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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MSC INTERNAL NOTE NO. 71-FM-175

May 11, 1971

APOLLO 15 (MISSION J-1)
BASIC CREW CHARTS FOR
JULY 26, 1971, LAUNCH

Mission Planning Support Office

MISSION PLANNING AND ANALYSIS DIVISION

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS



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PROJECT APOLLO

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FOR JULY 26, 1971, LAUNCH

By Data Management Group
Mission Planning Support Office

May 11, 1971

MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

Approved: John R. Gurley, Jr.
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Approved: John P. Mayer
John P. Mayer, Chief
Mission Planning and Analysis Division

FOREWORD

The purpose of this document is to present the Mission Planning and Analysis Division (MPAD) basic crew charts for the Apollo 15 (J-1) mission onboard data file. The command and service module (CSM) charts are in part I, and the lunar module (LM) charts are in part II. These charts were generated by MPAD in response to a request from the Crew Procedure Division (CPD)^a and were coordinated by the Data Management Group of the Mission Planning Support Office with Ted Guillory of the Flight Planning Branch of CPD.

The basic crew charts presented in this document reflect the Apollo 15 trajectory, consumables, and flight plan status as of May 3, 1971. Several charts provided in this document are denoted "final-mission independent" because they are mission independent and will not be updated for the final crew charts. Finally, the dependence of each crew chart (i.e., mission independent, profile dependent, flight plan dependent, etc.) is noted on each chart.

The planned publication date for the final Apollo 15 (J-1) crew charts is July 6, 1971. Any questions concerning the enclosed crew charts should be directed to Larry D. Davis, Mission Planning Support Office, HU3-4091.

^aMemo CE54-71M-050, dated March 9, 1971, signed by T. W. Holloway.

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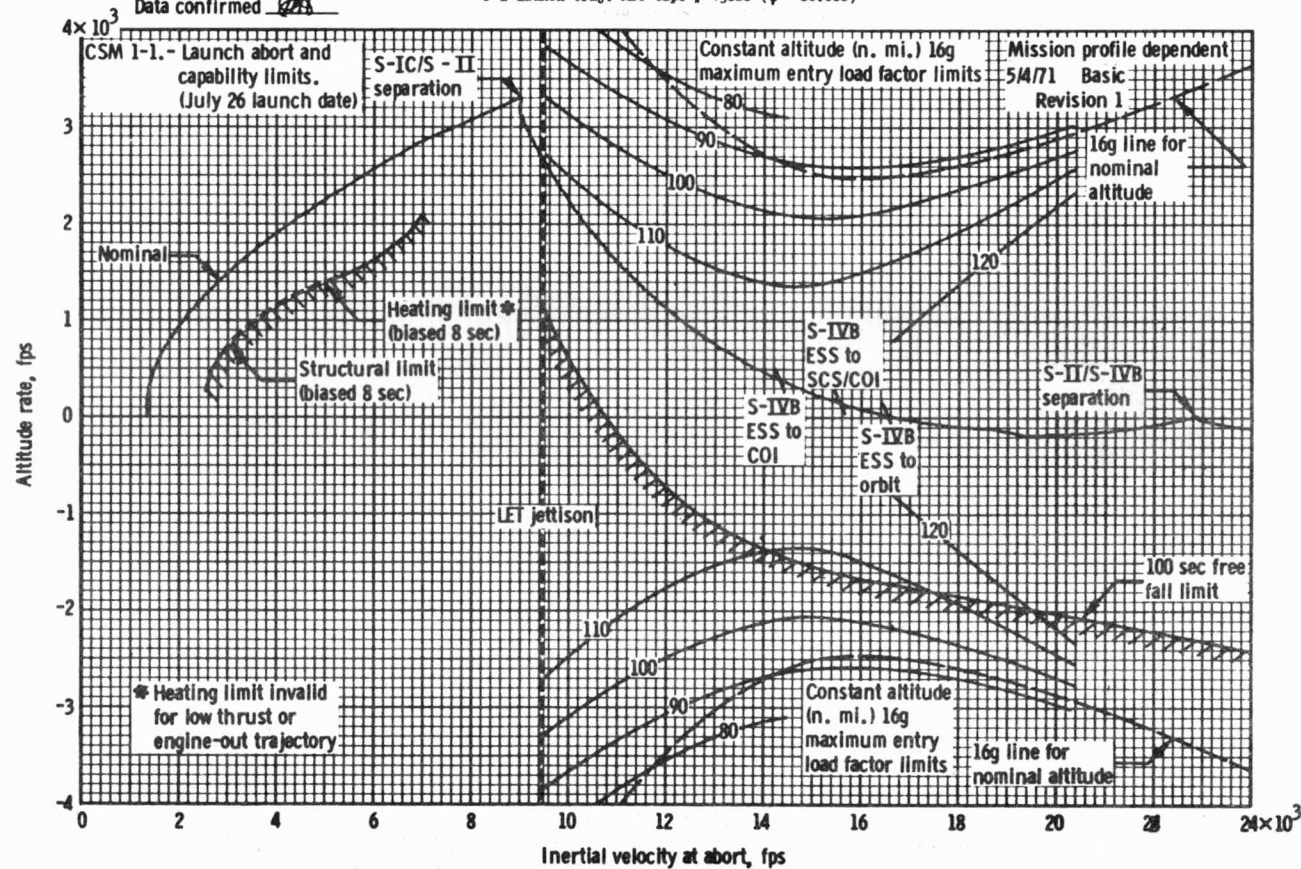
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Henderson/FAB/MPAD (for Launch Checklist)

Data source: BODB Vol. I Amend. 94 Bom Aero, BODB Vol. III Amend. 55 SPS performance.

Data confirmed: QAS J-1 launch traj. MBC tape # 43828 ($\psi = 80.088$)

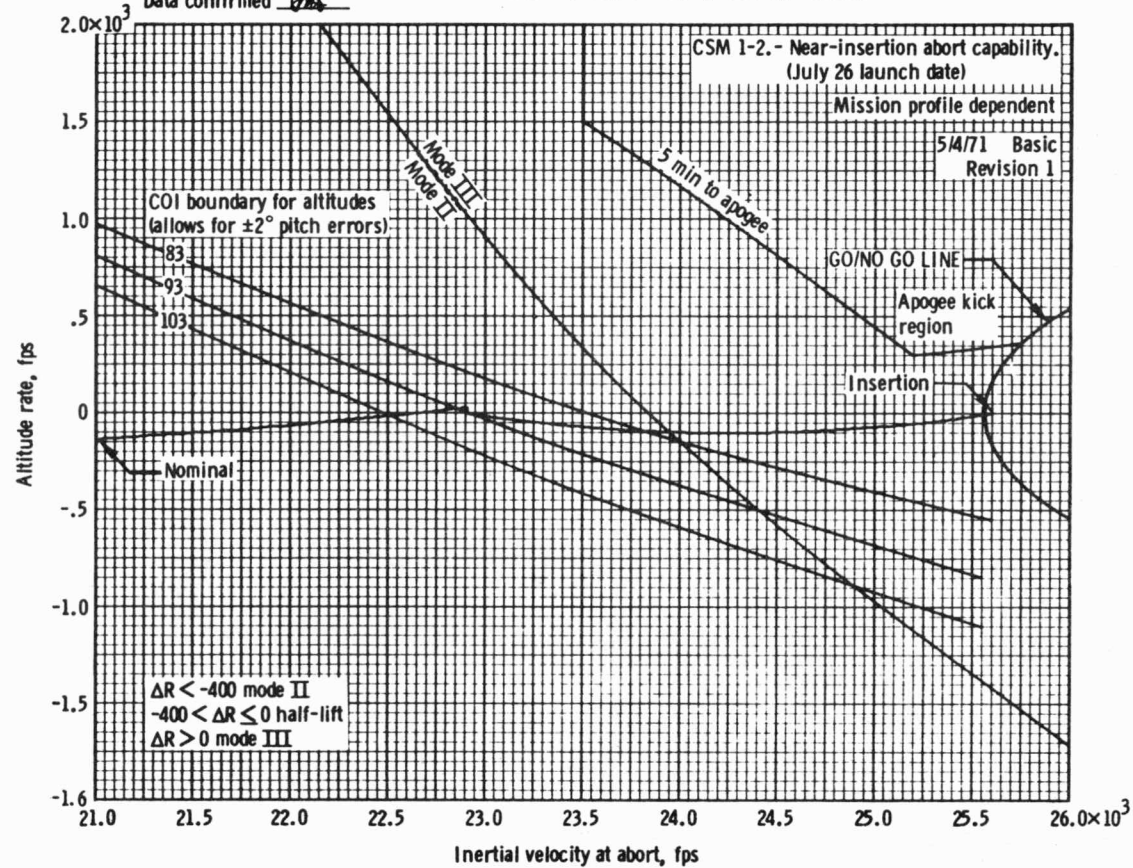


Launch abort and capability limits

Henderson/FAB/MPAD (for Launch Checklist)

Data source SODB Vol. I Amend. 94 Bom Aero. SODB Vol. III Amend. 55 SPS performance.

Data confirmed ~~7/1~~ J-1 launch traj. MSC tape # 43828 ($\psi = 80.088$)



Near-insertion abort capability.

Henderson/FAB/MPAD (for Launch Checklist)

Data source Orbital MechanicsData confirmed [Signature]CSM 1-4.- Recommended manual EOI
shutdown velocities.Mission independent
4/15/71 Final

SHUTDOWN ALTITUDE, h (N. MI.)	INERTIAL VELOCITY, V_i (fps)	h_a/h_p (N. MI.)
150	25291	150/90
145	25318	145/90
140	25344	140/90
135	25371	135/90
130	25398	130/90
125	25424	125/90
120	25451	120/90
115	25478	115/90
110	25505	110/90
105	25532	105/90
100	25559	100/90
95	25586	95/90
90	25613	90/90
85	25641	90/85
80	25668	90/80
75	25695	90/75
70	25723	90/70

NOTE: Insertion altitude defines cutoff velocity assuming $h = 0$ and results in $h = 90$ n mi (h_a or h_p) $1/2$ rev. later, example: If $h = 75$, V_i @ cutoff = 25,695 results in a 75/90 orbit.

Fraley/FAB/MPAD (for Launch Checklist)
 Data source Apollo 15 Dep Procedures Rec
 Data confirmed CWF

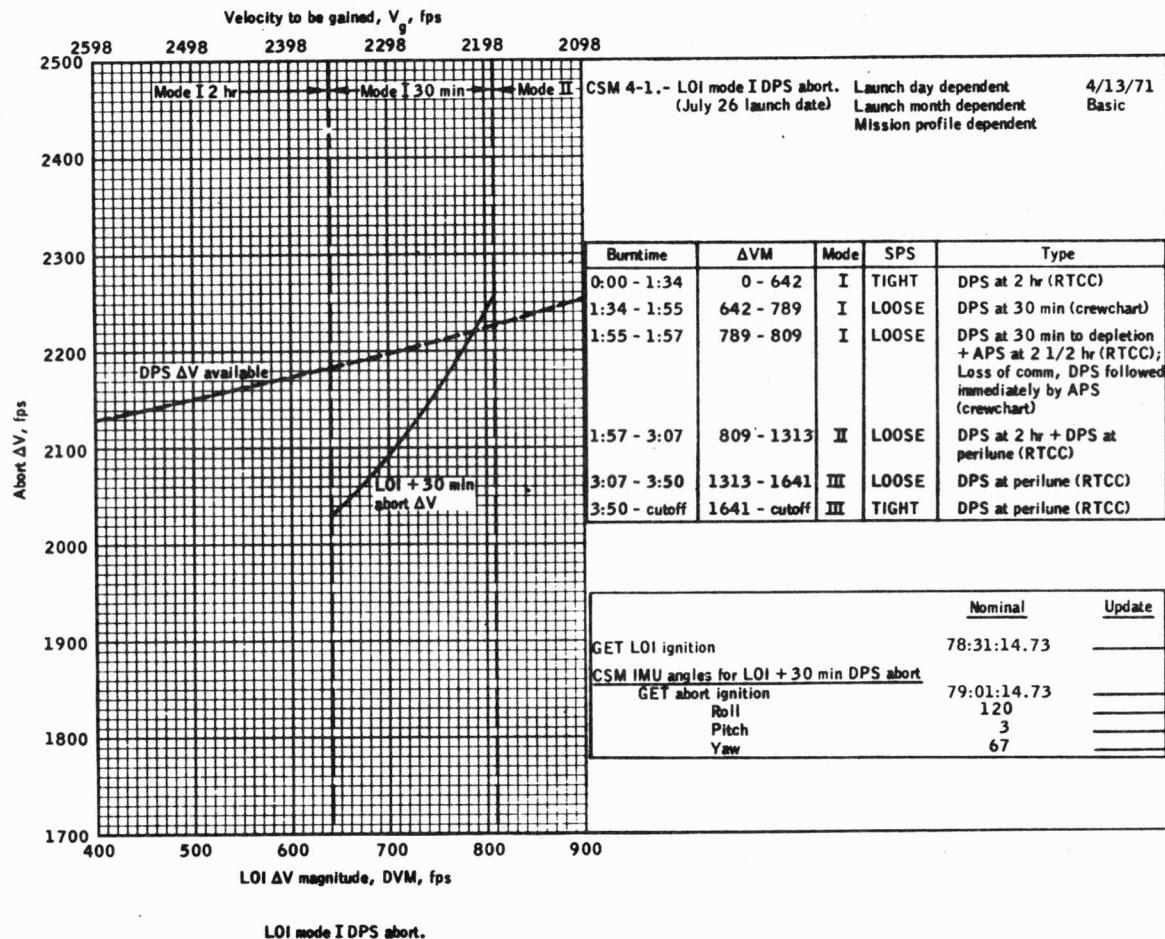
CSM 2-1.- Gimbal angles for observing
 S-IVB through CSM hatch window after
 CSM/IM ejection. (July 26 launch date)

Launch day dependent
 Launch month dependent 4/26/71 Basic
 Mission profile dependent Revision 1

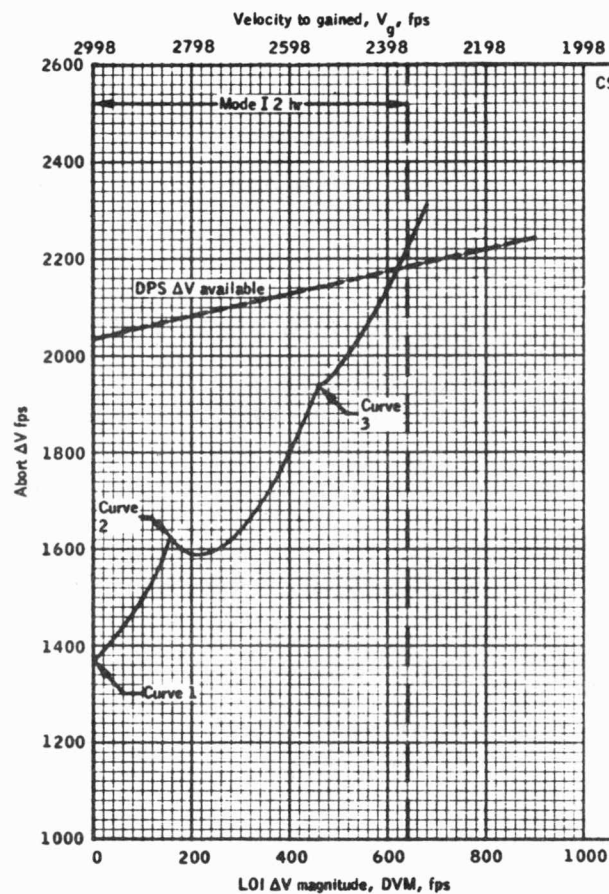
Time from ejection min:sec	S-IVB APS EVASIVE MANEUVER			SM RCS BACKUP EVASIVE MANEUVER		
	SC inertial attitude, deg			SC inertial attitude, deg		
	Roll	Pitch	Yaw	Roll	Pitch	Yaw
CSM/LM ejection 00:00						
S-IVB acquired 13:00	90.0	257.0	354.7	90.0	257.0	354.7
in hatch window 23:00	90.0	257.0	354.7	90.0	257.0	354.7
25:00	90.0	256.9	21.8	69.2	237.4	0.0
30:00	90.0	77.1	24.9	90.0	256.9	0.8
35:00	90.0	77.0	14.9	90.0	256.8	4.4
40:00	90.0	77.0	10.8	90.0	256.8	7.4
S-IVB venting 44:20	90.0	77.6	7.9	90.0	253.5	10.4
maneuver 50:00	31.5	48.4	0.0	309.2	78.9	0.0
55:00	8.7	47.7	0.0	302.9	79.6	0.0

Based on launch site refs mat

PMAAB
 Gonzales/ /MPAD (for G and C Checklist)
 Data source Ames 15-07
 Data confirmed ad



PMAB
 Gonzales/ /MPAD (for Contingency C/L and Flight Plan.
 Data source Ames RPT
 Data confirmed OK



CSM 4-2.- LOI mode I DPS abort.
 (July 26 launch date)

Launch day dependent
 Launch month dependent
 Mission profile dependent
 4/28/71 Basic
 Revision 2

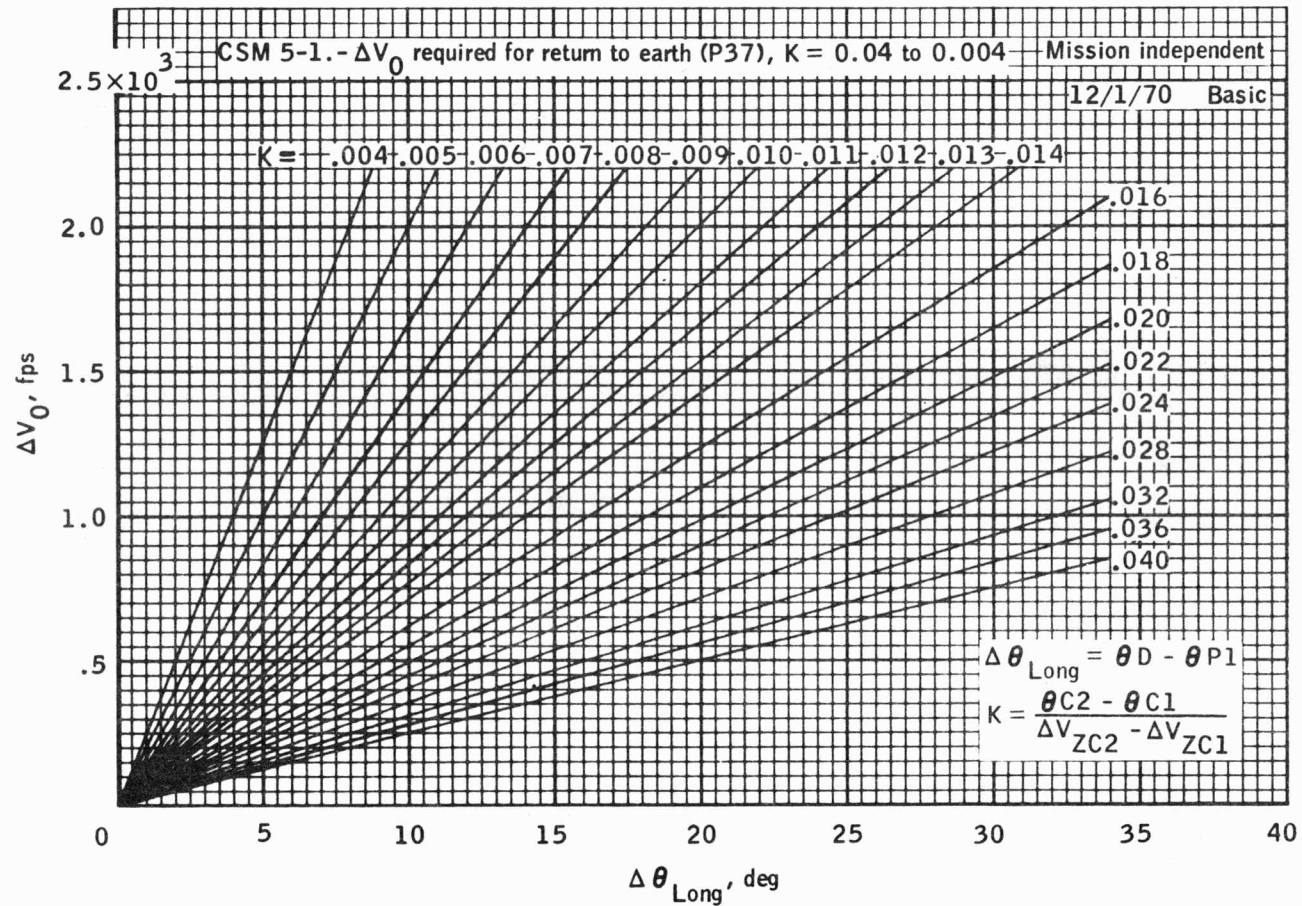
	Nominal
GET LOI ignition	78:31:14.73
GET abort ignition	80:31:14.73
<u>Curve 1</u>	
CSM IMU angles for LOI + 2 hr DPS abort	
Roll	298
Pitch	251
Yaw	80
LM FDAI angles for LOI + 2 hr DPS abort	
Roll	280
Pitch	69
Yaw	360
<u>Curve 2</u>	
CSM IMU angles for LOI + 2 hr DPS abort	
Roll	208
Pitch	335
Yaw	69
LM FDAI angles for LOI + 2 hr DPS abort	
Roll	269
Pitch	63
Yaw	340
<u>Curve 3</u>	
CSM IMU angles for LOI + 2 hr DPS abort	
Roll	189
Pitch	345
Yaw	57
LM FDAI angles for LOI + 2 hr DPS abort	
Roll	257
Pitch	50
Yaw	329

LOI mode I DPS abort.

Gonzales/PMAB/MPAD (for G and C Checklist)

Data source MIT-AG #239-69, Apollo Des. Group Memo #5

Data confirmed A. G.

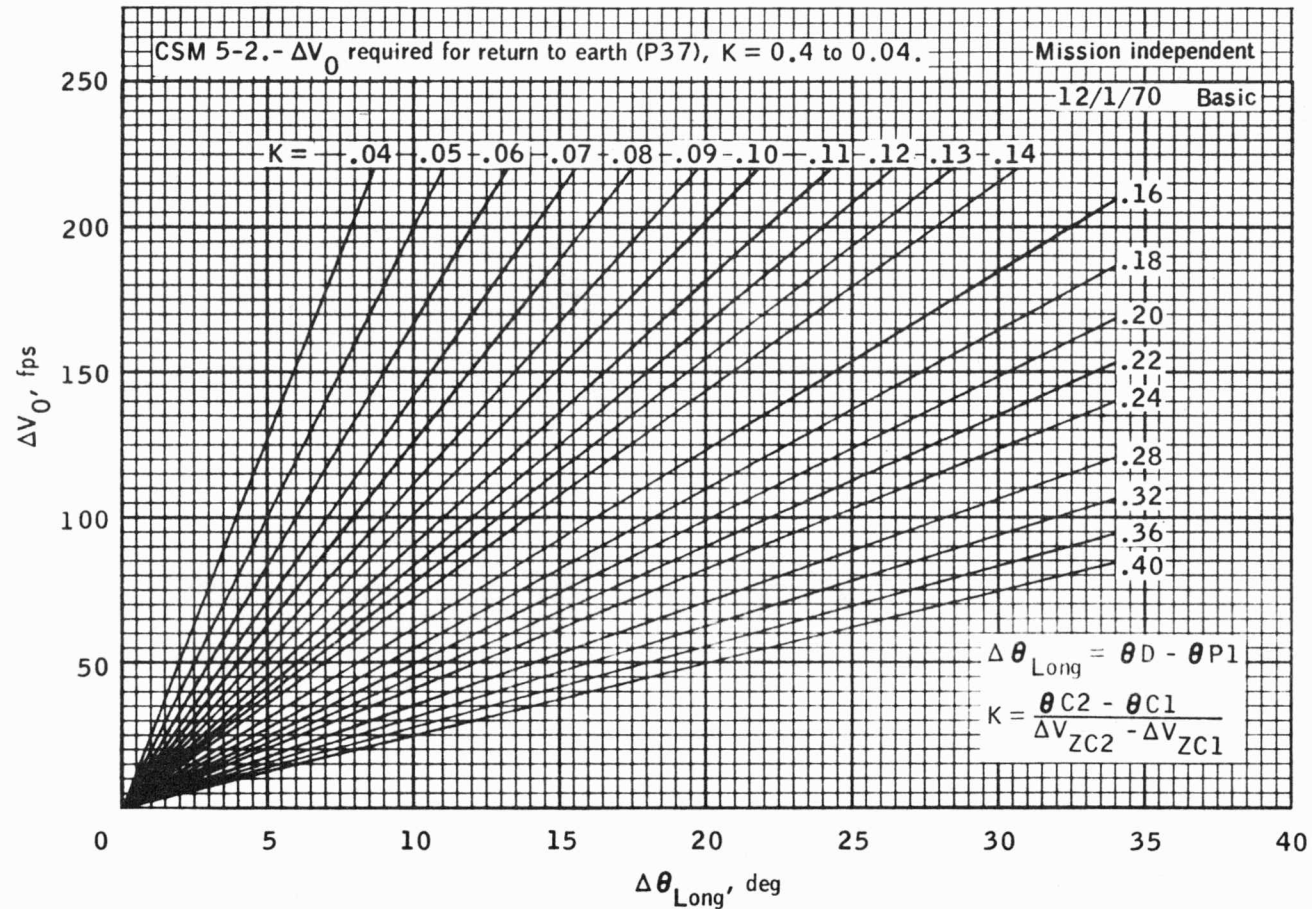


ΔV_0 required for return to earth (P37), $K = 0.04$ to 0.004 .

Gonzales/PMAB/MPAD (for G and C Checklist)

Data source MIT-AG #239-69, Apollo Doc. Group Memo #5

Data confirmed A. &



ΔV_0 required for return to earth (P37), $K = 0.4$ to 0.04 .

Blucker/MPB/MPAD (for G and C Checklist)

Data source: *TP-4*
Data confirmed: *3/26/71*

CSM 6-1.- Venus unit vectors. (July 26 launch date)

Launch day dependent
Launch month dependent
3/7/71 Basic

O HR GET = 7:26:13:34
LO = 7:26:___:___

VENUS UNIT VECTORS

TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
.0	-.40860	.83312	.37277
4.0	-.41188	.83172	.37228
8.0	-.41514	.83032	.37178
12.0	-.41840	.82891	.37128
16.0	-.42166	.82749	.37078
20.0	-.42490	.82605	.37026
24.0	-.42815	.82461	.36975
28.0	-.43138	.82315	.36923
32.0	-.43461	.82169	.36870
36.0	-.43784	.82021	.36817
40.0	-.44105	.81873	.36764
44.0	-.44426	.81723	.36710
48.0	-.44747	.81572	.36656
52.0	-.45067	.81412	.36601
56.0	-.45386	.81268	.36546
60.0	-.45705	.81114	.36490
64.0	-.46023	.80960	.36434
68.0	-.46340	.80804	.36377
72.0	-.46657	.80647	.36320
76.0	-.46973	.80490	.36263
80.0	-.47288	.80331	.36205
84.0	-.47603	.80171	.36146
88.0	-.47917	.80011	.36087
92.0	-.48230	.79849	.36028
96.0	-.48543	.79686	.35968
100.0	-.48854	.79523	.35908
104.0	-.49166	.79358	.35847
108.0	-.49476	.79193	.35786
112.0	-.49786	.79026	.35724
116.0	-.50096	.78858	.35662
120.0	-.50404	.78690	.35600
124.0	-.50712	.78520	.35537
128.0	-.51019	.78350	.35473
132.0	-.51325	.78179	.35409
136.0	-.51631	.78006	.35345
140.0	-.51936	.77833	.35280

VENUS UNIT VECTORS

TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
144.0	-.52240	.77658	.35215
148.0	-.52544	.77483	.35150
152.0	-.52847	.77307	.35084
156.0	-.53149	.77130	.35017
160.0	-.53450	.76952	.34950
164.0	-.53751	.76772	.34883
168.0	-.54051	.76592	.34815
172.0	-.54350	.76411	.34747
176.0	-.54649	.76230	.34678
180.0	-.54947	.76047	.34609
184.0	-.55244	.75863	.34539
188.0	-.55540	.75678	.34469
192.0	-.55835	.75492	.34399
196.0	-.56130	.75306	.34328
200.0	-.56424	.75118	.34257
204.0	-.56718	.74930	.34185
208.0	-.57010	.74740	.34113
212.0	-.57302	.74550	.34040
216.0	-.57593	.74359	.33967
220.0	-.57884	.74167	.33894
224.0	-.58173	.73974	.33820
228.0	-.58462	.73780	.33746
232.0	-.58750	.73585	.33671
236.0	-.59037	.73389	.33596
240.0	-.59324	.73192	.33520
244.0	-.59610	.72994	.33444
248.0	-.59895	.72796	.33367
252.0	-.60179	.72596	.33290
256.0	-.60463	.72396	.33213
260.0	-.60746	.72194	.33135
264.0	-.61028	.71992	.33057
268.0	-.61309	.71789	.32978
272.0	-.61590	.71585	.32899
276.0	-.61869	.71380	.32820
280.0	-.62148	.71174	.32740
284.0	-.62427	.70967	.32659
288.0	-.62704	.70759	.32578
292.0	-.62981	.70550	.32497
296.0	-.63257	.70341	.32415
300.0	-.63532	.70130	.32333

Blucker/MPB/MPAD (for G and C Checklist)

Data source: JP-6 Engineering Team

Data confirmed: JB 4-6-71

CSM 6-2.- Mars, Jupiter, Saturn unit vectors. (July 26 launch date)

Launch day dependent
Launch month dependent
3/7/71 Basic

0 HR GET = 7:26:13:34
LO = 7:26:___:___

MARS UNIT VECTORS

<u>TIME (GET)</u> <u>HOURS</u>	<u>X(R1)</u>	<u>Y(R2)</u>	<u>X(R3)</u>
.0	.76546	-.53659	-.35515
20.0	.76334	-.53855	-.35676
40.0	.76118	-.54056	-.35834
60.0	.75899	-.54260	-.35988
80.0	.75680	-.54466	-.36137
100.0	.75461	-.54673	-.36282
120.0	.75243	-.54880	-.36422
140.0	.75027	-.55086	-.36557
160.0	.74814	-.55290	-.36686
180.0	.74603	-.55493	-.36809
200.0	.74395	-.55693	-.36928
220.0	.74189	-.55892	-.37042
240.0	.73984	-.56089	-.37153
260.0	.73780	-.56287	-.37260
280.0	.73575	-.56485	-.37365
300.0	.73366	-.56687	-.37470

JUPITER UNIT VECTORS

<u>TIME (GET)</u> <u>HOURS</u>	<u>X(R1)</u>	<u>Y(R2)</u>	<u>X(R3)</u>
.0	-.55062	-.77126	-.31935
100.0	-.54975	-.77166	-.31985
200.0	-.54808	-.77257	-.32054
300.0	-.54576	-.77386	-.32138

SATURN UNIT VECTORS

<u>TIME (GET)</u> <u>HOURS</u>	<u>X(R1)</u>	<u>Y(R2)</u>	<u>Z(R3)</u>
.0	.43788	.83768	.32643
40.0	.43565	.83869	.32681
80.0	.43350	.83967	.32716
120.0	.43140	.84061	.32750
160.0	.42937	.84153	.32783
200.0	.42739	.84241	.32815
240.0	.42546	.84327	.32846
280.0	.42357	.84410	.32876

Pixley/MPB/MPAD (for G and C Checklist)

Data source PIP

Data confirmed PIP

CSM 7-1.- Loss of comm navigation
procedures.

