LEAK (33° SUN ANGLE, 10/1 CRATER ASPECT RATIO)
   LIOH POWER TOTAL
   294 145 439 BTU/HR.

B. METABOLIC HEAT LEAK (LUNAR NIGHT)
   LIOH POWER TOTAL
   -268 145 1832 BTU/HR.

EVA 2+40 HOURS

FEEDWATER WARNING TONE

HOURS PLUS MINUTES

RETURN TO LM
NOMINAL LUNAR SURFACE EVA

FIGURE 5-19 LMP - WATER

PREDICTED RATES IN BTU/HR.

A. METABOLIC
HEAT LEAK (33° SUN ANGLE)
10/1 CRATER ASPECT ANGLE)
LIOH
POWER
TOTAL
1250
294
327
145
2016 BTU/HR.

B. METABOLIC
HEAT LEAK (LUNAR NIGHT)
LIOH
POWER
TOTAL
1250
-268
327
145
1454 BTU/HR.

EVA 2+40 HRS.
RED LINE
FEEDWATER WARNING TONE

HOURS PLUS MINUTES
30
RETURN TO LM
NOTE A: 1550 BTU/Hr reaches specification limit at 4.2 to 4.6 hours.

NOTE B: 1250 BTU/Hr reaches specification limit at 6.5 to 8.8 hours.
SECTION VI - SUMMARY FLIGHT PLAN
FLIGHT PLAN

00:00
LIFT-OFF
SYSTEMS CK
P52 IMU REALIGN

02:00
GO/NO GO FOR TLI
TLI 02:44:18
CSM/SIVB SEP
DOCKING
PRESS LM & CONNECT UMBILICAL
LM EJECTION
EVASIVE MNVR
DOFF PGA'S
& STOW
P52 IMU REALIGN

04:00
P23 STAR EARTH HORIZON SIGHTINGS

06:00
P52 IMU REALIGN

08:00
M CC

10:00

12:00
TLI+9

12:00

 MISSION | EDITION      | DATE       | TIME       | DAY/REV | PAGE  
----------|---------------|------------|------------|---------|-------
 APOLLO 11 | PRELIMINARY  | APRIL 15, 1969 | 00:00 - 24:00 | 1/TLC  | 6-1   

MSC Form 8450 (Jan 69) 
FLIGHT PLANNING BRANCH
FLIGHT PLAN

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FLIGHT PLAN

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MSC Form 8450 (Jan 69)  
FLIGHT PLANNING BRANCH
## FLIGHT PLAN

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<td>E1-C</td>
<td>E1-C</td>
<td>E1-L</td>
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### MISSION EDITION DATE TIME DAY/REV PAGE

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<td>192:00-195:00</td>
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<td>6-9</td>
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Memorandum

TO: Distribution
FROM: CF/Chief, Flight Crew Support Division

DATE: MAY 12 1969

In reply refer to: CF34-9M-78

SUBJECT: Revision A and Option 1 to Apollo 11 Preliminary Flight Plan

Enclosed is Revision A and Option 1 to the Apollo 11 Preliminary Flight Plan. Revision A includes:

a. Revisions to the DOI, PDI, Lunar Surface, CSI, CDH, TPI, Lx update forms and a new Lx form, PDI + 10 minutes abort (Enclosure 1).

b. Revision of the post-EVA period of the detailed timeline to include back contamination procedures (Enclosure 2).

c. A comparison of the Lx activation and checkout procedures for the July launch windows (Enclosure 3).

The Option 1 plan includes:

a. A new detailed timeline from docking to splashdown (Enclosure 4). This incorporates a sleep period prior to TEI (TEI delayed 12 hours from the nominal plan) and incorporates the postdocking back contamination procedures.

b. A new summary flight plan (Enclosure 5) which agrees with the Option 1 detailed timeline of (a) above.

