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SPACECRAFT OPERATIONAL TRAJECTORY FOR APOLLO MISSION F VOLUME I - OPERATIONAL MISSION PROFILE LAUNCHED MAY 17, 1969

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Orbital Mission Analysis Branch
Lunar Mission Analysis Branch
and
Landing Analysis Branch

MISSION PLANNING AND ANALYSIS DIVISION

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

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PROJECT APOLLO

SPACECRAFT OPERATIONAL TRAJECTORY FOR APOLLO MISSION F VOLUME I - OPERATIONAL MISSION PROFILE LAUNCHED MAY 17, 1969

By Orbital Mission Analysis Branch, Lunar Mission Analysis Branch, and Landing Analysis Branch

March 26, 1969

MISSION PLANNING AND ANALYSIS DIVISION
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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FOREWORD

The spacecraft operational trajectory for Mission F is composed of five volumes which summarize the lunar orbital missions for a 3-month launch period, May, June, and July 1969. The contents of each volume are briefly described below.

1. Volume I - Operational Mission Profile, Launched May 17, 1969: Detailed mission description of the first launch opportunity, first injection opportunity, of the May launch window. MSC IN 69-FM-65, March 26, 1969.

2. Volume II - Operational Mission Profile Trajectory Parameters, Launched May 17, 1969: Listing of significant trajectory parameters computed at selected time points during each phase of the same typical mission described in Volume I. MSC IN 69-FM-66, March 10, 1969.

3. Volume III - Mission Summaries: May 1969 Launch Window: Summaries of CSM trajectory parameters at selected time points for each launch date in the May 1969 launch window. MSC IN 69-FM-67.

4. Volume IV - Mission Summaries: June 1969 Launch Window: Summaries of CSM trajectory parameters at selected time points for each launch date in the June 1969 window. MSC IN 69-FM-68.

5. Volume V - Mission Summaries: July 1969 Launch window: Summaries of CSM trajectory parameters at selected time points for each launch date in the July 1969 window. MSC IN 69-FM-69.

In addition to the five volumes of the operational trajectory described above, two additional documents supplement the operational trajectory:

1. Howell, E. C.; Hunt, C. R.; and Simmons, V. W.: Preliminary Lunar Orbit Attitude Sequence for Mission F. MSC IN 69-FM-51, February 21, 1969. This document contains the mission attitude timeline that shows the sequence of events for the lunar orbital phase of the mission. The event times were obtained from Volume II of the operational trajectory document and from the preliminary flight plan for Mission F.

2. Brewer, B. A.; and Vick, M. B.: TLI Ship Position and Coverage Data for Apollo Mission F Lunar Launch Opportunities for May 1969. MSC IN 69-FM-56, March 5, 1969. This document shows the injection ship positions and the launch azimuth range coverage for each day for both injection opportunities. The entry ship positions are not show.

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SPACECRAFT OPERATIONAL TRAJECTORY

FOR APOLLO MISSION F

VOLUME I - OPERATIONAL MISSION PROFILE LAUNCHED MAY 17, 1969

By Lunar Mission Analysis Branch, Lunar Landing Branch,
and Orbital Mission Analysis Branch

1.0 SUMMARY

This volume is the first in a series related to the Apollo Mission F (CSM-106/LM-4) Spacecraft Operational Trajectory. This volume and Volume II present a detailed operational mission profile for a typical lunar orbital mission that would occur within a 3-month launch period: May, June, and July 1969. Mission summaries for each of the 3 months are presented in volumes III, IV, and V. For all three monthly launch windows, translunar injections are from the Pacific. The operational trajectory was designed to reflect the changes in mission ground rules and constraints since the publication of the F mission reference trajectory. The most important changes are the following.

1. The launch date is May 17, 1969.

2. The total 36° launch azimuth range is used.

3. The TLI maneuver is biased to compensate for a CSM evasive maneuver that follows LM extraction.[a]

4. The time from LOI-1 to DOI is now approximately 24.4 hours rather than 22.4 hours.

5. After the nominal rendezvous, an APS burn to depletion is planned rather than a CSM rescue simulation.

6. The shorter range transearth flight times are planned.

7. The entry range is 1350 n. mi. (relative).

---

[a]The TLI bias and the evasive maneuver are not actually included in the translunar trajectory. The change was made after the generation of the trajectory.

The launch date for the profile is May 17, 1969; the launch azimuth is 72°; translunar injection occurs during the second orbit over the Pacific. The targeted lunar site is site 1, located at a selenographic longitude of 34.03° E and at a selenographic latitude of 2.63° N. The duration of this specific mission is approximately 7 days 23 hours; lunar orbital stay time is approximately 52 hours, and transearth flight time is 63 hours. The operational trajectory demonstrates the capability of the launch vehicle and spacecraft to meet all of the F mission objectives.

2.0 INTRODUCTION

This volume and volume II present the mission profile for the first launch opportunity (72° launch azimuth) first injection opportunity on May 17, 1969. The sequence of major events is presented in table 2-I. A timetable of mission events is presented in table 2-II. The elapsed times between all major mission events can be obtained from this chart, which is similar to the mileage charts on road maps. The May launch window summary is presented in table 2-III. The targeted lunar site is site 1, which is located 34.03° E, 2.63° N. The lunar site selenographic coordinates and elevation above the mean lunar sphere are listed in table 2-IV.

A complete trajectory description is provided in volume II, Operational Mission Profile Trajectory Parameters. The ground rules used in the design of the operational trajectory are defined in section 3 of volume I. The spacecraft (SC) weight summary and engine performance data are contained in tables 2-V and 2-VI, respectively. The assumed mission-independent expendables are presented in table 2-VII. Radar acquisition and termination data for all phases of the mission are provided in table 2-VIII. The AOS and LOS tracking information was computed for 0° and 5° minimum elevation angles for each mission phase. The tracking information and the tables and bar charts are for only the selected launch azimuth (72°) and for the first injection opportunity.

An earth orbital insertion ship and two translunar injection ships are used to provide the desired support (ref. 1). The ship locations for May 17 are as follows.

1. Insertion Ship - 25° N, 49° W

2. Injection Ship 1 - 34° S, 130° E

3. Injection Ship 2 - 14° S, 145.5° E

The insertion ship provides the required coverage for earth parking orbit insertion for the total 36° launch azimuth spread. The coverage requirement is 1 minute of postinsertion coverage above a 5° minimum elevation angle. The injection ships are placed to provide coverage for the last 2 minutes of the preignition sequence for as much of the daily window as possible. The mission shadow timeline is shown in table 2-IX(a) and 2-IX(b). The most significant points reflected by the data in table IX are that launch occurs in daylight and that earth landing occurs approximately 1 hour and 20 minutes prior to sunrise.

3.0 SYMBOLS AND NOMENCLATURE

AGS	abort guidance system
AOS	acquisition of signal
APS	ascent propulsion system
C	cross-product steering gain constant
CDH	constant delta height
CDR	commander
CMC	command module computer
CMP	command module pilot
CSI	concentric sequencing initiation
CSM	command and service modules
c.g.	center of gravity
DOI	descent orbit insertion
DPS	descent propulsion system
DSKY	display keyboard
EI	entry interface
EMS	entry monitor system
EPO	earth parking orbit
FTP	fixed throttle point

h_a	apogee altitude
h_p	perigee altitude
IGA	inner gimbal angle
IMU	inertial measurement unit
IVT	intervehicular transfer
Jerk	time derivative of acceleration
L/D	lift-to-drag ratio
LLM	lunar landing mission
LM	lunar module
LMP	lunar module pilot
LOI	lunar orbit insertion
LOS	loss of signal
LPO	lunar parking orbit
LOX	liquid oxygen
LV	launch vehicle
MGA	middle gimbal angle
MNBY	mean nearest Besselian year
MSFC	Marshall Space Flight Center
OGA	outer gimbal angle
OPS	oxygen purge system
PC	plane change
PDI	powered descent initiation
PGNCS	primary guidance and navigation control subsystem
PTC	passive thermal control

RDG	position target for LM powered descent guidance
RCS	reaction control system
REFSMMAT	transformation matrix from the basic reference coordinate system to the stable member (IMU) coordinate system
RT	target vector for Lambert guidance scheme
SC	spacecraft
SPS	service propulsion system
T&D	transposition and docking
TEI	transearth injection
t_{IG}	time at ignition
TLI	translunar injection
Tf	Δt from ignition time (t_{IG}) to Lambert target vector (RT)
TPF	terminal phase finalization
TPI	terminal phase initiation
VHF	very high frequency
ΔV_X, ΔV_Y, ΔV_Z	components of velocity to be gained in the local vertical coordinate system
X_{SM}, Y_{SM}, Z_{SM}	components of unit vector in vehicle stable member system

4.0 PRIMARY GUIDELINES AND CONSTRAINTS

The design of the mission and the resultant launch windows were based on the following primary guidelines and constraints.

a. The monthly launch windows will consist of six possible launch days across a 9-day period with launches scheduled for the first, second, fourth, seventh, eighth, and ninth days.

b. All launch dates are selected to achieve favorable lunar lighting conditions for the primary G mission landing sites.

c. Two additional launch days are added to the normal G mission window, which consists of only the first four launch days. The additional launch days, which are targeted to site 5, accept the resultant high sun elevations at the site.

d. Daylight launch is highly desirable.

e. A launch azimuth range of 72° to 108° will be targeted.

f. The launch window is designed for Pacific injection.

g. Two TLI opportunities are targeted: the first on the second revolution and the second on the third revolution.

h. TLI will be targeted for a free-return circumlunar trajectory.

i. The LOI maneuver will be performed in two stages; the first burn, LOI-1, will result in a 60- by 170-n. mi. elliptical orbit, and the second burn, LOI-2, will circularize the orbit at 60 n. mi. two revolutions later.

j. The lunar orbit orientation will be selected so that the spacecraft will pass over a primary G mission site on the thirteenth revolution after LOI-1. This orientation results in a delta time of approximately 24 hours from LOI-1 to DOI.

k. Lunar operations will simulate the G mission timeline as closely as possible. The operation will include a G mission type of rendezvous and an APS burn to depletion.

l. The APS burn to depletion will be targeted to escape the earth-moon system.

m. The time from LOI-1 to TEI nominally will be approximately 52 hours (26 revolutions), which allows for a rest period after rendezvous. However, an option will exist for performance of TEI on an earlier

revolution if the full rest period is not desired or on a later revolution if observation of an additional G candidate site for the G mission would be possible.

n. The TEI maneuver will be targeted to return as soon as possible to 165° W longitude within the available ΔV capability and without exceeding a return inclination of 40°.

o. The earth relative entry range target will be 1350 n. mi.

5.0 MISSION SUMMARY

In this section, a mission profile is summarized for a May 17, 1969, launch date. The burn times, propellants used, and most mission phase times that are presented in this section are typical of the lunar orbital missions planned for the May and June launch window

The profile is concisely presented in table 2-I. In this section, major events, spacecraft performance characteristics, and significant trajectory parameters are described in detail for each phase.

In the design of the spacecraft operational mission, the LV mission phases were simulated independently of the exact LV operational trajectory. The trajectory data presented here for the LV mission phases were simulated with LV data received from the MSFC for the Apollo 8 mission. This vehicle configuration is considerably lighter than the actual Mission F configuration. No attempt was made to duplicate exactly the LV operational mission, and the information for the LV phases will differ from that in the official trajectory document (ref. 2). The parameters for the LV mission phases would be considered as typical values only.

5.1 Earth Launch[a]

The launch time for this mission was determined to provide an optimized injected payload to support two injection opportunities. The launch time, in particular, differs slightly from the official launch time in the MSFC LV operational trajectory.

---

[a]The parameters for this phase are presented for information only. The official source for this phase is the MSFC LV operational trajectory (ref. 2).

To provide a daylight launch and acceptable lighting at the target lunar landing site, the mission was designed for a Pacific injection. The launch is summarized as follows.

Date, month, day, year	May 17, 1969
Time, hr:min:sec, e.s.t.	11:33:49:4
Azimuth, deg	72
Location (Cape Kennedy, Complex 39B)	
Geodetic latitude, deg:min:sec	28°:37':38.31"
Longitude, deg:min:sec	279°:22':44.86"

5.2 Earth Parking Orbit[a]

Insertion into EPO occurs at $00^h11^m21.6^s$ g.e.t. The insertion conditions are as follows.

Insertion location	
Geodetic latitude, deg	32.7
Longitude, deg	-54.3
Altitude, n. mi.	103.3
Inclination, deg	32.6

The insertion ship positioned at 25° N latitude and 49° W longitude tracks the vehicle for approximately 3 minutes after insertion; minimum elevation angle is 0°. A ground track of the EPO phase is given in figure 5.2-1.

The LV maintains local horizontal attitude throughout the EPO phase except for an inertial hold of approximately 10 seconds immediately after EPO insertion. The total time spent in EPO is 2^h20^m.

5.3 Translunar Injection

The TLI burn is initiated near the western coast of Australia during the second revolution in EPO. Note that the LV/SC weight model used to simulate the TLI phase was the Apollo 8 configuration and that the burn

---

[a]The parameters for this phase are approximate and are presented for information only. The offical source for this phase is the MSFC launch vehicle operational trajectory (ref. 2).

parameters below do not represent realistic values for the Apollo 10 (Mission F) configuration.

TLI burn initiation

Time, hr:min:sec, g.e.t.	2:31:36.4
Geodetic latitude, deg	-27.8
Longitude, deg	128.6

TLI cutoff

Geodetic latitude, deg	-18.3
Longitude, deg	151.8
Burn duration, sec	307.0
S-IVB propellant used, lb	149 000
Plane change, deg	1.0

The TLI maneuvers is initiated in darkness, and the vehicle enters sunlight approximately midway through the TLI burn. (Coverage for the major part of the preignition sequence is provided by Carnarvon, which also provides coverage during the early part of the burn. Additional support of the burn and preignition sequence is supplied by the injection ships (section 2.0). The tracking and lighting and mission events summary is shown in figure 5.3-1.

The TLI burn is biased for a 2 m/sec overburn to compensate for the SPS evasive maneuver that is performed after LM extraction (section 5.5).

5.4 Free-Return Circumlunar Trajectory

Free-return touchdown assumes perfect execution of TLI and no correction maneuvers. It is planned to occur in the Indian Ocean southeast of Madagascar. A more desirable landing position can be insured by application of a corrective maneuver at an acceptable time during either the translunar or transearth coast phases of the circumlunar trajectory. The free-return trajectory is characterized by the following.

Pericynthion

Time, hr:min:sec, g.e.t.	76:11:50.3
Altitude, n. mi.	59.3
Selenographic latitude, deg	1.97
Selenographic longitude, deg	178.5

Return vacuum perigee altitude, n. mi.	15.2

Transit time from TLI to entry interface, hr:min:sec	147:44:12

Earth entry

Time, hr:min:sec, g.e.t.	150:15:48.2
Altitude, n. mi.	65.8
Geodetic latitude, deg	-18.0
Longitude, deg	45.2
Inclination, deg	33.5

Touchdown

Geodetic latitude, deg	67.1
Longitude, deg	-27.9

5.5 Posttranslunar Injection Events

The summary of the major events from TLI cutoff ttrough S-IVB LOX blowdown is given in table 5.5-I. To determine the separation attitude maneuver (TB-7 plus 900 sec), the sun was constrained to between 32° and 90° of the LV +X-axis. This constraint provides over-the-shoulder lighting and avoids any CSM shadow on the S-IVB for the docking phase. The onboard SC event times will be referenced to TLI ignition (column 1 of table 5.5-I), and the LV event times will be referenced to TB-7. Therefore, the SC event times will vary with respect to TB-7 as the TLI burn time varies. The SC maneuver times referenced to TB-7 in the table assumed a 300-second TLI burn time. The purpose of the evasive maneuver at approximately TB-7 plus 9600 seconds is to decrease the probability of S-IVB recontact and to avoid the ice particles expected to be expelled by the S-IVB during the LOX dump.

The current profile combines an early SPS confidence burn with the evasive maneuver. This SPS burn will have a ΔV of 20 fps and will be approximately 3 seconds in duration. To achieve a burn of this magnitude without jeopardizing the RCS capability to reture to a free-return circumlunar mission, the TLI burnout conditions will be biased for a 2- m/sec overspeed at burn termination. The SPS evasive maneuver then will be performed in a direction which will compensate for the TLI bias. The attitude will be pitched down 75° with respect to the local horizontal. This attitude will provide for SC high gain S-band coverage with the steerable antenna, and a roll of approximately ±60° (based on the CSM/S-IVB separation attitude) provides for visual monitoring of the S-IVB during the evasive maneuver burn. At approximately 2 hours after TLI, the S-IVB is ground commanded to assume a local horizontal attitude for the LOX blowdown. The local horizontal attitude components are the following: pitch, 194°; yaw, 0°; roll, 180°. The magnitude of the ΔV that results from the LOX dump is expected to be approximately 120 fps.

The LOX dump maneuver is designed to reduce the probability of SC recontact with the S-IVB and also to prevent S-IVB impact with the earth or moon. Nominally, the LOX dump maneuver results in a

sling-shot trajectory; the S-IVB will pass behind the trailing edge of the moon and will be accelerated by the lunar gravitational field. The result is a heliocentric orbit which avoids either earth or lunar impact.

5.6 Translunar Coast

A ground track of the translunar coast phase is given in figure 5.6-1. Time histories of altitude and true anomaly for the first 10 hours of translunar coast are provided in figures 5.6-2 and 5.6-3, respectively.

Passive thermal control attitude will be maintained throughout most of the translunar coast phase. Four midcourse correction maneuver points have been defined at the following times.

1. TLI plus 7 hours (MCC-1)

2. TLI plus 24 hours (MCC-2)

3. LOI minus 22 hours (MCC-3)

4. LOI minus 5 hours (MCC-4)

The third midcourse correction (MCC-3) will be the prime maneuver to establish the desired lunar approach trajectory. The first two maneuvers will not be performed unless the magnitude of the MCC-3 maneuver exceeds 25 fps. The MCC-1 or MCC-2 maneuver or both will then be performed only if their values exceed the SPS minimum impulse ($\approx$3 fps). The MCC-1 and MCC-2 residuals will not be trimmed.

To avoid use of the SPS for the MCC-4 maneuver, the MCC-3 maneuver will be performed if the predicted magnitude of MCC-4 is greater than 3 fps using the SPS. Residuals will be trimmed to within 0.5 fps. If MCC-3 is less than 3 fps and if LOI-1 targeting cannot absorb the uncorrected approach dispersions without a shift greater than 45° in the line of apsides of the 60- by 170-n. mi. orbit, MCC-3 will be performed with the SM RCS; however, if LOI-1 targeting can absorb the dispersions with less than a 45° apsidal shift, MCC-3 will not be performed.

The MCC-4 maneuver will not be performed if the dispersions can be absorbed by the LOI-1 targeting with apsidal rotation less than 45°; otherwise the maneuver will be performed with the SPS if the ΔV greater than 3 fps or the SM RCS if the ΔV less than 3 fps. The residual will be trimmed to within 1 fps if the SPS is required for the MCC-4 maneuver.

The maneuvers are GNCS controlled and use external ΔV guidance. Unless gimbal lock problems occur, the pad IMU alinement (REFSMMAT) will be used for the MCC-1; the PTC REFSMMAT, for MCC-2 and MCC-3; and

the descent REFSMMAT, for MCC-4. The CSM remains in sunlight during the entire translunar coast phase [table 2-IX(a)]. The duration of the phase is 73 hours 37 minutes. Altitude above the lunar surface for the last 10 hours of translunar coast is provided in figure 5.6-4.

5.7 Lunar Orbit Insertion

The LOI-1 is designed to insert the CSM into approximately a 60- by 170-n. mi. LPO. A time history of trajectory parameters during the burn is presented in figure 5.7-1. The burn was simulated with the external ΔV guidance. A description of the burn is as follows.

LOI initiation	
Time, hr:min:sec, g.e.t.	76:08:17.6
Altitude, n. mi.	84.0
Selenographic latitude, deg	0.5
Selenographic longitude, deg	-165.0
Burn duration, min:sec	5:52.5
Inertial burn arc, deg	23.0
Plane change, deg	0.5
ΔV, fps	2867
SPS propellant used, lb	22 971
LOI burnout (start LPO)	
Time, hr:min:sec, g.e.t.	76:14:10.1
Altitude, n. mi.	58.9
Selenographic latitude, deg	2.6
Selenographic longitude, deg	172.0
Selenographic inclination, deg	174.3
Period of LPO, hr:min:sec	2:08:36
Altitude of pericynthion of LPO, n. mi.	58.9
Altitude of apocynthion of LPO, n. mi.	168.9

The LOI-1 burn parameters were computed without simulation of the SPS thrust buildup and tailoff. The effect of these, however, is reflected in the burn parameters presented in the simulation data package (ref. 3).

The REFSMMAT used for the LOI-1 burn as well as for all other burns in LPO is the landing site alinement at the nominal G mission landing time relative to DOI.

The target loads for the LOI-1 burn are given in table 5.7-I. More detailed information about the burn, including reset points, navigation updates, and ignition gimbal angles, is given in the F Mission Simulator Data Package (ref. 3).

5.8 Lunar Orbit Circularization

A coplanar circularization burn (LOI-2) is performed to place the CSM in approximately a 60-n. mi. circular LPO after two revolutions in the 60- by 170-n. mi. orbit. The target altitude of the orbit (60 n. mi.) is measured relative to the lunar target site (table 2-IV) and not relative to the mean lunar radius.

The landing REFSMMAT (table 5.8-I) is used, and the CSM is oriented heads down. The burn is initiated near pericynthion of the second revolution. More detailed information is given in reference 4. The characteristics of the burn are the following.

Circularization burn initiation

Time, hr:min:sec, g.e.t.	80:32:12.0
Altitude, n. mi.	58.9
Selenographic latitude, deg	2.8
Selenographic longitude, deg	167.1
Burn duration, sec	14.5
Inertial burn arc, deg	0.7
ΔV, fps	137.5
SPS propellant used, lb	946.2

5.9 CSM/LM Coast From LOI-2 to Undock

At a g.e.t. of 81^h45^m or at about 1 minute 13 seconds after LOI-2, the crew begins preparation for IVT to the LM. In the LM, general housekeeping and equipment storage is performed. Also, short checkout will be performed on the LM VHF and OPS systems. After about 2 hours 40 minutes in the LM, the CDR and LMP perform IVT to the CSM and close the hatch. At a g.e.t. of approximately 84^h40^m, landmark tracking is performed on a pseudosite with a sun elevation angle of approximately 3°. An inertial hold is initiated at a g.e.t. of 86^h00^m for an 8-hour crew rest period.

The rest period is ended at a g.e.t. of 94^h00^m. After a 1-hour eat period, the CDR and LMP perform IVT to enter the LM and begin LM checkout. At a g.e.t. of 96^h50^m (revolution 11), landmark tracking is performed on the target site. The LM checkout is completed, and undocking occurs at 98^h30^m during revolution 12 or approximately 4 hours 30 minutes after wakeup. The lunar ground tracks for the total lunar orbital phase is shown in figure 5.9-1. The CSM tracking, lighting, and events summary for the total lunar orbital phase is shown in figure 5.9-2.

5.10 LM Undock and CSM Separation

Undocking will occur 30 minutes prior to the RCS separation burn. After the CSM undocks from the LM, the CSM will perform stationkeeping at a distance of 30 feet from the LM for LM inspection. After completion of the inspection, the LM will perform stationkeeping while the CMP prepares for the RCS separation. At approximately a 180° central angle prior to DOI, the CSM performs a 2.5 fps radially downward separation maneuver, which places the LM and CSM in equiperiod orbits. Rendezvous will be accomplished from the equiperiod orbits if the DOI maneuver is not performed.

5.11 Rendezvous Sequence

5.11.1 Sequence summary.- The basic objective of the rendezvous sequence on the Apollo Mission F is to simulate as nearly as possible the LLM rendezvous profile after LM insertion following ascent from the lunar surface. The rendezvous sequence is shown in table 5.11-I. After separation of the LM and CSM, the rendezvous activities are initiated by the CSM separation maneuver (minifootball, section 5.10) at $98^h55^m40^s$ g.e.t. Then the LM must perform a DOI maneuver and a phasing maneuver to establish the proper relative conditions (LM 49.4 n. mi. below and 270.0 n. mi. behind the CSM) at the simulated insertion point over the target site (34° E). After the insertion maneuver has been completed, the LM will compute and execute the coelliptic sequence that is planned for the LLM rendezvous. The sequence of CSI, CHD, and TPI will result in LM approach, braking, and docking at approximately $106^h32^m00^s$ g.e.t., which completes the 7.5-hour exercise that began with separation. A detailed discussion of the rendezvous activities is given in sections 5.11.2 through 5.11.9.

The orbital schematic for the nominal F mission rendezvous is presented in figure 5.11-1. The relative motion of the descent stage with respect to the ascent stage after the staging sequence is presented in figure 5.11-4. A tracking, lighting, and mission events summary for the rendezvous sequence is presented in figure 5.11-5.

5.11.2 DOI.- After the CSM separation maneuver at $98^h55^m40^s$ g.e.t., the LM will fine aline the platform and will aline the AGS to the PGNCS in preparation for the DOI maneuver. The DOI maneuver is ground computed to be executed 195° prior to the target site, which duplicates the same maneuver required in the LLM. The DOI maneuver is external ΔV maneuver performed with the DPS in a horizontal retrograde direction so that the resultant LM pericynthion is 50 000 feet (referenced to the landing site radius) and is 15° up range from the landing site. The 72.8 fps maneuver is performed at $99^h54^m12^s$ g.e.t. with 10-percent thrust for 15 seconds and 40-percent thrust for 12.7 seconds. The target loads for the DOI maneuver are shown in table 5.11-II.

5.11.3 Phasing.- After the DOI maneuver, the LM will prepare for a landing radar test to be conducted as the vehicle passes over the target site at 34° E longitude and at an altitude of approximately 50 000 feet. Because the LM will lead the CSM (fig. 5.11-4) during this first pass over the site, a phasing maneuver is performed approximately 10 minutes after the site is passed to place the LM in a dwell orbit so that eventually the LM will fall behind the CSM and will trail the CSM by approximately 270 n. mi. at the time of the second pass, at which time the lunar landing mission relative profile can be simulated. The phasing maneuver is a ground-computed maneuver with an external ΔV of 193.5 fps initiated with the DPS at $101^h06^m35^s$ g.e.t. By use of the two-impulse processor, the maneuver is targeted to establish the nominal LLM phase and height offset relative to the CSM at the time of insertion. The target loads for the phasing maneuver are shown in table 5.11-II. The posigrade burn at a 26.1° pitch above the local horizontal will place the LM in a 194.4- by 9.8-n. mi. orbit. The DPS burn will be started at 10-percent thrust for 26 seconds and will be increased to full throttle (92.5 percent) for 16 seconds.

5.11.4 Insertion.- During the LM phasing orbit, the LM and CSM will conduct onboard tracking to determine the orbits. The onboard tracking data may be used by the ground to update the required insertion maneuver. The insertion maneuver will initiate the sequence that is designed to simulate the in-orbit ascent rendezvous of the LM after the lunar liftoff on the LLM. Prior to insertion, the LM will stage the DPS so that the burn may be executed with the APS. Current plans call for the staging to occur at $102^h53^m26^s$ g.e.t., approximately 10 minutes prior to insertion. While in a retrograde attitude, the LM will thrust posigrade 2 fps with the -X RCS jets, will stage, and immediately will null this ΔV with 2 fps retrograde with the +X jets. The result of the separation maneuver is to send the descent stage ahead of and above the ascent stage so that no recontact can occur after the ascent stage performs insertion. The relative motion of the descent stage with respect to the LM can be seen in figure 5.11-2. At $103^h03^m29^s$ g.e.t.,

the APS thrusts at a 152.6° pitch for 15 seconds to impart a retrograde ΔV of 213 fps and to place the LM into a 43.6- by 9.8-n. mi. orbit. Apocynthion occurs 51 minutes later. The 43.6- by 9.8-n. mi. orbit is identical to the orbit planned after LM insertion in the LLM, and the insertion maneuver is scheduled 5 minutes prior to entry into darkness to duplicate the LLM lighting conditions. The insertion maneuver is also targeted by the ground two-impulse processor which establishes the nominal CSI offset (LM 14.7 n. mi. below and 148 n. mi. behind the CSM) at the nominal time. Target loads for the insertion maneuver are shown in table 5.11-IV.

5.11.5 CSI.- After insertion, the LM will realine its platform and will begin radar tracking of the CSM to determine the orbits of the vehicles for onboard computation of the coelliptic sequence. The CSI maneuver will be scheduled for the apocynthion at $103^h54^m40^s$ g.e.t. and will be calculated to cause TPI to occur at the midpoint of darkness approximately 94 minutes later. The nominal relative condition will be such that the CSI will place the LM in a 46.2- by 42.9-n. mi. orbit, 15.0 n. mi. below the CSM orbit at the time of CDH, one-half an orbital period after the CSI. The CSI will be performed with the four +X RCS jets so that the interconnect can be opened and APS propellant can be used. The 32.1-second burn is horizontal and adds a posigrade ΔV of 50.5 fps. The target loads are shown in table 5.11-V.

5.11.6 Plane change technique.- An out-of-plane component, which nominally is not required, will be applied in conjunction with the CSI if an out-of-plane velocity is detected prior to the CSI. The out-of-plane component will be targeted to null to zero the out-of-plane velocity, which will force the existence of a common node approximately 90° later where the separate PC maneuver is scheduled. At PC, the out-of-plane velocity is again nulled to zero and a coplanar situation is established. If the out-of-plane situation is not determined soon enough to begin the PC at the CSI, the nodal shift would be initiated at the time of PC and completed in conjunction with the CDH. However, the CSI-PC sequence is more economical than the PC-CDH sequence because the in-plane component at the CSI is considerably larger than the in-plane component at CDH.

5.11.7 CDH.- After the CSI, the LM will continue to track the CSM and will compute the required CDH maneuver to be done at $104^h52^m41^s$ g.e.t. Normally, the CDH will be a small radial burn designed to coellipticize the LM orbit with the orbit of the CSM. If the CSM orbit were perfectly circular, the CDH would be zero; however, because of the simulated 61- by 58-n. mi. CSM orbit, a downward ΔV of 5.8 fps is required. The two-jet +Z thrusters were used in this simulation; however, the -X jets could be used so that radar lock-on at an elevation angle of approximately 9.5° above the local horizontal would not be disturbed. The

7.3-second burn places the LM in a 46.2- by 42.9-n. mi. orbit, 15 n. mi. below the CSM orbit and coelliptic with it. The target loads for the CDH maneuver are presented in table 5.11-VI.

5.11.8 TPI.- Radar tracking continues after CDH so that the LM may compute the required burn (TPI) when the elevation angle to the CSM reaches 26.6° above the LM local horizontal. Nominally, the maneuver should occur approximately 36.5 minutes after CDH, when the LM is 23 minutes into darkness. TPI will be calculated to start the LM on an intercepting orbit; theoretically, rendezvous would occur after 130° of CSM central angle travel. The 25.3-fps burn is planned to be executed with the four +X jets to use the APS propellant through the interconnect. However, this arrangement may cause a temporary loss of radar lock, which is not considered to be a problem. The TPI ignition is at $105^h28^m59^s$ g.e.t., and the burn duration is approximately 16 seconds. The target loads for the TPI maneuver are presented in table 5.11-VII.

5.11.9 Rendezvous midcourse corrections and braking.- The LM will track the CSM after TPI and will perform nominally zero midcourse correction maneuvers 15 minutes later and 30 minutes later. The braking schedule assumed for this trajectory simulation calls for a reduction in range rate to 15 fps at the 1-n. mi. gate, to 5 fps at 1000 feet, and to 0.25 fps at 300 feet. The braking schedule may be changed slightly after further simulations; line-of-sight corrections will be made as required. Final approach and stationkeeping should occur at approximately $106^h17^m00^s$ g.e.t., approximately 25 minutes after the vehicles enter sunlight on the backside of the moon. Docking should begin at approximately $106^h32^m00^s$ g.e.t. to complete 7.5 hours of rendezvous activities.

5.12 APS Burn to Depletion

At approximately $107^h15^m00^s$ g.e.t., just prior to earth LOS, the CSM/LM establishes an inertial attitude which is suitable for LM steerable antenna communications during and after the APS burn to depletion. The antenna is in a locked position. Near 90° E longitude, the unmanned LM is jettisoned in attitude hold, and the CSM performs a radially upward separation maneuver of approximately 2 fps, which will place the CSM above and behind the LM at the time of the APS burn.

The ullage maneuver and the APS burn are initiated under PGNCS control, and after confirmation of burn initiation a command is sent to transfer control to the AGS. The ascent stage will have been in attitude hold since jettison. Whether either or both of the RCS interconnects

will be open will depend on the RCS usage up to that time in the mission and will probably be a real-time decision. The need for attitude hold to be maintained during the burn and as long thereafter as possible could be satisfied either with one interconnect open or with both closed. However, if the RCS margin is low enough at the time of jettison, both interconnects would be open to assure attitude control during the entire burn. In this case, ascent stage tracking after the burn would not be assured. The characteristics of the burn are as follows.

Burn initiation

Time, hr:min:sec, g.e.t.	109:03:41.4
Δt from LM jettison, min	30
Selenographic latitude, deg	-.22
Selenographic longitude, deg . . .	0.0
Estimated propellant available, lb	2373
Vehicle attitude, local horizontal	
Pitch, deg	0
Yaw, deg	0
Roll, deg	0

Burn termination

Burn duration, min:sec	3:2.5
Burnout velocity, fps	8960
ΔV attained, fps	3616
Selenographic latitude, deg	-1.6
Selenographic longitude, deg . . .	-13.8
Burn arc, deg	13.8
Selenographic longitude of the lunar sphere exit, deg W	≈134

The resultant ascent stage trajectory is hyperbolic with respect to the earth-moon system, which assures a heliocentric orbit.

5.13 CSM Coast from APS Burn to Depletion to TEI

Shortly after the APS burn to depletion at a g.e.t. of $110^h00^m00^s$, an inertial attitude hold is initiated for an 8-hour crew rest period. After the rest period, four consecutive revolutions of landmark tracking will be performed, which will involve tracking either three or four landmarks per sunlight pass. After these four revolutions of tracking have been performed, one revolution of terminator-to-terminator stereo strip photography will be performed.[a]

[a]The terminator-to-terminator stereo photography will require adding one revolution to the lunar orbit timeline which is not included in this document.

5.14 Transearth Injection

The TEI maneuver occurs $51^h37^m00^s$ after LOI-1. A time history of significant parameters during the burn is provided in figure 5.14-1. The burn was targeted for a 63-hour transearth flight time. The target loads and REFSMMAT for the burn are presented in table 5.14-I. The characteristics of the burn are presented below.

Initiation time, hr:min:sec, g.e.t	127:51:34.8
Selenographic latitude, deg	0.5
Selenographic longitude, deg	168.0
Burn duration, sec	159.6
ΔV, fps	3250.9
SPS propellant used, lb	10 400
Plane change	1.75
Burnout	
Flight-path angle, deg	3.0
Altitude, n. mi.	60.4
Selenographic latitude, deg	1.3
Selenographic longitude, deg	157.6
Entry velocity (inertial), fps	36 210.5

5.15 Transearth Coast

A groundtrack of the transearth coast phase is provided in figure 5.15-1. Altitude above the moon is shown for the first 10 hours of coast in figure 5.15-2. Three midcourse decision points have been defined for the transearth phase.

1. MCC-5, TEI plus 15 hours

2. MCC-6, EI minus 15 hours

3. MCC-7, EI minus 3 hours

The maneuvers will be targeted for corridor control only. The midcourse strategy, which includes the threshold values for each maneuver, is contained in reference 5. Altitude is plotted against time for the last 10 hours of transearth coast in figure 5.15-3. The CSM remains in sunlight from TEI until darkness, which occurs approximately 21 minutes prior to EI. The last ground station coverage is by Honeysuckle [table 2-VIII(c)], which terminates at 0° elevation approximately 3 minutes prior to EI.

5.16 Entry

The entry phase of the operational trajectory was simulated with the Apollo Reentry Simulation program with six-degrees-of-freedom. Three-degree-of-freedom trajectories were used to determine the CM maneuver footprint. The entry corridor is presented in figure 5.16-1.

At the nominal EI, $191^h18^m16^s$ after lift-off, the CM is at an altitude of 399 720 feet, and the coordinates are 18.315° S geodetic latitude and 171.29° E longitude. Inertial velocity, flight-path angle, and azimuth at this point are 36 210 fps, 6.49° below the local horizontal, and 98.56°, respectively.

A plot of the CM maneuver footprint and the nominal ground trace on a map of the entry area are presented in figure 5.16-2. The footprint is extended to a 3500-n. mi. entry range. The nominal touchdown target location is 1350 n. mi. down range from the entry interface position, and the coordinates of the target are 165° W longitude and 20.25° S geodetic latitude. A sequence of pertinent events is given in table 5.16-I and includes the periods of communication blackout which occur along the trajectory. The guidance phases are shown in figure 5.16-3, which shows altitude as a function of range to the target. Time histories of the bank angle commanded by the guidance system, by the load factor, and by altitude are presented in figure 5.16-4. The load factor at the c.g. reaches a first maximum of 6.35g and a second maximum of 5.99g. Time histories of the total heating rate and the total heat load are presented in figure 5.16-5. The maximum total heating rate is 277.8 Btu/ft^2/sec, and the total heat load is 24 355 Btu/ft^2. Time histories for inertial and relative velocity and flight-path angles are presented in figure 5.16-6.

The CM RCS uses 11.55 pounds of propellant for the separation and attitude hold maneuvers before the spacecraft reaches 400 000 feet. The RCS uses 19.24 pounds of propellant to perform the guidance commands during the remainder of the entry. A time history of the total RCS propellant consumed from separation is presented in figure 5.16-7. In figure 5.16-8, the altitude is plotted in relation to relative velocity, and the boundaries for S-band and C-band communication blackout are shown (ref. 6). Time histories for the primary DSKY displays, commanded bank angle, inertial velocity, and altitude rate are shown in figure 5.16-9. Time histories for the final phase DSKY displays, commanded bank angle, cross-range error, and down-range error are shown in figure 5.16-10.

The drogue parachute deployment sequence begins at an altitude of 23 300 feet, 8 minutes 32 seconds after EI. The two drogue parachutes

are deployed 2 seconds later. At an altitude of 10 500 feet, the low altitude baroswitch closes, and the drogue parachutes are disconnected. The three main parachutes are deployed 1 second after the baroswitch closes. The CM, suspended on the main parachutes, reaches splashdown 14 minutes 20 seconds after EI. The relative velocity and relative flight-path angle are plotted against time from drogue chute deployment in figure 5.16-11. Load factor and altitude are plotted against time from drogue chute deployment in figure 5.16-12.

An EMS scroll (NON-EXIT pattern) is presented in figure 5.16-13(a) with the reference trajectory from 0.05g superimposed upon it. This pattern has limit lines which allow the crew to monitor the entry trajectory to prevent an exit by the spacecraft from the atmosphere ($g < 0.2$). The commanded bank angle and EMS range-to-go are plotted against the inertial velocity in figure 5.16-13(b).

The following input was used in the generation of the operational entry trajectory.

CM RCS engine performance data . . .	reference 7
CM mass properties for entry .	table 5.16-II, reference 13
Conditions at entry interface and target point	table 5.16-III
Aerodynamic coefficients	table 5.16-IV
Parachute aerodynamics	reference 7
Aerodynamic heating data	references 8 and 9
Entry guidance	references 10 and 11
Atmospheric model	reference 12
Entry REFSMMAT and gimbal angles at EI	table 5.16-V

TABLE 2.0-I.- SEQUENCE OF MAJOR EVENTS

[Launch occurs at 11:33:49 e.s.t. with a 72° launch azimuth]

Event	Time,[a] hr:min:sec g.e.t.	Data Summary	
Earth orbit insertion	00:11:21.6	Latitude, deg N	32.7
		Longitude, deg W	-54.3
		Inclination, deg	32.6
Translunar injection	02:31:36.4	Burn time, sec	307.0
		Plane change, deg	-1.03
Free return, circumlunar pericynthion	76:12:46.6	Altitude, n. mi.	61.0
		Selenographic latitude, deg	2.3
		Longitude, deg	174.1
Free-return entry	150:15:48.2	Altitude, n. mi.	65.8
		Longitude, deg	45.1
		Latitude, deg	-18.0
		Flight-path angle, deg	-6.8
		Velocity, fps	36 141.5
		Equatorial inclination, deg	33.5
		Vacuum perigee altitude, n. mi.	26.9
Lunar orbit insertion	76:08:17.6	Mass at ignition, lb	93 132.9
		Burn time, sec	352.5
		Propellant used, lb	22 971.1
		Inclination of LPO, deg	5.6
LOI-2	80:32:12	Mass at ignition, lb	70 115.9
		Burn duration, sec	14.5
		Propellant used, lb	946.2
Undocking	99:25:44		
LM separation	98:55:43.9	Mass at ignition, lb	37 768.2
		Burn time, sec	-7.1
		Propellant used, lb	-10.6
DOI	99:54:12	Ignition longitude, deg	-128.5
		ΔV, fps	72.8
		Burn duration, sec	27.7
CSM pass over target site (REV 13)	100:59:10.0	Sun elevation at site, deg	8.7
Phasing	101:06:35	Ignition longitude, deg	0.3
		ΔV, fps	193.5
		Burn duration, sec	42.0
Insertion	103:03:29	Ignition longitude, deg	31.3
		ΔV, fps	213.3
		Burn duration, sec	15.5

[a]Time refers to g.e.t. of ignition for burns.

TABLE 2.0-I.- SEQUENCE OF MAJOR EVENTS - Concluded

[Launch occurs at 11:33:49 e.s.t. with a 72° launch azimuth]

Event	Time,[a] hr:min:sec g.e.t.	Data summary	
CSI	103:54:40	Ignition longitude, deg	-131.8
		ΔV, fps	50.5
		Burn duration, sec	32.1
CDH	104:52:41	Ignition longitude, deg	47.6
		ΔV, fps	5.8
		Burn duration, sec	7.3
TPI	105:28:59	Ignition longitude, deg	-65.1
		ΔV, fps	25.3
		Burn duration, sec	16.0
TPF (impulsive)	106:11:41	Ignition longitude, deg	163.0
		ΔV, fps	31.5
		Burn duration, sec	39.8
LM jettison	108:34:01.9	Mass at ignition, lb	37 957.5
		Burn time, sec	5.7
		Propellant used, lb	8.5
APS burn to depletion	109:03:41	Ignition longitude, deg	0.0
		Burn duration, sec	207.7
		Mass at ignition, lb	7 725.5
		Propellant used, lb	2 372.9
		ΔV, fps	3 616.2
Transearth injection	127:51:34.8	Mass at ignition	37 858.0
		Burn time, sec	159.6
		Plane change, sec	-1.8
		Propellant used, lb	10 399.7
Entry interface	191:18:15.9	Velocity, fps	36 210.6
		Flight-path angle, deg	-6.49
		Latitude, deg	-183.2
		Longitude, deg	171.3
		Time from TEI, hr:min	63:24
Splashdown	191:32:35	Latitude, deg	-20.25
		Longitude, deg	-165.0
		Local time, a.m.	5:06
		Time of sunrise, a.m.	6:25

[a]Time refers to g.e.t. of ignition for burns.

