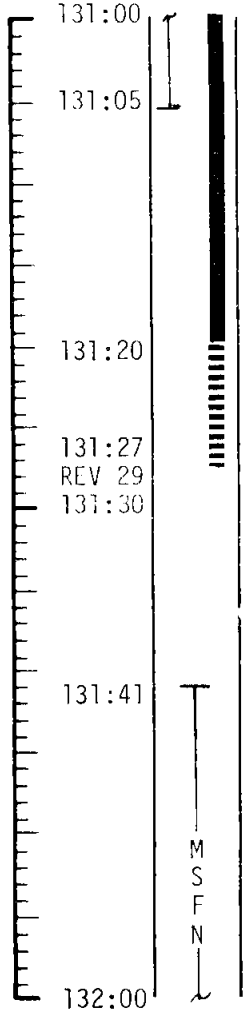
TEI
BURN CHART

	P OR Y RATES	ATT DEVIATION	SHUTDOWN TIME	RESIDUALS
TEI	10°/SEC TAKEOVER	±10° TAKEOVER	B/T + 2 SEC & ΔV_C = -40 FPS	

TEI ABORT MODES			
TEI V_{GO}	B/T	TRAJECTORY	ABORT MODE
3159.0 - 1371.0	0 - 90	LUNAR ORBIT	MODE III - AFTER 1 REV
1371.0 - 697.0	90 - 120	UNSTABLE	MODE II - 2 SPS BURNS FOR ORBIT STABLIZATION AND WATER OR CLA LANDING
697.0 - 0	120 - 149	HYPERBOLIC	MODE I - COAST OUT OF SPHERE - P37

FLIGHT PLAN

MCC-H
8:30 PM EDT



EXT ΔV - P30
SPS THRUST - P40
MNVR TO BURN ATT

SXT STAR CK

EMS ΔV TEST

SM RCS CK
GDC ALIGN TO IMU

TEI

GETI: 131:28:43
ULLAGE:
BT: 02:29
ΔV: 3158.7

SM RCS MON CK
SPS MON CK
V66 - TRANS CSM STATE VECTOR TO LM SLOT
PITCH DOWN TO ACQ MSFN AND
VISUALLY ACQ MOON

NOTES

BURN STATUS REPORT

X	X	:		ΔTIG
X	X	:		BT
			•	V_{gx}
		TRIM		
X	X	X		R
X	X	X		P
X	X	X		Y
☐			•	V_{gx}
☐			•	V_{gy}
☐			•	V_{gz}
☐			•	ΔV_c
X	X	X		FUEL
X	X	X		OX
X	X	X		UNBAL

REMARKS:

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	131:00 - 132:00	6/28-29	3-97

FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
9:30 PM EDT

132:00

CREW STATUS REPORT
DEACTIVATE PRIMARY EVAPORATIOR

CYCLE O_2 & H_2 FANS

O_2 FUEL CELL PURGE

M
S
F
N

133:00

CDR
REST PERIOD
(7 HOURS)

LiOH CANISTER CHANGE NO. 11
(13 INTO A, STORE 11 IN A3)

P27 UPDATE:
DESIRED
ORIENTATION
(PTC)

IMU REALIGN - P52
OPTION 1 - PREFERRED
AND STAR CK

134:00

NOTES

PTC ESTABLISHED IN
G&N P, Y + 20° DB
R RATE OF 0.1°/Sec

P52 - PULSE TORQUE
TO PTC REFSMMAT
PLATFORM ALIGN CHECKED
WITH OPTICS

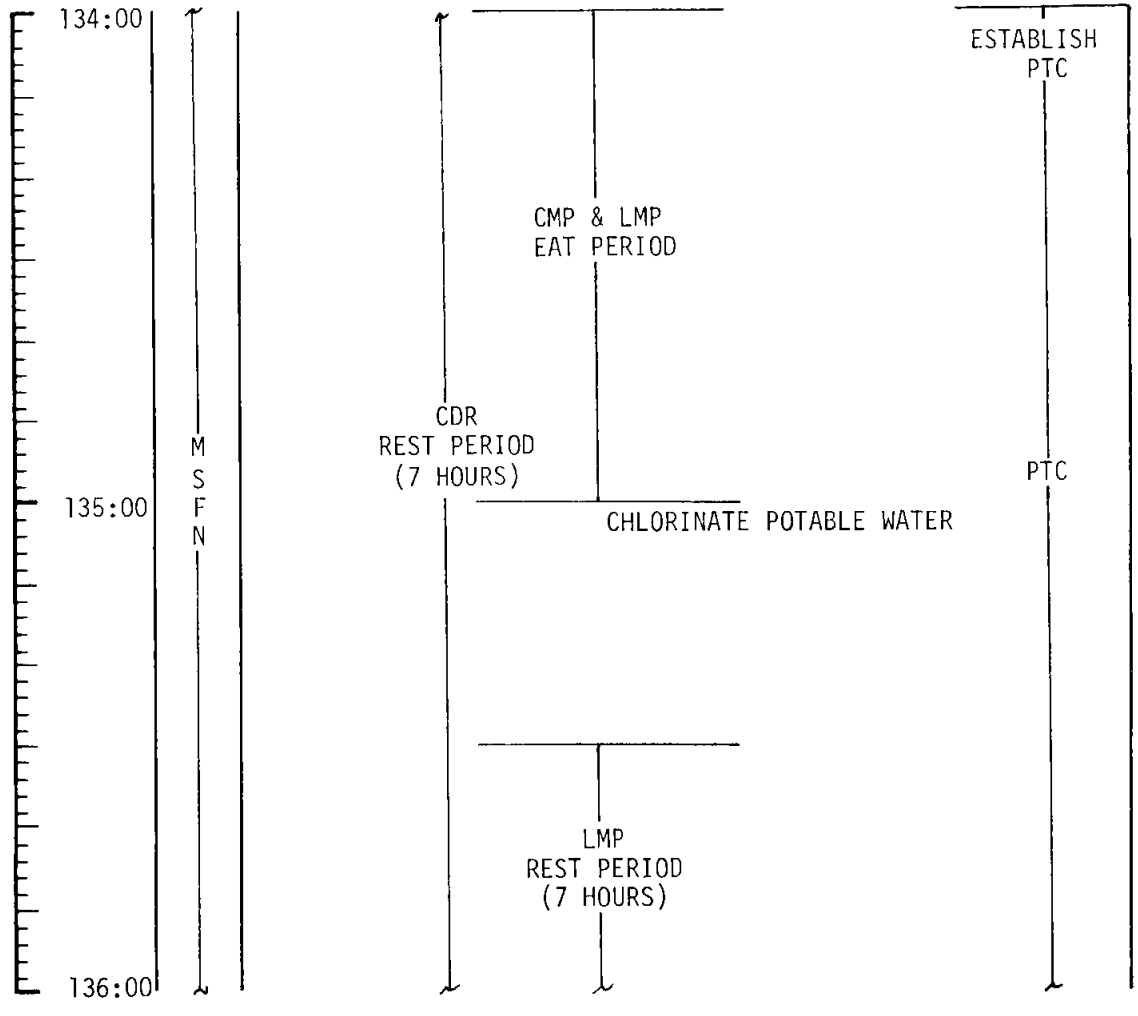
MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	132:00 - 134:00	6/TEC	3-98

MSC Form 29 OT (Mar. 69)

FLIGHT PLANNING BRANCH

FLIGHT PLAN

MCC-H
11:30 PM EDT



NOTES

PTC ESTABLISHED IN
G&N P,Y + 20° DB
R RATE OF 0.1°/SEC

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	134:00 - 136:00	6/TEC	3-99

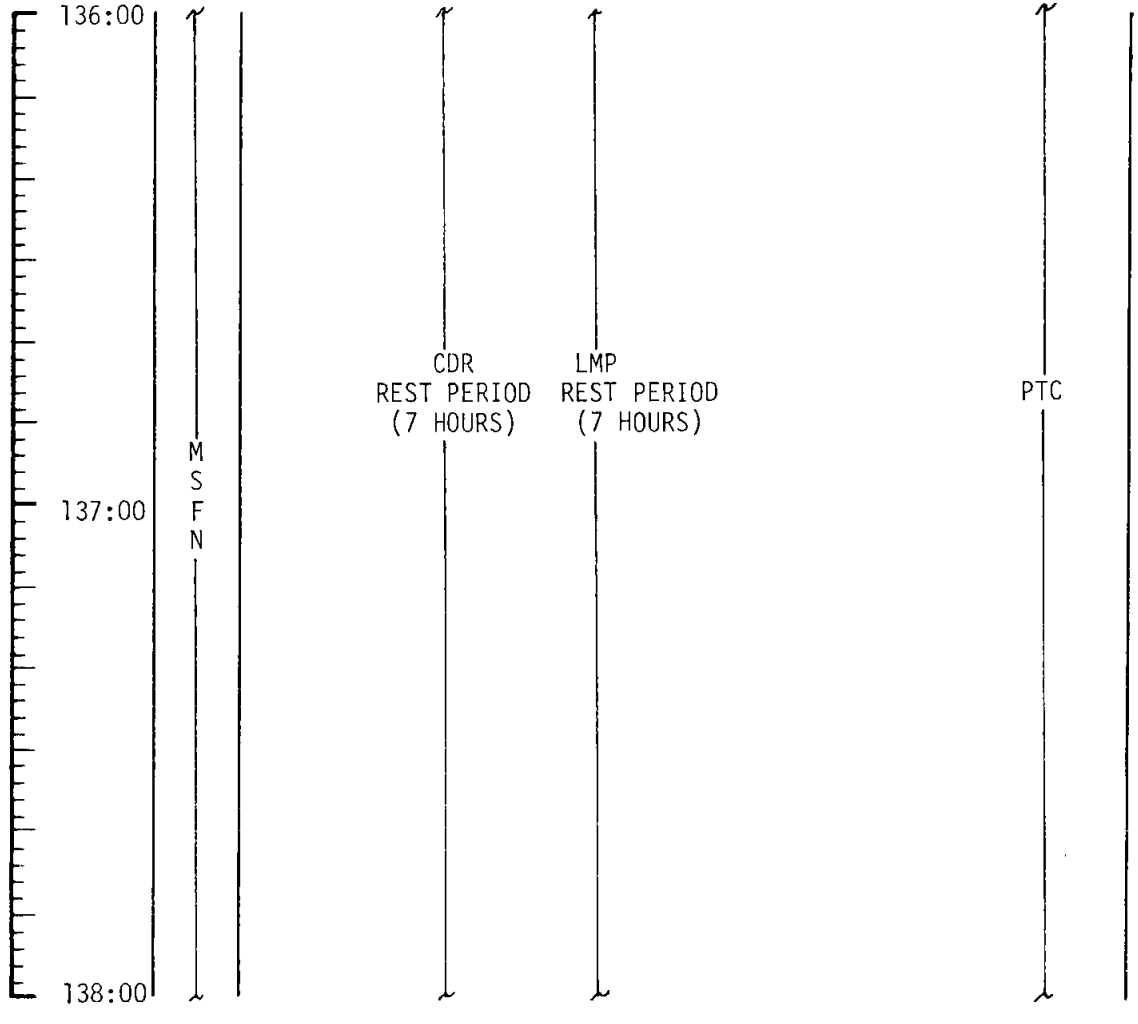
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

MCC-H
1:30 AM EDT

FLIGHT PLAN

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	136:00 - 138:00	6/TEC	3-100

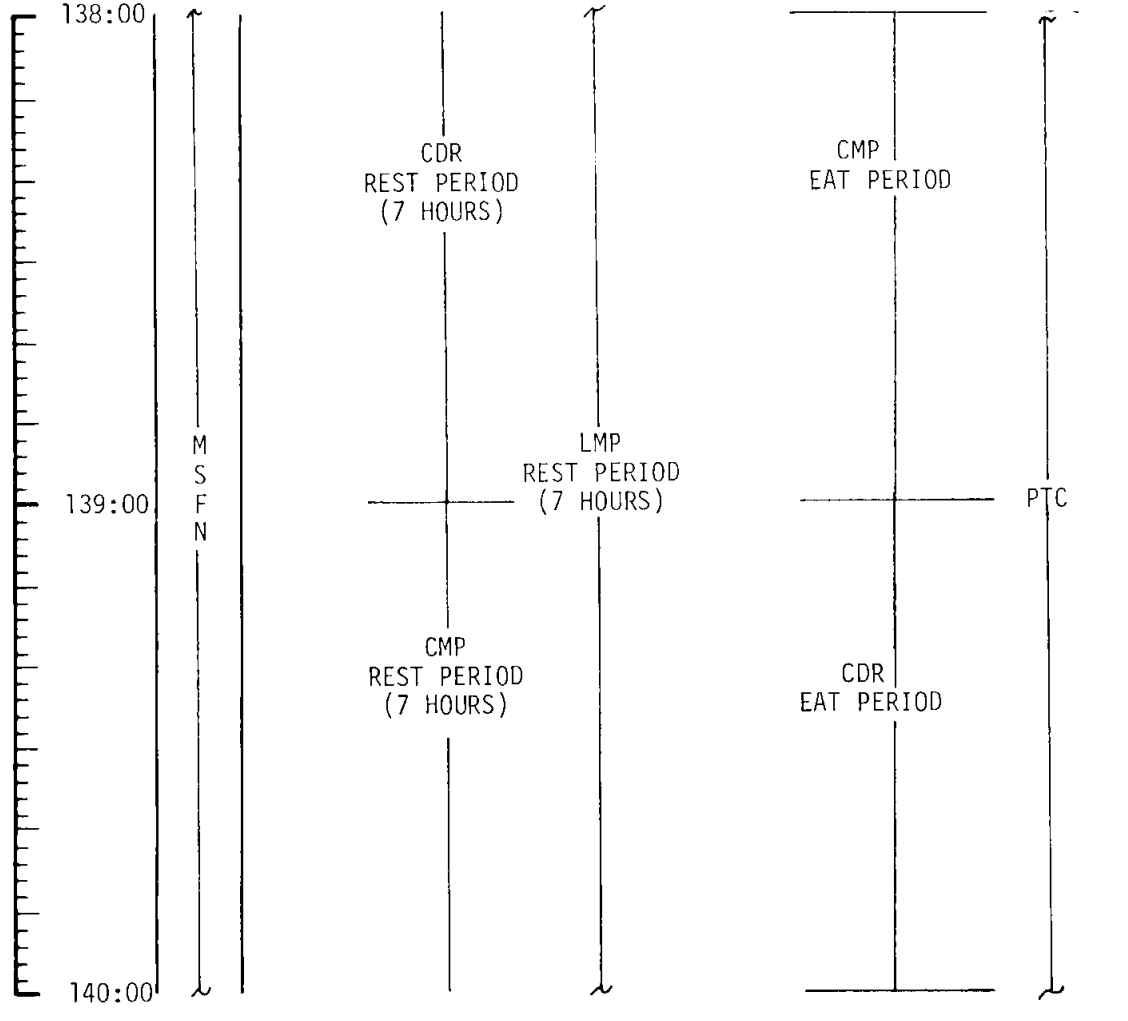
FLIGHT PLANNING BRANCH

MSC Form 20 OT (Mar. 69)

FLIGHT PLAN

MCC-H
3:30 AM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	138:00 - 140:00	6/TEC	3-101

FLIGHT PLANNING BRANCH

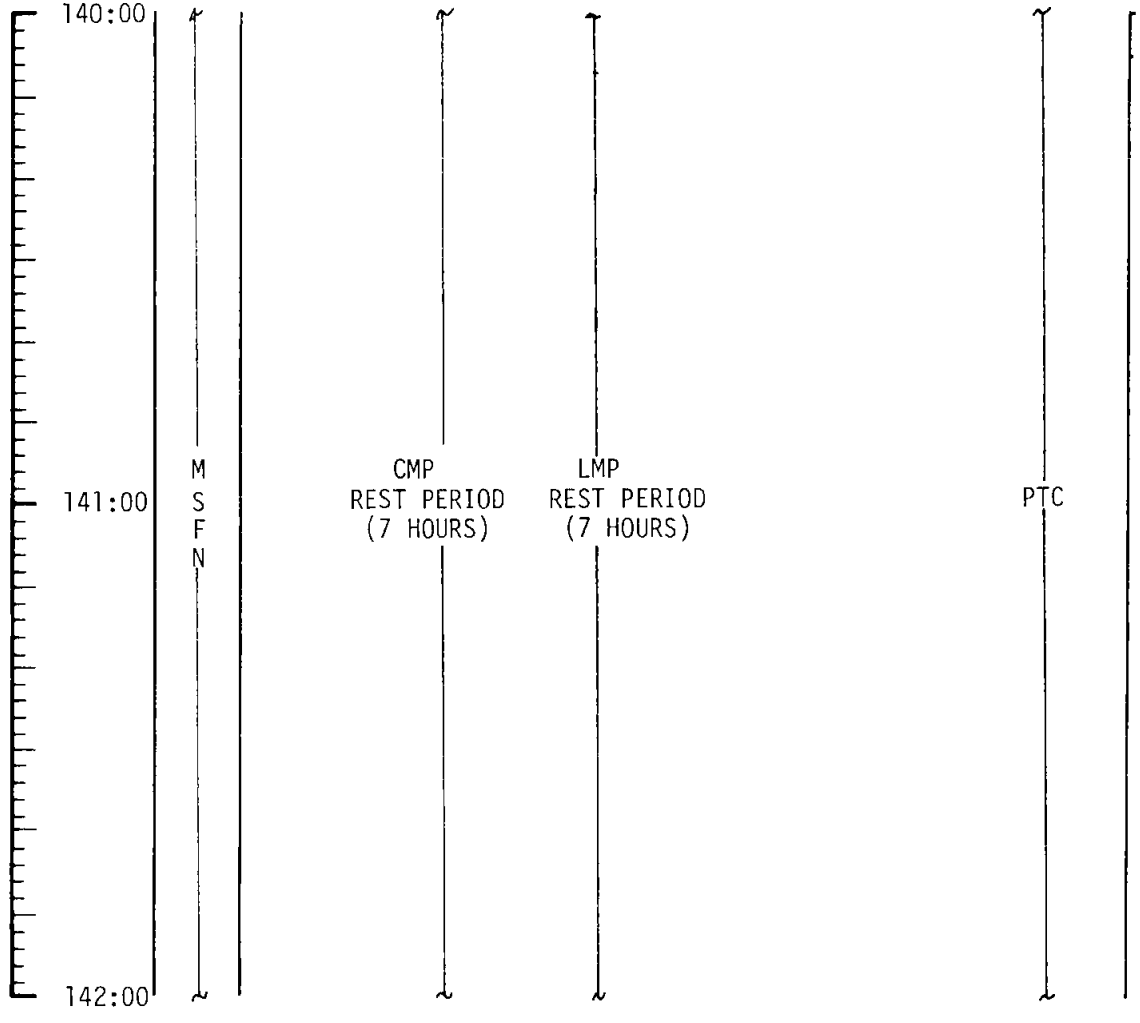
MSC Form 20 OT (Mar. 69)

FLIGHT PLAN

MCC-H
5:30 AM EDT

NOTES

P27 UPDATE:
STATE VECTOR
(CSM & LM)



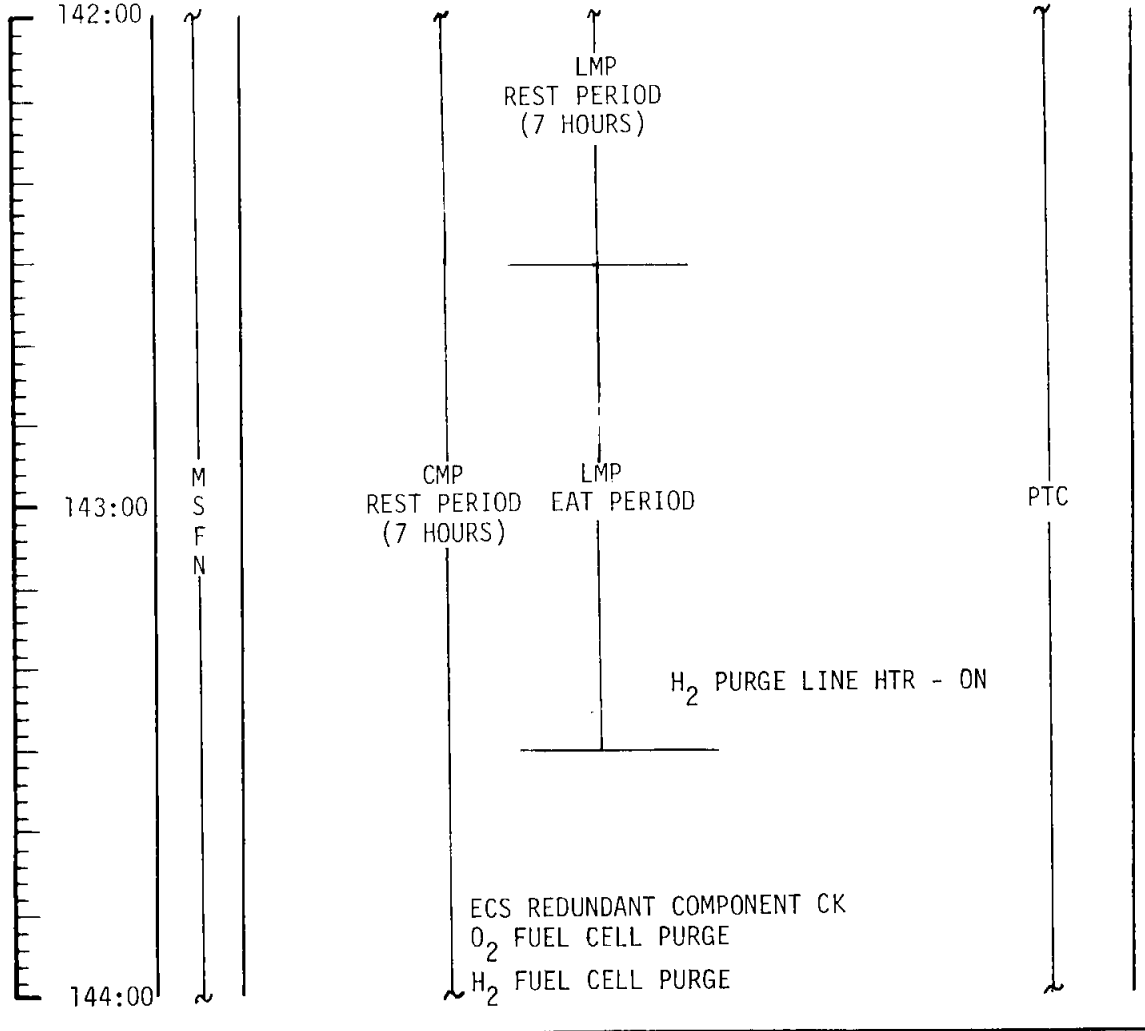
MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	140:00 - 142:00	6/TEC	3-102

FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
7:30 AM EDT



NOTES

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	142:00 - 144:00	6/TEC	3-103