Mission independent

12/1/70 Basic

LOSS OF COMM NAVIGATION

GENERAL RULES

- 1 A sighting or set is to consist of three marks.
- 2 Calibrate optics at the beginning of each batch and every half hour while navigation sightings in progress if the remaining sightings require more than 30 minutes to complete. The sextant calibration will be repeated until agreement of at least two checks (not necessarily sequential ones) are within 1 bit (.003°).
- 3 All attitude control should be done using coupled RCS thruster pairs.
- 4 While in P23 V06N49 display:
If $\Delta R > 50$ nm, Or $\Delta V > 50$ fps;
Reject mark, reselect star and repeat mark.

If large correction re-occurs, accept.

Corrections of above magnitude should not be expected except at initiation of tracking (first mark on each star in first batch) or at first switch of reference bodies.

Large ΔR , ΔV values may be expected at the following times:

At initiation of tracking (first mark of each star of first batch).

At first switch of reference bodies.

After long periods between sightings.

Last hours before EI.
- 5 Loss of W-Matrix after initiation of navigation sightings:
 - (a) Upon loss of W-Matrix, current onboard state vector is retained.

CSM 7-1.- Continued.

Mission independent
12/1/70 Basic(b) W-Matrix Reinitialization and Navigation Procedures(1) Sightings Not In Progress:

Before next batch, reinitialize W-Matrix, V67
V06N99 Load values shown in tables.

Continue Navigation

(2) Sightings In Progress:

Immediately reinitialize W-Matrix, V67
V06N99 Load values shown in tables.

Restart interrupted batch of navigation
sightings.

Continue navigation

GENERAL LOSS OF COMM NAV PROCEDURE

- 1 IF ENTRY PAD PREVIOUSLY RECEIVED, NO TRACKING PERFORMED.
IF NOT, PROCEED.
- 2 EXECUTE ABORT - IF REQUIRED (UNLESS COMM LOSS DURING
NOMINAL TEC).
- 3 REINITIALIZE W-MATRIX, V67 (DIAGONAL VALUES, V06N99,
FROM TABLES)
- 4 DETERMINE RETURN-TIME
- 5 SELECT NAVIGATION SCHEDULE (SEE TABLES). IF
TABLE I, II, OR III ARE NOT APPLICABLE, REFER TO
DO-IT-YOURSELF RULES.
- 6 SELECT STARTING BATCH
FIRST NAVIGATION SIGHTINGS TO USE STARS
CORRESPONDING TO NAVIGATION SCHEDULE
TIME FIRST OCCURRING AFTER ABORT.
- 7 ALTERNATE SIGHTINGS ARE PROVIDED IN THE EVENT THE
PREFERRED SIGHTING CANNOT BE PERFORMED.

CSM 7-1.- Continued.

Mission independent

12/1/70 Basic

DO-IT-YOURSELF RULES

- 1 Reinitialize W-Matrix and schedule a tracking interval as soon as possible after the abort burn; or in the case of the lunar flyby, about 1 hour after perilune. If sightings are performed translunar for any reason, reinitialize the W-Matrix 1 hour after perilune for trans-earth sightings. W-Matrix values are given in tables IV-1 and 2 for each return type.
- 2 A batch is to consist of at least three star/horizon sightings, although as many as five can be advantageous, particularly following a sleep period.
- 3 All available stars should be used in the sighting schedule. No more than three marks should be taken on a star within a batch of data.
- 4 Sightings during the last 10 hours before entry interface are important. Five earth horizon sightings should be scheduled at EI-5 hours and three earth horizon sightings should be scheduled following the MCC at EI-3 hours. If no earth horizon sightings are available, lunar horizon sightings should be used.
- 5 Whenever possible, the navigation batches should be scheduled so that, immediately following a time period of length Δt (not to exceed 3 hours) in a non-PTC mode, five times Δt should be spent in a PTC mode (thermal constraints). This rule will be violated most frequently in the following situations: (1) aborts from a translunar trajectory with short return lengths, (2) time critical aborts, (3) the 10-hour period before entry interface.

CSM 7-1.- Concluded.

Mission independent
12/1/70 Basic

- 6 If possible, both near and far horizons should be included in each batch of data.
- 7 Star availability is related to GMT not GET. Therefore, as a clue to determine stars available, refer to either Table I, II, or III which has a GMT for entry corresponding to your GMT for entry. In addition, the star charts should be used to select available stars.
- 8 Go to Table IV.

Mitchell/MPB/MPAD (for Contingency C/L)

Data source Data confirmed SM

CSM 7-2.- Star sighting schedule for
lift-off + 8 hr abort.
(July 26 launch date)

Launch day dependent
Launch month dependent
Mission profile dependent

4/14/71 Basic

TABLE I.- LIFT-OFF + 8 HR ABORT

W-MATRIX REINITIALIZATION

R1 + 80000
R2 + 00070
R3 + 00003

NAVIGATION SCHEDULE

ΔT to EI < 18 hrs, TABLE I(a)
 ΔT to EI > 18 hrs, TABLE I(b)

TABLE I(a)

Sighting Schedule for Abort from Translunar Coast
at 8:00 Hours GET, July 26, 1971 Launch Date
Short Return (Less than 18 hours)
(GMT of EI = 27 July 1971, 13 hours)

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
EI - 15.0	2 DIPHDA	EF	00120
	46	EN	00110
	131	EN	00110
	*44 ENIF	EF	00120
	*103	EN	00110
EI - 13.0	2 DIPHDA	EF	00120
	46	EN	00110
	131	EN	00110
	*133	EN	00110
	*223	EF	00120
EI - 11:00	2 DIPHDA	EF	00120
	11 ALDEBARAN	EN	00110
	46	EN	00110
	*131	EN	00110
	*223	EF	00120
EI - 9:00	1 ALPHERATZ	EF	00120
	11 ALDEBARAN	EN	00110
	46	EN	00110
	*10 MIRFAK	EN	00110
	*223	EF	00120

* Alternate stars - to be used if other sightings cannot be made.

CSM 7-2.- Continued.

Launch day dependent
Launch month dependent
Mission profile dependent

TABLE I(a) 4/14/71 Basic
Sighting Schedule for Abort from Translunar Coast
at 8:00 Hours GET, July 26, 1971 Launch Date
Short Return (Less than 18 hours)
(GMT of EI = 27 July 1971, 13 hours)
(Concluded)

EI - 7	1 ALPHERATZ	EF	00120
	11 ALDEBARAN	EN	00110
	135	EN	00110
	*2 DIPHDA	EF	00120
	*10 MIRFAK	EN	00110
EI - 5	1 ALPHERATZ	EF	00120
	13 CAPELLA	EN	00110
	60	EN	00110
	10 MIRFAK	EN	00110
	126	EF	00120
EI - 2.5	13 CAPELLA	EN	00110
	60	EN	00110
	64	EN	00110
	*55	EN	00110
	*106	EN	00110

Table 2. Sighting Schedule for an Abort from Translunar Coast
at 8:00 Hours GET, July 26, 1971 Launch Date
Long Return (Greater than 18 hours)
(GMT of EI = 27 July 1971, 16 hrs)

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
EI - 17.0	3 NAVI	EN	00110
	46	EN	00110
	131	EN	00110
	*103	EN	00110
	*224	EF	00120
EI - 15.0	2 DIPHDA	EF	00120
	46	EN	00110
	131	EN	00110
	*3 NAVI	EN	00110
	*224	EF	00120
EI - 13.0	2 DIPHDA	EF	00120
	11 ALDEBARAN	EN	00110
	46	EN	00110
	*3 NAVI	EN	00110
	*126	EF	00120
EI - 11.0	2 DIPHDA	EF	00120
	11 ALDEBARAN	EN	00110
	46	EN	00110
	*10 MIRFAK	EN	00110
	*126	EF	00120

*Alternate stars - to be used if other sightings cannot be made.

CSM 7-2.- Concluded.

Launch day dependent
 Launch month dependent
 Mission profile dependent

4/14/71 Basic

TABLE I(b)
 Sighting Schedule for an Abort from Translunar Coast
 at 8:00 Hours GET, July 26, 1971 Launch Date
 Long Return (Greater than 18 hours)
 (GMT of EI = 27 July 1971, 16 hrs)
 (Concluded)

EI - 9.0	1 ALPHERATZ	EF	00120
	11 ALDEBARAN	EN	00110
	135	EN	00110
	*10 MIRFAK	EN	00110
	*224	EF	00120
EI - 7.0	1 ALPHERATZ	EF	00120
	60	EN	00110
	126	EF	00120
	*2 DIPHDA	EF	00120
	*135	EN	00110
EI - 5.0	10 MIRFAK	EN	00110
	60	EN	00110
	126	EF	00120
	1 ALPHERATZ	EF	00120
	13 CAPELLA	EN	00110
EI - 2.5	55	EN	00110
	64	EN	00110
	67	EN	00110
	*106	EN	00110
	*144	EN	00110

* Alternate stars - to be used if other sightings cannot be made.

Mitchell/MPB/MPAD (for Contingency C/L)

Data source

Data confirmed P/M

CSM 7-3.- Star sighting schedule for
aborts from lunar orbit.
(July 26 launch date)

Launch day dependent
Launch month dependent
Mission profile dependent

4/14/71 Basic

TABLE II.- ABORTS FROM LUNAR ORBIT

A. ABORTS BECAUSE OF LOSS OF COMM

W-MATRIX REINITIALIZATION

R1 +30000
R2 +00300
R3 +00003

NAVIGATION SCHEDULE

GMT RETURN ON AUGUST 3, TABLE II(a)
GMT RETURN ON AUGUST 4, TABLE II(b)
GMT RETURN ON AUGUST 5, TABLE II(c)
GMT RETURN ON AUGUST 6, TABLE II(d)
GMT RETURN ON AUGUST 7, TABLE II(e)

B. COMM LOSS AFTER ABORT FROM LUNAR ORBIT

W-MATRIX REINITIALIZATION

a. COMM LOSS PRIOR TO TIME FOR NAV STG
BATCH 1

R1 + 30000
R2 + 00300
R3 + 00003

b. COMM LOSS AFTER TIME FOR BATCH 1
AND NO SV UPDATE AFTER TEI

R1 + 99000
R2 + 00020
R3 + 00003

c. COMM LOSS AFTER TIME FOR BATCH 1
AND AT LEAST ONE SV UPDATE AFTER TEI

R1 + 45000
R2 + 00006
R3 + 00003

NAVIGATION SCHEDULE

GMT EI AUGUST 3, TABLE II(a)
GMT EI AUGUST 4, TABLE II(b)
GMT EI AUGUST 5, TABLE II(c)
GMT EI AUGUST 6, TABLE II(d)
GMT EI AUGUST 7, TABLE II(e)

GMT NOT COVERED BY ABOVE, GO
TO "DO-IT-YOURSELF", TABLE IV.

CSM 7-3.- Continued.

Launch day dependent
 Launch month dependent
 Mission profile dependent
 4/14/71 Basic

TABLE II(a)

Sighting Schedule for Abort from Lunar Orbit
 (GMT of EI = 3 August 1971, 17 hrs)
 July 26, 1971 Launch Date

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
TEI + 2.0	76	MN	00210
	120	MN	00210
	127	MN	00210
	42 PEACOCK	MN	00210
	204	MN	00210
TEI + 13.5	12 RIGEL	EN	00110
	102	EF	00120
	13 CAPELLA	EN	00110
	*1 ALPHERATZ	EF	00120
	*11 ALDEBARAN	EN	00110
TEI + 14.0	76	MN	00210
	41 DABIH	MF	00220
	42 PEACOCK	MN	00210
	*77	MN	00210
	*127	MN	00210
TEI + 16.0	12 RIGEL	EN	00110
	102	EF	00120
	13 CAPELLA	EN	00110
	*1 ALPHERATZ	EF	00120
	*57	EN	00110
TEI + 20.5 (SAME AS TEI + 16.0)	12 RIGEL	EN	00110
	102	EF	00120
	13 CAPELLA	EN	00110
	*1 ALPHERATZ	EF	00120
	*57	EN	00110
TEI + 27.0	12 RIGEL	EN	00110
	102	EF	00120
	13 CAPELLA	EN	00110
	*1 ALPHERATZ	EF	00120
	*11 ALDEBARAN	EN	00110
EI - 32.0	12 RIGEL	EN	00110
	102	EF	00120
	13 CAPELLA	EN	00110
	*1 ALPHERATZ	EF	00120
	*105	EN	00110

* Alternate stars - to be used if other sightings cannot be made.

CSM 7-3.- Continued.

Launch day dependent
 Launch month dependent
 Mission profile dependent

4/14/71 Basic

TABLE II(a)
 Sighting Schedule for Abort from Lunar Orbit
 (GMT of EI = 3 August 1971, 17 hrs)
 July 26, 1971 Launch Date
 (Concluded)

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
EI - 27.0	12 RIGEL	EN	00110
	102	EF	00120
	13 CAPELLA	EN	00110
	*46	EF	00120
	*105	EN	00110
EI - 22.0 (SAME AS EI - 27.0)	12 RIGEL	EN	00110
	102	EF	00120
	13 CAPELLA	EN	00110
	*46	EF	00120
	*105	EN	00110
EI - 19.0 (SAME AS EI - 27.0)	12 RIGEL	EN	00110
	102	EF	00120
	13 CAPELLA	EN	00110
	*46	EF	00120
	*105	EN	00110
EI - 7.5	46	EF	00120
	13 CAPELLA	EN	00110
	105	EN	00110
	*131	EF	00120
	*57	EN	00110
EI - 5.0	15 SIRIUS	EN	00110
	46	EF	00120
	60	EN	00110
	63	EN	00110
	7 MENKAR	EF	00120
EI - 2.5	106	EN	00110
	16 PROCYON	EN	00110
	64	EN	00110

* Alternate stars - to be used if other sightings cannot be made.

CSM 7-3.- Continued.

Launch day dependent
 Launch month dependent
 Mission profile dependent
 4/14/71 Basic

TABLE II(b)
 Sighting Schedule for Abort from Lunar Orbit
 (GMT of EI 4 August 1971, 18 hrs)
 July 26, 1971 Launch Date

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
TEI + 2.0	120	MN	00210
	40 ALTAIR	MN	00210
	121	MN	00210
	45 FORMALHAUT	MN	00210
	101	MN	00210
TEI + 13.5	57	EN	00110
	103	EF	00120
	13 CAPELLA	EN	00110
	*102	EF	00120
	*105	EN	00110
TEI + 14.0	76	MN	00210
	40 ALTAIR	MF	00220
	77	MN	00210
	*44 ENIF	MF	00220
	*127	MN	00210
TEI + 16.0	57	EN	00110
	102	EF	00120
	13 CAPELLA	EN	00110
	*103	EF	00120
	*55	EN	00110
TEI + 20.5 (SAME AS TEI + 16.0)	57	EN	00110
	102	EF	00120
	13 CAPELLA	EN	00110
	*103	EF	00120
	*55	EN	00110
TEI + 27.0	57	EN	00110
	102	EF	00120
	13 CAPELLA	EN	00110
	*46	EF	00120
	*55	EN	00110
EI - 32.0	55	EN	00110
	46	EF	00120
	13 CAPELLA	EN	00110
	*102	EF	00120
	* 57	EN	00110
EI - 27.0	55	EN	00110
	46	EF	00120
	106	EN	00110
	*103	EF	00120
	* 57	EN	00110

* Alternate stars - to be used if other sightings cannot be made.

CSM 7-3.- Continued.

Launch day dependent
 Launch month dependent
 Mission profile dependent

4/14/71 Basic

TABLE II(b)
 Sighting Schedule for Abort from Lunar Orbit
 (GMT of EI 4 August 1971, 18 hrs)
 July 26, 1971 Launch Date)
 (Concluded)

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
EI - 22.0	55	EN	00110
	46	EF	00120
	106	EN	00110
	*103	EF	00120
	*63	EN	00110
EI - 19.0 (SAME AS EI - 22.0)	55	EN	00110
	46	EF	00120
	106	EN	00110
	*103	EF	00120
	*63	EN	00110
EI - 7.5	16 PROCYON	EN	00110
	132	EF	00120
	67	EN	00110
	*227	EF	00120
	*64	EN	00110
EI - 5	11 ALDEBARAN	EF	00120
	67	EN	00110
	16 PROCYON	EN	00110
	132	EF	00120
	64	EN	00110
EI - 2.5	16 PROCYON	EN	00110
	12 RIGEL	EF	00120
	67	EN	00110
	*136	EF	00120
	*50	EN	00110

* Alternate stars - to be used if other sightings cannot be made.

CSM 7-3.- Continued.

Launch day dependent
 Launch month dependent
 Mission profile dependent

4/14/71 Basic

TABLE II(c)

Sighting Schedule for Abort from Lunar Orbit
 (GMT of EI = 5 August 1971, 19 hrs)
 July 26, 1971 Launch Date

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
TEI + 2.0	1 ALPHERATZ	MN	00210
	2 DIPHDA	MN	00210
	126	MN	00210
	223	MN	00210
	101	MN	00210
TEI + 13.5	16 PROCYON	EN	00110
	103	EF	00120
	106	EN	00110
	*55	EN	00110
	*10 MIRFAK	EF	00120
TEI + 14.0	37 NUNKI	MF	00220
	224	MN	00210
	40 ALTAIR	MF	00220
	*214	MF	00220
	*212	MF	00220
TEI + 16.0	16 PROCYON	EN	00110
	103	EF	00120
	106	EN	00110
	*64	EN	00110
	*46	EF	00120
TEI + 20.5	16 PROCYON	EN	00110
	46	EF	00120
	106	EN	00110
	*64	EN	00110
	*103	EF	00120
TEI + 27.0	16 PROCYON	EN	00110
	7 MENKAR	EF	00120
	64	EN	00110
	*103	EF	00120
	*131	EF	00120
EI - 32.0	16 PROCYON	EN	00110
	46	EF	00120
	15 SIRIUS	EN	00110
	*103	EF	00120
	*64	EN	00110

* Alternate stars - to be used if other sightings cannot be made.

CSM 7-3.- Continued.

Launch day dependent
 Launch month dependent
 Mission profile dependent
 4/14/71 Basic

TABLE II(c)
 Sighting Schedule for Abort from Lunar Orbit
 (GMT of EI = 5 August 1971, 19 hrs)
 July 26, 1971 Launch Date)
 (Concluded)

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
EI - 27.0	16 PROCYON	EN	00110
	46	EF	00120
	67	EN	00110
	*103	EF	00120
	*64	EN	00110
EI - 22.0	16 PROCYON	EN	00110
	10 MIRFAK	EF	00120
	11 ALDEBARAN	EF	00120
	*64	EN	00110
	*133	EF	00120
EI - 19 (SAME AS EI - 22.0)	16 PROCYON	EN	00110
	10 MIRFAK	EF	00120
	11 ALDEBARAN	EF	00120
	*64	EN	00110
	*133	EF	00120
EI - 7.5	16 PROCYON	EN	00110
	11 ALDEBARAN	EF	00120
	67	EN	00110
	*133	EF	00120
	*50	EN	00110
EI - 5.0	37 NUNKI	MN	00210
	40 ALTAIR	MF	00220
	204	MN	00210
	45 FORMALHAUT	MF	00220
	213	MN	00210
EI - 2.5 (SAME AS EI - 5.0)	37 NUNKI	MN	00210
	40 ALTAIR	MF	00220
	204	MN	00210
	*45 FORMALHAUT	MF	00220
	*213	MN	00210

* Alternate stars - to be used if other sightings cannot be made.

CSM 7-3.- Continued.

Launch day dependent
Launch month dependent
Mission profile dependent

4/14/71 Basic

TABLE II(d)

Sighting Schedule for Abort from Lunar Orbit
(GMT of EI = 6 August 1971, 20 hours)
July 26, 1971 Launch Date

<u>TIME</u>	<u>STAR</u>	<u>HORIZON</u>	<u>R3</u>
TEI + 2.0	1	ALPHERATZ	MN
	221		MF
	2	DIPHDA	MN
	223		MN
	126		MN
TEI + 13.5	16	PROCYON	EN
	11	ALDEBARAN	EF
	50		EN
	*10	MIRFAK	EF
	*67		EN
TEI + 14.0	126		MN
	40	ALTAIR	MF
	224		MN
	*120		MF
	*223		MN
TEI + 16.0 (same as TEI + 13.5)	16	PROCYON	EN
	11	ALDEBARAN	EF
	50		EN
	*10	MIRFAK	EF
	*67		EN
TEI + 20.5	16	PROCYON	EN
	11	ALDEBARAN	EF
	50		EN
	*67		EN
	*133		EF
TEI + 27.0 (same as TEI + 20.5)	16	PROCYON	EN
	11	ALDEBARAN	EF
	50		EN
	*67		EN
	*133		EF
EI - 32.0	16	PROCYON	EN
	11	ALDEBARAN	EF
	50		EN
	*60		EF
	*67		EN

*Alternate stars - to be used if other sightings cannot be made.

CSM 7-3.- Continued.

Launch day dependent
 Launch month dependent
 Mission profile dependent
 4/14/71 Basic

TABLE II(d)
 Sighting Schedule for Abort from Lunar Orbit
 (GMT of EI = 6 August 1971, 20 hrs)
 July 26, 1971 Launch Date)
 (Concluded)

<u>TIME</u>	<u>STAR</u>	<u>HORIZON</u>	<u>R3</u>
EI - 27.0	16 PROCYON	EN	00110
(same as	11 ALDEBARAN	EF	00120
EI - 32.0)	50	EN	00110
	*60	EF	00120
	*67	EN	00110
EI - 22.0	16 PROCYON	EN	00110
	11 ALDEBARAN	EF	00120
	50	EN	00110
	*13 CAPELLA	EF	00120
	*67	EN	00110
EI - 19.0	60	EF	00120
	50	EN	00110
	13 CAPELLA	EF	00120
	*11 ALDEBARAN	EF	00120
	*133	EF	00120
EI - 10.0	11 ALDEBARAN	EF	00120
	60	EF	00120
	57	EF	00120
	*142	EF	00120
	*135	EF	00120
EI - 5.0	37 NUNKI	MF	00220
	121	MN	00210
	77	MF	00220
	2 DIPHDA	MN	00210
	214	MF	00220
EI - 2.5	45 FORMALHAUT	MN	00210
	235	MF	00220
	101	MN	00210
	*216	MF	00220
	*221	MN	00210

*Alternate stars - to be used if other sightings cannot be made.

CSM 7-3.- Continued.

Launch day dependent
 Launch month dependent
 Mission profile dependent
 4/14/71 Basic

TABLE II(e)
 Sighting Schedule for Abort from Lunar Orbit
 (GMT of EI = 7 August 1971, 21 hrs)
 July 26, 1971 Launch Date

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
TEI + 2.0	103	MN	00210
	224	MF	00220
	7 MENKAR	MN	00210
	122	MN	00210
	3 NAVI	MN	00210
TEI + 13.5	102	MN	00210
	45 FORMALHAUT	MF	00220
	217	MF	00220
	*1 ALPHERATZ	MN	00210
	*126	MN	00210
TEI + 14.0	50	EN	00110
	11 ALDEBARAN	EF	00120
	13 CAPELLA	EF	00120
	*57	EF	00120
	*60	EF	00120
TEI + 16.0 (SAME AS TEI + 14.0)	50	EN	00110
	11 ALDEBARAN	EF	00120
	13 CAPELLA	EF	00120
	*57	EF	00120
	*60	EF	00120
TEI + 20.5	11 ALDEBARAN	EF	00120
	13 CAPELLA	EF	00120
	57	EF	00120
	*60	EF	00120
	*142	EF	00120
TEI + 27.0 (SAME AS TEI + 20.5)	11 ALDEBARAN	EF	00120
	13 CAPELLA	EF	00120
	57	EF	00120
	*60	EF	00120
	*142	EF	00120
EI - 32.0	13 CAPELLA	EF	00120
	142	EF	00120
	60	EF	00120
	*144	EF	00120
	*106	EF	00120
EI - 27.0 (SAME AS EI - 32.0)	13 CAPELLA	EF	00120
	142	EF	00120
	60	EF	00120
	*144	EF	00120
	*106	EF	00120

* Alternate stars - to be used if other sightings cannot be made.

CSM 7-3.- Concluded.

Launch day dependent
 Launch month dependent
 Mission profile dependent
 4/14/71 Basic

TABLE II(e)
 Sighting Schedule for Abort from Lunar Orbit
 (GMT of EI = 7 August 1971, 21 hrs)
 July 26, 1971 Launch Date)
 (Concluded)

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
EI - 22.0	1 ALPHERATZ	MN	00210
	44 ENIF	MF	00220
	126	MN	00210
	*40 ALTAIR	MF	00220
	*224	MN	00210
EI - 19.0 (SAME AS EI - 22.0)	1 ALPHERATZ	MN	00210
	44 ENIF	MF	00220
	126	MN	00210
	*40 ALTAIR	MF	00220
	*224	MN	00210
EI - 7.5	224	MN	00210
	45 FORMALHAUT	MF	00220
	126	MN	00210
	*1 ALPHERATZ	MN	00210
	*40 ALTAIR	MF	00220
EI - 5.0	1 ALPHERATZ	MN	00210
	40 ALTAIR	MF	00220
	126	MN	00210
	224	MN	00210
	235	MF	00220
EI - 2.5	1 ALPHERATZ	MN	00210
	214	MF	00220
	40 ALTAIR	MF	00220
	*224	MN	00210
	*223	MN	00210

* Alternate stars - to be used if other sightings cannot be made.