Warren J. North

CF34:TA Guillory:avg 5-8-69

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan
P30 LM MANEUVER (REV A, MAY 9, 1969)

PURPOSE
PURPOSE OF MANEUVER
(SUCH AS DOI TARGETING)

TIG N33
HR XXX
MIN XX
SEC XX.XX
IGNITION TIME FOR THE MANEUVER

LOCAL VERT N81
ΔVX $^{+}XXX.X$ (fps)
ΔVY $^{+}XXX.X$ (FPS)
ΔVZ $^{+}XXX.X$ (fps)
LOCAL VERTICAL ΔV
COMPONENTS OF THE
MANEUVER

ΔVR $^{+}XXX.X$ (fps)
TOTAL ΔV REQUIRED FOR THE MANEUVER

BT X:XX(MIN:SEC)
DURATION OF THE MANEUVER

FDAO INER
R XXX (DEG)
P XXX (DEG)
INERTIAL FDAO ANGLES AT
THE BURN ATTITUDE

N86
ΔVX AGS $^{+}XXX.X$ (fps)
ΔVY AGS $^{+}XXX.X$ (fps)
ΔVZ AGS $^{+}XXX.X$ (fps)
LOCAL VERTICAL ΔV
COMPONENTS OF THE
MANEUVER USED TO
TARGET THE AGS: ROTATED
THROUGH THE HALF-ANGLE
OF THE BURN

COAS STAR CHECK
STAR XX(OCTAL)
IDENTIFIER FOR COAS STAR
USED TO VERIFY SPACECRAFT
ATTITUDE AT THE BURN
ATTITUDE

AZ $^{+}XX.X$ (DEG)
EL $^{+}XX.X$ (DEG)
THE AZIMUTH AND ELEVATION
ANGLE OF THE COAS STAR

2-23
DOI DATA PAD (REV A, MAY 9, 1969)

TIG N33

HR XXX
MIN XX IGNITION TIME FOR THE MANEUVER
SEC XX.XX

LOCAL VERT N81

$\Delta V_X^\star$ +XXXX.X (fps) LOCAL VERTICAL $\Delta V$
$\Delta V_Y^\star$ +XXXX.X (fps) COMPONENTS OF THE MANEUVER
$\Delta V_Z^\star$ +XXXX.X (fps)

$\Delta V_R^\star$ +XXXX.X (fps) TOTAL $\Delta V$ REQUIRED FOR THE MANEUVER
BT X:XX (MIN:SEC) DURATION OF THE MANEUVER

N86

VX AGS +XXXX.X (fps) LOCAL VERTICAL $\Delta V$
VY AGS +XXXX.X (fps) COMPONENTS OF THE MANEUVER USED TO
VZ AGS +XXXX.X (fps) TARGET THE AGS: ROTATED

FDAO INER

R XXX (DEG) INERTIAL FDAO ANGLES AT
P XXX (DEG) THE BURN ATTITUDE

COAS STAR CHECK

STAR XX(OCTAL) IDENTIFIER FOR COAS STAR

AZ +XX.X (DEG) USED TO VERIFY SPACECRAFT
EL +XX.X (DEG) ATTITUDE AT THE BURN

2-23b
<table>
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<tr>
<th>PURPOSE</th>
<th>TIME OF IGNITION (HR:MIN:SEC)</th>
<th>COMPONENTS OF ΔV APPLIED ALONG LOCAL VERTICAL AXIS AT TIG (LM VEH)</th>
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<tbody>
<tr>
<td>N33 GETI</td>
<td>XX:XX:XX</td>
<td>DELTA VX(VEH) XXXX.X (FPS)</td>
</tr>
<tr>
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<td></td>
<td>DELTA VY(VEH) XXXX.X (FPS)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DELTA VZ(VEH) XXXX.X (FPS)</td>
</tr>
</tbody>
</table>

P76 UPDATE PAD (REV A, MAY 9, 1969)
P32 CSI UPDATE (REV A, MAY 9, 1969)