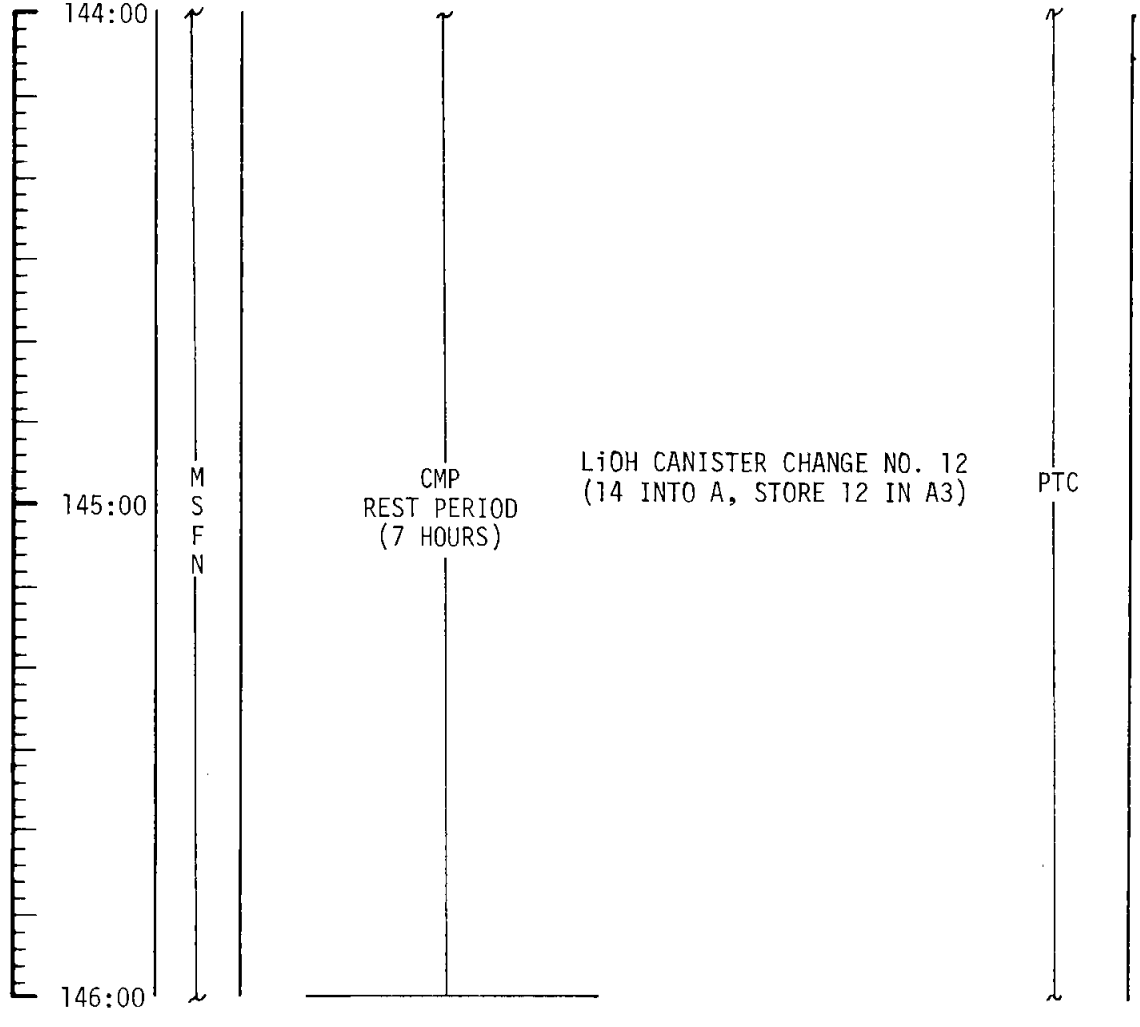
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

MCC-H
9:30 AM EDT

FLIGHT PLAN

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	144:00 - 146:00	6/TEC	3-104

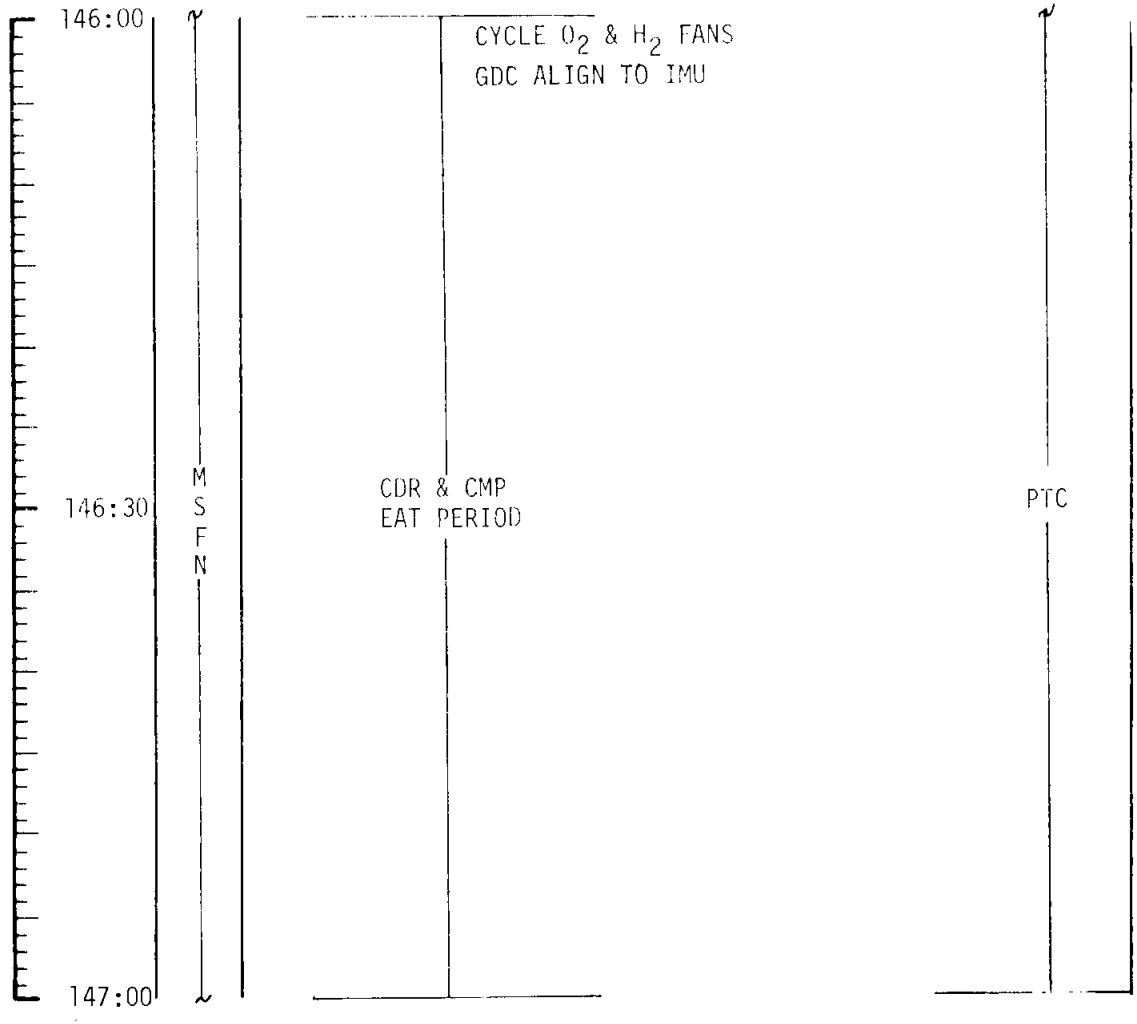
FLIGHT PLANNING BRANCH

MSC Form 20 OT (Mar. 69)

FLIGHT PLAN

MCC-H
11:30 AM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	146:00 - 147:00	7/TEC	3-105

FLIGHT PLANNING BRANCH

MCC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
12:30 PM EDT

147:00

CREW STATUS REPORT

P27 UPDATE:
STATE VECTOR
(CSM & LM)
TGT LOAD

VOICE UPDATE:
MNVR PAD

MSFN

147:30

CHLORINATE POTABLE WATER
RECORD MCC5 MNVR PAD

IMU REALIGN - P52
OPTION 3 - REFSMMAT

148:00

NOTES

CONSUMABLES UPDATE
Δ FROM NOMINAL

RCS TOT _____
A _____
B _____
C _____
D _____

H_2 TOT _____

O_2 TOT _____

P52 - (PTC REFSMMAT

N71: __ __ , __ __

N05: __ __ __ . __ __

N93:

X __ __ . __ __ __

Y __ __ . __ __ __

Z __ __ . __ __ __

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	147:00 - 148:00	7/TEC	3-106

FLIGHT PLANNING BRANCH

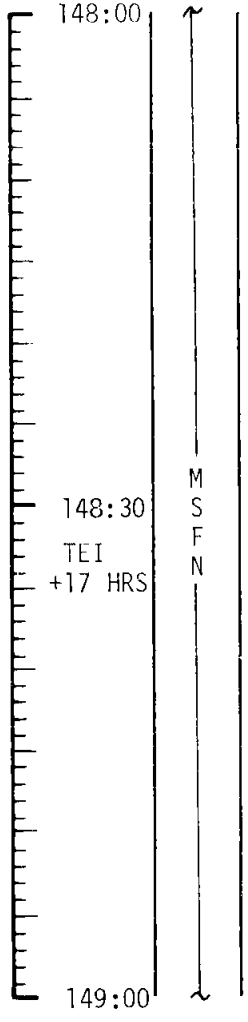
MSC Form 29 OT (Mar. 69)

MCC
BURN CHART

	P OR Y RATES	ATT DEVIATION	SHUTDOWN TIME	RESIDUALS
MCC_5	10°/SEC TAKEOVER	10° TAKEOVER	BT + 1 SEC	NO TRIM

FLIGHT PLAN

MCC-H
1:30 PM EDT



EXT ΔV - P30

SPS/RCS THRUST - P40/41

MNVR TO BURN ATT

SXT STAR CK

EMS ΔV TEST

SM RCS CK

GDC ALIGN TO IMU

MCC$_5$ ΔV NOMINALLY ZERO

SM RCS CK

SPS MON CK

V66 - TRANS CSM STATE VECTOR TO LM SLOT

PTC

NOTES

BURN STATUS REPORT

X	X		ΔTIG
X	X		BT
			V_{gx}
	TRIM		
X	X	X	R
X	X	X	P
X	X	X	Y
			V_{gx}
			V_{gy}
			V_{gz}
			ΔV_c
X	X	X	FUEL
X	X	X	OX
X	X	X	UNBAL

REMARKS:

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	148:00 - 149:00	7/TEC	3-107

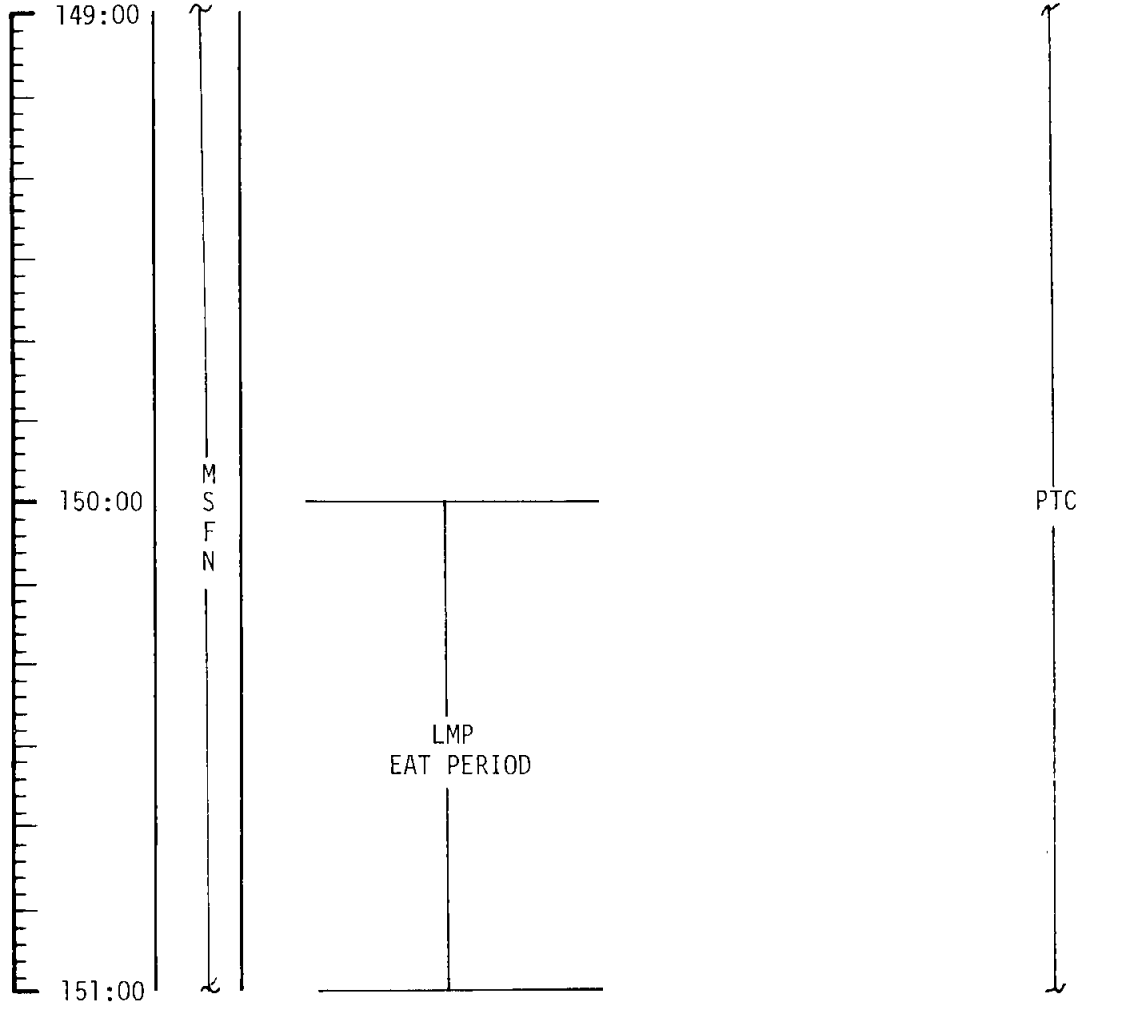
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
2:30 PM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	149:00 - 151:00	7/TEC	3-108

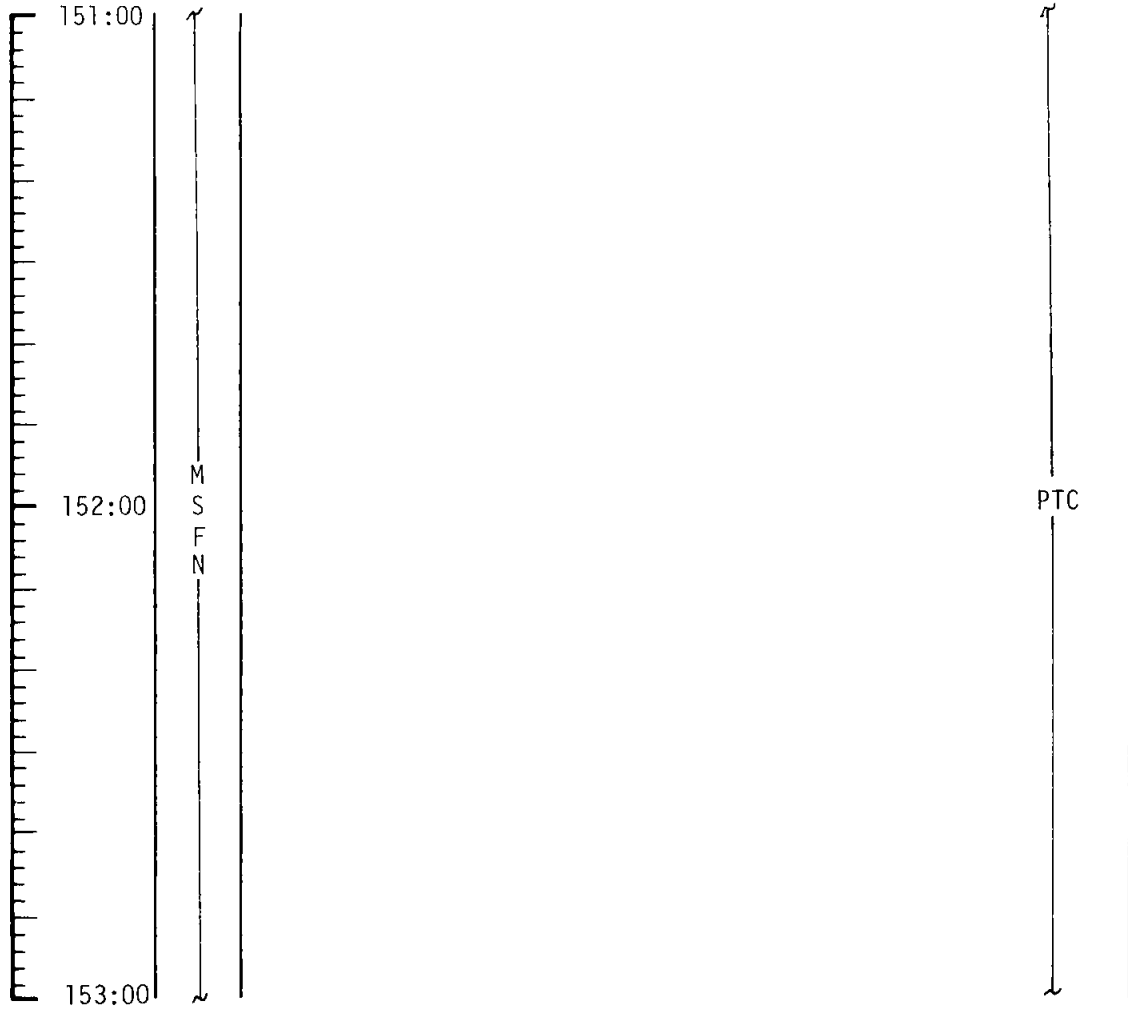
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
4:30 PM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINIARY	APRIL 15, 1969	151:00 - 153:00	7/TEC	3-109

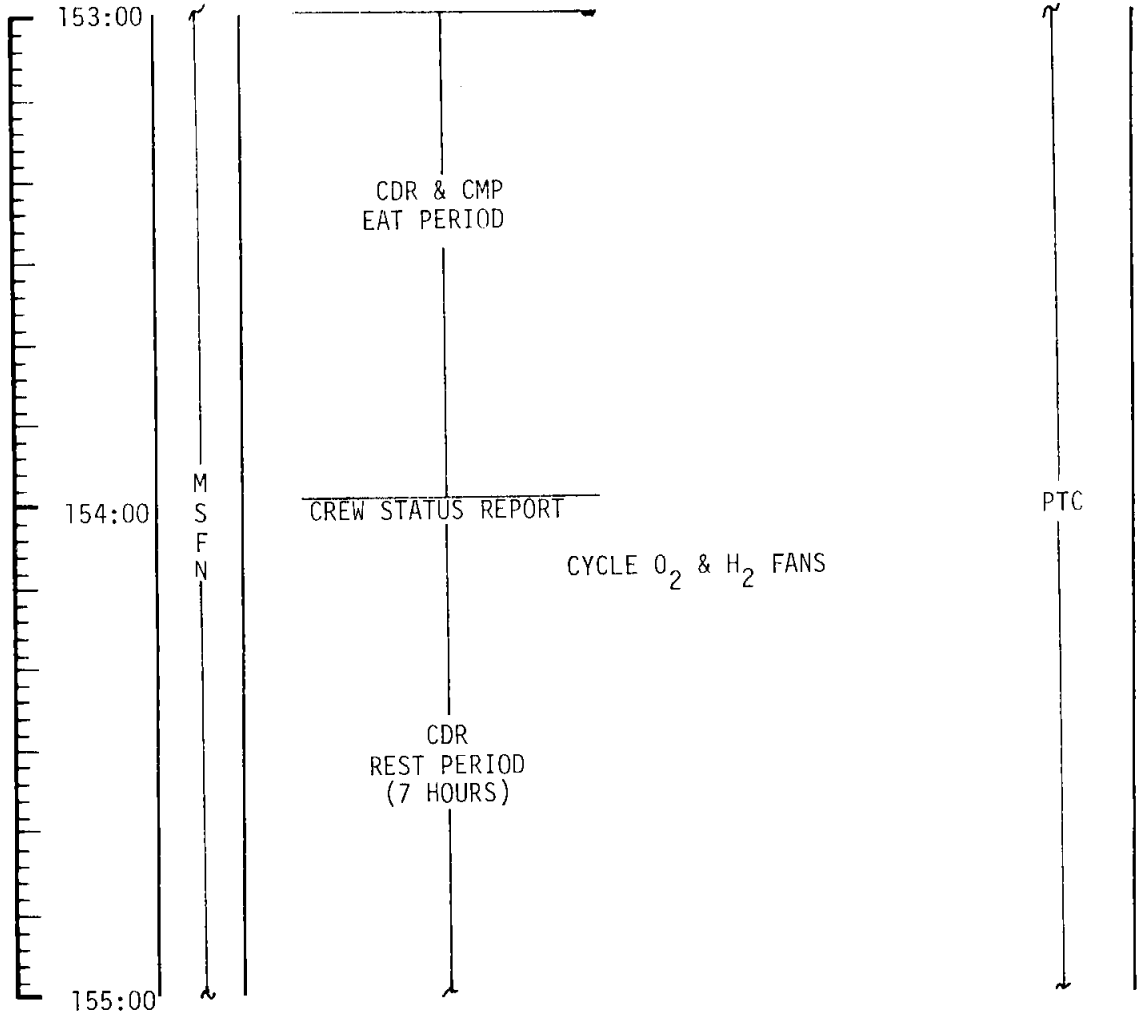
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
6:30 PM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	153:00 - 155:00	7/TEC	3-110

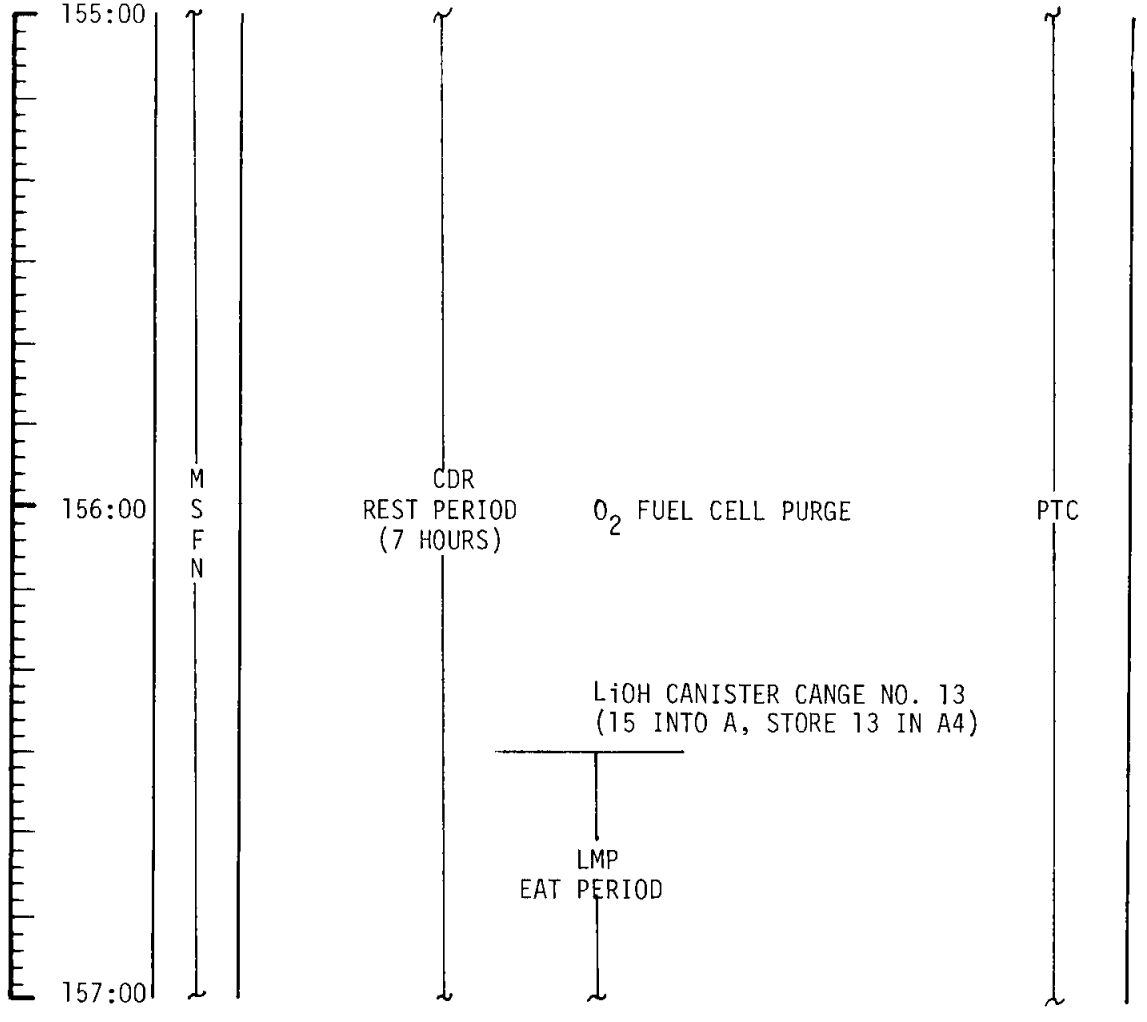
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

MCC-H
8:30 PM EDT

FLIGHT PLAN

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	155:00 - 157:00	7/TEC	3-111