Mitchell/MPB/MPAD (for Contingency C/L)

Data source _____

Data confirmed ihmCSM 7-4.- Comm loss during nominal TEC.
(July 26 launch date)Launch day dependent
Launch month dependent
Mission profile dependent

4/14/71 Basic

TABLE III.- COMM LOSS DURING NOMINAL TEC

W-MATRIX REINITIALIZATION

a. COMM LOSS PRIOR TO TIME FOR NAV STG BATCH 1

R1 + 30000

R2 + 00300

R3 + 00003

b. COMM LOSS AFTER TIME FOR NAV STG BATCH 1
AND NO SV UPDATE AFTER TEI

R1 + 99000

R2 + 00020

R3 + 00003

c. COMM LOSS AFTER TIME FOR NAV STG BATCH 1
AND AT LEAST ONE SV UPDATE AFTER TEI

R1 + 45000

R2 + 00006

R3 + 00003

Sighting Schedule for Nominal Transearth Coast
(GMT of EI = 7 August 1971, 20 hrs, 32 min, 20 sec)
July 26, 1971 Launch Date

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
TEI + 2.0	103	MN	00210
	44 ENIF	MF	00220
	43 DENE	MN	00210
	3 NAVI	MN	00210
	122	MN	00210
TEI + 13.5	57	EF	00120
	50	EN	00110
	13 CAPELLA	EF	00120
	*11 ALDEBARAN	EF	00120
	*22 REGULUS	EN	00110
TEI + 14.0	102	MN	00210
	40 ALTAIR	MF	00220
	2 DIPHA	MN	00210
	*1 ALPHERATZ	MN	00210
	*221	MF	00220
TEI + 16.0	57	EF	00120
	50	EN	00110
	13 CAPELLA	EF	00120
	*11 ALDEBARAN	EF	00120
	*22 REGULUS	EN	00110

* Alternate stars - to be used if other sightings cannot be made.

CSM 7-4.- Concluded.

Launch day dependent
 Launch month dependent
 Mission profile dependent
 4/14/71 Basic

TABLE III
 Sighting Schedule for Nominal Transearth Coast
 (GMT of EI = 7 August 1971, 20 hrs, 32 min, 20 sec)
 July 26, 1971 Launch Date

<u>Time</u>	<u>Star</u>	<u>Horizon</u>	<u>R3</u>
TEI + 20.5	57	EF	00120
	50	EN	00110
	13 CAPELLA	EF	00120
	*22 REGULUS	EN	00110
	*11 ALDEBARAN	EF	00120
TEI + 27.0	11 ALDEBARAN	EF	00120
	50	EN	00110
	13 CAPELLA	EF	00120
	*22 REGULUS	EN	00110
	*60	EF	00120
EI - 32.0	11 ALDEBARAN	EF	00120
	13 CAPELLA	EF	00120
	142	EF	00120
	*60	EF	00120
	*135	EF	00120
EI - 27.0	60	EF	00120
	21 ALPHARD	EN	00110
	13 CAPELLA	EF	00120
	*142	EF	00120
	*135	EF	00120
EI - 22.0	60	EF	00120
	21 ALPHARD	EN	00110
	13 CAPELLA	EF	00120
	*142	EF	00120
	*135	EF	00120
EI - 19.0	60	EF	00120
	21 ALPHARD	EN	00110
	13 CAPELLA	EF	00120
	*67	EF	00120
	*135	EF	00120
EI - 11.0	21 ALPHARD	EN	00110
	13 CAPELLA	EF	00120
	106	EF	00110
EI - 5.0	1 ALPHERATZ	MN	00210
	221	MF	00220
	101	MF	00220
	224	MN	00210
	223	MN	00210
EI - 2.5	1 ALPHERATZ	MN	00210
	37 NUNKI	MF	00220
	40 ALTAIR	MF	00220
	*224	MN	00210
	*223	MN	00210

* Alternate stars - to be used if other sightings cannot be made.

Pixley/MPB/MPAD (for G and C Checklist)

Data source PIP
Data confirmed PIP

CSM 7-5.- Do-it-yourself
sighting schedule.

Mission independent
12/1/70 Basic

TABLE IV - DO-IT-YOURSELF

1. ABORTS FROM TLC

W-MATRIX INITIALIZATION

R1 + 80000
R2 + 00070
R3 + 00003

NAVIGATION SCHEDULE

ΔT TO EI <20 hrs
BATCHES OF 3 SETS EVERY 2.5 hrs
BATCH OF 5 SETS AT EI-5
(BEFORE LAST MCC AT EI-3)
BATCH OF 3 SETS AFTER LAST MCC

ΔT >20 hrs
SLEEP PERIODS OF 8 HOURS MAY BE SCHEDULED.
CREW SHOULD BE AWAKE LAST 10 HOURS PRIOR
TO EI.

WHILE AWAKE:
BATCHES OF 3 SETS EVERY 3 HRS
BATCHES OF 5 SETS AFTER
SLEEP PERIODS
BATCH OF 5 SETS PRIOR TO
LAST MCC (AT EI-3)
BATCH OF 3 SETS AFTER LAST MCC

NOTE - ONLY STAR/EARTH HORIZON MARKS WILL BE MADE.

2. FLYBY, ABORT FROM LUNAR ORBIT, TEC.

W-MATRIX INITIALIZATION

a. COMM LOSS BEFORE BATCH 1
(at TEI + 1 or perilune +1 hr)

R1 + 30000
R2 + 00300
R3 + 00003

CSM 7-5.- Continued.

Mission independent

TABLE IV - Continued

12/1/70 Basic

- b. COMM LOS AFTER BATCH 1
(at TEI + 1 or perilune + 1 hr)
and
No SV update after TEI
R1 + 99000
R2 + 00020
R3 + 00003
- c. COMM LOSS AFTER BATCH 1
(at TEI + 1 or perilune +1 hr)
and
At least one SV update
after TEI
R1 + 45000
R2 + 00006
R3 + 00003

NAVIGATION SCHEDULE

A. RETURN LENGTH >70 hrs

- 1 Refer to Table III for placement of batches of star/horizon sightings and relate the times given at "TEI +" and "EI-" to the specific transearth situation. For each batch scheduled, take three marks on each available star (up to 5 stars).
- 2 Schedule three earth horizon sightings for every 5 hours between TEI + 32 and EI - 40 hours, or if an additional sleep period is needed for very slow returns, schedule five earth horizon sightings before the sleep period and five earth horizon sightings upon awakening.

CSM 7-5.- Concluded.

Mission independent

TABLE IV - (Concluded)

12/1/70 Basic

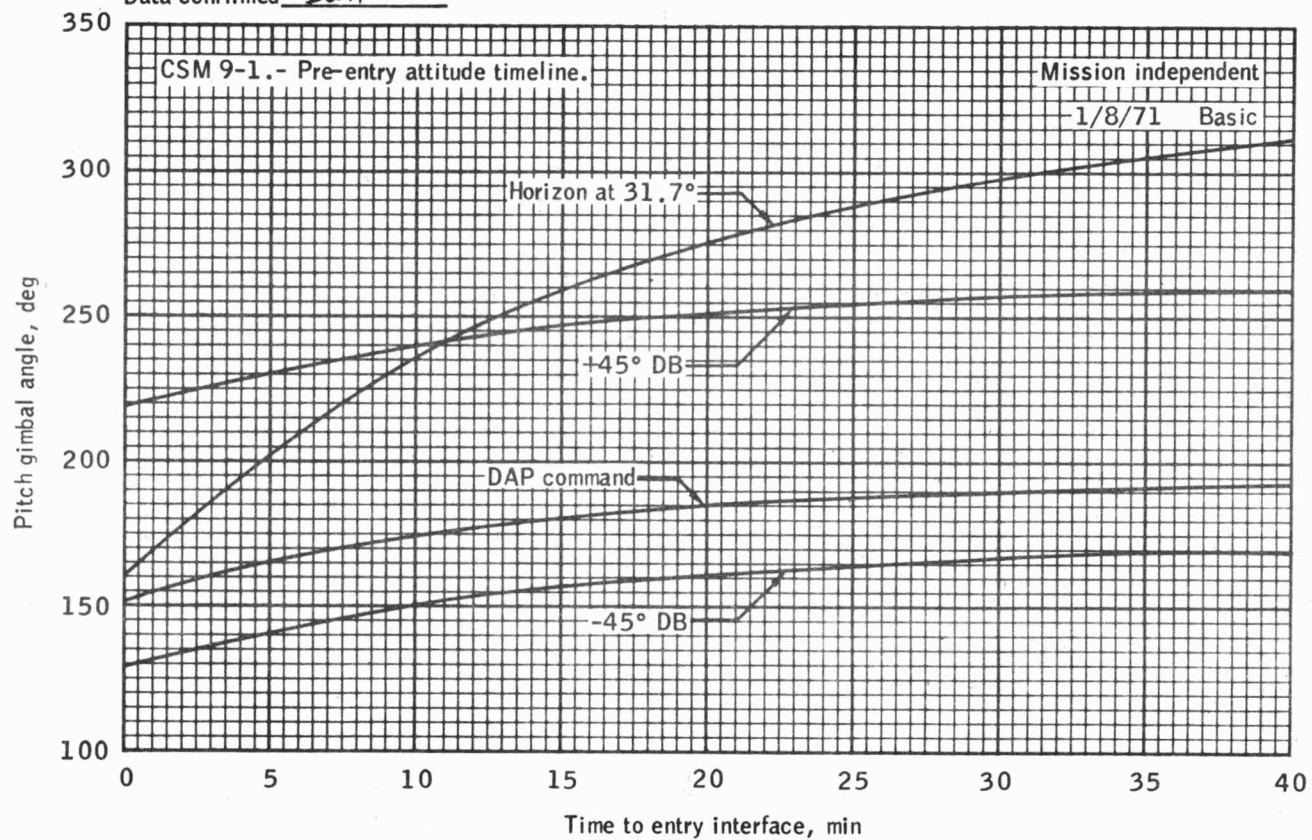
B. RETURN LENGTH <70 hrs

- 1 Sleep periods of 8 hours should be provided. Astronauts should be awake the last 10 hours before entry interface.
- 2 Three sets of star horizon observations should be scheduled every three hours while awake with five sets scheduled before and after each sleep period.
 - (a) A batch of lunar horizon sightings should be taken at TEI + 1 hour or perilune + 1 hour.
 - (b) The second batch of data should consist of earth horizon sightings.
 - (c) The third batch of data should consist of lunar horizon sightings.
 - (d) The remainder of the data should be earth horizon sightings. If no earth horizon sightings are available, lunar horizon sightings should be substituted.
- 3 Five earth/horizon sets should be scheduled at EI-5 hours before the MCC at EI = 3 hours. Three sets should be taken after the midcourse. If no earth horizon sightings are available, lunar horizon sightings should be substituted.

Heath/LAB/MPAD (for Entry Checklist and CSM Cue Cards)

Data source MSC I.N. 70-FM-71

Data confirmed DWrt

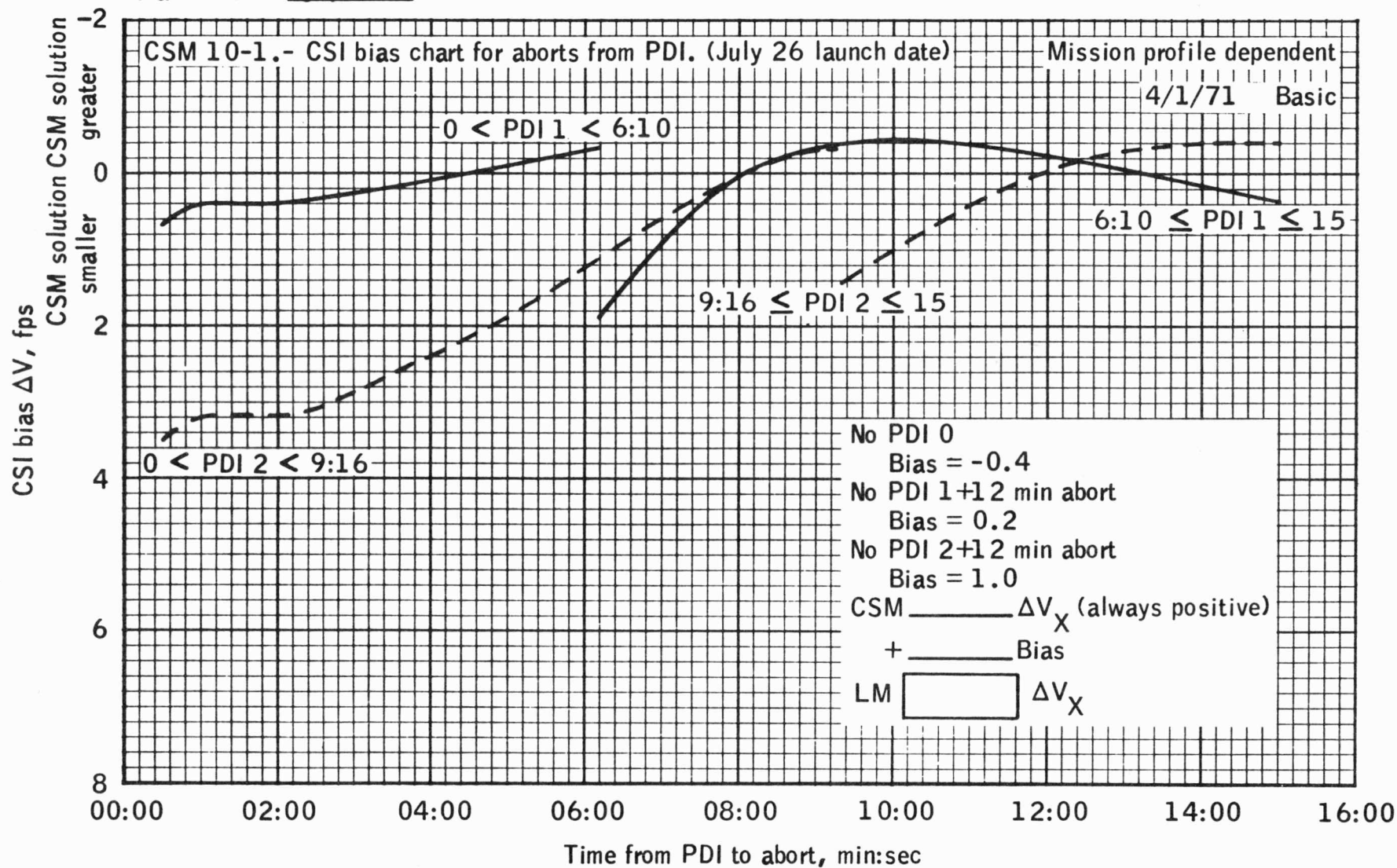


Pre-entry attitude timeline.

DuPont/OMAB/MPAD (for CSM Rescue LM Timeline)

Data source Spacecraft O.T.

Data confirmed Q7D

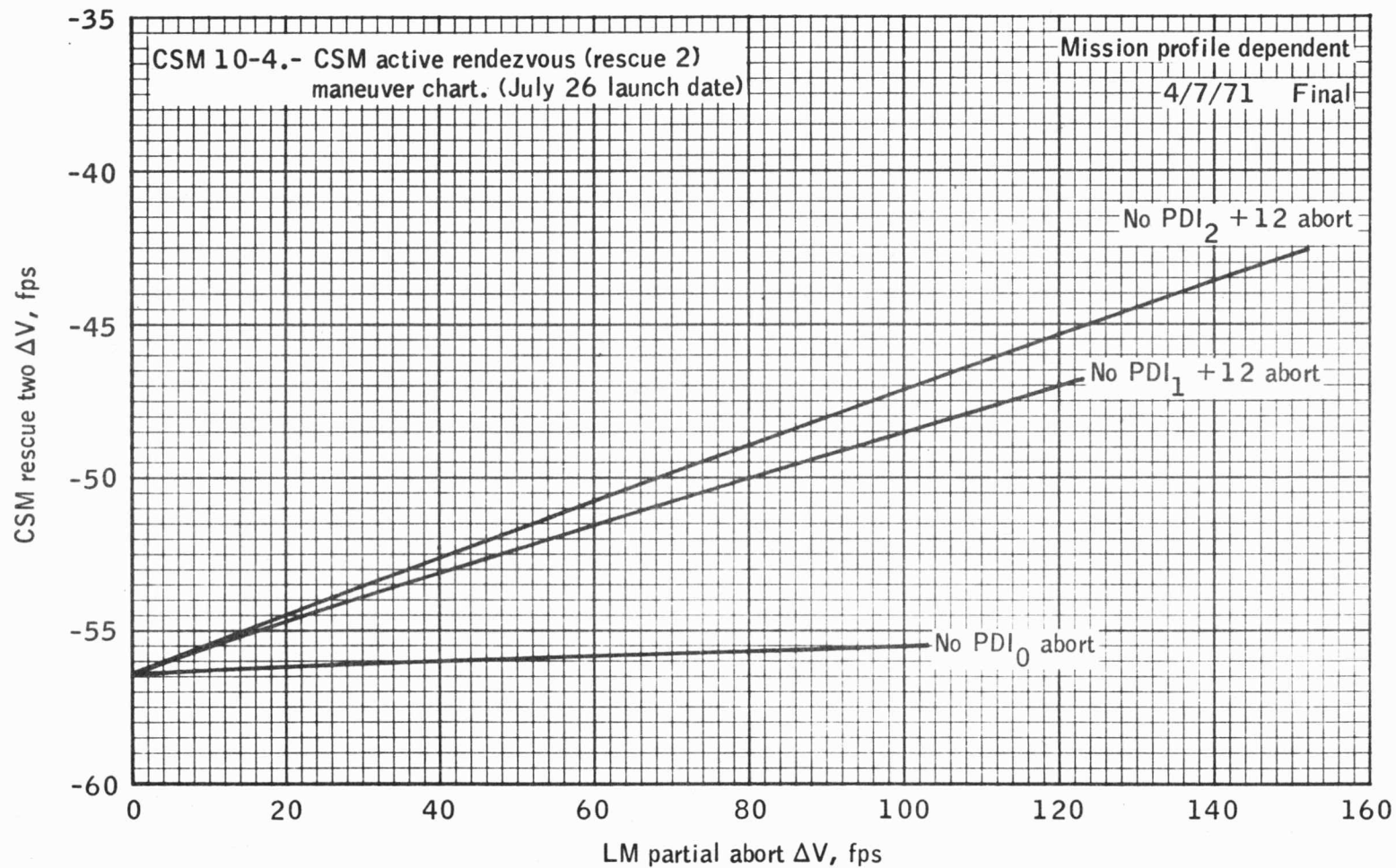


CSI bias chart for aborts from PDI.

DuPont/OMAB/MPAD (for CSM Rescue)

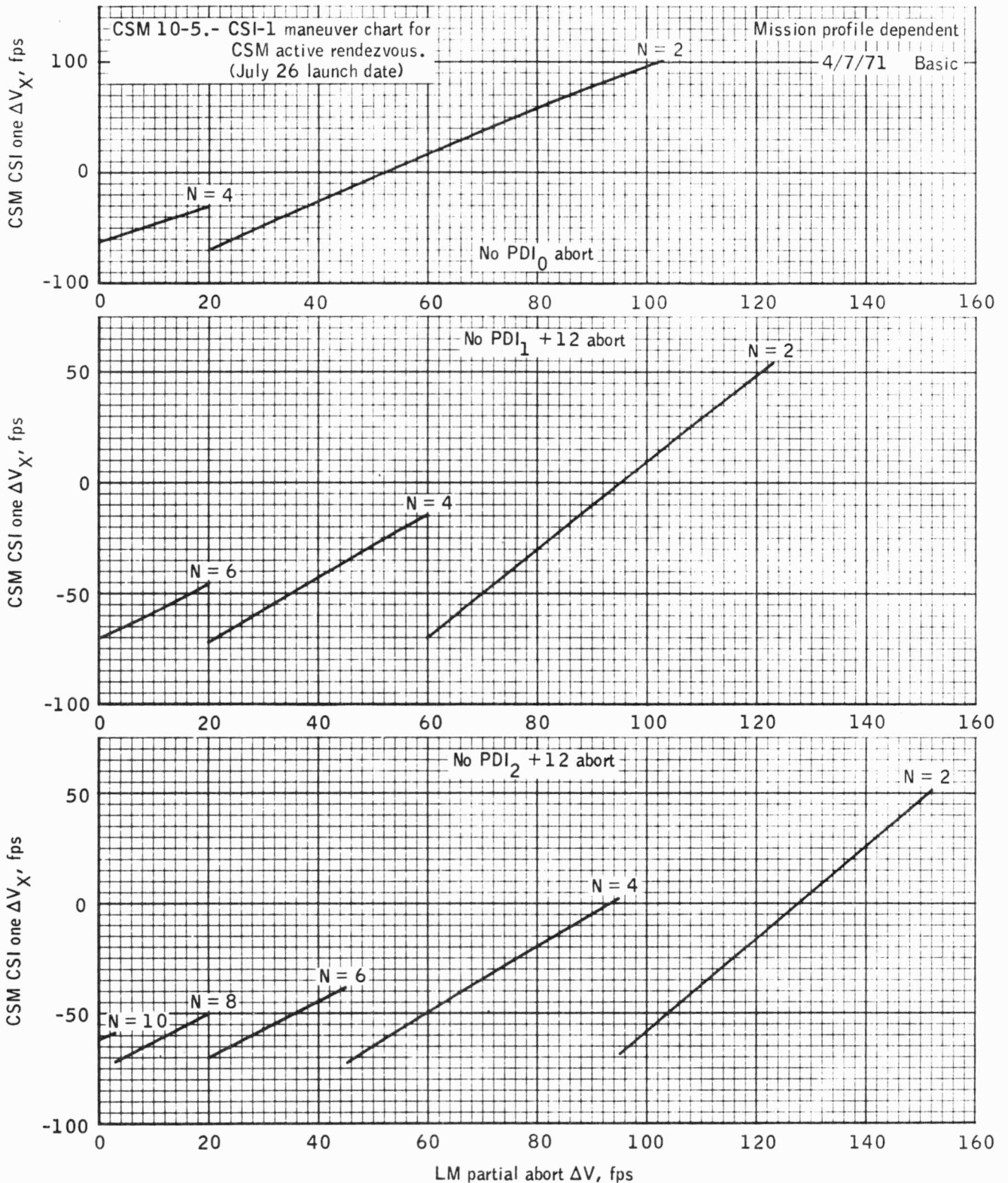
Data source Spacecraft O.T.

Data confirmed ASD



CSM active rendezvous (rescue 2) maneuver chart.

DuPont/OMAB/MPAD (for CSM Rescue)
 Data source Spacecraft 9 T.
 Data confirmed UFS

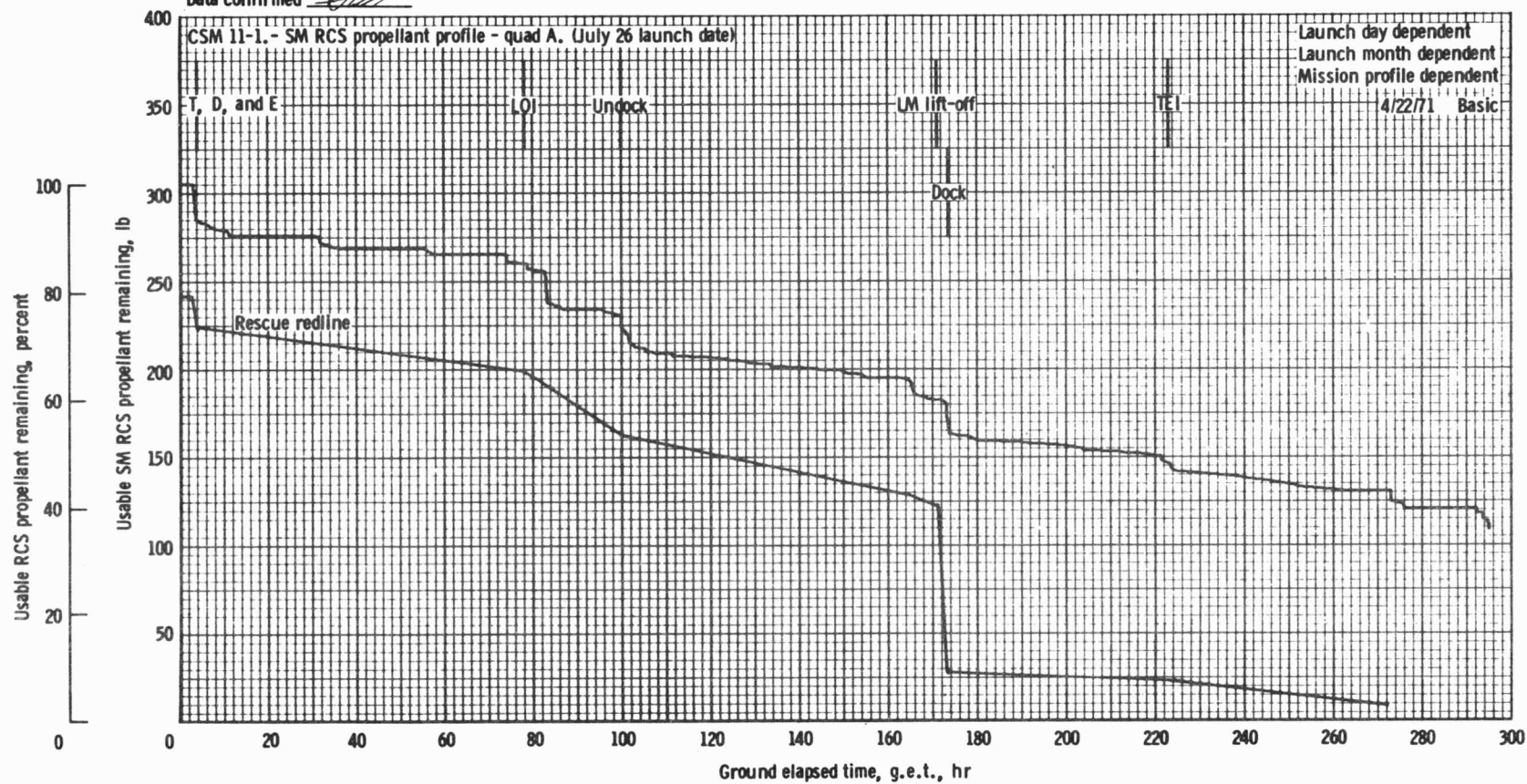


CSI-1 maneuver chart for CSM active rendezvous.

Mayfield/GPB/MPAD (for Flight Plan, CSM Systems Data)

Data source PRELIMINARY FLIGHT PLAN

Data confirmed MPAD

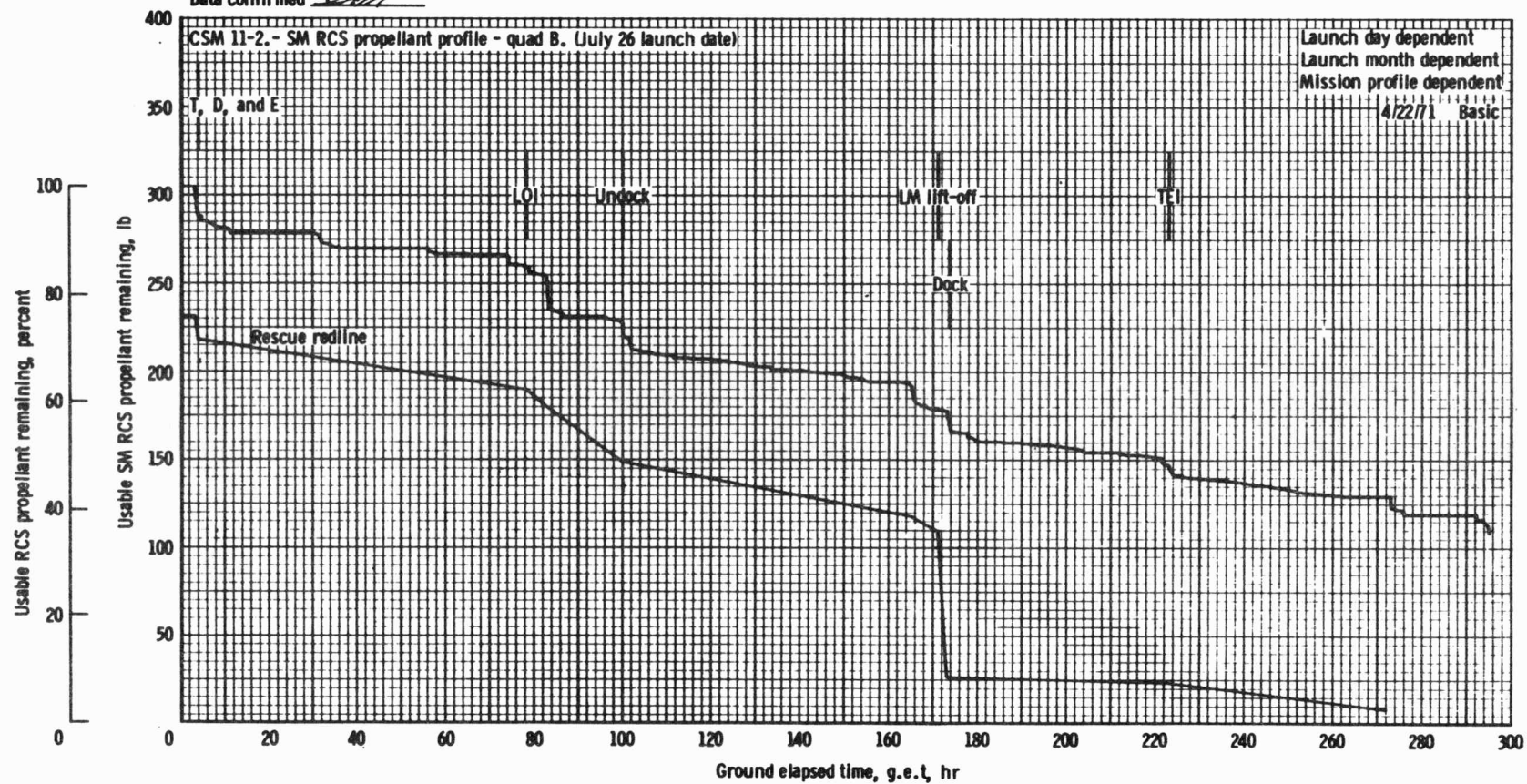


SM RCS propellant profile - quad A.