TABLE 2.0-II.- TIMETABLE OF MISSION EVENTS

	Launch	EOI	TLI	LOI-1	LOI-2	Undock	LM SEP	DOI	Phasing	Insertion	CSI	CDH	TPI	TPF	LM jettison	APS burn	TEI	EI	Splashdown
Launch		00:11:22	02:31:36	76:08:18	80:32:12	98:25:44	98:55:44	99:54:12	101:06:35	103:03:29	103:54:40	104:52:41	105:28:59	106:11:41	108:34:02	109:03:41	127:51:35	191:18:16	191:32:35
EOI	00:11:22		02:20:14	75:56:56	80:20:50	98:14:22	98:44:22	99:42:50	100:55:13	102:52:07	103:43:18	104:41:19	105:17:37	106:00:19	108:22:40	108:52:19	127:40:13	191:06:54	191:21:13
TLI	02:31:36	02:20:14		73:36:42	78:00:36	95:54:08	96:24:08	97:22:36	98:34:59	100:31:53	101:23:04	102:21:05	102:57:23	103:40:05	106:02:26	106:32:05	125:19:59	188:46:40	189:00:59
LOI-1	76:08:18	75:56:56	73:36:42		04:23:54	22:17:26	22:47:26	23:45:54	24:58:17	26:55:11	27:46:22	28:44:23	29:20:41	30:03:23	32:25:44	32:55:23	51:43:17	115:09:58	115:24:17
LOI-2	80:32:12	80:20:50	78:00:36	04:23:54		17:53:32	18:23:32	19:22:00	20:34:23	22:31:17	23:22:28	24:20:29	24:56:47	25:39:29	28:01:50	28:31:29	47:19:23	110:46:04	111:00:23
Undock	98:25:44	98:14:22	95:54:08	22:17:26	17:53:32		00:30:00	01:28:28	02:40:51	04:37:45	05:28:56	06:26:57	07:03:15	07:45:57	10:08:18	10:37:57	29:25:51	92:52:32	93:06:51
LM SEP	98:55:44	98:44:22	96:24:08	22:47:26	18:23:32	00:30:00		00:58:28	02:10:51	04:07:45	04:58:56	05:56:57	06:33:15	07:15:57	09:38:18	10:07:57	28:55:51	92:22:32	92:36:51
DOI	99:54:12	99:42:50	97:22:36	23:45:54	19:22:00	01:28:28	00:58:28		01:12:23	03:09:17	04:00:28	04:58:29	05:34:47	06:17:29	08:39:50	09:09:29	27:57:23	91:24:04	91:38:23
Phasing	101:06:35	100:55:13	98:34:59	24:58:17	20:34:23	02:40:51	02:10:51	01:12:23		01:56:54	02:48:05	03:46:06	04:22:24	05:05:06	07:27:27	07:57:06	26:45:00	90:11:41	90:26:00
Insertion	103:03:29	102:52:07	100:31:53	26:55:11	22:31:17	04:37:45	04:07:45	03:09:17	01:56:54		00:51:11	01:49:12	02:25:30	03:08:12	05:30:33	06:00:12	24:48:06	88:14:47	88:29:06
CSI	103:54:40	103:43:18	101:23:04	27:46:22	23:22:28	05:28:56	04:58:56	04:00:28	02:48:05	00:51:11		00:58:01	01:34:19	02:17:01	04:39:22	05:09:01	23:56:55	87:23:36	87:37:55
CDH	104:52:41	104:41:19	102:21:05	28:44:23	24:20:29	06:26:57	05:56:57	04:58:29	03:46:06	01:49:12	00:58:01		00:36:18	01:19:00	03:41:21	04:11:00	22:58:54	86:25:35	86:39:54
TPI	105:28:59	105:17:37	102:57:23	29:20:41	24:56:47	07:03:15	06:33:15	05:34:47	04:22:24	02:25:30	01:34:19	00:36:18		00:42:42	03:05:03	03:34:42	22:22:36	85:49:17	86:03:36
TPF	106:11:41	106:00:19	103:40:05	30:03:23	25:39:29	07:45:57	07:15:57	06:17:29	05:05:06	03:08:12	02:17:01	01:19:00	00:42:42		02:22:21	02:52:00	21:39:54	85:06:35	85:20:54
LM jettison	108:34:02	108:22:40	106:02:26	32:25:44	28:01:50	10:08:18	09:38:18	08:39:50	07:27:27	05:30:33	04:39:22	03:41:21	03:05:03	02:22:21		00:29:39	19:17:33	82:44:14	82:58:33
APS burn	109:03:41	108:52:19	106:32:05	32:55:23	28:31:29	10:37:57	10:07:57	09:09:29	07:57:06	06:00:12	05:09:01	04:11:00	03:34:42	02:52:00	00:29:39		18:47:54	82:14:35	82:28:54
TEI	127:51:35	127:40:13	125:19:59	51:43:17	47:19:23	29:25:51	28:55:51	27:57:23	26:45:00	24:48:06	23:56:55	22:58:54	22:22:36	21:39:54	19:17:33	18:47:54		63:26:41	63:41:00
EI	191:18:16	191:06:54	188:46:40	115:09:58	110:46:04	92:52:32	92:22:32	91:24:04	90:11:41	88:14:47	87:23:36	86:25:35	85:49:17	85:06:35	82:44:14	82:14:35	63:26:41		00:14:19
Splashdown	191:32:35	191:21:13	189:00:59	115:24:17	111:00:23	93:06:51	92:36:51	91:38:23	90:26:00	88:29:06	87:37:55	86:39:54	86:03:36	85:20:54	82:58:33	82:28:54	63:41:00	00:14:19	

TABLE 2.0-III.- LAUNCH WINDOW SUMMARY

Launch date, day, month, 1969	Target site number	Time at opening of window, hr:min:sec, e.s.t.	Launch window duration, hr:min:sec	Selenographic approach azimuth to target site, deg	Sun elevation at site, deg		Transearth flight time, hr:min:sec		Total mission duration, day:hr:min	
					[a]72° - 1	[b]108° - 2	[a]72° - 1	[b]108° - 2	[a]72° - 1	[b]108 - 2
May 17	1	11:33:49	04:20:25	-95.0	8.7	11.7	63:24:14	57:35:09	07:23:32	07:19:16
May 18	2	11:48:58	04:20:24	-95.25	11.0	13.9	77:58:06	72:22:27	09:00:30	08:20:16
May 20	3	12:02:45	04:21:27	-95.75	10.5	13.3	64:46:41	59:14:37	08:01:14	07:20:58
May 23	4	12:12:06	04:23:29	-92.0	10.0	12.5	70:25:15	65:32:13	08:03:16	07:24:00
May 24	5	12:14:53	04:24:34	-95.0	16.8	19.5	71:53:38	66:41:50	08:03:07	07:23:52
May 25	5	12:19:12	04:25:48	-95.0	26.3	31.0	74:15:40	69:07:02	08:04:59	08:00:44
June 16	1	10:11:55	04:21:16	-95.0	15.0	17.9	63:59:26	58:25:51	08:01:00	07:20:14
June 17	2	10:16:10	04:21:52	-95.25	16.7	19.5	64:57:20	59:33:51	08:01:37	07:21:21
June 19	3	10:21:49	04:23:16	-95.75	15.4	18.1	68:01:23	62:54:27	08:02:59	07:22:43
June 22	5	10:33:16	04:26:42	-95.0	9.8	12.4	74:22:28	69:16:33	08:05:28	08:01:12
June 23	5	10:41:53	04:28:50	-95.0	21.2	23.8	77:02:55	71:57:27	08:06:22	08:02:04
June 24	5	10:57:24	04:32:16	-95.0	32.6	35.3	79:36:25	74:26:40	08:07:09	08:02:48

[a]Launch azimuth = 72°, first injection opportunity.

[b]Launch azimuth = 108°, second injection opportunity.

TABLE 2.0-IV.- LUNAR TARGET SITE POSITIONS

Lunar target site no	Latitude, deg	Longitude, deg	Altitude,[a] n. mi.
1	2.632	34.025	-0.818
2	0.732	23.647	-1.66
3	0.374	-1.345	-0.502
4	-3.643	-36.698	-1.323
5	1.772	-41.939	-1.539

[a]Assumed mean lunar radius of 938.5 n. mi.

TABLE 2.0-V.- SPACECRAFT WEIGHT SUMMARY

Total CSM dry, lb	23 098
CSM inert, lb	12 300
SM inert, lb	10 700
SLA ring, lb	98
Total SPS propellant tanked, lb	40 634
SPS propellant usable, lb	40 264
SPS propellant unusable, lb	370
Total LM loaded, lb	30 849
LM descent stage inert, lb	4 703
LM DPS propellant tanked, lb	18 134
LM ascent stage inert, lb	5 393
LM APS propellant tanked, lb	2 619
SLA, lb	4 000
Total injected Saturn payload, lb	98 581

TABLE 2.0-VI.- ENGINE PERFORMANCE SUMMARY

Propulsion system	I_{sp}, sec	Thrust per engine, lb	Flow rate per engine, lb/sec
(a) Service module			
SPS	314.6	20 500	65.16
SM RCS	277.3	102.8	0.371
(b) Lunar module			
DPS (full throttle)	302.1 (average)	9712.5	32.15
APS	306.3	3500.0	11.43
LM RCS	273.0	100.0	0.37

TABLE 2.0-VII.- ASSUMED MISSION-INDEPENDENT EXPENDABLES[a]

Mission-independent SPS budget	
Translunar MCC, fps	120
Transearth MCC, fps	00
Total	120
SPS propellant allowances	
Unbalance meter, lb	100
Mean outage, lb	52
Dispersions, lb	548
Total	700
Other expendables	
Translunar coast, lb	332
Lunar orbital coast, lb	298
Transearth coast, lb	290
Total	920

[a]These figures were used only as estimates to compute the end of mission propellant reserves. A detailed dispersion and consumables analysis will be performed and will be published later.

TABLE 2.0-VIII.- MISSION RADAR TIMELINE

(a) Radar station characteristics

Geodetic latitude, LATR, deg
Longitude, LONR, deg
Altitude, ALTR, ft
Range capability, SRANGE, n. mi.
Keyhole, FTINDC: 0 = none
1 = north-south
2 = east-west

```
RADAR = MERRITT ISLAND CB, LATR=  28.424862, LONR =  -80.664404
      ALTR =      39.372, SRANGE =   23400.0, FTINDC = 0.0
RADAR = PATRICK AFB CB   , LATR=  28.226553, LONR =  -80.599292
      ALTR =      49.215, SRANGE =   23400.0, FTINDC = 0.0
RADAR = CAPE KENNEDY CB  , LATR=  28.481767, LONR =  -80.576514
      ALTR =      45.934, SRANGE =    1000.0, FTINDC = 0.0
RADAR = GRAND BAHAMA CB  , LATR=  26.636350, LONR =  -78.267708
      ALTR =      39.372, SRANGE =   23400.0, FTINDC = 0.0
RADAR = GRAND TURK CB    , LATR=  21.462889, LONR =  -71.132114
      ALTR =      91.868, SRANGE =   23400.0, FTINDC = 0.0
RADAR = BERMUDA CB       , LATR=  32.348103, LONR =  -64.653800
      ALTR =      59.058, SRANGE =   23400.0, FTINDC = 0.0
RADAR = ANTIGUA ISLAND CB, LATR=  17.144031, LONR =  -61.792858
      ALTR =     190.298, SRANGE =   23400.0, FTINDC = 0.0
RADAR = GRAND CANARY CB  , LATR=  27.763206, LONR =  -15.634814
      ALTR =     682.208, SRANGE =    2532.0, FTINDC = 0.0
RADAR = ASCENSION CB     , LATR=  -7.972761, LONR =  -14.401694
      ALTR =     469.183, SRANGE =   23400.0, FTINDC = 0.0
RADAR = PRETORIA CB      , LATR= -25.943733, LONR =   28.358489
      ALTR =    5334.906, SRANGE =   23400.0, FTINDC = 0.0
RADAR = CARNARVON CB     , LATR= -24.887403, LONR =  113.716078
      ALTR =     203.422, SRANGE =   23400.0, FTINDC = 0.0
RADAR = HAWAII CB        , LATR=  22.122092, LONR = -159.665383
      ALTR =    3740.340, SRANGE =   23400.0, FTINDC = 0.0
RADAR = PT ARGUELLO CB   , LATR=  34.582903, LONR = -120.561150
      ALTR =    2119.526, SRANGE =   23400.0, FTINDC = 0.0
RADAR = WHITE SANDS CB   , LATR=  32.358222, LONR = -106.369564
      ALTR =    4042.192, SRANGE =   23400.0, FTINDC = 0.0
RADAR = EGLIN AFB CB     , LATR=  30.421767, LONR =  -86.798114
      ALTR =      91.868, SRANGE =    1000.0, FTINDC = 0.0
RADAR = TANANARIVE TLM   , LATR= -19.003019, LONR =   47.314650
      ALTR =    4329.608, SRANGE =   23400.0, FTINDC = 0.0
RADAR = KANO NIGERIA TLM , LATR=  11.963722, LONR =    8.464444
      ALTR =    1601.128, SRANGE =    1500.0, FTINDC = 0.0
RADAR = MERRITT ISLAND SB, LATR=  28.538272, LONR =  -80.693417
      ALTR =      32.810, SRANGE =  225000.0, FTINDC = 1.0
RADAR = GRAND BAHAMA SB  , LATR=  26.632857, LONR =  -78.237654
      ALTR =      16.405, SRANGE =  225000.0, FTINDC = 1.0
RADAR = BERMUDA SB       , LATR=  32.351286, LONR =  -64.658191
      ALTR =      68.901, SRANGE =  225000.0, FTINDC = 1.0
RADAR = ANTIGUA ISLAND SB, LATR=  17.015917, LONR =  -61.752849
      ALTR =     141.083, SRANGE =  225000.0, FTINDC = 1.0
RADAR = GRAND CANARY SB  , LATR=  27.754536, LONR =  -15.634814
      ALTR =     567.613, SRANGE =  225000.0, FTINDC = 1.0
RADAR = ASCENSION SB     , LATR=  -7.355056, LONR =  -14.327578
      ALTR =    1843.922, SRANGE =  225000.0, FTINDC = 1.0
RADAR = CARNARVON SB     , LATR= -24.906647, LONR =  113.726035
      ALTR =      82.025, SRANGE =  225000.0, FTINDC = 1.0
RADAR = GUAM SB          , LATR=  13.339244, LONR =  144.734414
      ALTR =     416.687, SRANGE =  225000.0, FTINDC = 1.0
RADAR = HAWAII SB        , LATR=  22.124897, LONR = -159.664989
      ALTR =    3773.150, SRANGE =  225000.0, FTINDC = 1.0
RADAR = GUAYMAS SB       , LATR=  27.953206, LONR = -110.720850
      ALTR =      62.339, SRANGE =  225000.0, FTINDC = 1.0
RADAR = CORPUS TEX SB    , LATR=  27.653750, LONR =  -97.378469
      ALTR =      32.810, SRANGE =  225000.0, FTINDC = 1.0
RADAR = MADRID DS        , LATR=  40.454992, LONR =   -4.167994
      ALTR =    2553.930, SRANGE =  300000.0, FTINDC = 2.0
RADAR = CANBERRA DS      , LATR= -35.583494, LONR =  148.978286
      ALTR =    3756.433, SRANGE =  300000.0, FTINDC = 2.0
RADAR = GOLDSTONE DS     , LATR=  35.341594, LONR = -116.873200
      ALTR =    2976.175, SRANGE =  300000.0, FTINDC = 2.0
 RADAR = INSERTION SHIP, LATR=25.0, LONR=-49.0
 ALTR=0.0, SRANGE=23400.0, FTINDC=0.0
```

TABLE 2.0-VIII.- MISSION RADAR TIMELINE[a] - Continued

(b) Definitions of radar table headings[b]

MLA CB	Merritt Island C-band	MLA SB	Merritt Island S-band
PAT CB	Patrick C-band	GBI SB	Grand Bahama Island S-band
KEN CB	Cape Kennedy C-band	BDA SB	Bermuda S-band
GBI CB	Grand Bahama Island C-band	ANT SB	Antigua S-band
GTI CB	Grand Turk Island C-band	CYI SB	Grand Canary S-band
BDA CB	Bermuda C-band	ASC SB	Ascension S-band
ANT CB	Antigua C-band	CRO SB	Carnarvon S-band
CYI CB	Grand Canary C-band	GUM SB	Guam S-band
ASC CB	Ascension Island C-band	HAW SB	Hawaii S-band
PRE CB	Pretoria C-band	GYM SB	Guaymas S-band
CRO CB	Carnarvon C-band	TEX SB	Corpus S-band
HAW CB	Hawaii C-band	MAD DS	Madrid deep space
CAL CB	Pt. Arguello C-band	HSK DS	Canberra deep space
WHS CB	White Sands C-band	GLD DS	Goldstone deep space
EGL CB	Eglin C-band	SHIP 1	Insertion ship
TAN TM	Tananarive telemetry	SHIP 2	Injection ship (1)
KNO TM	Kano telemetry	SHIP 3	Injection ship (2)

[a]The enclosed radar table gives data for the coast phases only. If a station does not acquire or terminate at the nominal minimum elevation of 0° or 5°, the user must then investigate to see if the event took place because of exceeding maximum range, occulation, or end of a phase. All numbers are rounded off to the nearest unit of time, degrees, or nautical miles.

[b]Time is g.e.t. and range is slant range from the station to the spacecraft (n. mi.). See figure A-3b in the appendix for definitions of RA and DEC, figure A-3a for AZ and ELV, and figures A-3c and A-3d for X and Y. RA is equivalent to -HA in figure A-3b.

TABLE 2.0-VIII. - MISSION RADAR TIMELINE - Continued

(c) CSM acquisition and termination - 0° minimum elevation

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
EARTH ORBIT INSERTION														0 day 0 hr 11 min 22 sec											
BDA SB	0	1	19	0	0	11	22	149	8	85	7	83	5	545	0	0	12	41	155	5	84	0	90	5	850
BDA CB	0	1	19	0	0	11	22	149	8	85	7	83	5	545	0	0	12	41	155	5	84	0	90	5	850
SHIP 1	0	4	11	0	0	11	22	-41	56	-30	6	-78	60	553	0	0	15	32	-177	29	58	0	90	32	849
CYI SB	0	7	7	0	0	16	28	14	15	-73	0	-90	17	848	0	0	23	35	-167	-20	113	0	90	-23	841
CYI CB	0	7	7	0	0	16	28	14	15	-73	0	-90	17	848	0	0	23	35	-167	-20	113	0	90	-23	841
KNC TM	0	6	46	0	0	23	40	36	45	-44	0	-90	46	839	0	0	30	26	-133	-14	105	0	90	-15	832
TAN TM	0	5	33	0	0	36	59	133	63	-20	0	-90	70	824	0	0	42	32	-89	3	87	0	90	3	827
CRO CB	0	5	50	0	0	52	11	146	-28	-121	0	-90	-31	834	0	0	58	1	-1	-32	126	0	90	-36	834
CRO SB	0	5	51	0	0	52	11	146	-28	-121	0	-90	-31	834	0	0	58	2	-1	-32	126	0	90	-36	834
SHIP 2	0	6	57	0	0	55	12	178	1	-89	0	-90	1	835	0	1	2	10	-9	13	75	0	90	15	834
HSK DS	0	6	3	0	0	59	29	-155	10	-78	0	-90	-78	832	0	1	5	32	-14	37	42	0	-90	42	829
GYM SB	0	7	4	0	1	28	13	-41	-25	-118	0	-90	-28	840	0	1	35	17	134	13	76	0	90	14	848
CAL CB	0	4	15	0	1	28	27	7	-54	-169	0	-90	-79	838	0	1	32	35	101	-21	116	0	90	-26	844
GLD DS	0	4	39	0	1	28	55	2	-51	-163	0	90	-17	839	0	1	33	34	106	-19	114	0	90	66	845
WHS CB	0	6	44	0	1	29	41	-28	-31	-128	0	-90	-38	839	0	1	36	25	132	0	69	0	90	1	847
TEX SB	0	7	3	0	1	31	6	-39	-5	-95	0	-90	-5	844	0	1	38	9	152	21	67	0	90	23	850
EGL CB	0	7	8	0	1	33	33	-26	-2	-93	0	-90	-3	847	0	1	40	41	159	12	76	0	90	14	850
MLA SB	0	6	53	0	1	34	59	-29	10	-79	0	-90	11	848	0	1	41	53	169	18	70	0	90	20	850
MLA CB	0	6	53	0	1	34	62	-29	10	-75	0	-90	12	848	0	1	41	53	169	18	69	0	90	21	850
CNV CB	0	6	53	0	1	35	1	-29	10	-79	0	-90	11	848	0	1	41	54	169	18	70	0	90	20	850
PAT CB	0	6	51	0	1	35	2	-29	11	-78	0	-90	12	848	0	1	41	52	169	19	69	0	90	21	850

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GBI CB	0	6	30	0	1	35	42	-31	19	-69	0	-90	21	849	0	1	42	13	174	24	62	0	90	28	849
GBI SB	0	6	30	0	1	35	43	-31	19	-69	0	-90	21	849	0	1	42	13	174	25	62	0	90	28	849
BDA SB	0	7	10	0	1	38	26	-9	4	-85	0	-90	5	850	0	1	45	35	173	-4	95	0	90	-5	848
BDA CB	0	7	10	0	1	38	26	-9	4	-85	0	-90	5	850	0	1	45	35	173	-4	95	0	90	-5	848
GTI CB	0	4	16	0	1	38	31	-40	49	-36	0	-90	54	849	0	1	42	47	-167	47	38	0	90	52	848
SHIP 1	0	6	42	0	1	42	29	-6	31	-56	0	-90	34	849	0	1	49	11	-165	5	84	0	90	6	845
CYI SB	0	5	19	0	1	50	1	51	-10	-101	0	-90	-11	843	0	1	55	20	173	-57	161	0	90	-71	835
CYI CB	0	5	19	0	1	50	1	51	-10	-101	0	-90	-11	843	0	1	55	20	173	-57	161	0	90	-71	834
KNU TM	0	5	35	0	1	57	2	72	-2	-92	0	-90	-2	833	0	2	2	37	-139	-68	162	0	90	-72	827
PRE CB	0	3	5	0	2	7	57	-161	63	7	0	90	83	824	0	2	11	1	-99	27	60	0	90	30	826
TAN TM	0	6	51	0	2	9	6	119	15	-74	0	-90	16	827	0	2	15	56	-51	-35	127	0	90	-37	829
CRO CB	0	6	17	0	2	25	19	166	-33	-127	0	-90	-37	834	0	2	31	35	12	-14	106	0	90	-16	833
CRO SB	0	6	17	0	2	25	19	166	-33	-127	0	-90	-37	834	0	2	31	35	12	-14	106	0	90	-16	833
SHIP 2	0	3	22	0	2	28	15	-155	6	-83	0	-90	7	835	0	2	31	36	-84	43	-11	11	-44	74	396
				TLI IGNITION											0 day 2 hr 31 min 36 sec										
				TLI CUTOFF											0 day 2 hr 36 min 43 sec										
SHIP 3	0	6	6	0	2	36	43	30	-38	126	15	71	-34	481	0	2	42	50	36	16	74	0	90	16	2252
HAW CB	2	34	35	0	2	42	55	-64	-41	-135	0	-90	-45	2268	0	5	17	30	81	33	64	56	32	14	23400
HAW SB	12	54	24	0	2	42	55	-64	-41	-135	0	-90	-45	2269	0	15	37	20	96	29	-59	0	-90	31	77182
CAL CB	2	32	16	0	2	49	33	-32	-18	-112	0	-90	-22	3742	0	5	21	49	75	31	-111	82	-7	-3	23400
GLD DS	10	26	18	0	2	50	17	-29	-16	-109	0	90	-71	3906	0	13	16	36	94	28	-54	0	-90	-54	67734
GYM SB	9	32	56	0	2	51	7	-30	-8	-99	0	-90	-9	4089	0	12	24	4	92	29	-57	0	-90	33	63992
WHS CB	2	28	0	0	2	52	20	-24	-8	-100	0	-90	-10	4350	0	5	20	20	73	31	-86	69	-21	1	23400
TEX SB	8	29	24	0	2	54	35	-20	0	-91	0	-90	-1	4832	0	11	23	59	91	29	-57	0	-90	33	59545

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MLA SB	7	10	58	0	3	0	24	-6	7	-82	0	-90	8	6033	0	10	11	21	89	29	-57	0	-90	33	53895
MLA CB	2	13	45	0	3	0	25	-6	7	-82	0	-90	8	6036	0	5	14	10	69	31	-73	44	-44	12	23400
PAT CB	2	13	40	0	3	0	27	-5	7	-82	0	-90	8	6044	0	5	14	7	69	31	-73	44	-44	12	23400
GBI CB	2	11	39	0	3	1	35	-4	9	-80	0	-90	10	6272	0	5	13	14	68	31	-71	42	-47	14	23400
GBI SB	6	51	59	0	3	1	36	-4	9	-80	0	-90	10	6274	0	9	53	35	88	29	-57	0	-90	33	52459
GTI CB	2	4	11	0	3	5	56	3	15	-74	0	-90	16	7126	0	5	10	7	67	31	-66	33	-54	20	23400
BDA SB	6	2	25	0	3	7	53	9	11	-77	0	-90	13	7501	0	9	10	18	87	29	-55	0	-90	35	48869
BDA CB	2	1	33	0	3	7	53	9	11	-77	0	-90	13	7502	0	5	9	26	67	30	-73	32	-57	15	23399
ANT CB	1	52	10	0	3	13	41	14	20	-69	0	-90	21	8584	0	5	5	51	66	31	-63	23	-64	25	23396
ANT SB	4	48	29	0	3	13	46	14	20	-69	0	-90	21	8598	0	8	2	15	83	30	-59	0	-90	31	42901
SHIP 1	1	39	11	0	3	23	18	26	20	-67	0	-90	23	10293	0	5	2	29	65	29	-64	16	-73	25	23391
GUM SB	14	0	46	0	5	7	26	83	30	59	0	90	31	24900	0	19	8	12	99	29	-60	0	-90	30	90094
HSK DS	8	40	54	0	7	51	35	91	35	46	0	-90	46	41915	0	16	32	28	97	31	-50	0	-90	-50	80678
CRO SB	10	1	15	0	9	39	60	95	33	53	0	90	37	51337	0	19	41	15	99	30	-56	0	-90	34	91999
MAD DS	15	48	11	0	14	52	1	100	28	52	0	-90	52	74225	1	6	40	11	105	27	-53	0	-90	-53	125565
CYI SB	14	18	47	0	16	25	46	102	28	57	0	90	33	80269	1	6	44	33	104	28	-58	0	-90	32	125762
ASC SB	11	25	1	0	17	50	5	103	30	60	0	90	30	85457	1	5	15	6	104	29	-61	0	-90	29	121627
BDA SB	14	41	51	0	19	35	20	103	28	56	0	90	34	91668	1	10	17	11	106	27	-57	0	-90	33	135158
ANT SB	13	17	54	0	20	6	36	104	29	60	0	90	30	93455	1	9	24	30	105	28	-61	0	-90	29	132880
GBI SB	14	6	40	0	20	49	0	104	28	58	0	90	32	95845	1	10	55	41	106	27	-59	0	-90	31	136801

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MLA SB	14	17	13	0	2[illegible]	53	37	104	28	58	0	90	32	96103	1	11	10	50	106	27	-58	0	-90	32	137443
TEX SB	14	11	7	0	22	4	56	105	28	58	0	90	32	100021	1	12	16	3	106	27	-59	0	-90	31	140178
GYM SB	14	12	5	0	22	58	52	105	28	58	0	90	32	102913	1	13	10	57	106	27	-59	0	-90	31	142444
GLD DS	14	57	35	0	23	0	37	105	28	55	0	-90	55	103007	1	13	58	12	107	27	-56	0	-90	-56	144371
HAW SB	13	38	16	1	2	35	24	106	28	60	0	90	30	113973	1	16	13	40	107	27	-60	0	-90	30	149766
GUM SB	12	54	29	1	6	43	18	108	28	61	0	90	29	125702	1	19	37	47	108	27	-62	0	-90	28	157577
HSK DS	8	50	47	1	8	29	47	108	29	53	0	-90	53	130471	1	17	20	34	107	29	-54	0	-90	-54	152358
CRO SB	9	59	13	1	10	17	47	108	29	58	0	90	32	135174	1	20	17	0	108	28	-59	0	-90	31	159029
MAD DS	15	22	38	1	15	29	55	109	27	54	0	-90	54	148045	2	6	52	33	110	26	-54	0	-90	-54	181091
CYI SB	14	1	10	1	16	57	34	110	27	59	0	90	31	151479	2	6	58	44	110	27	-60	0	-90	30	181291
ASC SB	11	21	16	1	18	13	17	110	28	62	0	90	28	154384	2	5	34	33	109	27	-62	0	-90	28	178524
BDA SB	14	25	59	1	20	2	35	110	27	58	0	90	32	158504	2	10	28	34	110	26	-58	0	-90	32	187994
ANT SB	13	7	24	1	20	30	42	110	27	61	0	90	29	159544	2	9	38	6	110	27	-62	0	-90	28	186401
GBI SB	13	53	43	1	21	13	38	110	27	60	0	90	30	161124	2	11	7	21	110	26	-60	0	-90	30	189206
MLA SB	14	3	41	1	21	18	30	110	27	59	0	90	31	161302	2	11	22	11	110	26	-60	0	-90	30	189668
TEX SB	13	58	44	1	22	28	10	111	27	59	0	90	31	163830	2	12	26	55	110	26	-60	0	-90	30	191670
GYM SB	14	0	1	1	23	21	14	111	27	59	0	90	31	165729	2	13	21	15	110	26	-60	0	-90	30	193336
GLD DS	14	43	10	1	23	24	7	111	27	57	0	-90	57	165834	2	14	7	17	111	26	-57	0	-90	-57	194738
HAW SB	13	30	7	2	2	53	31	111	27	61	0	90	29	173124	2	16	23	37	111	26	-61	0	-90	29	198873
GUM SB	12	49	8	2	6	57	30	112	27	62	0	90	28	181248	2	19	46	38	111	26	-63	0	-90	27	204830

		TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
		HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
HSK	DS	8	59	32	2	8	36	7	112	28	55	0	-90	55	184421	2	17	35	40	111	27	-55	0	-90	-55	200962
CRO	SB	10	3	24	2	10	25	39	112	28	59	0	90	31	187892	2	20	29	3	111	27	-60	0	-90	30	206067
MAD	DS	12	17	4	2	15	43	1	113	26	55	0	-90	55	197650	3	4	0	5	111	26	-80	30	-17	-58	218039
CYI	SB	10	51	29	2	17	8	37	113	26	60	0	90	30	200208	3	4	0	6	111	26	-77	37	-52	11	217700
ASC	SB	9	39	58	2	18	20	11	113	27	63	0	90	27	202282	3	4	0	8	111	27	-57	21	-65	31	218530
BDA	SB	7	47	28	2	20	12	31	113	26	59	0	90	31	205598	3	3	59	59	112	27	-120	79	-9	-5	216406
ANT	SB	7	20	49	2	20	39	12	113	26	62	0	90	28	206380	3	4	0	1	112	27	-49	74	-12	10	216475
GBI	SB	6	37	17	2	21	22	41	113	26	60	0	90	30	207651	3	3	59	58	112	27	89	87	3	0	216352
MLA	SB	6	32	30	2	21	27	27	113	26	60	0	90	30	207781	3	3	59	57	112	27	108	84	5	-2	216363
TEX	SB	5	23	47	2	22	36	8	113	26	60	0	90	30	209770	3	3	59	54	112	27	88	70	20	1	216558
GYM	SB	4	30	50	2	23	29	2	113	26	60	0	90	30	211331	3	3	59	52	112	27	84	58	32	3	216870
GLD	DS	4	27	22	2	23	32	29	113	26	57	0	-90	57	211429	3	3	59	51	112	26	92	53	1	37	217040
HAW	SB	1	1	36	3	2	58	11	113	26	62	0	90	28	217714	3	3	59	47	113	26	67	13	76	23	218976

LOI(1) IGNITION 3 day 4 hr 8 min 18 sec

LOI(1) CUTOFF 3 day 4 hr 14 min 10 sec

HAW	SB	1	24	45	3	4	34	4	113	27	69	21	68	20	218133	3	5	58	49	114	26	73	38	50	13	217216
GYM	SB	1	24	49	3	4	34	12	112	27	87	66	24	1	215231	3	5	59	0	113	26	102	83	6	-1	215957
GLD	DS	1	24	50	3	4	34	13	112	27	98	60	4	30	216383	3	5	59	2	113	26	124	75	8	12	216045
TEX	SB	1	24	50	3	4	34	16	112	27	91	78	12	0	216003	3	5	59	7	113	26	-100	84	-6	-1	215957
MLA	SB	1	24	52	3	4	34	21	112	27	-123	87	-3	-2	215926	3	5	59	13	113	26	-90	69	-21	0	216164
GBI	SB	1	24	50	3	4	34	21	112	27	-88	85	-5	0	215933	3	5	59	12	113	26	-85	67	-23	2	216213
BDA	SB	1	24	48	3	4	34	25	111	27	-104	72	-17	-4	216078	3	5	59	13	112	26	-90	55	-35	0	216551

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
ANT SB	1	24	50	3	4	34	27	111	27	-61	67	-26	11	216182	3	5	59	16	112	27	-69	50	-38	14	216758
MAD DS	1	24	47	3	4	34	29	111	26	-75	24	-31	-62	217953	3	5	59	16	112	26	-64	9	-70	-62	218810
CYI SB	1	24	45	3	4	34	33	111	26	-74	30	-59	14	217639	3	5	59	17	112	26	-67	13	-76	22	218609
ASC SB	1	6	46	3	4	34	36	111	27	-60	14	-74	29	218517	3	5	41	22	112	27	-63	0	-90	27	218479
HAW SB	1	24	44	3	6	42	26	114	26	74	48	41	10	216752	3	8	7	10	115	26	75	66	23	6	216177
GLD DS	1	24	45	3	6	42	35	113	26	167	81	9	2	215929	3	8	7	20	114	26	-116	72	8	-16	216066
GYM SB	1	24	46	3	6	42	36	113	27	-111	86	-4	-1	215893	3	8	7	22	114	26	-89	68	-22	0	216142
TEX SB	1	24	44	3	6	42	41	113	26	-90	74	-16	0	216008	3	8	7	24	114	26	-84	56	-33	4	216472
MLA SB	1	24	43	3	6	42	44	112	26	-86	59	-31	2	216352	3	8	7	27	113	26	-79	42	-48	8	217041
GBI SB	1	24	42	3	6	42	44	112	26	-82	57	-33	4	216427	3	8	7	26	113	26	-77	39	-50	10	217155
BDA SB	1	24	43	3	6	42	45	112	26	-84	46	-44	4	216842	3	8	7	27	113	26	-76	29	-60	12	217664
MAD DS	0	13	12	3	6	42	45	112	26	-57	2	-86	-57	219178	3	6	55	57	112	26	-55	0	-90	-55	218623
CYI SB	0	20	42	3	6	42	47	112	26	-62	4	-86	27	219063	3	7	3	30	112	26	-60	0	-90	30	218269
ANT SB	1	24	41	3	6	42	48	112	27	-69	40	-49	16	217111	3	8	7	29	113	26	-68	22	-67	20	218061
GUM SB	1	4	17	3	7	2	45	114	26	63	0	90	27	218300	3	8	7	2	115	26	66	13	76	24	218522

LOI(2) IGNITION 3 day 8 hr 32 min 12 sec

LOI(2) CUTOFF 3 day 8 hr 32 min 26 sec

GUM SB	1	11	44	3	8	51	48	115	26	67	23	65	21	217856	3	10	3	32	116	26	67	39	49	18	217020
CNB DS	1	11	43	3	8	51	57	115	27	54	2	-87	54	219086	3	10	3	40	116	27	44	12	-73	42	218412
HAW SB	1	11	40	3	8	52	5	114	26	69	77	13	5	215876	3	10	3	46	115	26	-35	85	-3	4	215761
GLD DS	1	11	40	3	8	52	13	114	26	-102	63	6	-26	216144	3	10	3	53	115	26	-90	49	0	-41	216579
GYM SB	1	11	37	3	8	52	18	114	26	-85	58	-32	3	216284	3	10	3	55	114	26	-80	43	-46	8	216827

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
BDA SB	1	11	35	3	8	52	20	113	26	-71	20	-69	18	218033	3	10	3	56	114	26	-64	6	-83	26	218790
TEX SB	1	11	36	3	8	52	21	113	26	-80	46	-43	7	216714	3	10	3	58	114	26	-75	32	-58	13	217381
GBI SB	1	11	38	3	8	52	22	113	26	-74	29	-60	14	217509	3	10	3	60	114	26	-68	15	-74	21	218291
MLA SB	1	11	37	3	8	52	22	113	26	-75	32	-57	12	217374	3	10	3	59	114	26	-70	18	-71	19	218135
ANT SB	0	57	7	3	8	52	24	113	26	-66	12	-77	24	218499	3	9	49	32	114	26	-63	0	-90	27	218438
CRO SB	1	11	53	3	10	50	16	116	27	59	3	86	31	218978	3	12	2	9	117	26	50	16	70	38	218187
GUM SB	1	11	53	3	10	50	18	116	26	65	49	38	16	216578	3	12	2	11	117	26	57	64	22	14	216055
HSK DS	1	11	58	3	10	50	23	116	27	34	18	-68	32	218067	3	12	2	21	117	27	20	25	-64	18	217675
HAW SB	1	11	60	3	10	50	31	115	26	-71	76	-14	5	215848	3	12	2	30	116	26	-76	60	-29	7	216169
MLA SB	0	43	57	3	10	50	36	114	26	-65	8	-81	25	218672	3	11	34	33	115	26	-61	0	-90	29	217913
GLD DS	1	11	55	3	10	50	37	114	26	-84	40	-7	-50	216974	3	12	2	33	115	25	-76	26	-27	-61	217653
GBI SB	0	28	14	3	10	50	37	114	26	-64	5	-84	26	218837	3	11	18	52	115	26	-61	0	-90	29	217907
GYM SB	1	11	56	3	10	50	39	114	26	-76	33	-56	12	217288	3	12	2	35	115	26	-70	19	-70	19	218054
TEX SB	1	11	57	3	10	50	39	114	26	-71	21	-67	17	217896	3	12	2	36	115	25	-65	7	-82	25	218701
CRO SB	1	11	41	3	12	48	44	117	27	42	23	57	43	217746	3	14	0	26	118	26	29	33	37	48	217217
GUM SB	1	11	40	3	12	48	50	116	26	40	73	11	13	215851	3	14	0	30	117	26	-19	77	-4	13	215752
CNB DS	1	11	43	3	12	48	53	116	27	8	27	-63	7	217532	3	14	0	36	117	26	-9	27	-62	-8	217496
HAW SB	1	11	41	3	12	49	3	116	26	-76	50	-39	9	216498	3	14	0	44	116	26	-73	34	-54	14	217153
GLD DS	1	11	36	3	12	49	4	115	25	-70	17	-49	-64	218128	3	14	0	40	117	25	-62	4	-82	-61	218857
GYM SB	0	47	53	3	12	49	6	115	26	-66	9	-80	24	218573	3	13	36	59	116	25	-61	0	-90	29	217976

		TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
		HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CRO	SB	1	11	60	3	14	47	6	117	26	16	37	21	50	217014	3	15	59	5	118	26	-3	39	-3	51	216879
GUM	SB	1	11	58	3	14	47	9	117	26	-49	70	-16	13	215862	3	15	59	8	118	26	-64	56	-31	14	216208
HSK	DS	1	11	59	3	14	47	12	117	26	-21	25	-64	-19	217618	3	15	59	11	118	26	-36	18	-68	-34	217943
HAW	SB	1	11	54	3	14	47	17	116	26	-71	24	-65	17	217672	3	15	59	12	117	25	-67	9	-80	23	218491
MAD	DS	1	11	32	3	16	45	22	119	25	62	6	-78	61	218683	3	17	56	55	120	25	72	17	-45	65	217936
CRO	SB	1	11	38	3	16	45	45	118	26	-16	37	-20	50	216933	3	17	57	23	119	26	-33	31	-43	46	217217
GUM	SB	1	11	36	3	16	45	50	118	26	-67	45	-42	16	216570	3	17	57	26	119	25	-68	30	-58	19	217271
HSK	DS	1	11	39	3	16	45	51	118	26	-45	12	-73	-44	218265	3	17	57	29	119	26	-56	2	-87	-56	218867
CYI	SB	0	19	53	3	17	37	1	120	25	62	0	90	28	217989	3	17	56	54	120	25	64	4	86	26	218736
CYI	SB	1	11	56	3	18	43	29	120	25	69	13	76	21	218191	3	19	55	25	121	25	75	27	62	13	217325
MAD	DS	1	11	56	3	18	43	30	120	25	79	26	-22	62	217471	3	19	55	26	121	25	89	39	-1	51	216761
CRO	SB	1	11	53	3	18	43	60	119	26	-43	24	-57	42	217542	3	19	55	53	120	26	-54	13	-74	35	218157
GUM	SB	1	11	48	3	18	44	3	118	25	-68	19	-69	21	217819	3	19	55	51	119	25	-65	4	-85	24	218681
ASC	SB	1	11	14	3	18	44	13	120	25	64	0	90	26	218939	3	19	55	27	121	25	61	15	73	28	218024
ASC	SB	1	11	42	3	20	42	6	121	25	57	25	61	29	217457	3	21	53	47	122	25	49	39	43	31	216706
CYI	SB	1	11	37	3	20	42	6	121	25	79	38	52	9	216809	3	21	53	43	122	25	85	53	37	3	216124
MAD	DS	1	11	40	3	20	42	6	121	25	97	48	6	42	216367	3	21	53	47	122	24	113	60	13	27	215874
CRO	SB	0	20	34	3	20	42	32	119	25	-60	4	-86	30	218648	3	21	3	6	120	25	-62	0	-90	28	217861
BDA	SB	1	7	21	3	20	46	16	121	25	61	0	90	29	218696	3	21	53	37	122	24	69	12	77	21	218130
ANT	SB	0	41	56	3	21	11	40	122	25	64	0	90	26	217619	3	21	53	37	122	25	67	8	81	23	218328

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
ANT SB	1	11	49	3	22	40	15	122	25	69	19	70	20	217735	3	23	52	4	123	24	72	34	54	15	216843
GBI SB	1	11	49	3	22	40	15	122	24	67	8	81	23	218359	3	23	52	3	123	24	73	22	67	16	217466
MLA SB	1	11	47	3	22	40	16	122	24	66	7	82	24	218432	3	23	52	3	123	24	73	21	68	16	217553
BDA SB	1	11	48	3	22	40	18	122	24	74	21	68	15	217600	3	23	52	6	123	24	82	35	54	7	216796
CYI SB	1	11	51	3	22	40	25	122	25	90	63	27	0	215793	3	23	52	16	123	24	103	78	12	-3	215438
ASC SB	1	11	52	3	22	40	26	122	25	39	47	31	32	216346	3	23	52	18	123	25	18	55	12	33	215970
MAD DS	1	11	45	3	22	40	32	122	25	131	68	15	16	215667	3	23	52	17	123	24	177	74	16	1	215501
TEX SB	0	36	5	3	23	15	57	123	24	62	0	90	28	217493	3	23	52	3	123	24	66	7	83	24	218374
TEX SB	1	11	44	4	0	38	42	123	24	71	16	73	18	217807	4	1	50	26	124	24	77	31	59	11	216948
GYM SB	1	11	41	4	0	38	43	123	24	66	6	84	24	218445	4	1	50	25	124	24	73	19	70	16	217562
GLD DS	1	11	41	4	0	38	45	123	24	63	4	-81	63	218538	4	1	50	25	124	24	72	17	-46	66	217722
MLA SB	1	11	46	4	0	38	45	123	24	77	31	58	11	217014	4	1	50	32	124	24	84	46	44	4	216261
BDA SB	1	11	48	4	0	38	46	123	24	87	45	45	2	216342	4	1	50	35	124	24	97	60	30	-4	215760
ANT SB	1	11	51	4	0	38	47	123	25	72	45	43	13	216349	4	1	50	37	124	24	70	61	28	9	215731
GBI SB	1	11	44	4	0	38	47	123	24	77	33	57	11	216925	4	1	50	31	124	24	83	48	42	5	216181
MAD DS	1	11	54	4	0	38	59	122	24	-147	71	16	-10	215525	4	1	50	53	123	24	-117	61	14	-25	215724
CYI SB	1	11	52	4	0	38	60	122	24	169	87	1	-3	215354	4	1	50	51	123	24	-100	75	-15	-3	215426
ASC SB	1	11	56	4	0	39	2	122	25	-1	57	-1	33	215890	4	1	50	58	123	25	-28	53	-19	32	215993
GYM SB	0	18	41	4	2	37	3	124	24	77	30	60	11	217017	4	2	55	44	124	24	78	33	56	10	215873
GLD DS	0	18	40	4	2	37	4	124	24	78	26	-23	62	217204	4	2	55	44	124	24	80	30	-16	59	216068

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
TEX SB	0	18	37	4	2	37	7	124	24	81	41	48	7	216449	4	2	55	44	124	24	83	45	45	5	215335
MLA SB	0	18	33	4	2	37	10	124	24	88	56	34	1	215862	4	2	55	44	124	24	91	60	30	0	214798
GBI SB	0	18	32	4	2	37	12	124	24	86	58	32	2	215792	4	2	55	44	124	24	88	62	28	1	214735
BDA SB	0	18	32	4	2	37	12	124	24	108	69	20	-6	215497	4	2	55	44	124	24	115	73	15	-7	214492
ANT SB	0	18	29	4	2	37	15	124	24	64	71	17	8	215460	4	2	55	44	124	24	58	75	13	8	214460
CYI SB	0	18	16	4	2	37	28	123	24	-91	64	-26	-1	215605	4	2	55	44	123	24	-89	60	-30	1	214790
MAD DS	0	18	15	4	2	37	29	123	24	-104	53	10	-36	215958	4	2	55	44	123	24	-100	49	9	-40	215159
ASC SB	0	18	10	4	2	37	34	123	25	-41	46	-32	32	216202	4	2	55	44	123	25	-45	43	-37	31	215407

LM SEPARATION BURN IGNITION 4 day 2 hr 55 min 44 sec

LM SEPARATION BURN CUTOFF 4 day 2 hr 55 min 51 sec

GLD DS	0	52	58	4	2	55	51	124	24	80	30	-16	59	216062	4	3	48	49	125	24	87	40	-4	50	216448
GYM SB	0	52	60	4	2	55	51	124	24	78	33	56	10	215867	4	3	48	51	125	24	83	44	46	5	216243
TEX SB	0	53	2	4	2	55	51	124	24	83	45	45	5	215329	4	3	48	53	125	24	88	56	34	1	215793
GBI SB	0	53	6	4	2	55	51	124	24	88	62	28	1	214729	4	3	48	57	125	24	95	73	17	-2	215361
MLA SB	0	53	6	4	2	55	51	124	24	91	60	30	0	214792	4	3	48	57	125	24	99	71	19	-3	215405
BDA SB	0	53	9	4	2	55	51	124	24	115	73	15	-7	214487	4	3	48	60	125	24	155	81	4	-8	215266
ANT SB	0	53	9	4	2	55	51	124	24	58	75	13	8	214454	4	3	49	0	125	24	10	83	1	7	215249
MAD DS	0	53	18	4	2	55	51	123	24	-100	49	9	-40	215154	4	3	49	9	124	24	-92	40	2	-50	216452
CYI SB	0	53	20	4	2	55	51	123	24	-89	60	-30	0	214785	4	3	49	11	124	24	-85	49	-41	3	216060
ASC SB	0	53	24	4	2	55	51	123	25	-45	43	-37	31	215403	4	3	49	15	124	24	-53	34	-50	30	216728
HAW SB	0	0	3	4	3	48	43	125	24	64	0	90	26	218626	4	3	48	47	125	24	64	0	90	26	218629
HAW SB	1	11	37	4	4	35	26	125	24	68	10	79	21	218028	4	5	47	4	126	24	73	25	64	15	217107