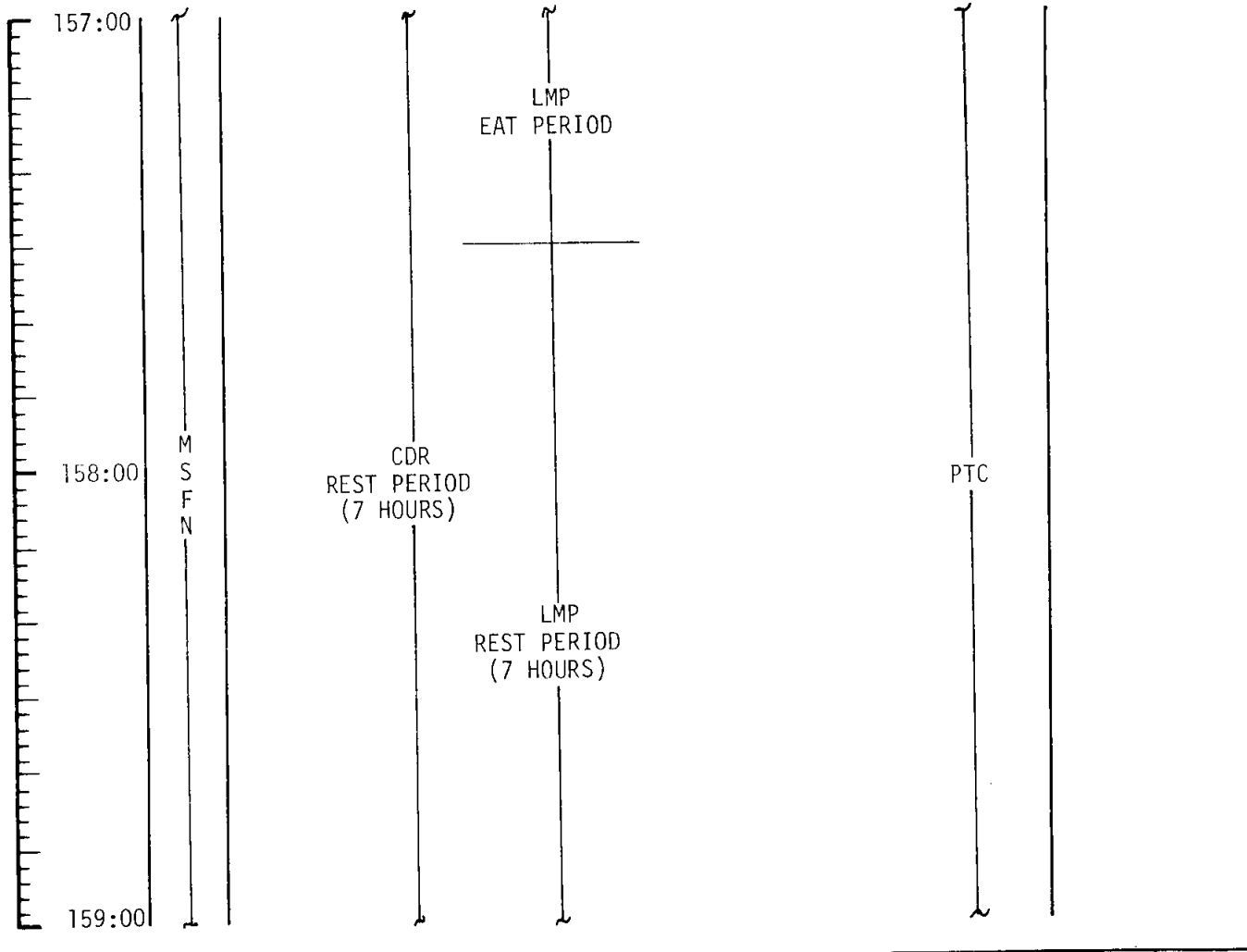
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
10:30 PM EDT

P27 UPDATE:
STATE VECTOR
(CSM & LM)



NOTES

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	157:00 - 159:00	7/TEC	3-112

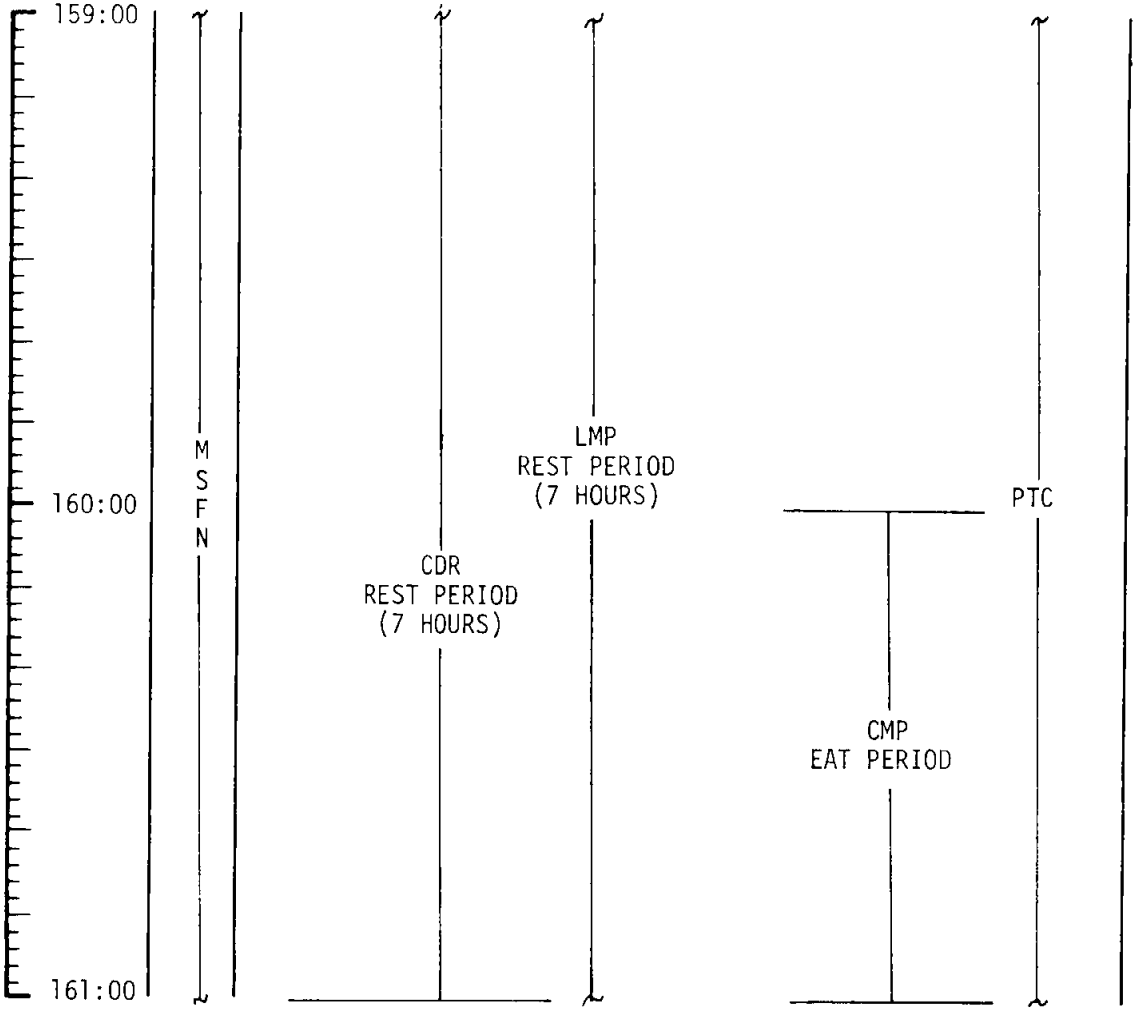
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

MCC-H
12:30 AM EDT

FLIGHT PLAN

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APO::0 11	PRELIMINARY	APRIL 15, 1969	159:00-161:00	7/TEC	3-113

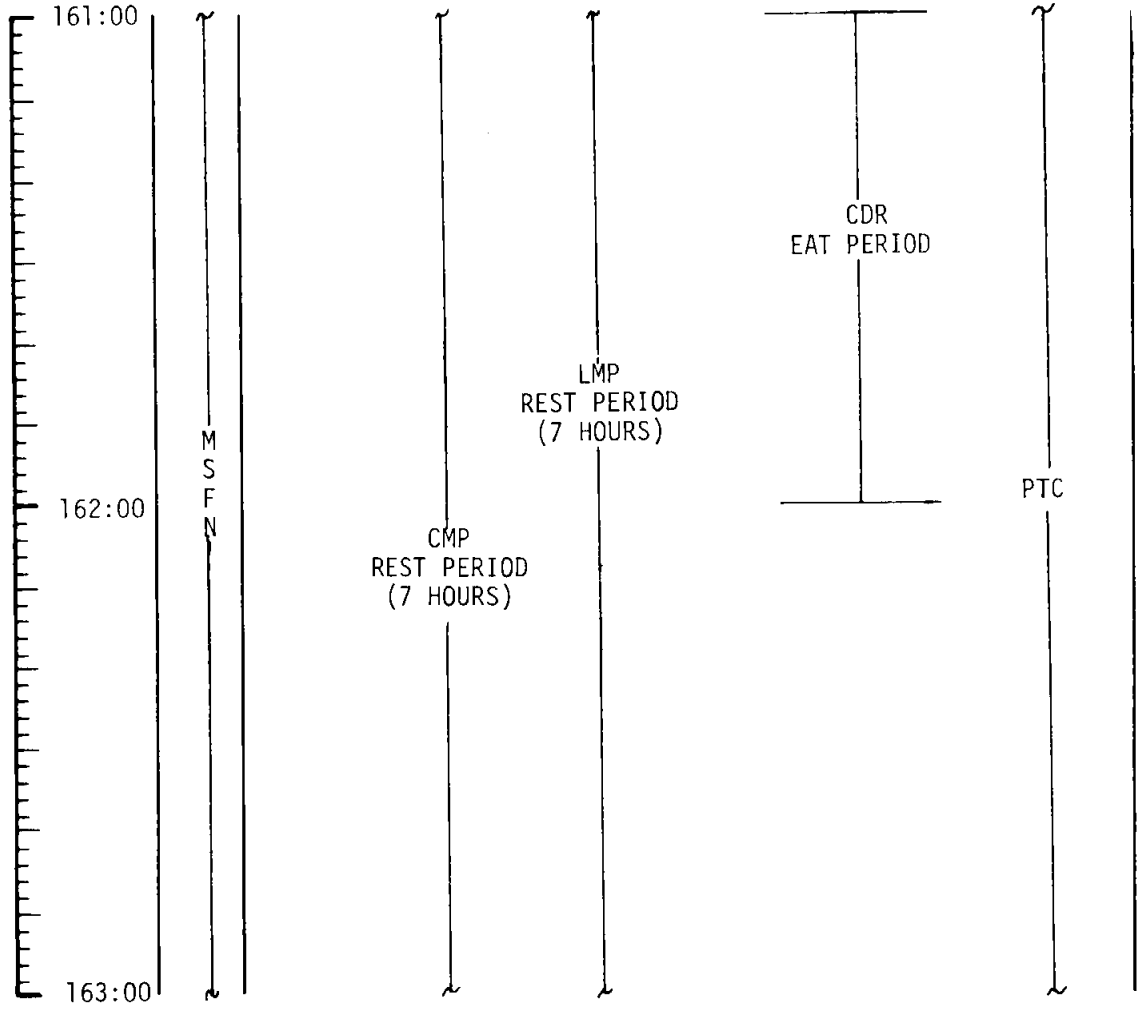
MSC Form 29 OT (Mar. 69)

FLIGHT PLANNING BRANCH

FLIGHT PLAN

MCC-H
2:30 AM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	161:00-163:00	7/TEC	3-114

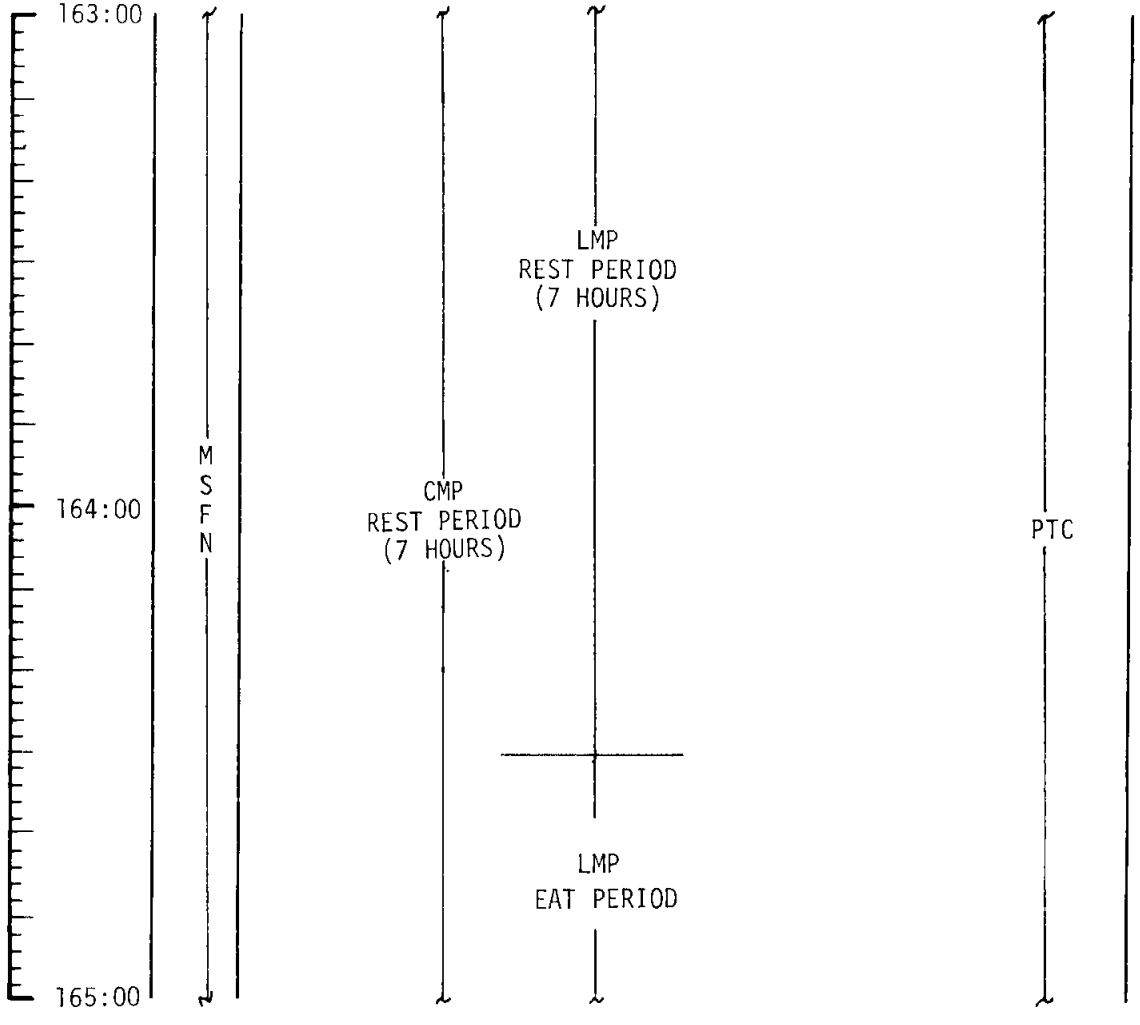
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

MCC-H
4:30 AM EDT

FLIGHT PLAN

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	163:00-165:00	7/TEC	3-115

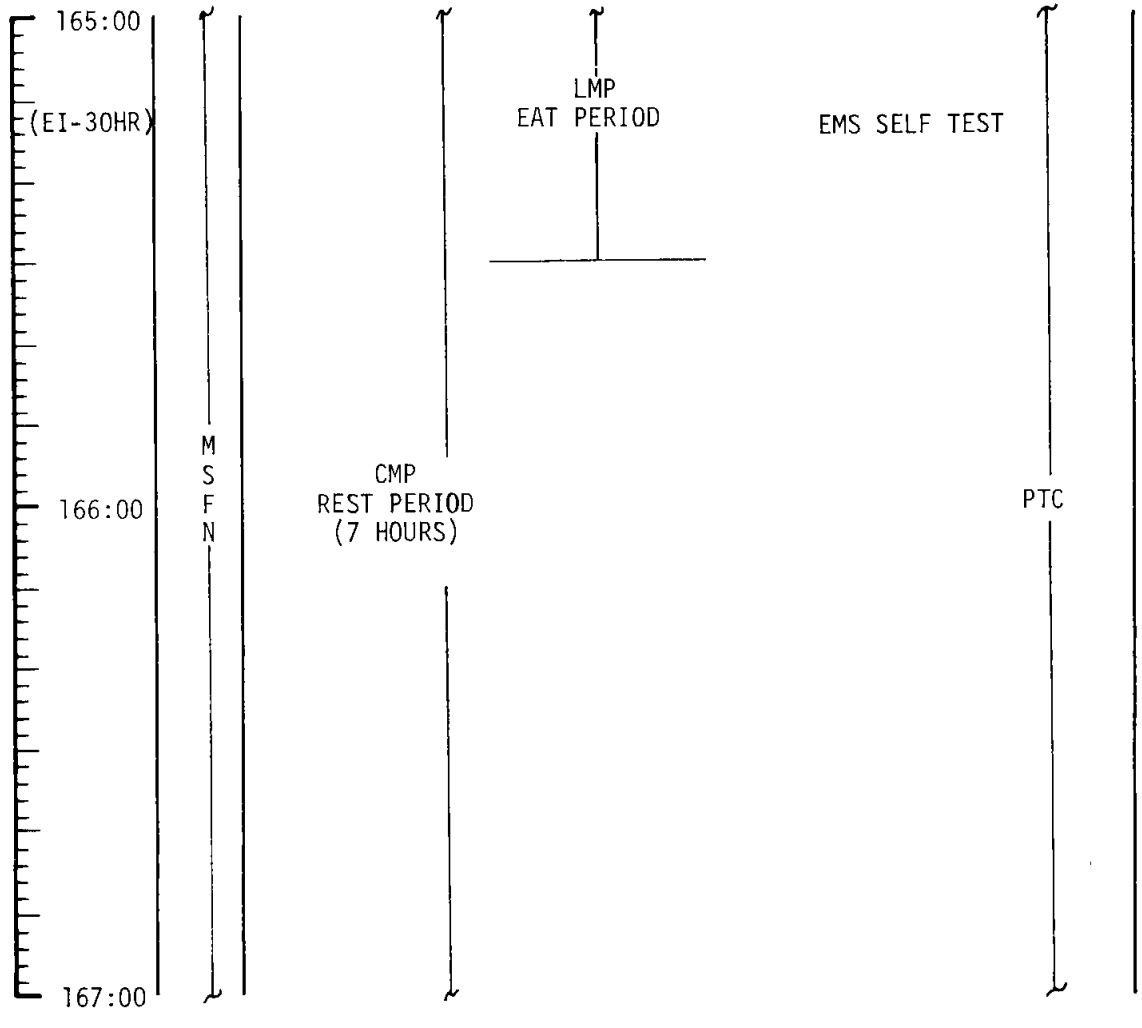
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
6:30 AM EDT

P27 UPDATE:
STATE VECTOR
(CSM & LM)



NOTES

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	165:00-167:00	7/TEC	3-116

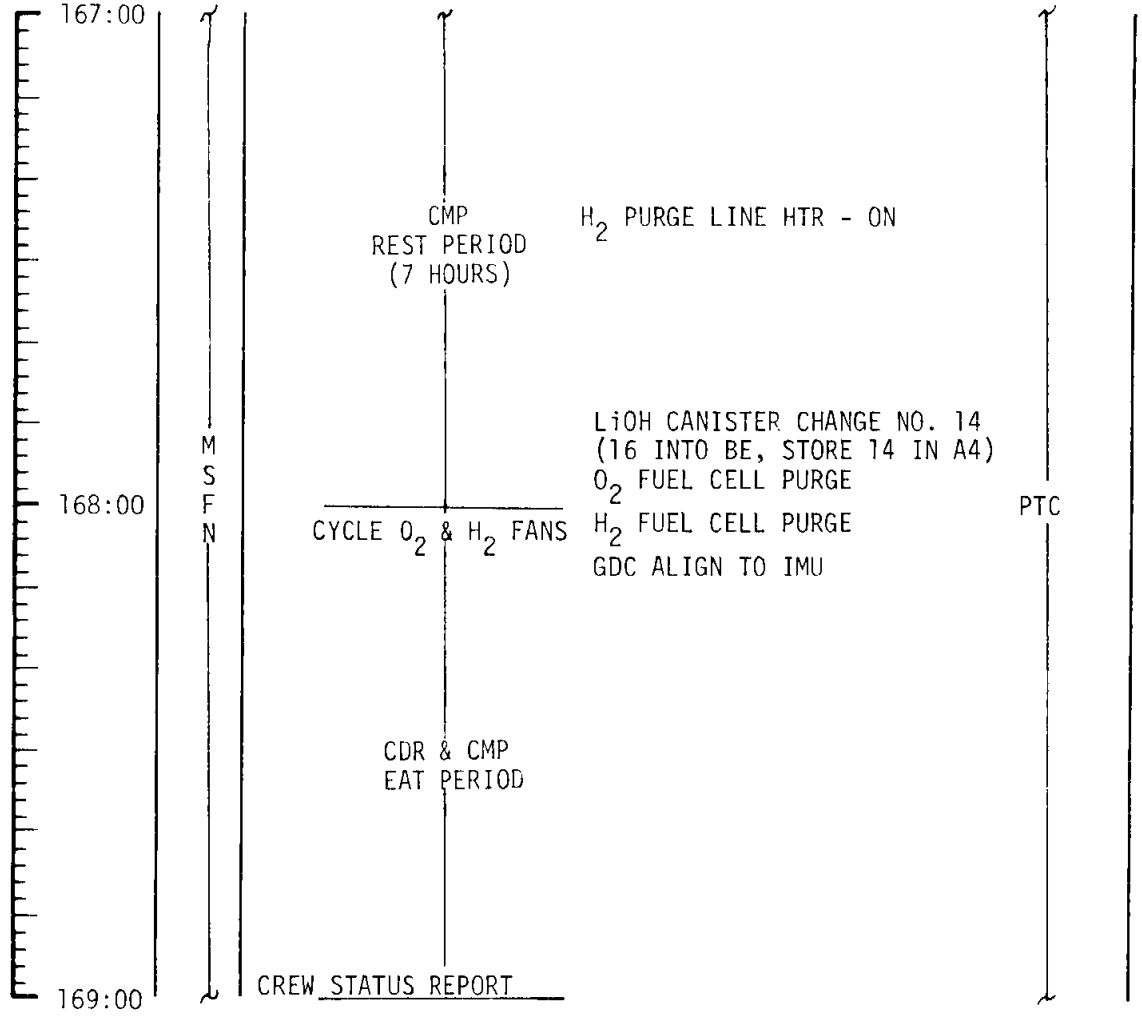
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
8:30 AM EDT

NOTES



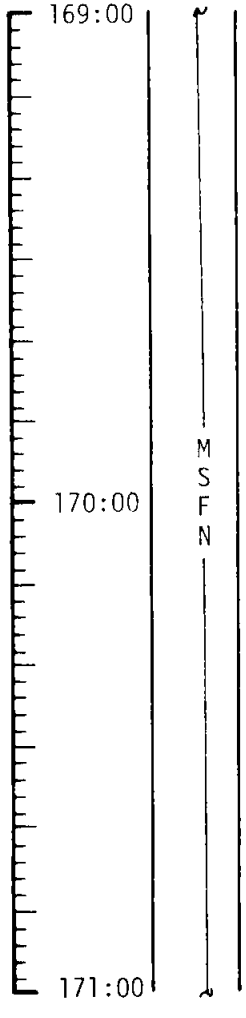
MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	167:00-169:00	7-8/TEC	3-117

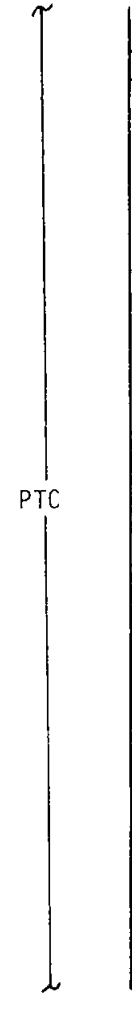
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
10:30 AM EDT