Mayfield/GPB/MPAD (for Flight Plan, CSM Systems Data)

Data source PRELIMINARY FLIGHT PLAN

Data confirmed 10/71

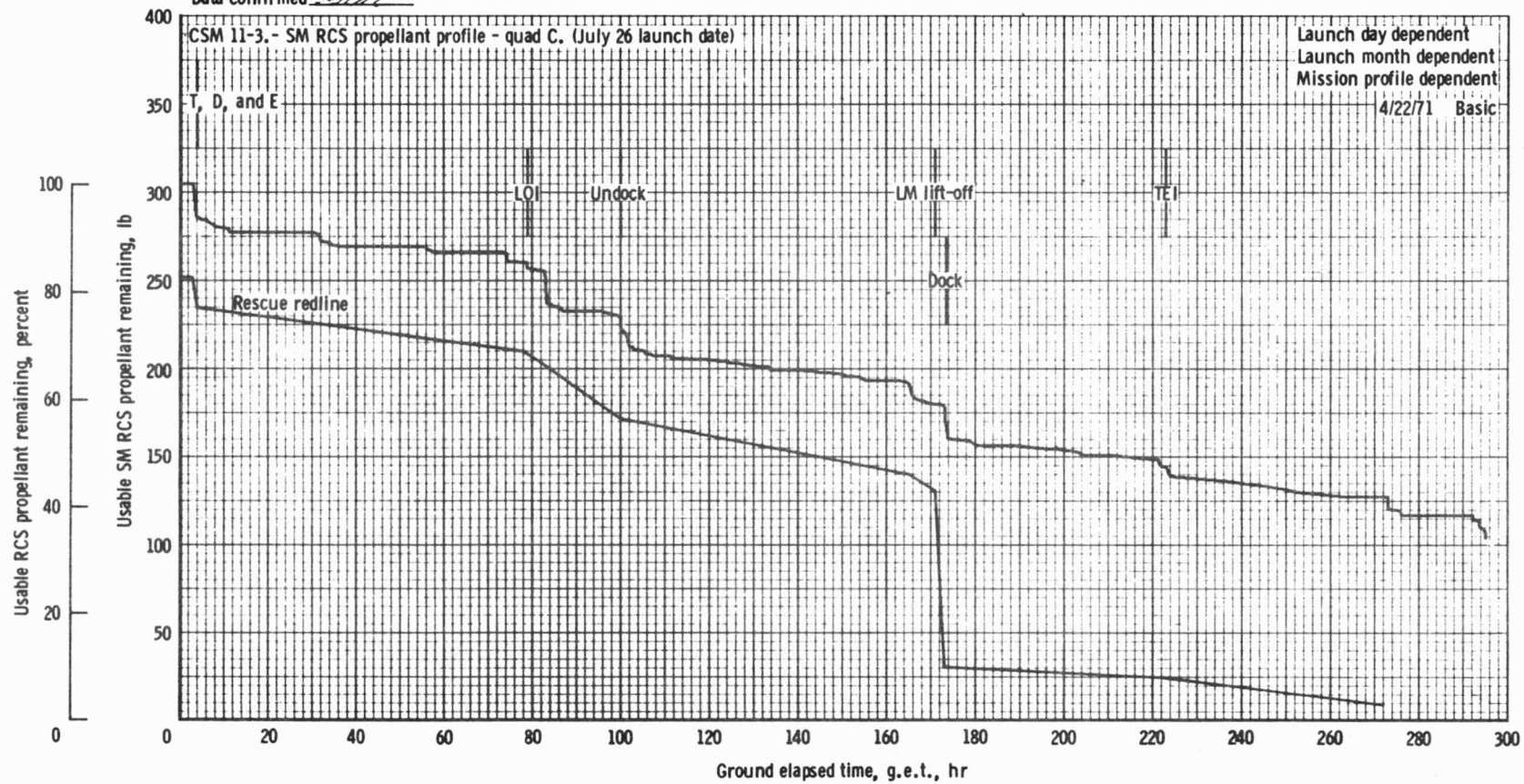


SM RCS propellant profile - quad B.

Mayfield/GPB/MPAD (for Flight Plan, CSM Systems Data)

Data source PRELIMINARY FLIGHT PLAN

Data confirmed 10/22

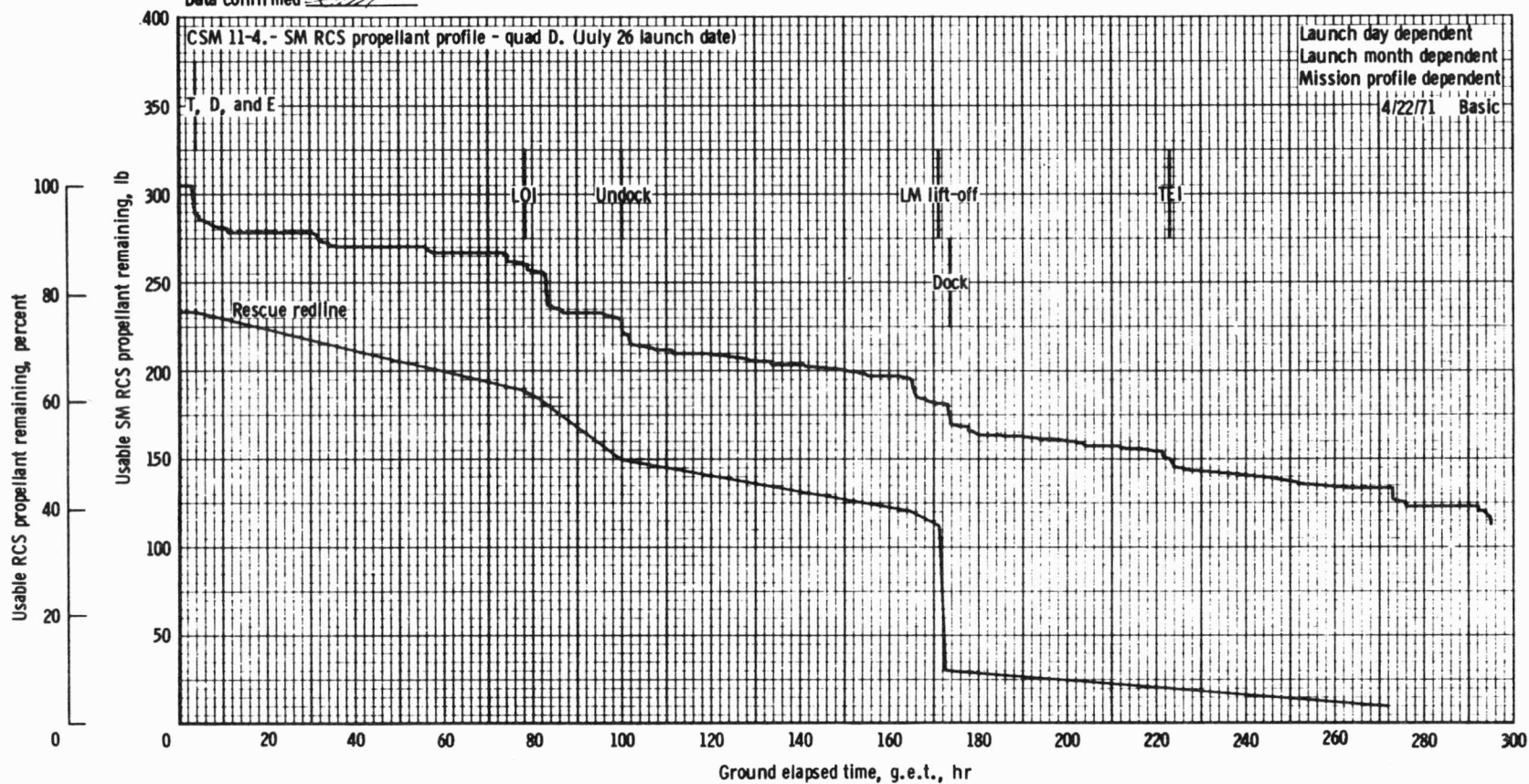


SM RCS propellant profile - quad C.

Mayfield/GPB/MPAD (for Flight Plan, CSM Systems Data)

Data source PRELIMINARY FLIGHT PLAN

Data confirmed 5/22/71

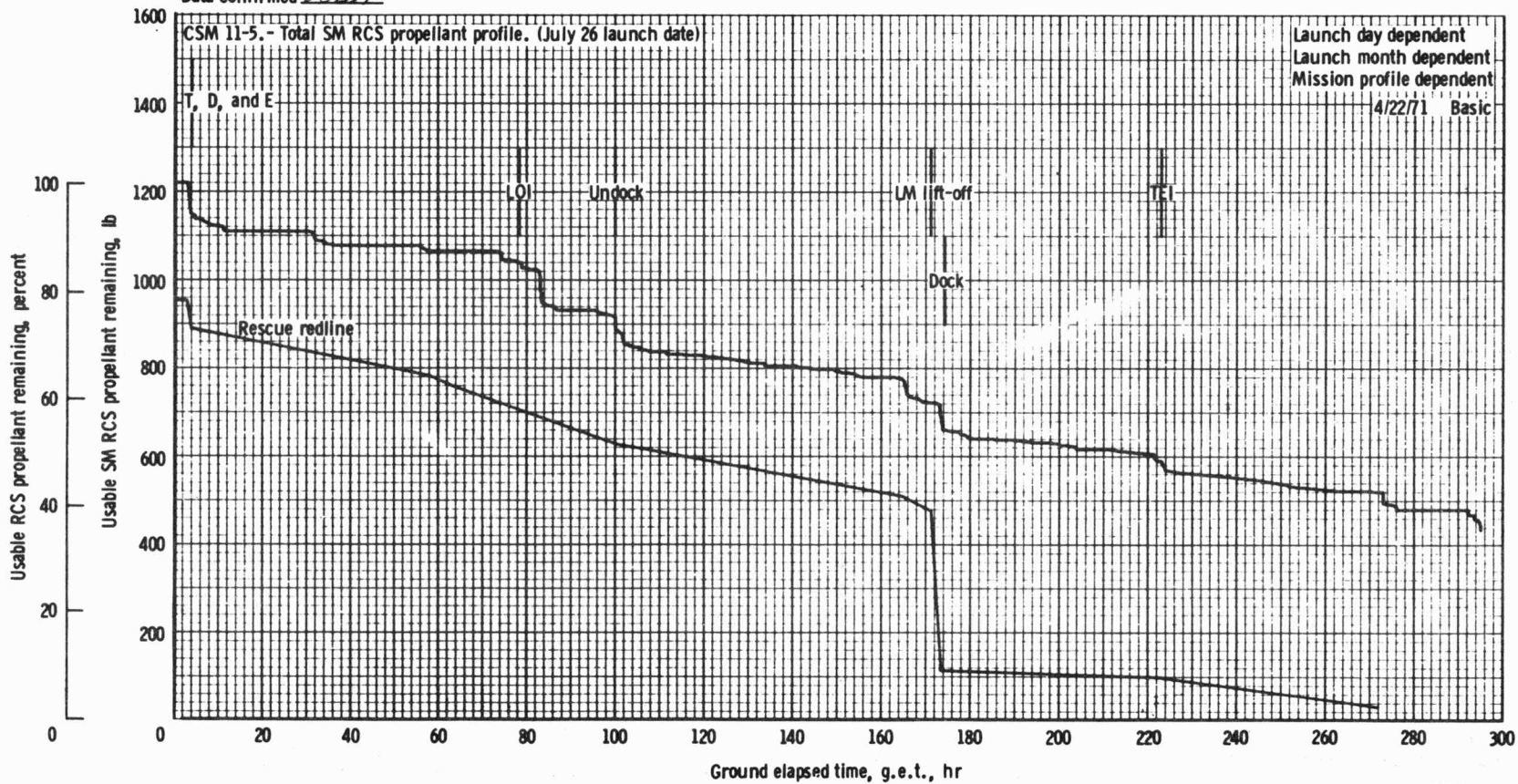


SM RCS propellant profile - quad D.

Mayfield/GPB/MPAD (for Flight Plan, CSM Systems Data)

Data source PRELIMINARY FLIGHT PLAN

Data confirmed SP11

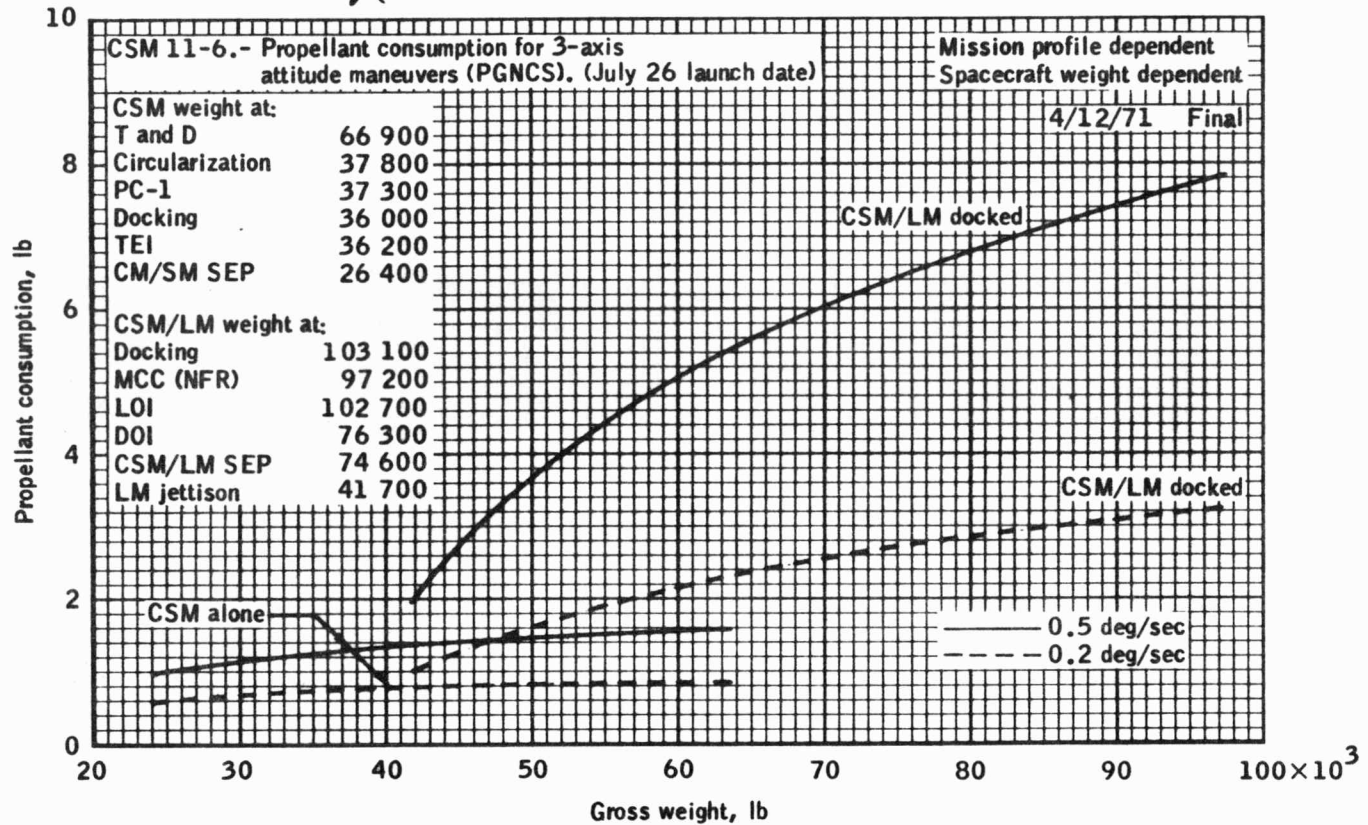


Total SM RCS propellant usage profile.

Loyd/GPB/MPAD (G and C Checklist)

Data source SOPB

Data confirmed Small Lloyd

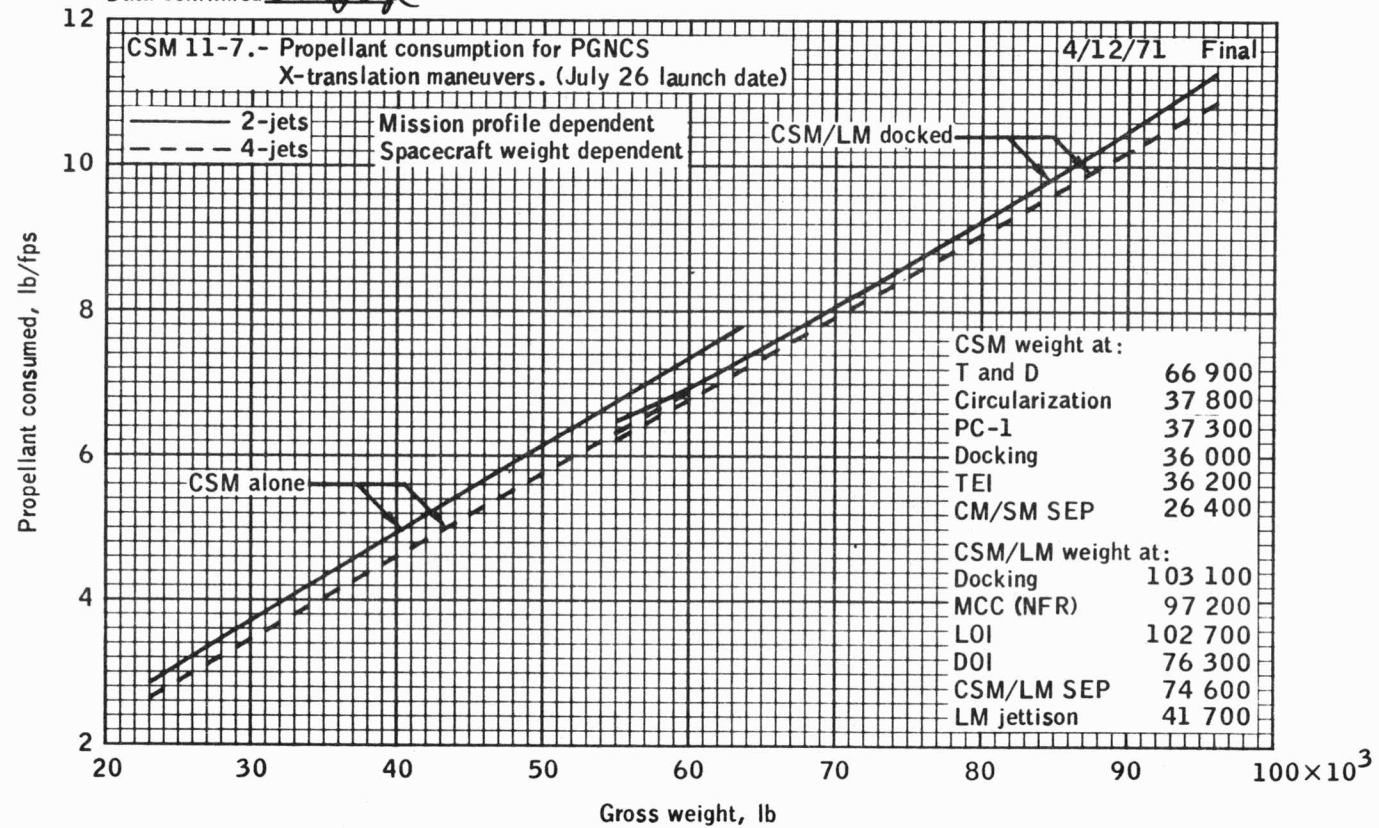


Propellant consumption 3-axis attitude maneuvers (PGNCS).

Loyd/GPB/MPAD

Data source SoDB

Data confirmed Guadalupe J. Loyd

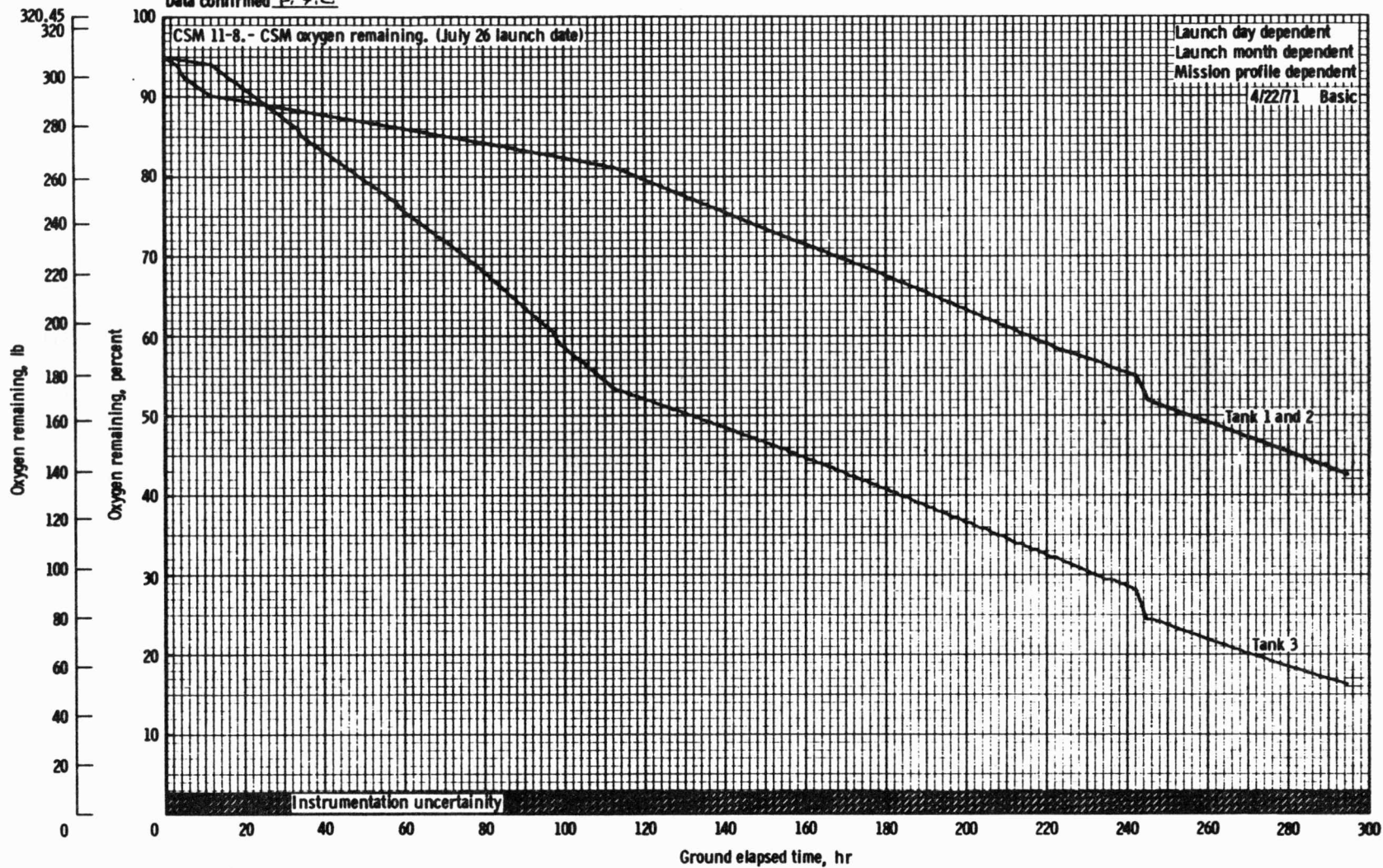


Propellant consumption for PGNCs X-translation maneuvers.

Cantin/GPB/MPAD (for Flight Plan)

Data source 3.1.1.1.5.0.1.5

Data confirmed P. J. C.



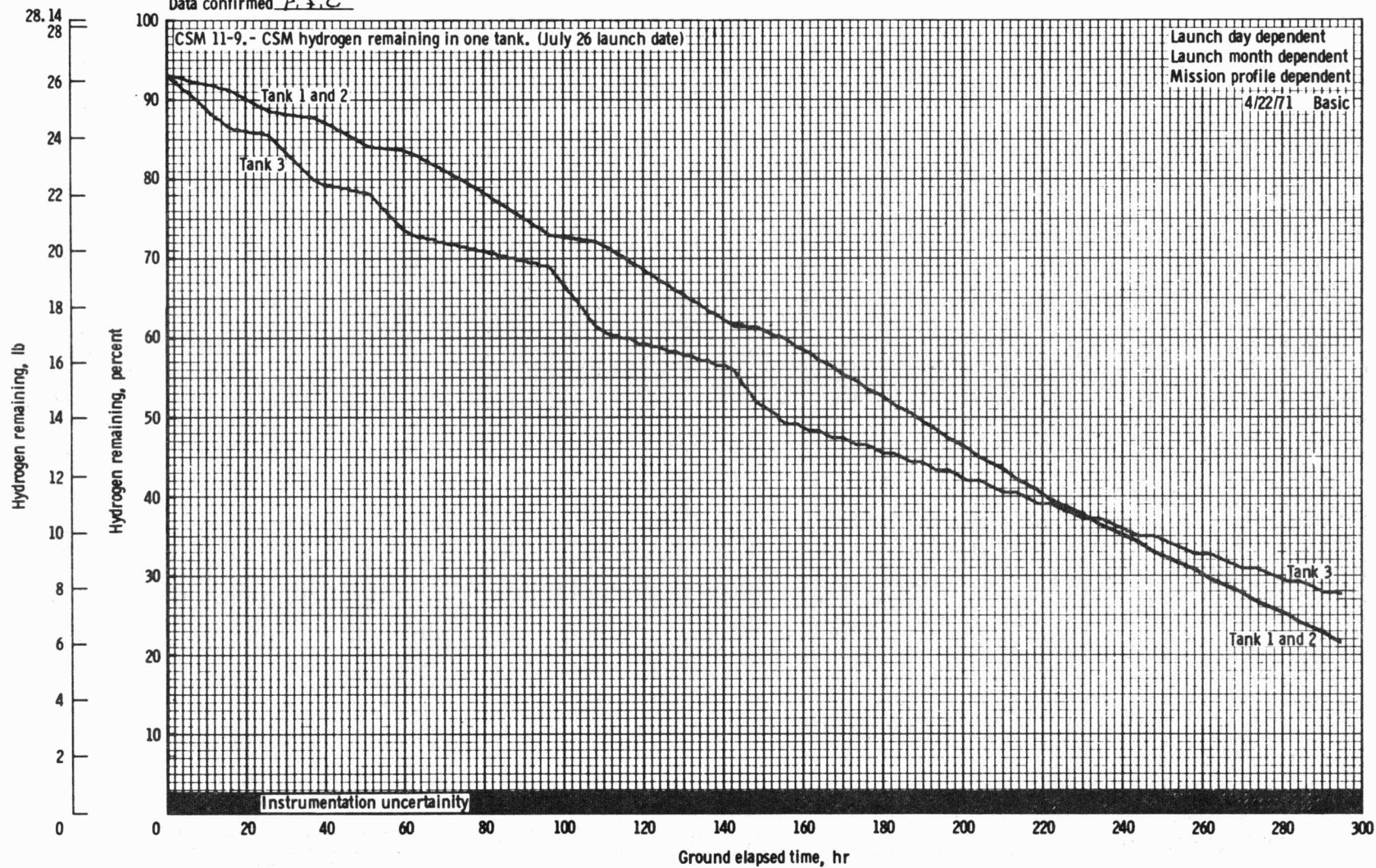
CSM oxygen remaining.

57

Cantin/GPB/MPAD (for Flight Plan)

Data source 7th, 8th, 5028

Data confirmed A. J. C.



CSM hydrogen remaining in one tank.

Cantin/GPB/MPAD (for Flight Plan)

Data source 308 Aln. 5028

Data confirmed P. 31C.

CSM 11-10.- Ground rules and assumptions
for the CSM cryogenics. (July 26 launch date)

Mission profile dependent
4/22/71 Basic

GROUND RULES AND ASSUMPTIONS FOR THE CSM CRYOGENICS

1. Three O_2 and H_2 tanks are available.
2. Fuel cell purging is included in the EPS requirements.
3. No cryogenic venting was assumed in flight.
4. The EPS hydrogen consumption rate ($\dot{H}_2$) (lb/hr) = $0.00257 \times I_{fc}$
when I_{fc} is the total fuel cell current.
5. The EPS oxygen consumption rate ($\dot{O}_2$) (lb/hr) = $7.936 \times \dot{H}_2$.
6. No allowance for the SM enhancement battery is assumed.