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GLD DS	1	11	39	4	4	35	32	125	24	94	49	3	41	216027	4	5	47	11	126	23	108	63	9	26	215509
GYM SB	1	11	42	4	4	35	33	125	24	88	55	35	1	215829	4	5	47	14	126	24	97	70	20	-3	215348
TEX SB	1	11	42	4	4	35	35	125	24	93	67	23	-1	215480	4	5	47	17	126	24	116	81	8	-4	215178
MLA SB	1	11	42	4	4	35	39	125	24	119	81	8	-4	215243	4	5	47	21	125	24	-121	81	-8	-5	215185
GBI SB	1	11	44	4	4	35	40	125	24	114	84	6	-3	215220	4	5	47	24	125	24	-104	80	-10	-3	215201
BDA SB	1	11	40	4	4	35	45	124	24	-139	79	-7	-8	215257	4	5	47	25	125	24	-106	66	-23	-6	215428
ANT SB	1	11	44	4	4	35	46	124	24	-53	76	-10	7	215273	4	5	47	31	125	24	-71	63	-26	9	215518
MAD DS	1	11	42	4	4	35	53	124	24	-84	31	-10	-59	216853	4	5	47	34	125	23	-74	18	-40	-66	217515
CYI SB	1	11	42	4	4	35	54	124	24	-81	39	-51	7	216467	4	5	47	37	125	23	-75	24	-65	14	217187
ASC SB	1	11	42	4	4	35	57	124	24	-59	24	-62	28	217191	4	5	47	39	125	24	-64	10	-79	26	217999
HAW SB	1	11	51	4	6	33	41	126	24	76	35	54	11	216567	4	7	45	31	127	23	80	51	39	6	215813
GLD DS	1	11	51	4	6	33	51	126	24	125	72	11	15	215300	4	7	45	42	127	23	-176	78	12	-1	215133
GYM SB	1	11	51	4	6	33	52	126	24	113	80	9	-4	215178	4	7	45	43	127	23	-124	82	-7	-4	215091
TEX SB	1	11	47	4	6	33	60	125	24	-140	85	-3	-4	215133	4	7	45	46	126	23	-98	71	-19	-3	215249
MLA SB	1	11	46	4	6	34	2	125	24	-100	71	-19	-3	215303	4	7	45	48	126	23	-90	56	-34	0	215646
GBI SB	1	11	44	4	6	34	5	125	24	-93	69	-21	-1	215339	4	7	45	51	126	23	-86	54	-36	2	215726
BDA SB	1	11	42	4	6	34	7	125	24	-96	57	-33	-3	215676	4	7	45	49	126	23	-87	42	-48	2	216187
ANT SB	1	11	46	4	6	34	8	125	24	-73	52	-36	10	215823	4	7	45	54	126	23	-73	37	-52	13	216439
MAD DS	0	58	18	4	6	34	11	125	23	-68	9	-66	-66	217965	4	7	32	30	126	23	-59	0	-90	-59	217806
CYI SB	1	11	26	4	6	34	13	125	23	-71	14	-75	19	217704	4	7	45	39	126	23	-64	0	-90	26	218475

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GUM SB	1	11	44	4	8	32	6	127	23	68	8	81	22	217979	4	9	43	50	129	23	70	23	65	18	217009
HAW SB	1	11	50	4	8	32	15	127	23	81	62	28	4	215444	4	9	44	5	128	23	83	78	12	2	215054
GLD DS	1	11	51	4	8	32	25	126	23	-134	74	12	-12	215171	4	9	44	16	127	23	-107	61	9	-27	215402
GYM SB	1	11	51	4	8	32	26	126	23	-101	72	-18	-3	215194	4	9	44	18	127	23	-90	57	-32	[illegible]	215530
TEX SB	1	11	55	4	8	32	28	126	23	-91	60	-30	0	215476	4	9	44	23	127	23	-84	45	-45	4	215980
MLA SB	1	11	53	4	8	32	31	126	23	-85	45	-44	4	216005	4	9	44	24	127	23	-79	31	-59	10	216666
BDA SB	1	11	53	4	8	32	33	126	23	-81	32	-56	7	215625	4	9	44	26	127	23	-74	18	-71	15	217356
GBI SB	1	11	49	4	8	32	33	126	23	-82	43	-47	6	216106	4	9	44	22	127	23	-77	28	-61	12	216797
ANT SB	1	11	53	4	8	32	36	126	23	-72	26	-63	16	216949	4	9	44	29	127	23	-69	10	-79	21	217790
HSK DS	0	25	44	4	9	18	13	128	24	60	0	-90	60	217220	4	9	43	57	128	24	57	4	-82	56	218117
GUM SB	1	11	40	4	10	30	31	128	23	71	34	54	16	216434	4	11	42	12	129	23	70	50	38	13	215660
HSK DS	1	11	44	4	10	30	37	128	24	49	12	-72	47	217648	4	11	42	21	129	24	36	21	-64	33	217026
HAW SB	1	11	38	4	10	30	48	128	23	52	88	1	1	214942	4	11	42	26	128	23	-84	76	-14	1	214987
GLD DS	1	11	35	4	10	30	56	127	23	-97	52	6	-38	215665	4	11	42	32	128	23	-87	38	-3	-52	216208
GYM SB	1	11	37	4	10	30	53	127	23	-85	47	-43	3	215865	4	11	42	35	128	23	-79	32	-58	9	216511
BDA SB	0	46	15	4	10	30	59	127	23	-68	8	-81	21	217846	4	11	17	14	128	22	-63	0	-90	27	217156
TEX SB	1	11	34	4	10	30	60	127	23	-80	35	-55	8	216399	4	11	42	34	128	23	-74	20	-69	15	217135
MLA SB	1	11	35	4	10	30	62	127	23	-74	20	-69	15	217153	4	11	42	34	128	22	-68	6	-83	22	217934
GBI SB	1	11	35	4	10	31	1	127	23	-73	18	-71	16	217371	4	11	42	36	128	22	-67	3	-86	23	218099
CRO SB	0	26	9	4	11	16	3	129	23	64	0	90	26	217117	4	11	42	12	130	23	61	5	84	29	217975

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CRO SB	0	5	9	4	12	28	52	129	23	55	14	73	34	217431	4	12	34	2	129	23	55	15	72	34	217108
GUM SB	0	5	7	4	12	28	55	129	23	66	61	27	11	215289	4	12	34	2	129	23	66	62	26	11	214991
HSK DS	0	5	2	4	12	29	[illegible]	129	24	25	26	-61	22	216741	4	12	34	2	129	24	24	27	-61	21	216456
HAW SB	0	4	55	4	12	29	7	128	23	-83	65	-25	3	215181	4	12	34	2	128	23	-83	63	-26	3	214954
GYM SB	0	4	53	4	12	29	9	128	23	-75	21	-68	14	217018	4	12	34	2	128	23	-75	20	-69	15	216822
GLD DS	0	4	53	4	12	29	9	128	23	-81	28	-16	-61	216655	4	12	34	2	128	23	-81	27	-18	-61	216452
TEX SB	0	4	49	4	12	29	13	128	23	-70	10	-79	20	217672	4	12	34	2	128	23	-69	9	-80	21	217479

LM JETTISON BURN IGNITION 4 day 12 hr 34 min 02 sec

LM JETTISON BURN CUTOFF 4 day 12 hr 34 min 08 sec

TEX SB	0	46	37	4	12	34	6	128	23	-69	9	-80	21	217475	4	13	20	45	129	22	-65	0	-90	25	217230
CRO SB	1	5	33	4	12	34	8	129	23	55	15	72	34	217102	4	13	40	41	130	23	45	26	55	40	216671
GUM SB	1	6	39	4	12	34	8	129	23	66	62	26	11	214985	4	13	40	46	130	23	48	75	11	10	214892
HSK DS	1	6	45	4	12	34	8	129	24	24	27	-61	21	216451	4	13	40	54	130	23	8	31	-59	7	216447
HAW SB	1	6	55	4	12	34	8	128	23	-83	63	-26	3	214950	4	13	41	2	129	22	-81	49	-41	6	215638
GLD DS	1	6	55	4	12	34	8	128	23	-81	27	-16	-61	216448	4	13	41	3	129	22	-73	14	-49	-68	217363
GYM SB	1	6	55	4	12	34	8	128	23	-74	20	-69	15	216818	4	13	41	3	129	22	-69	7	-83	21	217799
CRO SB	1	11	46	4	14	27	21	130	23	35	33	41	44	216295	4	15	39	7	131	23	17	40	19	47	215878
GUM SB	1	11	47	4	14	27	25	130	23	-1	61	0	9	214799	4	15	39	13	130	22	-59	71	-16	10	214868
CRO DS	1	11	43	4	14	27	33	130	23	-5	31	-59	-4	216395	4	15	39	16	130	23	-23	28	-60	-20	216489
GLD DS	0	30	22	4	14	27	39	129	22	-67	5	-77	-66	217842	4	14	58	0	129	22	-63	0	-90	-63	216864
HAW SB	1	11	39	4	14	27	4[illegible]	129	22	-78	38	-51	9	216051	4	15	39	20	130	22	-74	23	-67	14	216791
CRO SB	1	12	8	4	16	25	52	131	23	3	42	3	48	215765	4	17	36	0	131	23	-18	40	-23	46	215693

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GUM SB	1	11	59	4	16	25	55	130	22	-68	61	-27	11	215083	4	17	37	54	131	22	-72	45	-44	13	215591
HAW SB	0	59	16	4	16	25	58	130	22	-71	12	-77	19	217343	4	17	25	14	131	22	-67	0	-90	23	217371
HSK DS	1	11	60	4	16	25	58	130	23	-34	23	-63	-31	216695	4	17	37	58	131	23	-48	15	-69	-46	217143
MAD DS	0	23	41	4	17	13	37	132	21	61	0	-90	61	216896	4	17	37	18	132	21	65	4	-81	65	217764
MAD DS	1	11	39	4	18	23	54	132	21	72	12	-55	68	217254	4	19	35	33	133	21	82	24	-16	64	216450
CRO SB	1	11	39	4	18	24	23	131	23	-31	36	-36	44	215942	4	19	36	2	132	22	-46	26	-55	39	216365
GUM SB	1	11	38	4	18	24	26	131	22	-72	34	-55	15	216032	4	19	36	4	132	22	-71	18	-71	18	216823
HSK DS	0	43	59	4	18	24	27	131	23	-56	7	-78	-55	217520	4	19	8	26	132	22	-62	0	-90	-62	216685
CYI SB	1	4	27	4	18	31	4	132	22	65	0	90	25	217600	4	19	35	31	134	21	72	12	77	17	217137
ASC SB	0	4	29	4	19	31	3	134	22	68	0	90	22	217640	4	19	35	32	134	22	68	1	89	22	217807
CYI SB	1	11	60	4	20	22	11	133	21	77	22	67	12	216559	4	21	34	11	134	21	84	37	53	5	215699
ASC SB	1	12	1	4	20	22	12	133	22	66	12	77	24	217164	4	21	34	14	134	22	61	27	60	26	216214
MAD DS	1	11	56	4	20	22	15	133	21	90	34	-1	56	215973	4	21	34	11	134	21	102	46	11	43	215298
GUM SB	0	34	28	4	20	22	37	132	22	-70	7	-82	20	217437	4	20	57	6	132	21	-68	0	-90	22	216497
CRO SB	1	11	53	4	20	22	38	132	22	-54	18	-68	34	216775	4	21	34	37	133	22	-63	5	-84	27	217477
BDA SB	1	11	34	4	22	20	39	134	21	69	7	83	20	217349	4	23	32	13	135	21	78	20	69	11	216454
ANT SB	1	11	35	4	22	20	39	134	21	69	4	86	21	217524	4	23	32	14	136	21	73	19	70	16	216525
CYI SB	1	11	36	4	22	20	45	134	21	88	48	42	1	215210	4	23	32	21	135	21	98	63	27	-4	214608
ASC SB	1	11	41	4	22	20	46	134	22	55	37	47	27	215680	4	23	32	27	135	21	42	50	30	28	215028
MAD DS	1	11	35	4	22	20	48	134	21	113	55	15	32	214940	4	23	32	23	135	21	138	65	19	16	214541

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GBI SB	0	37	31	4	22	54	42	135	21	67	0	90	23	216388	4	23	32	13	136	21	71	7	82	19	217207
MLA SB	0	30	38	4	23	1	35	135	21	66	0	90	24	216406	4	23	32	13	136	21	70	6	84	20	217292
GBI SB	1	12	0	5	0	18	47	135	21	75	17	72	14	216618	5	1	30	48	136	20	82	32	58	7	215704
TEX SB	1	11	56	5	0	18	48	135	21	67	2	88	23	217552	5	1	30	45	137	20	75	16	74	15	216605
BDA SB	1	11	58	5	0	18	50	135	21	83	30	50	6	215919	5	1	30	48	136	20	92	44	46	-2	215133
MLA SB	1	11	56	5	0	18	50	135	21	75	16	74	15	216708	5	1	30	47	136	20	82	30	60	7	215800
ANT SB	1	11	58	5	0	18	50	135	21	75	30	59	13	215931	5	1	30	48	136	21	78	46	44	9	215076
MAD DS	1	12	2	5	0	18	59	135	21	165	70	20	5	214425	5	1	31	1	136	20	-150	68	20	-11	214379
CYI SB	1	11	58	5	0	18	60	135	21	110	73	16	-6	214363	5	1	30	58	136	21	-179	83	0	-7	214146
ASC SB	1	12	2	5	0	19	2	135	21	27	57	17	29	214767	5	1	31	3	136	21	-3	61	-2	29	214549
GYM SB	0	22	40	5	1	8	4	136	20	67	0	90	23	216469	5	1	30	44	137	20	69	4	85	21	217263
GLD DS	0	12	54	5	1	17	51	136	20	65	0	-90	65	216876	5	1	30	45	136	20	67	2	-84	67	217392
TEX SB	1	11	38	5	2	17	22	136	20	79	26	64	10	216012	5	3	29	0	137	20	87	41	49	3	215166
GLD DS	1	11	34	5	2	17	22	136	20	73	11	-55	70	216831	5	3	28	57	137	20	82	25	-16	64	215964
GYM SB	1	11	37	5	2	17	23	136	20	74	14	75	15	216655	5	3	28	59	137	20	81	29	61	8	215743
GBI SB	1	11	40	5	2	17	24	136	20	86	43	47	3	215180	5	3	29	4	137	20	94	58	32	-2	214503
MLA SB	1	11	40	5	2	17	25	136	20	87	41	49	3	215271	5	3	29	5	137	20	96	56	34	-3	214580
BDA SB	1	11	40	5	2	17	29	136	20	100	54	35	-6	214717	5	3	29	9	137	20	119	68	20	-10	214236
ANT SB	1	11	41	5	2	17	31	136	21	78	57	32	6	214632	5	3	29	12	137	20	76	73	17	4	214139
CYI SB	1	11	45	5	2	17	39	135	21	-120	77	-11	-7	214164	5	3	29	25	136	20	-100	62	-27	-4	214390

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MAD DS	1	11	41	5	2	17	41	135	20	-128	62	18	-22	214434	5	3	29	23	136	20	-108	50	15	-38	214803
ASC SB	1	11	44	5	2	17	43	135	21	-24	56	-14	29	214583	5	3	29	27	136	21	-46	48	-32	27	214854
GLD DS	1	11	56	5	4	15	31	137	20	89	34	-2	56	215456	5	5	27	27	138	20	100	48	9	41	214725
GYM SB	1	11	56	5	4	15	32	137	20	86	39	51	3	215218	5	5	27	29	138	20	95	54	36	-3	214495
TEX SB	1	11	56	5	4	15	37	137	20	92	51	39	-1	214715	5	5	27	33	138	20	104	66	23	-6	214149
MLA SB	1	11	53	5	4	15	43	137	20	105	66	23	-6	214257	5	5	27	36	138	20	139	79	7	-8	213926
GBI SB	1	11	52	5	4	15	45	137	20	103	68	21	-5	214196	5	5	27	37	138	20	144	82	5	-7	213898
BDA SB	1	11	53	5	4	15	45	137	20	146	76	8	-12	214066	5	5	27	38	138	20	-147	75	-8	-12	213974
ANT SB	1	11	53	5	4	15	48	137	20	57	64	5	3	213978	5	5	27	41	137	20	-73	79	-11	3	213932
MAD DS	1	11	45	5	4	15	60	136	20	-98	41	10	-48	215118	5	5	27	45	137	19	-87	28	-5	-62	215687
CYI SB	1	11	47	5	4	16	1	136	20	-92	52	-38	-1	214673	5	5	27	48	137	20	-85	37	-53	4	215246
ASC SB	1	11	46	5	4	16	7	136	21	-55	39	-45	26	215184	5	5	27	53	137	20	-63	25	-62	24	215842
HAW SB	0	46	47	5	4	40	36	138	20	68	0	90	22	216195	5	5	27	22	139	20	73	9	80	17	216704
HAW SB	1	11	43	5	6	14	3	138	20	76	20	69	13	216074	5	7	25	46	139	19	81	35	54	7	215152
GLD DS	1	11	46	5	6	14	9	138	20	110	57	12	30	214360	5	7	25	55	139	19	136	69	15	14	213951
GYM SB	1	11	46	5	6	14	12	138	20	103	65	25	-5	214150	5	7	25	58	139	19	134	78	9	-8	213803
TEX SB	1	11	50	5	6	14	13	138	20	121	76	12	-7	213925	5	7	26	3	139	19	-152	81	-4	-8	213777
MLA SB	1	11	50	5	6	14	17	137	20	-155	81	-4	-9	213868	5	7	26	7	138	19	-110	68	-20	-7	213975
GBI SB	1	11	49	5	6	14	19	137	20	-136	81	-6	-7	213863	5	7	26	7	138	19	-103	67	-23	-5	214011
BDA SB	1	11	53	5	6	14	19	137	20	-119	58	-20	-11	214072	5	7	26	12	138	19	-102	54	-36	-7	214393

	TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE		DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
ANT SB	1	11	56	5	6	14	22	137	20	-79	68	-22	4	214076		5	7	26	18	138	20	-80	51	-38	6	214491
MAD DS	1	11	45	5	6	14	26	137	19	-80	19	-27	-69	216125		5	7	26	11	138	19	-70	6	-73	-69	216795
CYI SB	1	11	50	5	6	14	28	137	20	-80	26	-64	9	215719		5	7	26	18	138	19	-74	11	-78	16	216492
ASC SB	1	6	14	5	6	14	31	137	20	-67	14	-75	23	216377		5	7	20	46	138	20	-70	0	-90	20	216880
				TEI IGNITION											5 day 7 hr 51 min 35 sec												
				TEI CUTOFF											5 day 7 hr 54 min 14 sec												
HAW SB	9	43	7	5	8	2	31	139	20	84	44	46	4	215101		5	17	45	37	138	20	-69	0	-90	21	195007
GLD DS	7	16	43	5	8	2	36	138	19	161	73	16	5	214208		5	15	19	18	138	19	-66	0	-90	-66	200452
GYM SB	6	37	6	5	8	2	37	138	20	-177	82	0	-8	214101		5	14	39	43	138	19	-68	0	-90	22	201948
TEX SB	5	42	48	5	8	2	39	138	20	-119	75	-13	-7	214181		5	13	45	27	137	19	-68	0	-90	22	203990
MLA SB	4	37	40	5	8	2	41	138	19	-101	60	-29	-5	214503		5	12	40	21	137	19	-68	0	-90	22	206411
GBI SB	4	24	20	5	8	2	41	138	20	-96	59	-31	-3	214560		5	12	27	2	137	19	-68	0	-90	22	206915
BDA SB	3	40	46	5	8	2	42	138	19	-95	46	-44	-4	215013		5	11	43	29	137	19	-67	0	-90	23	208560
ANT SB	3	2	28	5	8	2	44	138	20	-79	43	-47	8	215163		5	11	5	11	137	20	-70	0	-90	20	209994
CYI SB	0	16	19	5	8	2	44	138	19	-70	3	-86	20	217270		5	8	19	3	137	19	-68	0	-90	22	216772
GUM SB	12	32	13	5	8	42	37	139	20	70	0	90	20	215726		5	21	14	50	138	20	-70	0	-90	20	187051
HSK DS	9	50	41	5	9	45	38	139	20	65	0	-90	65	213108		5	19	36	18	138	21	-64	0	-90	-64	190815
CRO SB	10	35	7	5	11	44	59	139	20	67	0	90	23	208500		5	22	20	5	138	20	-67	0	-90	23	184523
MAD DS	14	16	15	5	17	48	45	140	19	64	0	-90	64	194843		6	8	5	0	140	19	-64	0	-90	-64	160785
CYI SB	13	22	35	5	19	1	25	140	19	68	0	90	22	192148		6	8	24	0	140	19	-68	0	-90	22	159971
ASC SB	11	31	31	5	19	51	40	140	20	70	0	90	20	190234		6	7	23	11	139	20	-70	0	-90	20	162556
BDA SB	13	40	42	5	22	9	48	140	19	67	0	90	23	184930		6	11	50	30	140	19	-67	0	-90	23	150955

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
ANT SB	12	46	26	5	22	25	16	140	20	69	0	90	21	184328	6	11	11	42	140	20	-69	0	-90	21	152676
GBI SB	13	18	57	5	23	15	25	140	19	68	0	90	22	182374	6	12	34	23	140	19	-68	0	-90	22	148991
MLA SB	13	25	52	5	23	21	52	140	19	68	0	90	22	182122	6	12	47	44	140	19	-68	0	-90	22	148389
TEX SB	13	22	49	6	0	30	40	141	19	68	0	90	22	179416	6	13	53	29	141	19	-68	0	-90	22	145403
GYM SB	13	24	4	6	1	23	53	141	19	68	0	90	22	177304	6	14	47	57	141	19	-68	0	-90	22	142897
GLD DS	13	53	45	6	1	33	48	141	19	66	0	-90	66	176909	6	15	27	33	141	19	-66	0	-90	-66	141057
HAW SB	13	3	57	6	4	51	34	141	20	69	0	90	21	168889	6	17	55	31	141	19	-69	0	-90	21	134025
GUM SB	12	36	27	6	6	50	16	142	20	70	0	90	20	158843	6	21	26	43	142	20	-70	0	-90	20	123536
HSK DS	9	51	17	6	9	55	29	142	21	64	0	-90	64	156015	6	19	46	45	142	21	-64	0	-90	-64	128564
CRO SB	10	36	58	6	11	55	35	143	21	67	0	90	23	150722	6	22	32	33	142	21	-67	0	-90	23	120141
MAD DS	14	21	31	6	16	2	48	144	19	65	0	-90	65	133675	7	8	24	19	147	18	-66	0	-90	-66	86263
CYI SB	13	28	33	6	19	16	40	144	19	68	0	90	22	130063	7	8	45	13	146	19	-69	0	-90	21	84922
ASC SB	11	37	4	6	20	7	15	145	20	70	0	90	20	127546	7	7	44	20	146	20	-70	0	-90	20	88788
BDA SB	13	48	57	6	22	27	55	145	19	67	0	90	23	120389	7	12	16	51	149	18	-69	0	-90	21	70569
ANT SB	12	55	11	6	22	43	11	146	19	70	0	90	20	119593	7	11	38	21	148	19	-70	0	-90	20	73296
GBI SB	13	28	41	6	23	34	25	146	19	68	0	90	22	116903	7	13	3	6	149	18	-70	0	-90	20	67209
MLA SB	13	35	40	6	23	41	3	146	19	68	0	90	22	116552	7	13	16	43	149	18	-69	0	-90	21	66202
TEX SB	13	34	23	7	0	51	3	146	19	68	0	90	22	112802	7	14	25	27	150	18	-70	0	-90	20	60982
GYM SB	13	37	23	7	1	45	18	147	19	68	0	90	22	109842	7	15	22	41	151	18	-70	0	-90	20	56442
GLD DS	14	6	55	7	1	55	55	147	19	67	0	-90	67	109257	7	16	2	49	153	17	-69	0	-90	-69	53137

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
HAW SB	13	30	9	7	5	17	37	149	19	69	0	90	21	97728	7	18	47	46	157	17	-72	0	-90	18	38180
GUM SB	13	49	45	7	9	24	1	151	19	70	0	90	20	82399	7	23	13	46	-67	-75	173	0	90	-83	1722
HSK DS	10	48	18	7	10	32	9	152	21	64	0	-90	64	77852	7	21	20	27	168	22	-62	0	-90	-62	20978
CRO SB	10	34	11	7	12	38	22	154	21	67	0	90	23	69011	7	23	12	33	-46	18	70	0	90	20	2018
MAD DS	1	40	35	7	20	16	48	173	13	73	0	-90	73	28748	7	21	57	23	-168	7	81	0	-90	81	15842
CRO CB	2	26	11	7	20	46	22	167	23	-34	34	-39	43	23400	7	23	12	33	-46	18	70	0	90	20	2019
TAN TM	2	7	33	7	20	48	9	176	21	50	30	53	34	23400	7	22	55	42	-113	15	74	0	90	16	5796
PRE CB	1	42	17	7	20	56	14	179	22	59	11	77	30	23400	7	22	38	32	-141	20	68	0	90	22	9127
HSK DS	0	24	11	7	22	51	13	-168	24	-60	0	-90	-60	6708	7	23	15	24	-61	51	18	0	-90	18	1330

ENTRY INTERFACE 7 day 23 hr 18 min 16 sec

TABLE 2.0-VIII. - MISSION RADAR TIMELINE - Continued

(d) CSM acquisition and termination - 5° minimum elevation

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
EARTH ORBIT INSERTION														**0 day 0 hr 11 min 22 sec**											
BDA SB	0	0	15	0	0	11	22	149	8	85	7	83	5	545	0	0	11	36	150	7	85	5	85	5	601
BDA CB	0	0	15	0	0	11	22	149	8	85	7	83	5	545	0	0	11	36	150	7	85	5	85	5	601
SHIP 1	0	2	44	0	0	11	22	-41	56	-30	6	-78	60	553	0	0	14	5	-170	47	39	5	82	51	601
CYI SB	0	4	59	0	0	17	32	19	17	-74	5	-85	16	599	0	0	22	31	-172	-18	113	5	85	-23	594
CYI CB	0	4	58	0	0	17	32	19	17	-74	5	-85	16	599	0	0	22	31	-172	-18	113	5	85	-23	594
KNO TM	0	4	30	0	0	24	43	40	53	-36	5	-82	53	590	0	0	29	18	-137	-6	97	5	85	-7	586
TAN TM	0	2	25	0	0	38	34	-170	66	4	5	38	84	578	0	0	40	58	-103	23	63	5	84	26	579
CRO SB	0	2	54	0	0	53	40	139	-48	-141	5	-82	-51	587	0	0	56	33	8	-52	146	5	81	-56	587
CRO CB	0	2	53	0	0	53	40	139	-48	-141	5	-82	-51	587	0	0	56	33	8	-52	146	5	81	-56	587
SHIP 2	0	4	48	0	0	56	17	-176	1	-85	5	-85	5	587	0	1	1	5	-16	12	71	5	85	19	586
HSK BS	0	3	23	0	1	0	49	-141	19	-62	5	-79	-62	584	0	1	4	12	-35	43	26	5	-84	26	582
GYM SB	0	4	55	0	1	29	18	-34	-24	-121	5	-84	-31	594	0	1	34	12	128	13	78	5	85	12	599
WHS CB	0	4	25	0	1	30	50	-16	-34	-136	5	-83	-46	593	0	1	35	16	123	-4	98	5	85	-8	597
TEX SB	0	4	52	0	1	32	12	-36	2	-91	5	-85	-1	597	0	1	37	4	150	27	62	5	84	28	600
EGL CB	0	4	58	0	1	34	38	-25	3	-90	5	-85	0	599	0	1	39	36	156	17	74	5	85	16	601
MLA SB	0	4	36	0	1	36	8	-28	19	-71	5	-85	19	600	0	1	40	44	168	27	62	5	84	28	601
MLA CB	0	4	35	0	1	36	9	-26	19	-71	5	-85	19	600	0	1	40	44	168	27	62	5	84	28	601
CNV CB	0	4	36	0	1	36	10	-28	19	-71	5	-85	19	600	0	1	40	45	168	27	62	5	84	28	601
PAT CB	0	4	32	0	1	36	11	-28	21	-69	5	-85	21	600	0	1	40	43	169	28	60	5	84	30	601
GBI CB	0	3	60	0	1	36	58	-32	33	-56	5	-84	34	600	0	1	40	57	176	38	50	5	83	40	601
GBI SB	0	3	60	0	1	36	58	-32	33	-56	5	-84	34	600	0	1	40	58	176	38	50	5	83	40	601

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
BDA SB	0	5	1	0	1	39	30	-5	7	-85	5	-85	5	601	0	1	44	31	168	-2	95	5	85	-5	600
BDA CB	0	5	1	0	1	39	30	-5	7	-85	5	-85	5	601	0	1	44	31	168	-2	95	5	85	-5	600
SHIP 1	0	4	19	0	1	43	41	-6	42	-46	5	-83	44	600	0	1	47	60	-166	17	74	5	85	16	597
CYI SB	0	1	37	0	1	51	53	73	-32	-131	5	-83	-40	592	0	1	53	30	117	-56	-169	5	-66	-78	590
CYI CB	0	1	37	0	1	51	53	73	-32	-131	5	-83	-40	592	0	1	53	30	117	-56	-169	5	-66	-78	590
KNG TM	0	2	25	0	1	58	37	83	-23	-115	5	-84	-25	584	0	2	1	2	145	-72	-175	5	-46	-83	581
TAN TM	0	4	40	0	2	10	11	122	8	-79	5	-85	11	580	0	2	14	51	-55	-41	132	5	83	-42	581
CRO SB	0	3	43	0	2	26	36	162	-48	-141	5	-82	-51	586	0	2	30	18	14	-29	120	5	84	-30	586
CRO CB	0	3	42	0	2	26	36	162	-48	-141	5	-82	-51	586	0	2	30	18	14	-29	120	5	84	-30	586
SHIP 2	0	2	5	0	2	29	31	-142	15	-69	5	-85	4	586	0	2	31	36	-84	43	-11	11	-44	74	396
				TLI IGNITION											0 day 2 hr 31 min 36 sec										
				TLI CUTOFF											0 day 2 hr 36 min 43 sec										
SHIP 3	0	3	10	0	2	36	43	30	-38	126	15	71	-34	481	0	2	39	53	32	7	82	5	85	8	1347
HAW CB	2	33	50	0	2	43	40	-57	-40	-137	5	-83	-47	2152	0	5	17	30	81	33	64	56	32	14	23400
HAW SB	12	27	8	0	2	43	40	-57	-40	-137	5	-83	-47	2153	0	15	10	48	96	29	-61	5	-84	29	75158
CAL CB	2	31	5	0	2	50	43	-27	-15	-112	5	-85	-22	3711	0	5	21	49	75	31	-111	82	-7	-3	23400
GLD DS	9	53	9	0	2	51	32	-24	-13	-110	5	76	-70	3888	0	12	44	41	93	29	-58	5	-81	-58	65177
GYM SB	9	2	20	0	2	52	27	-25	-5	-98	5	-85	-8	4086	0	11	54	47	92	29	-60	5	-84	30	61549
WHS CB	2	26	33	0	2	53	47	-20	-5	-99	5	-85	-9	4369	0	5	20	20	73	31	-86	69	-21	1	23400
TEX SB	7	58	0	0	2	56	18	-15	2	-90	5	-85	0	4899	0	10	54	18	90	29	-60	5	-84	30	56975
MLA SB	6	37	26	0	3	2	54	-1	10	-82	5	-85	8	6239	0	9	40	19	88	29	-59	5	-84	30	51075
MLA CB	2	11	15	0	3	2	55	-1	10	-82	5	-85	8	6243	0	5	14	10	69	31	-73	44	-44	12	23400
PAT CB	2	11	10	0	3	2	58	-1	10	-82	5	-85	8	6252	0	5	14	7	69	31	-73	44	-44	12	23400
GBI CB	2	8	57	0	3	4	17	1	12	-79	5	-85	11	6512	0	5	13	14	68	31	-71	42	-47	14	23400

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GBI SB	6	18	35	0	3	4	18	1	12	-79	5	-85	11	6515	0	9	22	53	87	29	-60	5	-84	30	49628
GTI CB	2	0	39	0	3	9	27	9	17	-73	5	-85	17	7505	0	5	10	7	67	31	-66	33	-54	20	23400
BDA SB	5	24	28	0	3	11	44	14	14	-77	5	-85	13	7931	0	8	36	11	85	29	-59	5	-84	31	45633
BDA CB	1	57	43	0	3	11	44	14	14	-77	5	-85	13	7931	0	5	9	26	67	30	-73	32	-57	15	23399
ANT CB	1	46	46	0	3	19	5	20	23	-68	5	-85	22	9261	0	5	5	51	66	31	-63	23	-64	25	23396
ANT SB	4	11	12	0	3	19	11	20	23	-68	5	-85	22	9279	0	7	30	23	81	30	-60	5	-84	30	39651
SHIP 1	1	30	44	0	3	31	44	32	23	-67	5	-85	23	11417	0	5	2	29	65	29	-64	16	-73	25	23391
GUM SB	13	1	44	0	5	41	55	86	31	60	5	84	30	28578	0	18	43	39	98	29	-61	5	-84	29	88357
HSK DS	7	25	36	0	8	30	55	92	35	40	5	-83	40	45156	0	15	56	31	97	32	-45	5	-83	-44	78102
CRO SB	9	2	32	0	10	10	16	96	33	50	5	83	40	53497	0	19	12	48	99	31	-53	5	-84	37	90055
MAD DS	14	41	43	0	15	26	4	101	28	57	5	-81	56	76156	1	6	7	47	104	27	-58	5	-81	-58	123780
CYI SB	13	24	40	0	16	53	19	102	29	60	5	84	30	81690	1	6	17	59	104	28	-61	5	-84	29	124247
ASC SB	10	37	5	0	18	14	18	103	30	59	5	84	31	86612	1	4	51	23	104	29	-60	5	-84	30	120214
BDA SB	13	44	58	0	20	4	12	104	28	60	5	84	30	93021	1	9	49	10	105	27	-61	5	-84	29	133652
ANT SB	12	29	1	0	20	31	19	104	29	61	5	84	28	94552	1	9	0	20	105	28	-62	5	-84	27	131524
GBI SB	13	13	53	0	21	15	44	104	28	61	5	84	29	97029	1	10	29	36	106	27	-62	5	-84	28	135390
MLA SB	13	23	14	0	21	20	59	104	28	61	5	84	29	97319	1	10	44	13	106	27	-61	5	-84	28	136014
TEX SB	13	17	51	0	22	31	51	105	28	61	5	84	29	101172	1	11	49	42	106	27	-62	5	-84	28	138778
GYM SB	13	18	42	0	23	25	51	105	28	61	5	84	29	104039	1	12	44	33	106	27	-62	5	-84	28	141058
GLD DS	13	58	27	0	23	30	34	105	28	59	5	-80	59	104287	1	13	29	1	106	27	-60	5	-80	-60	142884

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
HAW SB	12	48	12	1	3	0	38	107	28	62	5	84	28	114909	1	15	48	49	107	27	-62	5	-84	27	148489
GUM SB	12	7	26	1	7	6	58	108	28	62	5	84	28	126477	1	19	14	24	108	27	-63	5	-84	27	156400
HSK DS	7	46	54	1	9	1	48	108	29	48	5	-83	48	131579	1	16	48	43	107	29	-49	5	-82	-49	150824
CRO SB	9	5	59	1	10	44	29	108	29	55	5	84	35	136015	1	19	50	28	108	28	-56	5	-84	34	157743
MAD DS	14	18	56	1	16	1	60	109	27	58	5	-80	58	149011	2	6	20	56	110	26	-59	5	-80	-59	179757
CYI SB	13	8	55	1	17	23	49	110	27	62	5	84	28	152194	2	6	32	44	110	27	-62	5	-84	27	180142
ASC SB	10	35	2	1	18	36	27	110	28	61	5	84	29	154964	2	5	11	29	109	27	-61	5	-84	29	177460
BDA SB	13	30	48	1	20	30	20	110	27	61	5	84	29	159233	2	10	1	8	110	26	-62	5	-84	28	186831
ANT SB	12	19	57	1	20	54	31	111	27	63	5	84	27	160121	2	9	14	28	110	27	-64	5	-84	26	185352
GBI SB	13	2	20	1	21	39	23	111	27	62	5	84	28	161766	2	10	41	48	110	27	-63	5	-84	27	188107
MLA SB	13	11	13	1	21	44	51	111	27	62	5	84	28	161962	2	10	56	4	110	27	-62	5	-84	27	188554
TEX SB	13	6	49	1	22	54	16	111	27	62	5	84	28	164467	2	12	1	4	110	26	-63	5	-84	27	190573
GYM SB	13	8	1	1	23	47	22	111	27	62	5	84	28	166357	2	12	55	23	110	26	-63	5	-84	27	192245
GLD DS	13	45	34	1	23	53	5	111	27	61	5	-80	60	166551	2	13	38	40	111	26	-61	5	-80	-61	193568
HAW SB	12	40	51	2	3	18	9	111	27	63	5	84	27	173661	2	15	58	60	111	26	-63	5	-84	26	197822
GUM SB	12	3	11	2	7	20	43	112	27	64	5	84	26	181702	2	19	23	54	111	27	-64	5	-84	26	203883
HSK DS	7	57	45	2	9	7	0	112	28	50	5	-82	50	185108	2	17	4	50	111	28	-51	5	-82	-50	199752
CRO SB	9	11	10	2	10	51	45	112	28	56	5	84	33	188409	2	20	2	53	111	27	-57	5	-84	33	204995
MAD DS	11	45	42	2	16	14	23	113	26	60	5	-80	59	198282	3	4	0	5	111	26	-80	30	-17	-58	218039
CYI SB	10	26	8	2	17	33	56	113	26	63	5	84	27	200628	3	4	0	6	111	26	-77	37	-52	11	217700

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
ASC SB	9	16	50	2	18	43	19	113	27	62	5	84	28	202679	3	4	0	8	111	27	-57	21	-65	31	218530
BDA SB	7	20	3	2	20	39	56	113	26	62	5	84	28	206102	3	3	59	59	112	27	-120	79	-9	-5	216406
ANT SB	6	57	41	2	21	2	22	113	26	64	5	84	26	206738	3	4	0	1	112	27	-49	74	-12	10	216475
GBI SB	6	12	18	2	21	47	42	113	26	63	5	84	27	208061	3	3	59	58	112	27	89	87	3	[illegible]	216352
MLA SB	6	6	22	2	21	53	34	113	26	63	5	84	27	208249	3	3	59	57	112	27	108	84	5	-2	216363
TEX SB	4	57	55	2	23	1	6[illegible]	113	26	63	5	84	27	210233	3	3	59	54	112	27	88	70	20	1	216558
GYM SB	4	4	55	2	23	54	57	113	26	63	5	84	27	211798	3	3	59	52	112	27	84	58	32	3	216870
GLD DS	3	58	51	3	[illegible]	1	[illegible]	113	26	61	5	-60	61	211971	3	3	59	51	112	26	92	53	1	37	217040
HAW SB	0	37	44	3	3	22	3	113	26	64	5	84	26	218214	3	3	59	47	113	26	67	13	76	23	218976

LOI(1) IGNITION 3 day 4 hr 8 min 18 sec

LOI(1) CUTOFF 3 day 4 hr 14 min 10 sec

HAW SB	1	24	45	3	4	34	4	113	27	69	21	68	20	218133	3	5	58	49	114	26	73	38	50	13	217216
GYM SB	1	24	49	3	4	34	12	112	27	87	66	24	1	216231	3	5	59	0	113	26	102	83	6	-1	215957
GLD DS	1	24	50	3	4	34	13	112	27	98	60	4	30	216383	3	5	59	2	113	26	124	75	8	12	216045
TEX SB	1	24	50	3	4	34	16	112	27	91	78	12	0	216003	3	5	59	7	113	26	-100	84	-6	-1	215957
MLA SB	1	24	52	3	4	34	21	112	27	-123	67	-3	-2	215926	3	5	59	13	113	26	-90	69	-21	[illegible]	216164
GBI SB	1	24	50	3	4	34	21	112	27	-88	85	-5	0	215933	3	5	59	12	113	26	-85	67	-23	2	216213
BDA SB	1	24	48	3	4	34	25	111	27	-104	72	-17	-4	216078	3	5	59	13	112	26	-9[illegible]	55	-35	[illegible]	216551
ANT SB	1	24	50	3	4	34	27	111	27	-61	67	-20	11	216182	3	5	59	16	112	27	-69	59	-38	14	216758
MAD DS	1	24	47	3	4	34	29	111	26	-75	24	-31	-62	217953	3	5	59	16	112	26	-64	9	-70	-62	218810
CYI SB	1	24	45	3	4	34	33	111	26	-74	30	-59	14	217639	3	5	59	17	112	26	-67	13	-76	22	218609
ASC SB	0	41	59	3	4	34	36	111	27	-60	14	-74	29	218517	3	5	16	34	111	27	-62	5	-84	28	217527

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
HAW SB	1	24	44	3	6	42	26	114	26	74	48	41	10	216752	3	8	7	10	115	26	75	66	23	6	216177
GLD DS	1	24	45	3	6	42	35	113	26	167	81	9	2	215929	3	8	7	20	114	26	-116	72	8	-16	216066
GYM SB	1	24	46	3	6	42	36	113	27	-111	86	-4	-1	215893	3	8	7	22	114	26	-89	68	-22	0	216142
TEX SB	1	24	44	3	6	42	41	113	26	-90	74	-16	0	216008	3	8	7	24	114	26	-84	56	-33	4	216472
MLA SB	1	24	43	3	6	42	44	112	26	-86	59	-31	2	216352	3	8	7	27	113	26	-79	42	-48	8	217041
GBI SB	1	24	42	3	6	42	44	112	26	-82	57	-33	4	216427	3	8	7	26	113	26	-77	39	-50	10	217155
BDA SB	1	24	43	3	6	42	45	112	26	-84	46	-44	4	216842	3	8	7	27	113	26	-76	29	-60	12	217664
ANT SB	1	24	41	3	6	42	48	112	27	-69	40	-49	16	217111	3	8	7	29	113	26	-68	22	-67	20	218061
GUM SB	0	39	8	3	7	27	54	115	26	64	5	84	26	217509	3	8	7	2	115	26	66	13	76	24	218522

LOI(2) IGNITION 3 day 8 hr 32 min 12 sec

LOI(2) CUTOFF 3 day 8 hr 32 min 26 sec

GUM SB	1	11	44	3	8	51	48	115	26	67	23	65	21	217856	3	10	3	32	116	26	67	39	49	18	217020
HAW SB	1	11	40	3	8	52	5	114	26	69	77	13	5	215876	3	10	3	46	115	26	-35	85	-3	4	215761
GLD DS	1	11	40	3	8	52	13	114	26	-102	63	6	-26	216144	3	10	3	53	115	26	-90	49	0	-41	216579
GYM SB	1	11	37	3	8	52	18	114	26	-85	58	-32	3	216234	3	10	3	55	114	26	-80	43	-46	8	216827
BDA SB	1	11	35	3	8	52	21	113	26	-71	20	-69	16	218033	3	10	3	56	114	26	-64	6	-83	26	218790
TEX SB	1	11	36	3	8	52	21	113	26	-80	46	-43	7	216714	3	10	3	58	114	26	-75	32	-58	13	217381
GBI SB	1	11	38	3	8	52	22	113	26	-74	29	-60	14	217509	3	10	3	60	114	26	-68	15	-74	21	218291
MLA SB	1	11	37	3	8	52	22	113	26	-75	32	-57	12	217374	3	10	3	59	114	26	-70	18	-71	19	218135
ANT SB	0	31	49	3	8	52	24	113	26	-66	12	-77	24	218499	3	9	24	13	114	26	-64	5	-84	26	217587
HSK DS	0	51	54	3	9	11	46	115	27	52	5	-82	51	217912	3	10	3	40	116	27	44	12	-73	42	218412
GUM SB	1	11	53	3	10	50	18	115	26	65	49	38	16	216578	3	12	2	11	117	26	57	64	22	14	216055