NOTES

CONSUMABLES UPDATE
Δ FROM NOMINAL

RCS TOT _____
A _____
B _____
C _____
D _____

H_2 TOT _____
O_2 TOT _____

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	169:00-171:00	8/TEC	3-118

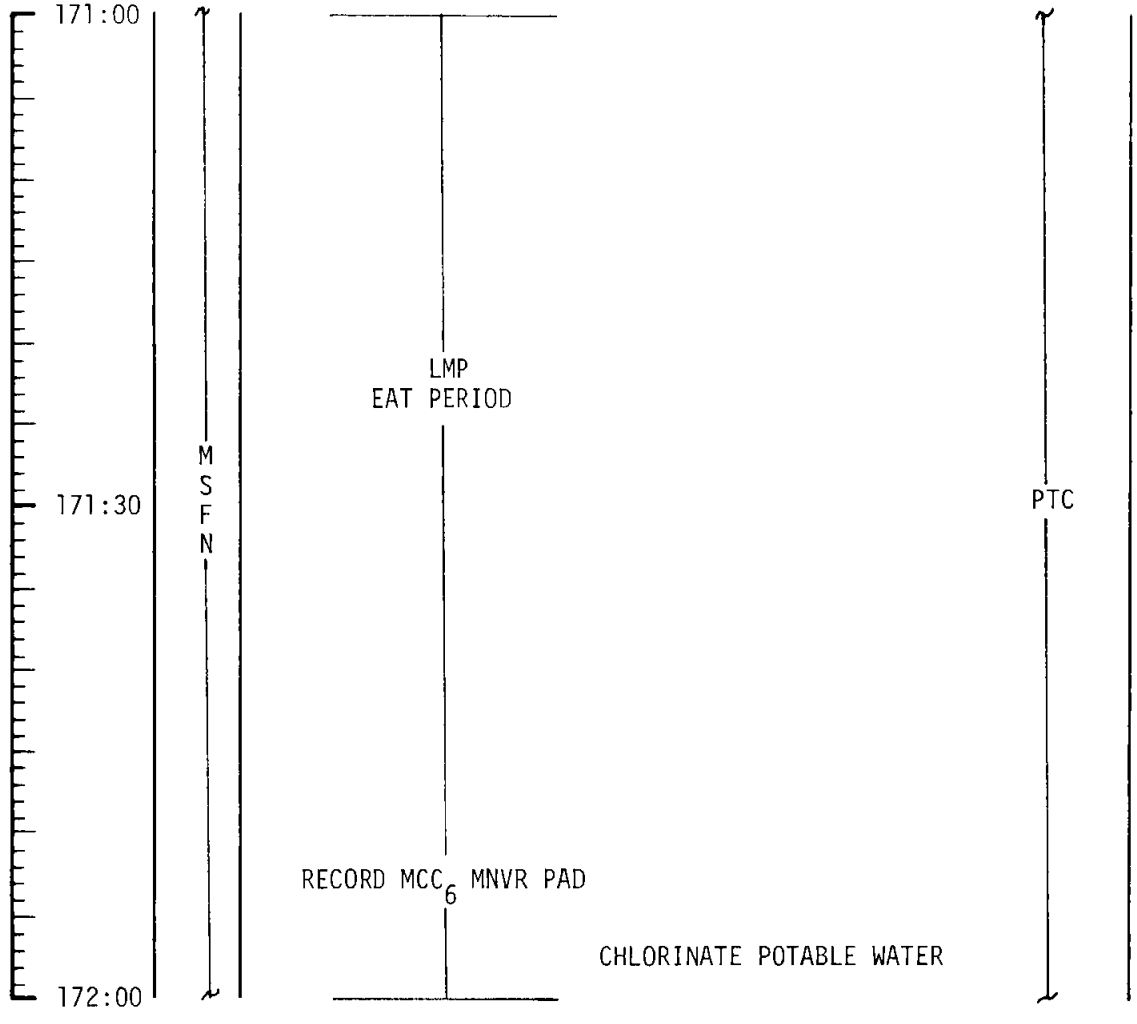
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
12:30 PM EDT

NOTES



P27 UPDATE:
STATE VECTOR
(CSM & LM)
TGT LOAD

VOICE UPDATE:
PAD DATA

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	171:00-172:00	8/TEC	3-119

FLIGHT PLANNING BRANCH

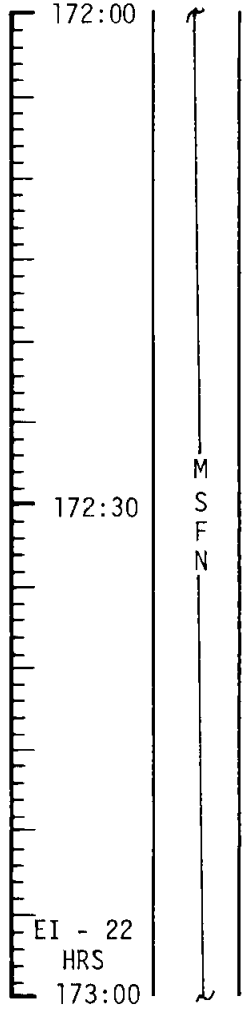
MSC Form 29 OT (Mar. 69)

MCC
BURN CHART

	P OR Y RATES	ATT DEVIATION	SHUTDOWN TIME	RESIDUALS
MCC_6	10°/SEC TAKEOVER	10° TAKEOVER	BT + 1 SEC	NO TRIM

FLIGHT PLAN

MCC-H
1:30 PM EDT



IMU REALIGN - P52
(OPTION 3 - REFSMMAT)

EXT ΔV - P30
SPS/RCS THRUST - P40/41
MNVR TO BURN ATT

SXT STAR CK

EMS ΔV TEST

SM RCS CK

GDC ALIGN TO IMU

MCC$_6$ ΔV NOMINALLY ZERO

BURN STATUS REPORT

X	X			ΔTIG
X	X			BT
				V_{gx}
		TRIM		
X	X	X		R
X	X	X		P
X	X	X		Y
				V_{gx}
				V_{gy}
				V_{gz}
				ΔV_c
X	X	X		FUEL
X	X	X		OX
X	X	X		UNBAL

REMARKS:

NOTES

P52 - (PTC REFSMMAT)
N71: __ __,__ __
N05: __ __ __.__ __
N93:
X __ __.__ __ __
Y __ __.__ __ __
Z __ __.__ __ __

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	172:00-173:00	8/TEC	3-120

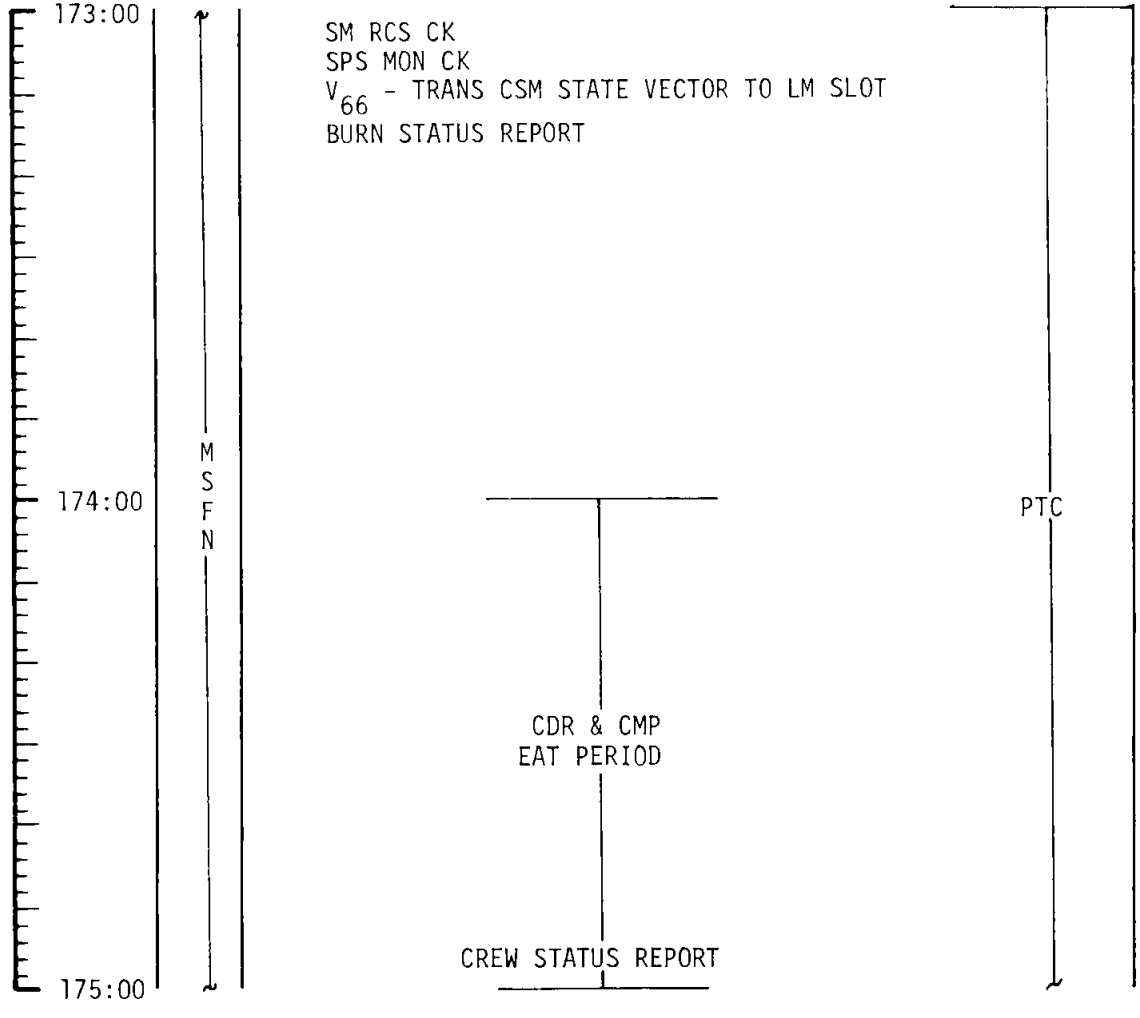
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
2:30 PM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	173:00-175:00	8/TEC	3-121

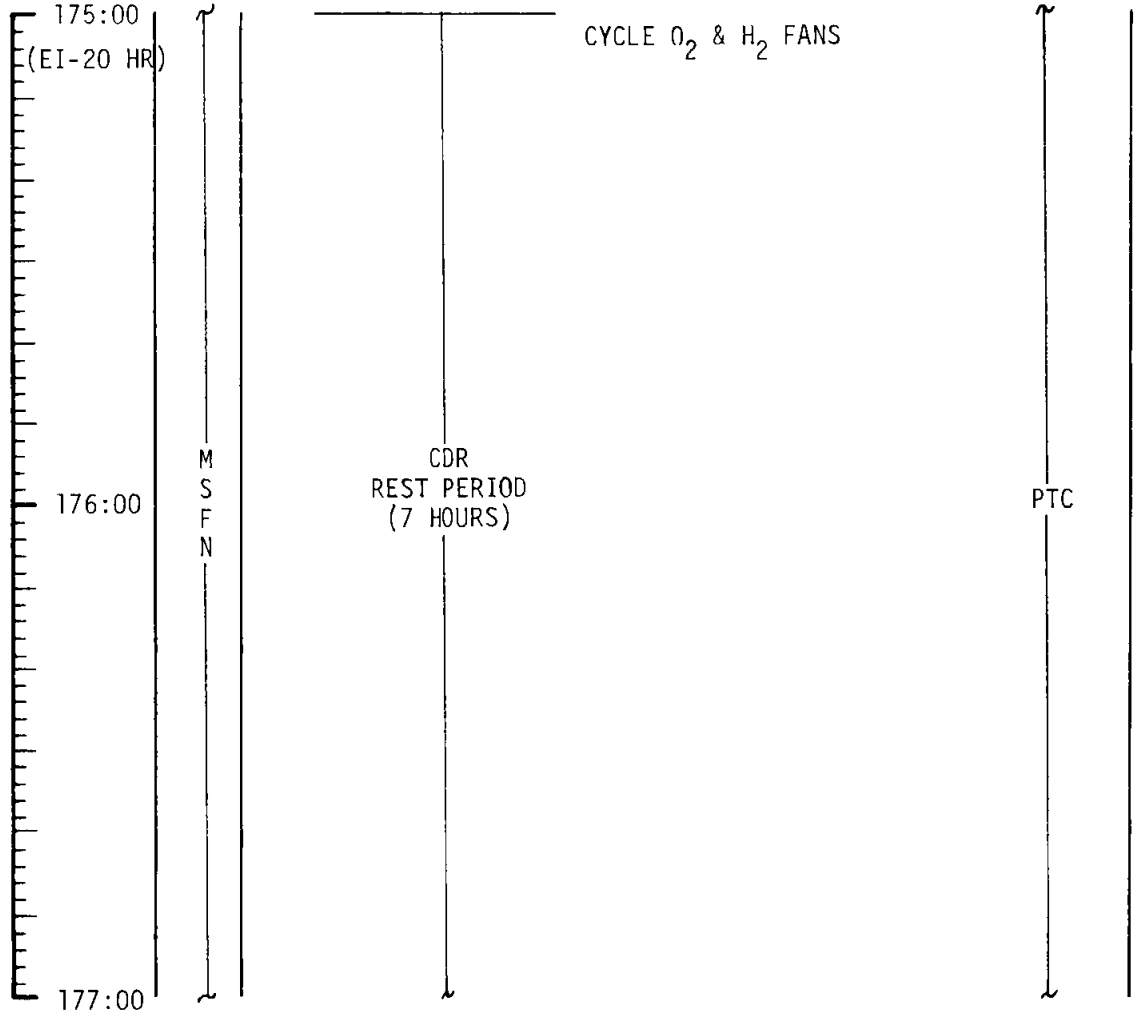
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
4:30 PM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	175:00-177:00	8/TEC	3-122

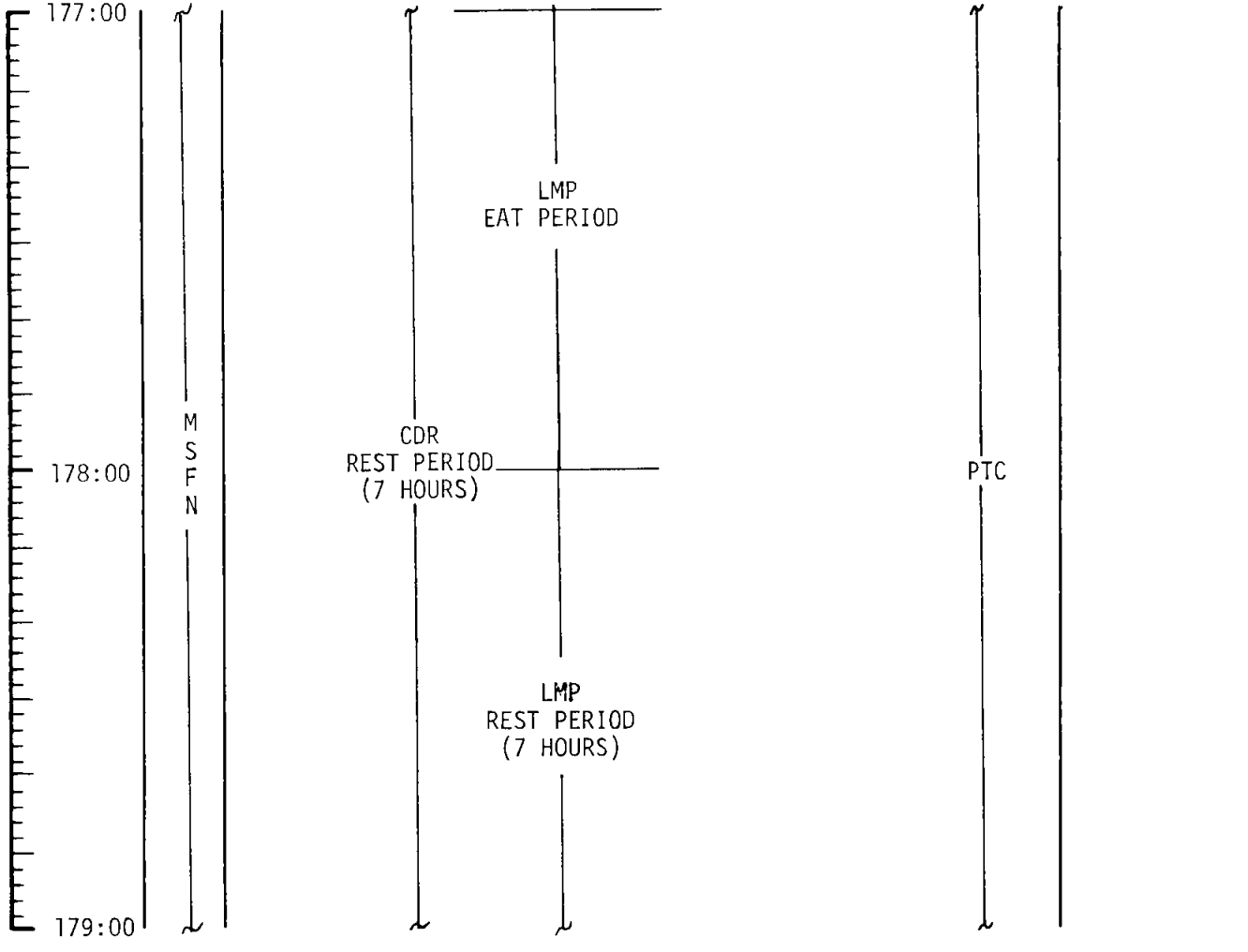
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

MCC-H
6:30 PM EDT

FLIGHT PLAN

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	177:00-179:00	8/TEC	3-123

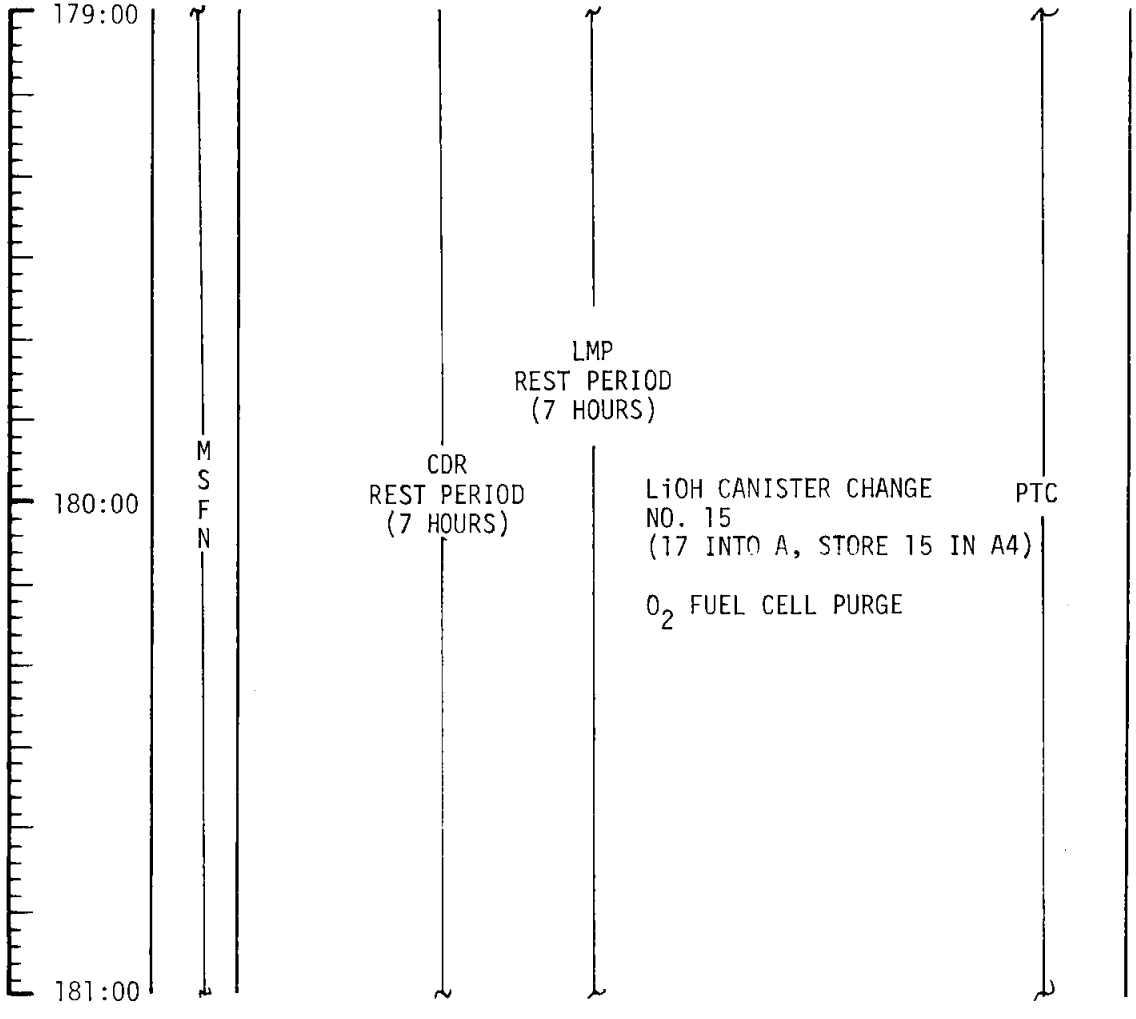
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
8:30 PM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	179:00-181:00	8/TEC	3-124

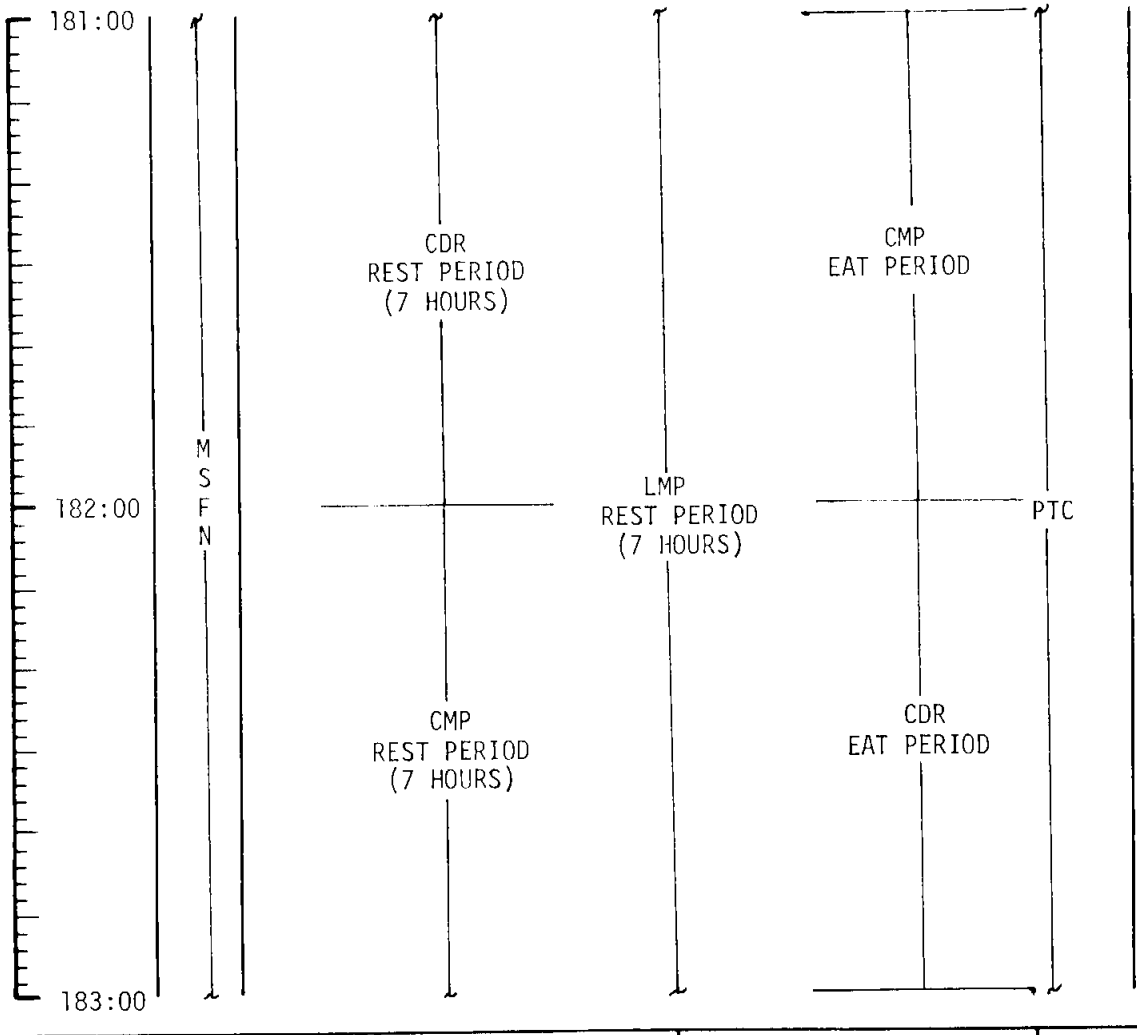
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
10:30 PM EDT