Cantin/GPB/MPAD (for Flight Plan)

Data source 706, Aln, 50 dBData confirmed A. F. C.CSM 11-11.- Cryogenic summary.
(July 26 launch date)Mission profile dependent
4/22/71 Basic

APOLLO 15 CRYOGENIC SUMMARY

	H ₂ lbs	O ₂ lbs
PLANNING ALLOWANCE		
TOTAL LOADED	87.9	990.3
LESS RESIDUAL	3.5	19.8
LESS INSTRUMENTATION ERROR	<u>2.3</u>	<u>26.0</u>
AVAILABLE FOR MISSION PLANNING	82.1	944.5
PRELAUNCH REQUIREMENT*	5.0	56.5
FLIGHT REQUIREMENT		
EPS (INCLUDING FUEL CELL PURGE)	58.7	464.9
ECS (INCLUDING CABIN PURGE + EVA)	--	108.7
LM PRESSURIZATION	<u>--</u>	<u>11.5</u>
	58.7	585.1
NOMINAL RESERVES		
EPS UNCERTAINTY (2.5%)	1.5	11.6
ECS UNCERTAINTY (.08 #/HR)	<u>--</u>	<u>23.6</u>
	1.5	35.2
TOTAL REQUIREMENT	65.2	676.8
MARGIN T = 0 (FILL/LAUNCH)	16.9	267.7

*Supplied by KSC.

Mayfield/GPB/MPAD (for Flight Plan)

Data source OFFICE IN ANALYSIS

Data confirmed 4/22/71

CSM 11-12.- CM RCS propellant summary.
(July 26 launch date)

Mission profile dependent
4/22/71 Basic

CM RCS PROPELLANT SUMMARY

Item	Propellant required, lb	Propellant remaining, lb
Loaded	--	245.0
Trapped	36.4	208.6
Available for mission planning . . .	--	208.6
Nominal usage	38.9	169.7
Nominal remaining	--	169.7

Mayfield/GPB/MPAD (for Flight Plan)

Data source PRELIMINARY FLIGHT PLAN

Data confirmed ASAP

CSM 11-13.- SM RCS budget.
(July 26 launch date)

Mission profile dependent
4/22/71 Basic

Ground Rules and Assumption

1. Following transposition and docking, the S-IVB performs the evasive maneuver.
2. Two midcourse corrections (translunar) are executed as SPS burns with one MCC followed by an RCS trim.
3. One midcourse correction (transearth) is executed as an RCS burn of 5 fps.
4. Quad management is to be determined during the mission.
5. Single jet RCS control during SIM exps.
6. Couple jet RCS control during SIM off periods (major burns)
7. All maneuvering at low rate ($0.2^\circ/\text{sec}$) both docked and undocked.
8. Attitude hold deadband during SIM photography and major burns - 0.5° .
9. Attitude hold deadband at other time - 5.0° .
10. Nominal 4-jet ullages.
11. Redlines have been defined by the Flight Control Division as an aid in assuring that mission rules are not violated during the mission. They are subject to review during the mission as mission phases are completed and systems capabilities are evaluated. In the event the rescue redline is violated prior to rendezvous, lunar orbit photography activities can be curtailed to conserve propellant. The lunar orbit redline includes a nominal transearth coast phase (with all navigational sightings) plus a 3 sigma G&N TEI cutoff error MCC. If a rescue is required and the lunar orbit redline is violated prior to the nominal TEI, TEI can be performed early and navigational sighting activity curtailed during the transearth phase. The rescue redline is based on the minimized activity during the transearth phase.

Mayfield/GPB/MPAD (for Flight Plan)

Data source PRELIMINARY FLIGHT PLAN

Data confirmed WILL

CSM 11-14.- SM RCS propellant loading Mission profile dependent
and usage summary. (July 26 launch date) 4/22/71 Basic

APOLLO 15 SM RCS ANALYSIS

Item	Required, lb	Remaining, lb
Expected loading	- -	1342.4
Initial outage M/R	15.6	- -
Total trapped	26.4	- -
Gaging inaccuracy	80.4	- -
Deliverable		1220.0
Nominal usage		
Translunar coast	181	- -
Lunar orbit	452	- -
Transearth coast	127	- -
Total	760	- -
Nominal remaining usable		460

Mayfield/GPB/MPAD (for Flight Plan)

Data source _____

Data confirmed _____

CSM 11-15.- Assumptions for the SPS
propellant analysis. (July 26 launch date)

Mission profile dependent
4/22/71 Basic

THE SPS ANALYSIS ASSUMPTIONS

FOR THE SPS PROPELLANT ANALYSIS

1. The 3σ dispersions are the RSS of the penalties imposed on the SPS margin by 3σ dispersions in propellant loading, mixture ratio, engine I_{sp} , maneuver ΔV , spacecraft weight, and consumable weight losses. All spacecraft weights and consumable losses are from Volume III, Rev 3, of the Spacecraft Operational Data Book.

2. The CSM/LM weights, for the J-missions, have increased to an extent that, for some launch dates, the SIV-B will not have sufficient propellant reserves to compensate for a 3σ engine. Thus, in order to have a combined 3σ confidence level for the S-IVB and CSM, the SIV-B ΔV deficit is covered in the SPS propellant budget. However, for the Apollo 15, July 26, 1971, launch date the SIV-B has adequate reserves for a 3 performance. Consequently, no SPS propellant allocation is required.

3. The ground rule for a contingency allowance is to budget for either a LM rescue or a maneuver to avoid adverse weather conditions at entry, whichever produces the least SPS propellant margin. For this launch date, the weather avoidance presents the worst case.

Mayfield/GPB/MPAD (for Flight Plan)

Data source SPS 11-16Data confirmed SPS 11-16CSM 11-16.- SPS propellant summary.
(July 26 launch date).Mission profile dependent
4/22/71 Basic

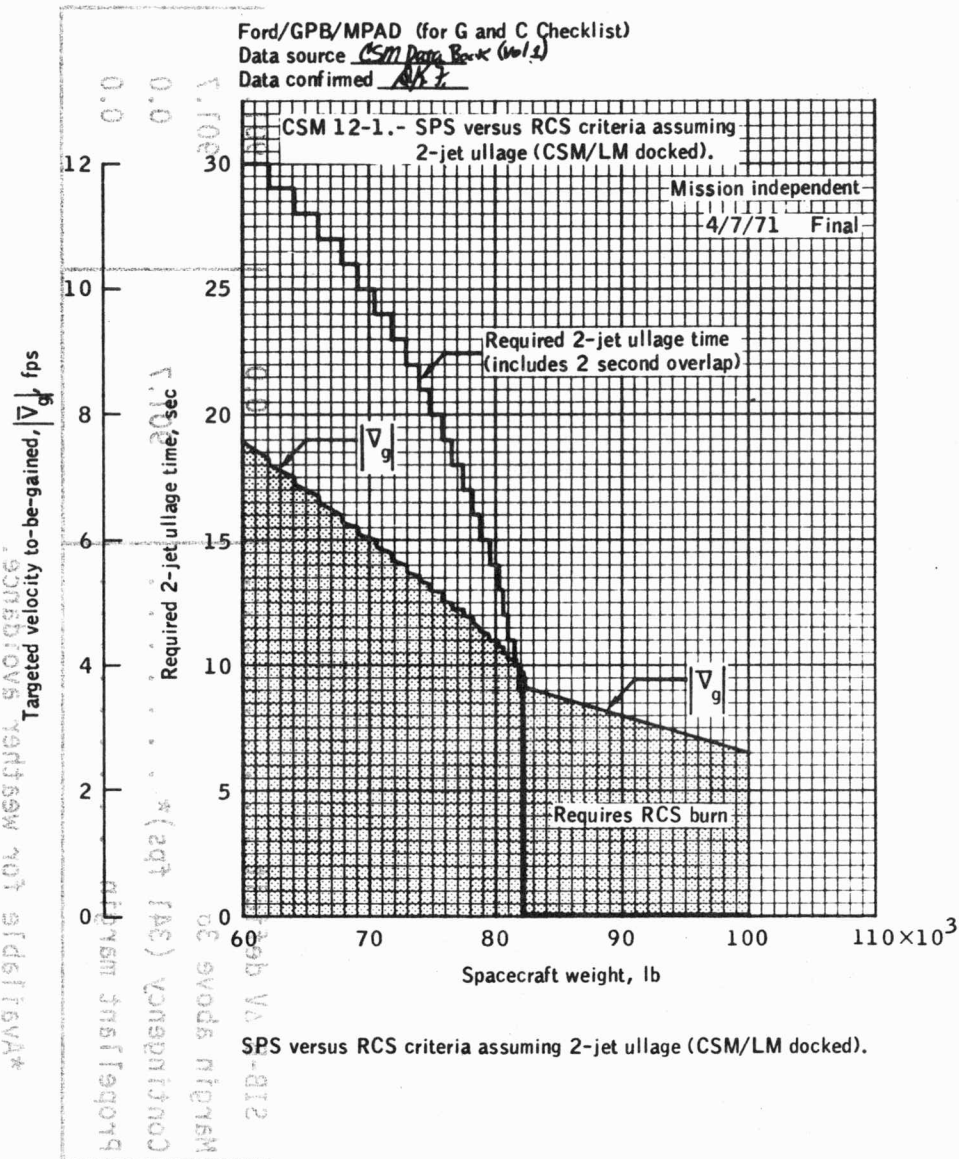
APOLLO 15 SPS PROPELLANT SUMMARY

JULY 26, 1971, LAUNCH DATE; 80° LAUNCH AZIMUTH

Item	Required, lb	Remaining, lb
Expected loading		40 796.0
Trapped and unavailable	441.4	40 354.6
Outage	59.8	40 294.8
Unbalance meter	100.0	40 194.8
Available for ΔV		40 194.8
Required for ΔV		
LOI (2997.9 fps)	26 277.4	13 917.4
DOI (207.6 fps)	1 559.7	12 357.7
CIRC (70.8 fps)	278.3	12 079.4
LOPC (308.6 fps)	1 133.2	10 946.2
TEI (3046.7 fps)	9 413.8	1 532.4
Nominal remaining		
Dispersions		
TLMC (23 fps)	262.7	1 269.7
-3 σ performance	368.0	901.7
SIB-B ΔV deficit	0.0	901.7
Margin above 3 σ		901.7
Contingency (341 fps)*	901.7	0.0
Propellant margin		0.0

*Available for weather avoidance.

Ford/GPB/MPAD (for G and C Checklist)
 Data source CSM Data Book (Vol. 1)
 Data confirmed AKZ



SPS versus RCS criteria assuming 2-jet ullage (CSM/LM docked).

Assumptions

Spacecraft weight assumed to consist of CSM and fully loaded LM

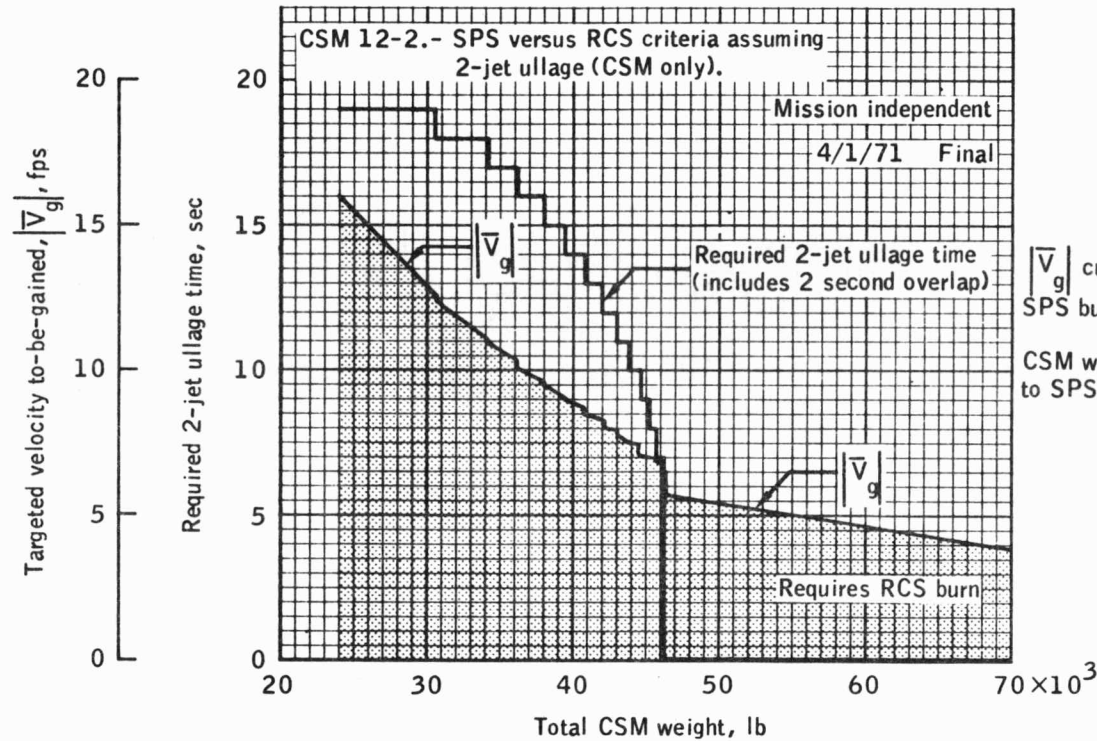
$|\bar{V}_g|$ curve represents minimum SPS burn of 0.5 seconds

CSM weight variations are due to SPS propellant loss only

Ford/GPB/MPAD (for G and C Checklist)

Data source CSM Data Book (vol 3)

Data confirmed A.F.

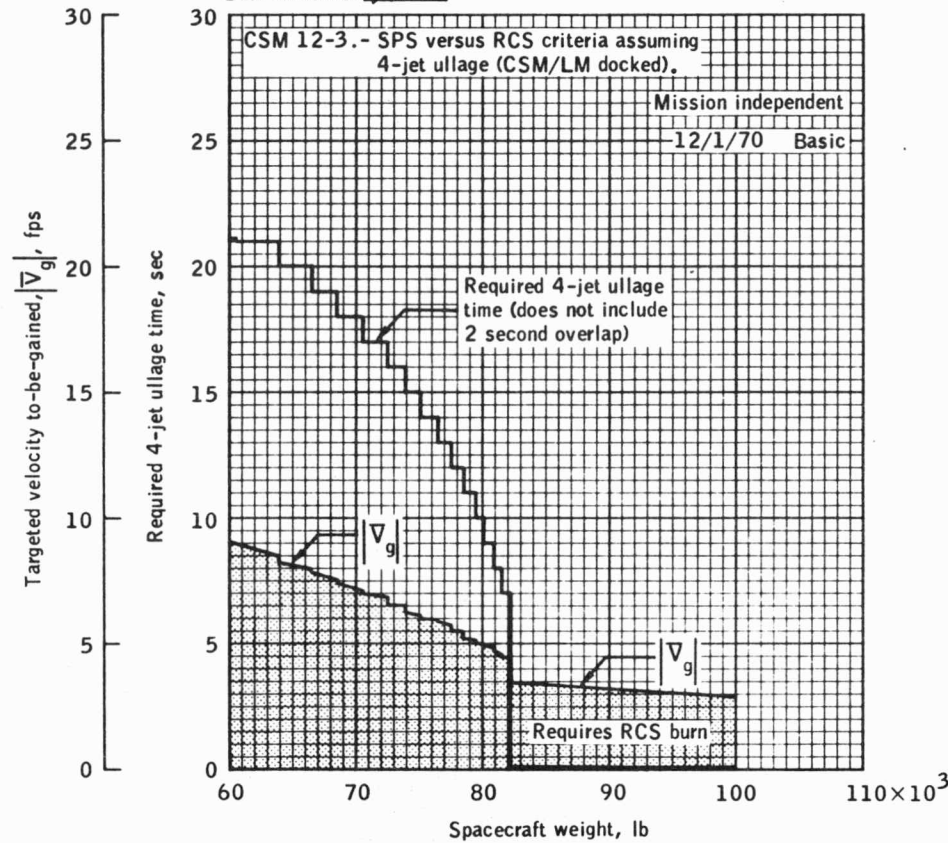


SPS versus RCS criteria assuming 2-jet ullage (CSM only).

Ford/GPB/MPAD (for G and C Checklist)

Data source CSM Data Book (Vol. 1)

Data confirmed AK-31



SPS versus RCS criteria assuming 4-jet ullage (CSM/LM docked).

Assumptions

Spacecraft weight assumed to consist of CSM and fully loaded LM

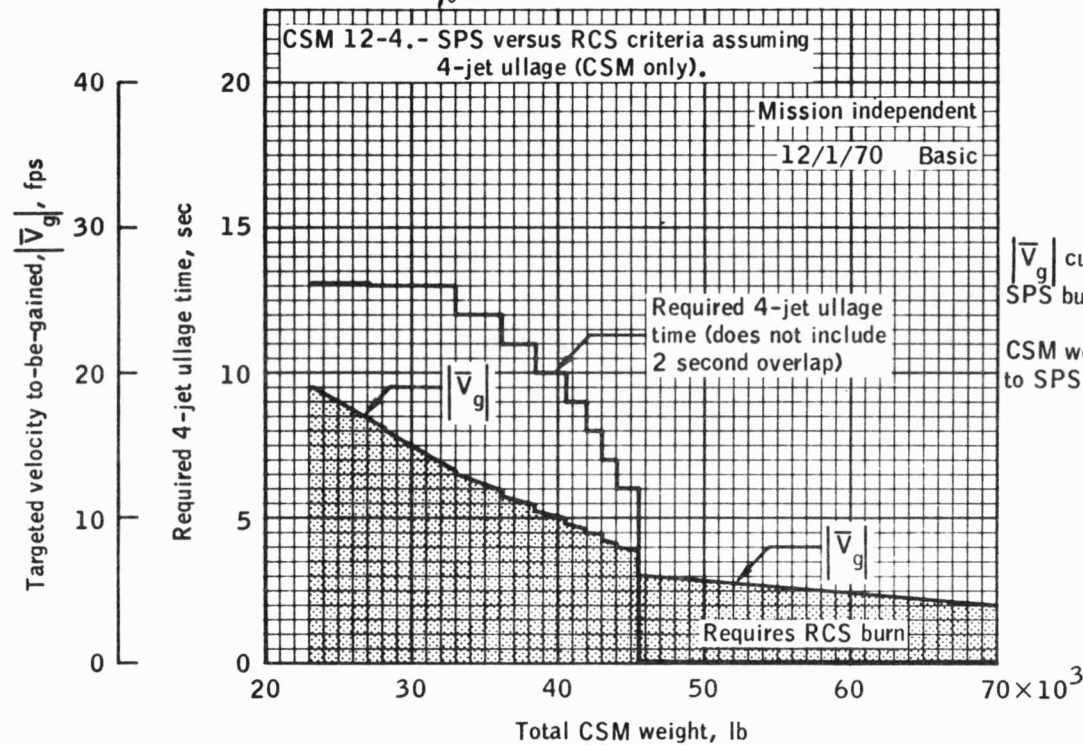
$|V_g|$ curve represents minimum SPS burn of 0.5 seconds

CSM weight variations are due to SPS propellant loss only

Ford/GPB/MPAD (for G and C Checklist)

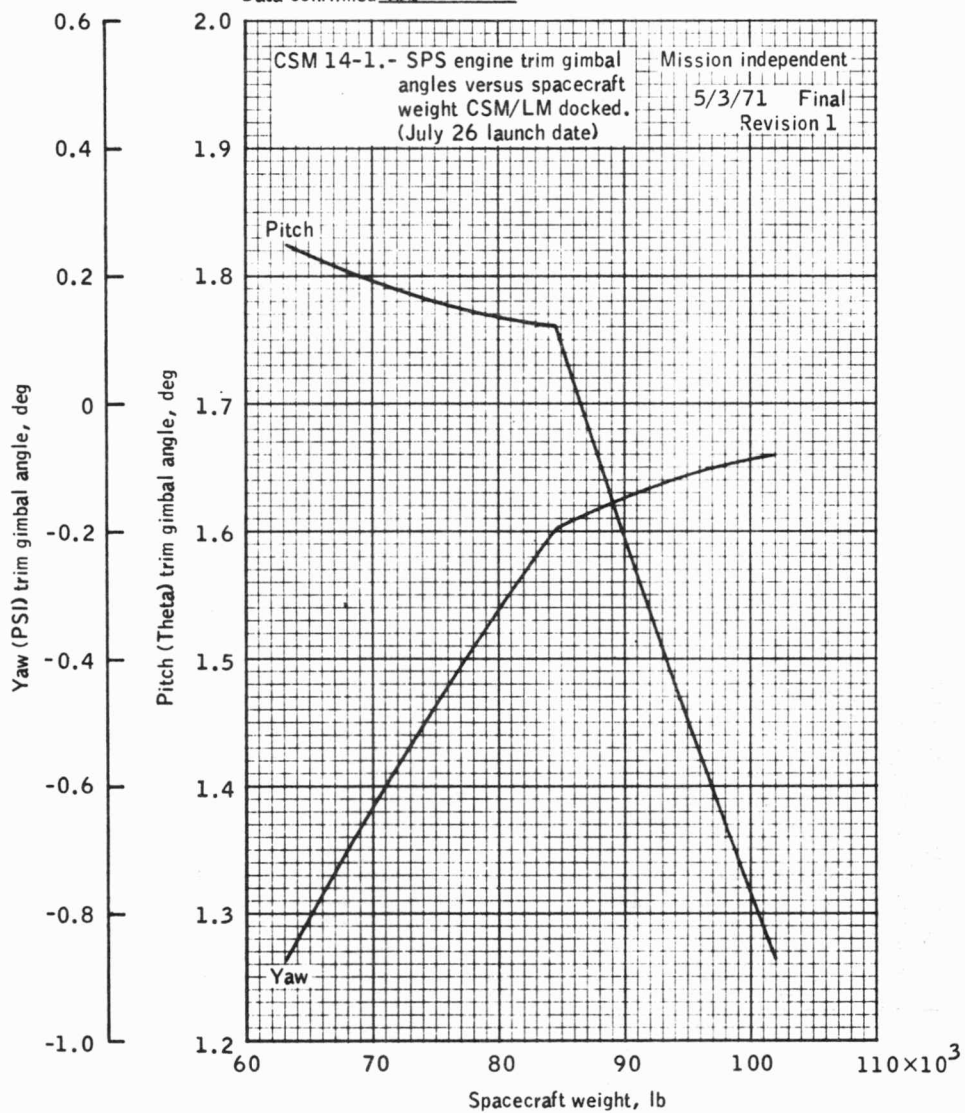
Data source CSM Data Book Vol 1

Data confirmed D.K.F.



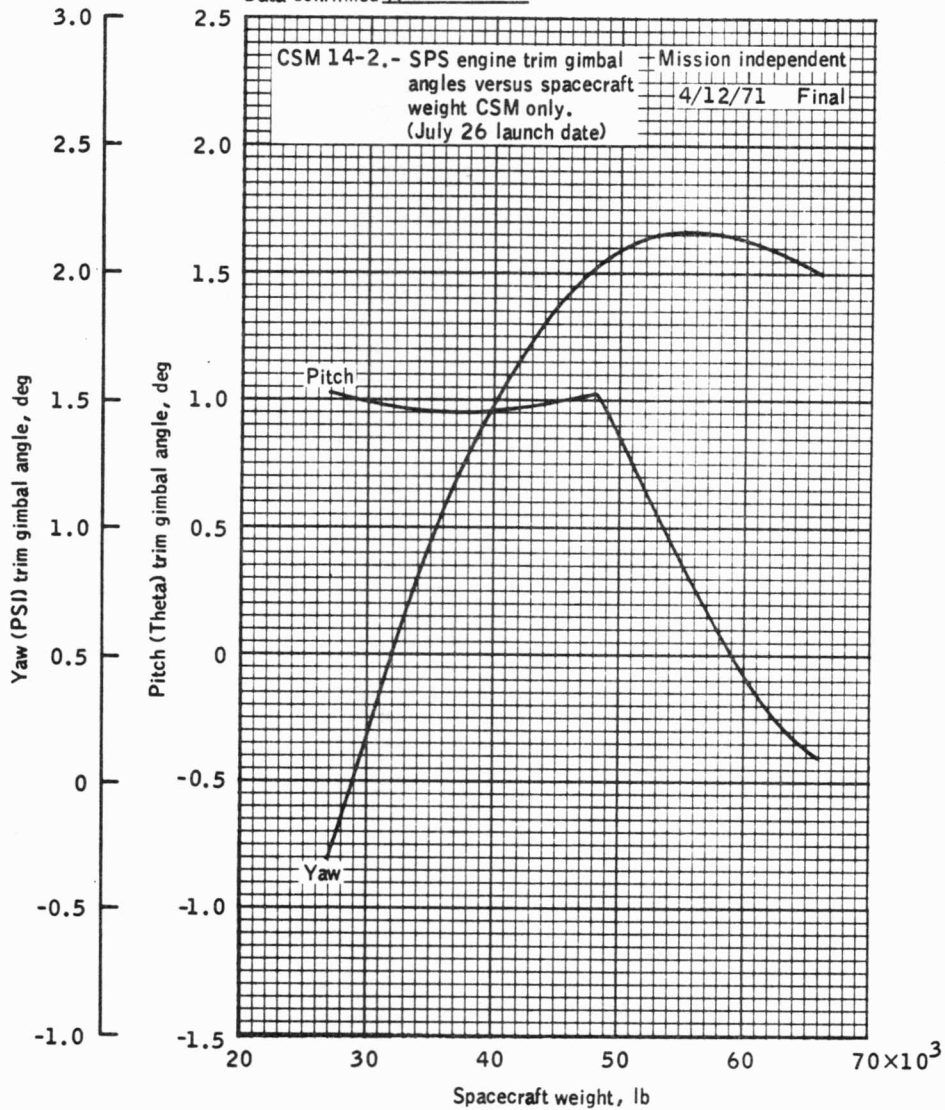
SPS versus RCS criteria assuming 4-jet ullage (CSM only).

Hischke/MPSO/MPAD (G and C Checklist)

Data source SPR V-III A-74Data confirmed GA

SPS engine trim gimbal angles versus spacecraft weight CSM/LM docked.

Hischke/MPSO/MPAD (for G and C Checklist)

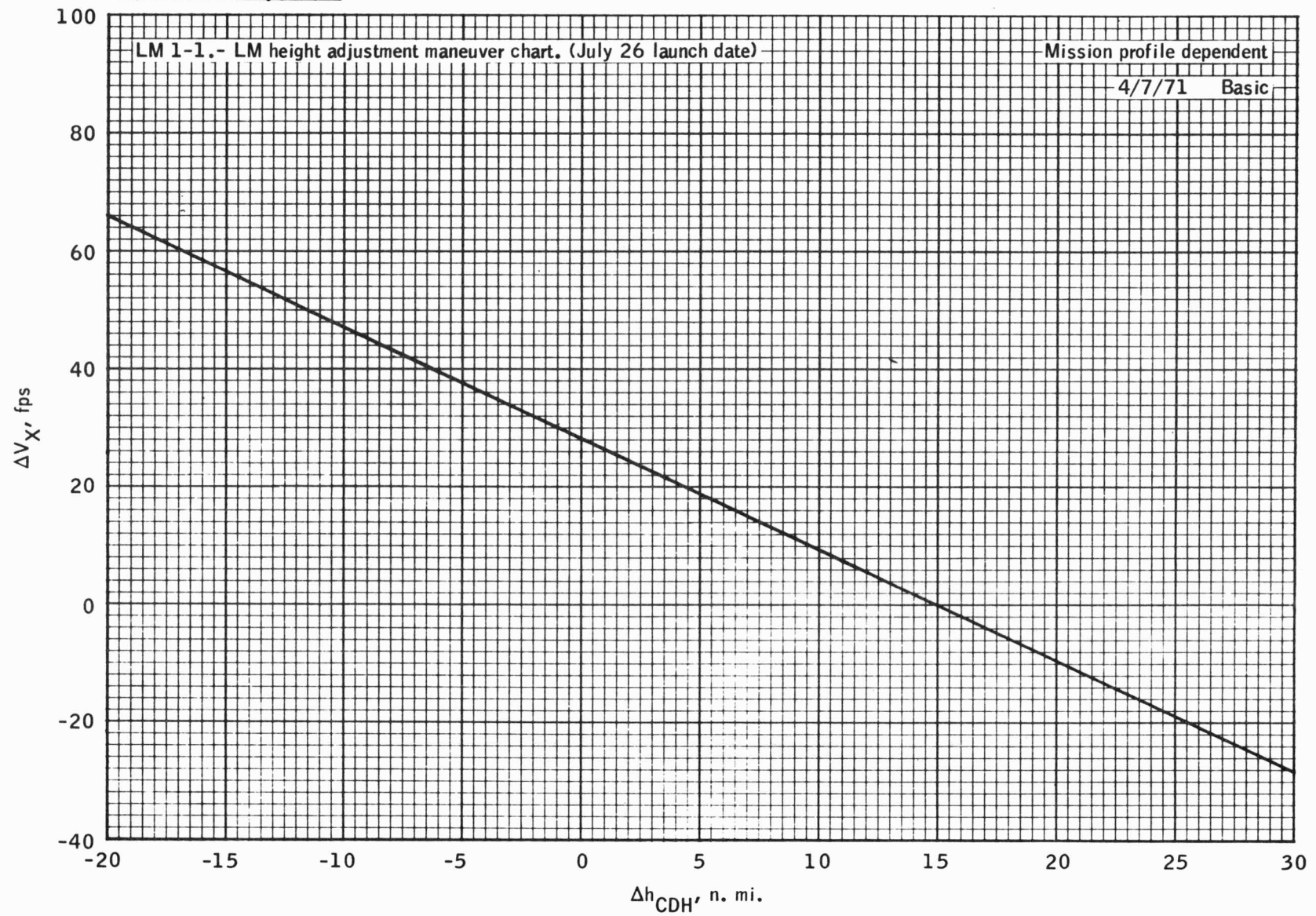
Data source SPDS VIII A-94Data confirmed RA

SPS engine trim gimbal angles versus
spacecraft weight CSM only.