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
HSK DS	1	11	58	3	10	50	23	116	27	34	18	-68	32	218067	3	12	2	21	117	27	20	25	-64	18	217675
HAW SB	1	11	60	3	10	50	31	115	26	-71	76	-14	5	215848	3	12	2	30	116	26	-76	60	-29	7	216169
MLA SB	0	16	16	3	10	50	36	114	26	-65	8	-81	25	218672	3	11	6	52	114	26	-63	5	-84	26	218023
GLD DS	1	11	55	3	10	50	37	114	26	-64	40	-7	-30	215974	3	12	2	33	115	25	-76	26	-27	-61	217653
GBI SB	0	1	38	3	10	50	37	114	26	-64	5	-84	26	218837	3	10	52	16	114	26	-64	5	-84	26	218771
GYM SB	1	11	56	3	10	50	39	114	26	-76	33	-56	12	217288	3	12	2	35	115	26	-70	19	-70	19	218054
TEX SB	1	11	57	3	10	50	39	114	26	-71	21	-67	17	217896	3	12	2	36	115	25	-65	7	-82	25	218701
CRO SB	1	1	42	3	11	0	27	116	27	58	5	84	32	218332	3	12	2	9	117	26	50	16	70	38	218187
CRO SB	1	11	41	3	12	48	44	117	27	42	23	57	43	217746	3	14	0	26	118	26	29	33	37	48	217217
GUM SB	1	11	40	3	12	48	50	116	26	40	73	11	13	215851	3	14	0	30	117	26	-19	77	-4	13	215752
HSK DS	1	11	43	3	12	48	53	116	27	8	27	-63	7	217532	3	14	0	36	117	26	-9	27	-62	-8	217496
HAW SB	1	11	41	3	12	49	3	116	26	-76	50	-39	9	216498	3	14	0	44	116	26	-73	34	-54	14	217153
GLD DS	1	5	12	3	12	49	4	115	25	-70	17	-49	-64	218128	3	13	54	16	116	25	-63	5	-79	-62	218460
GYM SB	0	20	12	3	12	49	6	115	26	-66	9	-80	24	218573	3	13	9	18	115	25	-64	5	-84	26	217805
CRO SB	1	11	60	3	14	47	6	117	26	16	37	21	50	217014	3	15	59	5	118	26	-3	39	-3	51	216879
GUM SB	1	11	58	3	14	47	9	117	26	-49	70	-16	13	215862	3	15	59	8	118	26	-64	56	-31	14	216208
HSK DS	1	11	59	3	14	47	12	117	26	-21	25	-64	-19	217618	3	15	59	11	118	26	-36	18	-68	-34	217943
HAW SB	1	11	54	3	14	47	17	116	26	-71	24	-65	17	217672	3	15	59	12	117	25	-67	9	-80	23	218491
MAD DS	1	11	32	3	16	45	22	119	25	62	6	-78	61	218683	3	17	56	55	120	25	72	17	-45	65	217936
CRO SB	1	11	38	3	16	45	45	118	26	-16	37	-20	50	216933	3	17	57	23	119	26	-33	31	-43	46	217217

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GUM SB	1	11	36	3	16	45	50	118	26	-67	45	-42	16	216570	3	17	57	26	119	25	-68	30	-58	19	217271
HSK DS	0	51	30	3	16	45	51	118	26	-45	12	-73	-44	218265	3	17	37	21	118	26	-53	5	-82	-53	217691
CYI SB	1	11	56	3	18	43	29	120	25	69	13	76	21	218191	3	19	55	25	121	25	75	27	62	13	217325
MAD DS	1	11	56	3	18	43	30	120	25	79	26	-22	62	217471	3	19	55	26	121	25	89	39	-1	51	216761
CRO SB	1	11	53	3	18	43	60	119	26	-43	24	-57	42	217542	3	19	55	53	120	26	-54	13	-74	35	218157
GUM SB	1	7	41	3	18	44	3	118	25	-68	19	-69	21	217819	3	19	51	43	119	25	-66	5	-85	24	218418
ASC SB	0	47	38	3	19	7	49	121	25	63	5	84	26	217517	3	19	55	27	121	25	61	15	73	28	218024
ASC SB	1	11	42	3	20	42	6	121	25	57	25	61	29	217457	3	21	53	47	122	25	49	39	43	31	216706
CYI SB	1	11	37	3	20	42	6	121	25	79	38	52	9	216809	3	21	53	43	122	25	85	53	37	3	216124
MAD DS	1	11	40	3	20	42	6	121	25	97	48	6	42	216367	3	21	53	47	122	24	113	60	13	27	215874
BDA SB	0	38	21	3	21	15	17	122	24	64	5	84	26	217272	3	21	53	37	122	24	69	12	77	21	218130
ANT SB	0	16	31	3	21	37	5	122	25	66	5	85	24	217706	3	21	53	37	122	25	67	8	81	23	218328
ANT SB	1	11	49	3	22	40	15	122	25	69	19	70	20	217735	3	23	52	4	123	24	72	34	54	15	216843
GBI SB	1	11	49	3	22	40	15	122	24	67	6	81	23	218359	3	23	52	3	123	24	73	22	67	16	217466
MLA SB	1	11	47	3	22	40	16	122	24	66	7	82	24	218432	3	23	52	3	123	24	73	21	68	16	217553
BDA SB	1	11	48	3	22	40	18	122	24	74	21	66	15	217670	3	23	52	6	123	24	82	35	54	7	216796
CYI SB	1	11	51	3	22	40	25	122	25	90	63	27	0	215793	3	23	52	16	123	24	103	78	12	-3	215438
ASC SB	1	11	52	3	22	40	26	122	25	39	47	31	32	216346	3	23	52	18	123	25	18	55	12	33	215970
MAD DS	1	11	45	3	22	40	32	122	25	131	68	15	16	215667	3	23	52	17	123	24	177	74	16	1	215501
TEX SB	0	8	41	3	23	43	22	123	24	65	5	85	25	218027	3	23	52	3	123	24	66	7	83	24	218374

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
TEX SB	1	11	44	4	0	38	42	123	24	71	16	73	18	217807	4	1	50	26	124	24	77	31	59	11	216948
GYM SB	1	11	41	4	0	38	43	123	24	66	6	84	24	218445	4	1	50	25	124	24	73	19	70	16	217562
MLA SB	1	11	46	4	0	38	45	123	24	77	31	58	11	217014	4	1	50	32	124	24	84	46	44	4	216261
BDA SB	1	11	48	4	0	38	46	123	24	87	45	45	2	216342	4	1	50	35	124	24	97	60	30	-4	215760
ANT SB	1	11	51	4	0	38	47	123	25	72	45	43	13	216349	4	1	50	37	124	24	70	61	28	9	215731
GBI SB	1	11	44	4	0	38	47	123	24	77	35	57	11	216925	4	1	50	31	124	24	83	48	42	5	216181
MAD DS	1	11	54	4	0	38	59	122	24	-147	71	16	-10	215525	4	1	50	53	123	24	-117	61	14	-25	215724
CYI SB	1	11	52	4	0	38	60	122	24	169	87	1	-3	215354	4	1	50	51	123	24	-100	75	-15	-3	215426
ASC SB	1	11	56	4	0	39	2	122	25	-1	57	-1	33	215890	4	1	50	58	123	25	-28	53	-19	32	215993
GLD DS	1	6	17	4	0	44	9	123	24	64	5	-79	64	218199	4	1	50	25	124	24	72	17	-46	66	217722
GYM SB	0	18	41	4	2	37	3	124	24	77	30	60	11	217017	4	2	55	44	124	24	78	33	56	10	215873
GLD DS	0	18	40	4	2	37	4	124	24	78	26	-23	62	217204	4	2	55	44	124	24	80	30	-16	59	216068
TEX SB	0	18	37	4	2	37	7	124	24	81	41	46	7	216449	4	2	55	44	124	24	83	45	45	5	215335
MLA SB	0	18	33	4	2	37	11	124	24	88	56	34	1	215862	4	2	55	44	124	24	91	60	30	0	214798
GBI SB	0	18	32	4	2	37	12	124	24	86	58	32	2	215792	4	2	55	44	124	24	88	62	28	1	214735
BDA SB	0	18	32	4	2	37	12	124	24	108	69	20	-6	215497	4	2	55	44	124	24	115	73	15	-7	214492
ANT SB	0	18	29	4	2	37	15	124	24	64	71	17	6	215460	4	2	55	44	124	24	58	75	13	8	214460
CYI SB	0	18	16	4	2	37	28	123	24	-91	64	-26	-1	215605	4	2	55	44	123	24	-89	60	-30	0	214790
MAD DS	0	18	15	4	2	37	29	123	24	-104	53	10	-36	215958	4	2	55	44	123	24	-100	49	9	-40	215159
ASC SB	0	18	10	4	2	37	34	123	25	-41	46	-32	32	216202	4	2	55	44	123	25	-45	43	-37	31	215407

LM SEPARATION BURN IGNITION 4 day 2 hr 55 min 44 sec

LM SEPARATION BURN CUTOFF 4 day 2 hr 55 min 51 sec

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GLD DS	0	52	58	4	2	55	51	124	24	80	30	-16	59	216062	4	3	48	49	125	24	87	40	-4	50	216448
GYM SB	0	52	60	4	2	55	51	124	24	78	33	56	10	215867	4	3	48	51	125	24	83	44	46	5	216243
TEX SB	0	53	2	4	2	55	51	124	24	83	45	45	5	215329	4	3	48	53	125	24	88	56	34	1	215793
GBI SB	0	53	6	4	2	55	51	124	24	88	62	28	1	214729	4	3	48	57	125	24	95	73	17	-2	215361
MLA SB	0	53	6	4	2	55	51	124	24	91	66	30	0	214792	4	3	48	57	125	24	99	71	19	-3	215405
BDA SB	0	53	9	4	2	55	51	124	24	115	73	15	-7	214487	4	3	48	60	125	24	155	81	4	-8	215266
ANT SB	0	53	9	4	2	55	51	124	24	58	75	13	8	214454	4	3	49	0	125	24	10	83	1	7	215249
MAD DS	0	53	18	4	2	55	51	123	24	-100	49	9	-40	215154	4	3	49	9	124	24	-92	40	2	-50	216452
CYI SB	0	53	20	4	2	55	51	123	24	-89	66	-30	0	214785	4	3	49	11	124	24	-85	49	-41	3	216060
ASC SB	0	53	24	4	2	55	51	123	25	-45	43	-37	31	215403	4	3	49	15	124	24	-53	34	-50	30	216728
HAW SB	1	11	37	4	4	35	26	125	24	68	10	79	21	218028	4	5	47	4	126	24	73	25	64	15	217107
GLD DS	1	11	39	4	4	35	32	125	24	94	49	3	41	216027	4	5	47	11	126	23	108	63	9	26	215509
GYM SB	1	11	42	4	4	35	33	125	24	88	55	35	1	215829	4	5	47	14	126	24	97	70	20	-3	215348
TEX SB	1	11	42	4	4	35	35	125	24	93	67	23	-1	215480	4	5	47	17	126	24	116	81	6	-4	215178
MLA SB	1	11	42	4	4	35	39	125	24	119	81	6	-4	215243	4	5	47	21	125	24	-121	81	-8	-5	215185
GBI SB	1	11	44	4	4	35	4[illegible]	125	24	114	84	6	-3	215220	4	5	47	24	125	24	-104	80	-10	-3	215201
BDA SB	1	11	40	4	4	35	45	124	24	-139	79	-7	-8	215257	4	5	47	25	125	24	-106	66	-23	-6	215428
ANT SB	1	11	44	4	4	35	46	124	24	-53	78	-10	7	215273	4	5	47	31	125	24	-71	63	-26	9	215518
MAD DS	1	11	42	4	4	35	53	124	24	-84	31	-10	-59	215853	4	5	47	34	125	23	-74	18	-40	-66	217515
CYI SB	1	11	42	4	4	35	54	124	24	-81	39	-51	7	216467	4	5	47	37	125	23	-75	24	-65	14	217187

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
ASC SB	1	11	42	4	4	35	57	124	24	-59	24	-62	28	217191	4	5	47	39	125	24	-64	1[illegible]	-79	26	217999
HAW SB	1	11	51	4	6	33	41	126	24	76	35	54	11	216567	4	7	45	31	127	23	80	51	39	6	215813
GLD DS	1	11	51	4	6	33	51	126	24	125	72	11	15	215[illegible]	4	7	45	42	127	23	-176	78	12	-1	215133
GYM SB	1	11	51	4	6	33	52	126	24	113	80	9	-4	215178	4	7	45	43	127	23	-124	82	-7	-4	215091
TEX SB	1	11	47	4	6	33	6[illegible]	125	24	-140	85	-3	-4	215133	4	7	45	46	126	23	-98	71	-19	-3	215249
MLA SB	1	11	46	4	6	34	2	125	24	-100	71	-19	-3	215[illegible]3	4	7	45	48	126	23	-90	56	-34	[illegible]	215646
GBI SB	1	11	44	4	6	34	5	125	24	-93	69	-21	-1	215339	4	7	45	51	126	23	-86	54	-36	2	215726
BDA SB	1	11	42	4	6	34	7	125	24	-96	57	-33	-3	215676	4	7	45	49	126	23	-87	42	-48	2	216187
ANT SB	1	11	46	4	6	34	8	125	24	-73	52	-36	10	215823	4	7	45	54	126	23	-73	37	-52	13	216439
MAD DS	0	26	47	4	6	34	11	125	23	-68	9	-66	-66	217965	4	7	0	59	125	23	-64	5	-79	-63	217008
CYI SB	0	45	32	4	6	34	13	125	23	-71	14	-75	19	217[illegible]4	4	7	19	44	125	23	-66	5	-85	23	217012
GUM SB	1	11	44	4	8	32	6	127	23	68	8	81	22	217979	4	9	43	50	129	23	70	23	65	18	217009
HAW SB	1	11	50	4	8	32	15	127	23	81	62	26	4	215444	4	9	44	5	128	23	83	78	12	2	215054
GLD DS	1	11	51	4	8	32	25	126	23	-134	74	12	-12	215171	4	9	44	16	127	23	-107	61	9	-27	215402
GYM SB	1	11	51	4	8	32	26	126	23	-101	72	-16	-3	215194	4	9	44	18	127	23	-90	57	-33	[illegible]	215530
TEX SB	1	11	55	4	8	32	28	126	23	-91	60	-30	[illegible]	215476	4	9	44	23	127	23	-84	45	-45	4	215980
MLA SB	1	11	53	4	8	32	31	126	23	-85	45	-44	4	216[illegible]5	4	9	44	24	127	23	-79	31	-59	10	216666
BDA SB	1	11	53	4	8	32	33	126	23	-81	32	-58	7	216625	4	9	44	26	127	23	-74	18	-71	15	217356
GBI SB	1	11	49	4	8	32	33	126	23	-82	43	-47	6	216[illegible]6	4	9	44	22	127	23	-77	28	-61	12	216797
ANT SB	1	11	53	4	8	32	36	126	23	-72	26	-63	16	216949	4	9	44	29	127	23	-69	1[illegible]	-7[illegible]	21	217790

	TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE		DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GUM SB	1	11	40	4	10	30	31	128	23	71	34	54	16	216434		4	11	42	12	129	23	70	50	38	13	215660
CNB DS	1	11	44	4	10	30	37	128	24	49	12	-72	47	217648		4	11	42	21	129	24	36	21	-64	33	217026
HAW SB	1	11	38	4	10	30	46	128	23	52	88	1	1	214942		4	11	42	26	128	23	-84	76	-14	1	214987
GLD DS	1	11	36	4	10	30	56	127	23	-97	52	6	-38	215665		4	11	42	32	128	23	-87	38	-3	-52	216208
GYM SB	1	11	37	4	10	30	58	127	23	-85	47	-43	3	215865		4	11	42	35	128	23	-79	32	-58	9	216511
BDA SB	0	18	21	4	10	30	59	127	23	-68	8	-81	21	217846		4	10	49	20	127	23	-66	5	-85	24	217120
TEX SB	1	11	34	4	10	30	60	127	23	-80	35	-55	8	216399		4	11	42	34	128	23	-74	20	-69	15	217135
MLA SB	1	11	35	4	10	31	60	127	23	-74	26	-69	15	217153		4	11	42	34	128	22	-68	6	-83	22	217934
OBI SB	1	4	3	4	10	31	1	127	23	-73	18	-71	16	217301		4	11	35	4	128	22	-67	5	-85	23	217622
CAR SB	0	0	23	4	11	41	49	130	23	61	5	84	28	217961		4	11	42	12	130	23	61	5	84	29	217975
CAR SB	0	5	9	4	12	28	52	129	23	55	14	73	34	217431		4	12	34	2	129	23	55	15	72	34	217108
GUM SB	0	5	7	4	12	28	55	129	23	66	61	27	11	215289		4	12	34	2	129	23	66	62	26	11	214991
CNB DS	0	5	2	4	12	29	0	129	24	25	26	-61	22	216741		4	12	34	2	129	24	24	27	-61	21	216456
HAW SB	0	4	55	4	12	29	7	128	23	-83	65	-25	3	215181		4	12	34	2	128	23	-83	63	-26	3	214954
GYM SB	0	4	53	4	12	29	9	128	23	-75	21	-53	14	217018		4	12	34	2	128	23	-75	20	-69	15	216822
GLD DS	0	4	53	4	12	29	9	128	23	-81	26	-16	-61	216655		4	12	34	2	128	23	-61	27	-18	-61	216452
TEX SB	0	4	49	4	12	29	13	128	23	-70	10	-79	20	217672		4	12	34	2	128	23	-69	9	-80	21	217479

LM JETTISON BURN IGNITION 4 day 12 hr 34 min 02 sec

LM JETTISON BURN CUTOFF 4 day 12 hr 34 min 08 sec

TEX SB	0	23	9	4	12	34	8	128	23	-69	9	-80	21	217475		4	12	54	17	128	22	-67	5	-85	23	216784
CNB SB	1	6	33	4	12	34	8	129	23	55	15	72	34	217102		4	13	40	41	130	23	45	26	55	40	216671
GUM SB	1	6	39	4	12	34	8	129	23	66	62	26	11	214985		4	13	40	46	130	23	48	75	11	10	214892

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
HSK DS	1	6	46	4	12	34	8	129	24	24	27	-61	21	216451	4	13	40	54	130	23	8	31	-59	7	216447
HAW SB	1	6	55	4	12	34	8	128	23	-83	63	-26	3	214950	4	13	41	2	129	22	-81	49	-41	6	215638
GLD DS	1	6	55	4	12	34	8	128	23	-61	27	-18	-61	216448	4	13	41	3	129	22	-73	14	-49	-68	217363
GYM SB	1	6	56	4	12	34	8	128	23	-74	20	-69	15	216818	4	13	41	3	129	22	-69	7	-83	21	217799
CRO SB	1	11	46	4	14	27	21	130	23	35	33	41	44	216295	4	15	39	7	131	23	17	40	19	47	215878
GUM SB	1	11	47	4	14	27	26	130	23	-1	81	0	9	214799	4	15	39	13	130	22	-59	71	-16	10	214868
HSK DS	1	11	43	4	14	27	33	130	23	-5	31	-59	-4	216395	4	15	39	16	130	23	-23	28	-60	-20	216489
GLD DS	0	1	54	4	14	27	38	129	22	-67	5	-77	-66	217842	4	14	29	32	129	22	-66	5	-78	-66	217768
HAW SB	1	11	39	4	14	27	40	129	22	-78	36	-51	9	216051	4	15	39	20	130	22	-74	23	-67	14	216791
CRO SB	1	16	8	4	16	25	52	131	23	3	42	3	48	215765	4	17	36	0	131	23	-18	40	-20	46	215693
GUM SB	1	11	59	4	16	25	55	130	22	-68	61	-27	11	215083	4	17	37	54	131	22	-72	45	-44	13	215591
HAW SB	0	34	22	4	16	25	58	130	22	-71	12	-77	19	217343	4	17	0	19	130	22	-68	5	-85	21	216420
HSK DS	1	11	60	4	16	25	58	130	23	-34	23	-63	-31	216695	4	17	37	58	131	23	-48	15	-69	-46	217143
MAD DS	1	11	39	4	16	23	54	132	21	72	12	-55	68	217254	4	19	35	33	133	21	82	24	-16	64	216450
CRO SB	1	11	39	4	18	24	23	131	23	-31	36	-36	44	215942	4	19	36	2	132	22	-46	26	-55	39	216365
GUM SB	1	11	38	4	18	24	26	131	22	-72	34	-55	15	216032	4	19	36	4	132	22	-71	18	-71	18	216823
HSK DS	0	12	13	4	18	24	27	131	23	-56	7	-78	-55	217520	4	18	36	40	131	23	-58	5	-81	-57	216997
CYI SB	0	37	48	4	18	57	43	133	21	68	5	85	22	216317	4	19	35	31	134	21	72	12	77	17	217137
CYI SB	1	11	60	4	20	22	11	133	21	77	22	67	12	216559	4	21	34	11	134	21	84	37	53	5	215699
ASC SB	1	12	1	4	20	22	12	133	22	66	12	77	24	217164	4	21	34	14	134	22	61	27	60	26	216214

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
MAD DS	1	11	56	4	20	22	15	133	21	90	34	-1	56	215973	4	21	34	11	134	21	102	46	11	43	215298
GUM SB	0	10	44	4	20	22	37	132	22	-70	7	-82	20	217407	4	20	33	22	132	21	-69	5	-85	21	216980
CRO SB	1	11	58	4	20	22	38	132	22	-54	18	-68	34	216775	4	21	34	37	133	22	-63	5	-84	27	217477
BDA SB	1	11	34	4	22	20	39	134	21	69	7	83	20	217349	4	23	32	13	135	21	78	20	69	11	216454
CYI SB	1	11	36	4	22	20	45	134	21	88	48	42	1	215210	4	23	32	21	135	21	98	63	27	-4	214608
ASC SB	1	11	41	4	22	20	46	134	22	55	37	47	27	215680	4	23	32	27	135	21	42	50	30	28	215028
MAD DS	1	11	35	4	22	20	48	134	21	113	55	15	32	214940	4	23	32	23	135	21	138	65	19	16	214541
ANT SB	1	5	54	4	22	26	20	135	21	69	5	85	20	217153	4	23	32	14	136	21	73	19	70	16	216525
GBI SB	0	11	5	4	23	21	8	135	21	69	5	85	21	216776	4	23	32	13	136	21	71	7	82	19	217207
MLA SB	0	4	8	4	23	28	5	135	21	69	5	85	21	217132	4	23	32	13	136	21	70	6	84	20	217292
GBI SB	1	12	0	5	0	18	47	135	21	75	17	72	14	216618	5	1	30	48	136	20	82	32	58	7	215704
BDA SB	1	11	58	5	0	18	50	135	21	83	30	60	6	215919	5	1	30	48	136	20	92	44	46	-2	215133
MLA SB	1	11	56	5	0	18	53	135	21	75	16	74	15	216708	5	1	30	47	136	20	82	30	60	7	215800
ANT SB	1	11	58	5	0	18	53	135	21	75	30	59	13	215931	5	1	30	48	136	21	78	46	44	9	215076
MAD DS	1	12	2	5	0	18	59	135	21	165	70	20	5	214425	5	1	31	1	136	20	-150	68	20	-11	214379
CYI SB	1	11	58	5	0	18	60	135	21	110	73	16	-6	214363	5	1	30	58	136	21	-179	83	0	-7	214146
ASC SB	1	12	2	5	0	19	2	135	21	27	57	17	29	214767	5	1	31	3	136	21	-3	61	-2	29	214549
TEX SB	0	54	15	5	0	36	26	136	21	69	5	85	21	216433	5	1	30	45	137	20	75	16	74	15	216605
TEX SB	1	11	38	5	2	17	22	136	20	79	26	64	16	216012	5	3	29	0	137	20	87	41	49	3	215166
GLD DS	1	11	34	5	2	17	22	136	20	73	11	-55	70	216831	5	3	28	57	137	20	82	25	-16	64	215964

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GYM SB	1	11	37	5	2	17	23	136	20	74	14	75	15	216655	5	3	28	59	137	20	81	29	61	8	215743
GBI SB	1	11	40	5	2	17	24	136	20	86	43	47	3	215180	5	3	29	4	137	20	94	58	32	2	214503
MLA SB	1	11	40	5	2	17	25	136	20	87	41	49	3	215271	5	3	29	5	137	20	96	56	34	-3	214580
BDA SB	1	11	40	5	2	17	29	136	20	100	54	35	-6	214717	5	3	29	9	137	20	119	68	20	-10	214236
ANT SB	1	11	41	5	2	17	31	136	21	78	57	32	6	214632	5	3	29	12	137	20	76	73	17	4	214139
CYI SB	1	11	45	5	2	17	39	135	21	-120	77	-11	-7	214164	5	3	29	25	136	20	-100	62	-27	-4	214390
MAD DS	1	11	41	5	2	17	41	135	20	-128	62	18	-22	214484	5	3	29	23	136	20	-108	50	15	-38	214803
ASC SB	1	11	44	5	2	17	43	135	21	-24	58	-14	29	214583	5	3	29	27	136	21	-46	48	-32	27	214854
GLD DS	1	11	56	5	4	15	31	137	20	89	34	-2	56	215456	5	5	27	27	136	20	100	48	9	41	214725
GYM SB	1	11	56	5	4	15	32	137	20	86	39	51	3	215218	5	5	27	29	138	20	95	54	36	-3	214495
TEX SB	1	11	56	5	4	15	37	137	20	92	51	39	-1	214715	5	5	27	33	138	20	104	66	23	-6	214149
MLA SB	1	11	53	5	4	15	43	137	20	105	66	23	-6	214257	5	5	27	36	138	20	139	79	7	-8	213926
GBI SB	1	11	52	5	4	15	45	137	20	103	68	21	-5	214196	5	5	27	37	138	20	144	82	5	-7	213898
BDA SB	1	11	53	5	4	15	45	137	20	146	76	8	-12	214066	5	5	27	38	138	20	-147	75	-8	-12	213974
ANT SB	1	11	53	5	4	15	48	137	20	57	64	5	3	213978	5	5	27	41	137	20	-73	79	-11	3	213932
MAD DS	1	11	45	5	4	15	60	136	20	-98	41	10	-48	215118	5	5	27	45	137	19	-87	28	-5	-62	215687
CYI SB	1	11	47	5	4	16	1	136	20	-92	52	-38	-1	214673	5	5	27	48	137	20	-85	37	-53	4	215246
ASC SB	1	11	46	5	4	16	7	136	21	-55	39	-45	26	215184	5	5	27	53	137	20	-63	25	-62	24	215842
HAW SB	0	21	15	5	5	6	7	138	20	71	5	65	19	215961	5	5	27	22	139	20	73	9	80	17	216704
HAW SB	1	11	43	5	6	14	3	138	20	76	20	69	13	216074	5	7	25	46	139	19	81	35	54	7	215152

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GLD DS	1	11	46	5	6	14	9	138	20	113	57	12	30	214360	5	7	25	55	139	19	136	69	15	14	213951
GYM SB	1	11	46	5	6	14	12	138	20	103	65	25	-5	214157	5	7	25	58	139	19	134	78	9	-8	213803
TEX SB	1	11	50	5	6	14	13	138	20	121	76	12	-7	213925	5	7	26	3	139	19	-152	81	-4	-8	213777
MLA SB	1	11	50	5	6	14	17	137	20	-155	81	-4	-9	213868	5	7	26	7	138	19	-110	68	-20	-7	213975
GBI SB	1	11	49	5	6	14	19	137	20	-136	81	-6	-7	213863	5	7	26	7	138	19	-103	67	-23	-5	214011
BDA SB	1	11	53	5	6	14	19	137	20	-119	68	-20	-11	214072	5	7	26	12	138	19	-102	54	-36	-7	214393
ANT SB	1	11	56	5	6	14	22	137	20	-79	68	-22	4	214076	5	7	26	18	138	20	-80	51	-38	6	214491
MAD DS	1	11	45	5	5	14	25	137	19	-80	19	-27	-69	216125	5	7	26	11	138	19	-70	6	-73	-69	216795
CYI SB	1	11	50	5	6	14	28	137	20	-80	26	-64	9	215719	5	7	26	18	138	19	-74	11	-78	16	216492
ASC SB	0	43	18	5	6	14	31	137	20	-67	14	-75	23	216377	5	6	57	50	137	20	-69	5	-85	21	215640

TEI IGNITION 5 day 7 hr 51 min 35 sec

TEI CUTOFF 5 day 7 hr 54 min 14 sec

HAW SB	9	20	20	5	8	2	31	139	20	84	44	46	4	215101	5	17	22	51	138	20	-71	5	-85	19	195534
GLD DS	6	50	7	5	8	2	38	138	19	161	73	16	5	214208	5	14	52	42	138	19	-70	5	-76	-69	201157
GYM SB	6	12	38	5	8	2	37	138	20	-177	82	0	-8	214101	5	14	15	16	137	19	-71	5	-85	19	202578
TEX SB	5	18	55	5	8	2	39	138	20	-119	75	-23	-7	214181	5	13	21	34	138	19	-71	5	-85	19	204556
MLA SB	4	13	7	5	8	2	41	138	19	-101	90	-29	-5	214513	5	12	15	48	137	19	-71	5	-85	19	207047
GBI SB	4	0	40	5	8	2	41	138	20	-96	59	-31	-5	214561	5	12	3	22	137	19	-71	5	-85	19	207483
BDA SB	3	15	18	5	8	2	42	138	19	-95	46	-44	-4	215013	5	11	18	18	137	19	-70	5	-85	20	209191
ANT SB	2	40	2	5	8	2	44	138	20	-79	43	-47	8	215163	5	10	42	45	137	20	-71	5	-85	19	210573
GUM SB	11	48	40	5	9	4	15	139	20	71	5	55	19	214521	5	20	52	55	138	20	-71	5	-85	19	187594
BEN DS	5	55	2	5	10	13	27	139	20	60	5	-30	60	211765	5	19	8	29	138	21	-60	5	-80	-60	191573

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CRO SB	9	46	36	5	12	9	18	139	20	65	5	84	25	207267	5	21	55	54	138	21	-65	5	-84	25	185161
MAD DS	13	18	37	5	18	17	35	140	19	69	5	-76	68	193449	6	7	36	12	140	19	-69	5	-76	-68	161709
CYI SB	12	33	58	5	19	25	44	140	20	71	5	85	19	197925	6	7	59	42	140	19	-71	5	-85	19	160709
ASC SB	10	48	6	5	20	13	22	140	20	69	5	85	21	189186	6	7	1	28	139	20	-69	5	-85	21	163173
BDA SB	12	49	30	5	22	35	22	140	19	70	5	85	20	183637	6	11	24	53	140	19	-70	5	-85	20	151794
ANT SB	12	1	42	5	22	47	37	140	20	71	5	85	19	183159	6	10	49	19	140	20	-71	5	-85	19	153364
GBI SB	12	30	48	5	23	39	30	140	20	71	5	85	19	181131	6	12	10	17	140	19	-71	5	-85	19	149771
MLA SB	12	36	50	5	23	46	22	140	19	71	5	85	19	180862	6	12	23	11	140	19	-71	5	-85	19	149193
TEX SB	12	34	11	6	0	54	59	141	20	71	5	85	19	178152	6	13	29	10	140	19	-71	5	-85	19	146212
GYM SB	12	35	17	6	1	48	14	141	19	71	5	85	19	176031	6	14	23	31	141	19	-71	5	-85	19	143724
GLD DS	13	0	27	6	2	0	27	141	19	70	5	-76	69	175543	6	15	0	53	141	19	-70	5	-76	-69	141998
HAW SB	12	17	35	6	5	14	45	141	20	71	5	85	19	167633	6	17	32	20	141	19	-71	5	-85	19	134843
GUM SB	11	52	18	6	9	12	19	142	20	71	5	85	19	157593	6	21	4	37	142	20	-71	5	-85	19	124361
HSK DS	8	54	54	6	10	23	38	142	21	60	5	-80	60	154485	6	19	18	32	142	21	-60	5	-80	-59	129662
CRO SB	9	48	0	6	12	20	3	143	21	64	5	84	25	149327	6	22	8	3	142	21	-64	5	-84	26	121110
MAD DS	13	23	24	6	18	31	51	144	19	69	5	-76	69	131962	7	7	55	15	146	18	-70	5	-76	-70	87806
CYI SB	12	39	16	6	19	41	14	145	19	71	5	85	19	128547	7	8	20	30	146	19	-71	5	-85	18	86205
ASC SB	10	52	53	6	20	29	14	145	20	69	5	85	21	126145	7	7	22	8	145	20	-69	5	-85	21	89874
BDA SB	12	56	49	6	22	53	51	146	19	71	5	85	19	118737	7	11	50	41	148	18	-72	5	-85	18	72131
ANT SB	12	9	30	6	23	5	53	146	19	71	5	85	19	118116	7	11	15	23	148	19	-72	5	-85	18	74598

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GBI SB	12	39	30	6	23	58	49	146	19	71	5	85	19	115308	7	12	38	19	149	18	-72	5	-85	18	68721
MLA SB	12	45	34	7	0	5	56	146	19	71	5	85	19	114928	7	12	51	30	149	18	-72	5	-85	18	67761
TEX SB	12	44	35	7	1	15	44	147	19	71	5	85	19	111162	7	14	0	19	150	18	-72	5	-85	18	62619
GYM SB	12	47	8	7	2	1[illegible]	7	147	19	71	5	85	19	108170	7	14	57	15	151	18	-72	5	-85	17	58183
GLO DS	13	12	12	7	2	22	58	147	19	70	5	-75	70	107456	7	15	35	10	152	17	-72	5	-74	-72	55126
HAW SB	12	40	44	7	5	41	22	149	19	71	5	85	19	96016	7	18	22	6	156	17	-74	5	-85	16	40386
GUM SB	13	25	51	7	9	46	54	152	19	71	5	65	19	83591	7	23	12	45	-105	-71	-177	5	-30	-84	1690
BSK DS	9	34	39	7	11	1	51	152	21	59	5	-80	59	75525	7	20	36	30	164	22	-58	5	-81	-58	26154
CRO SB	10	7	12	7	13	4	31	155	21	64	5	84	26	66798	7	23	11	43	-53	21	64	5	84	26	1939
CRO CB	2	25	21	7	2[illegible]	46	22	167	23	-34	34	-39	43	234[illegible]	7	23	11	43	-53	21	64	5	84	26	1939
TAN TM	2	4	33	7	20	48	9	176	21	50	30	53	54	23400	7	22	52	42	-119	17	71	5	85	19	6119
PRE CB	1	32	46	7	2[illegible]	56	14	179	22	59	11	77	30	23400	7	22	29	0	-150	21	64	5	84	26	10514
BEK DS	0	9	5	7	23	4	3[illegible]	-152	29	-48	5	-82	-48	3653	7	23	13	36	-98	49	-5	5	-85	-5	1490

ENTRY INTERFACE 7 day 23 hr 18 min 16 sec

TABLE 2.0-VIII. - MISSION RADAR TIMELINE - Continued

(e) LM acquisition and termination - 0° minimum elevation

	TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE		DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GTI CB	0	9	60	4	2	55	51	123	24	-100	49	-40	-7	215154		4	3	5	51	123	24	-98	48	-42	-6	214897
PRE CB	0	9	60	4	2	55	51	124	24	80	30	60	8	216062		4	3	5	51	125	24	82	31	58	7	215640
CAR CB	0	9	60	4	2	55	51	124	24	78	33	56	10	215867		4	3	5	51	125	24	79	35	54	9	215442
HAW CB	0	9	60	4	2	55	51	124	24	83	45	45	5	215329		4	3	5	51	124	24	84	47	43	4	214918
RENDEZVOUS RADAR TRACKING •																											
GTI CB	0	38	14	4	3	5	51	123	24	-96	48	-42	-6	214897		4	3	44	5	124	24	-92	41	-49	-2	216151
PRE CB	0	38	14	4	3	5	51	125	24	82	31	58	7	215640		4	3	44	5	125	24	86	39	51	3	216248
CAR CB	0	38	14	4	3	5	51	125	24	79	35	54	9	215442		4	3	44	5	125	24	83	43	47	5	216043
HAW CB	0	38	14	4	3	5	51	124	24	84	47	43	4	214918		4	3	44	5	125	24	87	55	35	2	215582
COAST TO DOI BURN •																											
PRE CB	0	4	43	4	3	44	5	125	24	86	39	51	3	216248		4	3	48	48	125	24	87	40	50	2	216445
CAR CB	0	4	44	4	3	44	5	125	24	83	43	47	5	216043		4	3	48	46	125	24	83	44	46	5	216240
HAW CB	0	4	45	4	3	44	5	125	24	87	55	35	2	215582		4	3	48	50	125	24	88	56	34	1	215790
GTI CB	0	5	4	4	3	44	5	124	24	-92	41	-49	-2	216151		4	3	49	8	124	24	-91	40	-50	-1	216450
ASC CB	0	0	3	4	3	43	42	125	24	69	0	90	26	218626		4	3	48	45	125	24	69	0	90	26	218626
ULLAGE FOR DOI BURN																											
DOI BURN																											
RENDEZVOUS RADAR TRACKING •																											
ASC CB	0	18	24	4	4	38	3	125	24	69	11	79	21	217798		4	4	56	27	126	24	70	14	75	19	216673
PRE CB	0	18	18	4	4	38	9	125	24	94	50	40	-3	215808		4	4	56	27	125	24	97	53	36	-4	214774
CAR CB	0	18	15	4	4	38	12	125	24	88	55	35	1	215608		4	4	56	27	125	24	90	59	31	0	214569
HAW CB	0	18	15	4	4	38	13	125	24	99	67	23	-1	215268		4	4	56	27	125	24	97	71	19	-2	214292
GTI CB	0	18	2	4	4	38	26	124	24	-89	30	-60	5	216681		4	4	56	27	124	24	-81	27	-63	8	215969
COAST TO PHASE MANEUVER																											
GTI CB	0	9	60	4	4	56	27	124	24	-81	27	-63	8	215969		4	5	6	27	124	23	-80	25	-64	9	215855
ASC CB	0	9	60	4	4	56	27	126	24	70	14	75	19	216673		4	5	6	27	126	24	71	16	73	19	216351

	TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE		DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	
PRE CB	0	9	60	4	4	56	27	125	29	97	53	30	-4	214779		4	5	6	27	125	29	99	55	34	-4	[illegible]	
[illegible] CB	0	9	60	4	4	56	27	125	29	90	59	[illegible]	-1	214585		4	5	6	27	125	29	91	61	29		[illegible]	
[illegible] CB	0	9	60	4	4	56	27	125	29	97	73	17	-3	214292		4	5	6	27	125	29	99	73	17	-3	[illegible]	
				ULLAGE FOR PHASING BURN																							
[illegible]	0	0	7	4	5	6	27	124	23	-80	25	-64	9	[illegible]		4	[illegible]	6	35	124	23	-80	25	-64	[illegible]	[illegible]	
[illegible] CB	0	0	7	4	5	6	27	126	29	71	16	73	17	[illegible]		4	5	6	35	126	29	71	16	73	[illegible]	[illegible]	
PRE CB	0	0	7	4	5	6	27	125	29	99	55	34	-5	214504		4	[illegible]	6	35	125	29	99	55	34		[illegible]	
CAR CB	0	0	7	4	5	6	27	125	29	91	61	29	0	214321		4	5	6	35	125	29	91	61	29	[illegible]	[illegible]	
[illegible]	0	0	7	4	5	6	27	125	29	99	73	17	-3	[illegible]		4	5	6	35	125	29	99	73	17	[illegible]	[illegible]	
				PHASING BURN																							
[illegible]	0	0	42	4	5	6	35	124	23	-80	25	-64	9	215856		4	5	7	17	124	23	-80	25	-64	9	[illegible]	
ASC CB	0	0	42	4	5	6	35	126	29	71	16	73	17	216349		4	5	7	17	126	29	71	17	73	[illegible]	[illegible]	
PRE CB	0	0	42	4	5	6	35	125	29	99	55	34	-5	214505		4	5	7	17	125	29	99	55	34	[illegible]	[illegible]	
CAR CB	0	0	42	4	5	6	35	125	29	91	61	29	0	214320		4	5	7	17	125	29	91	61	29	-1	214313	
HEX CB	0	0	42	4	5	6	35	125	29	99	73	17	-3	214046		4	5	7	17	125	29	99	73	17	-3	214040	
				COAST AT BURN ATTITUDE *																							
GTI CB	0	7	60	4	5	7	17	124	23	-80	25	-65	9	215659		4	5	15	17	124	23	-79	24	-62	13	215495	
ASC CB	0	7	60	4	5	7	17	126	29	71	17	73	15	[illegible]		4	5	[illegible]	17	126	29	71	9	74	9	[illegible]	
PRE CB	0	7	60	4	5	7	17	125	29	99	55	34	-3	[illegible]		4	5	9	17	126	29	101	52	33	[illegible]	[illegible]	
CAR CB	0	7	60	4	5	7	17	125	29	91	61	29	-1	[illegible]		4	5	[illegible]	17	126	29	92	63	[illegible]	1	[illegible]	
[illegible]	0	7	60	4	5	7	17	125	29	99	73	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	15	17	125	29	107	25	21	[illegible]	[illegible]	
				COAST TO JETTISON DESCENT STAGE																							
[illegible] CB	[illegible]	44	49	4	5	15	17	126	29	71	16	71	10	216397		4	5	50	1	126	29	79	25	29	1	[illegible]	
[illegible]	1	39	55	4	5	15	17	126	29	101	57	35	-6	[illegible]		4	5	50	11	126	29	109	53	[illegible]	[illegible]	[illegible]	

	TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE		DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CAR CB	0	34	58	4	5	15	17	126	24	92	63	27	-1	214328		4	5	50	14	126	24	98	70	19	-3	215612
HAW CB	0	35	1	4	5	15	17	125	24	101	75	15	-3	214075		4	5	50	18	126	24	118	82	7	-4	215450
GTI CB	0	35	16	4	5	15	17	124	23	-79	24	-66	10	215995		4	5	50	33	125	23	-74	17	-72	15	217819
ASC CB	0	14	26	4	6	38	60	126	24	76	37	53	11	216578		4	6	53	26	126	24	77	40	50	10	215661
PRE CB	0	14	10	4	6	39	16	126	24	128	72	14	-11	215347		4	6	53	26	126	24	137	75	11	-11	214557
CAR CB	0	14	10	4	6	39	16	126	24	117	81	8	-4	215232		4	6	53	26	126	24	131	84	5	-4	214457
HAW CB	0	14	6	4	6	39	21	125	24	-131	64	-4	-4	215205		4	6	53	26	126	24	-116	82	-8	-4	214473
GTI CB	0	13	54	4	6	39	33	125	23	-67	9	-81	23	218086		4	6	53	26	125	23	-65	6	-83	25	217485
				LM-DESCENT STAGE JETTISON •																							
GTI CB	0	0	9	4	6	53	26	125	23	-65	6	-83	25	217485		4	6	53	36	125	23	-65	6	-83	25	217479
ASC CB	0	0	9	4	6	53	26	126	24	77	40	50	10	215661		4	6	53	36	126	24	77	40	49	10	215652
PRE CB	0	0	9	4	6	53	26	126	24	137	75	11	-11	214557		4	6	53	36	126	24	137	75	11	-11	214549
CAR CB	0	0	9	4	6	53	26	126	24	131	84	5	-4	214457		4	6	53	36	126	24	131	84	5	-4	214449
HAW CB	0	0	9	4	6	53	26	126	24	-116	82	-8	-4	214473		4	6	53	36	126	24	-116	81	-8	-4	214465
				LM ASCENT RETRO BURN •																							
GTI CB	0	0	3	4	6	53	36	125	23	-65	6	-83	25	217479		4	6	53	38	126	23	-65	6	-83	25	217477
ASC CB	0	0	3	4	6	53	36	126	24	77	40	49	10	215652		4	6	53	38	126	24	77	40	49	10	215649
PRE CB	0	0	3	4	6	53	36	126	24	137	75	11	-11	214549		4	6	53	38	126	24	137	75	11	-11	214547
CAR CB	0	0	3	4	6	53	36	126	24	131	84	5	-4	214449		4	6	53	38	126	24	132	84	5	-4	214446
HAW CB	0	0	3	4	6	53	36	126	24	-116	81	-8	-4	214465		4	6	53	38	126	24	-116	81	-8	-4	214463
				COAST TO INSERTION •																							
GTI CB	0	9	47	4	6	53	38	125	23	-65	6	-83	25	217477		4	7	3	26	125	23	-63	5	-85	27	217148
ASC CB	0	9	47	4	6	53	38	126	24	77	40	49	10	215649		4	7	3	26	127	24	78	42	47	9	215132