P27 UPDATE:
STATE VECTOR
(CSM & LM)



NOTES

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	181:00-183:00	8/TEC	3-125

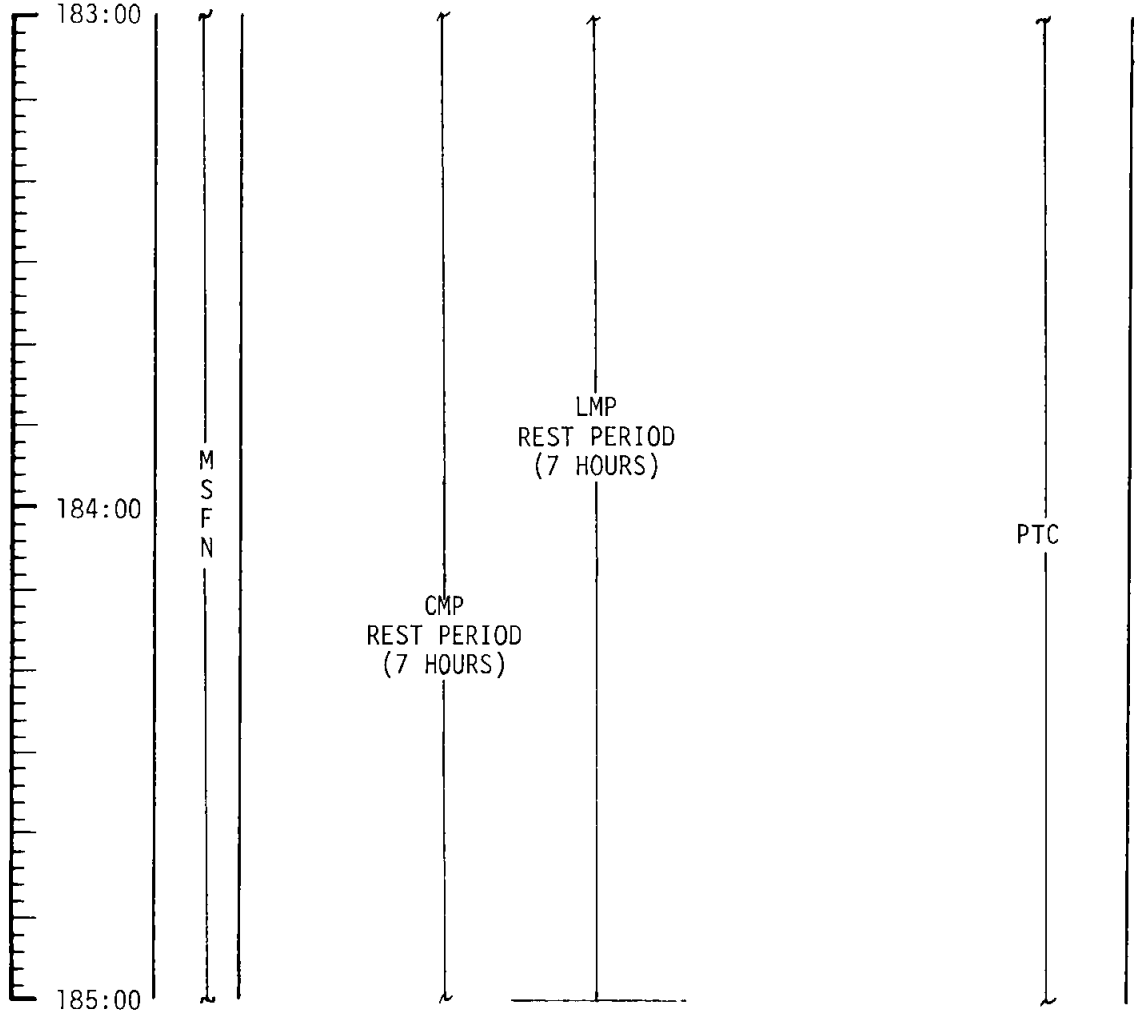
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
12:30 AM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	183:00-185:00	8/TEC	3-126

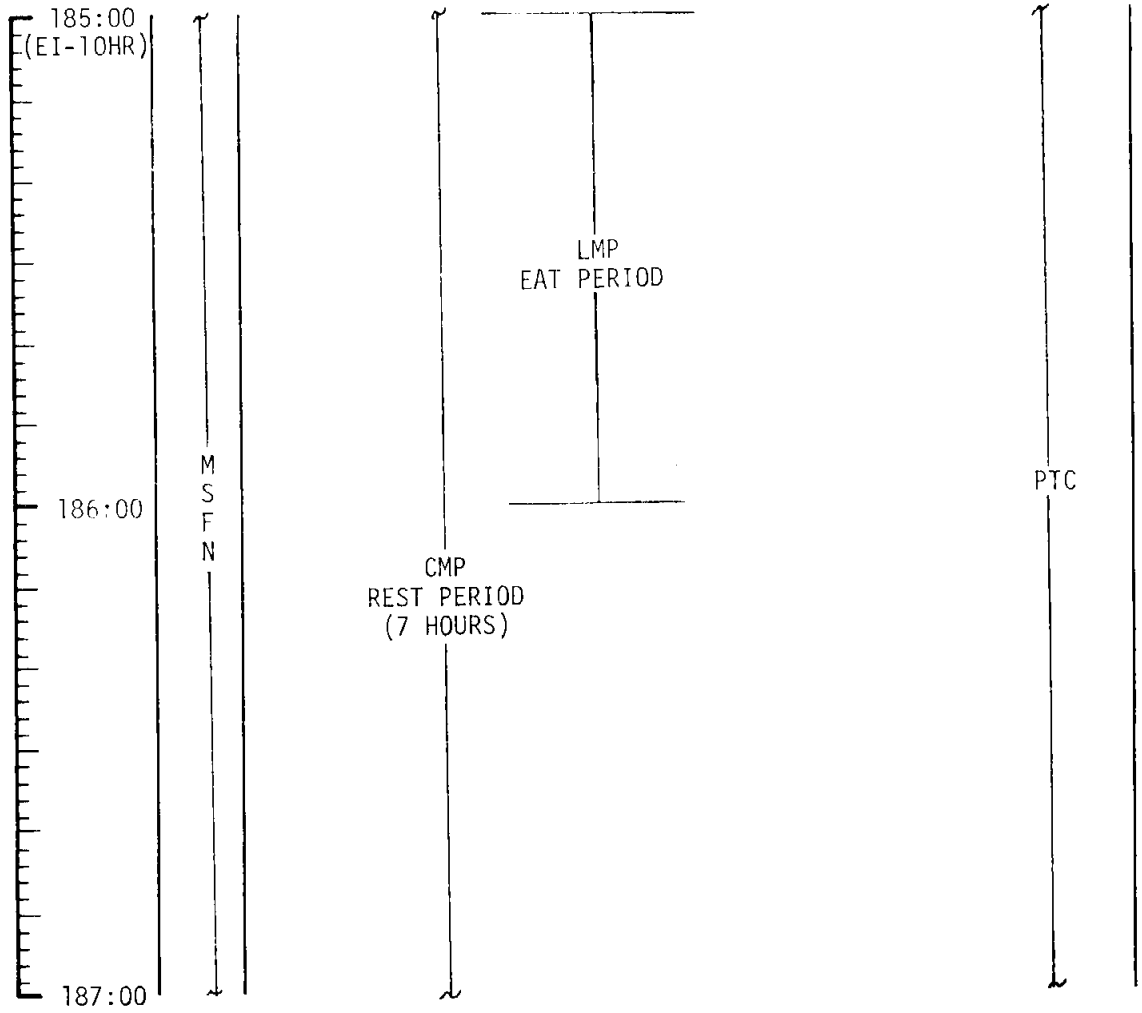
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
2:30 AM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	185:00-187:00	8/TEC	3-127

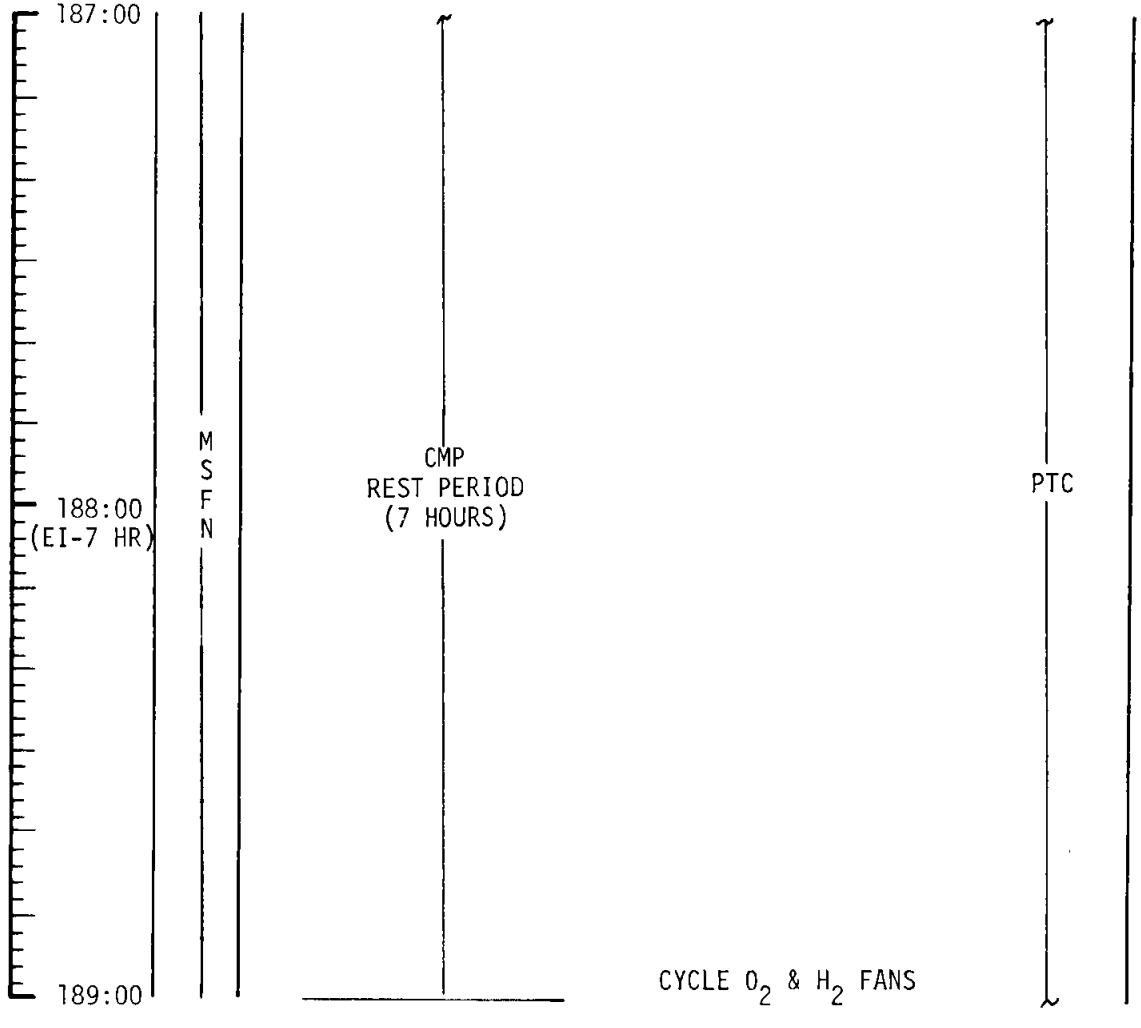
FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
4:30 AM EDT

NOTES



MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	187:00-189:00	8/TEC	3-128

FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H

6:30 AM EDT

GO/NO-GO

VOICE UPDATE:
- MNVR PAD
- ENTRY PAD

P27 UPDATE:
- STATE VECTOR (CSM & LM)
- DESIRED ORIENT (ENTRY)
- TGT LOAD
- ENTRY LAT & LONG
- VHF SIMP - A

189:00 (EI-6HRS)

GDC ALIGN TO IMU
GO/NO-GO FOR MCC7

RECORD MNVR & ENTRY PAD

CDR/CMP EAT PERIOD

MSFN

190:00 (EI-5HRS)

CREW STATUS REPORT

PTC

ECS MON CK
EPS MON CK
SPS MON CK
SM/CM MONITOR CK
C & W CK
ECS REDUNDANT COMPONENT CK
VHF ACTIVATION & C/O

191:00

NOTES

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	189L00-191:00	8/TEC	3-129

FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
8:30 AM EDT

191:00
(EI-4 HR)
191:30
192:00

MSFN

LiOH CANISTER CHANGE NO. 16
(18 INTO B, STORE 16 IN A4)
CMC SELF TEST
DSKY COND LT TEST

IMU REALIGN - P52
OPTION 1 - PREFERRED

EXT ΔV - P30
SPS/RCS THRUST - P40/41
MNVR TO BURN ATT
SXT STAR CK
EMS ΔV TEST
SM RCS CK

NOTES

P52 - (ENTRY REFSMMAT)
N71: __ __,__ __
N05: __ __ __.__ __
N93:
X __ __.__ __ __
Y __ __.__ __ __
Z __ __.__ __ __

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	191:00-192:00	8/TEC	3-130

FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

MCC
BURN CHART

	P OR Y RATES	ATT DEVIATION	SHUTDOWN TIME	RESIDUALS
MCC_7	10°/SEC TAKEOVER	10° TAKEOVER	BT + 1 SEC	NO TRIM

FLIGHT PLAN

MCC-H
9:30 AM EDT

192:00
(EI-3HRS)
192:30
(EI-2.5)
193:00

MSFN

GDC ALIGN TO IMU

MCC$_7$ ΔV NOMINALLY ZERO

SM RCS CK
SPS MON CK
V_{66} - TRANS CSM STATE VECTOR TO LM SLOT
BURN STATUS REPORT

FINAL STOWAGE

LMP - SNACK PERIOD

MNVR TO ENTRY ATT

NOTES

BURN STATUS REPORT

X	X	•	ΔTIG
X	X	•	BT
		•	V_{gx}
		TRIM	
X	X	X	R
X	X	X	P
X	X	X	Y
		•	V_{gx}
		•	V_{gy}
		•	V_{gz}
		•	ΔV_c
X	X	X	FUEL
X	X	X	OX
X	X	X	UNBAL

REMARKS:

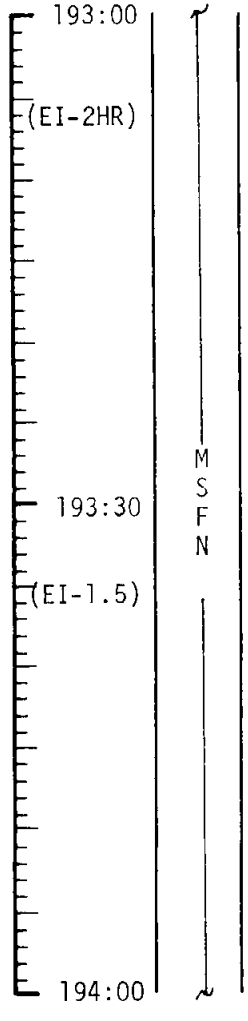
MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	192:00-193:00	9/TEC	3-131

FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
10:30 AM EDT



COAS STAR CK

SXT STAR CK

IMU REALIGN - P52
(OPTION 3 - REFSMMAT)

EMS CK

INITIATE CM RCS PREHEAT

NOTES

P52 - (ENTRY REFSMMAT)
N71: __ __,__ __
N05: __ __ __.__ __
M93:
X __ __.__ __ __
Y __ __.__ __ __
Z __ __.__ __ __

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	193:00-194:00	9/TEC	3-132

FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

FLIGHT PLAN

MCC-H
11:30 AM EDT

NOTES

194:00

PRELIMINARY EVAPORATOR ACTIVATION

(EI-1HR)

P27 UPDATE:
STATE VECTOR
(CSM & LM)

VOICE UPDATE:
ENTRY PAD
RCVY PAD

FINAL GDC DRIFT CHECK
TERM CK RCS PREHEAT
PYRO BATT CK

RECORD ENTRY PAD AND RECOVERY DATA

MSFN

SET DET TO RRT
EMS INITIALIZATION
RSI ALIGN TO GDC
CM RCS CK

194:30

(EI-30)

ENTRY BATTS - ON

GO FOR PYRO ARM

SEPARATION CKLT
GO FOR PYRO ARM
P61 ENTRY PREP
MNVR TO CM/SM SEP ATT

CM/SM SEP

P62 - ENTRY ATTITUDE
MNVR TO ENTRY ATT

195:00

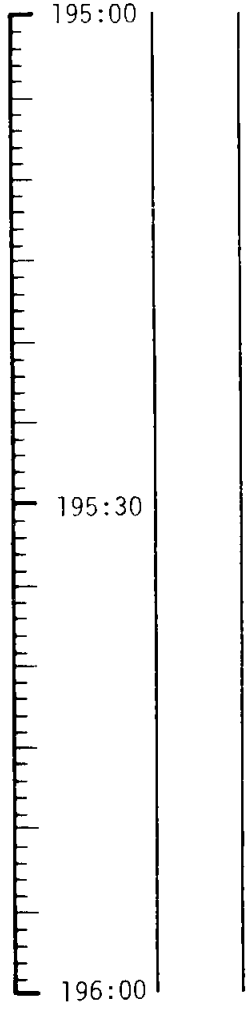
MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	194:00-195:00	9/TEC	3-133

FLIGHT PLANNING BRANCH

MSC Form 20 OT (Mar. 69)

FLIGHT PLAN

MCC-H
12:30 PM EDT



P63 - ENTRY INITIATE

EI - GETI = 195:06:27

P64 - ENTRY POST .05G

EVENT	TIME FROM EI - min:sec
400,000 FT	00:00
ENTER S-BAND BLACKOUT	00:26
0.05G	00:30
KA - INITIATE CONSTANT DRAG	00:52
RDOT = -700 FPS	01:20
PEAK G	01:24
P64 TO P67	02:10
EXIT S-BAND BLACKOUT	03:26
GUIDANCE TERMINATION	07:30
DROGUE DEPLOYMENT	08:33.2
MAIN DEPLOYMENT	09:22.0
TOUCHDOWN	14:15.2

L/D = 0.286
V = 36,221 R=1350
γ = -6.48

NOTES

MISSION	EDITION	DATE	TIME	DAY/REV	PAGE
APOLLO 11	PRELIMINARY	APRIL 15, 1969	195:00-196:00	9/TEC	3-134

FLIGHT PLANNING BRANCH

MSC Form 29 OT (Mar. 69)

SECTION IV - DETAILED TEST OBJECTIVES

SECTION 4

DETAILED OBJECTIVE ACTIVITIES

This section contains the activity summaries which reflect the test objectives for Mission G as described in "Mission Requirements G Type Mission", SPD9-R-038, dated March 5, 1969. These activity summaries are presented in the approximate sequence in which they are planned to occur during the mission.

Each activity summary provides the following information:

A. TEST OBJECTIVES. This is the listing of the Functional Test Objectives (complete or partial) which relate to the particular activity;

B. TEST REQUIREMENTS. Here the special test prerequisites (and mission phase if necessary) are presented in addition to brief statements of the requirements for performing the activity;

C. TEST PROCEDURES/CHECKLISTS. These are the procedural references for the performance of the activity as far as the test objectives are concerned; and

D. DATA REQUIREMENTS. This part of the summary identifies the gross data which are needed for evaluation of test results in terms of flight crew and ground support requirements.

Cross references for relating Detailed and Functional Test Objectives with the activity summaries and relating activities to Functional Test Objectives, are provided as the initial part of this section.

The following ground rules are to be used in implementing data requirements:

A. The collection of highly desirable (HD) data should not constrain the timeline of the crew procedures.

B. Post-flight debriefing requirements which are fulfilled by real time transmission of data per the DATA REQUIREMENTS sections may be deleted from the post-flight debriefing.

TABLE 4-1 MISSION ACTIVITY & TEST OBJECTIVE CROSS REFERENCE

ACTIVITY	FTO
LM Descent	I-1, H-1, H-3
Locate Landed LM	H-1, H-2, H-3
Evaluate Support Equipment	C-1, C-2, C-3
Lunar Surface EVA	B-1, B-2, D-1, D-5, I-2
Surface Sample Collection	A-1, G-1, G-2, J-3, K-1, K-2, K-3, K-4
External LM Observations	D-2, E-1, E-2, E-3, E-4, L-3
Lunar Surface Observations	D-3, D-4, F-1, F-2, F-3, K-5, L-1, L-2, L-3
Experiment Deployment/Conduct	S-031, S-078, S-080
Contamination Prevention	J-1, J-2

TABLE 4-2
TEST OBJECTIVE/MISSION ACTIVITY
CROSS REFERENCE

DTO/FTO NUMBER	TEST OBJECTIVE	MISSION ACTIVITY	SECTION PAGE NO.
A	Contingency Sample Collection		
A-1	Provide A Contingency Lunar Surface Sample	Surface Sample Collection	4-14
B	Lunar Surface EVA Operations		
B-1	Demonstrate Egress To/Ingress From the Lunar Surface	Lunar Surface EVA	4-12
B-2	Evaluate Crew Lunar Surface EVA Capability	Lunar Surface EVA	4-12
C	EMU Lunar Surface Operations		
C-1	EMU Capability To Provide A Habitable Environment	Evaluate Support Equipment	4-10
C-2	EMU Effects On Crew Mobility, Dexterity & Comfort	Evaluate Support Equipment	4-10
C-3	Demonstrate EVA Data/Voice Communications	Evaluate Support Equipment	4-10
D	Television Coverage		
D-1	TV Coverage of Astronaut Descending To The Lunar Surface	Lunar Surface EVA	4-12
D-2	TV Coverage of External Landed LM	External LM Observations	4-16
D-3	TV Coverage of Lunar Surface Near LM	Lunar Surface Observations	4-18
D-4	TV Panoramic Coverage of Distant Terrain Features	Lunar Surface Observations	4-18
D-5	TV Coverage of Astronaut Activities On The Lunar Surface	Lunar Surface EVA	4-12
E	Landing Effects On LM		
E-1	LM Landing Gear Performance Under Landing Conditions	External LM Observations	4-16
E-2	Effects of Landing On LM Structure and Components	External LM Observations	4-16
E-3	Descent Engine Skirt Damage/Clearance After Landing	External LM Observations	4-16
E-4	Effects of RCS Plume Impingement on LM Structure & Components	External LM Observations	4-16

TABLE 4-2
TEST OBJECTIVE/MISSION ACTIVITY
CROSS REFERENCE

DTO/FTO NUMBER	TEST OBJECTIVE	MISSION ACTIVITY	SECTION PAGE NO.
F	Landing Surface Characteristics		
F-1	Data On Behavior/Characteristics Of The Lunar Surface	Lunar Surface Observations	4-18
F-2	Lunar Soil Erosion From DPS Plume Impingement	Lunar Surface Observations	4-18
F-3	Effect of Any DPS Venting On The Lunar Surface	Lunar Surface Observations	4-18
G	Bulk Sample Collection		
G-1	Collect Rock Samples And Fine Grained Material	Surface Sample Collection	4-14
G-2	Photograph Collection Area of Samples	Surface Sample Collection	4-14
H	Landed LM Location		
H-1	Determine Location of Landed LM From LM Data	LM Descent	4-6
		Locate Landed LM	4-8
H-2	Determine Location of Landed LM From CSM Data	Locate Landed LM	4-8
H-3	Capability of Locating Landed LM In Real Time	LM Descent	
		Locate Landed LM	4-8
I	Lunar Environment Visibility		
I-1	Data On Landing Aids & Final Approach Visibility	LM Descent	4-6
I-2	Crew Performance of Visual Tacks On Lunar Surface	Lunar Surface EVA	4-12
J	Assessment of Contamination By Lunar Material		
J-1	Prevent Earth Contamination By Lunar Exposed Materials	Contamination Prevention	4-22
J-2	Minimize Crew/CM Contamination By Lunar Exposed Materials	Contamination Prevention	4-22
J-3	Lunar Sample For Quarantine Testing	Surface Sample Collection	4-14
K	Documented Sample Collection		
K-1	Obtain An Aseptic Sample of The Lunar Surface	Surface Sample Collection	4-14
K-2	Obtain A Core Sample of The Lunar Surface	Surface Sample Collection	4-14
K-3	Collect Lunar Geologic Samples	Surface Sample Collection	4-14
K-4	Collect A Lunar Environment Sample	Surface Sample Collection	4-14
K-5	Study and Describe Lunar Topography Features	Lunar Surface Observations	4-18

TABLE 4-2
TEST OBJECTIVE/MISSION ACTIVITY
CROSS REFERENCE

DTO/FTO NUMBER	TEST OBJECTIVE	MISSION ACTIVITY	SECTION PAGE NO.
L	Lunar Surface Structure Photography		
L-1	Close Up Stereo Photographs Of Undisturbed Surface Areas	Lunar Surface Observations	4-18
L-2	Close Up Stereo Photographs Of Imprinted Surface Areas	Lunar Surface Observations	4-18
L-3	Close Up Stereo Photographs Of Lunar Soiled Objects	External LM Observations	4-16
		Lunar Surface Observations	4-18
S-031	Lunar Passive Seismology	Experiment Deployment/Conduct	4-21
S-078	Laser Ranging Retro-Reflector	Experiment Deployment/Conduct	4-21
S-080	Solar Wind Composition	Experiment Deployment/Conduct	4-21

LM DESCENT

A. Test Objectives

I-1 Data On Landing Aids and Final Approach Visibility
H-1 Location of the Landed LM From LM Data
H-3 Capability of Locating The Landed LM In Real Time From LM/CSM/MSFN Data

B. Test Requirements

1. Determine landing site visibility, extent of washout and visibility of landing site landmarks. [I]

2. Photograph the landing site during the approach through the LM pilot's window with the data acquisition camera. [I, H]

3. Evaluate landing aids, i.e., Landing Point Designator, maps, photographs. [I]

4. Access visual phenomena during LM landing significantly different from expected. [I]

5. Voice anotate location and identity of features during final descent. [H]

6. Determine landing location in real time by description of terrain features during descent. [H]

C. Procedures/Checklist

1. Photographic Operations Plan.

D. Data Requirements

1. Flight Crew Reports/Logs/Photographs

   a. LM crew comments on landing site visibility during final approach and landing phases and on effectiveness of the Landing Point Designator and landing site recognition aids. [I] (M)

   b. GET at start of data acquisition camera photographs during LM final approach. [I] (M)

   c. Voice track regarding observations of surface features during the descent phase. [H] (M)

d. Data Acquisition Camera photographs of the landing site from high gate to touchdown. [I] (M)

e. Photographs of the landing site and surrounding lunar surface features taken through a LM window during descent. [H] (M)

f. Comments on any lunar dust observed during the final approach, the severity of the landing and vehicle stability after touchdown. [E] (M)

2. Ground Support

a. LM TM HBR. [H, I] (M)

b. LM TM LBR. [H] (M)

c. LM BET from DOI through touchdown. [H, I] (M)

d. MSFN tracking data of LM from acquisition of signal through touchdown. [H] (M)

Locate Landed LM

A. Test Objectives

H-1 Determine the Location of the Landed LM from LM Data
H-2 Determine the Location of the Landed LM from CSM Data
H-3 Determine Capability of Locating the Landed LM in Real Time from LM/CSM/MSFN Data.