DuPont/OMAB/MPAD (for LM Timeline)

Data source Spacecraft O.T.

Data confirmed 10/20/71



LM height maneuver chart.

Moore/OMAB/MPAD (for LM Timeline)

Data source Wallops 15 D.T.

Data confirmed Apr 17 RMM

LM 2-1.- Range and range rate table.
(July 26 launch date)

Mission profile dependent

5/3/71 Basic
Revision 1

M = 1

TIME min:sec	RANGE n. mi.	RANGE RATE fps
L.O.		
5:00	139.7	1659.5
6:00	152.1	812.9
7:00	155.4	-174.5
INS	154.6	-445.8
1:00	150.2	-442.7
2:00	145.8	-439.1
3:00	141.5	-435.0
4:00	137.2	-430.3
5:00	133.0	-425.2
6:00	128.8	-419.6
7:00	124.6	-413.5
8:00	120.6	-407.1
9:00	116.6	-400.1
10:00	112.6	-392.8

Moore/OMAB/MPAD. (for LM Timeline)

Data source Ballistic Rnd. for July 26

Data confirmed: Lang 3 Rm

LM 2-2.- Range and range rate table.
(July 26 launch date)

Mission profile dependent

5/3/71 Basic

$$M = 2$$

TIME min:sec	RANGE n. mi.	RANGE RATE fps
INS	282.8	-451.3
1:00	278.4	-447.3
2:00	273.9	-443.7
3:00	269.6	-437.5
4:00	265.3	-431.8
5:00	261.0	-425.6
6:00	256.8	-418.9
7:00	252.7	-411.7
8:00	248.6	-404.0
9:00	244.7	-396.0
10:00	240.8	-387.5

Fridge, DuPont/OMAB/MPAD (for LM Timeline)

Data source Spacecraft C.T.

Data confirmed JFD C.T.

LM 3-1.- PDI abort summary data. (July 26 launch date)

Launch month dependent
Mission profile dependent

4/30/71 Basic
Revision 1

PAGE	ABORT	INS			BOOST	HAM	CSI		CDH			TPI	AIM		
		TIME PDI+	N76	HA/HINS	TIME INS+	TIME INS+	TIME INS+	ΔVX	TIME INS+	ΔVX	ΔVZ		TIME PDI+	ΔVX	ΔVZ
	PDIO	NA	NA	NA	NA	NA	1+00+31Δ	48.6	2+02+37Δ	-121.7	26.5	2+46+19Δ	NA	102.8	0.0
	NO 1+12	NA	NA	NA	1+07+00*	2+07+00*	3+07+00*	36.1	4+09+24*	-129.7	-4.3	4+49+41	12+00	112.8	-50.0
	1+00	2+07	5672.7	145.6/53004.	1+00+00	2+00+00	3+00+00	38.0	4+02+24	-129.0	-12.4	4+49+47	NA	NA	NA
	2+00	4+02	5666.1	144.4/60016.				35.8	4+02+19	-126.7	-10.9				
	3+00	5+44	5663.7	142.5/60020.				35.4	4+02+14	-124.2	-6.4				
	4+00	7+21	5660.2	139.6/60025.				35.1	4+02+05	-120.5	.7				
	5+00	8+52	5655.6	135.8/60033.				34.9	4+01+55	-115.6	10.4				
	6+00	10+16	5649.5	130.9/60042.				34.6	4+01+41	-109.3	21.9				
	7+00	12+35	5660.1	142.8/65668.	NA	NA	0+55+00	41.3	1+57+09	-121.6	-64.3	2+51+20	NA	NA	NA
	8+00	14+36	5634.8	125.6/71201.				41.1	1+56+24	-101.6	-38.9				
	9+00	16+13	5611.6	108.7/73761.				41.3	1+55+40	-81.2	-17.1				
	10+00	17+24	5595.2	95.0/72046.	NA	NA	0+55+00	42.2	1+55+04	-64.0	-1.7	2+51+20	NA	NA	NA
	11+00	18+25	5584.4	83.2/65533.				44.0	1+54+33	-48.9	9.6				
	12+00	19+27	5571.2	71.0/61463.				45.1	1+53+60	-32.8	19.5				
	13+00	20+29	5553.1	57.0/60268.				45.4	1+53+22	-14.0	28.8				
	14+00	21+28	5538.0	46.0/60265.				45.4	1+52+53	1.2	34.4				
	15+00	22+27	5522.8	35.1/60261.				45.3	1+52+23	16.5	38.1				
	T2-1	7+21Ω	5515.8	30.2/60244.	50+00	1+50+00	2+40+00	38.2	3+37+15	20.2	22.9	4+49+42	NA	NA	NA
	NO 2+12	NA	NA	NA	1+12+00*	2+12+00*	3+12+00*	35.0	4+15+33*	-159.0	3.3	4+54+30	12+00	143.3	-50.0
	1+00	2+10	5701.3	169.4/52994.	1+00+00	2+00+00	3+00+00	34.9	4+03+23	-153.9	-92.0	4+52+35	NA	NA	NA
	2+00	4+05	5694.6	168.0/60019.				32.8	4+03+18	-151.9	-89.2				
	3+00	5+46	5692.4	166.2/60021.				32.6	4+03+13	-150.0	-83.1				
	4+00	7+23	5688.9	163.3/60026.				32.9	4+03+06	-146.7	-73.0				
	5+00	8+53	5684.3	159.4/60034.				33.3	4+02+56	-142.5	-59.9				
	6+00	10+18	5678.3	154.5/60043.				33.8	4+02+44	-137.2	-43.8				
	7+00	12+36	5665.9	147.6/65694.	1+00+00	2+00+00	3+00+00	32.8	4+02+25	-129.1	-25.1	4+52+35	NA	NA	NA
	8+00	14+38	5651.0	138.7/71250.				31.7	4+02+01	-118.6	-2.4				
	9+00	16+15	5638.7	130.2/73801.				31.1	4+01+38	-108.2	17.6				
	10+00	17+27	5656.7	143.8/72131.	NA	NA	0+55+00	39.6	1+57+12	-122.8	-66.4	2+56+08	NA	NA	NA
	11+00	18+29	5646.8	131.9/65587.				42.1	1+56+41	-109.2	-48.4				
	12+00	19+31	5634.4	119.7/61523.				43.8	1+56+09	-94.8	-31.5				
	13+00	20+32	5617.6	105.8/60282.	NA	NA	0+55+00	44.8	1+55+33	-77.8	-14.0	2+56+08	NA	NA	NA
	14+00	21+31	5603.6	94.9/60279.				45.2	1+55+04	-64.1	-1.9				
	15+00	22+31	5589.3	84.1/60276.				45.4	1+54+35	-50.2	8.5				
	T2-2	7+21Ω	5515.8	30.2/60244.	NA	NA	0+50+00	47.7	1+47+14	20.9	26.8	2+56+02	NA	NA	NA

63

Ω INDICATES TIME IS REFERENCED TO LIFT-OFF.

*INDICATES TIME IS REFERENCED TO PDI.

ΔINDICATES TIME IS REFERENCED TO AIM.

DuPont/OMAB/MPAD (for LM Timeline)

Data source Spacecraft C.T.

Data confirmed QXR

LM 4-1.- Range and range rate data at insertion and 10 minutes prior to subsequent maneuvers. (July 26 launch date)

Mission profile dependent

4/30/71 Basic
Revision 1

PAGE	ABORT	INS		BOOST		HAM		CSI		CDH	
	TIME PDI+	RANGE	RANGE RATE	RANGE	RANGE RATE	RANGE	RANGE RATE	RANGE	RANGE RATE	RANGE	RANGE RATE
	PDIO	NA	NA	NA	NA	NA	NA	148.8	-542.7	105.9	-190.8
	NO 1+12	NA	NA	377.5	-700.9	149.9	445.8	187.8	-597.4	100.0	-165.0
	01+00	371.5	595.6	368.5	-689.3	137.9	451.5	185.9	-587.7	105.5	-167.6
	02+00	368.2	582.9	364.3	-678.0	138.2	440.9	183.5	-579.2	102.9	-153.0
	03+00	354.0	570.6	349.3	-662.7	131.6	434.8	174.2	-563.1	101.7	-157.9
	04+00	328.4	562.6	324.7	-642.4	119.9	435.9	161.1	-541.5	100.5	-165.2
	05+00	290.1	552.1	288.4	-611.6	103.1	437.5	142.8	-508.4	99.5	-162.5
	06+00	237.2	537.3	238.8	-567.7	80.5	432.9	118.5	-456.9	94.7	-183.8
	07+00	169.4	533.0	NA	NA	NA	NA	187.8	-512.1	101.6	-115.8
	08+00	91.4	442.8	NA	NA	NA	NA	115.9	-384.4	99.7	-124.3
	09+00	46.7	-39.7	NA	NA	NA	NA	54.2	-200.9	96.9	-141.0
	10+00	77.6	-423.2	NA	NA	NA	NA	27.9	206.5	95.6	-143.4
	11+00	123.7	-459.9	NA	NA	NA	NA	54.7	226.3	94.8	-145.7
	12+00	174.5	-455.1	NA	NA	NA	NA	94.0	126.8	92.7	-151.8
	13+00	223.8	-441.4	NA	NA	NA	NA	132.2	34.4	91.9	-154.7
	14+00	274.4	-424.4	NA	NA	NA	NA	170.9	-58.5	89.8	-156.6
	15+00	325.2	-406.0	NA	NA	NA	NA	209.0	-152.3	89.0	-159.9
	T2-1	625.5	-366.3	544.0	-214.7	364.2	-359.7	225.4	-216.3	95.0	-117.0
	NO 2+12	NA	NA	560.3	-908.5	272.5	465.6	271.4	-784.9	98.5	-207.0
	01+00	594.0	622.7	586.2	-814.8	246.9	372.8	307.1	-705.6	105.8	-98.0
	02+00	591.1	609.7	581.7	-804.5	247.8	364.2	304.4	-697.8	101.2	-97.7
	03+00	577.5	599.8	566.5	-794.0	240.4	362.6	293.8	-687.8	101.6	-104.5
	04+00	552.7	594.1	541.4	-779.3	227.8	369.6	279.0	-674.9	100.4	-131.4
	05+00	515.2	587.3	504.4	-757.0	209.7	381.5	258.1	-655.6	100.7	-126.1
	06+00	463.1	579.0	453.6	-725.4	184.5	397.6	230.1	-627.2	99.6	-141.8
	07+00	395.1	568.3	388.1	-682.2	152.1	416.1	194.8	-585.7	99.5	-146.5
	08+00	312.9	553.7	309.9	-625.6	113.9	432.1	153.9	-526.1	97.3	-168.0
	09+00	236.8	536.3	238.3	-566.8	80.1	432.0	118.0	-455.6	94.8	-184.4
	10+00	176.6	537.2	NA	NA	NA	NA	194.3	-521.5	100.7	-112.6
	11+00	126.9	498.5	NA	NA	NA	NA	149.2	-447.5	99.0	-126.4
	12+00	79.5	408.3	NA	NA	NA	NA	104.3	-359.0	98.3	-126.5
	13+00	48.7	100.6	NA	NA	NA	NA	63.9	-244.0	96.6	-137.4
	14+00	60.6	-355.3	NA	NA	NA	NA	31.0	16.8	95.8	-138.3
	15+00	101.8	-453.3	NA	NA	NA	NA	38.9	259.5	93.7	-146.2
	T2-2	340.6	-395.3	NA	NA	NA	NA	226.0	-212.2	92.5	-140.5

Moore/OMAB/MPAD (for LM Timeline)

Data source Apple 15 05.

Data confirmed April 1 R. W. W.

LM 7-1.- Lift-off table.
(July 26 launch date)

Launch day dependent

Launch month dependent

Mission profile dependent

4/7/71 Basic

REV	NEW TIG	NOM TIG
15		106:40:58
16		108:39:10
17		110:37:19
18		112:35:28
19		114:33:36
20		116:31:45
21		118:29:53
22		120:28:02
23		122:26:10
24		124:24:19
25		126:22:27
26		128:20:36
27		130:18:44
28		132:16:53
29		134:15:01
30		136:13:09
31		138:11:18
32		140:09:26
33		142:07:34
34		144:05:43
35		146:03:51
36		148:01:59
37		150:00:07
38		151:58:15
39		153:56:23
40		155:54:31
41		157:52:39
42		159:50:46
43		161:48:54
44		163:47:02
45		165:45:23
46		167:43:32
47		169:41:40

Blucker/MPB/MPAD (for G and C Checklist)

Data source J. De Engle's tapes

Data confirmed 7-24-71

LM 8-1.- Planet unit vectors (lunar referenced)
Venus, Mars, Jupiter, Saturn. (July 26 launch date)

Launch day dependent
Launch month dependent

3/7/71 Basic

0 HR GET = 7:26:13:34 GMT
LO = 7:26:__:__

VENUS UNIT VECTORS

TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
100.0	-.48921	.79491	.35886
104.0	-.49232	.79327	.35826
108.0	-.49542	.79161	.35765
112.0	-.49851	.78995	.35703
116.0	-.50159	.78827	.35641
120.0	-.50467	.78659	.35579
124.0	-.50774	.78490	.35516
128.0	-.51080	.78320	.35453
132.0	-.51385	.78148	.35389
136.0	-.51689	.77976	.35325
140.0	-.51993	.77803	.35261
144.0	-.52296	.77630	.35196
148.0	-.52598	.77455	.35131
152.0	-.52900	.77279	.35065
156.0	-.53200	.77102	.34999
160.0	-.53500	.76925	.34932
164.0	-.53799	.76746	.34866
168.0	-.54098	.76567	.34798
172.0	-.54395	.76387	.34731
176.0	-.54692	.76206	.34662
180.0	-.54988	.76024	.34594
184.0	-.55283	.75841	.34525
188.0	-.55578	.75657	.34456
192.0	-.55871	.75472	.34386
196.0	-.56164	.75286	.34316
200.0	-.56456	.75100	.34245

MARS UNIT VECTORS

TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
100.0	.75236	-.54892	-.36419
120.0	.75016	-.55105	-.36553
140.0	.74805	-.55308	-.36677
160.0	.74605	-.55502	-.36792
180.0	.74415	-.55686	-.36897
200.0	.74236	-.55861	-.36994

JUPITER UNIT VECTORS

TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
100.0	-.54982	-.77161	-.31986
140.0	-.54916	-.77197	-.32014
180.0	-.54838	-.77240	-.32044

SATURN UNIT VECTORS

TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
100.0	.43239	.84017	.32733
140.0	.43037	.84108	.32766
180.0	.42841	.84196	.32797

Blucker/MPB/MPAD (for G and C Checklist)
 Data source Penetration
 Data confirmed 4-6-71

LM 8-2.- Earth unit vectors. (July 26 launch date)

0 HR GET = 7:26:13:34 GMT
 LO = 7:26:___:___

Launch day dependent
 Launch month dependent
 Mission profile dependent
 3/7/71 Basic

Earth Unit Vectors

TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
100.0	.76286	.55144	.33759
100.5	.76004	.55450	.33895
101.0	.75720	.55755	.34030
101.5	.75434	.56059	.34165
102.0	.75147	.56362	.34299
102.5	.74858	.56665	.34433
103.0	.74567	.56966	.34566
103.5	.74275	.57266	.34698
104.0	.73982	.57565	.34830
104.5	.73687	.57863	.34961
105.0	.73390	.58160	.35092
105.5	.73092	.58456	.35221
106.0	.72793	.58751	.35351
106.5	.72492	.59046	.35479
107.0	.72189	.59339	.35607
107.5	.71885	.59631	.35734
108.0	.71579	.59922	.35861
108.5	.71272	.60211	.35987
109.0	.70963	.60500	.36112
109.5	.70653	.60788	.36237
110.0	.70341	.61075	.36361
110.5	.70028	.61361	.36484
111.0	.69714	.61645	.36607
111.5	.69397	.61929	.36729
112.0	.69080	.62211	.36850
112.5	.68761	.62492	.36971
113.0	.68440	.62772	.37091
113.5	.68118	.63052	.37210
114.0	.67795	.63329	.37329
114.5	.67470	.63606	.37447
115.0	.67143	.63882	.37564
115.5	.66815	.64157	.37680
116.0	.66486	.64430	.37796
116.5	.66155	.64702	.37911
117.0	.65823	.64973	.38026
117.5	.65489	.65243	.38140
118.0	.65154	.65512	.38253
118.5	.64818	.65780	.38365
119.0	.64480	.66046	.38477

Earth Unit Vectors

TIME (GET) HOURS	X(R1)	Y(R2)	Z(R3)
119.5	.64140	.66311	.38588
120.0	.63799	.66576	.38698
120.5	.63457	.66838	.38807
121.0	.63113	.67100	.38916
121.5	.62768	.67360	.39024
122.0	.62422	.67620	.39131
122.5	.62074	.67878	.39238
123.0	.61725	.68134	.39344
123.5	.61374	.68390	.39449
124.0	.61022	.68644	.39553
124.5	.60669	.68897	.39657
125.0	.60314	.69149	.39759
125.5	.59958	.69400	.39861
126.0	.59600	.69649	.39963
126.5	.59241	.69897	.40063
127.0	.58881	.70144	.40163
127.5	.58519	.70389	.40262
128.0	.58156	.70633	.40361
128.5	.57792	.70876	.40458
129.0	.57426	.71118	.40555
129.5	.57059	.71358	.40651
130.0	.56691	.71597	.40746
130.5	.56321	.71834	.40841
131.0	.55950	.72070	.40934
131.5	.55578	.72305	.41027
132.0	.55204	.72539	.41119
132.5	.54829	.72771	.41210
133.0	.54453	.73002	.41301
133.5	.54075	.73231	.41391
134.0	.53697	.73459	.41479
134.5	.53316	.73686	.41568
135.0	.52935	.73912	.41655
135.5	.52552	.74136	.41741
136.0	.52168	.74358	.41827
136.5	.51783	.74579	.41912
137.0	.51397	.74799	.41996
137.5	.51009	.75017	.42079
138.0	.50620	.75234	.42162
138.5	.50230	.75450	.42243
139.0	.49838	.75664	.42324
139.5	.49445	.75876	.42404

LM 8-2.- Concluded.

0 HR GET = 7:26:13:34 GMT
LO = 7:26:___:___

Launch day dependent
Launch month dependent
Mission profile dependent
3/7/71 Basic

Earth Unit Vectors

<u>TIME (GET)</u> <u>HOURS</u>	<u>X(R1)</u>	<u>Y(R2)</u>	<u>Z(R3)</u>
140.0	.49051	.76088	.42483
140.5	.48656	.76297	.42561
141.0	.48260	.76506	.42638
141.5	.47862	.76712	.42715
142.0	.47463	.76918	.42791
142.5	.47063	.77122	.42866
143.0	.46662	.77324	.42940
143.5	.46260	.77525	.43013
144.0	.45856	.77724	.43085
144.5	.45451	.77922	.43157
145.0	.45045	.78119	.43227
145.5	.44638	.78313	.43297
146.0	.44230	.78507	.43366
146.5	.43820	.78699	.43434
147.0	.43410	.78889	.43501
147.5	.42998	.79078	.43567
148.0	.42585	.79265	.43632
148.5	.42171	.79450	.43697
149.0	.41756	.79634	.43760
149.5	.41340	.79817	.43823
150.0	.40922	.79998	.43885
150.5	.40504	.80177	.43946
151.0	.40084	.80355	.44006
151.5	.39664	.80531	.44065
152.0	.39242	.80706	.44123
152.5	.38819	.80879	.44180
153.0	.38395	.81050	.44237
153.5	.37970	.81220	.44292
154.0	.37544	.81388	.44347
154.5	.37117	.81554	.44400
155.0	.36689	.81719	.44453
155.5	.36260	.81882	.44505
156.0	.35830	.82044	.44556
156.5	.35398	.82204	.44606
157.0	.34966	.82362	.44655
157.5	.34533	.82518	.44703
158.0	.34099	.82673	.44750
158.5	.33663	.82826	.44796
159.0	.33227	.82978	.44842
159.5	.32790	.83128	.44886

Earth Unit Vectors

<u>TIME (GET)</u> <u>HOURS</u>	<u>X(R1)</u>	<u>Y(R2)</u>	<u>Z(R3)</u>
160.0	.32352	.83276	.44929
160.5	.31913	.83422	.44972
161.0	.31472	.83567	.45013
161.5	.31031	.83710	.45054
162.0	.30589	.83851	.45093
162.5	.30146	.83991	.45132
163.0	.29702	.84129	.45170
163.5	.29258	.84265	.45207
164.0	.28812	.84399	.45242
164.5	.28365	.84531	.45277
165.0	.27918	.84662	.45311
165.5	.27469	.84791	.45344
166.0	.27020	.84918	.45376
166.5	.26570	.85044	.45406
167.0	.26119	.85168	.45436
167.5	.25667	.85289	.45465
168.0	.25214	.85409	.45493
168.5	.24760	.85528	.45520
169.0	.24306	.85644	.45546
169.5	.23851	.85759	.45571
170.0	.23395	.85872	.45595
170.5	.22938	.85983	.45618
171.0	.22480	.86092	.45640
171.5	.22022	.86199	.45661
172.0	.21562	.86305	.45681
172.5	.21102	.86408	.45700
173.0	.20642	.86510	.45718
173.5	.20180	.86610	.45734
174.0	.19718	.86708	.45750
174.5	.19255	.86804	.45765
175.0	.18791	.86898	.45779

Cockrell/MPB/MPAD (for Star Charts)

Data source W. NOData confirmed BAE

LM 8-3.- Star unit vectors. (July 26 launch date)

Nearst mean Besselian year

4/7/71 Basic

DATA VALID FROM 1 JULY 71 TO 30 JUNE 72

STAR NO. (OCTAL)	UNIT VECTORS			ECLIPTIC COORDINATES		COMMON NAME	STAR IDENTIFICATION GREEK IDENTIFIER AND CONSTELLATION
	X (R1)	Y (R2)	Z (R3)	LONGITUDE (DEG.)	LATITUDE (DEG.)		
046	.78378	.47837	.39604	37.3	10.0	HAMAL	ALPHA ARIETIS
047	.58785	.64650	-.48628	34.2	-44.7		ALPHA FORNACIS
050	-.38535	.79355	.47094	112.8	6.7	POLLUX	BETA GEMINORUM
051	-.25993	.23220	-.93729	211.6	-72.2	MIAPLACIDUS	BETA CARINAE
052	-.45598	.11790	.88215	134.8	49.7	DUBHE	ALPHA URSAE MAJORIS
053	-.64862	-.11426	-.75249	211.9	-40.2		GAMMA CENTAURI
054	-.37780	-.31056	-.87225	239.1	-42.6	RIGIL KENT	ALPHA CENTAURI
055	.02745	.99128	.12885	88.4	-16.0	BETELGEUSE	ALPHA ORIONIS
056	-.42788	-.25162	-.86810	233.4	-44.1	HADAR	BETA CENTAURI
057	.15707	.98142	.11018	80.6	-16.8	BELLATRIX	GAMMA ORIONIS
060	.13540	.86760	.47847	82.2	5.4	EL NATH	BETA TAURI
061	.10975	.99373	-.02127	83.1	-24.5	ALNI LAM	EPSILON ORIONIS
062	.08995	.99536	-.03413	84.3	-25.3	ALNITAK	ZETA ORIONIS
063	-.08898	.94720	-.30804	96.8	-41.3	MURZIM	BETA CANIS MAJORIS
064	-.15044	.94732	.28275	98.7	-6.7	ALHENA	GAMMA GEMINORUM
065	-.21737	.84776	-.48379	110.4	-51.4	ADHERA	EPSILON CANIS MAJORIS
066	-.25920	.85781	-.44382	113.0	-48.5	AL WAZOR	DELTA CANIS MAJORIS
067	-.33431	.77987	.52919	109.9	10.1	CASTOR	ALPHA GEMINORUM
070	-.29533	.41426	-.86091	172.8	-72.7	AVIOR	EPSILON CARINAE
071	-.37986	.43725	-.81518	168.6	-67.2		DELTA VELORUM
072	-.54073	-.07023	-.83826	216.3	-47.8	GACRUX	GAMMA CRUCIS
073	-.49678	-.10124	-.86195	221.3	-48.6	BECRUX	BETA CRUCIS
074	-.54285	-.12733	.83012	158.5	54.3	ALIOH	EPSILON URSAE MAJORIS
075	-.09824	-.79167	-.60300	264.2	-13.8	SHAULA	LAMBDA SCORPII
076	-.07868	-.72733	-.68176	265.2	-19.6		THETA SCORPII
077	.08021	-.82121	-.56496	274.7	-11.0	KAUS AUST	EPSILON SAGITTARI
100	.51482	.01724	.85712	34.7	51.2	CAPH	BETA CASSIOPEIAE
101	.73342	.08001	-.67505	345.1	-40.6	ANKAA	ALPHA PHOENICIS
102	.77864	.23864	.58031	30.0	25.9	MIRACH	BETA ANDROMEDAE
103	.63806	.37649	.67167	43.8	27.8	ALMACH	GAMMA-PRIME ANDROMEDAE
104	.12804	.99175	-.00556	82.0	-23.6	MINTAKA	DELTA ORIONIS
105	.05834	.98404	-.16812	86.0	-33.1	SAIPH	KAPPA ORIONIS
106	.00780	.70773	.70644	89.5	21.5	MENKALINAN	BETA AURIGAE
107	-.30908	.81594	-.48858	119.1	-50.6	ALUDRA	ETA CANIS MAJORIS
110	-.39096	.65976	-.64177	138.2	-58.3		ZETA PUPPIS
111	-.52985	.49858	-.68606	160.8	-55.9	SUHAIL	LAMBDA VELORUM
112	-.38743	.33577	-.85858	184.9	-67.1		IOTA CARINAE
113	-.53277	.14235	.83420	139.0	45.1	MERAK	BETA URSAE MAJORIS
114	-.53560	-.20239	.81986	165.3	56.4	MIZAR	ZETA URSAE MAJORIS
115	-.19927	-.18383	.96255	132.9	73.0	KOCHAB	BETA URSAE MINORIS
116	-.01099	-.62254	.78251	267.6	74.9	ELTANIN	GAMMA DRACONIS
117	.44164	-.62363	.64501	324.5	57.1	SADR	GAMMA CYGNI
120	.59893	-.32359	-.73251	315.5	-32.9	AL NA'IR	ALPHA GRUIS
121	.64150	-.23032	-.73173	321.9	-35.4		BETA GRUIS
122	.54566	.09353	.83277	37.4	46.6	SCHEDAR	ALPHA CASSIOPEIAE
123	-.58957	.01965	.80748	150.1	47.1	PHECDA	GAMMA URSAE MAJORIS
124	-.46642	-.79717	-.38338	242.2	-2.0		DELTA SCORPII
125	-.25426	-.78658	-.56272	254.9	-11.7		EPSILON SCORPII
126	.96452	.04966	.25929	8.8	12.6		GAMMA PEGASI
127	-.06586	-.77416	-.62955	266.1	-15.6		KAPPA SCORPII
130	.46554	.17863	.86681	47.5	46.4		DELTA CASSIOPEIAE
131	.82401	.44316	.35301	33.6	8.5		BETA ARIETIS
132	.50475	.76127	.40705	59.6	4.0		ETA TAURI
133	.44921	.72146	.52698	62.7	11.3		ZETA PERSEI
134	.39503	.65724	.64186	65.3	19.1		EPSILON PERSEI
135	.23377	.80421	.54644	76.2	10.5		IOTA AURIGAE
136	.23052	.96896	-.08927	74.9	-27.9		BETA ERIDANI
137	.13398	.92530	-.35479	79.3	-43.9		BETA LEPORIS

LM 8-3.- Concluded.