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
PRE CB	0	9	47	4	6	53	38	126	24	137	75	11	-11	214597	4	7	3	26	126	23	144	76	9	-11	214105
CAR CB	0	9	47	4	6	53	38	126	24	132	84	5	-4	214446	4	7	3	26	126	24	149	85	3	-4	214015
HAW CB	0	9	47	4	6	53	38	126	24	-116	81	-8	-4	214463	4	7	3	26	126	24	-110	80	-10	-4	214058
ULLAGE FOR INSERTION BURN																									
GTI CB	0	0	3	4	7	3	26	125	23	-63	5	-85	27	217148	4	7	3	29	125	23	-63	5	-85	27	217147
ASC CB	0	0	3	4	7	3	26	127	24	78	42	47	9	215132	4	7	3	29	127	24	78	42	47	9	215130
PRE CB	0	0	3	4	7	3	26	126	23	144	76	9	-11	214105	4	7	3	29	126	23	144	76	9	-11	214103
CAR CB	0	0	3	4	7	3	26	126	24	149	85	3	-4	214015	4	7	3	29	126	24	149	85	3	-4	214013
HAW CB	0	0	3	4	7	3	26	126	24	-110	80	-10	-4	214058	4	7	3	29	126	24	-110	80	-10	-4	214056
INSERTION BURN																									
GTI CB	0	0	16	4	7	3	29	125	23	-63	5	-85	27	217147	4	7	3	45	125	23	-63	5	-85	27	217141
ASC CB	0	0	16	4	7	3	29	127	24	78	42	47	9	215130	4	7	3	45	127	24	78	42	47	9	215119
PRE CB	0	0	16	4	7	3	29	126	23	144	76	9	-11	214103	4	7	3	45	126	23	144	76	8	-11	214094
CAR CB	0	0	16	4	7	3	29	126	24	149	85	3	-4	214013	4	7	3	45	126	24	149	85	3	-4	214004
HAW CB	0	0	16	4	7	3	29	126	24	-110	80	-10	-4	214056	4	7	3	45	126	24	-110	80	-10	-4	214048
COAST TO RENDEZVOUS RADAR TRACKING *																									
GTI CB	0	17	60	4	7	3	45	125	23	-63	5	-85	27	217141	4	7	21	45	126	23	-61	2	-88	29	217205
ASC CB	0	17	60	4	7	3	45	127	24	78	42	47	9	215117	4	7	21	45	127	23	79	46	44	8	214852
PRE CB	0	17	60	4	7	3	45	126	23	144	76	8	-11	214094	4	7	21	45	126	23	159	77	5	-12	213967
CAR CB	0	17	60	4	7	3	45	126	24	149	85	3	-4	214004	4	7	21	45	126	23	-164	85	-1	-4	213896
HAW CB	0	17	60	4	7	3	45	126	24	-110	80	-10	-4	214048	4	7	21	45	126	23	-104	76	-14	-3	213986
RENDEZVOUS RADAR TRACKING *																									
GTI CB	0	10	41	4	7	21	45	126	23	-61	2	-88	29	217205	4	7	32	26	126	23	-59	0	-90	31	217665
ASC CB	0	22	55	4	7	21	45	127	23	79	46	44	8	214852	4	7	44	40	127	23	80	51	39	7	215627

	TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE		DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
PRE CB	0	22	55	4	7	21	45	126	23	159	77	5	-12	213967		4	7	44	40	127	23	-177	78	-1	-12	214931
CAR CB	0	22	55	4	7	21	45	126	23	-164	85	-1	-4	213896		4	7	44	40	127	23	-125	82	-6	-4	214887
HAW CB	0	22	55	4	7	21	45	126	23	-104	76	-14	-3	213986		4	7	44	40	126	23	-99	71	-19	-3	215039
				COAST TO CSI																							
ASC CB	0	2	44	4	7	44	40	127	23	80	51	39	7	215627		4	7	47	24	127	23	80	51	38	6	215743
PRE CB	0	2	58	4	7	44	40	127	23	-177	78	-1	-12	214931		4	7	47	38	127	23	-174	78	-1	-12	215083
CAR CB	0	2	59	4	7	44	40	127	23	-125	82	-6	-4	214887		4	7	47	39	127	23	-122	82	-7	-4	215043
HAW CB	0	3	5	4	7	44	40	126	23	-99	71	-19	-3	215039		4	7	47	45	126	23	-98	70	-19	-3	215208
				CSI BURN																							
				COAST TO RENDEZVOUS RADAR TRACKING •																							
				RENDEZVOUS RADAR TRACKING •																							
CYI CB	0	10	2	4	8	34	39	127	23	68	9	81	22	217902		4	8	44	41	128	23	68	11	78	21	217239
ASC CB	0	9	53	4	8	34	48	127	23	81	62	27	4	215384		4	8	44	41	127	23	82	65	25	4	214800
PRE CB	0	9	47	4	8	34	54	126	23	-132	73	-13	-11	215136		4	8	44	41	126	23	-127	72	-15	-11	214643
CAR CB	0	9	45	4	8	34	56	126	23	-100	72	-18	-3	215163		4	8	44	41	126	23	-98	70	-20	-3	214685
HAW CB	0	9	38	4	8	35	3	126	23	-91	60	-30	0	215443		4	8	44	41	126	23	-90	58	-32	0	214999
				COAST TO CDH •																							
CYI CB	0	7	60	4	8	44	41	128	23	68	11	78	21	217239		4	8	52	41	128	23	69	13	77	21	216752
ASC CB	0	7	60	4	8	44	41	127	23	82	65	25	4	214800		4	8	52	41	127	23	82	66	23	3	214370
PRE CB	0	7	60	4	8	44	41	126	23	-127	72	-15	-11	214643		4	8	52	41	126	23	-123	70	-17	-11	214281
CAR CB	0	7	60	4	8	44	41	126	23	-98	70	-20	-3	214685		4	8	52	41	126	23	-97	68	-22	-2	214335
HAW CB	0	7	60	4	8	44	41	126	23	-90	58	-32	0	214999		4	8	52	41	126	23	-89	56	-34	1	214668
				CDH BURN •																							
CYI CB	0	0	7	4	8	52	41	128	23	69	13	77	21	216752		4	8	52	48	128	23	69	13	76	21	216745
ASC CB	0	0	7	4	8	52	41	127	23	82	66	23	3	214370		4	8	52	48	127	23	82	66	23	3	214365
PRE CB	0	0	7	4	8	52	41	126	23	-123	70	-17	-11	214281		4	8	52	48	126	23	-123	70	-17	-11	214277

	TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE		DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CAR CB	0	0	7	4	8	52	41	126	23	-97	68	-22	-2	214335		4	8	52	48	126	23	-97	68	-22	-2	214330
HAW CB	0	0	7	4	8	52	41	126	23	-89	56	-34	1	214668		4	8	52	48	126	23	-89	56	-34	1	214663
				COAST TO RENDEZVOUS RADAR TRACKING •																							
CYI CB	0	3	60	4	8	52	48	128	23	69	13	76	21	216745		4	8	56	48	128	23	69	13	76	21	216543
ASC CB	0	3	60	4	8	52	48	127	23	82	66	23	3	214365		4	8	56	48	127	23	82	67	23	3	214191
PRE CB	0	3	60	4	8	52	48	126	23	-123	70	-17	-11	214277		4	8	56	48	127	23	-122	70	-17	-10	214136
CAR CB	0	3	60	4	8	52	48	126	23	-97	68	-22	-2	214330		4	8	56	48	126	23	-96	67	-23	-2	214196
HAW CB	0	3	60	4	8	52	48	126	23	-89	56	-34	1	214663		4	8	56	48	126	23	-88	55	-35	1	214538
				RENDEZVOUS RADAR TRACKING •																							
CYI CB	0	18	60	4	8	56	48	128	23	69	13	76	21	216543		4	9	15	48	128	23	70	17	71	20	216142
ASC CB	0	18	60	4	8	56	48	127	23	82	67	23	3	214191		4	9	15	48	128	23	82	71	19	2	213933
PRE CB	0	18	60	4	8	56	48	127	23	-122	70	-17	-10	214136		4	9	15	48	127	23	-115	66	-22	-10	214035
CAR CB	0	18	60	4	8	56	48	126	23	-96	67	-23	-2	214196		4	9	15	48	127	23	-94	63	-27	-2	214121
HAW CB	0	18	60	4	8	56	48	126	23	-88	55	-35	1	214538		4	9	15	48	127	23	-87	51	-39	2	214505
				COAST TO TPI •																							
CYI CB	0	13	11	4	9	15	48	128	23	70	17	71	20	216142		4	9	28	59	128	23	70	20	69	19	216423
ASC CB	0	13	11	4	9	15	48	128	23	82	71	19	2	213933		4	9	28	59	128	23	83	74	16	2	214322
PRE CB	0	13	11	4	9	15	48	127	23	-115	66	-22	-10	214035		4	9	28	59	127	23	-111	64	-24	-9	214533
CAR CB	0	13	11	4	9	15	48	127	23	-94	63	-27	-2	214121		4	9	28	59	127	23	-92	60	-30	-1	214636
HAW CB	0	13	11	4	9	15	48	127	23	-87	51	-39	2	214505		4	9	28	59	127	23	-86	46	-42	3	215049
WHS CB	0	11	21	4	9	17	38	128	24	60	0	90	30	217200		4	9	28	59	128	24	59	2	88	31	217488
ANT CB	0	10	48	4	9	18	12	128	24	60	0	90	30	217213		4	9	28	59	128	24	59	2	88	31	217494
				TPI BURN •																							
ANT CB	0	0	16	4	9	28	59	128	24	59	2	88	31	217494		4	9	29	15	128	24	59	2	88	31	217503

	TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CYI CB	0	0	16	4	9	28	59	128	23	70	20	69	19	216423	4	9	29	15	128	23	70	23	69	19	216432
ASC CB	0	0	16	4	9	28	59	128	23	83	74	16	2	214322	4	9	29	15	128	23	83	74	16	2	214333
PRE CB	0	0	16	4	9	28	59	127	23	-111	64	-24	-9	214533	4	9	29	15	127	23	-111	64	-24	-9	214546
CAR CB	0	0	16	4	9	28	59	127	23	-92	60	-30	-1	214636	4	9	29	15	127	23	-92	60	-30	-1	214650
HAW CB	0	0	16	4	9	28	59	127	23	-86	48	-42	3	215049	4	9	29	15	127	23	-86	48	-42	3	215064
WHS CB	0	0	16	4	9	28	59	128	24	59	2	88	31	217488	4	9	29	15	128	24	59	2	88	31	217496
COAST TO 1ST BRAKING GATE •																									
CYI CB	0	14	8	4	9	29	15	128	23	70	20	69	19	216432	4	9	43	23	129	23	70	23	65	18	216980
WHS CB	0	14	15	4	9	29	15	128	24	59	2	88	31	217498	4	9	43	30	128	24	57	4	65	33	[illegible]
ANT CB	0	14	16	4	9	29	15	128	24	59	2	88	31	217503	4	9	43	31	128	24	57	4	65	33	[illegible]
ASC CB	0	14	23	4	9	29	15	128	23	83	74	16	2	214333	4	9	43	38	126	23	83	77	13	2	215019
PRE CB	0	14	33	4	9	29	15	127	23	-111	64	-24	-9	214546	4	9	43	48	127	23	-107	61	-28	-8	215364
CAR CB	0	14	33	4	9	29	15	127	23	-92	60	-30	-1	214650	4	9	43	48	127	23	-90	57	-33	0	[illegible]
HAW CB	0	14	41	4	9	29	15	127	23	-86	48	-42	3	215064	4	9	43	56	127	23	-84	45	-45	4	215941

COAST TO 2ND BRAKING GATE •

COAST TO 3RD BRAKING GATE •

1ST BRAKING MANEUVER •

COAST TO 4TH BRAKING GATE •

2ND BRAKING MANEUVER •

COAST TO 5TH BRAKING GATE •

3RD BRAKING MANEUVER •

COAST TO DOCKING •

COAST TO REDEZVOUS RADAR TRACKING •

REDEZVOUS RADAR TRACKING •

APS BURN TO DEPLETION

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
[illegible]	0	14	2	4	13	7	9	128	22	-66	3	-87	24	216773	4	13	21	11	129	22	-65	0	-90	25	217238
[illegible]	1	12	9	4	13	7	9	128	22	-72	14	-76	18	216112	4	14	19	18	130	22	-65	0	-90	25	219255
[illegible]	1	56	1	4	13	7	9	128	22	-77	21	-31	-66	215708	4	15	3	10	131	21	-64	0	-90	-64	220773
[illegible]	6	25	1	4	13	7	9	129	24	16	29	-60	14	215247	4	19	32	10	136	20	-46	0	-90	-65	230419
[illegible]	4	59	0	4	17	31	34	135	20	63	0	-90	63	225915	5	22	30	36	166	11	107	36	23	52	300000
[illegible]	13	58	15	5	1	54	25	143	17	69	0	-90	69	244947	5	15	52	40	152	12	-75	0	-90	-75	282342
[illegible]	11	1	24	8	10	8	58	149	15	71	0	-90	71	266272	5	21	10	24	165	12	-76	0	-90	-76	297917

17 MAY 69 72.1 COAST AFTER APS BURN TO DEPLETION

TABLE 2.0-VIII. - MISSION RADAR TIMELINE - Concluded

(f) LM acquisition and termination - 5° minimum elevation

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GTI CB	0	9	60	4	2	55	51	123	24	-100	49	-40	-7	215154	4	3	5	51	123	24	-98	48	-42	-6	214897
PRE CB	0	9	60	4	2	55	51	124	24	80	30	60	8	216062	4	3	5	51	125	24	82	31	58	7	215640
CAR CB	0	9	60	4	2	55	51	124	24	78	33	56	10	215867	4	3	5	51	125	24	79	35	54	9	215442
HAW CB	0	9	60	4	2	55	51	124	24	83	45	45	5	215329	4	3	5	51	124	24	84	47	43	4	214918
				RENDEZVOUS RADAR TRACKING *																					
GTI CB	0	38	14	4	3	5	51	123	24	-98	48	-42	-6	214897	4	3	44	5	124	24	-92	41	-49	-2	216151
PRE CB	0	38	14	4	3	5	51	125	24	82	31	58	7	215640	4	3	44	5	125	24	86	39	51	3	216248
CAR CB	0	38	14	4	3	5	51	125	24	79	35	54	9	215442	4	3	44	5	125	24	83	43	47	5	216043
HAW CB	0	38	14	4	3	5	51	124	24	84	47	43	4	214918	4	3	44	5	125	24	87	55	35	2	215582
				COAST TO DOI BURN *																					
PRE CB	0	4	43	4	3	44	5	125	24	86	39	51	3	216248	4	3	48	48	125	24	87	40	50	2	216445
CAR CB	0	4	44	4	3	44	5	125	24	83	43	47	5	216043	4	3	48	48	125	24	83	44	46	5	216240
HAW CB	0	4	45	4	3	44	5	125	24	87	55	35	2	215582	4	3	48	50	125	24	88	56	34	1	215790
GTI CB	0	5	4	4	3	44	5	124	24	-92	41	-49	-2	216151	4	3	49	8	124	24	-91	40	-50	-1	216450
				ULLAGE FOR DOI BURN																					
				DOI BURN																					
				RENDEZVOUS RADAR TRACKING *																					
ASC CB	0	18	24	4	4	38	3	125	24	69	11	79	21	217798	4	4	56	27	126	24	70	14	75	19	216673
PRE CB	0	18	18	4	4	38	9	125	24	94	50	40	-3	215808	4	4	56	27	125	24	97	53	36	-4	214779
CAR CB	0	18	15	4	4	38	12	125	24	88	55	35	1	215608	4	4	56	27	125	24	90	59	31	0	214589
HAW CB	0	18	15	4	4	38	13	125	24	94	67	23	-1	215268	4	4	56	27	125	24	97	71	19	-2	214292
GTI CB	0	18	2	4	4	38	26	124	24	-84	30	-60	5	216681	4	4	56	27	124	24	-81	27	-63	8	215969
				COAST TO PHASE MANEUVER																					
GTI CB	0	9	60	4	4	56	27	124	24	-81	27	-63	8	215969	4	5	6	27	124	23	-80	25	-64	9	215855
ASC CB	0	9	60	4	4	56	27	126	24	70	14	75	19	216673	4	5	6	27	126	24	71	16	73	19	216351
PRE CB	0	9	60	4	4	56	27	125	24	97	53	36	-4	214779	4	5	6	27	125	24	99	55	34	-5	214508

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CAR CB	0	9	60	4	4	56	27	125	24	90	59	31	0	214589	4	5	6	27	125	24	91	61	29	0	214321
HAW CB	0	9	60	4	4	56	27	125	24	97	71	19	-2	214292	4	5	6	27	125	24	99	73	17	-3	214047
				ULLAGE FOR PHASING BURN																					
GTI CB	0	0	7	4	5	6	27	124	23	-80	25	-64	9	215855	4	5	6	35	124	23	-80	25	-64	9	215856
ASC CB	0	0	7	4	5	6	27	126	24	71	16	73	19	216351	4	5	6	35	126	24	71	16	73	19	216349
PRE CB	0	0	7	4	5	6	27	125	24	99	55	34	-5	214508	4	5	6	35	125	24	99	55	34	-5	214506
CAR CB	0	0	7	4	5	6	27	125	24	91	61	29	0	214321	4	5	6	35	125	24	91	61	29	0	214320
HAW CB	0	0	7	4	5	6	27	125	24	99	73	17	-3	214047	4	5	6	35	125	24	99	73	17	-3	214046
				PHASING BURN																					
GTI CB	0	0	42	4	5	6	35	124	23	-80	25	-64	9	215856	4	5	7	17	124	23	-80	25	-65	9	215859
ASC CB	0	0	42	4	5	6	35	126	24	71	16	73	19	216349	4	5	7	17	126	24	71	17	73	19	216338
PRE CB	0	0	42	4	5	6	35	125	24	99	55	34	-5	214506	4	5	7	17	125	24	99	55	34	-5	214499
CAR CB	0	0	42	4	5	6	35	125	24	91	61	29	0	214320	4	5	7	17	125	24	91	61	29	-1	214313
HAW CB	0	0	42	4	5	6	35	125	24	99	73	17	-3	214046	4	5	7	17	125	24	99	73	16	-3	214040
				COAST AT BURN ATTITUDE *																					
GTI CB	0	7	60	4	5	7	17	124	23	-80	25	-65	9	215859	4	5	15	17	124	23	-79	24	-66	10	215995
ASC CB	0	7	60	4	5	7	17	126	24	71	17	73	19	216338	4	5	15	17	126	24	71	18	71	18	216307
PRE CB	0	7	60	4	5	7	17	125	24	99	55	34	-5	214499	4	5	15	17	126	24	101	57	33	-6	214511
CAR CB	0	7	60	4	5	7	17	125	24	91	61	29	-1	214313	4	5	15	17	126	24	92	63	27	-1	214328
HAW CB	0	7	60	4	5	7	17	125	24	99	73	16	-3	214040	4	5	15	17	125	24	101	75	15	-3	214075
				COAST TO JETTISON DESCENT STAGE																					
ASC CB	0	34	44	4	5	15	17	126	24	71	18	71	18	216307	4	5	50	0	126	23	74	25	64	15	217350
PRE CB	0	34	54	4	5	15	17	126	24	101	57	33	-6	214511	4	5	50	11	126	23	109	63	25	-8	215771
CAR CB	0	34	58	4	5	15	17	126	24	92	63	27	-1	214328	4	5	50	15	126	24	98	70	19	-3	215612

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
HAW CB	0	55	1	4	5	15	17	125	24	101	75	15	-3	214075	4	5	50	18	126	24	118	82	7	-4	215451
GTI CB	0	55	17	4	5	15	17	124	23	-79	24	-66	10	215995	4	5	50	34	125	23	-74	17	-72	15	217820
ASC CB	0	14	26	4	6	38	50	126	24	76	37	53	11	216578	4	6	53	26	126	24	77	40	50	10	215661
CAR CB	0	14	12	4	6	39	14	126	24	117	81	8	-4	215233	4	6	53	26	126	24	131	84	5	-4	214457
PRE CB	0	14	12	4	6	39	14	126	24	128	72	14	-11	215349	4	6	53	26	126	24	137	75	11	-11	214557
HAW CB	0	14	5	4	6	39	21	125	24	-131	84	-4	-4	215204	4	6	53	26	126	24	-116	82	-8	-4	214473
GTI CB	0	13	54	4	6	39	33	125	23	-67	9	-81	23	218086	4	6	53	26	125	23	-65	6	-83	25	217485
LM-DESCENT STAGE JETTISON *																									
GTI CB	0	0	9	4	6	53	26	125	23	-65	6	-83	25	217485	4	6	53	36	125	23	-65	6	-83	25	217479
ASC CB	0	0	9	4	6	53	26	126	24	77	40	50	10	215661	4	6	53	36	126	24	77	40	49	10	215652
PRE CB	0	0	9	4	6	53	26	126	24	137	75	11	-11	214557	4	6	53	36	126	24	137	75	11	-11	214549
CAR CB	0	0	9	4	6	53	26	126	24	131	84	5	-4	214457	4	6	53	36	126	24	131	84	5	-4	214449
HAW CB	0	0	9	4	6	53	26	126	24	-116	82	-8	-4	214473	4	6	53	36	126	24	-116	81	-8	-4	214465
LM ASCENT RETRO BURN *																									
GTI CB	0	0	3	4	6	53	36	125	23	-65	6	-83	25	217479	4	6	53	38	125	23	-65	6	-83	25	217477
ASC CB	0	0	3	4	6	53	36	126	24	77	40	49	10	215652	4	6	53	38	126	24	77	40	49	10	215649
PRE CB	0	0	3	4	6	53	36	126	24	137	75	11	-11	214549	4	6	53	38	126	24	137	75	11	-11	214547
CAR CB	0	0	3	4	6	53	36	126	24	131	84	5	-4	214449	4	6	53	38	126	24	132	84	5	-4	214446
HAW CB	0	0	3	4	6	53	36	126	24	-116	81	-8	-4	214465	4	6	53	38	126	24	-116	81	-8	-4	214463
COAST TO INSERTION *																									
GTI CB	0	7	5	4	6	53	38	125	23	-65	6	-83	25	217477	4	7	0	44	125	23	-64	5	-84	26	217220
ASC CB	0	9	47	4	6	53	38	126	24	77	40	49	10	215649	4	7	3	26	127	24	78	42	47	9	215132
PRE CB	0	9	47	4	6	53	38	126	24	137	75	11	-11	214547	4	7	3	26	126	23	144	76	9	-11	214105

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CAR CB	0	9	47	4	6	53	38	126	24	132	84	5	-4	214446	4	7	3	26	126	24	149	85	3	-4	214015
HAW CB	0	9	47	4	6	53	38	126	24	-116	81	-6	-4	214463	4	7	3	26	126	24	-110	80	-10	-4	214056
				DELAYS FOR INSERTION BURN																					
ASC CB	0	0	3	4	7	3	26	127	24	78	42	47	9	215132	4	7	3	29	127	24	78	42	47	9	215130
PRE CB	0	0	3	4	7	3	26	126	23	144	76	9	-11	214105	4	7	3	29	126	23	144	76	9	-11	214103
CAR CB	0	0	3	4	7	3	26	126	24	149	85	3	-4	214015	4	7	3	29	126	24	149	85	3	-4	214013
HAW CB	0	0	3	4	7	3	26	126	24	-110	80	-10	-4	214056	4	7	3	29	126	24	-110	80	-10	-4	214056
				INSERTION BURN																					
ASC CB	0	0	16	4	7	3	29	127	24	78	42	47	9	215130	4	7	3	45	127	24	78	42	47	9	215119
PRE CB	0	0	16	4	7	3	29	126	23	144	76	9	-11	214103	4	7	3	45	126	23	144	76	8	-11	214094
CAR CB	0	0	16	4	7	3	29	126	24	149	85	3	-4	214013	4	7	3	45	126	24	149	85	3	-4	214004
HAW CB	0	0	16	4	7	3	29	126	24	-110	80	-10	-4	214056	4	7	3	45	126	24	-110	80	-10	-4	214048
				COAST TO RENDEZVOUS RADAR TRACKING *																					
ASC CB	0	18	0	4	7	3	45	127	24	78	42	47	9	215119	4	7	21	45	127	23	79	46	44	8	214852
PRE CB	0	18	0	4	7	3	45	126	23	144	76	8	-11	214094	4	7	21	45	126	23	159	77	5	-12	213967
CAR CB	0	18	0	4	7	3	45	126	24	149	85	3	-4	214004	4	7	21	45	126	23	-164	85	-1	-4	213956
HAW CB	0	18	0	4	7	3	45	126	24	-110	80	-10	-4	214048	4	7	21	45	126	23	-104	76	-14	-3	213956
				RENDEZVOUS MEAN TRACKING *																					
ASC CB	0	22	55	4	7	21	45	127	23	79	46	44	8	214852	4	7	44	40	127	23	80	51	39	7	215627
PRE CB	0	22	55	4	7	21	45	126	23	159	77	5	-12	213967	4	7	44	40	127	23	-177	78	-1	-12	214931
CAR CB	0	22	55	4	7	21	45	126	23	-164	85	-1	-4	213956	4	7	44	40	127	23	-165	83	-6	-4	214927
HAW CB	0	22	55	4	7	21	45	126	23	-104	76	-14	-3	213956	4	7	44	40	126	23	-99	71	-19	-3	[illegible]
				COAST TO CSI																					
ASC CB	0	2	42	4	7	44	40	127	23	80	51	39	7	215627	4	7	47	22	127	23	80	51	39	6	215742
PRE CB	0	2	56	4	7	44	40	127	23	-177	78	-1	-12	214931	4	7	47	38	127	23	-176	78	-1	-12	214933

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CAR CB	0	2	59	4	7	44	40	127	23	-125	82	-6	-4	214887	4	7	47	39	127	23	-122	82	-7	-4	215043
HAW CB	0	3	6	4	7	44	40	126	23	-99	71	-19	-3	215039	4	7	47	46	126	23	-98	70	-19	-3	215210
				CSI BURN																					
				COAST TO RENDEZVOUS RADAR TRACKING *																					
				RENDEZVOUS RADAR TRACKING *																					
CAR CB	0	11	37	4	8	33	4	126	23	-100	72	-18	-3	215248	4	8	44	41	126	23	-98	70	-20	-3	214685
CYI CB	0	10	1	4	8	34	40	127	23	68	9	81	22	217901	4	8	44	41	128	23	68	11	78	21	217239
ASC CB	0	9	54	4	8	34	47	127	23	81	62	27	4	215385	4	8	44	41	127	23	82	65	25	4	214800
PRE CB	0	9	48	4	8	34	53	126	23	-132	73	-13	-11	215137	4	8	44	41	126	23	-127	72	-15	-11	214643
HAW CB	0	9	42	4	8	34	59	126	23	-91	60	-30	0	215446	4	8	44	41	126	23	-90	58	-32	0	214999
				COAST TO CDH *																					
CYI CB	0	7	60	4	8	44	41	128	23	68	11	78	21	217239	4	8	52	41	128	23	69	13	77	21	216752
ASC CB	0	7	60	4	8	44	41	127	23	82	65	25	4	214800	4	8	52	41	127	23	82	66	23	3	214370
PRE CB	0	7	60	4	8	44	41	126	23	-127	72	-15	-11	214643	4	8	52	41	126	23	-123	70	-17	-11	214281
CAR CB	0	7	60	4	8	44	41	126	23	-98	70	-20	-3	214685	4	8	52	41	126	23	-97	68	-22	-2	214335
HAW CB	0	7	60	4	8	44	41	126	23	-90	58	-32	0	214999	4	8	52	41	126	23	-89	56	-34	1	214668
				CDH BURN *																					
CYI CB	0	0	7	4	8	52	41	128	23	69	13	77	21	216752	4	8	52	48	128	23	69	13	76	21	216745
ASC CB	0	0	7	4	8	52	41	127	23	82	66	23	3	214370	4	8	52	48	127	23	82	66	23	3	214365
PRE CB	0	0	7	4	8	52	41	126	23	-123	70	-17	-11	214281	4	8	52	48	126	23	-123	70	-17	-11	214277
CAR CB	0	0	7	4	8	52	41	126	23	-97	68	-22	-2	214335	4	8	52	48	126	23	-97	68	-22	-2	214330
HAW CB	0	0	7	4	8	52	41	126	23	-89	56	-34	1	214668	4	8	52	48	126	23	-89	56	-34	1	214663
				COAST TO RENDEZVOUS RADAR TRACKING *																					
CYI CB	0	3	60	4	8	52	48	128	23	69	13	76	21	216745	4	8	56	48	128	23	69	13	76	21	216543
ASC CB	0	3	60	4	8	52	48	127	23	82	66	23	3	214365	4	8	56	48	127	23	82	67	23	3	214191
PRE CB	0	3	60	4	8	52	48	126	23	-123	70	-17	-11	214277	4	8	56	48	127	23	-122	70	-17	-10	214136

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA											STATION TERMINATION DATA										
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CAR CB	0	3	60	4	8	52	48	126	23	-97	68	-22	-2	214330	4	8	56	48	126	23	-96	67	-23	-2	214196
HAW CB	0	3	60	4	8	52	48	126	23	-89	56	-34	1	214663	4	8	56	48	126	23	-88	55	-35	1	214538
RENDEZVOUS RADAR TRACKING *																									
CYI CB	0	18	60	4	8	56	48	128	23	69	13	76	21	216543	4	9	15	48	128	23	70	17	71	20	216142
ASC CB	0	18	60	4	8	56	48	127	23	82	67	23	3	214191	4	9	15	48	128	23	82	71	19	2	213933
PRE CB	0	18	60	4	8	56	48	127	23	-122	70	-17	-10	214136	4	9	15	48	127	23	-115	66	-22	-10	214035
CAR CB	0	18	60	4	8	56	48	126	23	-96	67	-23	-2	214196	4	9	15	48	127	23	-94	63	-27	-2	214121
HAW CB	0	18	60	4	8	56	48	126	23	-88	55	-35	1	214538	4	9	15	48	127	23	-87	51	-39	2	214505
COAST TO TP1 *																									
CYI CB	0	13	10	4	9	15	48	128	23	70	17	71	20	216142	4	9	28	59	128	23	70	20	69	19	216423
ASC CB	0	13	10	4	9	15	48	128	23	82	71	19	2	213933	4	9	28	59	128	23	83	74	16	2	214321
PRE CB	0	13	10	4	9	15	48	127	23	-115	66	-22	-10	214035	4	9	28	59	127	23	-111	64	-24	-9	214533
CAR CB	0	13	10	4	9	15	48	127	23	-94	63	-27	-2	214121	4	9	28	59	127	23	-92	60	-30	-1	214636
HAW CB	0	13	10	4	9	15	48	127	23	-87	51	-39	2	214505	4	9	28	59	127	23	-86	48	-42	3	215049
TP1 TO TP2 *																									
CYI CB	0	0	10	4	9	28	59	128	23	70	20	69	19	216423	4	9	29	15	128	23	70	20	69	19	216432
ASC CB	0	0	10	4	9	28	59	128	23	83	74	16	2	214321	4	9	29	15	128	23	83	74	16	2	214333
PRE CB	0	0	10	4	9	28	59	127	23	-111	64	-24	-9	214533	4	9	29	15	127	23	-111	64	-24	-9	214546
CAR CB	0	0	10	4	9	28	59	127	23	-92	60	-30	-1	214636	4	9	29	15	127	23	-92	60	-30	-1	214650
HAW CB	0	0	10	4	9	28	59	127	23	-86	49	-42	3	215049	4	9	29	15	127	23	-86	48	-42	3	215063
COAST TO EST PRANIC GATE *																									
CYI CB	0	14	7	4	9	29	15	128	23	70	20	69	19	216432	4	9	43	22	129	23	70	23	65	18	216979
ASC CB	0	14	25	4	9	29	15	128	23	83	74	16	2	214333	4	9	43	39	128	23	83	77	12	2	215021
PRE CB	0	14	35	4	9	29	15	127	23	-111	64	-24	-9	214546	4	9	43	56	127	23	-107	61	-28	-8	215366

VEHICLE 2 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE		DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
CAR CB	0	14	37	4	9	29	15	127	23	-92	60	-30	-1	214650		4	9	43	52	127	23	-90	57	-33	0	215493
HAW CB	0	14	40	4	9	29	15	127	23	-86	48	-42	3	215063		4	9	43	55	127	23	-84	45	-45	4	215941

COAST TO 2ND BRAKING GATE *

COAST TO 3RD BRAKING GATE *

3RD BRAKING MANEUVER

COAST TO 4TH BRAKING GATE *

4TH BRAKING MANEUVER *

COAST TO 5TH BRAKING GATE *

5TH BRAKING MANEUVER

COAST TO DOCKING *

APS BURN TO DEPLETION

VEHICLE 1 RADAR TABLE

	TRACKING TIME			STATION ACQUISITION DATA												STATION TERMINATION DATA											
	HRS	MIN	SEC	DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE		DAY	HRS	MIN	SEC	RA	DEC	AZ	ELV	X	Y	RANGE
GYM SB	0	45	47	4	13	7	9	128	22	-72	14	-76	18	216112		4	13	52	56	130	22	-68	5	-85	22	218034
GLD BS	1	27	18	4	13	7	9	128	22	-77	21	-31	-66	215708		4	14	34	27	130	21	-67	5	-77	-67	219483
HAW SB	4	3	30	4	13	7	9	129	23	-82	36	-34	5	214081		4	17	10	39	133	21	-70	5	-85	20	224872
CNB BS	5	34	36	4	13	7	9	129	24	16	29	-60	14	215247		4	19	1	45	135	21	-68	5	-80	-60	228817
MAD BS	4	27	18	4	18	3	17	136	23	68	5	-77	67	226732		5	22	30	36	156	11	107	35	23	52	300000
GLD BS	13	4	33	5	2	22	20	143	17	73	5	-74	72	245787		5	15	26	53	151	13	-78	5	-67	-77	280806
CNB BS	17	7	35	5	17	35	52	149	15	68	5	-77	67	267195		5	20	43	27	154	12	-72	5	-75	-71	296270

17 MAY 69 72.1 COAST AFTER APS BURN TO DEPLETION

TABLE 2.0-IX. - MISSION SHADOW TIMELINE

(a) CSM

LIGHTING CONDITION FOR VEH 1

17 MAY 69 72.1 COAST FROM EOI TO TLI

VEH IN SUN LIGHT AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING EARTH PENUMBRA	0	0	32	22.5				
					0	0	0	7.8
VEH ENTERING EARTH UMBRA	0	0	32	30.3				
					0	0	37	11.8
VEH ENTERING EARTH PENUMBRA	0	1	9	42.1				
					0	0	0	8.3
VEH ENTERING SUNLIGHT	0	1	9	50.4				
					0	0	50	39.7
VEH ENTERING EARTH PENUMBRA	0	2	0	30.1				
					0	0	0	7.8
VEH ENTERING EARTH UMBRA	0	2	0	38.0				

17 MAY 69 72.1 COAST FROM TLI TO LOI 1

LIGHTING CONDITION FOR VEH 1

17 MAY 69 72.1 COAST FROM LOI 1 TO LOI 2

VEH IN SUN LIGHT AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING LUNAR PENUMBRA	3	5	12	34.4				
					0	0	0	13.0
VEH ENTERING LUNAR UMBRA	3	5	12	47.4				
					0	0	46	28.1
VEH ENTERING LUNAR PENUMBRA	3	5	59	15.5				
					0	0	0	15.4
VEH ENTERING SUNLIGHT	3	5	59	30.9				
					0	1	21	32.4
VEH ENTERING LUNAR PENUMBRA	3	7	21	3.4				
					0	0	0	14.4
VEH ENTERING LUNAR UMBRA	3	7	21	17.7				
					0	0	46	29.3
VEH ENTERING LUNAR PENUMBRA	3	8	7	47.0				
					0	0	0	12.6
VEH ENTERING SUNLIGHT	3	8	7	59.6				

17 MAY 69 72.1 COAST FROM LOI 2 TO LM SEPARATION

LIGHTING CONDITION FOR VEH 1

17 MAY 69 72.1 COAST FROM TLI TO LOI 1

VEH IN SUN LIGHT AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS

17 MAY 69 72.1 COAST FROM LOI 1 TO LOI 2

LIGHTING CONDITION FOR VEH 1

17 MAY 69 72.1 COAST FROM LOI 2 TO LM SEPARATION

VEH IN SUN LIGHT AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING LUNAR PENUMBRA	3	9	21	58.3				
					0	0	0	10.4
VEH ENTERING LUNAR UMBRA	3	9	22	8.7				
					0	0	46	5.6
VEH ENTERING LUNAR PENUMBRA	3	10	8	14.3				
					0	0	0	10.7
VEH ENTERING SUNLIGHT	3	10	8	25.0				
					0	1	12	16.0
VEH ENTERING LUNAR PENUMBRA	3	11	20	41.0				
					0	0	0	10.2
VEH ENTERING LUNAR UMBRA	3	11	20	51.2				
					0	0	45	59.3
VEH ENTERING LUNAR PENUMBRA	3	12	6	50.5				
					0	0	0	10.6
VEH ENTERING SUNLIGHT	3	12	7	1.2				
					0	1	12	16.5
VEH ENTERING LUNAR PENUMBRA	3	13	19	17.7				
					0	0	0	10.8
VEH ENTERING LUNAR UMBRA	3	13	19	28.5				
					0	0	46	4.8
VEH ENTERING LUNAR PENUMBRA	3	14	5	33.3				
					0	0	0	14.9
VEH ENTERING SUNLIGHT	3	14	5	48.2				

LIGHTING CONDITION FOR VEH 1

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
					0	1	12	3.0
VEH ENTERING LUNAR PENUMBRA	3	15	17	51.3				
					0	0	0	15.1
VEH ENTERING LUNAR UMBRA	3	15	18	6.4				
					0	0	46	4.9
VEH ENTERING LUNAR PENUMBRA	3	16	4	11.3				
					0	0	0	10.8
VEH ENTERING SUNLIGHT	3	16	4	22.1				
					0	1	12	16.4
VEH ENTERING LUNAR PENUMBRA	3	17	16	38.4				
					0	0	0	10.6
VEH ENTERING LUNAR UMBRA	3	17	16	49.1				
					0	0	45	59.2
VEH ENTERING LUNAR PENUMBRA	3	18	2	48.3				
					0	0	0	10.2
VEH ENTERING SUNLIGHT	3	18	2	58.5				
					0	1	12	16.2
VEH ENTERING LUNAR PENUMBRA	3	19	15	14.7				
					0	0	0	10.7
VEH ENTERING LUNAR UMBRA	3	19	15	25.4				
					0	0	46	5.6
VEH ENTERING LUNAR PENUMBRA	3	20	1	31.0				
					0	0	0	10.3
VEH ENTERING SUNLIGHT	3	20	1	41.4				

LIGHTING CONDITION FOR VEH 1

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
					0	1	12	10.7
VEH ENTERING LUNAR PENUMBRA	3	21	13	52.1				
					0	0	0	8.4
VEH ENTERING LUNAR UMBRA	3	21	14	.5				
					0	0	46	7.6
VEH ENTERING LUNAR PENUMBRA	3	22	0	8.1				
					0	0	0	10.9
VEH ENTERING SUNLIGHT	3	22	0	19.0				
					0	1	12	16.5
VEH ENTERING LUNAR PENUMBRA	3	23	12	35.5				
					0	0	0	10.8
VEH ENTERING LUNAR UMBRA	3	23	12	46.3				
					0	0	46	4.3
VEH ENTERING LUNAR PENUMBRA	3	23	58	50.6				
					0	0	0	13.8
VEH ENTERING SUNLIGHT	3	23	59	4.3				
					0	1	12	7.6
VEH ENTERING LUNAR PENUMBRA	4	1	11	12.0				
					0	0	0	10.6
VEH ENTERING LUNAR UMBRA	4	1	11	22.5				
					0	0	46	6.0
VEH ENTERING LUNAR PENUMBRA	4	1	57	28.5				
					0	0	0	10.5
VEH ENTERING SUNLIGHT	4	1	57	39.0				

17 MAY 69 72.1 COAST FROM LM SEP TO LM JETTISON

LIGHTING CONDITION FOR VEH 1

17 MAY 69 72.1 COAST FROM LM SEP TO LM JETTISON

VEH IN SUN LIGHT AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING LUNAR PENUMBRA	4	3	9	52.8				
					0	0	0	10.7
VEH ENTERING LUNAR UMBRA	4	3	10	3.6				
					0	0	46	5.4
VEH ENTERING LUNAR PENUMBRA	4	3	56	9.0				
					0	0	0	3.5
VEH ENTERING SUNLIGHT	4	3	56	12.5				
					0	1	12	16.7
VEH ENTERING LUNAR PENUMBRA	4	5	8	29.2				
					0	0	0	10.6
VEH ENTERING LUNAR UMBRA	4	5	8	39.8				
					0	0	46	5.0
VEH ENTERING LUNAR PENUMBRA	4	5	54	44.8				
					0	0	0	10.4
VEH ENTERING SUNLIGHT	4	5	54	55.2				
					0	1	12	13.5
VEH ENTERING LUNAR PENUMBRA	4	7	7	8.7				
					0	0	0	8.3
VEH ENTERING LUNAR UMBRA	4	7	7	17.0				
					0	0	46	4.4
VEH ENTERING LUNAR PENUMBRA	4	7	53	21.4				
					0	0	0	10.9
VEH ENTERING SUNLIGHT	4	7	53	32.3				

LIGHTING CONDITION FOR VEH 1

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
					0	1	12	17.5
VEH ENTERING LUNAR PENUMBRA	4	9	5	49.8				
					0	0	0	10.8
VEH ENTERING LUNAR UMBRA	4	9	6	.6				
					0	0	46	2.1
VEH ENTERING LUNAR PENUMBRA	4	9	52	2.8				
					0	0	0	11.9
VEH ENTERING SUNLIGHT	4	9	52	14.6				
					0	1	12	11.9
VEH ENTERING LUNAR PENUMBRA	4	11	4	26.6				
					0	0	0	10.5
VEH ENTERING LUNAR UMBRA	4	11	4	37.1				
					0	0	46	5.1
VEH ENTERING LUNAR PENUMBRA	4	11	50	42.1				
					0	0	0	10.5
VEH ENTERING SUNLIGHT	4	11	50	52.7				

17 MAY 69 72.1 COAST FROM LM JETTISON TO TEI

LIGHTING CONDITION FOR VEH 1

17 MAY 69 72.1 COAST FROM LM JETTISON TO TEI

VEH IN SUN LIGHT AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING LUNAR PENUMBRA	4	13	3	10.9				
					0	0	0	10.7
VEH ENTERING LUNAR UMBRA	4	13	3	21.6				
					0	0	46	6.3
VEH ENTERING LUNAR PENUMBRA	4	13	49	27.9				
					0	0	0	2.9
VEH ENTERING SUNLIGHT	4	13	49	30.8				
					0	1	12	16.4
VEH ENTERING LUNAR PENUMBRA	4	15	1	47.2				
					0	0	0	10.6
VEH ENTERING LUNAR UMBRA	4	15	1	57.8				
					0	0	46	5.3
VEH ENTERING LUNAR PENUMBRA	4	15	48	3.1				
					0	0	0	10.4
VEH ENTERING SUNLIGHT	4	15	48	13.5				
					0	1	12	12.9
VEH ENTERING LUNAR PENUMBRA	4	17	0	26.4				
					0	0	0	8.3
VEH ENTERING LUNAR UMBRA	4	17	0	34.8				
					0	0	46	5.0
VEH ENTERING LUNAR PENUMBRA	4	17	46	39.8				
					0	0	0	10.9
VEH ENTERING SUNLIGHT	4	17	46	50.7				

LIGHTING CONDITION FOR VEH 1

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
					0	1	12	17.1
VEH ENTERING LUNAR PENUMBRA	4	18	59	7.8				
					0	0	0	10.8
VEH ENTERING LUNAR UMBRA	4	18	59	18.6				
					0	0	46	2.1
VEH ENTERING LUNAR PENUMBRA	4	19	45	20.7				
					0	0	0	12.8
VEH ENTERING SUNLIGHT	4	19	45	33.5				
					0	1	12	11.0
VEH ENTERING LUNAR PENUMBRA	4	20	57	44.5				
					0	0	0	10.5
VEH ENTERING LUNAR UMBRA	4	20	57	55.1				
					0	0	46	5.4
VEH ENTERING LUNAR PENUMBRA	4	21	44	.5				
					0	0	0	10.5
VEH ENTERING SUNLIGHT	4	21	44	11.0				
					0	1	12	9.6
VEH ENTERING LUNAR PENUMBRA	4	22	56	20.6				
					0	0	0	14.0
VEH ENTERING LUNAR UMBRA	4	22	56	34.6				
					0	0	46	2.1
VEH ENTERING LUNAR PENUMBRA	4	23	42	36.7				
					0	0	0	10.8
VEH ENTERING SUNLIGHT	4	23	42	47.5				

LIGHTING CONDITION FOR VEH 1

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
					0	1	12	17.1
VEH ENTERING LUNAR PENUMBRA	5	0	55	4.6				
					0	0	0	10.9
VEH ENTERING LUNAR UMBRA	5	0	55	15.5				
					0	0	46	6.4
VEH ENTERING LUNAR PENUMBRA	5	1	41	21.9				
					0	0	0	8.3
VEH ENTERING SUNLIGHT	5	1	41	30.2				
					0	1	12	11.9
VEH ENTERING LUNAR PENUMBRA	5	2	53	42.1				
					0	0	0	10.4
VEH ENTERING LUNAR UMBRA	5	2	53	52.5				
					0	0	46	5.2
VEH ENTERING LUNAR PENUMBRA	5	3	39	57.7				
					0	0	0	10.7
VEH ENTERING SUNLIGHT	5	3	40	8.3				
					0	1	12	16.4
VEH ENTERING LUNAR PENUMBRA	5	4	52	24.7				
					0	0	0	1.8
VEH ENTERING LUNAR UMBRA	5	4	52	26.5				
					0	0	46	7.3
VEH ENTERING LUNAR PENUMBRA	5	5	38	33.8				
					0	0	0	10.6
VEH ENTERING SUNLIGHT	5	5	38	44.5				

LIGHTING CONDITION FOR VEH 1

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
					0	1	12	17.1
VEH ENTERING LUNAR PENUMBRA	5	6	51	1.5				
					0	0	0	10.8
VEH ENTERING LUNAR UMBRA	5	6	51	12.3				
					0	0	46	4.2
VEH ENTERING LUNAR PENUMBRA	5	7	37	16.6				
					0	0	0	14.6
VEH ENTERING SUNLIGHT	5	7	37	31.1				

17 MAY 69 72.1 COAST FROM TEI TO ENTRY

LIGHTING CONDITION FOR VEH 1

17 MAY 69 72.1 COAST FROM TEI TO ENTRY

VEH IN SUN LIGHT AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING EARTH PENUMBRA	7	22	56	54.1				
					0	0	0	12.9
VEH ENTERING EARTH UMBRA	7	22	57	7.1				

TABLE 2.0-IX. - MISSION SHADOW TIMELINE - Concluded

(b) LM

LIGHTING CONDITION FOR VEH 2

RENDEZVOUS RADAR TRACKING •

LUNAR PENUMBRA VEH EN AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING LUNAR UMBRA	4	3	9	57.5				

COAST TO DOI BURN •

ULLAGE FOR DOI BURN

DOI BURN

RENDEZVOUS RADAR TRACKING •

LIGHTING CONDITION FOR VEH 2

RENDEZVOUS RADAR TRACKING •

LUNAR PENUMBRA VEH EN AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING SUNLIGHT	4	3	56	18.6				

COAST TO PHASE MANEUVER

LIGHTING CONDITION FOR VEH 2

COAST TO PHASE MANEUVER

LUNAR PENUMBRA VEH EN AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING LUNAR UMBRA	4	5	1	36.0				

ULLAGE FOR PHASING BURN

PHASING BURN

COAST AT BURN ATTITUDE •

COAST TO JETTISON DESCENT STAGE

LIGHTING CONDITION FOR VEH 2

COAST TO JETTISON DESCENT STAGE

LUNAR PENUMBRA VEH EN AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS HRS MINS SECS
VEH ENTERING SUNLIGHT	4	5	48	50.5	

LM-DESCENT STAGE JETTISON •

LM ASCENT RETRO BURN •

COAST TO INSERTION •

ULLAGE FOR INSERTION BURN

INSERTION BURN

COAST TO RENDEZVOUS RADAR TRACKING •

LIGHTING CONDITION FOR VEH 2

COAST TO RENDEZVOUS RADAR TRACKING •

LUNAR PENUMBRA VEH EN AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS HRS MINS SECS
VEH ENTERING LUNAR UMBRA	4	7	8	20.7	

RENDEZVOUS RADAR TRACKING •

COAST TO CSI

CSI BURN

COAST TO RENDEZVOUS RADAR TRACKING •

LIGHTING CONDITION FOR VEH 2

COAST TO RENDEZVOUS RADAR TRACKING •

LUNAR PENUMBRA VEH EN AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS HRS MINS SECS
VEH ENTERING SUNLIGHT	4	7	57	8.1	

RENDEZVOUS RADAR TRACKING •

COAST TO CDH •

CDH BURN •

COAST TO RENDEZVOUS RADAR TRACKING •

RENDEZVOUS RADAR TRACKING •

LIGHTING CONDITION FOR VEH 2

RENDEZVOUS RADAR TRACKING •

LUNAR PENUMBRA VEH EN AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING LUNAR UMBRA	4	9	6	11.3				
COAST TO TPI			•					
TPI BURN		•						
COAST TO 1ST BRAKING GATE				•				

LIGHTING CONDITION FOR VEH 2

COAST TO 1ST BRAKING GATE •

LUNAR PENUMBRA VEH EN AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING SUNLIGHT	4	9	52	37.4				
COAST TO 2ND BRAKING GATE				•				
COAST TO 3RD BRAKING GATE				•				
1ST BRAKING MANEUVER			•					
COAST TO 4TH BRAKING GATE				•				
2ND BRAKING MANEUVER			•					
COAST TO 5TH BRAKING GATE				•				
3RD BRAKING MANEUVER			•					
COAST TO DOCKING			•					

LIGHTING CONDITION

27 MAY 69 72.1 COAST AFTER APS BURN TO DEPLETION

VEH IN LUNAR UMBRA AT PHASE INITIATION

	DAYS	HRS	MINS	SECS	TIME SPENT IN REGION DAYS	HRS	MINS	SECS
VEH ENTERING LUNAR PENUMBRA	4	13	37	43.9				
					[illegible]	[illegible]	[illegible]	21.4
VEH ENTERING SUNLIGHT	4	14	33	5.2				

TABLE 5.5-I.- SUMMARY OF EVENTS FROM TLI CUTOFF THROUGH LOX DUMP

Time from TLI ignition[a]	Time from TB-7 sec[b]	Event	ΔV, fps	Comments
	0	Hold cutoff attitude		
	20	Command and hold local horizontal		
	900	Initiate maneuver to separation attitude		
	1200	Freeze separation attitude inertially		Latest time for maneuver to be completed
1800	1500	Begin SC separation/SLA jettison	0.8	
1835	1535	Null 0.3 fps separation rate	.3	-X RCS
1840	1540	Pitch 180° (SC)		1.5/deg/sec
1960	1660	Null pitch Start roll 60°		.5 deg/sec
2080	1780	Null 0.5 fps separation rate and initiate 1 fps closing rate	1.5	+X RCS
2230	1930	Null 1 fps closing rate	1	-X RCS
2235	1935	Begin dock		Estimated worst case dock completed by TLI plus 1.5 hr
5700	5400	LM/CSM undock from S-IVB	1.6	Spring ejection and 5 sec -X RCS
5800	5500	Maneuver to evasive maneuver attitude		Pitch down 75° with respect to local horizontal 0.5 deg/sec rates
6300	6600	Begin SPS evasive maneuver	20	SPS between 1:35 and 1:50 after TLI
7500	7200	Receive ground command to start TB-8		Earliest possible time to initiate TB-8
7505	7205	Start maneuver to LOX dump attitude		Local horizontal attitude pitch = 194° yaw = 0° roll = 180°
8220	7920	Initiate LOI dump	120	

[a]The SC maneuver times will be referenced to TLI ignition, the LV maneuvers to TB-7.