B. Test Requirements

1. Correlate lunar surface features surrounding the landing site with photomaps and mark the LM location. [H]

2. Photograph terrain features thru the LM window and during EVA to correlate LM location. [H]

3. Obtain two sets of LM IMU alignments after landing. [H]

4. Provide TV coverage of prominent terrain features. [H]

5. Track the CSM with RR during one pass. [H]

6. Track the landed LM from the CSM during two orbital passes. Mark on a landmark near the landed LM. [H]

7. Obtain 70 MM photographs of the landed LM or its shadow and the surrounding lunar features. [H]

8. Assist MCCH in determining the landed LM location in real time. [H]

C. Procedures/Checklist

1. Photographic Operations Plan

2. LM AOH, "PGNCS Lunar Surface Align Program (P57)".

3. LM AOH, "Lunar Surface Navigation Program (P22)".

4. CSM AOH, "Orbital Navigation (P22)".

D. Data Requirements

1. Flight Crew Reports/Logs/Photographs

   a. Update lunar photomaps with estimate of the landed LM location. [H] (M)

b. Comments by LM crew regarding any difficulties encountered in estimating the location of the LM with respect to lunar surface features. [H] (HD)

c. Comments by CM crewman on location of landed LM with respect to prominent terrain features. [H] (M)

d. Obtain high resolution photographs of the landing area from the CSM. [H] (M)

e. Photographs of the landing site and surrounding lunar surface features taken through a LM window after landing. [H] (M)

f. Photographs of the landing site and surrounding lunar surface features taken during EVA. [H] (M)

g. Provide TV coverage of the lunar surface as viewed from the LM.

2. Ground Support

a. LM TLM HBR. [H] (M)

b. LM TLM LBR. [H] (M)

c. BET of CSM during the lunar surface phase. [H] (M)

d. Photographs of the landing area obtained during previous lunar missions. [H] (M)

Evaluate Support Equipment

A. Test Objectives

C-1 EMU Capability to Provide a Habitable Environment
C-2 EMU Effects on Crew Mobility/Dexterity/Comfort
C-3 Data/Voice Communications Capability During EVA

B. Test Requirements

1. Perform EMU checkout prior to all extravehicular activities. [C]

2. Donning, doffing and check-out of the EMU to be accomplished in accordance with the EVA procedures document. [C]

3. Egress to the lunar surface and ingress to the spacecraft to be accomplished in accordance with the EVA procedures document. [C]

4. Activities on the lunar surface to be accomplished in accordance with the Lunar Surface Operations. [C]

5. During EVA, communicate with MSFN via the EVA-LM-MSFN two way voice relay. [C]

C. Procedures/Checklist

1. EVA Procedures Document

2. Lunar Surface Operations Plan

D. Data Requirements

1. Flight Crew Reports/Logs/Photographs

a. Notify MSFN of the initial and final positions of the PLSS water diverter valve, primary oxygen shutoff valve and water shutoff/relief valve each time they are changed. [C] (M)

b. Notify MSFN when PLSS; High O_2 flowrate, low vent vent flow, low feed water pressure or PGA pressure low remote control unit status indicators and audible warning tone come on. [C] (M)

c. Record EMU radiation dosimeter readings just prior to and after completion of the EVA. [C] (M)

d. Notify MSFN if noxious odors occur or any condensation on the visor assembly. [C] (HD)

e. Comment on the adequacy of procedures and difficulties encountered during donning and doffing of EMU equipment. [C] (HD)

f. Comment on time required and adequacy of the EMU checkout procedures. [C] (HD)

g. Comment on the adequacy of EMU thermal environment when walking from a sunlit area to shadow or vice versa. [C] (M)

h. Comment on estimated energy expenditure and comfort as compared to simulation experience. [C] (HD)

i. Comment on voice quality for EVA-EVA and EVA-LM-MSFN communications. [C] (M)

2. Ground Support

a. LM TM FM [C] (M)

b. Flight Directors Post Mission Report [C] (M)

c. MSFN recording of EVA-LM-MSFN voice. [C] (M)

Lunar Surface EVA

A. Test Objectives

B-1 Demonstrate Egress-to/Ingress-from the Lunar Surface
B-2 Evaluate Crew Lunar Surface EVA Capability
D-1 TV Coverage of An Astronaut Descending to the Lunar Surface
D-5 TV Coverage of Astronaut Activities on the Lunar Surface
I-2 Crew Performance of Visual Tasks on the Lunar Surface

B. Test Requirements

1. The MESA pallet with pre-mounted TV camera will be released and camera power turned on prior to the astronaut's descent to the lunar surface. [D]

2. Perform lunar surface EVA operations in accordance with the Lunar Surface Operations Plan. [B]

3. Deploy and set the TV camera to provide TV coverage of the lunar surface EVA activity. [D]

4. While on the lunar surface, view and take still photographs of the terrain at various azimuths with respect to the sun including 0, 90, and 180 degrees and comment on ability to see terrain features in these areas. [I]

5. Estimate the distance to prominent terrain features within the field of view of photographs taken. [I]

C. Procedures/Checklist

1. EVA Procedures Document

2. Lunar Surface Operations Plan

D. Data Requirements

1. Flight Crew Reports/Logs/Photographs

   a. Provide data on the adequacy of hardware and procedures, and the time required to perform the egress from the LM, the lunar surface EVA operations and the ingress to the LM. [B] (M)

   b. Provide sequence camera coverage and TV camera coverage of: [C] (HD)

      1) A crew memeber descending to the lunar surface.

      2) A crew member walking on the lunar surface.

      3) A crew member performing lunar surface EVA operations.

      4) A crew member ascending the LM ladder.

c. Provide still camera coverage of an astronaut performing lunar surface EVA operations. [C] (HD)

d. Report condition of the two temperature indicator viewing ports on the TV camera after removal from the MESA and at the end of the TV operations. [D] (M)

e. Report position of the TV camera scan rate switch at start of each TV operations. [D] (M)

f. Comments on the visibility of the lunar terrain as a function of the sun/viewing angle and on their ability to perform visual tasks while on the lunar surface. [I] (M)

g. Comments on color/contrast perception. [I] (M)

h. Comments on and significant unexpected visual phenomena. [I] (M)

i. Estimate of distance to at least one prominent terrain feature within the field of view of the photographs in item j below. [I] (M)

j. Photograph the lunar terrain at various sun azimuths to include 0 degrees, 90 degrees, and 180 degrees. [I] (M)

k. Photograph any unexpected visual phenomena. [I] (HD)

2. Ground Support

a. LM TM FM [B] (HD)

b. Ground recorded TV signals. [B] (HD)

c. LM TM LBR [D] (HD)

d. Post-scan conversion video tape of all TV coverage. [D] (M)

e. Record of S-band signal strength during video transmission. [D] (HD)

f. Flight Directors Post Mission Report. [D] (M)

g. Estimate of incident illumination. [D] (M)

h. LM position on lunar surface. [I] (HD)

Surface Sample Collection

A. Test Objectives

A-1 Provide A Contingency Lunar Surface Sample
G-1 Collect Rock Samples and Fine Grained Material
G-2 Photograph Collection Area of Samples
J-3 Obtain A Lunar Sample for Quarantine Testing
K-1 Obtain An Aseptic Sample of the Lunar Surface
K-2 Obtain A Core Sample of the Lunar Surface
K-3 Collect Lunar Geologic Samples
K-4 Collect A Lunar Environment Sample

B. Test Requirements

1. Obtain a contingency sample upon first descending to the lunar surface. [A]

2. Obtain 30 pounds of bulk material consisting of 1/3 fragmentary and 2/3 loose samples. [G,K]

3. Photograph sample areas. [A, G, K]

4. Obtain a biologically clean sample from beneath the lunar surface with the aseptic sampler tool. [K]

5. Obtain a core sample with the driver tube. [K]

6. Obtain geologic samples using tools stowed in the MESA. [K]

7. The lunar environment sample (representative of the bulk sample) shall be sealed in the special gas analysis container. [K]

C. Procedures/Checklist

1. Lunar Landing Mission Flight Plan

2. Lunar Surface Photographic Operations Plan

D. Data Requirements

1. Flight Crew Reports/Logs/Photographs

   a. Record areas in relation to LM where samples were collected. [A,G,K] (M)

   b. Record unusual lunar surface observations. [A,G,K] (M)

   c. Take sequence photographs during sample collection. [A,G] (HD)

   d. Photograph the lunar surface sample areas and of the samples as defined in the Photographic Operations Plan. [K] (M)

e. Provide Lunar Surface TV coverage. [K] (HD)

2. Ground Support

a. Sample analysis in (LRL) Lunar Receiving Laboratory. [A,G,J,K] (M)

b. Flight Directors Post Mission Report. [K] (M)

c. MSFN recordings of all MSFN/EVA voice conferences. [K] (M)

External LM Observations

A. Test Objectives

D-2 TV Coverage of External Landed LM
E-1 Effects of Landing On LM Landing Gear
E-2 Effects of Landing On LM Structure and Components
E-3 Descent Engine Skirt Damage and Clearance After Landing
E-4 Effects of RCS Plume Impingement on LM Structure and Components
L-3 Close Up Stereo Photographs of Lunar Soiled Objects

B. Test Requirements

1. Operate the TV camera to provide an external view of the LM. [D]

2. Photograph any observed LM external structural damage. [E]

3. Determine descent engine skirt ground clearance. [E]

4. Photograph any effects of RCS plume impingement observed. [E]

5. Obtain photographs of any lunar material collected on the LM.[E]

C. Procedures/Checklist

1. Mission G-1 Lunar Landing Phase Photographic Operations Plan.

D. Data Requirements

1. Flight Crew Reports/Logs/Photographs

   a. Comment on any LM component damage to include any visible discoloration or lunar soil accumulation. [E] (M)

   b. Comments describing any descent engine skirt damage and an estimate of any skirt ground clearance. [E] (M)

   c. If the landing gear strut assembly photographs cannot be obtained, estimate the amount of stroking of each primary and secondary strut assembly. [E] (M)

   d. Comments on LM foot pad-lunar soil interactions to include estimates of the amount of penetration, soil displacement and foot pad skidding. [E] (M)

   e. Photograph the landing gear to show the stroking of the primary and secondary strut assemblies. [E] (M)

   f. Photograph the LM exterior showing any structural damage. [E] (M)

   g. Photograph each landing gear assembly along the Z axis and the Y axis. [E] (HD)

h. Photograph the descent engine skirt. [E] (HD)

i. Photograph the LM base heat shield. [E] (HD)

j. Photograph the LM exterior,i.e., structure antenna, RCS jets, windows and foot pads. [E] (HD)

k. Photograph soil accumulation on the LM. [E] (HD)

l. Photograph each LM foot pad and surrounding lunar soil exhibiting evidence of LM foot pad-lunar soil interaction. [E] (HD)

m. Comments as to the tendency of the lunar surface material to collect on the LM. [L] (HD)

2. Ground Support

a. LM TM LBR [D] (HD), [E] (M)

b. Flight Directors Post Mission Report. [D] (M)

c. LM TM HBR [E] (M)

d. LM Mass, center of gravity and mass moment of inertia calculations. [E] (M)

Lunar Surface Observations

A. Test Objectives

D-3 TV Coverage of Lunar Surface Near LM
D-4 TV Panoramic Coverage of Distant Terrain Features
F-1 Behavior and Characteristics of the Lunar Surface
F-2 Erosion of Lunar Surface by DPS Plume Impingement
F-3 Effect of Any DPS Venting On The Lunar Surface
K-5 Study and Description of Lunar Topography Features
L-1 Close Up Stereo Photographs of Undistrubed Surface Areas
L-2 Close Up Stereo Photographs of Imprinted Surface Areas
L-3 Close Up Stereo Photographs of Lunar Soiled Objects

B. Test Requirements

1. Provide TV coverage of the lunar surface in the vicinity of the LM and panoramic scenes of distant terrain features. [D]

2. Observe lunar surface characteristics including texture, consistency, compressibility, cohesiveness, density and color. [F]

3. Study and photograph the mechanical behavior of the lunar surface from interactions of LM foot pad, astronauts boots and equipment foot pad with the lunar soil, erosion by DPS plume impingement and DPS venting. [F,L]

4. Describe and photograph field relationships such as shape, size, range, pattern of alignment or distribution of all accessible types of lunar topographic features. [K]

5. Photograph the structure of lunar surface material in its natural state. [L]

C. Procedures/Checklist

1. Mission G-1 Lunar Landing Phase Photographic Operations Plan.

D. Data Requirements

1. Flight Crew Reports/Logs/Photographs

a. Report condition of the two temperature indicator viewing ports on the TV camera at the end of the TV operations. [D] (M)

b. Position of the TV camera scan rate switch at start of each TV operation. [D] (M)

c. Comments on LM foot pad-lunar soil interactions to include estimates of the amount of penetration, soil displacement and foot pad skidding. [F] (M)

d. Comments describing the interaction between astronaut boots and lunar surface while walking. [F] (M)

e. Comments on slope and roughness characteristics of the landing terrain to include descriptions of craters, depressions, embankments or other obstacles. [F] (M)

f. Comments on the color and texture of both undisturbed and mechanically disturbed areas of the lunar surface. [F] (M)

g. Comments on lunar soil conditions adjacent to DPS vents to include any discoloration. [F] (M)

h. Comments describing the lunar surface penetration by the Solar Wind Composition Staff and core sample tool under their own weight and the estimated force. [F] (M)

i. Comments on lunar soil erosion as caused by the DPS plume impingement during landing. [F] (M)

j. Record vent valves opened. [F] (M)

k. Comment on soil behavior during collection of samples. [F] (M)

l. Photograph the lunar surface showing DPS plume impingement erosive effects. [F] (M)

m. Photograph each LM foot pad and surrounding lunar soil exhibiting evidence of LM foot pad-lunar soil interaction. [F] (M)

n. Photograph the lunar surface adjacent to DPS vents if soil discoloration is observed. [F] (M)

o. Photograph an astronaut footprint showing interaction between astronaut boots and lunar surface. [F] (M)

p. Photograph the Solar Wind Composition Experiment Staff and core sampling tool after being inserted to their maximum depth as penetrometers. [F] (HD)

q. Photograph the natural slopes, crater walls and embankments in the vicinity of the landing site. [F] (M)

r. Photograph from the CSM the lunar surface surrounding the LM. [F] (HD)

s. Photograph a representative depression caused by use of the scoop in collecting fine grained fragmental material. [F] (M)

t. Photograph one scoop of fine grained fragmental material placed in one of the pre-numbered bags. [F] (HD)

u. Designate the specific location of each area or object photographed. [L] (M)

v. Comment on the change in appearance of the surface layer when crushed or disturbed. [L] (HD)

w. Comment as to the tendency of the lunar surface material to collect on the camera, LM or helmet visor. [L] (HD)

2. Ground Support

a. LM TM LBR [D,F] (HD)

b. Flight Director's Post Mission Report. [D] (M)

c. Estimate of incidence illumination. [D] (M)

d. LM TM HBR [F] (HD)

Experiment Deployment/Conduct

A. Test Objectives

S-031 Deploy the Passive Seismic Experiment Package
S-078 Deploy the Laser Ranging Retro-Reflector Experiment
S-080 Conduct the Solar Wind Composition Experiment

B. Test Requirements

1. Emplace, level and orient the Passive Seismic Experiment Package (PSEP). Deploy the solar panels and aim the antenna at the earth. Activate the PSEP. [S-031]

2. Photograph the deployed PSEP and deployment area. [S-031]

3. Remove the Laser Ranging Retro-Reflector (LRRR) from the descent stage and carry it to the deployment site. [S-078]

4. Emplace, level and orient the LRRR and adjust it to the calibration marks corresponding to the landing site. [S-078]

5. Remove the Solar Wind Composition Experiment from the LM MESA and deploy it on the lunar surface. [S-080]

6. After one hour operation, disassemble the Solar Wind Composition Experiment, place the reel and foil in a teflon bag and store in a sample return cortainer. [S-080]

C. Procedures/Checklist

None

D. Data Requirements

1. Flight Crew Rports/Logs/Photographs

   a. Comment on deployment and activation of experiments. [S-031, S-078, S-080] (M)

   b. Photograph deployment area. [S-031, S-078, S-080] (M)

   c. Comment on location of deployed experiment with respect to the LM, attitude of deployed foil with respect to the sun and total time foil was deployed. [S-080] (M)

   d. Retrieve reel and foil from the Solar Wind Composition Experiment. [S-080] (M)

   e. Comments on orientation and elevation setting used for deployment. [S-078] (HD)

2. Ground Support

   a. Experiment TLM Data [S-301, S-078] (M)

Contamination Prevention

A. Test Objectives

J-1 Prevent Earth Contamination by Lunar Exposed Materials
J-2 Minimize Crew/CM Contamination by Lunar Exposed Materials

B. Test Requirements

1. All contamination related operations from the initial astronaut egress to the lunar surface until postflight crew/cm quarantine will be completed per procedures contained in the documents listed below. [J]

C. Procedures/Checklist

1. Lunar Surface Operations Plan

2. EVA Procedures Document

3. Quarantine Procedures

D. Data Requirements

1. Flight Crew Reports/Logs/Photographs

   a. Crew comments on the adequacy of Biological Isolation Garment, sample return containers, Mobile Quarantine Facility and related equipment and procedures used to prevent back contamination. [J] (M)

   b. Photograph boots, clothing and equipment showing adhesion of particles. [J] (HD)

2. Ground Support

   a. Deliver samples, CM and Mobile Quarantine Facility to the Lunar Receiving Laboratory. [J] (M)

   b. Comment on ground procedures and hardware used for retrieval, biological isolation and CM transfer to the Lunar Receiving Laboratory. [J] (M)

   c. Report on the existance of contamination of the crew on CM. [J] (M)

SECTION V - CONSUMABLES ANALYSIS

NOTE

Acknowledgement is made to the Consumables Analysis Section (CAS) of the Mission Planning and Analysis Division (MPAD) for their work in the preparation of the consumable analysis presented herein and to the Crew Systems Division for the PLSS Consumables.

RCS Propellant Usage

Table 5-1 shows RCS propellant usage in pounds for the CSM and LM at various spacecraft weights and maneuver rates. Rates given for the CSM are 0.2^{o}/sec and 0.5^{o}/sec and for the LM are 0.5^{o}/sec and 2^{o}/sec. The left columns are for 1-axis, 180^{o} maneuvers and the right columns for 3-axis, 180^{o} maneuvers.

Table 5-2 gives CSM RCS propellant usage for +x translation maneuvers at various S/C weights and for 2-jet, 20 second and 4 jet, 15 second ullage maneuvers.

Table 5-3 gives CSM RCS propellant usage rates for attitude holds at various S/C weights and deadbands. The usage is given in lbs/hour for 3-axis and 2-axis holds.

TABLE 5-1 RCS PROPELLANT USAGE - LBS/MANEUVER

SPACECRAFT MANEUVERS

CSM (GNCS)				
1-AXIS (180°)		3-AXIS (180°)		S/C WT IN LBS
0.2°/SEC	0.5°/SEC	0.2°/SEC	0.5°/SEC	
2.2	5.6	3.2	7.7	94,000
1.7	4.5	2.5	6.0	70,000
1.0	2.5	1.5	3.4	47,600
0.3	0.9	0.75	1.3	38,000
0.3	0.75	0.7	1.2	28,600
LM (AGS)				
0.5°/Sec	2°/Sec	0.5°/Sec	2°/Sec	
0.4	1.3	0.8	2.6	31,000
0.2	0.75	0.4	1.5	8,400
0.2	0.7	0.4	1.4	8,000

TABLE 5-2 CSM G&N RCS TRANSLATION

20 SEC, 2 JET ULLAGE	14.0 LBS.	N/A
15 SEC, 4 JET ULLAGE	19.4 LBS	N/A
1 FPS +X TRANSLATION	10.7 LBS.	94,000
1 FPS +X TRANSLATION	8.0 LBS	70,000
1 FPS +X TRANSLATION	4.3 LBS	38,000
1 FPS +X TRANSLATION	3.3 LBS.	28,600

TABLE 5-3 G&N RCS ATTITUDE HOLD PROPELLANT USAGE RATES (LBS/HR)

0.5^{o} DEADBAND		5.0^{o} DEADBAND		10.0^{o} DEADBAND		S/C WT IN LBS
3-AXIS	2-AXIS P & Y	3-AXIS	2-AXIS P & Y	3-AXIS	2-AXIS P & Y	
0.066	0.011	0.0066	0.001	0.0033	0.0005	98,000
0.216	0.152	0.022	0.015	0.011	0.007	94,000
1.015	0.195	0.10	0.020	0.05	0.01	70,000
2.04	1.01	2.20	0.101	0.10	0.05	64,000
1.95	0.55	0.20	0.055	0.10	0.028	45,600
3.0	1.3	0.30	0.13	0.15	0.065	37,600

NOTE: 3-Axis is for 2 adjacent quads
2-Axis is for 2 opposite quads

AS-506/CSM-107/LM5 PROPELLANT BUDGET

The results of the Propellant Budget Analysis are summarized in the following Tables and Figures:

TABLE 5-4 SM RCS Propellant Loading And Usage Summary

TABLE 5-5 SM RCS Budget

TABLE 5-6 SPS Propellant Loading & Usage Summary

TABLE 5-7 LM RCS Propellant Loading And Usage Summary

TABLE 5-8 LM RCS Budget

TABLE 5-9 DPS Propellant Loading And Usage Summary

TABLE 5-10 APS Propellant Loading And Usage Summary

FIGURE 5-1 Total SM RCS Propellant Profile

FIGURE 5-2 Quads A&C SM RCS Propellant Profile

FIGURE 5-3 Quads B&D SM RCS Propellant Profile

FIGURE 5-4 Total LM RCS Propellant Profile

SM-RCS BUDGET

GROUND RULES & ASSUMPTIONS

1. The transposition and docking phase of the mission includes an SPS evasive maneuver.

2. The first and third midcourse corrections (translunar) are executed as SPS burns with the third MCC followed by an RCS trim.