DATA VALID FROM 1 JULY 71 TO 30 JUNE 72

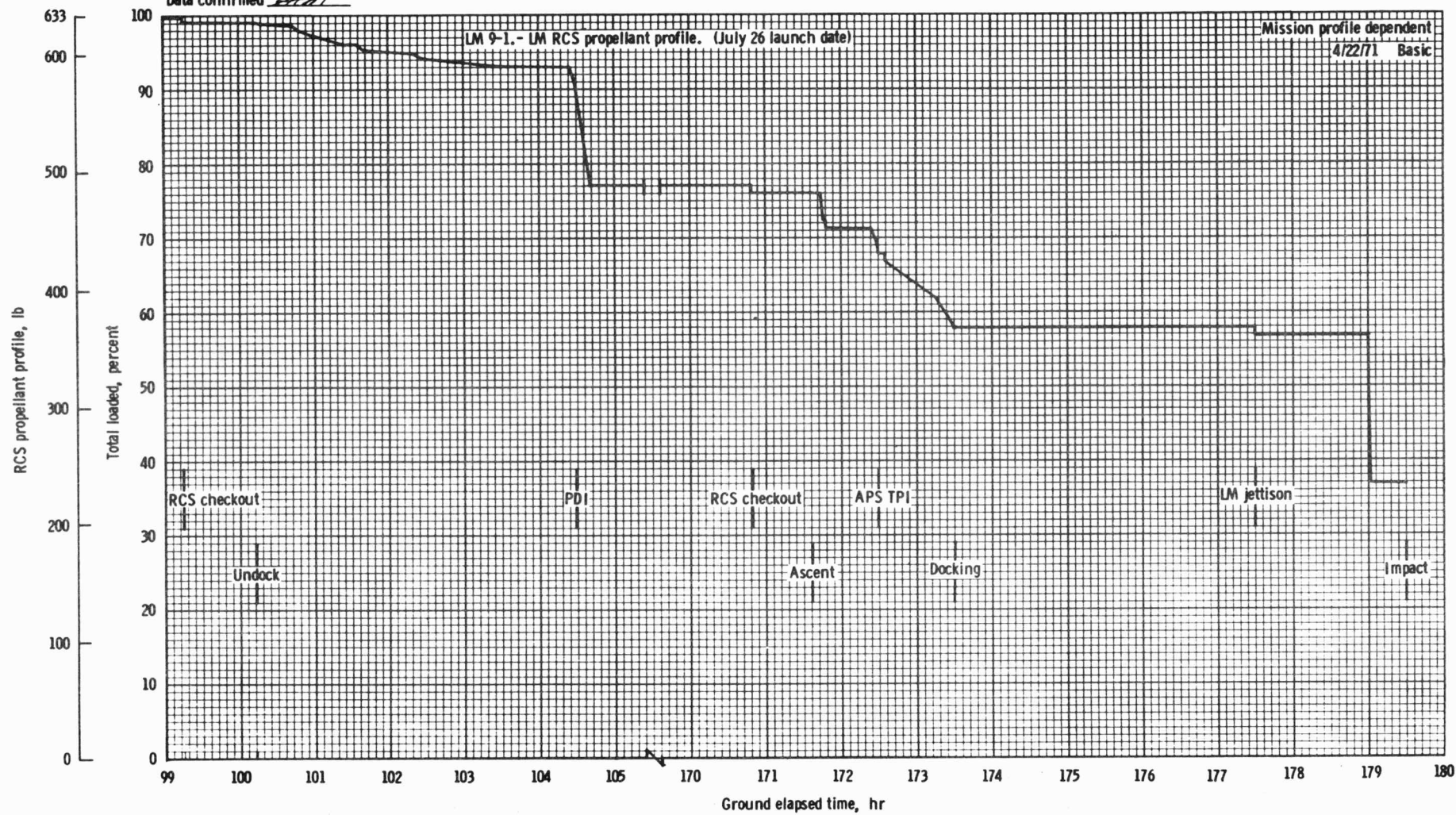
Nearst mean Besselian year
4/7/71 Basic

STAR NO. (OCTAL)	UNIT VECTORS			ECLIPTIC COORDINATES		COMMON NAME	STAR IDENTIFICATION GREEK IDENTIFIER AND CONSTELLATION
	X (R1)	Y (R2)	Z (R3)	LONGITUDE (DEG.)	LATITUDE (DEG.)		
140	.11809	.94456	-.30638	81.0	-41.1		ALPHA LEPORIS
141	.11233	.98829	-.10326	82.6	-29.2		IOTA ORIONIS
142	.09762	.92766	.36044	84.4	-2.2		ZETA TAURI
143	.07710	.82458	-.56047	81.8	-57.4		ALPHA COLUMBAE
144	.00760	.79636	.60477	89.6	13.8		THETA AURIGAE
145	-.13538	.62039	-.77252	117.3	-72.9		TAU PUPPIS
146	-.26036	.75449	-.60246	119.9	-58.5		PI PUPPIS
147	-.47769	.77684	-.41029	131.0	-43.3		RHO PUPPIS
150	-.44258	.36729	-.81806	178.5	-63.7		KAPPA VELORUM
151	-.84900	.40299	.34176	149.2	8.8		GAMMA-PRIME LEONIS
152	-.61835	.20822	-.75781	190.1	-51.1		MU VELORUM
153	-.91566	.19204	.35310	160.9	14.3		DELTA LEONIS
154	-.90939	-.13150	-.39462	197.0	-18.0		BETA CORVI
155	-.35438	-.05533	-.93346	230.0	-56.6		ALPHA MUSCAE
156	-.98437	-.17463	-.02262	189.8	2.8		GAMMA VIRGINIS
157	-.76073	-.18517	.62209	174.2	40.1		ALPHA-SQUARED CANES VENATICI
160	-.94695	-.25720	.19268	189.6	16.2		EPSILON VIRGINIS
161	-.75591	-.27146	-.59574	212.7	-26.0		IOTA CENTAURI
162	-.54339	-.24793	-.80203	225.2	-39.6		EPSILON CENTAURI
163	-.83450	-.45004	.31792	198.9	28.1		ETA BOOTIS
164	-.61951	-.47946	.62156	197.3	49.6		GAMMA BOOTIS
165	-.58182	-.46165	-.66960	229.9	-25.5		ETA CENTAURI
166	-.51969	-.43630	-.73455	233.1	-30.0		ALPHA LUPORIS
167	-.67191	-.58286	.45696	207.7	40.6		EPSILON BOOTIS
170	-.71089	-.64757	-.27440	224.7	.3	ZUBEN'UBI	ALPHA-SQUARED LIBRAE
171	-.52437	-.50943	-.68229	234.6	-25.0		BETA LUPI
172	-.64911	-.74341	-.16127	229.0	8.5		BETA LIBRAE
173	-.45035	-.60456	-.65703	241.1	-21.2		GAMMA LUPI
174	-.55958	-.82098	.11342	231.7	25.5		ALPHA SERPENTIS
175	-.45889	-.77251	-.43892	242.5	-5.5		PI SCORPII
176	-.45705	-.82288	-.33759	242.8	1.0		BETA-PRIME SCORPII
177	-.19434	-.43449	.87946	194.1	78.4		ETA DRACONIS
200	-.35962	-.85776	.36730	240.7	42.7		BETA HERCULIS
201	-.32264	-.82048	-.47193	251.1	-6.1		TAU SCORPII
202	-.35390	-.91732	-.18244	248.8	11.4		ZETA OPHIUCHI
203	-.29034	-.80020	.52477	241.1	53.1		ZETA HERCULIS
204	-.21341	-.93878	-.27046	257.6	7.2	SABIK	ETA OPHIUCHI
205	-.09111	-.55895	-.82418	263.8	-32.3		BETA ARAE
206	-.10780	-.78840	-.60565	263.6	-14.0		MU SCORPII
207	-.08506	-.63908	-.76442	264.5	-26.6		ALPHA ARAE
210	-.08031	-.60593	.79145	251.6	75.3		BETA DRACONIS
211	-.07783	-.99377	.07981	264.9	27.9		BETA OPHIUCHI
212	.07258	-.86436	-.49760	274.2	-6.5		DELTA SAGITTARII
213	.10317	-.89713	-.42955	275.9	-2.1		LAMBDA SAGITTARII
214	.22735	-.83636	-.49882	283.2	-7.2		ZETA SAGITTARII
215	.30991	-.63473	.70787	315.9	64.4		DELTA CYGNI
216	.43454	-.88187	.18299	300.5	31.2		GAMMA AQUILAE
217	.54770	-.62411	.55723	327.4	49.4		EPSILON CYGNI
220	.35139	-.30035	.88674	12.4	68.9		ALPHA CEPHI
221	.79939	-.53163	-.27991	323.1	-2.6		DELTA CAPRICORNI
222	.44451	-.21537	-.86949	309.3	-45.4		ALPHA TUCANAE
223	.85577	-.21967	.46840	359.0	31.1		BETA PEGASI
224	.93634	-.23622	.25973	353.1	19.4	MARKAB	ALPHA PEGASI
225	.41267	.23321	-.88052	341.7	-64.2		ALPHA HYDRI
226	.82309	.56532	-.05415	31.1	-15.9		OMICRON CETI
227	.51988	.54947	.65407	55.8	22.4		BETA PERSEI
230	-.43367	.33165	-.83782	183.8	-64.2		N VELORUM
231	-.40953	.14512	-.90068	208.8	-62.1		THETA CARINAE
232	-.63489	-.01912	-.77236	207.1	-44.5		DELTA CENTAURI
233	-.23663	-.38112	-.89373	251.5	-41.9		BETA TRIANGULI AUSTRALIS
234	.26815	-.93329	.23888	289.4	36.2		ZETA AQUILAE
235	.27321	-.89225	-.35950	285.9	1.4		PI SAGITTARII
236	-.44968	-.89095	-.06320	241.9	17.2		DELTA OPHIUCHI

Mayfield/GPB/MPAD (for LM Systems)

Data source SODB Vol II, III, POSTFLIGHT

Data confirmed APN1

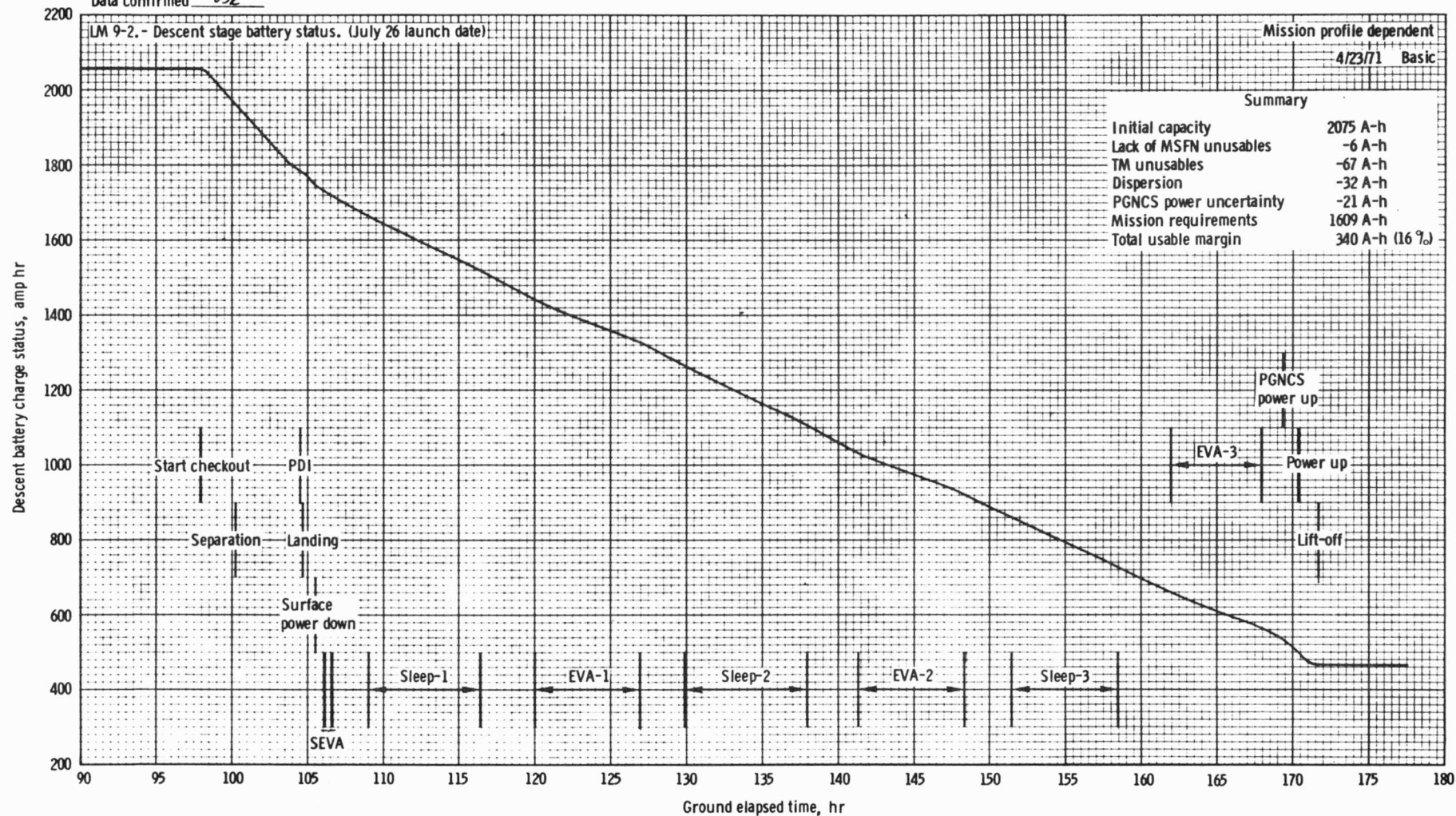


LM RCS propellant profile.

Ritchey/GPB/MPAD (for LM Systems)

Data source Ascent Flight Plan

Data confirmed VSE

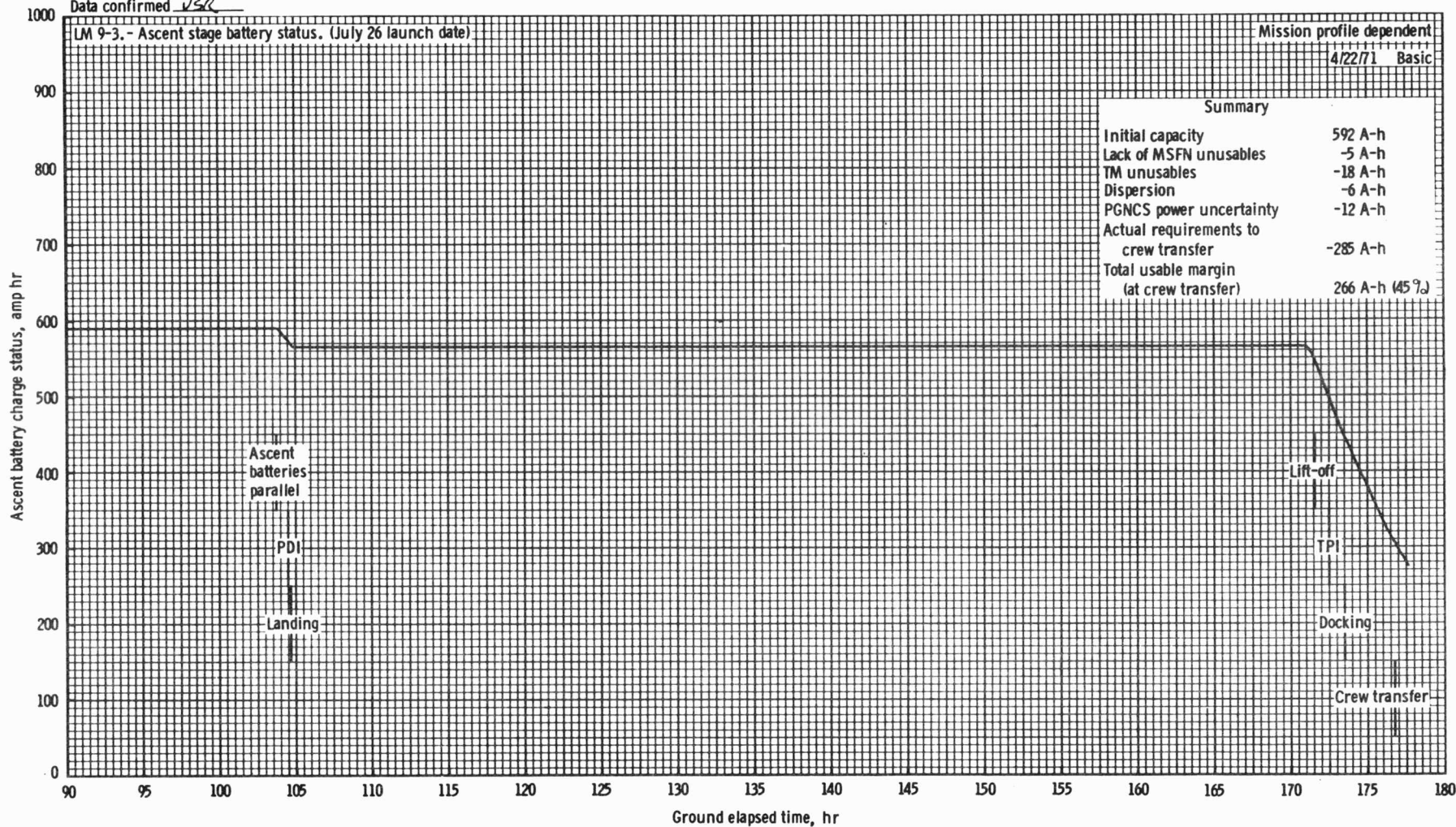


Apollo 15 descent electrical energy remaining.

Ritchey/GPB/MPAD (for LM Systems)

Data source *Ascent Flight Plan*

Data confirmed *VSR*

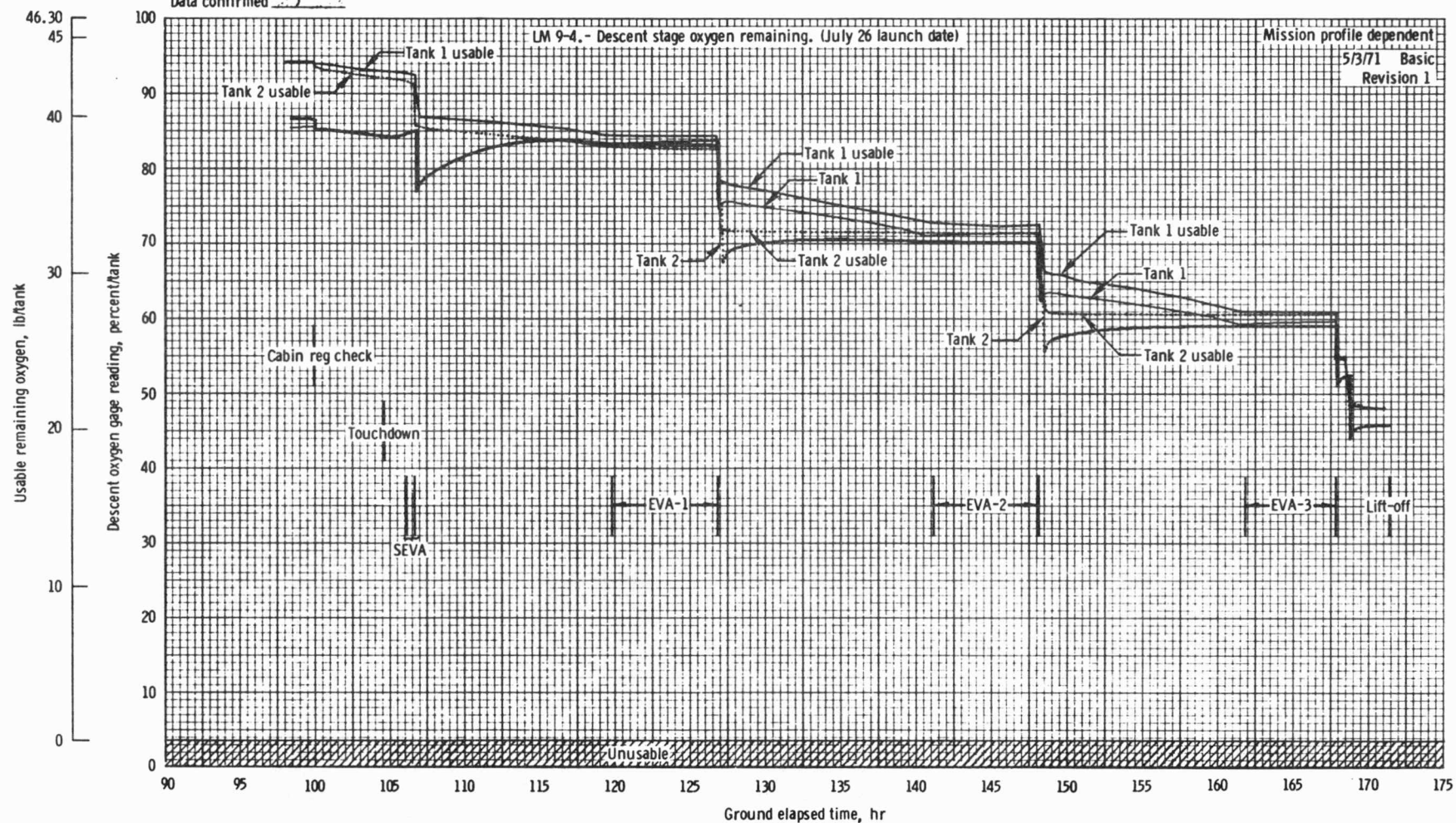


Apollo 15 ascent electrical energy remaining.

Swain/GPB/MPAD (for LM Systems)

Data source _____

Data confirmed _____

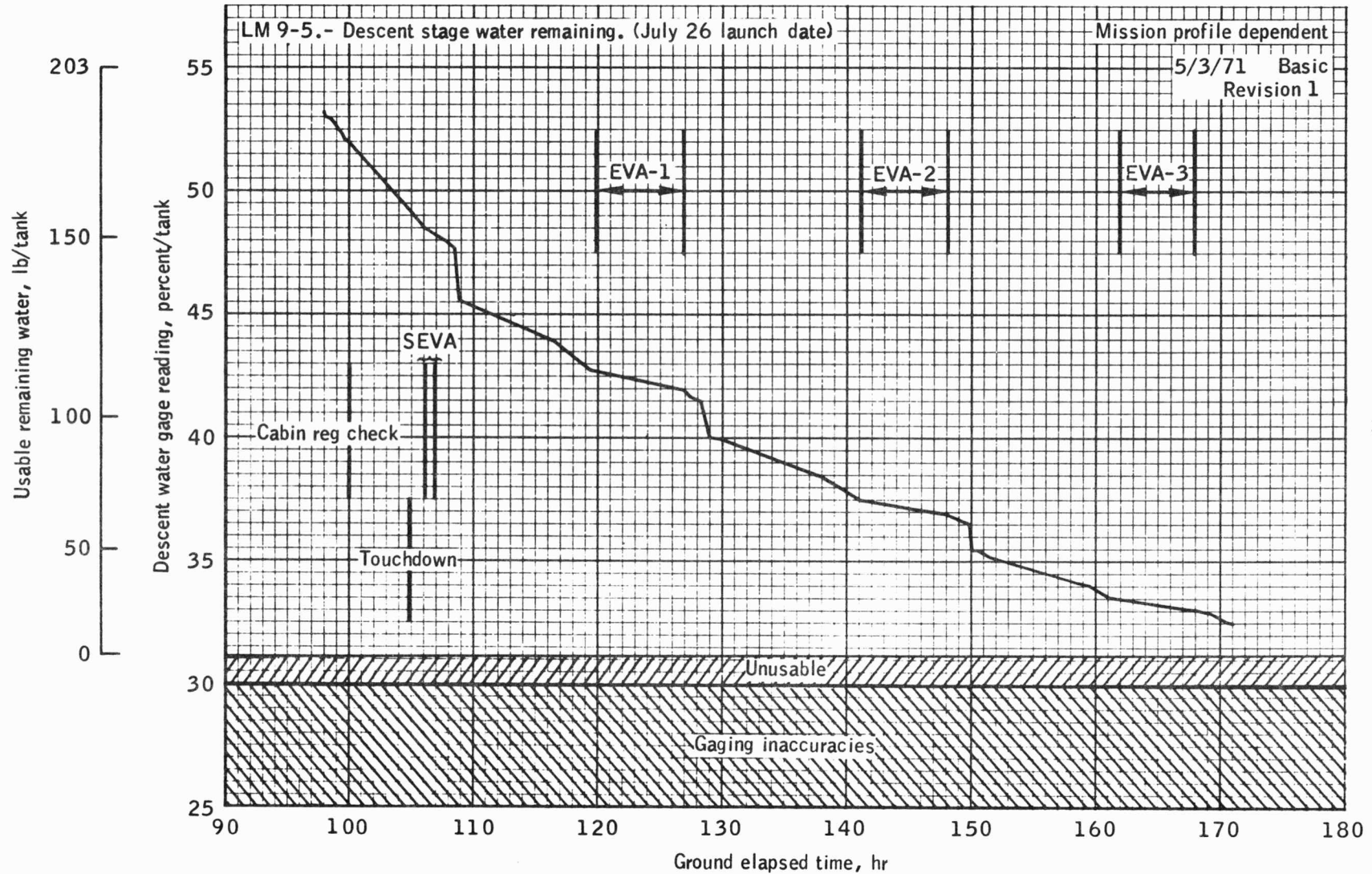


Descent stage oxygen remaining.

Swalin/GPB/MPAD (for LM Systems)

Data source Swalin/GPB/MPAD

Data confirmed Swalin

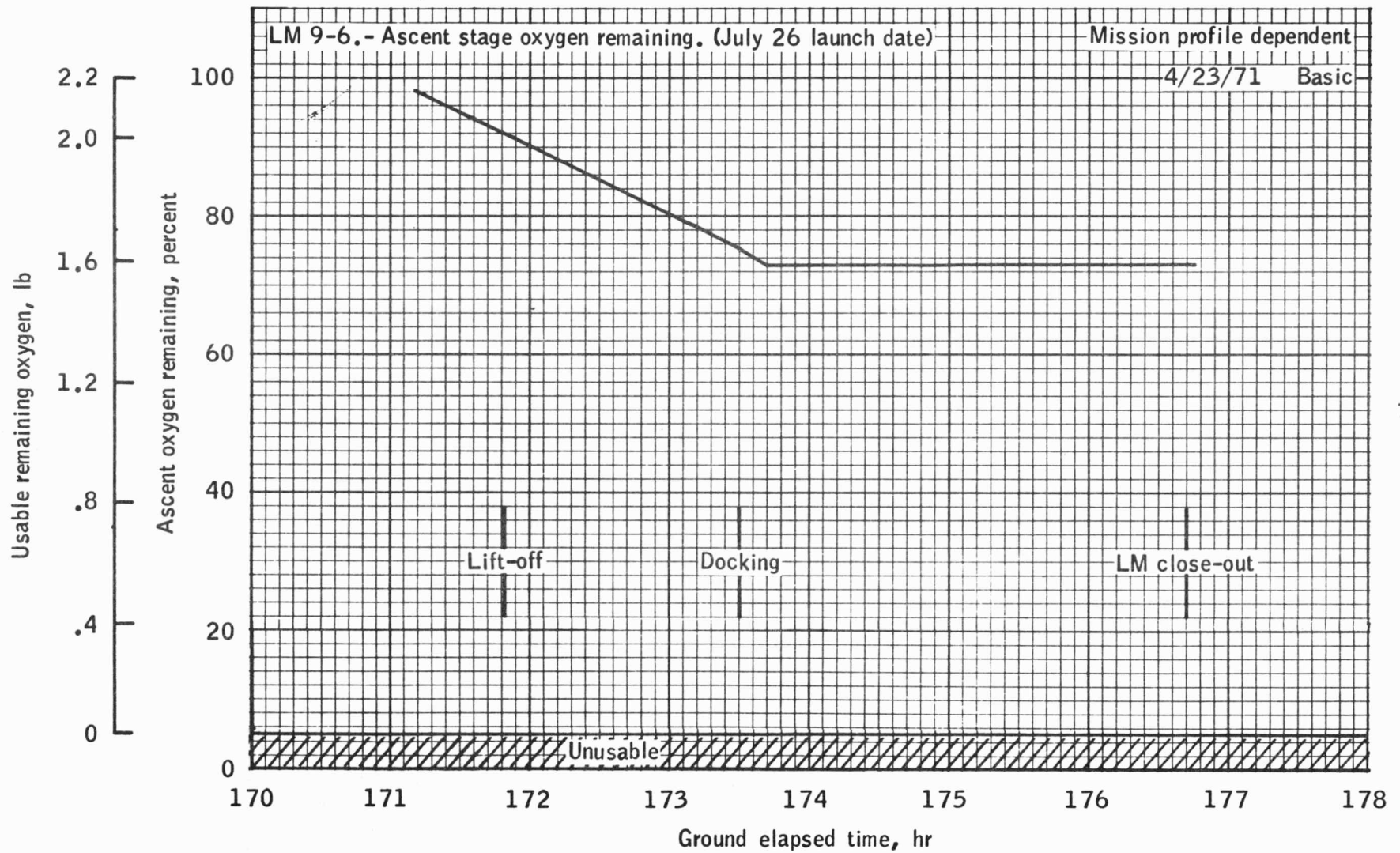


Descent stage water remaining.