[b]The times of the SC maneuvers referenced to TB-7 (column 2) are approximate and based on a 300-second TLI burn time. These times will change as TLI burn time changes.

TABLE 5.7-I.- TARGET LOAD FOR LOI-1

[Propulsion system: SPS, guidance: external ΔV]

(a) Target

t_{IG}, hr:min:sec, g.e.t.	76:08:17.58
ΔV_X, fps	-2864.9
ΔV_Y, fps	43.7
ΔV_Z, fps	-92.0
Weight, lb	93 133

(b) REFSMMAT

$$\begin{bmatrix} 0.93365762 & -0.34652012 & -0.090594013 \\ -0.07075493 & -0.42639754 & 0.90176432 \\ -0.35110853 & -0.83552915 & -0.42262731 \end{bmatrix}$$

(c) Gimbal angles at t_{IG}

IGA, deg	221
MGA, deg	0
OGA, deg	0

TABLE 5.8-I.- TARGET LOAD FOR LOI-2

[Propulsion system: SPS, guidance: external ΔV]

(a) Target

t_{IG}, hr:min:sec, g.e.t.	80:32:11.97
ΔV_X, fps	-137.5
ΔV_Y, fps	0.0
ΔV_Z, fps	-4.0
Weight, lb	70 162

(b) REFSMMAT

$$\begin{bmatrix} 0.93365762 & -0.34652012 & -0.090594013 \\ -0.07075493 & -0.42639754 & 0.90176432 \\ -0.35110853 & -0.83552915 & -0.42262731 \end{bmatrix}$$

(c) Gimbal angles at t_{IG}

IGA, deg	210
MGA, deg	359
OGA, deg	360

TABLE 5.11-I.- RENDEZVOUS SEQUENCE OF EVENTS

Event	Time of ignition, hr:min:sec, g.e.t.	Δt from previous maneuver, min	Main propulsion system	ΔV, fps	Burn duration, sec	Yaw from velocity vector, deg	Pitch from local horizontal, deg	RCS thruster usage	h_a/h_p, n. mi.	Longitude of burn ignition, deg E
DOI	99:54:12.0	58.4	DPS 15 sec @ 10% 12.7 sec @ 40%	72.8	27.7	180.0	-1.6	+X, 2-jet	57.4/7.9	231.5
Phasing	101:06:34.9	72.4	DPS 26 sec @ 10% 16 sec @ 92.5%	193.5	42.0	0.0	26.1	+X. 2-jet	194.4/9.8	0.3
LM ascent descent } staging	102:53:26.5	106.9	RCS	2.0	9.4	0.0	0.0	+X, 2-jet	195.4/9.2	65.1
LM ascent sep } staging	102:53:35.9	.2	RCS	2.0	2.6	0.0	180.0	+X, 2-jet	193.8/9.0	64.6
Insertion	103:03:29.2	9.9	APS	213.3	15.5	0.0	152.6	+X, 2-jet	43.6/9.8	31.3
CSI	103:54:39.9	51.2	RCS	50.5	32.1	0.0	0.0	+X, 4-jet	46.2/42.9	228.2
CDH	104:52:41.1	58.0	RCS	5.8	7.3	0.0	-90.0	+Z, 2-jet	46.2/47.9	47.6
TPI	105:28:59.2	36.3	RCS	25.3	16.0	0.0	27.8	+X, 4-jet	61.8/42.4	294.9
First braking	106:08:35.4	39.6	RCS	16.1	20.4	0.2	-152.5	-Z, 2-jet	60.5/49.6	172.4
Second braking	106:14:10.0	5.6	RCS	9.7	12.2	0.0	-134.5	-Z, 2-jet	60.3/54.8	155.5
Third braking	106:16:26.0	2.3	RCS	4.5	5.7	0.0	-126.0	-Z, 2-jet	60.5/57.3	148.6

TABLE 5.11-II.- TARGET LOADS FOR DOI MANEUVER

[Propulsion system: LM DPS]

(a) Target

t_{IG}, hr:min:sec, g.e.t.	99:54:12.0
ΔV_x, fps	-72.77
ΔV_y, fps	0.0
ΔV_z, fps	2.24
Weight, lb	31 214.5

(b) REFSMMAT

$$\begin{bmatrix} X_{SM} \\ Y_{SM} \\ Z_{SM} \end{bmatrix} = \begin{bmatrix} .93365762 & -.34652012 & -.090594013 \\ -.07075492 & -.42639752 & .90176434 \\ -.35110854 & -.83552916 & -.42262729 \end{bmatrix} \begin{bmatrix} X_I \\ Y_I \\ Z_I \end{bmatrix}_{MNBY}$$

(c) Gimbal angles at t_{IG}

IGA, deg	-71.5
MGA, deg	-0.3
OGA, deg	0.1

TABLE 5.11-III.- TARGET LOADS FOR PHASING MANEUVER

[Propulsion system: LM DPS]

(a) Target

t_{IG}, hr:min:sec, g.e.t.	101:06:34.9
ΔV_x, fps	173.02
ΔV_y, fps	0.0
ΔV_z, fps	-86.62
Weight, lb	30 952.1

(b) REFSMMAT

$$\begin{bmatrix} X_{SM} \\ Y_{SM} \\ Z_{SM} \end{bmatrix} = \begin{bmatrix} .93365762 & -.34652012 & -.090594013 \\ -.07075492 & -.42639752 & .90176434 \\ -.35110854 & -.83552916 & -.42262729 \end{bmatrix} \begin{bmatrix} X_I \\ Y_I \\ Z_I \end{bmatrix}_{MNBY}$$

(c) Gimbal angles at t_{IG}

IGA, deg	-97.8
MGA, deg	-0.3
OGA, deg	0.0

TABLE 5.11-IV.- TARGET LOADS FOR INSERTION MANEUVER

[Propulsion system: LM APS]

(a) Target

t_{IG}, hr:min:sec, g.e.t.	103:03:29.2
ΔV_x, fps	-190.11
ΔV_y, fps	0.0
ΔV_z, fps	-96.70
Weight, lb	8380.1

(b) REFSMMAT

$$\begin{bmatrix} X_{SM} \\ Y_{SM} \\ Z_{SM} \end{bmatrix} = \begin{bmatrix} .93365762 & -.34652012 & -.090594013 \\ -.07075492 & -.42639752 & .90176434 \\ -.35110854 & -.83552916 & -.42262729 \end{bmatrix} \begin{bmatrix} X_I \\ Y_I \\ Z_I \end{bmatrix}_{MNBY}$$

(c) Gimbal angles at t_{IG}

IGA, deg	61.0
MGA, deg	0.3
OGA, deg	-180.0

TABLE 5.11-V.- TARGET LOADS FOR CSI MANEUVER

[Propulsion system: LM RCS]

(a) Target

t_{IG}, hr:min:sec, g.e.t.	103:54:39.9
ΔV_x, fps	50.32
ΔV_y, fps	0.0
ΔV_z, fps	0.0
Weight, lb	8202.9

(b) REFSMMAT

$$\begin{bmatrix} X_{SM} \\ Y_{SM} \\ Z_{SM} \end{bmatrix} = \begin{bmatrix} .93365762 & -.34652012 & -.090594013 \\ -.07075492 & -.42639752 & .90176434 \\ -.35110854 & -.83552916 & -.42262729 \end{bmatrix} \begin{bmatrix} X_I \\ Y_I \\ Z_I \end{bmatrix}_{MNBY}$$

(c) Gimbal angles at t_{IG}

IGA, deg	105.8
MGA, deg	0.3
OGA, deg	-0.1

TABLE 5.11-VI.- TARGET LOADS FOR CDH MANEUVER

[Propulsion system: LM RCS]

(a) Target

t_{IG}, hr:min:sec, g.e.t.	104:52:41.1
ΔV_x, fps	-0.7
ΔV_y, fps	0.0
ΔV_z, fps	5.78
Weight, lb	8155.9

(b) REFSMMAT

$$\begin{bmatrix} X_{SM} \\ Y_{SM} \\ Z_{SM} \end{bmatrix} = \begin{bmatrix} .93365762 & -.34652012 & -.090594013 \\ -.07075492 & -.42639752 & .90176434 \\ -.35110854 & -.83552916 & -.42262729 \end{bmatrix} \begin{bmatrix} X_I \\ Y_I \\ Z_I \end{bmatrix}_{MNBY}$$

(c) Gimbal angles at t_{IG}

IGA, deg	-74.3
MGA, deg	-0.3
OGA, deg	0.1

TABLE 5.11-VII.- TARGET LOADS FOR TPI MANEUVER

[Propulsion system: LM RCS]

(a) Target

t_{IG}, hr:min:sec, g.e.t.	105:28:59.2
ΔV_x, fps	22.0
ΔV_y, fps	0.0
ΔV_z, fps	-11.3
Weight, lb	8150.6

(b) REFSMMAT

$$\begin{bmatrix} X_{SM} \\ Y_{SM} \\ Z_{SM} \end{bmatrix} = \begin{bmatrix} .93365762 & -.34652012 & -.090594013 \\ -.07075492 & -.42639752 & .90176434 \\ -.35110854 & -.83552916 & -.42262729 \end{bmatrix} \begin{bmatrix} X_I \\ Y_I \\ Z_I \end{bmatrix}_{MNBY}$$

(c) Gimbal angles at t_{IG}

IGA, deg	-159.1
MGA, deg	-0.2
OGA, deg	-0.3

TABLE 5.14-I.- TARGET LOAD FOR TEI

[Propulsion system: SPS, guidance: external ΔV]

(a) Target

t_{IG}, hr:min:sec, g.e.t.	127:51:34.78
ΔV_X, fps	3238.9
ΔV_Y, fps	-263.0
ΔV_Z, fps	94.7
Weight, lb	37 858

(b) REFSMMAT

$$\begin{bmatrix} 0.93365762 & -0.34652012 & -0.090594013 \\ -0.07075493 & -0.42639754 & 0.90176432 \\ -0.35110853 & -0.83552915 & -0.42262731 \end{bmatrix}$$

(c) Gimbal angles at t_{IG}

IGA, deg	50
MGA, deg	357
OGA, deg	180

TABLE 5.16-I.- ENTRY EVENTS SEQUENCE

Event	Time from lift-off, hr:min:sec	Time from 400 000 ft, min:sec
Entry	191:18:16	0:00
Enter S-band communication blackout	191:18:42	0:26
Enter C-band communication blackout, load factor = 0.05 g	191:18:46	:30
Maximum heating rate	191:19:26	1:10
Guidance initiate at R-DOT = -700 fps	191:19:34	1:18
Maximum load factor (FIRST)	191:19:38	1:22
Exit C-band communication blackout	191:21:20	3:04
Exit S-band communication blackout	191:21:46	3:30
Maximum load factor (SECOND)	191:24:12	5:56
Termination of CMC guidance	191:25:44	7:28
Drogues parachute deployment	191:26:48	8:32
Main parachutes deployment	191:27:36	9:20
Splashdown	191:32:35	14:19

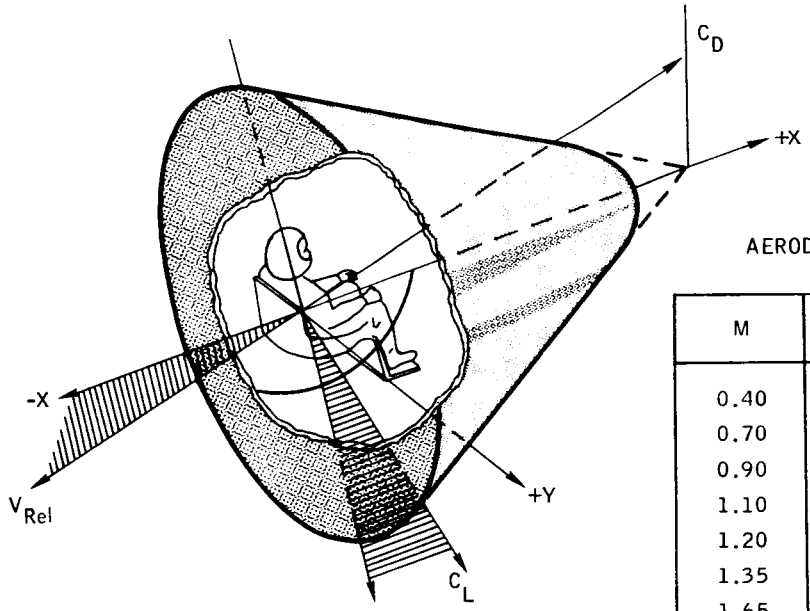
TABLE 5.16-II.- COMMAND MODULE MASS PROPERTIES

CM weight	
Entry, lb	12 121.5
Main chute deployment, lb	11 564.7
Splashdown, lb	10 902.5
Center of gravity in Apollo coordinate system	
X_A, in.	1040.9
Y_A, in.	-0.2
Z_A, in.	5.8
Moment of inertia	
I_{XX}, slug-ft^2	5824
I_{YY}, slug-ft^2	4826
I_{ZZ}, slug-ft^2	4757
Product of inertia	
I_{XY}, slug-ft^2	44
I_{XZ}, slug-ft^2	-427
I_{YZ}, slug-ft^2	3

TABLE 5.16-III.- CONDITIONS AT ENTRY INTERFACE AND TARGET POINT

Elapsed time from launch, hr:min:sec	191:18:16
Inertial velocity, fps	36 210
Inertial flight-path angle, deg	-6.49
Inertial azimuth, deg	98.56
Spacecraft geodetic latitude, deg S	-18.315
Spacecraft longitude, deg E	171.29
Altitude, ft	399 720
Target geodetic latitude, deg S	20.25
Target longitude, deg W	165

TABLE 5.16-IV.- COMMAND MODULE AERODYNAMIC COEFFICIENTS



AERODYNAMIC COEFFICIENTS AT TRIM ANGLE OF ATTACK AS A FUNCTION OF MACH NUMBER

M	α, deg	C_L	C_D	L/D
0.40	167.65	0.23383	0.85483	0.27354
0.70	165.02	0.25607	0.98916	0.25883
0.90	162.33	0.31169	1.0702	0.29124
1.10	155.72	0.48038	1.17980	0.40717
1.20	155.88	0.46683	1.16510	0.40068
1.35	154.73	0.54943	1.28750	0.42674
1.65	153.92	0.54083	1.27440	0.42438
2.00	153.87	0.52576	1.28610	0.40880
2.40	154.42	0.49990	1.2561	0.39797
3.00	154.87	0.47178	1.2322	0.38288
4.00	156.77	0.43416	1.22680	0.35389
10.00	157.40	0.42158	1.23690	0.34084
29.50	160.70	0.37898	1.3014	0.29121

Center of gravity location in body coordinates

X_{cg} = 1040.90 in.

Y_{cg} = -0.20 in.

Z_{cg} = 5.80 in.

TABLE 5.16-V.- ENTRY REFSMMAT AND GIMBAL ANGLES AT EI

(a) REFSMMAT

$$\begin{bmatrix} .89680623 & .41920909 & -.14142961 \\ -.25520260 & .22903267 & -.93936982 \\ -.36140037 & .87852591 & .31238118 \end{bmatrix}$$

(b) Gimbal angles

IGA, deg	156
MGA, deg	0
OGA, deg	0

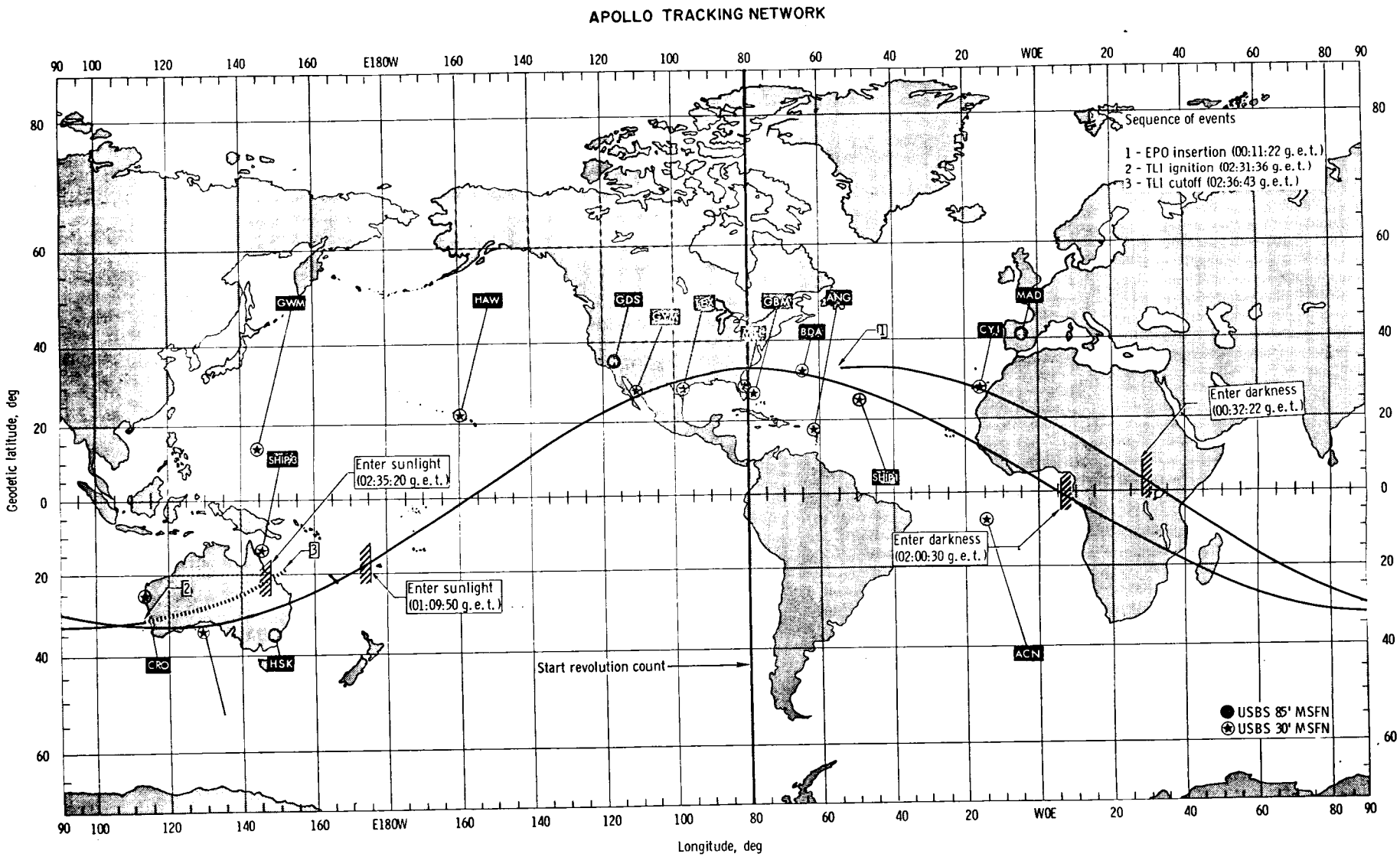


Figure 5.2-1. - Mission groundtracks - earth parking orbit.

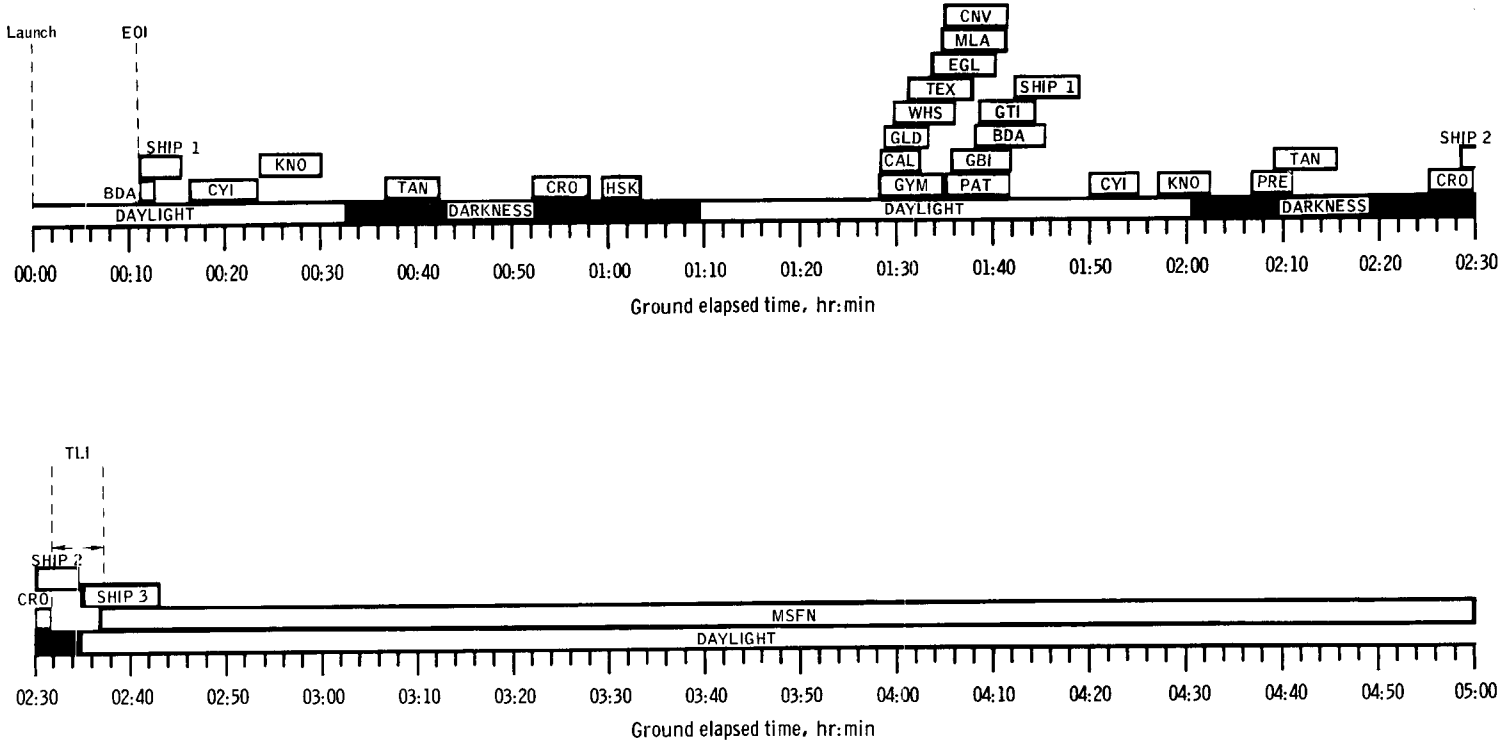


Figure 5.3-1. - Tracking, lighting, and mission events summary from lift-off to 5 hours.

APOLLO TRACKING NETWORK

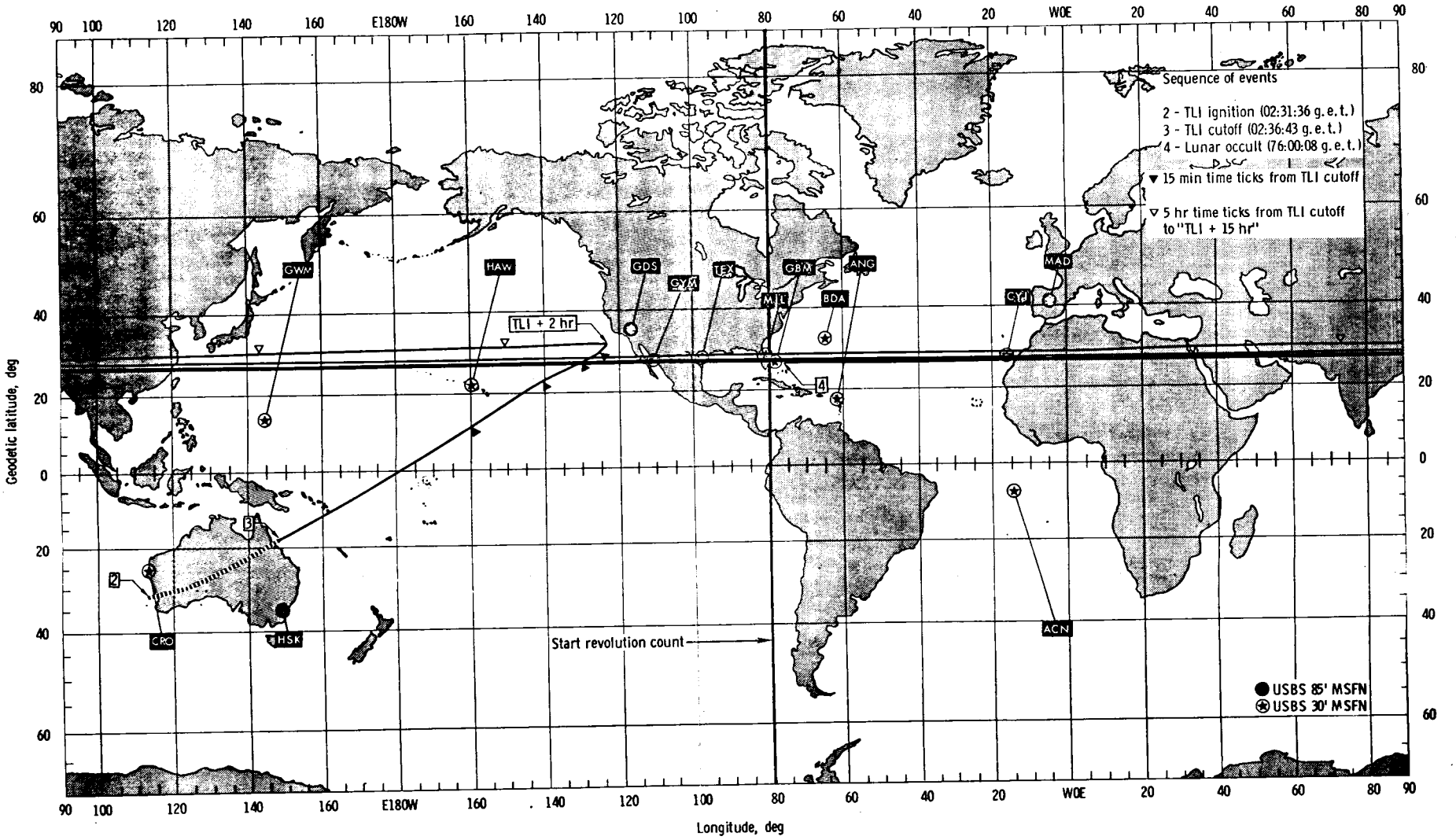


Figure 5.6-1. - Mission groundtracks - translunar coast.

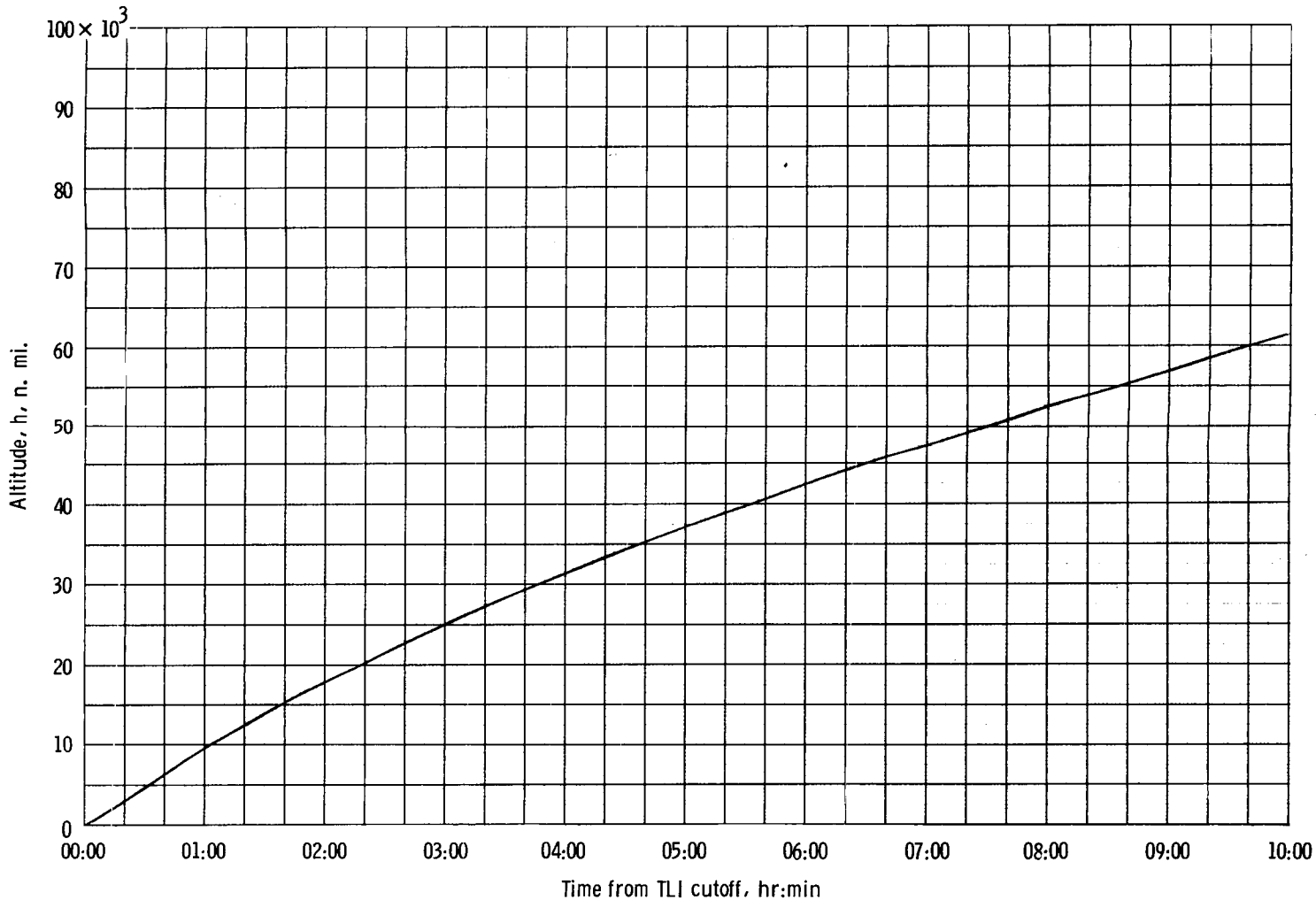


Figure 5.6-2. - Time history of altitude for first 10 hours of translunar coast phase.

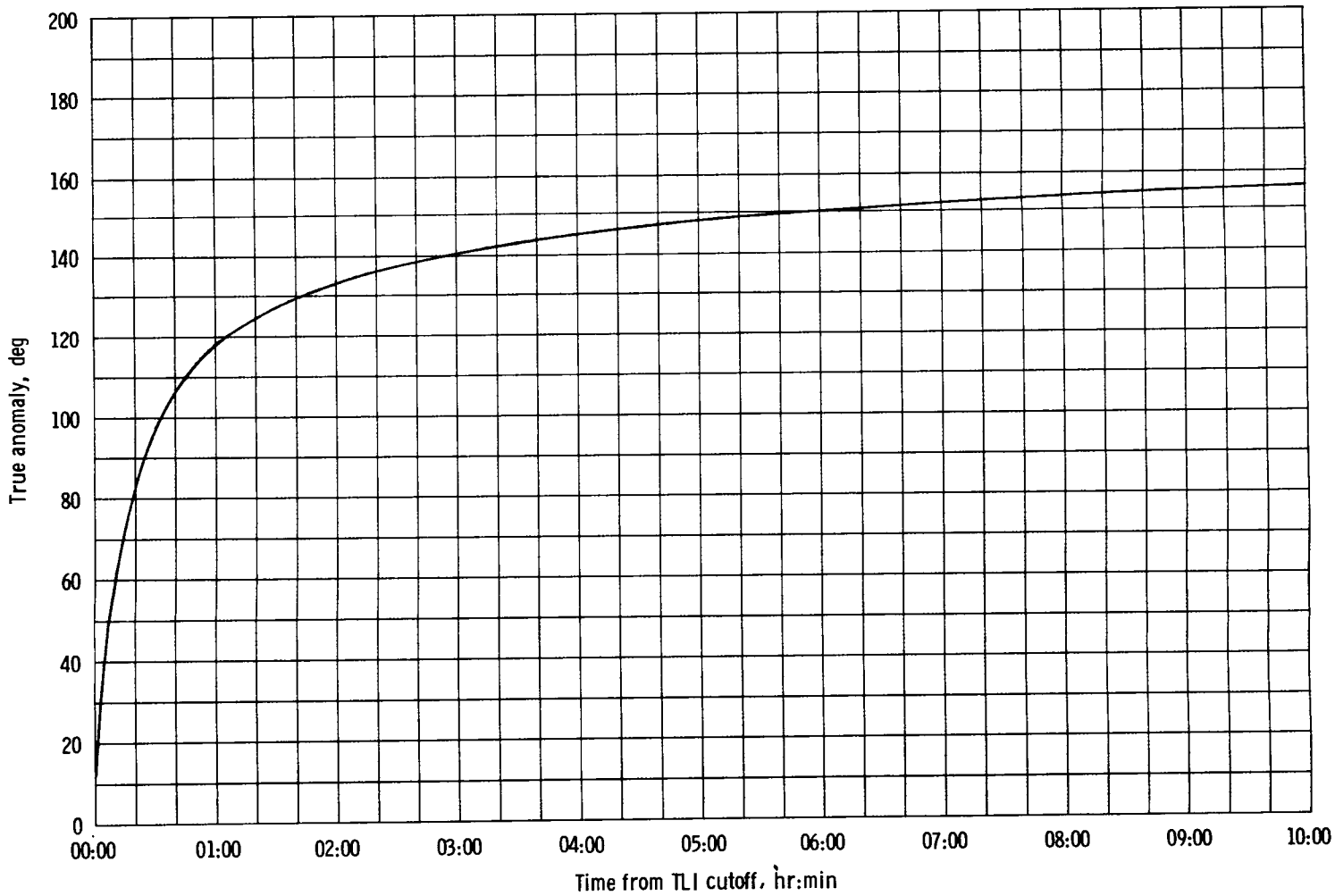


Figure 5.6-3. - Time history of true anomaly for first 10 hours of translunar coast.