3. Passive thermal control is assumed to be in the PGNCS wide deadband control mode and to require 1 lb/hr (as compared to 1.1 - 1.7 on Apollo 8 in the SCS control mode).

4. The sixth midcourse correction (transearth) is executed as an RCS burn of 5 fps.

TABLE 5-4 SM RCS PROPELLANT LOADING AND USAGE SUMMARY

Nominal loaded			1342.4 lb
Initial outage due to loaded mixture ratio			15.6
Total trapped			26.4
Gauging inaccuracy			80.4
Deliverable SM-RCS propellant			1220.0
Nominal usage			681
Translunar phase		351	
o Transposition and docking	110		
o Midcourse corrections	38		
o Passive thermal control	76		
o Other	97		
Lunar orbit phase (LOI-TEI inclusive)		215	
o Docked CSM activities	74		
o Undocked CSM activities	141		
Transearth Phase		104	
o Midcourse corrections	23		
o Passive thermal control	61		
o Other			
Outage due to mission duty cycle mixture ratio		41	
Nominal remaining			489 lb

TABLE 5-5
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
.0	MISSION G	63579.	.0	1342.4	100.
.0	SM RCS CHECKOUT	63574.	5.8	1336.6	100.
.7	IMU ALIGN	63573.	1.0	1335.6	99.
3.2	TRANSPOSITION AND DOCKING -X 0.8 FPS	63567.	6.1	1329.5	99.
3.2	+X 0.3 FPS	63564.	2.5	1327.0	99.
3.2	PITCH TO ACQUIRE SIVB PITCH 180 DEG AT 1.5 DEG/SEC	63562.	2.3	1324.8	99.
3.2	NULL RELATIVE DEL V 0.5 FPS	63558.	4.0	1320.8	98.
3.2	FORMATION FLYING AND SYSTEMS FAMILIARIZATION	63528.	29.8	1291.0	96.
3.4	VISUAL INSPECTION OF SLA	63527.	1.0	1289.9	96.
3.4	FLY TO DOCKING INTERFACE	63523.	3.8	1286.1	96.
3.4	NULL DEL VEL .4 FPS	63520.	3.2	1282.9	96.
3.4	ROLL CSM 60 DEG 2 DEG/SEC	63519.	1.3	1281.6	95.
3.5	INDEX AND DOCK	63463.	56.0	1225.6	91.
4.2	LM EJECTION -X 5 SEC 4 JET	96051.	7.4	1218.2	91.
4.3	OBSERVE SIVB 0.2 DEG/SEC PGNCS	96047.	4.2	1214.0	90.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
4.5	SPS BURN TO EVADE SIVB ORIENT AT 0.2 DEG/SEC	96043.	4.2	1209.8	90.
4.5	ATTITUDE HOLD 0.5 DEG DB PGNCS	96042.	.8	1209.0	90.
4.5	SPS BURN BUILD UP	96039.	.0	1209.0	90.
4.5	STEADY STATE BURN	95841.	.3	1208.7	90.
4.5	TAILOFF	95800.	.6	1208.1	90.
4.5	DAMP SHUTDOWN TRANSIENT	95799.	1.1	1207.0	90.
5.5	PS2 IMU ALIGN	95795.	4.2	1202.8	90.
5.9	NAVIGATION SIGHTINGS ORIENT AT 0.2 DEG/SEC	95790.	4.2	1198.6	89.
6.1	NAVIGATION SIGHTINGS ORIENT AT 0.2 DEG/SEC	95786.	4.2	1194.3	89.
6.3	NAVIGATION SIGHTINGS ORIENT AT 0.2 DEG/SEC	95782.	4.2	1190.1	89.
6.3	MIN. IMPULSE MARKING	95778.	4.3	1185.8	88.
7.0	ORIENT FOR PTC 3AXIS 0.2 DEG/SEC	95774.	4.0	1181.8	88.
7.0	ATTITUDE HOLD 0.5 DEG DB PGNCS	95773.	.8	1181.0	88.
7.0	ROLL 0.1 DEG/SEC	95773.	.2	1180.8	88.
7.0	PITCH AND YAW CONTROL	95769.	3.5	1177.3	88.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
10.7	P52 IMU ALIGN	95765.	4.2	1173.1	87.
11.2	MIDCOURSE CORRECTION NO 1 3 AXIS ORIENT PGNCS	95761.	4.2	1168.9	87.
11.2	ATTITUDE HOLD 0.5 DEG DB PGNCS	95760.	.8	1168.1	87.
11.2	START TRANSIENT CONTROL	95759.	1.3	1166.8	87.
11.2	SPS BURN BUILD UP	95756.	.0	1166.8	87.
11.2	STEADY STATE BURN 3 FPS PGNCS	95720.	.1	1166.7	87.
11.2	TAILOFF	95679.	.8	1165.9	87.
11.2	DAMP SHUT.DOWN TRANSIENT	95678.	1.1	1164.8	87.
12.0	P52 IMU ALIGN	95674.	4.2	1160.6	86.
12.5	ORIENT FOR PTC 3AXIS 0.2 DEG/SEC	95670.	4.1	1156.5	86.
12.5	ATTITUDE HOLD 0.5 DEG DB PGNCS	95669.	.8	1155.7	86.
12.5	ROLL 0.1 DEG/SEC	95669.	.2	1155.6	86.
12.5	PITCH AND YAW CONTROL	95659.	10.0	1145.6	85.
22.5	P52 IMU ALIGN	95655.	4.2	1141.3	85.
23.0	CISLUNAR NAVIGATION STAR/EARTH HORIZON ORIENT	95650.	4.2	1137.1	85.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
23.2	NAVIGATION SIGHTINGS ORIENT AT 0.2 DEG/SEC	95646.	4.2	1132.9	84.
23.4	NAVIGATION SIGHTINGS ORIENT AT 0.2 DEG/SEC	95642.	4.2	1128.7	84.
23.4	MIN. IMPULSE MARKING	95638.	4.3	1124.4	84.
25.8	P52 IMU ALIGN	95633.	4.2	1120.1	83.
26.6	MIDCOURSE CORRECTION NO 2 MNVR TO BURN ATT	95629.	4.2	1115.9	83.
26.6	ATTITUDE HOLD 0.5 DEG DB PGNCS	95628.	.8	1115.1	83.
26.7	DELTA VEL = NOMINALLY ZERO	95628.	.0	1115.1	83.
27.0	ORIENT FOR PTC 3AXIS 0.2 DEG/SEC	95624.	4.1	1111.0	83.
27.0	ATTITUDE HOLD 0.5 DEG DB PGNCS	95623.	.8	1110.2	83.
27.0	ROLL 0.1 DEG/SEC	95623.	.2	1110.1	83.
27.0	PITCH AND YAW CONTROL	95613.	10.0	1100.1	82.
37.0	PITCH AND YAW CONTROL	95604.	9.0	1091.1	81.
46.0	PITCH AND YAW CONTROL	95597.	7.0	1084.1	81.
53.0	P52 IMU ALIGN	95593.	4.2	1079.9	80.
53.6	MIDCOURSE CORRECTION NO 3 MNVR TO BURN ATT	95589.	4.3	1075.6	80.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM_RCS USED (LBS)	SM_RCS LEFT (LBS)	SM_ RCS LEFT (%)
53.6	ATTITUDE HOLD 0.5 DEG DB PGNCS	95588.	.8	1074.8	80.
53.6	START TRANSIENT CONTROL	95587.	1.3	1073.5	80.
53.6	SPS BURN BUILD UP	95584.	.0	1073.5	80.
53.6	STEADY STATE BURN 3 FPS	95548.	.1	1073.4	80.
53.6	TAILOFF	95507.	.8	1072.6	80.
53.6	DAMP SHUT.DOWN TRANSIENT	95506.	1.1	1071.5	80.
53.6	RCS TRIM 1 FPS	95495.	11.1	1060.5	79.
54.0	ORIENT FOR PTC 3AXIS 0.2 DEG/SEC	95491.	4.1	1056.4	79.
54.0	ATTITUDE HOLD 0.5 DEG DB PGNCS	95490.	.8	1055.6	79.
54.0	ROLL 0.1 DEG/SEC	95490.	.2	1055.4	79.
54.0	PITCH AND YAW CONTROL	95484.	6.0	1049.4	78.
60.0	PITCH AND YAW CONTROL	95474.	10.0	1039.4	77.
70.0	PS2 IMU ALIGN	95470.	4.3	1035.2	77.
70.5	MIDCOURSE CORRECTION NO 4 MNVR TO BURN ATT	95465.	4.3	1030.9	77.
70.5	ATTITUDE HOLD 0.5 DEG DB PGNCS	95465.	.8	1030.1	77.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
70.5	DEL VEL = NOM ZERO	95465.	.0	1030.1	77.
72.7	PS2 IMU ALIGN	95460.	4.3	1025.8	76.
74.7	PS2 IMU ALIGN	95456.	4.3	1021.6	76.
75.5	LUNAR ORBIT INSERTION BURN 1 3-AXIS ORIENT PGNCS	95452.	4.3	1017.3	76.
75.5	ATTITUDE HOLD 0.5 DEG DB PGNCS	95451.	.8	1016.5	76.
75.5	START TRANSIENT CONTROL	95450.	1.3	1015.2	76.
75.9	LOI BURN BUILD UP	95447.	.0	1015.2	76.
75.9	STEADY STATE BURN	71795.	.5	1014.7	76.
75.9	TAILOFF	71755.	.0	1014.7	76.
75.9	DAMP SHUT DOWN TRANSIENT	71754.	1.1	1013.6	76.
77.5	PS2 IMU ALIGN	71750.	3.5	1010.0	75.
79.2	PS2 IMU ALIGN	71747.	3.5	1006.5	75.
80.0	LOI 2 LPO CIRC MNVR TO BURN ATT	71743.	3.5	1002.9	75.
80.0	ATTITUDE HOLD 0.5 DEG DB PGNCS	71742.	.8	1002.2	75.
80.0	ULLAGE 2 JET B AND D QUADS	71728.	14.6	987.6	74.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
80.1	SPS BURN BUILD UP	71725.	.0	987.6	74.
80.1	STEADY STATE BURN	70754.	.2	987.4	74.
80.1	TAILOFF	70714.	.0	987.4	74.
80.1	DAMP SHUTDOWN TRANSIENT	70713.	1.1	986.3	73.
80.4	REACQUIRE MSFN ROLL 0.2 DEG/SEC	70713.	.2	986.1	73.
82.3	MNVR TO LDG SITE OBS ATT	70709.	3.4	982.7	73.
82.3	LDG SITE OBSERVATION	70709.	.4	982.2	73.
82.3	MANEUVER TO LOOK SEE ATTITUDE	70705.	3.5	978.8	73.
83.1	P52 IMU ALIGN	70702.	3.5	975.3	73.
83.1	REACQUIRE MSFN	70702.	.2	975.1	73.
85.0	MANEUVER TO SLEEP ATTITUDE 3 AXIS 0.2 DEG/SEC	70698.	3.5	971.6	72.
85.0	REACQUIRE MSFN	70698.	.2	971.4	72.
85.0	WIDE DEADBAND ATTITUDE HOLD	70684.	14.3	957.2	71.
94.5	REACQUIRE MSFN	70684.	.2	957.0	71.
95.1	MNVR TO ALIGN ATT	70680.	3.5	953.5	71.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
96.5	MNVR TO LDG SITE OBS ATT	70677.	3.5	950.0	71.
96.5	LDG SITE OBSERVATION	70676.	.4	949.6	71.
96.9	REACQUIRE MSFN ROLL 0.2 DEG/SEC	70676.	.1	949.5	71.
97.7	ORIENT TO UNDOCKING ATTITUDE ROLL 0.2 DEG/SEC	70676.	.2	949.3	71.
98.2	CSM ACTIVE UNDOCK SEP AND NULL VEL 0.5 FPS	38075.	4.7	944.7	70.
98.2	FORMATION FLYING	38065.	10.0	934.7	70.
98.2	REACQUIRE MSFN	38065.	.3	934.3	70.
98.6	ORIENT FOR SEP BURN	38063.	1.8	932.6	69.
98.7	RCS SEPARATION BURN 2.5 FPS	38052.	11.2	921.4	69.
98.8	MANEUVER TO SXT AND VHF TRACKING 3 AXIS 0.5 DEG/SEC	38050.	1.8	919.6	69.
99.0	P52 IMU ALIGN	38049.	.8	918.8	68.
99.6	MANEUVER TO SXT TRACKING	38048.	1.7	917.1	68.
100.4	REACQUIRE MSFN ROLL 0.5 DEG/SEC	38047.	.3	916.8	68.
100.5	MANEUVER TO SXT TRACKING	38046.	1.7	915.1	68.
101.0	P52 IMU ALIGN	38045.	.8	914.3	68.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
102.3	MNVR TO LDG SITE OBS ATT	38044.	.8	913.6	68.
102.3	LDG SITE OBS	38044.	.4	913.1	68.
102.7	TRACK LM	38042.	1.7	911.4	68.
102.9	REACQUIRE MSFN ROLL 0.5 DEG/SEC	38042.	.3	911.1	68.
103.0	P52 IMU ALIGN	38040.	1.7	909.4	68.
104.3	REACQUIRE MSFN ROLL 0.5 DEG/SEC	38040.	.3	909.1	68.
105.0	PLANE CHANGE MNVR TO BURN ATT	38038.	1.8	907.4	68.
105.0	ATTITUDE HOLD 0.5 DEG DB PGNCS	38037.	.8	906.6	68.
105.0	ULLAGE 2 JET B AND D	38023.	13.9	892.6	66.
105.1	SPS BURN BUILD UP	38020.	.0	892.6	66.
105.1	STEADY STATE	37953.	.1	892.5	66.
105.1	TAILOFF	37911.	1.0	891.5	66.
105.1	DAMP SHUTDOWN TRANSIENT	37910.	1.1	890.4	66.
105.3	P52 IMU ALIGN	37909.	.8	889.6	66.
105.3	MANEUVER TO SLEEP ATTITUDE	37908.	1.7	887.9	66.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
109.5	MANEUVER TO LOOK SEE ATTITUDE	37906.	1.7	886.2	66.
114.5	MANEUVER TO SLEEP ATTITUDE	37904.	1.7	884.5	66.
118.7	PS2 IMU ALIGN	37904.	.8	883.7	66.
120.1	ORIENT FOR SEXTANT TRACKING	37903.	.8	883.0	66.
120.1	SEXTANT TRACKING	37901.	1.3	881.7	66.
120.1	REACQUIRE MSFN	37901.	.1	881.6	66.
122.5	MANEUVER TO SUPPORT LM LIFTOFF	37901.	.8	880.8	66.
122.5	MIN IMPULSE CONTROL	37899.	1.3	879.5	66.
123.5	MNVR TO BURN ATT	37898.	1.7	877.8	65.
123.5	ATTITUDE HOLD 0.5 DEG DB PGNCS	37897.	.8	877.0	65.
123.7	REACQUIRE LM	37895.	1.7	875.3	65.
123.7	MINIMUM IMPULSE CONTROL	37893.	2.2	873.1	65.
123.7	ATTITUDE HOLD 0.5 DEG DB PGNCS	37892.	.8	872.4	65.
124.0	MNVR TO RNDZ TRACKING ATT	37890.	1.7	870.7	65.
124.0	MINIMUM IMPULSE CONTROL	37888.	2.2	868.5	65.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
124.4	MNVR TO BURN ATT	37887.	1.7	866.8	65.
124.4	RNDZ NAV	37885.	1.7	865.1	64.
124.4	MINIMUM IMPULSE CONTROL	37883.	1.7	863.4	64.
124.4	ATTITUDE HOLD 0.5 DEG DB PGNCS	37882.	.8	862.6	64.
124.6	RNDZ NAV	37881.	1.7	860.9	64.
124.6	MINIMUM IMPULSE CONTROL	37877.	3.9	857.0	64.
124.6	ATTITUDE HOLD 0.5 DEG DB PGNCS	37876.	.8	856.2	64.
124.6	ATT HOLD	37873.	3.0	853.2	64.
124.6	REINITIATE RNDZ NAV	37871.	1.7	851.5	63.
124.6	MINIMUM IMPULSE CONTROL	37869.	2.2	849.4	63.
124.6	ATT HOLD	37867.	2.2	847.2	63.
124.9	MNVR TO BURN ATT	37865.	1.7	845.5	63.
125.0	RNDZ NAV	37864.	1.7	843.7	63.
125.1	MANEUVER TO COAS TRACK	37862.	1.7	842.0	63.
125.5	ORIENT TO DOCKING ATTITUDE	37860.	1.7	840.3	63.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
125.7	MAINTAIN BORESIGHT	37858.	1.7	838.6	62.
126.0	DOCKING	43520.	2.5	836.1	62.
127.7	MNVR TO JETTISON ATT	43519.	1.2	834.8	62.
128.0	JETTISON LM 1 FPS	37850.	4.6	830.3	62.
128.0	ORIENT TO TRACKING ATT	37848.	1.7	828.5	62.
128.0	TRACK LM	37848.	.4	828.1	62.
128.6	HOLD INERTIAL ATT	37847.	.4	827.7	62.
129.0	PS2 IMU ALIGN	37846.	1.7	825.9	62.
130.5	PS2 IMU ALIGN	37845.	.8	825.2	61.
130.5	SXT STAR CHECK	37845.	.4	824.8	61.
131.3	TRANS-EARTH INJECTION MNVR TO BURN ATT	37843.	1.7	823.1	61.
131.3	ATTITUDE HOLD 0.5 DEG DB PGNCS	37842.	.8	822.3	61.
131.3	ULLAGE 2 JET B AND D	37828.	13.9	808.4	60.
131.5	SPS BURN BUILD UP	37825.	.0	808.4	60.
131.5	STEADY STATE SPS BURN	27785.	.3	808.1	60.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
131.5	TAILOFF	27745.	.0	808.1	60.
131.5	DAMP SHUTDOWN TRANSIENT	27744.	1.1	807.0	60.
132.0	P52 IMU ALIGN	27742.	1.5	805.5	60.
133.5	ORIENT FOR PTC 3AXIS 0.2 DEG/SEC	27741.	.6	804.9	60.
133.5	ATTITUDE HOLD 0.5 DEG DB PGNCS	27741.	.8	804.1	60.
133.5	ROLL 0.1 DEG/SEC	27741.	.1	804.0	60.
133.5	PITCH AND YAW CONTROL	27734.	6.5	797.5	59.
140.0	PITCH AND YAW CONTROL	27727.	7.5	790.0	59.
147.6	P52 IMU ALIGN	27725.	1.5	788.6	59.
148.5	MIDCOURSE CORRECTION NO 5 MNVR TO BURN ATT	27724.	1.5	787.1	59.
148.5	ATTITUDE HOLD 0.5 DEG DB PGNCS	27723.	.8	786.3	59.
148.5	DEL VEL = NOM ZERO	27723.	.0	786.3	59.
148.7	ORIENT FOR PTC 3AXIS 0.2 DEG/SEC	27722.	.7	785.7	59.
148.7	ATTITUDE HOLD 0.5 DEG DB PGNCS	27721.	.8	784.9	58.
148.7	ROLL 0.1 DEG/SEC	27721.	.1	784.8	58.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
148.7	PITCH AND YAW CONTROL	27713.	8.3	776.5	58.
156.0	PITCH AND YAW CONTROL	27706.	7.5	769.0	57.
163.5	PITCH AND YAW CONTROL	27697.	8.5	760.5	57.
172.0	P52 IMU ALIGN	27696.	1.5	759.0	57.
172.5	MIDCOURSE CORRECTION NO 6 MNVR TO BURN ATT	27694.	1.5	757.5	56.
172.5	ATTITUDE HOLD 0.5 DEG DB PGNCS	27693.	.8	756.7	56.
172.5	RCS -X TRANS 5 FPS	27677.	16.1	740.6	55.
173.0	ORIENT FOR PTC 3AXIS 0.2 DEG/SEC	27677.	.7	740.0	55.
173.0	ATTITUDE HOLD 0.5 DEG DB PGNCS	27676.	.8	739.2	55.
173.0	ROLL 0.1 DEG/SEC	27676.	.1	739.1	55.
173.0	PITCH AND YAW CONTROL	27667.	9.0	730.1	54.
178.0	PITCH AND YAW CONTROL	27658.	9.2	720.9	54.
191.2	P52 IMU ALIGN	27656.	1.5	719.4	54.
192.0	MIDCOURSE CORRECTION NO 7 MNVR TO BURN ATT	27655.	1.5	717.9	53.
192.0	ATTITUDE HOLD 0.5 DEG DB PGNCS	27654.	.8	717.1	53.

TABLE 5-5 (CONT'D)
SM-RCS PROPELLANT BUDGET

TIME (HR)	EVENT	S/C WT (LBS)	SM-RCS USED (LBS)	SM-RCS LEFT (LBS)	SM-RCS LEFT (%)
192.0	DEL VEL = NOM ZERO	27654.	.0	717.1	53.
192.0	STAR CHECK MIN IMPULSE	27653.	.4	716.7	53.
192.8	MANEUVER TO REENTRY ATTITUDE	27652.	1.5	715.2	53.
193.3	IMU ALIGN	27650.	1.5	713.7	53.
193.3	ATTITUDE HOLD 0.5 DEG DB PGNCS	27650.	.8	712.9	53.
193.3	PITCH TO ACQUIRE HORIZON	27649.	.6	712.3	53.
193.3	YAW 45 DEG	27648.	.7	711.6	53.
193.3	ATTITUDE HOLD 0.5 DEG DB PGNCS	27647.	.8	710.9	53.
194.8	CM/SM SEPARATION DELTA VEL=3 FPS	15261.	8.0	702.8	52.