Swalin/GPB/MPAD (for LM Systems)

Data source *Engineering Council Analysis*

Data confirmed *APC*

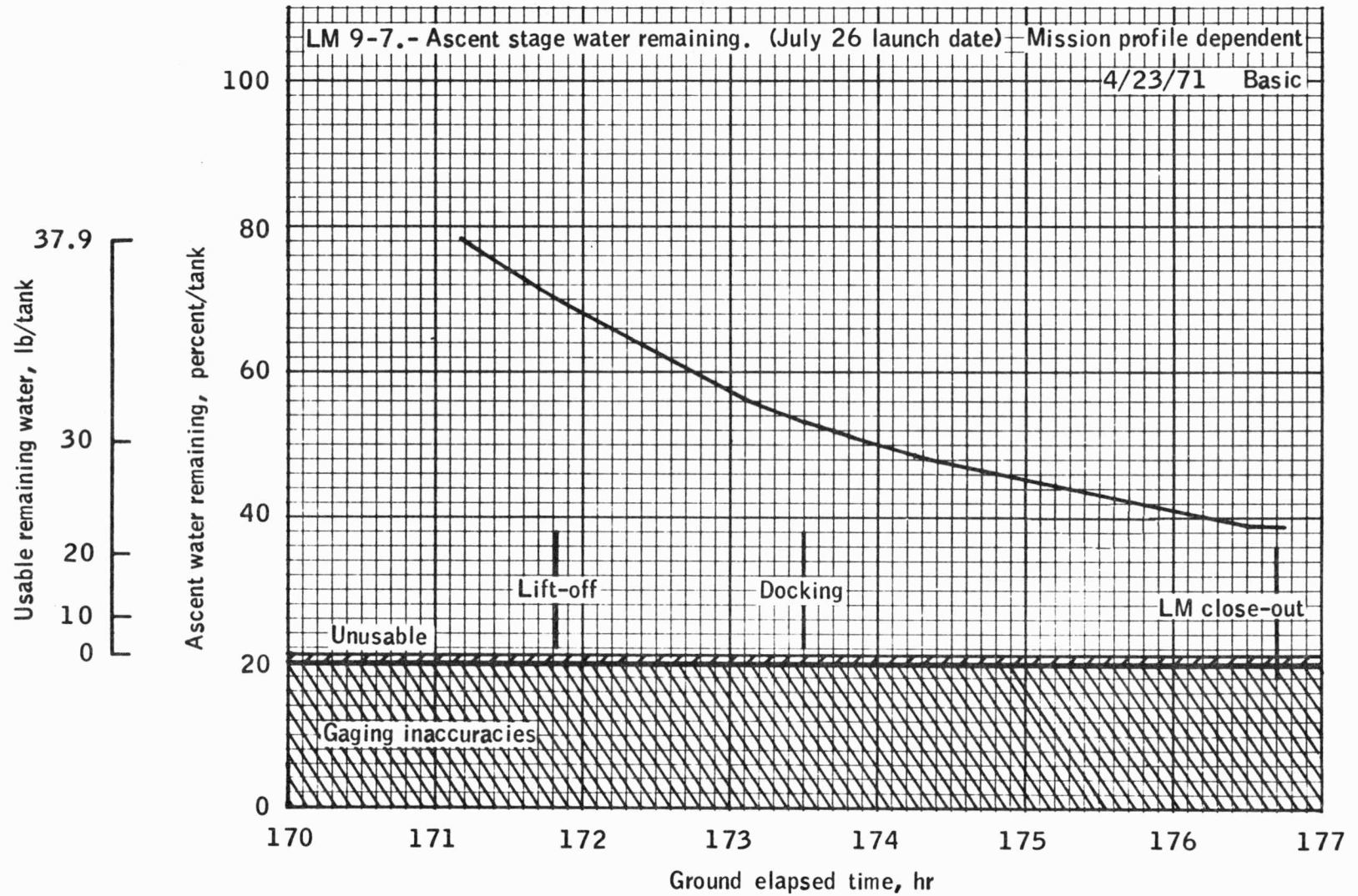


Ascent stage oxygen remaining.

Swalin/GPB/MPAD (for LM Systems)

Data source Preliminary Calculations: Analysis

Data confirmed YES



Ascent stage water remaining.

Ritchey/GPB/MPAD (for LM Systems)

Data source Flight Plan

Data confirmed USR

LM 9-8.- Assumptions for LM EPS analysis.
(July 26 launch date)

Mission profile dependent
4/22/71 Basic

ASSUMPTIONS FOR THE LM EPS ANALYSIS

- a. Energy available from the descent batteries is 2075 A-h and from the ascent batteries is 592 A-h.
- b. Energy unusables caused by lack of continuous MSFN coverage for the descent and ascent stages are 6 and 5 A-h, respectively.
- c. Energy unusables caused by TM inaccuracies for the descent and ascent stages were 67 and 18 A-h, respectively. The new descent battery current measurement uncertainty of 0.5 amperes per battery was used.
- d. Energy unusables caused by checklist deviations (dispersion) for the descent and ascent stages were 32 and 6 A-h, respectively. This dispersion is obtained by calculating 2 percent of the energy used.
- e. Energy unusables caused by PGNCs power uncertainty (2.3 amperes) for the descent and ascent stages were 21 and 12 A-h, respectively.
- f. In accordance with the Flight Plan, the PGNCs was standby mode from surface powerdown until 1 hour before powerup.
- g. The RCS heaters were assumed to have a 100 percent duty cycle for 15 minutes after initial activation and then to decrease to a 7 percent duty cycle until undocking. From undocking until lunar surface powerdown, the heaters were assumed to cycle at 0 percent, but, from surface powerdown until lunar lift-off, the duty cycle was assumed to be 4.5 percent.
- h. The MESA heater duty cycle was assumed to be 19 percent from circuit breaker activation to the beginning of EVA-1 and between EVA-1 and EVA-2. The duty cycle during EVA-1 was 52 percent. In accordance with the lunar surface checklist, the MESA heaters were off for the remainder of the mission.
- i. All AC power was off from powerdown to PGNCs powerup (lift-off - 2:15). This includes integral and numeric lighting.
- j. The two urine dump system heaters were never activated.
- k. The CDR and LMP forward window heaters were assumed not to be needed.
- l. TV power is supplied by the LM during the first hour of EVA-1. For the remainder of EVA-1 and the other EVA's, the TV will be powered by the lunar communications relay unit (LCRU).

LM 9-8.- Concluded.

Mission profile dependent
4/22/71 Basic

ASSUMPTIONS FOR THE LM EPS ANALYSIS - Concluded

m. The liquid cooled garment pump was cycled as dictated by the time line.

n. The S-band power amplifier was cycled as dictated by the time line.

o. The portable utility lights were assumed to be off throughout the mission.

p. In accordance with the Flight Plan, the floodlights were turned off at the beginning of the first sleep period, and on again at PGNCs powerup (lift-off - 2:15). The overhead and forward floodlights were turned on for pre- and post-EVA activity, totaling 9.42 hours of operation.

q. The short ($M=1$) rendezvous was considered nominal.

r. At the beginning of the analysis, it was assumed that a total of 10 A-h had been used from the descent batteries between the period starting 30 minutes before launch and ending at the conclusion of transposition and docking.

Ritchey/GPB/MPAD (for Flight Plan)

Data source Flight PlanData confirmed JSRLM 9-9.- Descent and ascent stage EPS summary.
(July 26 launch date)Mission profile dependent
4/22/71 Basic

DESCENT STAGE EPS SUMMARY

Item	A-h required	A-h remaining
Initial capacity	--	2075
Total unusables	126	1949
Available for mission planning	--	1949
Total mission requirements	1609	340
Total usable margin	--	340 (16 per- cent)

ASCENT STAGE EPS SUMMARY

Item	A-h required	A-h remaining
Initial capacity	--	592
Total unusables	-41	551
Available for mission planning	--	551
Total requirement through crew transfer	285	266
Total usable margin	--	266 (45 per- cent)

Swalin/GPB/MPAD (for Flight Plan)

Data source _____

Data confirmed _____

LM 9-10.- LM ECS assumptions.
(July 26 launch date)

Mission profile dependent
4/22/71 Basic

LM ECS Assumptions

a. The oxygen analyses were calculated using a cabin leak rate of 0.06 lb/hr based on previous Apollo postflight analyses.

b. Metabolic rates were varied using the time line of reference 4 and table 4.3-II of reference 2.

c. Metabolic oxygen consumed was calculated by $(1.643 \times 10 \times \text{lb/Btu})$ (metabolic rate, Btu/hr).

d. The cabin regulator check and the suit integrity check were assumed to require 0.5 pound of oxygen.

e. The cabin was pressurized five times with 5.5 pounds required for all pressurizations except the last one which required 5.8 pounds.

f. The dispersion in the oxygen profile was calculated as 5 percent of the nominal oxygen requirement.

g. The PLSS refills required 63.8 pounds of water and 5.4 pounds of oxygen.

h. The sublimator fill required 2.23 pounds.

i. The drink bags required 12.0 pounds of water.

j. Water lost through crew micturition was 0.11 lb/hr per man.

k. Water required for thermal control was calculated by dividing the total spacecraft heat load by 1040 Btu/lb.

l. The dispersion in the water profile was calculated as 5 percent of the nominal usage.

m. The descent oxygen tanks were loaded to 2465.0 psi at 75.0°F.

Swalin/GPB/MPAD (for Flight Plan)

Data source Data confirmed LM 9-11.- LM ECS summary.
(July 26 launch date)Mission profile dependent
4/22/71 Basic

LM ECS SUMMARY

(a) Water

Description	Descent, lb/tank	Ascent, lb/tank
Loaded	406.0	85.0
Sampling	16.0	--
Residual	13.3	1.7
Telemetry uncertainty	18.8	15.0
Loading uncertainty	5.6	--
Available for mission	352.3	68.3
Required to lunar landing	40.8	0.0
Required to lunar lift-off	279.3	0.0
Required to LM/CSM docking	0.0	13.4
Required to LM close-out	0.0	16.5
Required to lunar impact	0.0	12.4
Remaining in tanks	32.2	26.0
Dispersion	16.0	2.1
Margin	16.2	23.9

(b) Oxygen

Description	Descent, lb/tank	Ascent 1, lb	Ascent 2, lb
Loaded	87.1	2.4	2.4
Residual	1.6	0.1	0.1
Loading uncertainty	1.7	0.1	0.1
Available for mission	83.8	2.2	2.2
Required to lunar landing	1.6	0.0	0.0
Required to lunar lift-off	42.4	0.0	0.0
Required to LM/CSM docking	0.0	0.6	0.0
Required to LM close-out	0.0	0.1	0.0
Remaining in tank	39.8	1.5	2.2
Dispersion	2.2	0.1	0.0
Margin	37.6	1.4	2.2

Mayfield/GPB/MPAD (for Flight Plan)

Data source PRE-FLIGHT PLAN & SODB

Data confirmed LE 212

LM 9-12.- Assumptions and ground rules for
the LM RCS analysis. (July 26 launch date)

Mission profile dependent
4/22/71 Basic

ASSUMPTIONS AND GROUND RULES FOR THE LM RCS ANALYSIS

1. Data for the LM RCS engine performance and propellant requirements were obtained from the SODB, Volume II, and from postflight analyses of Apollo 9-14 missions.
2. The analysis assumes an RCS tweak burn (nominally zero) of 30 fps.
3. It is assumed there will be a 10-fps RCS trim following the APS TPI maneuver.

Mayfield/GPB/MPAD (for Flight Plan)

Data source ~~PPE FLIGHT PLAN~~ & GODE

Data confirmed 18721

LM 9-13.- LM RCS propellant loading and
usage summary. (July 26 launch date)

Mission profile dependent
4/22/71 Basic

LM RCS PROPELLANT LOADING AND USAGE SUMMARY

Item	Required, lb	Remaining, lb
Loaded		631.2
Trapped	38.0	593.2
Gaging inaccuracy and loading tolerance	43.5	549.7
Mixture ratio uncertainty	17.0	532.7
Usable		
Nominal usage through lunar landing	145.7	387.0
Nominal usage from landing through docking	119.9	267.1
Nominal usage from docking through impact	132.4	134.7
Usable propellant remaining		134.7

Kamen/GPB/MPAD (for Flight Plan)

Data source GPB/MPAD

Data confirmed Sak

LM 9-14.- Assumptions for the APS analysis.
(July 26 launch date)

Mission profile dependent
4/22/71 Basic

ASSUMPTIONS FOR THE APS ANALYSIS

Propellant loading data were obtained from the Apollo 15 preflight data and were optimized for the nominal mission. The LM-10 data were used for engine performance, and ΔV requirements were coordinated with the Landing Analysis Branch and the Orbital Mission Analysis Branch. The ΔV requirement for the lunar ascent differs from that in the Operational Trajectory because of a decrease in the inert vehicle weight.

The budget shown in table 4-1 accounts for an APS TPI, engine valve-pair malfunction, and balanced couples. A touchdown abort was not considered because the nominal lift-off weight is heavier than the abort weight. The following data were used.

- a. $I_{sp} = 309.57 \pm 3.91$ seconds
- b. Mixture ratio = $1.602 \pm .0273$
- c. Lift-off weight = $10\,754.8 \pm 38.7$ pounds

Kamen/GPB/MPAD (for Flight Plan)

Data source SCD 13 000001 Rev 3Data confirmed JakLM 9-15.- APS propellant summary.
(July 26 launch date)Mission profile dependent
4/22/71 Basic

APS PROPELLANT SUMMARY

Item	Total propellant, lb
Loaded	5242.9
Trapped and unavailable	-51.9
Outage	-11.8
Available for ΔV	5179.2
Required for ascent (6050.1 fps) . . .	-4890.4
Remaining	288.8
Required for APS TPI ^a (54.3 fps) . . .	-31.9
Remaining	256.9
Dispersions (-3σ)	-67.7
Pad	189.2
Contingencies	
Engine valve=pair malfunction ($\Delta MR = +.01$ or $-.018$)	-21.2
Balanced couples	-37.5
Half-degree out of plane (18 fps)	-10.5
Margin	120.0

^aThe total TPI ΔV is 76.3 fps. It is assumed that 22 fps is obtained by 10-sec, 4-jet ullage.

Kamen/GPB/MPAD (for Flight Plan)

Data source SCS 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100

Data confirmed SK

LM 9-16.- Assumptions for the DPS analysis.
(July 26 launch date)

Mission profile dependent
4/22/71 Basic

ASSUMPTIONS FOR THE DPS ANALYSIS

Propellant loading data were obtained from the Apollo 15 preflight data and were optimized for the nominal mission. The LM-10 data were used for engine performance, and ΔV requirements were coordinated with the Landing Analysis Branch. The ΔV requirement for lunar descent differs from that in the Operational Trajectory because of an increase in the inert vehicle weight.

The 3σ dispersions represent total propellant cost based on 3σ uncertainties in propellant loading, trapped propellant, I_{sp} , ΔV , separation weight, non- ΔV consumables weight, mixture ratio, and physical location of the low-level sensor.

A flying time of 2 minutes and 30 seconds below low gate will be called a nominal requirement.

The following data were used.

- The separation weight is $36\,689.3 \pm 36.9$ pounds.
- Integrated average I_{sp} is 304.6 ± 3.3 seconds.
- Mixture ratio is $1.601 \pm .0282$.
- Non- ΔV consumables from separation to PDI are 87.5 pounds.

Kamen/GPB/MPAD (for Flight Plan)

Data source SC-7000-10000 R0.13Data confirmed SKKLM 9-17.- DPS propellant summary.
(July 26 launch date)Mission profile dependent
4/22/71 Basic

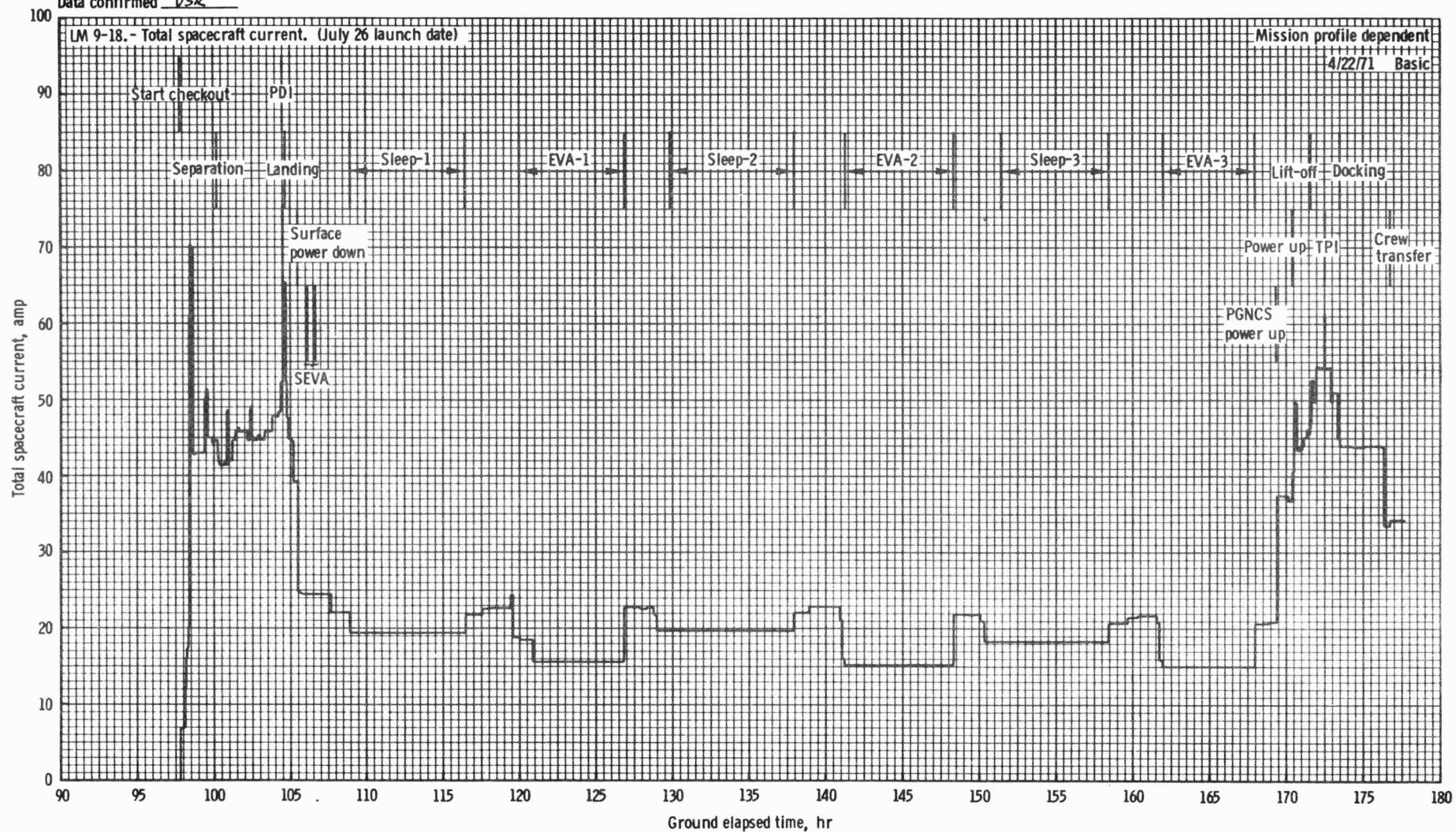
DPS PROPELLANT SUMMARY

Item	Total propellant, lb	Hover time, sec
Loaded	19 583.2	--
Trapped and unavailable	-138.4	--
Outage	-39.6	--
Available for ΔV	19 405.2	--
Required for ΔV (150-sec flying time from low gate, $\Delta V = 7068.0$)	-18 766.2	--
Remaining	639.0	69
Dispersions (-3σ)	-323.7	--
Pad	315.3	34
Operational allowances		
Low-level (5 sec, 26.5 fps)	-47.0	--
Abort reserve (20 sec, 106 fps)	-187.0	--
Margin (hover time before abort decision point)	81.3	9

Ritchey/GPB/MPAD (for LM Systems)

Data source Lunar Flight Plan

Data confirmed VSR

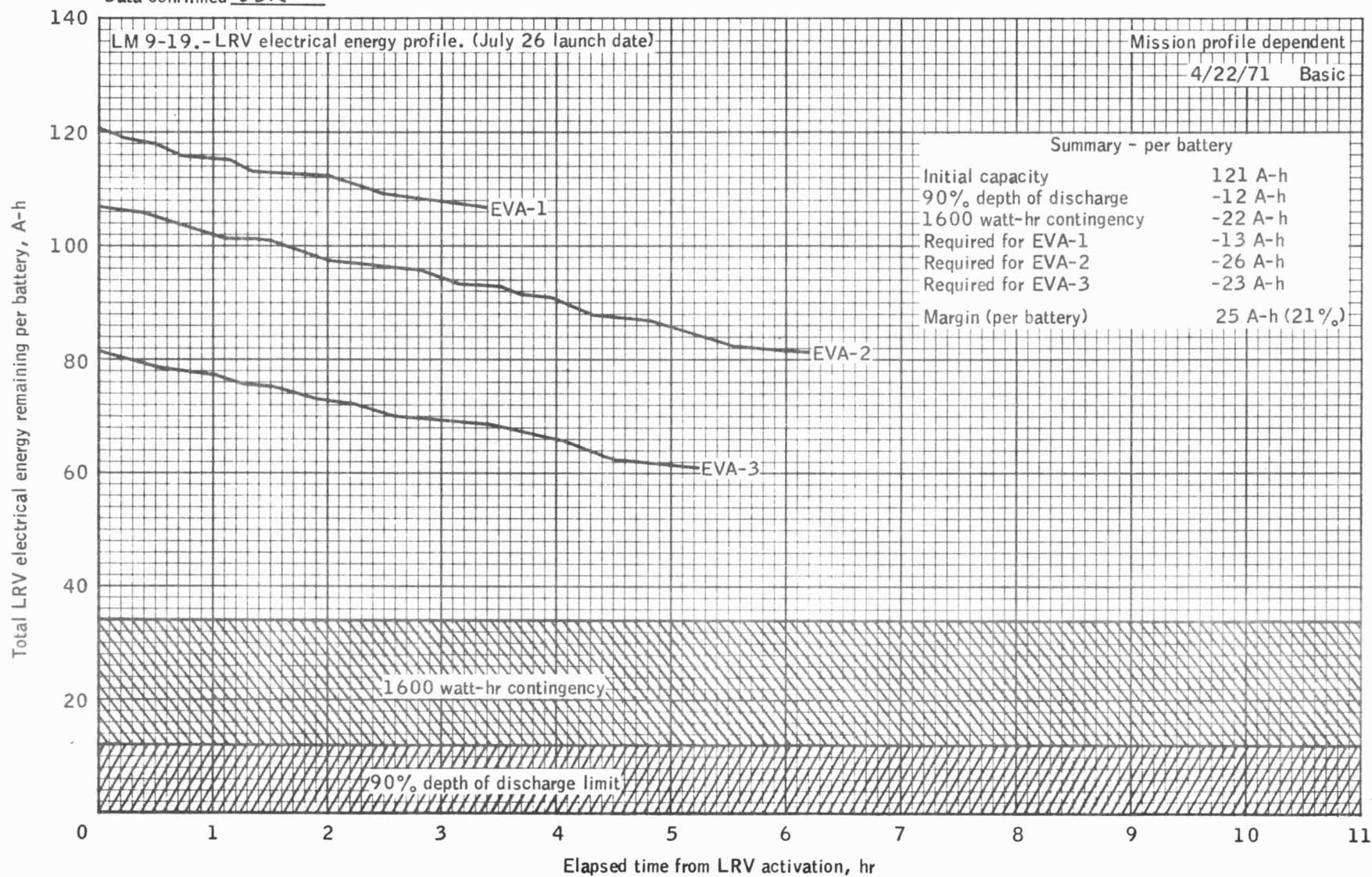


Apollo 15 total spacecraft current.

Ritchey/GPB/MPAD (for LM Systems)

Data source Trueman Trueman Plan

Data confirmed USR



LRV electrical energy profile.

Scheffman/PMAB/MPAD (for LM Cue Cards)

Data source TRWData confirmed DSScheffman

LM 11-1.- S-band 4/7/71

antenna angles. Basic

Launch day dependent

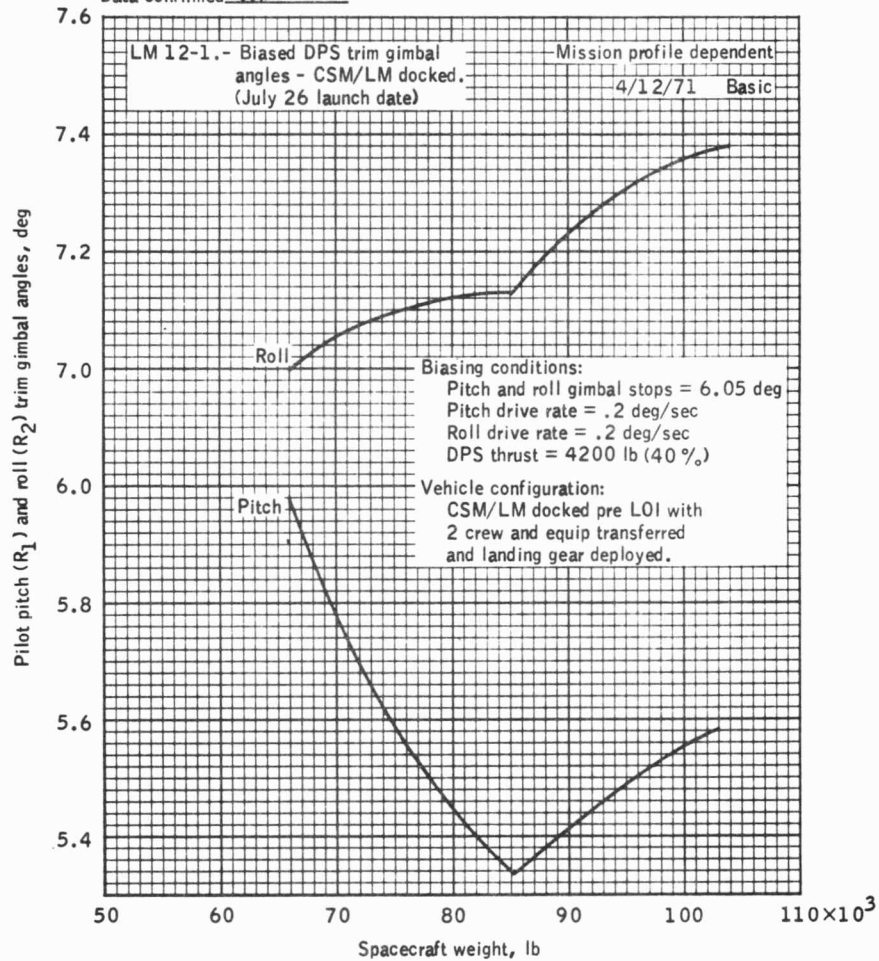
Launch month dependent

Mission profile dependent

S-BAND
ANTENNA ANGLES
DESCENT REFSMMAT

YAW=0°		IGA (PITCH)	YAW=180°	
ANTENNA			ANTENNA	
P	Y		P	Y
72	-63	0	99	-26
53	-60	10	109	-24
38	-55	20	119	-21
26	-49	30	128	-17
17	-42	40	137	-12
8	-35	50	145	-7
1	-28	60	152	-1
-6	-21	70	159	6
-13	-14	80	166	12
-20	-7	90	172	19
-26	-1	100	179	26
-34	5	110	186	33
-41	11	120	194	40
-50	16	130	204	47
-58	20	140	215	53
-68	23	150	229	57
282	25	160	247	62
271	26	170	267	64
261	26	180	-72	63
251	24	190	-53	60
241	21	200	-38	55
232	17	210	-26	49
223	12	220	-17	42
215	7	230	-8	35
208	1	240	-1	28
201	-6	250	6	21
194	-12	260	13	14
188	-19	270	20	7
181	-26	280	26	1
174	-33	290	34	-5
166	-40	300	41	-11
156	-47	310	50	-16
145	-53	320	59	-20
131	-59	330	68	-23
113	-62	340	78	-25
93	-64	350	89	-26

Hischke/MPSO/MPAD (LM Contingency)

Data source SEPA V-III A-94Data confirmed CR

Biased DPS trim gimbal angles - CSM/LM docked.