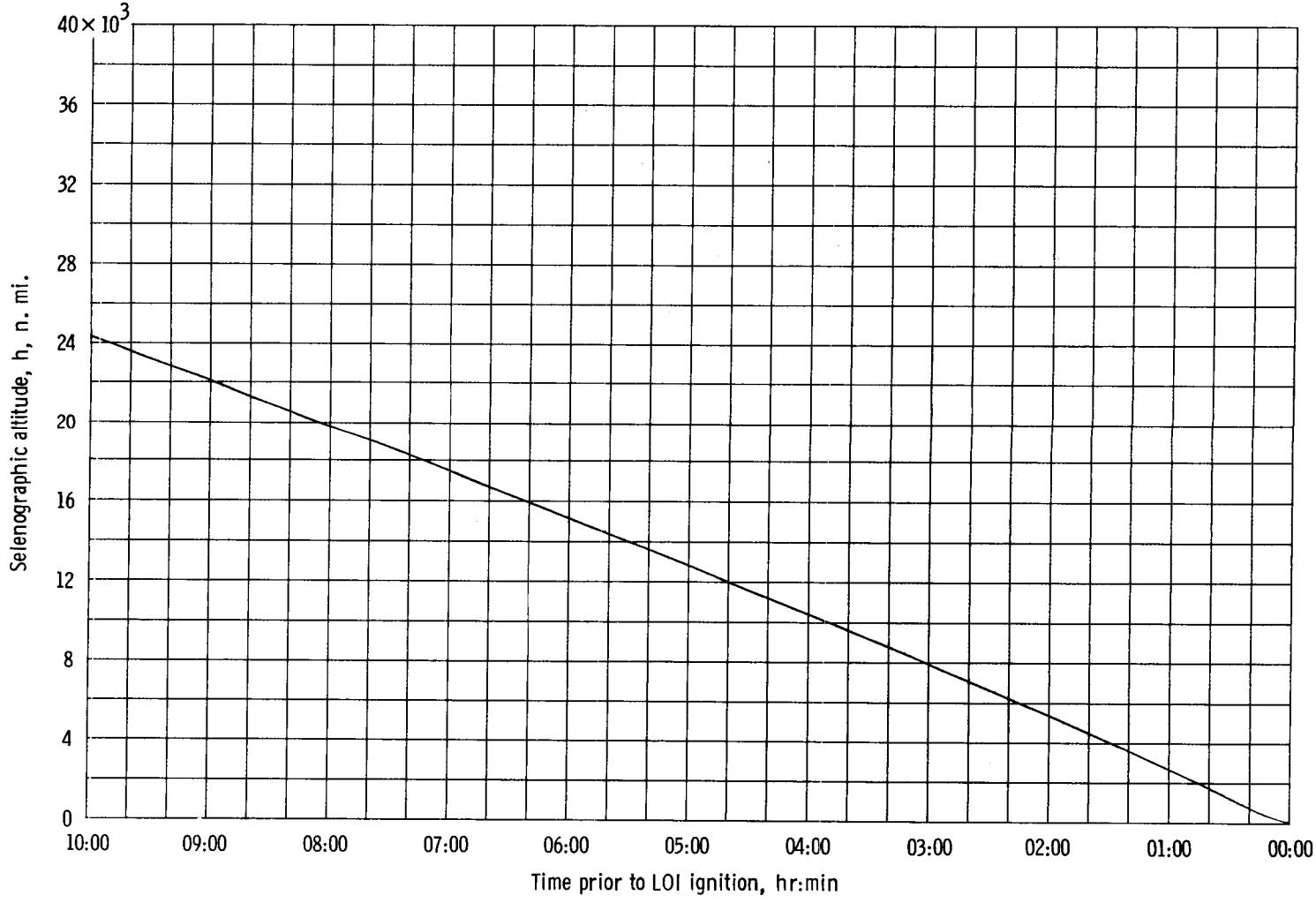
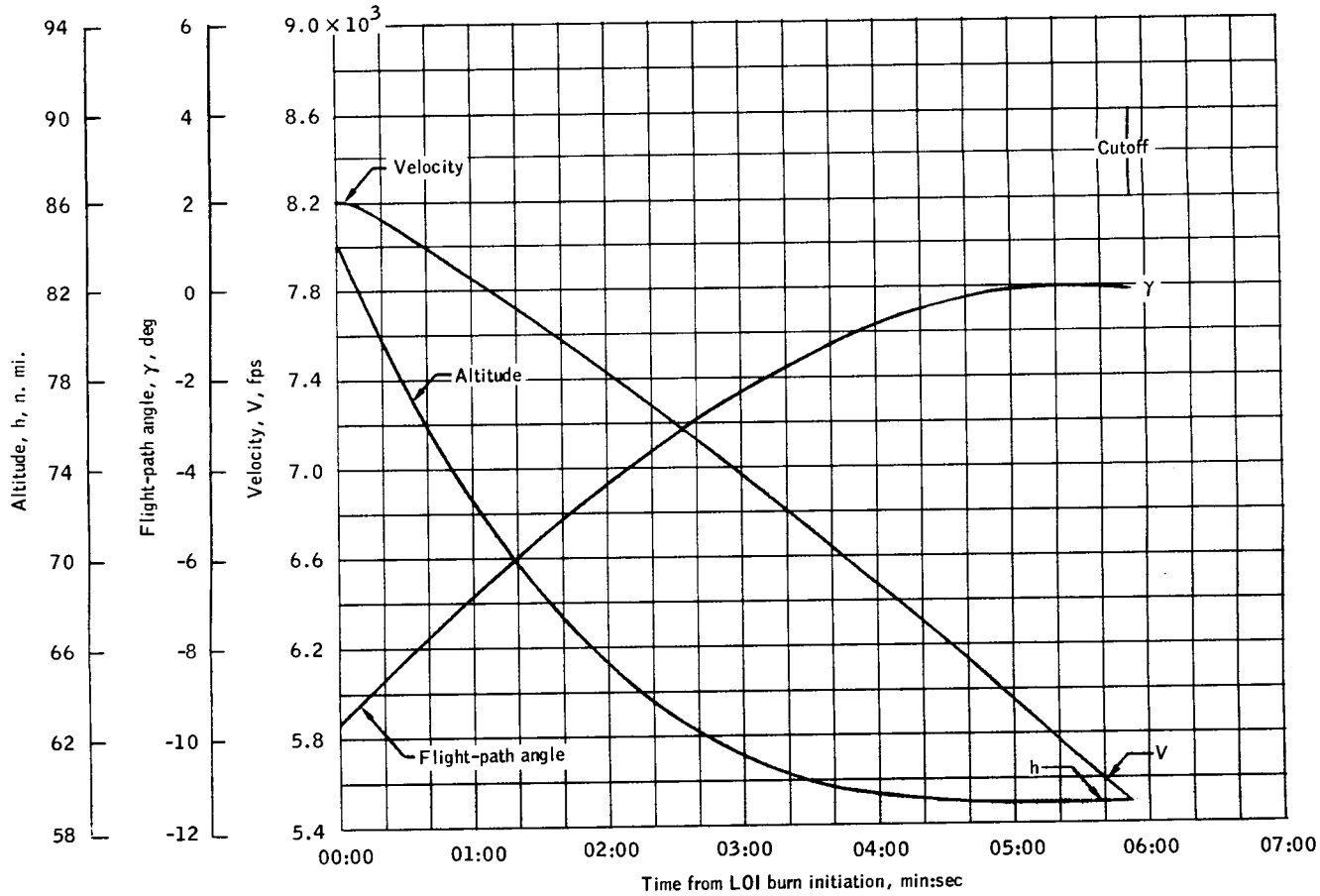
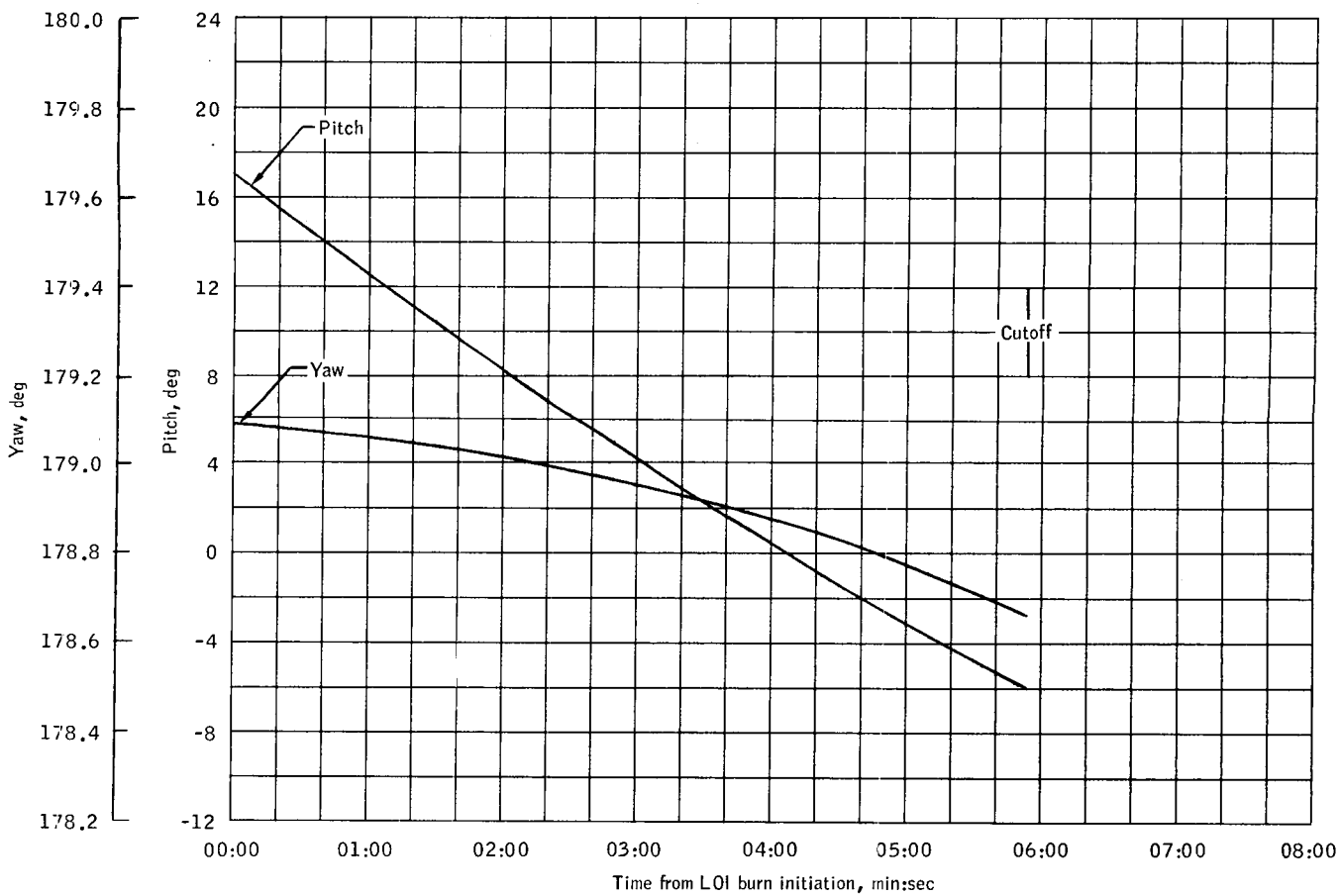


Figure 5.6-4. - Time history of altitude 10 hours prior to LOI ignition.



(a) Velocity, flight-path angle, and altitude versus time from LOI burn initiation.

Figure 5.7-1.- Time history of trajectory parameters for LOI phase.



(b) Local horizontal pitch and yaw versus time from LOI burn initiation.

Figure 5.7-1.- Concluded.

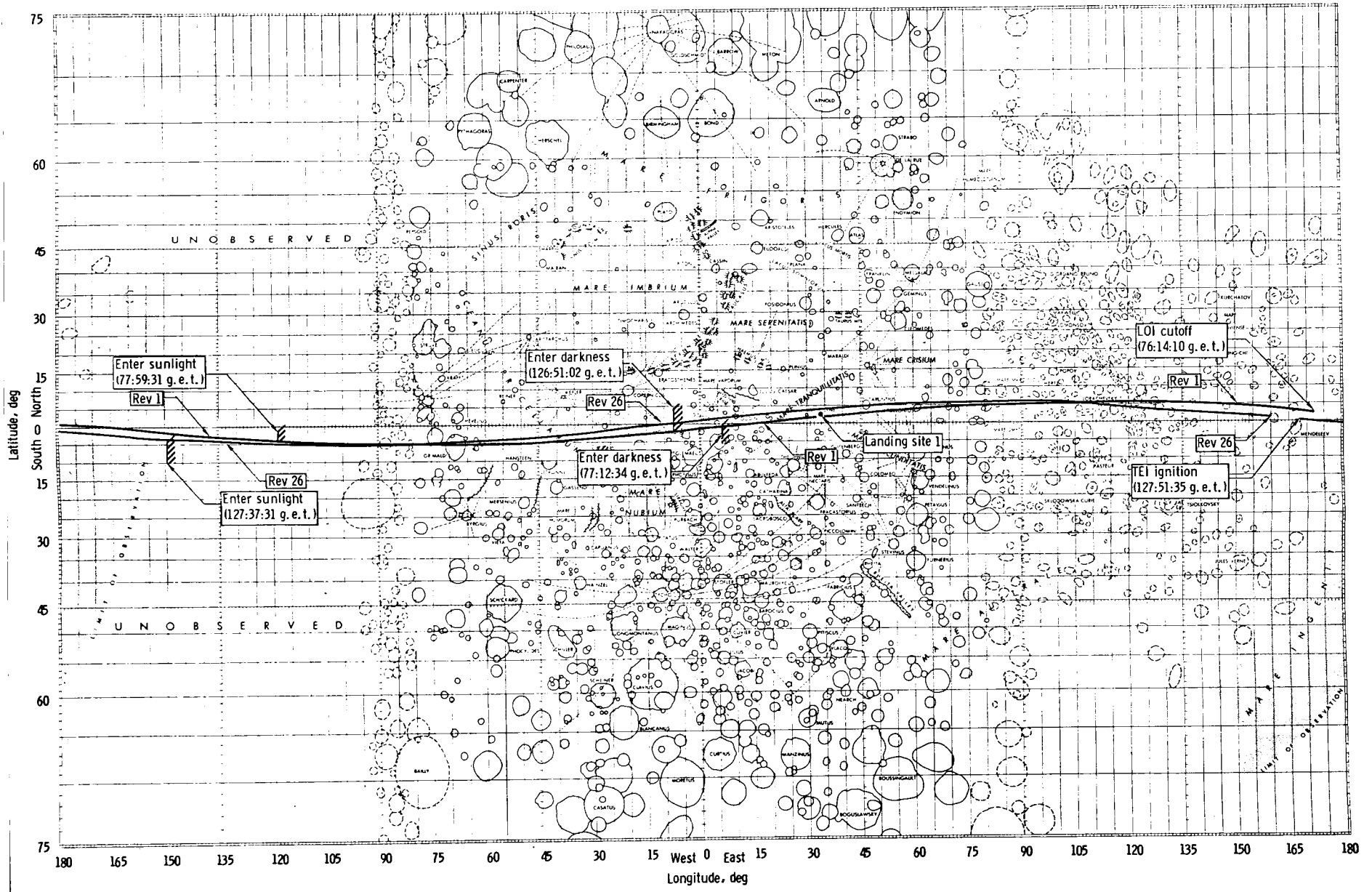
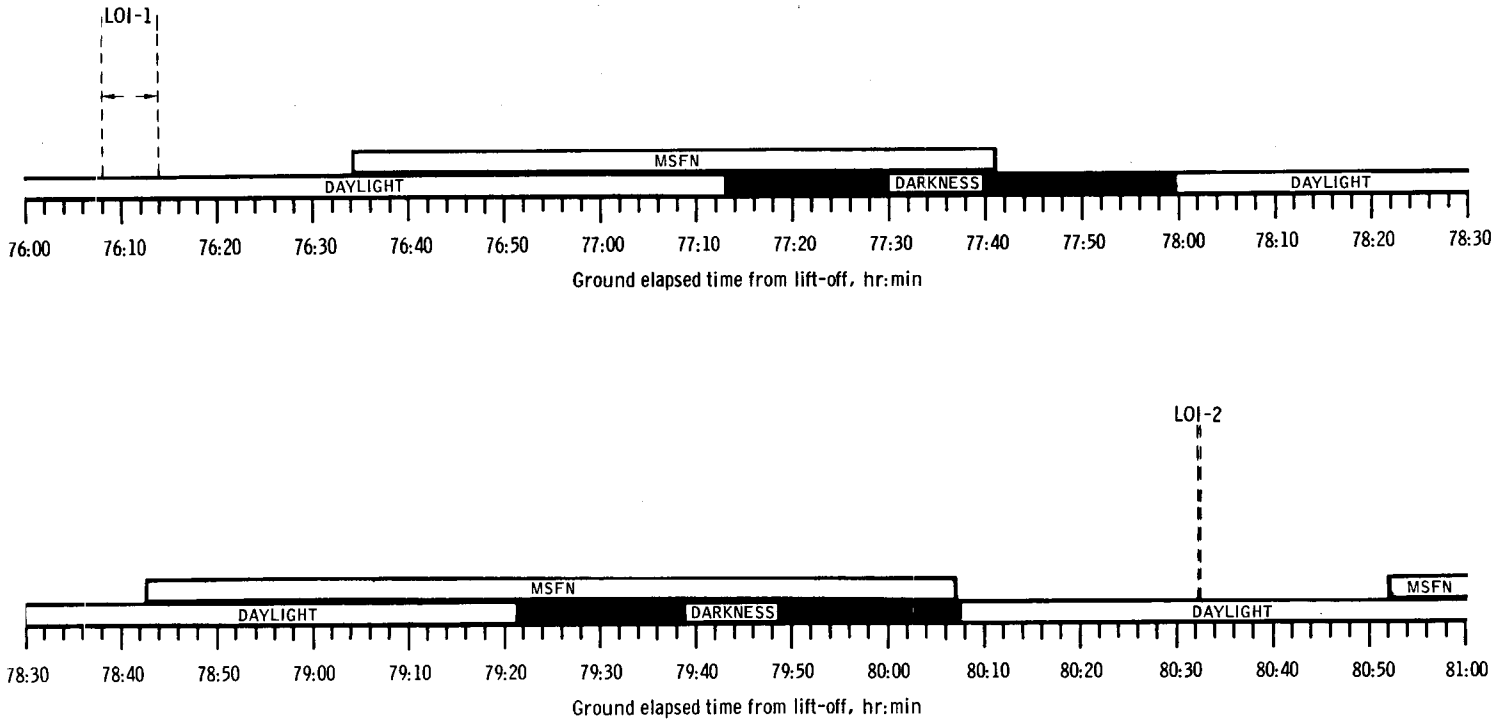
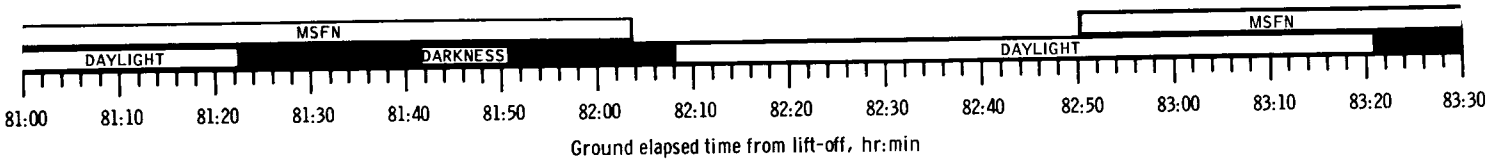


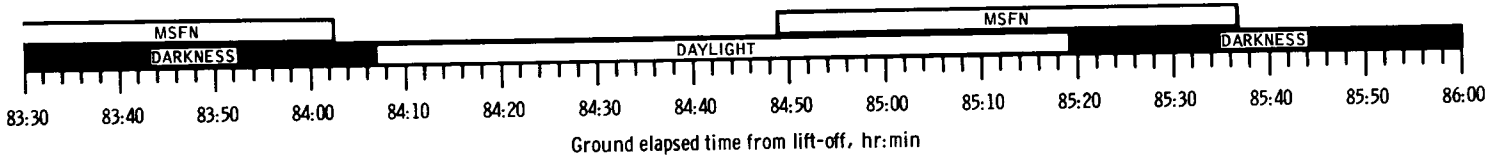
Figure 5.9-1. - Mission groundtracks - lunar parking orbit.



(a) 76 hours to 81 hours.

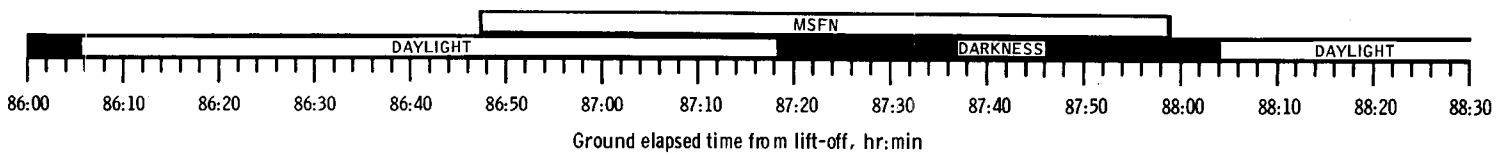
Figure 5.9-2. - Tracking, lighting, and mission events summary for lunar orbit phase for CSM.

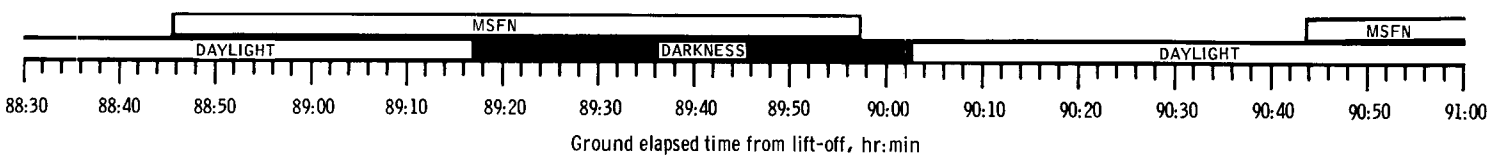




(b) 81 hours to 86 hours.

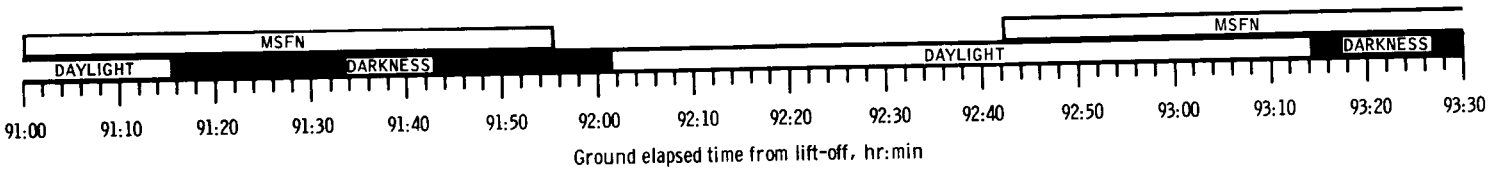
Figure 5.9-2. - Continued.

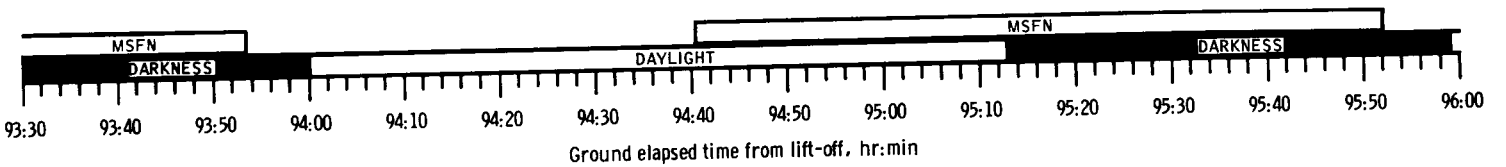




(c) 86 hours to 91 hours.

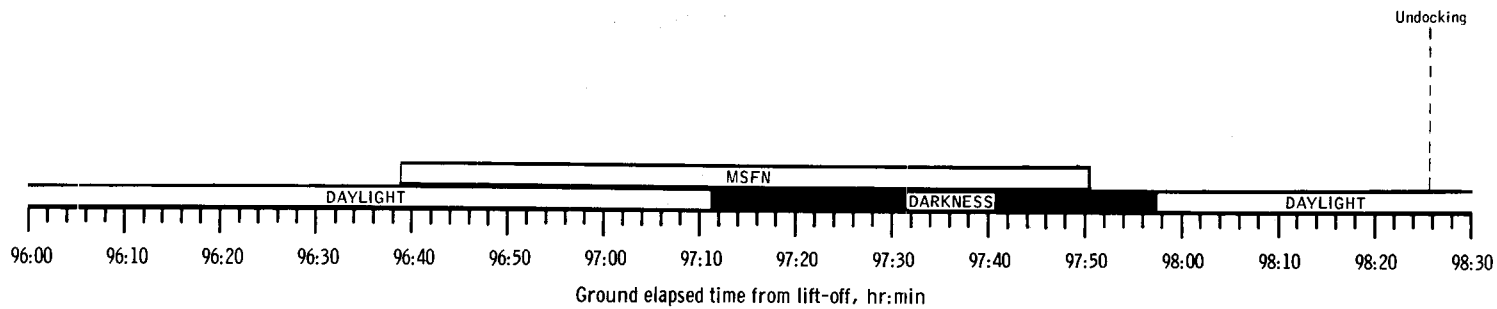
Figure 5.9-2. - Continued.

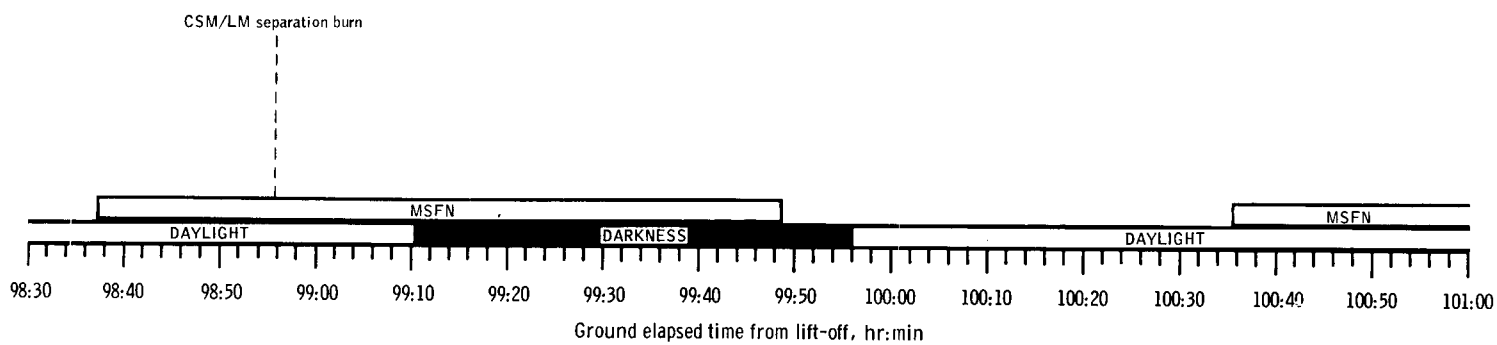




(d) 91 hours to 96 hours.

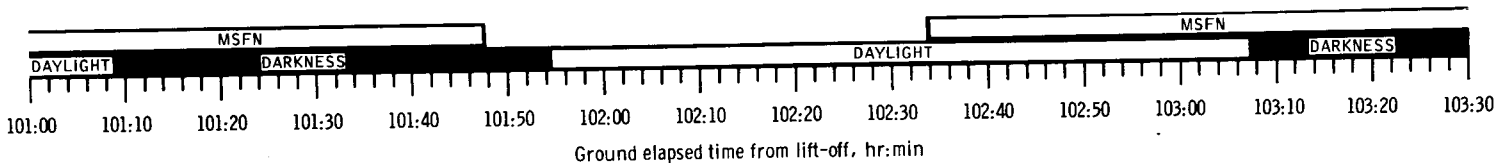
Figure 5.9-2. - Continued.

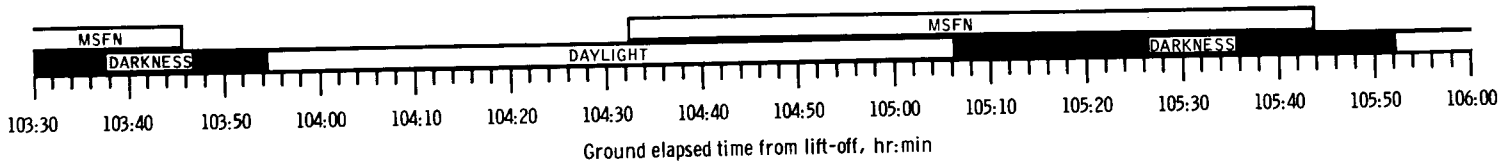




(e) 96 hours to 101 hours.

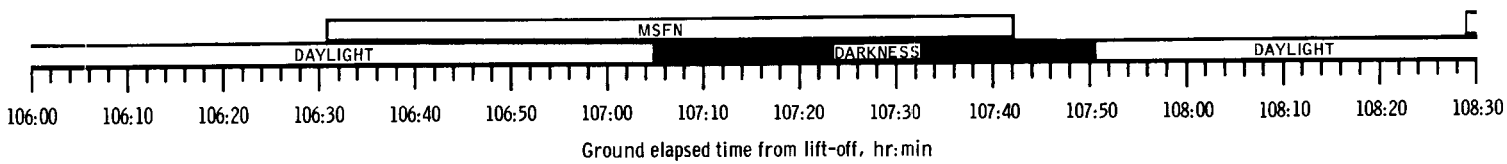
Figure 5.9-2. - Continued.

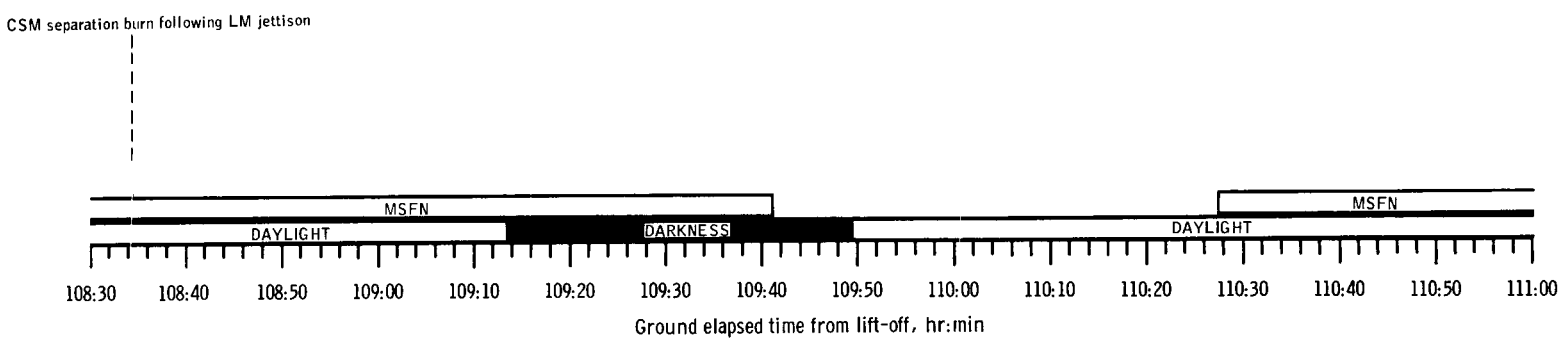




(f) 101 hours to 106 hours.

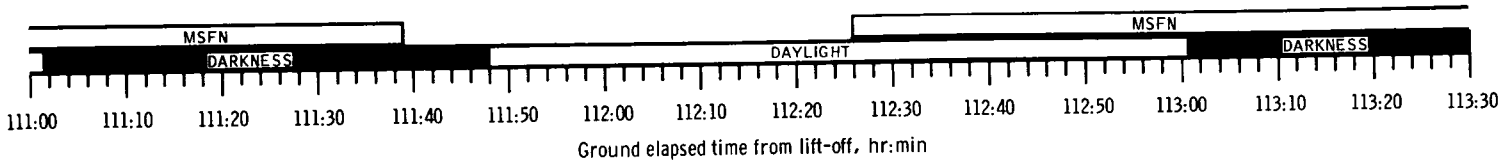
Figure 5.9-2. - Continued.

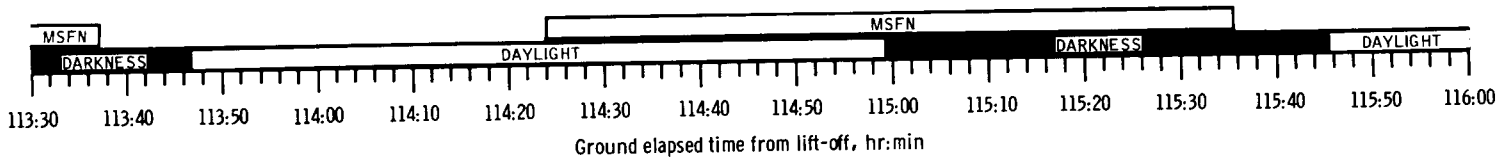




(g) 106 hours to 111 hours.

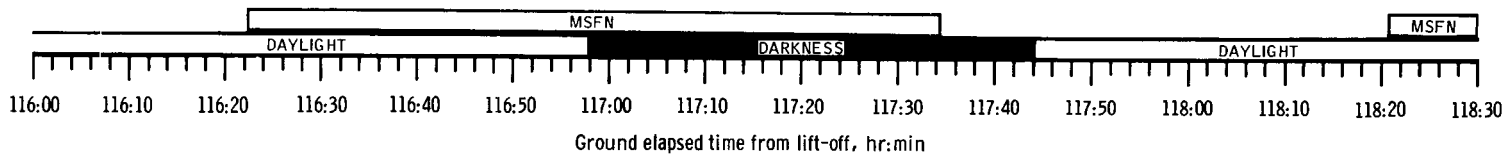
Figure 5.9-2. - Continued.

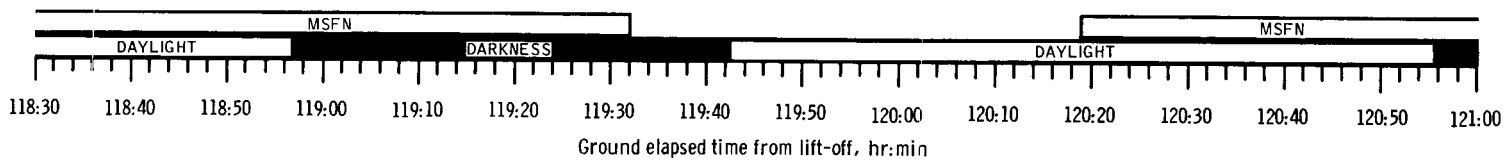




(h) 111 hours to 116 hours.

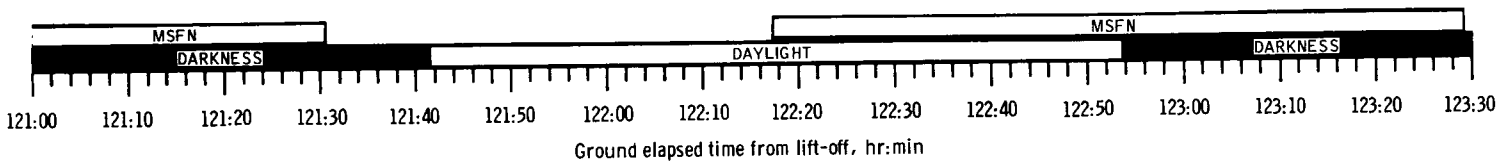
Figure 5.9-2. - Continued.

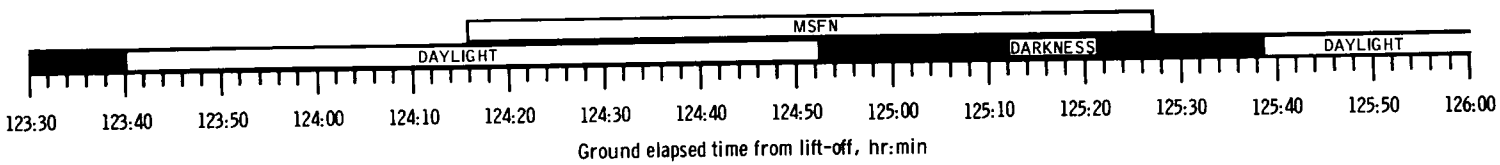




(i) 116 hours to 121 hours.

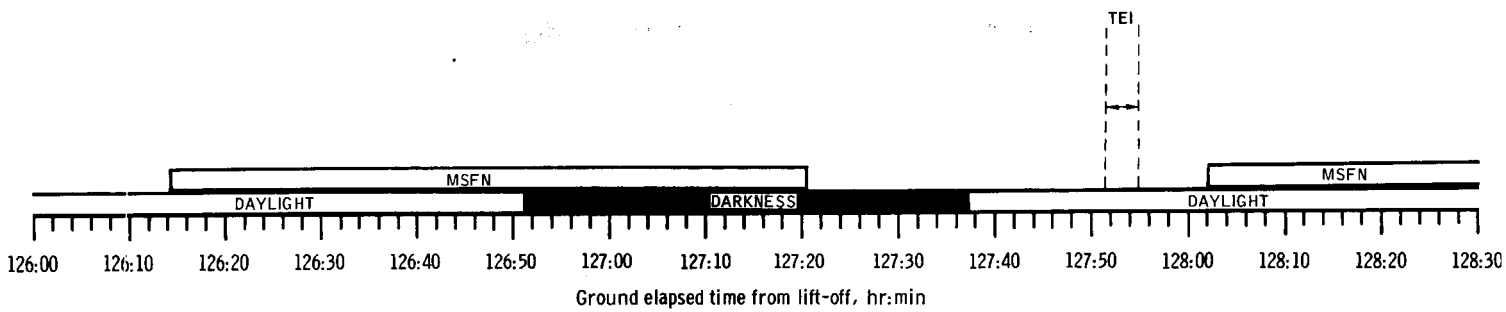
Figure 5.9-2. - Continued.

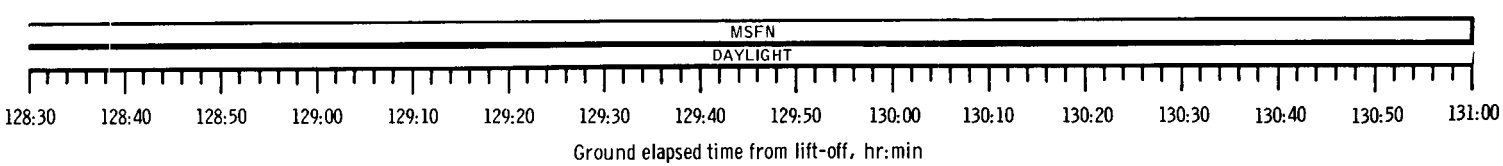




(j) 121 hours to 126 hours.

Figure 5.9-2. - Continued.





(k) 126 hours to 131 hours.

Figure 5.9-2. - Concluded.

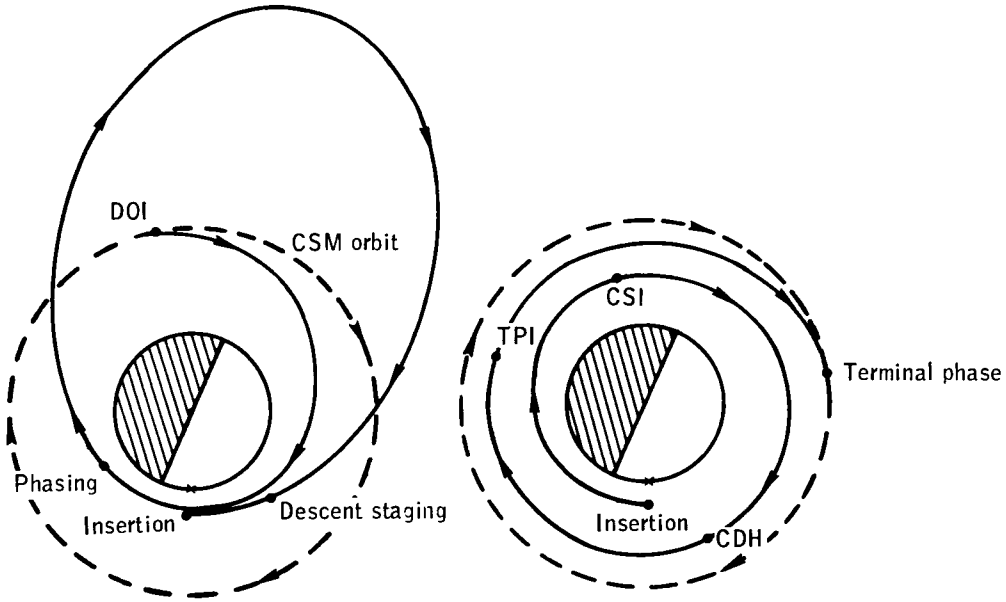


Figure 5.11-1.- F mission nominal rendezvous.

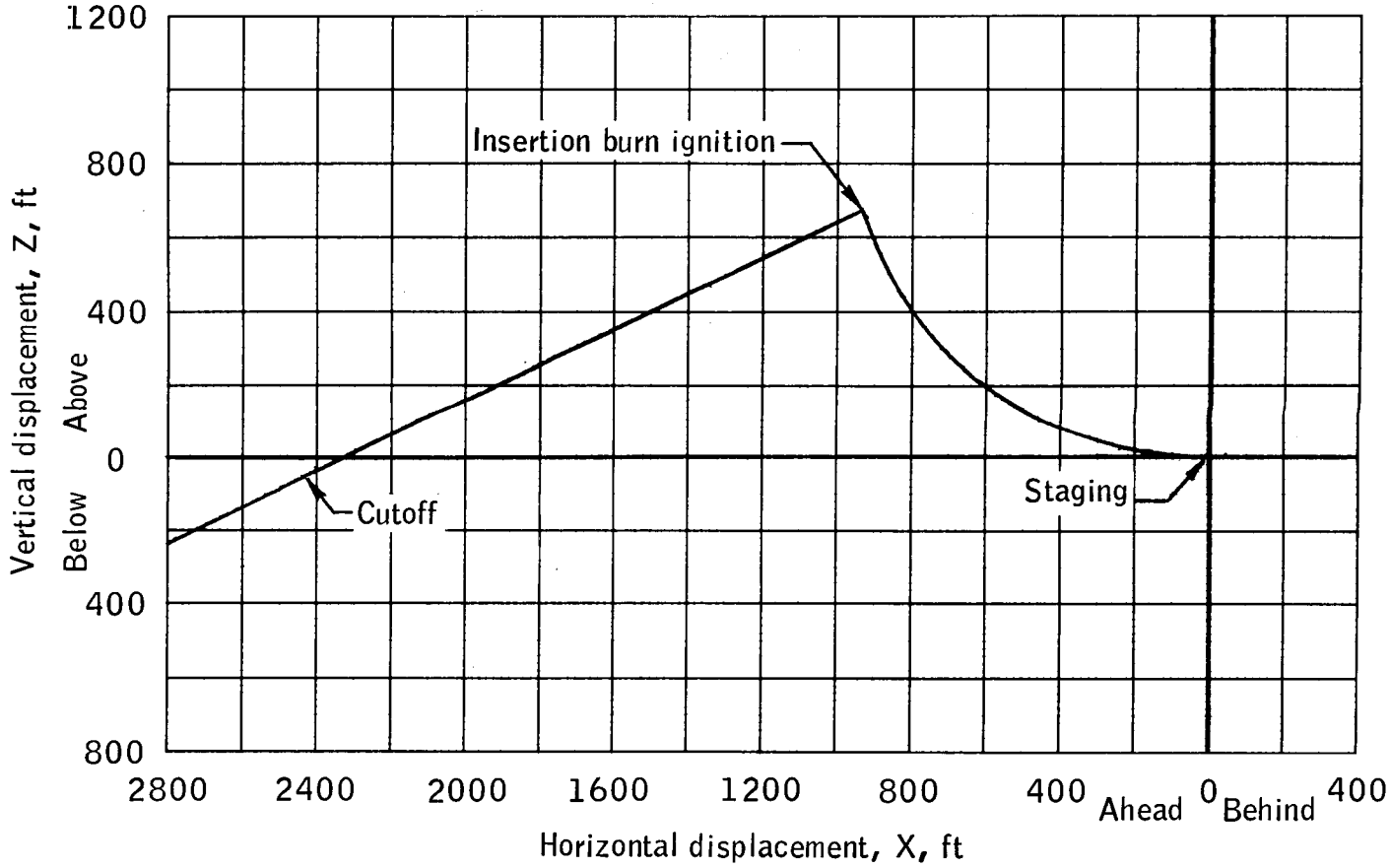
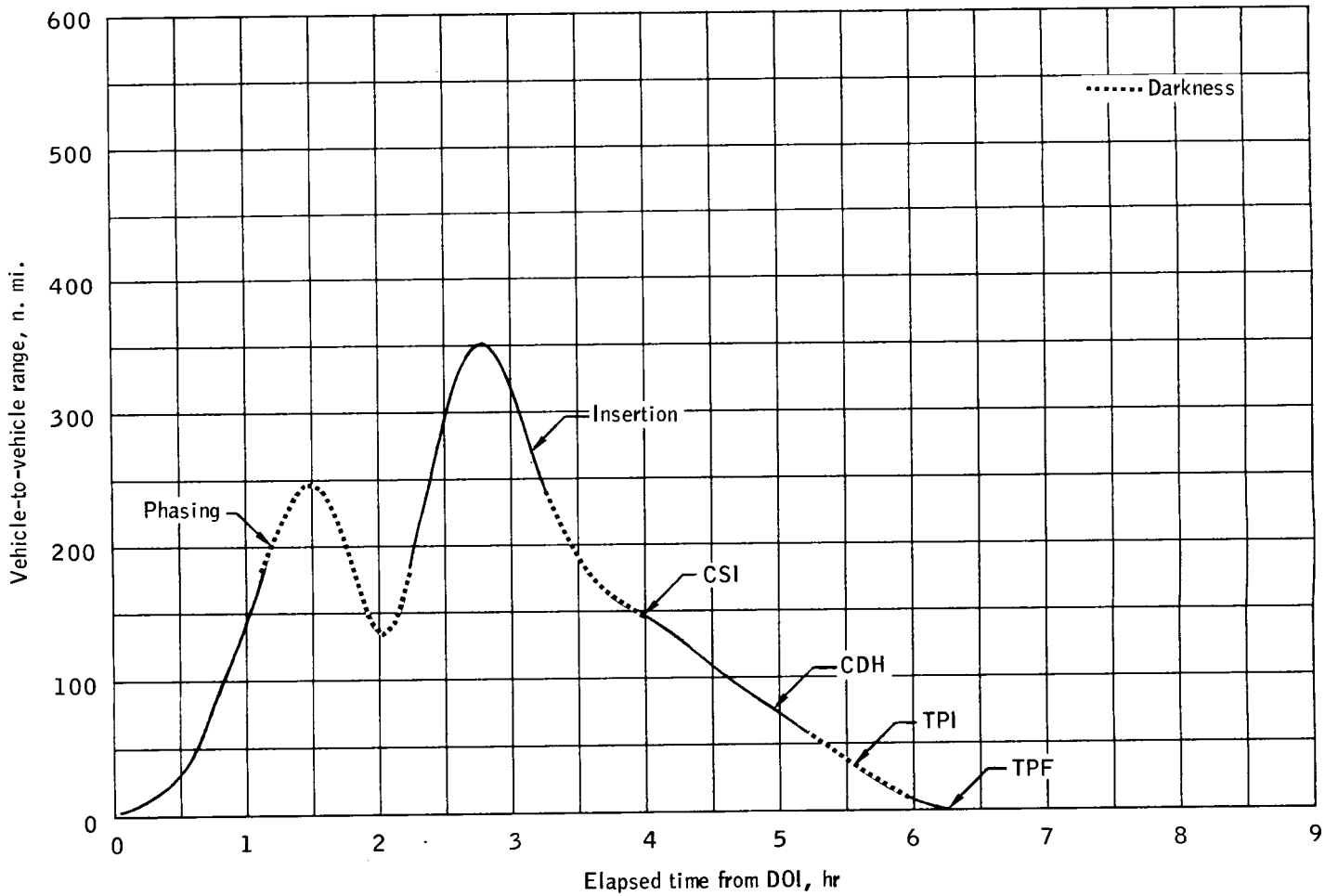
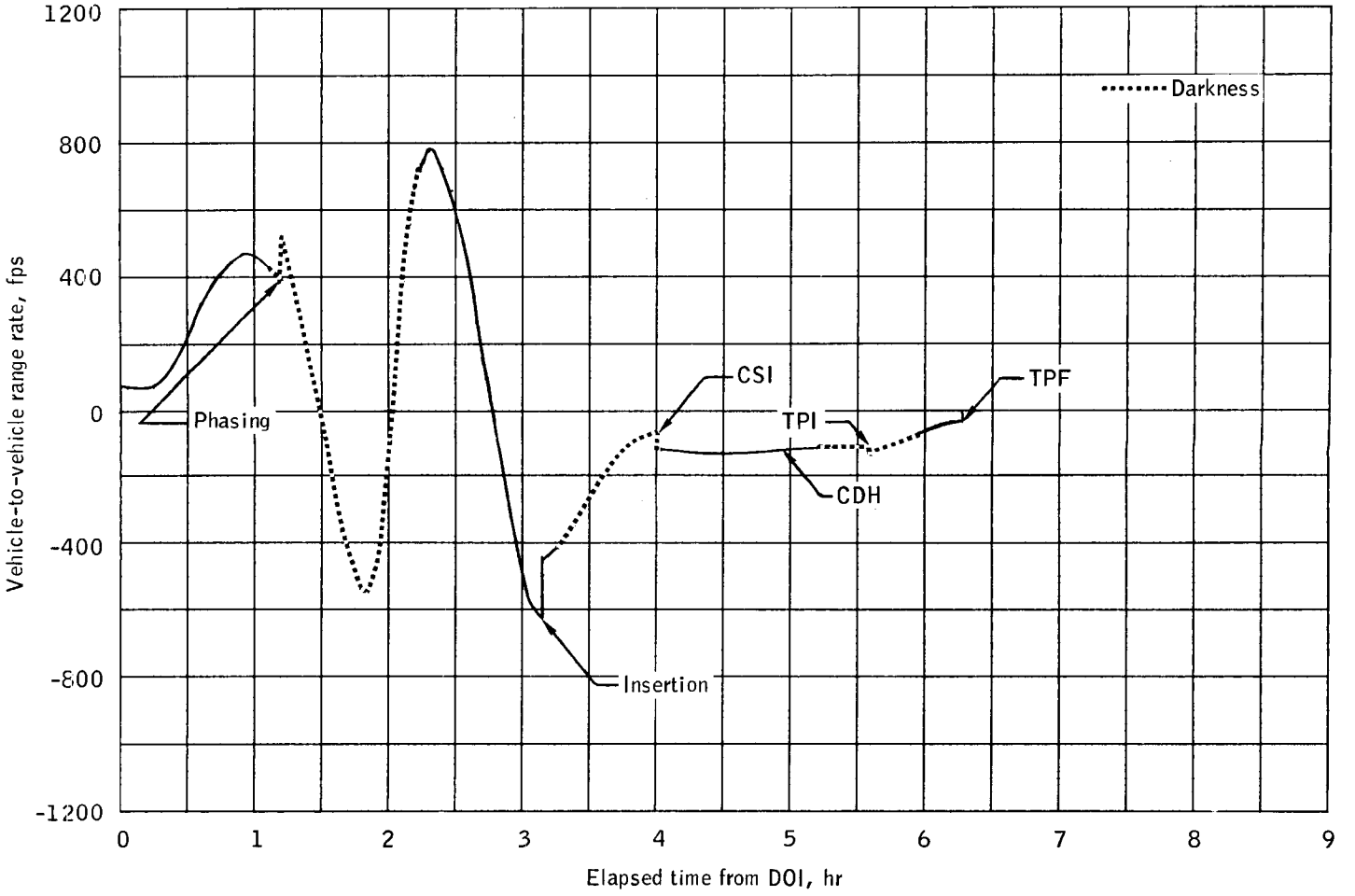


Figure 5.11-2.- Relative motion of descent stage with respect to ascent stage from staging through insertion.