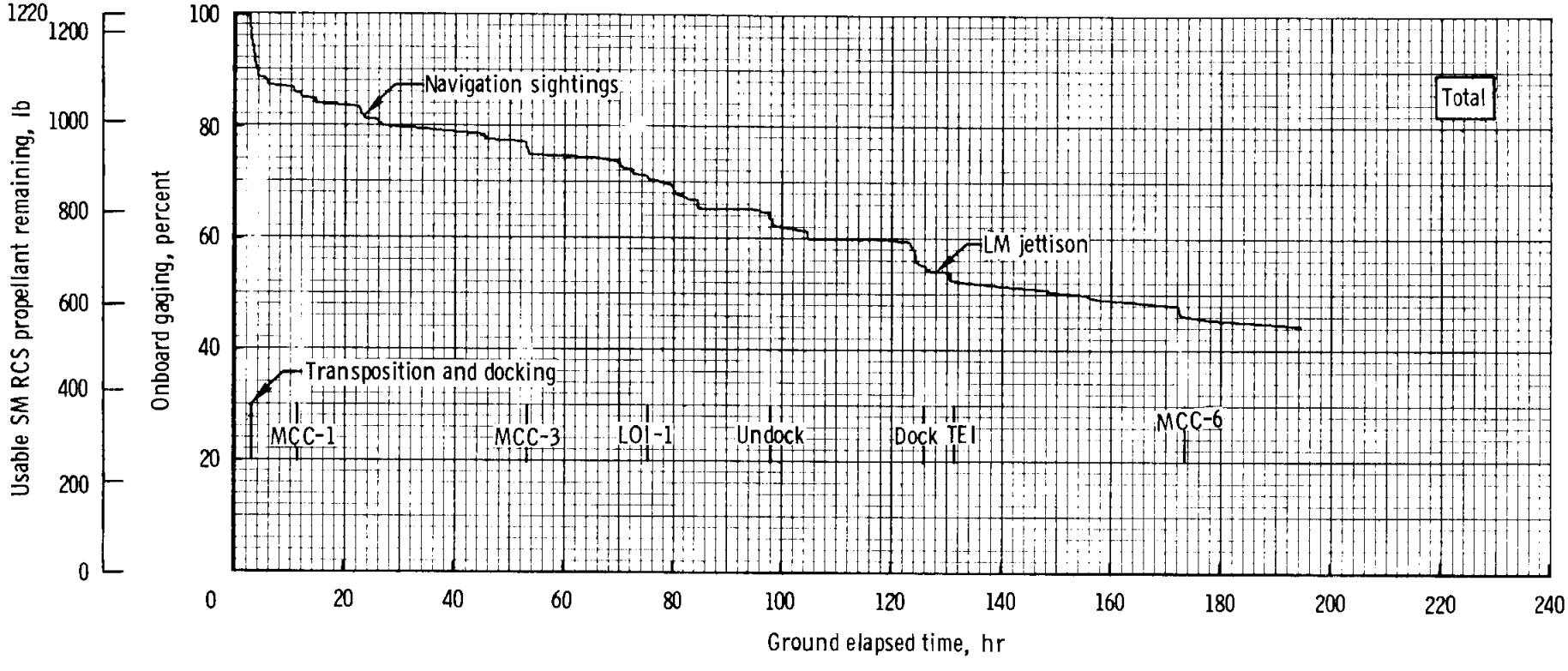


FIGURE 5-1 TOTAL SM RCS PROPELLANT PROFILE

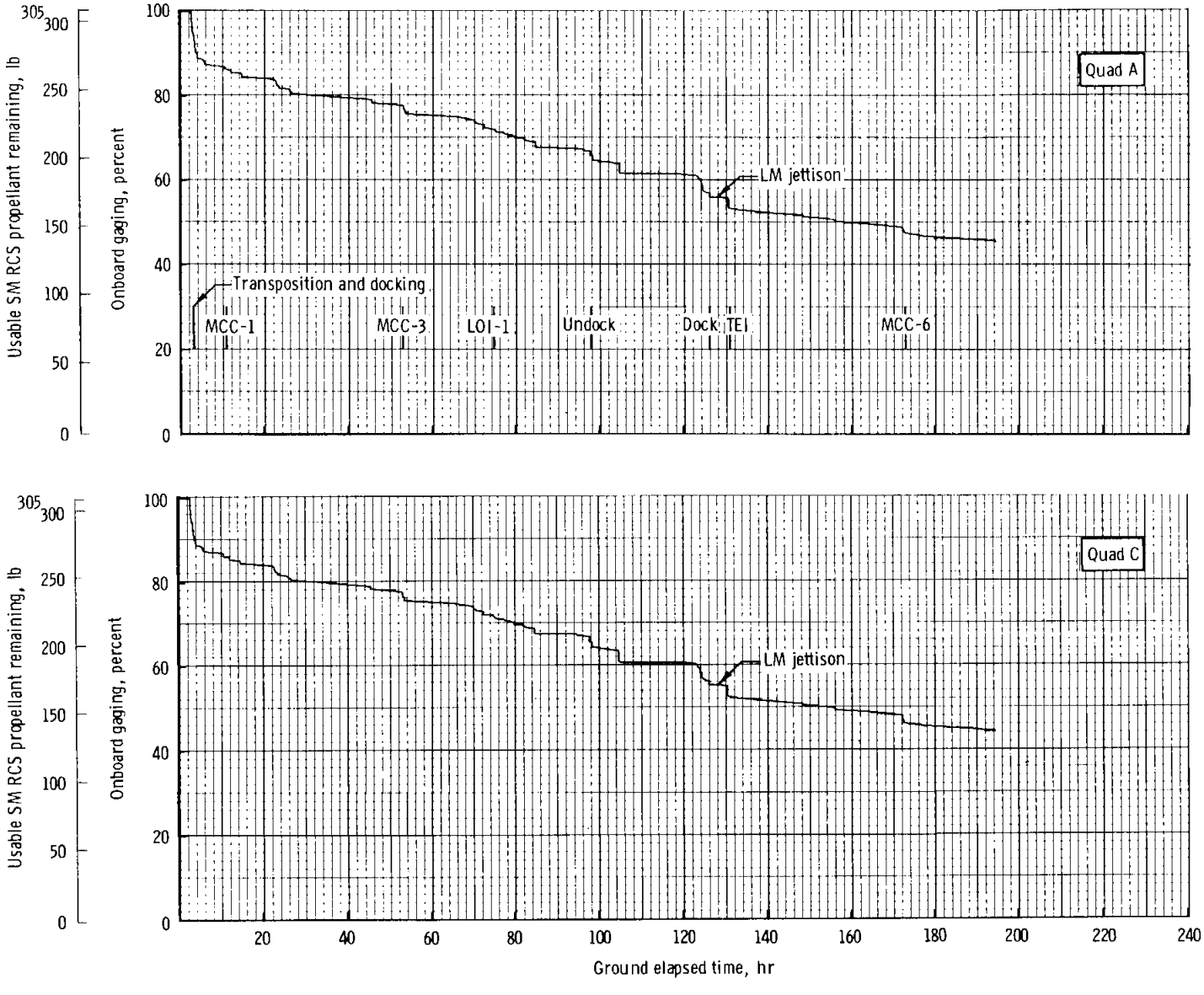


FIGURE 5-2 QUADS A&C SM RCS PROPELLANT PROFILE

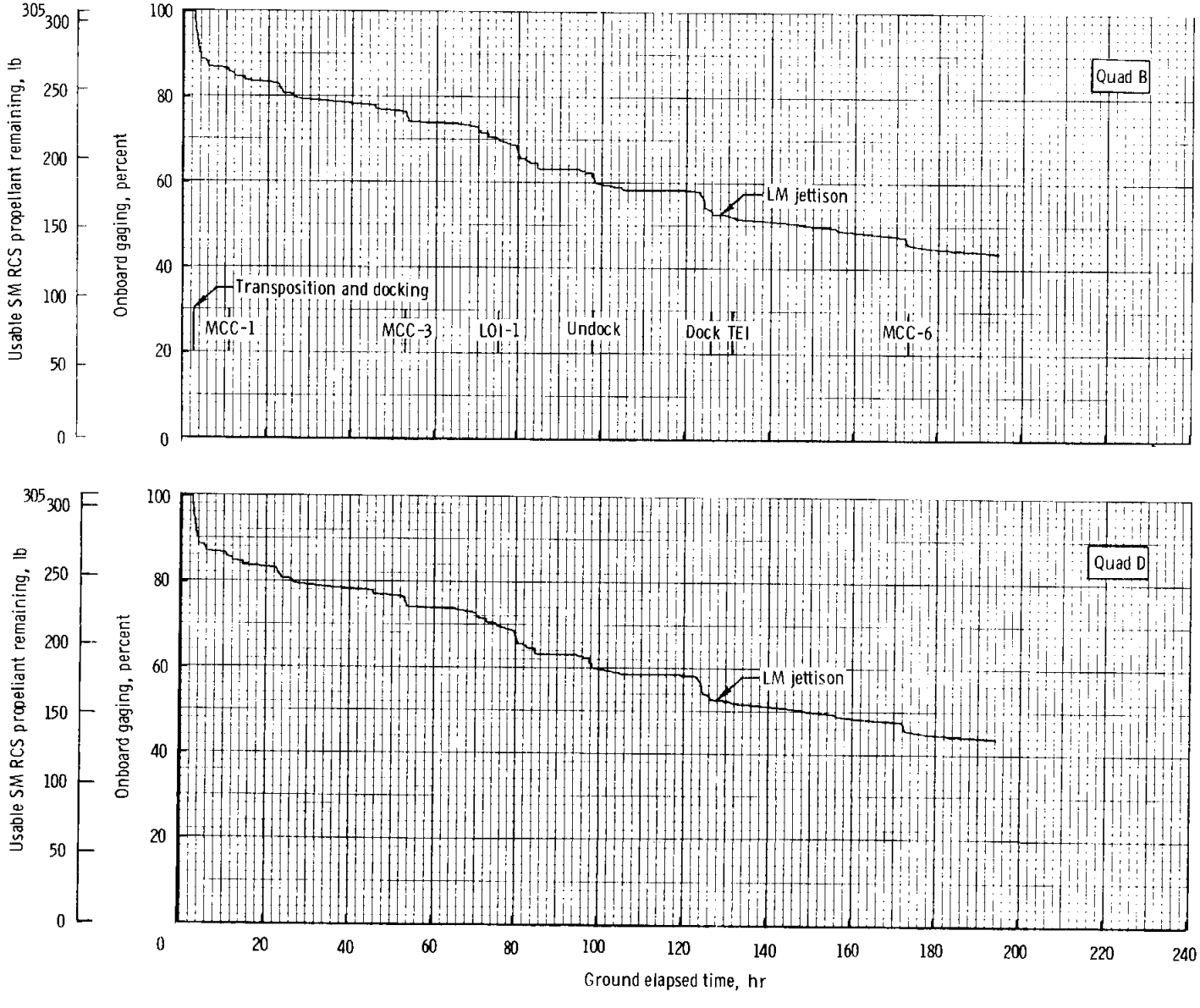


FIGURE 5-3 QUADS B&D SM RCS PROPELLANT PROFILE

SERVICE PROPULSION SYSTEM

GROUND RULES AND ASSUMPTIONS

1. There is a non-propulsive propellant loss of 14.4 lb for each engine start. LM rescue assumed three engine starts.

2. A mission flexibility ΔV of 900 fps has been included in the SPS budget to provide the capability to perform a worst case LM rescue, or to handle several other contingencies (such as loss of PGNCS), or to perform a quicker earth return.

3. Spacecraft weight:

CM	12 280.3 lb
SM	10 595.2 lb
SLA Ring	98.0 lb
Tanked SPS	40 606.4 lb
LM (unmanned)	33 317.9 lb
Total	96 897.8 lb

4. Lunar orbit activity:

Total weight transfer (CSM to LM) = 456.0 lb
Total weight transfer (LM to CSM) = 284.0 lb

5. SM RCS, EPS, and ECS weight losses:

Mission Period	Incremental Wt. Loss, lb
EL to TLMC	88.1
TLMC to LOI-1	417.0
LOI-1 to LOI-2	35.0
LOI-2 to LOPC	131.7
LOPC to TEI	193.0

6. SM RCS usage for LM rescue was 531 lb.

7. Performance parameters:

I_{sp} = 314.6 seconds

TABLE 5-6 G MISSION SPS PROPELLANT LOADING & USAGE SUMMARY

ITEM	PROPELLANT REQUIRED, LB	PROPELLANT REMAINING, LB
Loaded	--	40 808.7
Trapped and unavailable	441.4	40 367.3
Outage	51.4	40 315.9
Unbalance meter bias	100.0	40 215.9
Available for ΔV	--	40 215.9
Required for ΔV		
TLMC (120 fps)	1 155.3	39 060.6
LOI-1 (2861.2 fps)	23 465.1	15 595.5
LOI-2 (138 fps)	985.8	14 609.7
LOPC (17.6 fps)	78.4	14 531.3
TEI (3170.6 fps)	9 926.6	4 604.7
Nominal remaining	--	4 604.7
Mission flexibility ΔV (900 fps)	2 175.6	2 429.1
Dispersions (-3σ)	526.2	1 902.9
Propellant margin	--	1 902.9

LM RCS BUDGET

GROUND RULES AND ASSUMPTIONS

1. Data for the LM RCS engine performance and propellant requirements were obtained from the Spacecraft Operational Data Book.

2. All orientation maneuvers were assumed to be made at 2.0 deg/sec.

3. All orientation maneuvers were assumed to be three-axis maneuvers.

4. Line-of-sight with the CSM was assumed to be maintained in the minimum-impulse mode.

TABLE 5-7 RCS PROPELLANT LOADING AND USAGE SUMMARY

Loaded	633.0
Trapped	-40.6
Nominal deliverable	592.4
Gaging inaccuracy and loading tolerance	-39.5
Mixture ratio uncertainty	-17.0
Usable	535.9
Nominal mission requirement	359.7
Nominal remaining	176.2

TABLE 5-8 LM - RCS PROPELLANT BUDGET

TIME HRS	TIME MIN	EVENT TITLE	S/C WT (LBS)	LM RCS USED (LBS)	LM RCS LEFT (LBS)	LM RCS LEFT (%)
0	0	OUTPUT PROPELLANT LOADINGS	33763.	.0	633.0	100.
0	0	DEBIT DPS WATER	33738.	.0	633.0	100.
97	25	RCS HOT FIRE	33733	5.0	628.0	99.
98	18	UNDOCKING	33733.	.0	628.0	99.
98	18	NULL UNDOCKING VELOCITY	33732.	1.9	626.1	99.
98	23	LM MNVR FOR INSPECTION YAW	33730.	1.7	624.4	99.

LM - RCS PROPELLANT BUDGET - Continuous

TIME HRS	TIME MIN	EVENT TITLE	S/C WT (LBS)	LM RCS USED (LBS)	LM RCS LEFT (LBS)	LM RCS LEFT (%)
98	23	LM MNVR FOR INSPECTION PITCH	33728.	2.0	622.4	98.
98	23	LM MNVR FOR INSPECTION YAW	33727.	.8	621.6	98.
98	23	FORMATION FLYING	33725.	2.0	619.6	98.
98	23	DEBIT DPS WATER	33700.	.0	619.6	98.
98	50	RR LOCK ON MNVR	33696.	4.3	615.3	97.
99	10	IMU REALIGN STAR 1	33692.	4.3	611.0	97.
99	10	IMU REALIGN STAR 2	33687.	4.3	606.7	96.
99	10	IMU REALIGN STAR 3	33683.	4.3	602.4	95.
99	10	DEBIT DPS WATER	33676.	.0	602.4	95.
99	35	MNVR TO DOI BURN ATTITUDE	33672.	4.3	598.1	94.
99	35	ATTITUDE HOLD	33671.	.4	597.8	94.
99	42	2 JET ULLAGE	33665.	5.9	591.9	94.
99	42	DOI BURN	33416.	.0	591.9	94.
99	42	MOMENT CONTROL DOI BURN	33416.	.5	591.3	93.
99	42	TRIM HORIZONTAL RESIDUAL	33408.	7.6	583.7	92.
99	42	PITCH DOWN 90 DEG	33407.	1.0	582.8	92.
99	42	ATTITUDE HOLD	33407.	.5	582.3	92.
100	0	MNVR TO PDI ATTITUDE	33402.	4.3	578.0	91.
100	0	MAINTAIN LOS	33401.	1.5	576.5	91.
100	0	ATTITUDE HOLD	33400.	.6	575.9	91.
100	0	DEBIT DPS WATER	33398.	.0	575.9	91.
100	39	2 JET ULLAGE	33392.	5.9	570.1	90.
100	39	PDI BURN	16123.	.0	570.1	90.
100	39	PDI MOMENT CONTROL	16091.	31.5	538.6	85.
100	50	TOUCHDOWN	16045.	46.3	492.3	78.
113	00	ADD LUNAR SAMPLES	16138.	.0	492.3	78.
122	23	LUNAR LIFT OFF	11079.	.0	492.3	78.
122	28	POWERED ASCENT AND MOMENT CONT ROL	6121.	.0	492.3	78.
122	35	INSERTION BURN CONTROL	6119.	1.8	490.5	77.

LM - RCS PROPELLANT BUDGET - Continued

TIME HRS	TIME MIN	EVENT TITLE	S/C WT (LBS)	LM RCS USED (LBS)	LM RCS LEFT (LBS)	LM RCS LEFT (%)
122	35	TRIM OUT OF PLANE ERROR	6116.	3.3	487.1	77.
122	35	ATTITUDE HOLD	6112.	3.7	483.4	76.
122	40	IMU REALIGN STAR 1	6111.	.6	482.8	76.
122	40	IMU REALIGN STAR 2	6111.	.6	482.1	76.
122	40	IMU REALIGN STAR 3	6110.	.6	481.5	76.
122	55	RR LOCK ON MNVR	6109.	.6	480.8	76.
122	55	MAINTAIN LOS	6106.	3.3	477.5	75.
122	55	ATTITUDE HOLD	6105.	1.2	476.3	75.
123	26	CSI BURN RCS +Z	6072.	32.6	443.7	70.
123	26	ATTITUDE HOLD	6068.	3.8	440.0	70.
123	30	MAINTAIN LOS	6064.	4.2	435.8	69.
123	30	MNVR TO PLANE CHANGE ATTITUDE	6064.	.6	435.2	69.
123	30	ATTITUDE HOLD	6062.	1.2	434.0	69.
123	55	RCS PLANE CHANGE BURN	6058.	4.3	429.7	68.
123	55	ATTITUDE HOLD	6054.	3.8	429.7	68.
123	55	ATTITUDE HOLD	6054.	3.8	425.9	67.
123	57	RR LOCK ON MNVR	6054.	.6	425.3	67.
123	57	MAINTAIN LOS	6051.	2.5	422.8	67.
123	57	ATTITUDE HOLD	6050.	1.2	421.6	67.
124	24	CDH RCS BURN	6049.	1.4	420.2	66.
124	24	ATTITUDE HOLD	6045.	3.8	416.4	66.
124	24	MAINTAIN LOS	6040.	5.0	411.4	65.
124	24	ATTITUDE HOLD	6039.	1.2	410.2	65.
125	2	RCS TPI BURN	6022.	16.7	393.5	62.
125	2	MAINTAIN LOS	6020.	1.7	391.8	62.
125	15	MCC AND BREAKING	5987.	33.3	358.5	57.
125	15	ATTITUDE AND LOS CONTROL	5971.	16.0	342.5	54.
126	0	DOCKING	5949.	22.4	320.1	51.

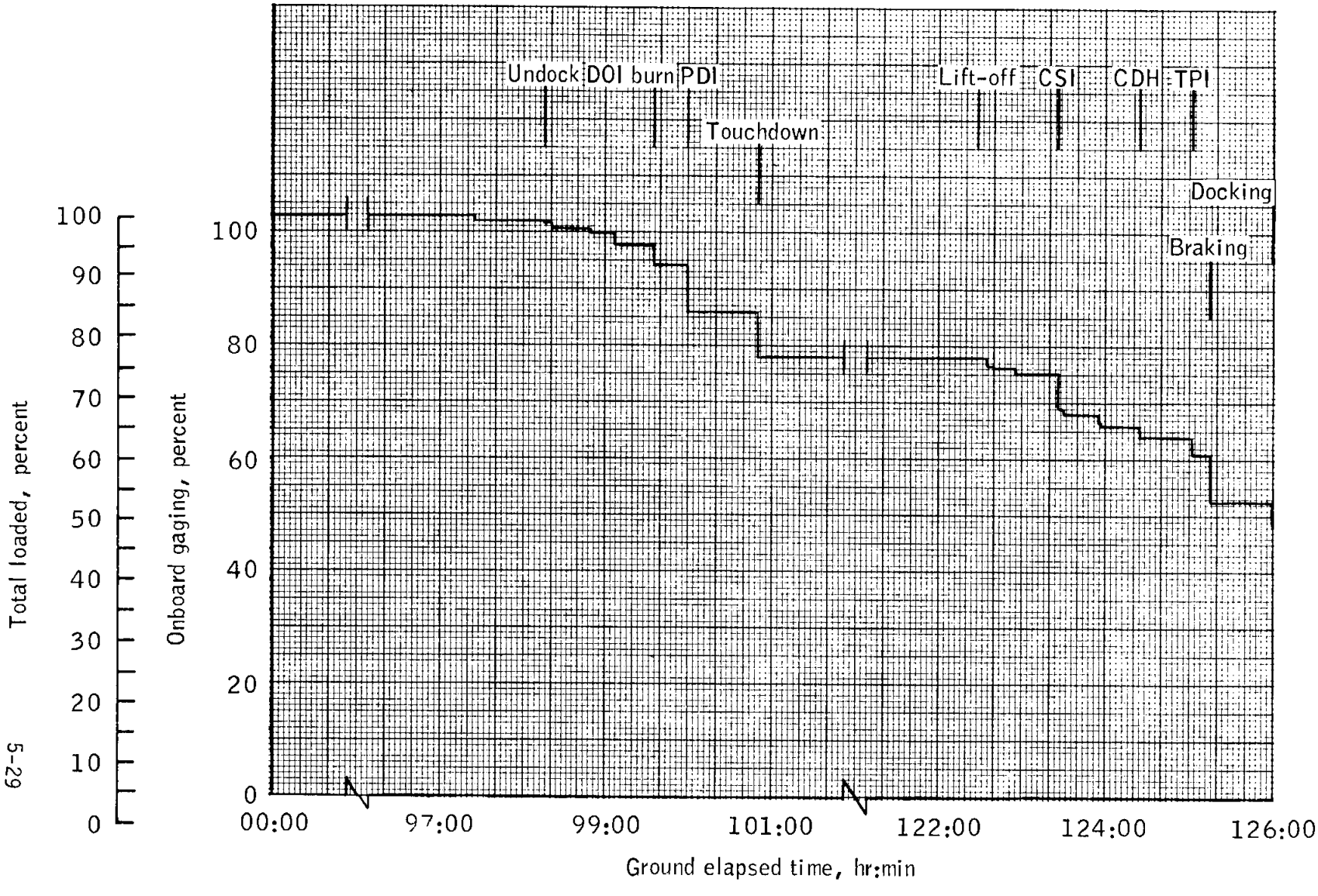


Figure 5-4 .- LM RCS propellant profile.

DESCENT PROPULSION SYSTEM (DPS)

GROUND RULES AND ASSUMPTIONS

1. Integrated average I_{SP} = 301.25 seconds
2. LM separation weight of 33742 lb
3. Non-ΔV consumables of 33.7 lb prior to DOI and 178.9 lb from DOI to lunar landing (linear function)

TABLE 5-9 MISSION G DPS PROPELLANT LOADING & USAGE SUMMARY

ITEM	PROPELLANT REQUIRED, LB	PROPELLANT REMAINING, LB
Loaded[a]	--	18 179.7
Trapped and unavailable	223.5	17 956.2
Outage	29.8	17 926.4
Contingencies		
Engine valve malfunction	64.0	17 862.4
Redline low level sensor	68.7	17 793.7
Usable for ΔV	--	17 793.7
Required for ΔV of 6997 fps[b]	17 268.3	525.4
Dispersions (-3σ)	270.7	254.7
Propellant margin above 3σ	--	254.7

[a]6970.4 lb fuel and 11,209.3 lb oxidizer; reflects optimum fuel off-loading to minimize malfunction penalty.

[b]275.9 lb for DOI and 16,992.4 lb for PDI.

ASCENT PROPULSION SYSTEM (APS)

GROUND RULES AND ASSUMPTIONS

1. Integrated average I_{sp} = 307.5 seconds.
2. Ascent weight at lunar liftoff is 10 879 lb.
3. Mixture ratio for powered ascent is 1.606.

TABLE 5-10 MISSION G APS PROPELLANT LOADING & USAGE SUMMARY

ITEM	PROPELLANT REQUIRED, LB	PROPELLANT REMAINING, LB
Loaded[a]	--	5 227.1
Trapped and unavailable	48.9	5 178.2
Outage	13.0	5 165.2
Contingencies		
Engine malfunction	17.7	5 147.5
Usable for ΔV	--	5 147.5
Required for ΔV of 6090 fps	4 997.2	150.3
Dispersions (-3σ	59.2	91.1
Propellant margin above 3σ	--	91.1

[a]2008.7 lb fuel and 3218.4 lb oxidizer; reflects optimum fuel off-loading to minimize malfunction penalty.

AS-506/CSM-107/LM5 CRYOGENIC/EPS AND ECS BUDGET

The results of the Cryogenic, EPS, and ECS analysis are summarized in the following tables and figures:

CSM EPS BUDGET

ASSUMPTIONS AND GROUND RULES

1. 100% fill for H2 and 02
2. First opportunity liftoff
3. No venting allowance included
4. Two complete LM and tunnel pressurizations are included
5. EPS Hydrogen consumption rate (lb/hr) = 0.00257 x I ft
6. EPS Oxygen consumption rate (lb/hr) = 7936 x $\dot{H}2$
7. Fuel cells were purged every 900 A-h
8. Avg ECS rate was .4 lb/hr