N11 TIG CSI

IGNITION TIME FOR THE CSI MANEUVER

HR XXX
MIN XX
SEC XX.XX

N37 TIG TPI

IGNITION TIME FOR THE TPI MANEUVER

HR XXX
MIN XX
SEC XX.XX

N81 LOCAL VERT

LOCAL VERTICAL DG V COMPONENTS OF CSI MANEUVER

\[ \Delta V_x \] XXX.X (fps)
\[ \Delta V_y \] +XX.X (fps)

N86

LOCAL VERTICAL DG V COMPONENTS OF CSI

\[ \Delta V_x \text{ AGS} \] +XX.X (fps)
\[ \Delta V_y \text{ AGS} \] -XX.X (fps)
\[ \Delta V_z \text{ AGS} \] -XX.X (fps)

PLM FDAI XXX(DEC)

LM FDAI INERTIAL PITCH ANGLE AT CSI BURN ATTITUDE
IGNITION TIME FOR THE CDH MANEUVER

HR
MIN
SEC

LOCAL VERT

\( \Delta V_X \) \(+XX.X\) (fps)
\( \Delta V_Y \) \(+XX.X\) (fps)
\( \Delta V_Z \) \(+XX.X\) (fps)

LOCAL VERTICAL \( \Delta V \) COMPONENTS OF THE CDH MANEUVER

\( \Delta V_X \) AGS \(-XX.X\) (fps)
\( \Delta V_Y \) AGS \(+XX.X\) (fps)
\( \Delta V_Z \) AGS \(+XX.X\) (fps)

LOCAL VERTICAL \( \Delta V \) COMPONENTS OF CDH USED TO TARGET AGS
EXTR \( \Delta V \): ROTATED THROUGH THE HALF-ANGLE OF THE BURN

PLM FDAI

XXX (DEG)
LM FDAI INERTIAL PITCH ANGLE AT CDH BURN ATTITUDE
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<th>Parameter</th>
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<th>Description</th>
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<td>Ignition time for the TPI maneuver</td>
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<tr>
<td>HR</td>
<td>XXX</td>
<td>Total ∆V required for the maneuver</td>
</tr>
<tr>
<td>MIN</td>
<td>XX</td>
<td>Line-of-sight ∆V components of the TPI maneuver</td>
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<tr>
<td>SEC</td>
<td>XX.XX</td>
<td>Local vertical ∆V components of the TPI maneuver</td>
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<tr>
<td>∆V TPI</td>
<td>+XX.X (fps)</td>
<td>LM FDAI roll &amp; pitch angle at TPI burn attitude</td>
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<tr>
<td>F/A</td>
<td>+XX.X (fps)</td>
<td>Range at TPI TIG -5 min</td>
</tr>
<tr>
<td>R/L</td>
<td>+XX.X (fps)</td>
<td>Range rate at TPI TIG -5 min</td>
</tr>
<tr>
<td>D/U</td>
<td>+XX.X (fps)</td>
<td>Duration of the maneuver</td>
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<tr>
<td><strong>N59 ∆V LOS</strong></td>
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<td><strong>N81 LOCAL VERT</strong></td>
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<tr>
<td>∆VX</td>
<td>+XX.X (fps)</td>
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<tr>
<td>∆VY</td>
<td>+XX.X (fps)</td>
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<td>∆VZ</td>
<td>+XX.X (fps)</td>
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<td><strong>N42 FDAI INER</strong></td>
<td></td>
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<tr>
<td>R LM</td>
<td>XXX (DEG)</td>
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<td>P LM</td>
<td>XXX (DEG)</td>
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<td><strong>N54 TIG-5</strong></td>
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<td>R TPI</td>
<td>XX.XX (FT)</td>
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<td>BT</td>
<td>XX:XX (MIN:SEC)</td>
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### AGS STATE VECTOR UPDATE

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### APRIL 1, 1969

**REMARKS:**
### AGS State Vector Update

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PDI DATA CARD (REV A, MAY 9, 1969)

TIG

TGO

CR

R

P

Y

231

N61

FDAO @ TIG

P63

PDI+10 ABORT

N81

N33

Δ VX

Δ VY

Δ VR

BT

FDAO

R

P

Δ VX

Δ VY

Δ VZ

Δ VZ
POI PAD (REV A, MAY 9, 1969)

TIG PDI

HRS XXX
MIN XX
SEC XX.XX

TIME OF IGNITION FOR PDI

N61 TGO XX:XX(HRS:MIN)

TIME FROM THROTTLE UP
TO 1ST TARGET POINT

CR(CROSSRANGE)  \( \pm \) XXX.X (N.M.)

OUT OF PLANE DISTANCE
BETWEEN LM ORBITAL PLANE
AND LANDING SITE (POSITIVE
INDICATES LANDING SITE IS
NORTH OF ORBITAL PLANE)

FDAI AT TIG

R XXX (DEG)
P XXX (DEG)
Y XXX (DEG)

INERTIAL FDAI ANGLES
AT IGNITION

DED A 231 XXXX (100's FT)

LUNAR RADIUS AT THE
LANDING SITE

PDI +10 ABORT PAD

SAME AS LM P30 PAD WITHOUT THE COAS CHECK STAR
LUNAR SURFACE PAD
(REV A, MAY 9, 1969)
<p>| | | |</p>
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<tr>
<td><strong>LUNAR SURFACE PAD</strong> (REV A, MAY 9, 1969)</td>
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<tr>
<td><strong>T2</strong></td>
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</table>
| HRS | XXX | **LIFT OFF TIME -SECOND**  
| MIN | XX | **PREFERRED TIME AFTER TOUCHDOWN (T.D. + 11 MIN)**  
| SEC | XX.XX |   |
| **T3** |   |   |
| HRS | XXX | **LIFT OFF TIME -AFTER FIRST CSM REVOLUTION**  
| MIN | XX |    
| SEC | XX.XX |   |
| **P** | XXX:XX:XX (HRS:MIN:SEC) | **CSM PERIOD**  
| **P + Δt** | XXX:XX:XX (HRS:MIN:SEC) | **CSM PERIOD PLUS THE TIME INTERVAL BETWEEN CLOSEST APPROACH AND LIFT OFF TIME**  
| **TPI** |   |   |
| HRS | XXX | **TIME OF IGNITION FOR TPI AFTER ABORT FROM POWER DESCENT**  
<p>| MIN | XX |<br />
| SEC | XX.XX |   |</p>
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<tr>
<th>ASCENT PAD</th>
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<td>HRS TIG</td>
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<td>+ 0 0 0 0 + 0 0 + 0 0</td>
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<tr>
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<td>CROSS RANGE N76</td>
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<tr>
<td>XXX XX XXX XX</td>
<td>R FDAI</td>
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<tr>
<td>XXX XX XXX XX</td>
<td>P AT TIG</td>
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<td>+ 0 0 + 0</td>
<td>HRS N11</td>
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<td>+ 0 0 + 0</td>
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<td>MIN TPI</td>
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<td>SEC</td>
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</table>

*NOTE: LOAD 8 MI IF CROSS RANGE IS GREATER THAN 8

COMMENTS:

APRIL 1, 1969

DED A 47

DED A 53

2-40
FLIGHT PLAN

CSM

CDR

EASEP DEPLOYMENT

LM

LMP

1+30

1+40

1+50

2+00

2+10

2+20

2+30

DOCUMENTED SAMPLE COLLECTION

DOCUMENTED SAMPLE COLLECTION

W I PE SUIT & EMU

W I PE SUIT & EMU

W I PE FE E T ON LM

LANDING PAD AND LADDER

W I PE FE E T ON LM

LANDING PAD AND LADDER

SRC PACK AND TRANSFER

MISSION | EDITION | DATE   | TIME          | DAY/REV | PAGE
---------|---------|--------|---------------|---------|-----
APOLLO 11 | PRELIM REV A | MAY 9, 1969 | 112:00 - 113:00 | 5/20  | 3/80