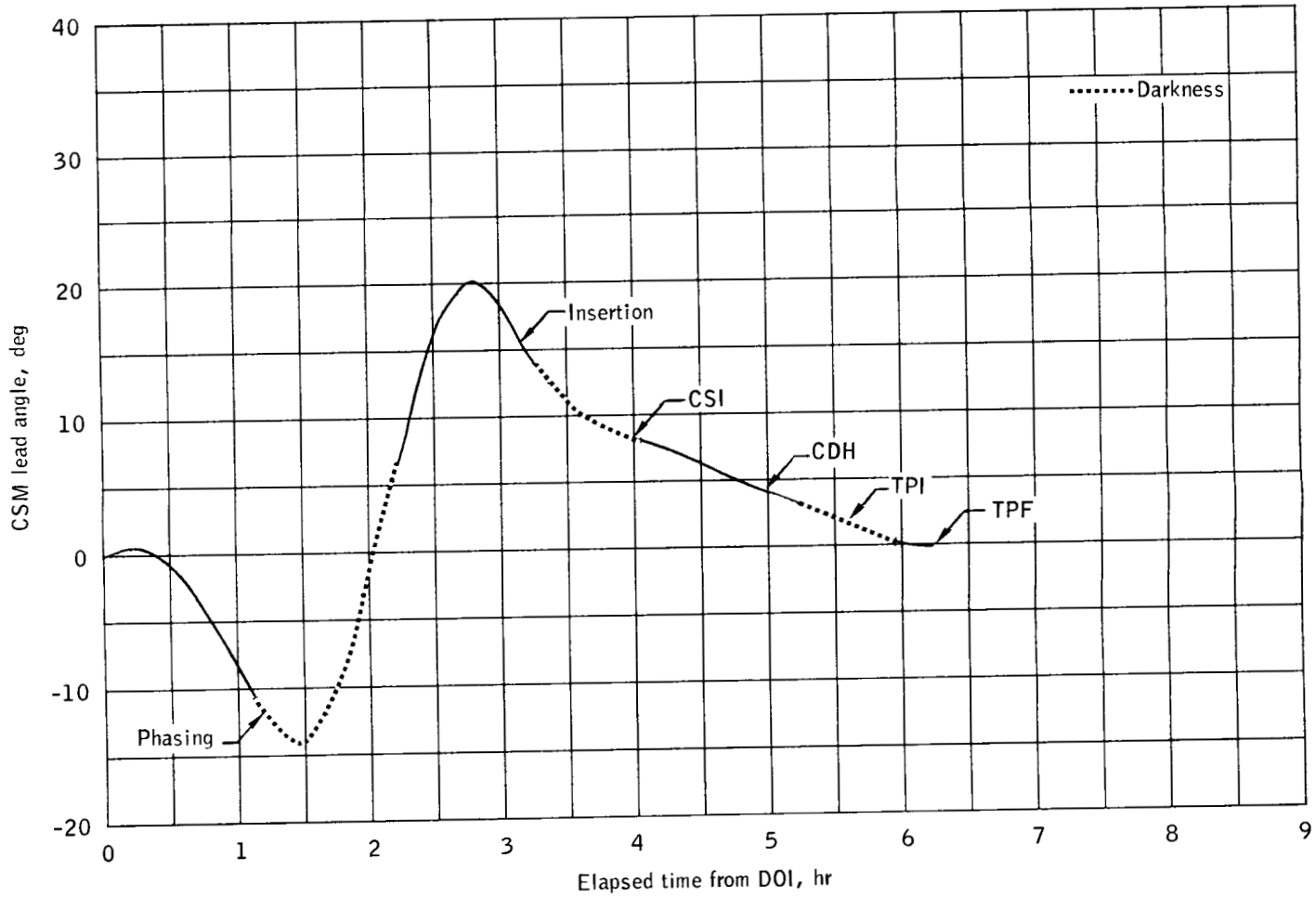
(a) Range.

Figure 5.11-3.- Time histories of various parameters from DOI to rendezvous.



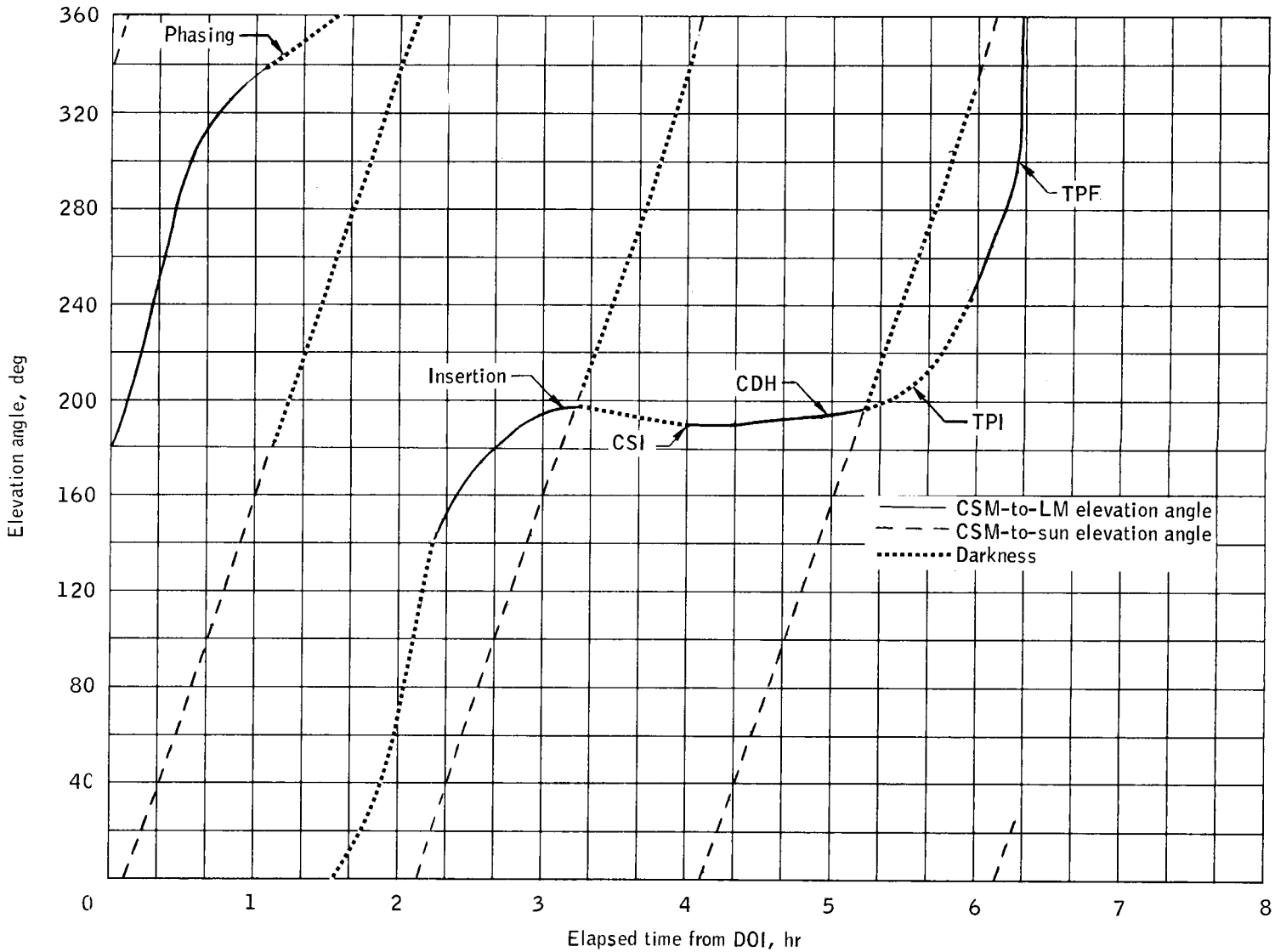
(b) Range rate.

Figure 5.11-3.- Continued.



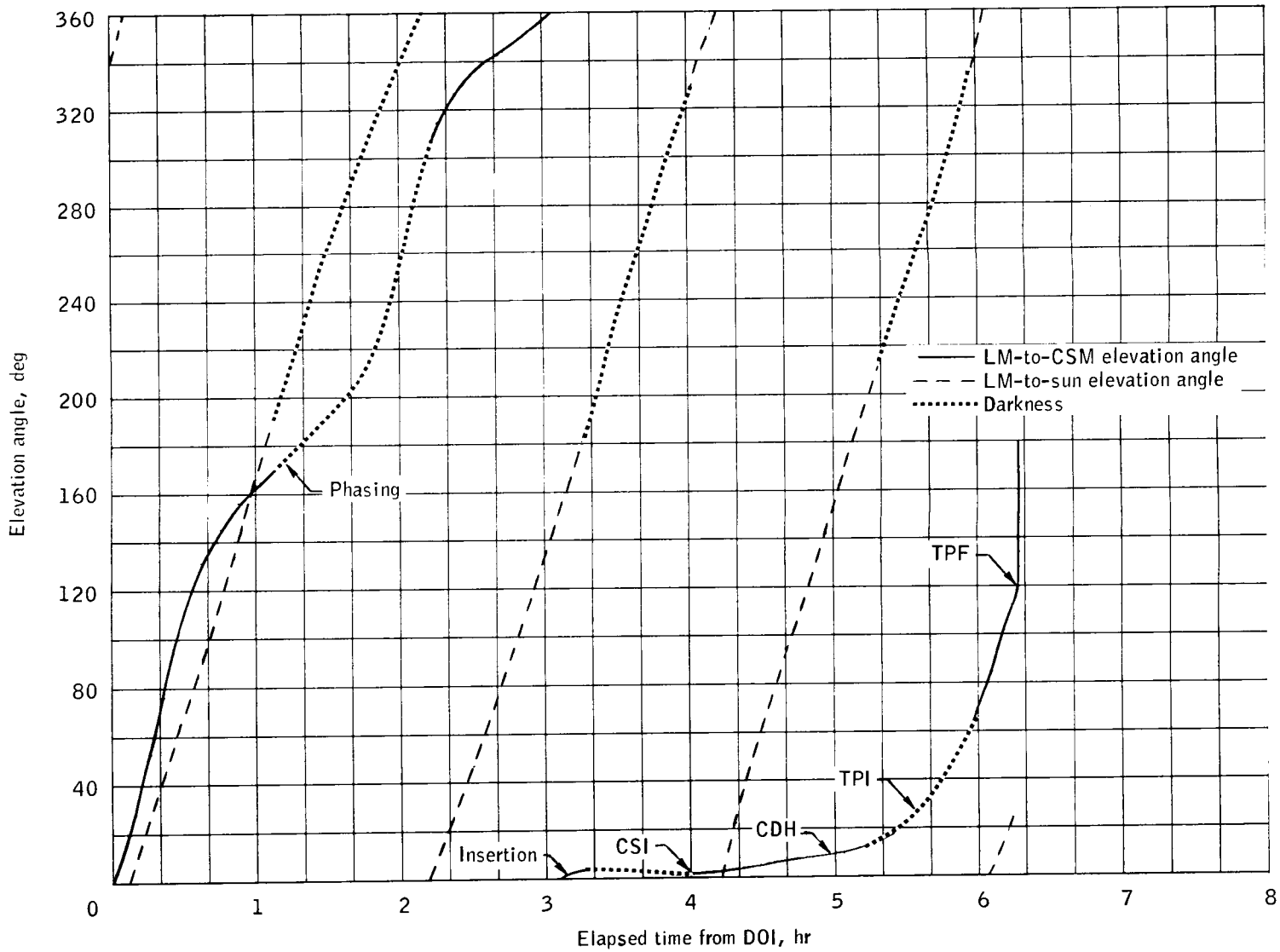
(c) CSM lead angle.

Figure 5.11-3.- Continued.



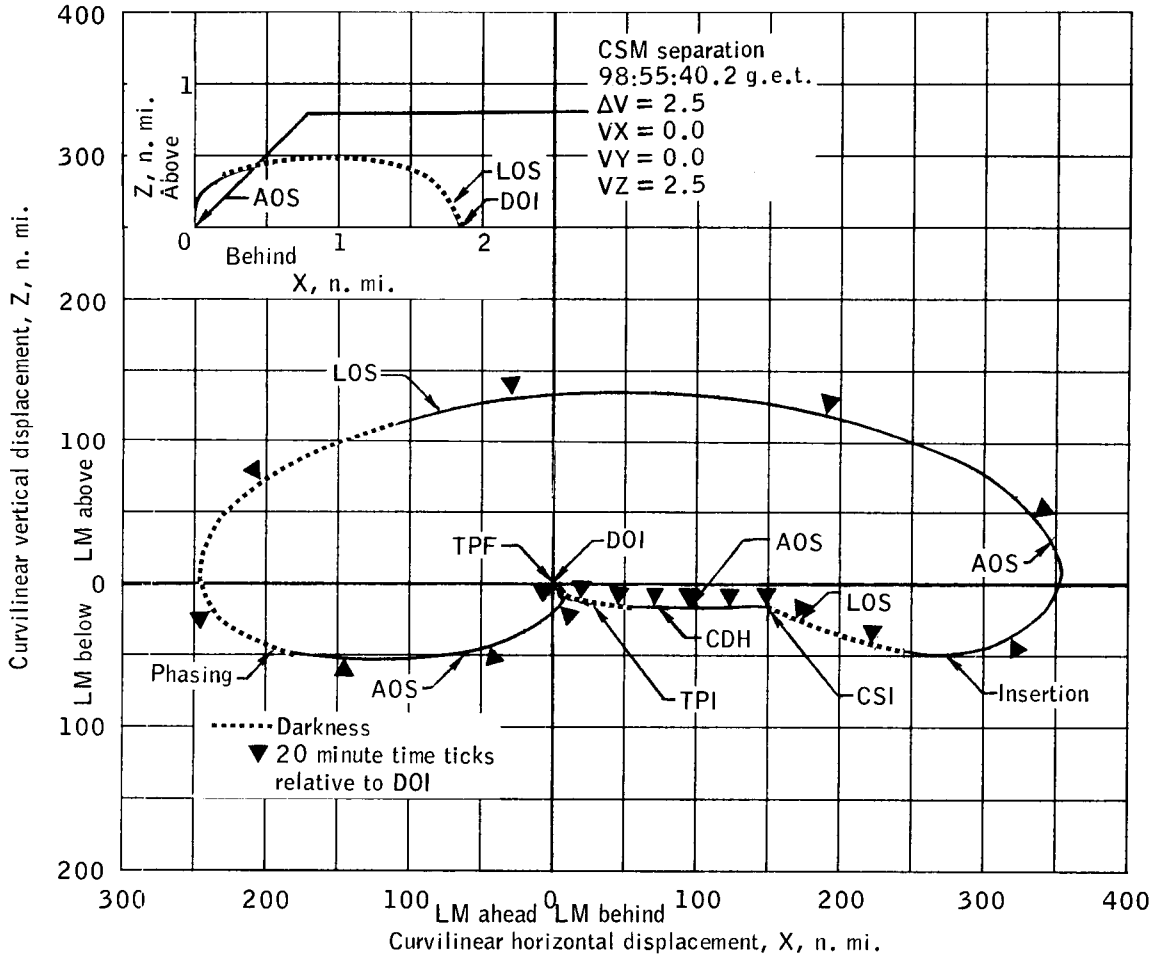
(d) CSM-to-LM elevation angle and CSM-to-sun elevation angle.

Figure 5.11-3.- Continued.



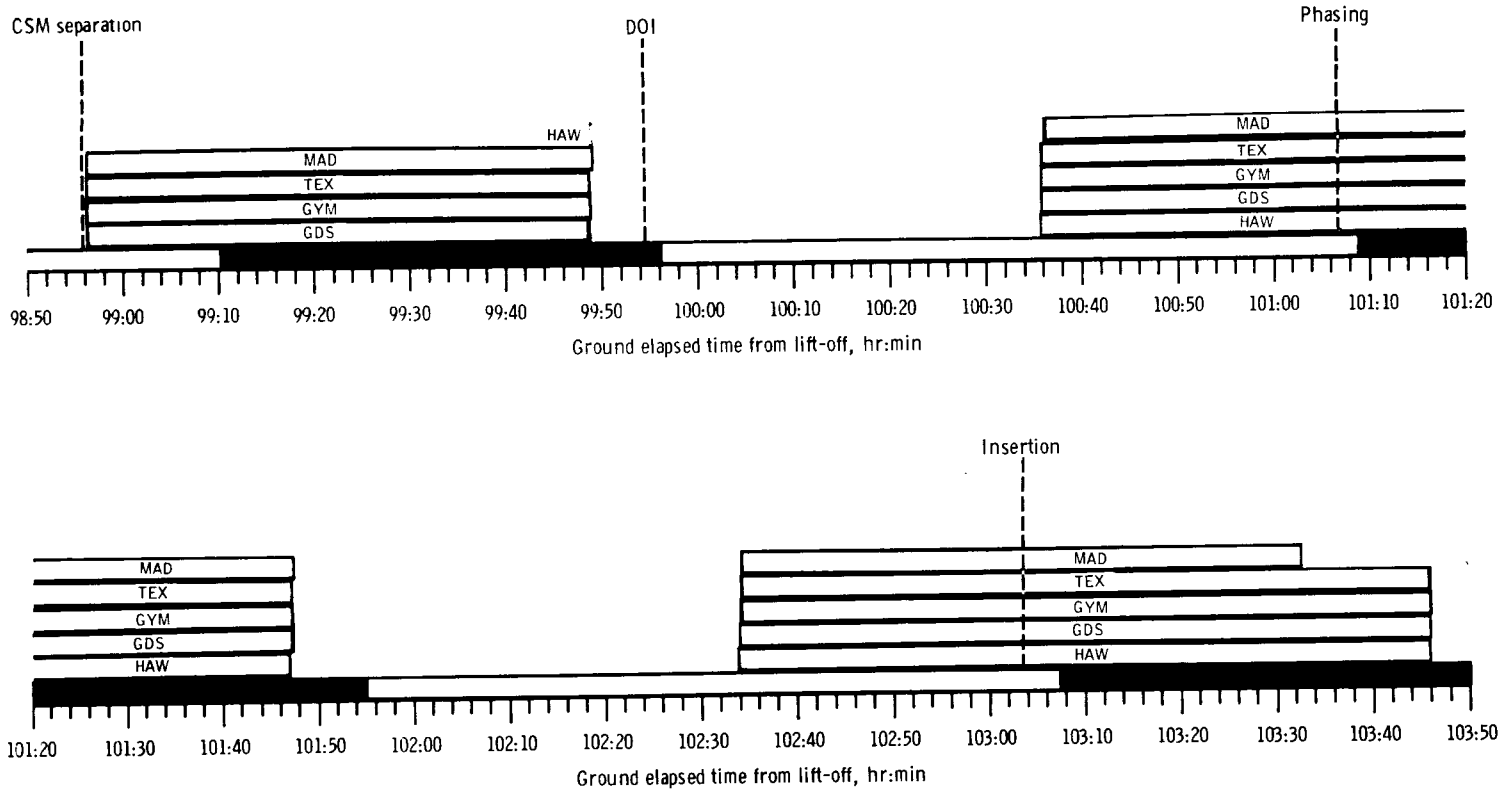
(e) LM-to-CSM elevation angle and LM-to-sun elevation angle.

Figure 5.11-3.- Concluded.



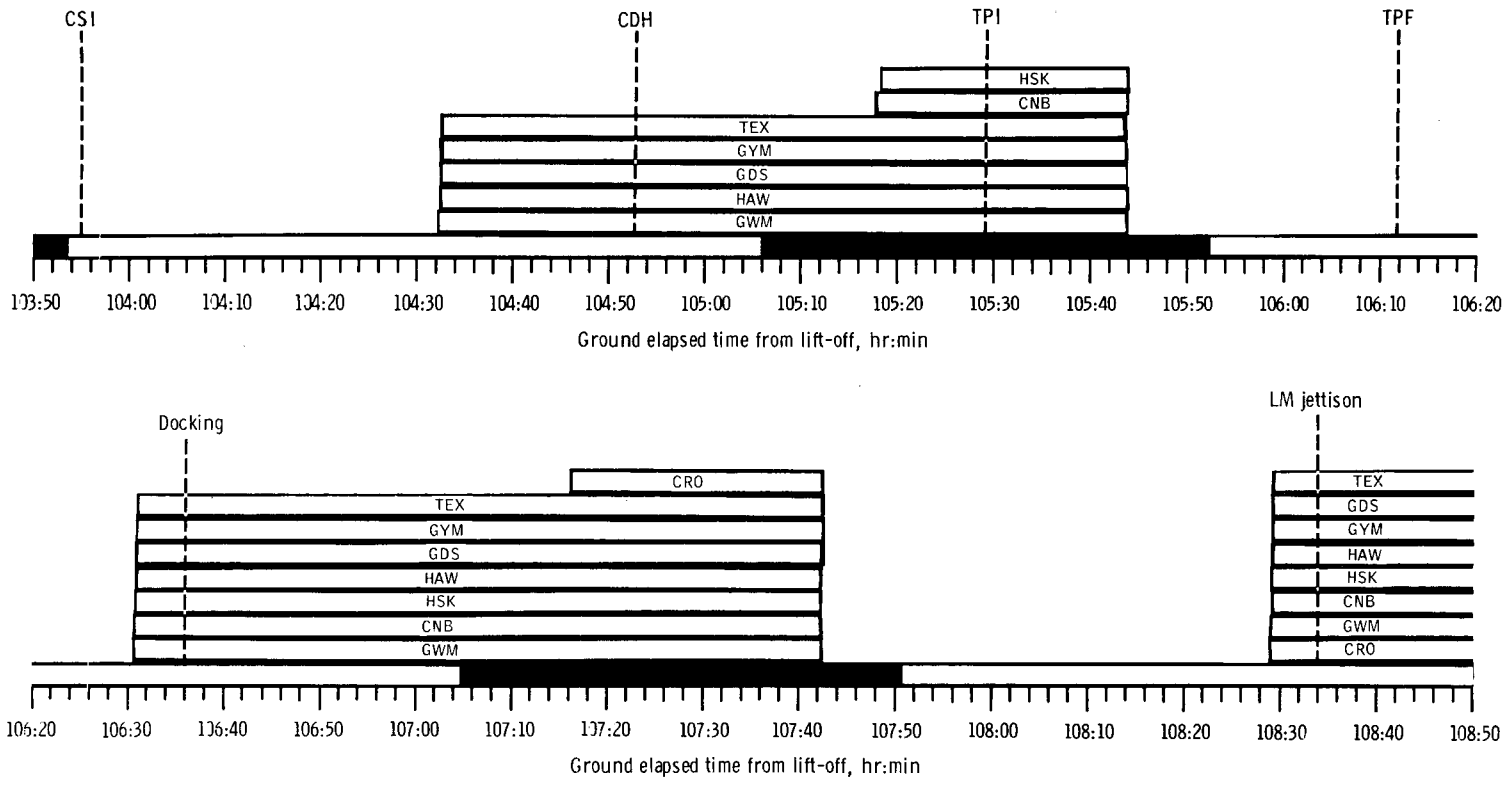
DOI	99:54:12.0 g.e.t. ΔV = 72.8 VX = -72.8 VY = 0.0 VZ = 2.2
Phasing	101:06:34.9 g.e.t. ΔV = 193.5 VX = 173.1 VY = -0.0 VZ = -86.5
Insertion	103:03:29.2 g.e.t. ΔV = 213.3 VX = -190.1 VY = -0.0 VZ = -96.7
CSI	103:54:39.9 g.e.t. ΔV = 50.5 VX = 50.5 VY = 0.0 VZ = -0.0
CDH	104:52:41.1 g.e.t. ΔV = 5.8 VX = -0.5 VY = -0.0 VZ = 5.8
TPI	105:28:59.2 g.e.t. ΔV = 25.3 VX = 22.5 VY = 0.0 VZ = -11.3
TPF	106:11:25.0 g.e.t. ΔV = 31.7 VX = 18.8 VY = -0.0 VZ = 25.6

Figure 5.11-4.- Relative motion (curvilinear, CSM-centered) for LM active phase of F mission.



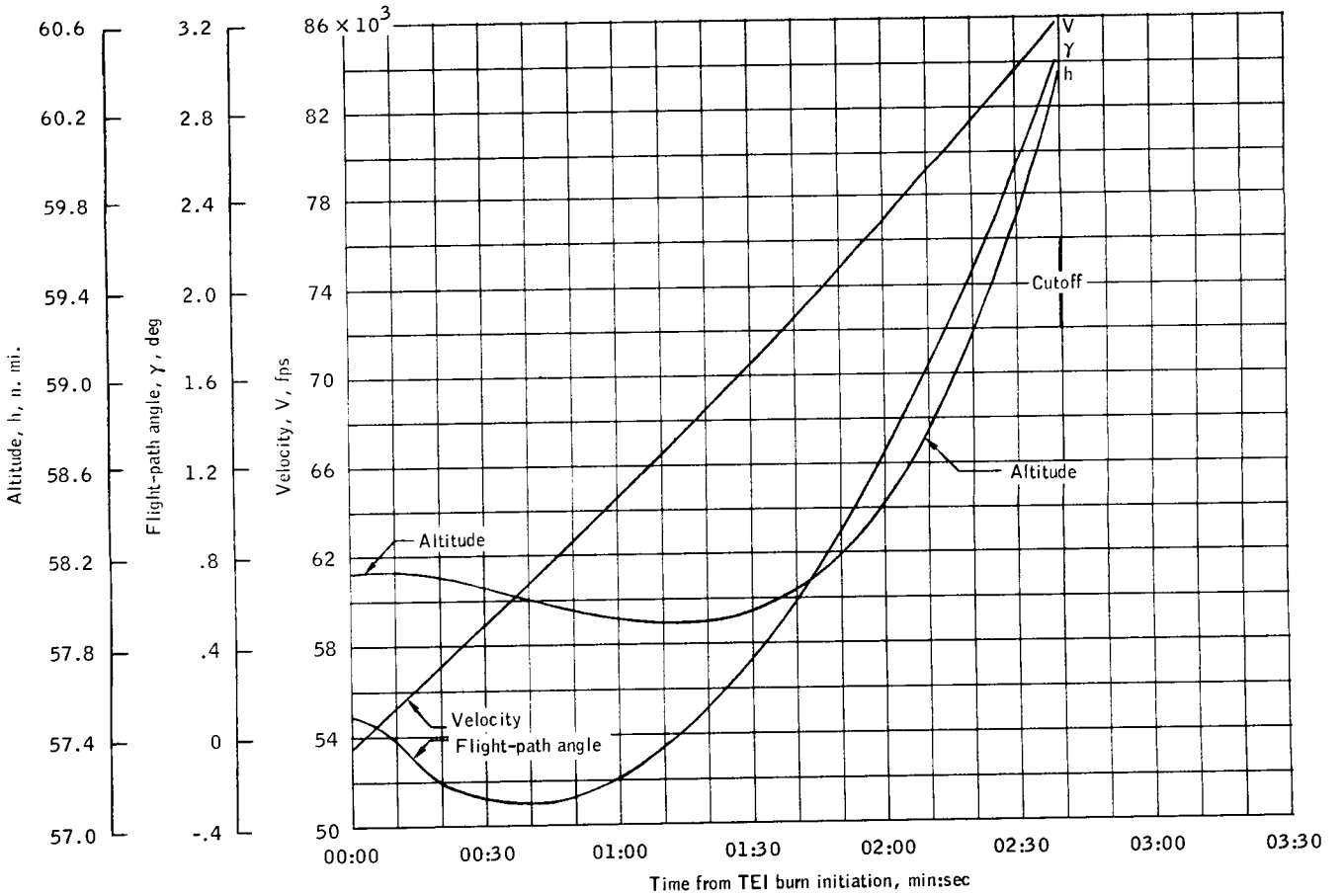
(a) 98:50 hours to 103:50 hours.

Figure 5.11-5.- Tracking, lighting, and mission events summary for LM from CSM separation to LM jettison.



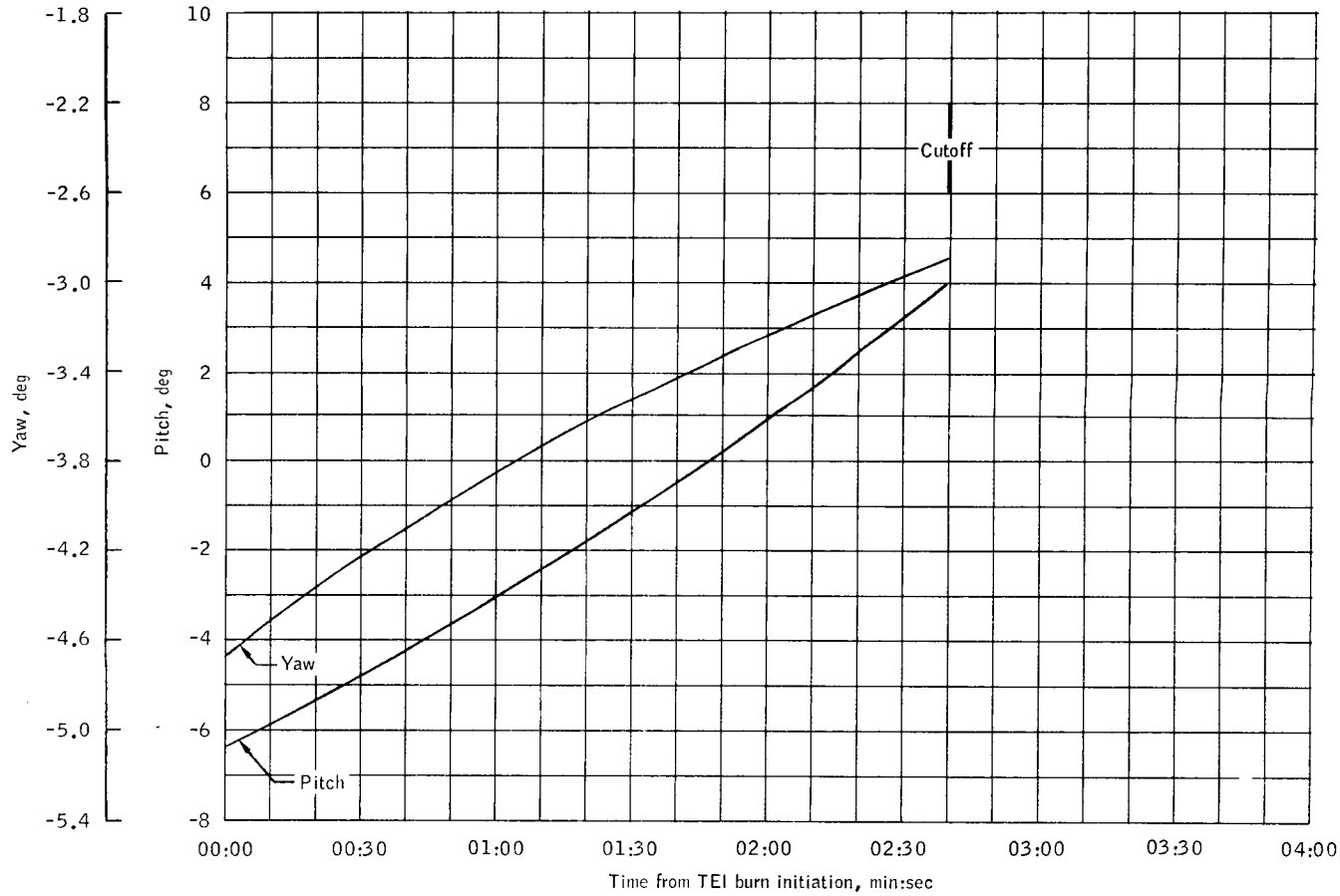
(b) 103:50 hours to 108:50 hours.

Figure 5.11-5. - Concluded.



(a) Velocity, flight-path angle, and altitude versus time from TEI burn initiation.

Figure 5.14-1.- Time history of trajectory parameters for TEI phase.



(b) Local horizontal pitch and yaw versus time from TEI burn initiation.

Figure 5.14-1.- Concluded.

APOLLO TRACKING NETWORK

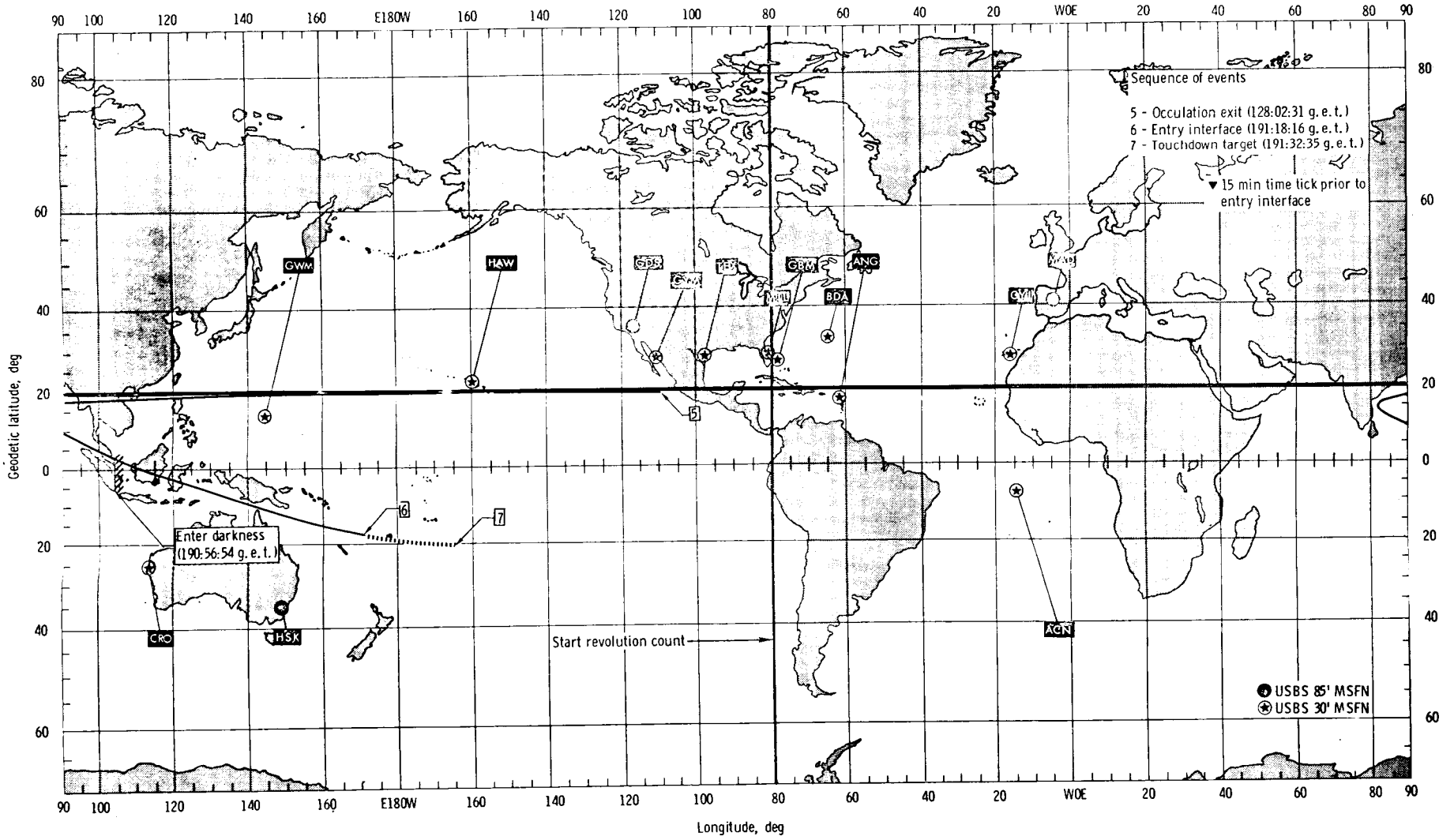


Figure 5.15-1. - Mission groundtracks - transearth coast.

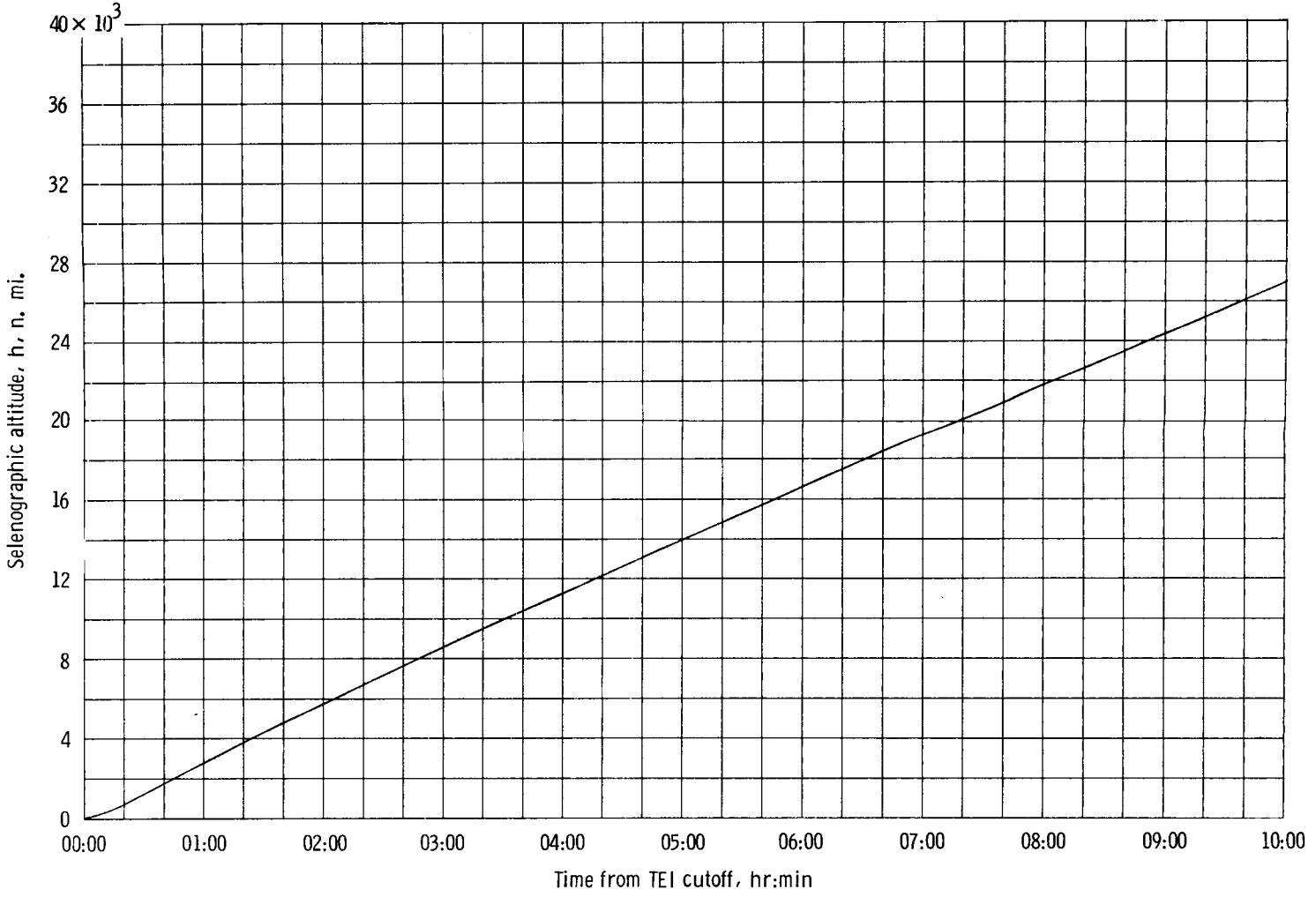


Figure 5.15-2. - Time history of altitude for first 10 hours of transearth coast phase.

Figure 5.15-3. - Time history of altitude 10 hours prior to entry interface.

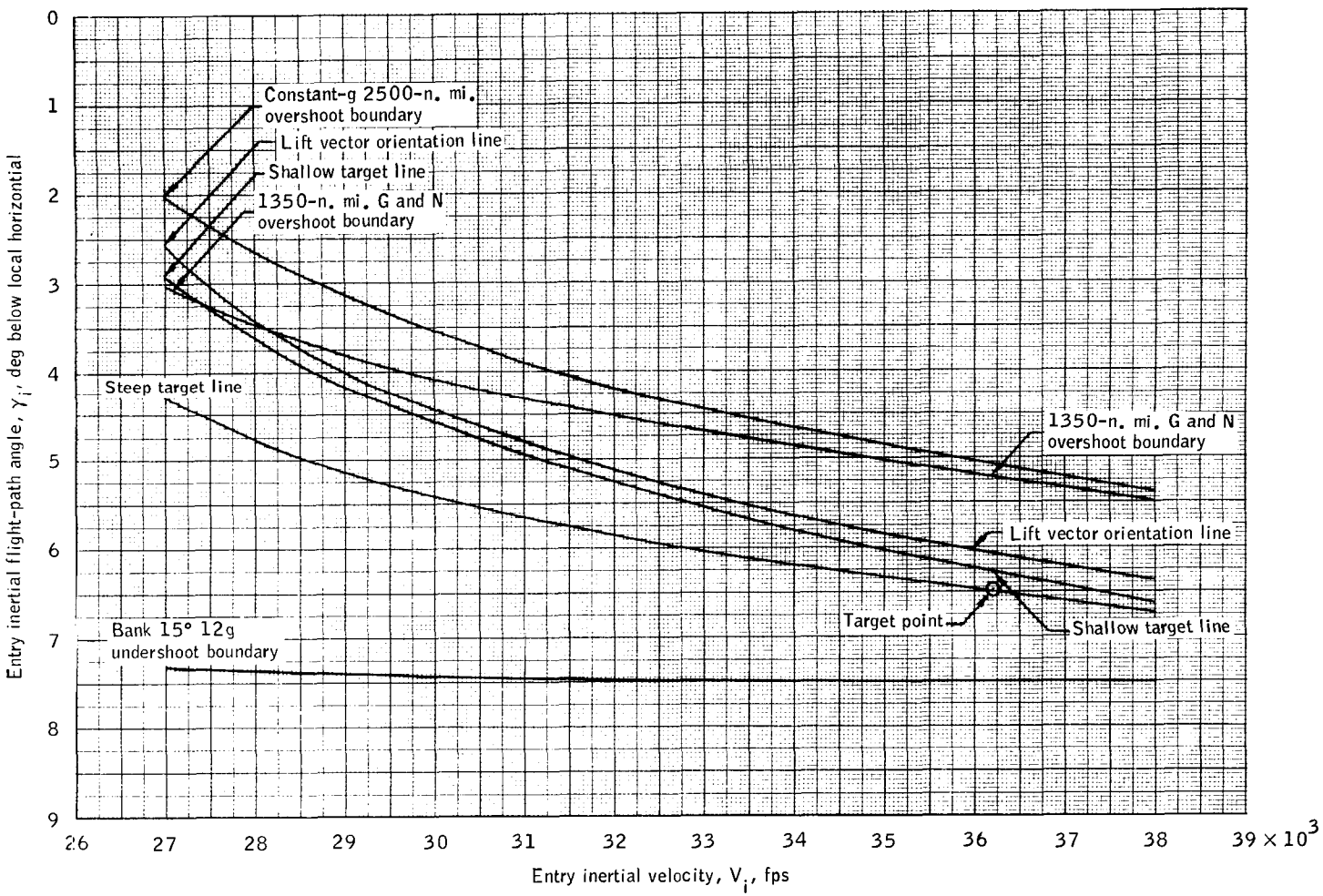


Figure 5.16-1.- Entry corridor.

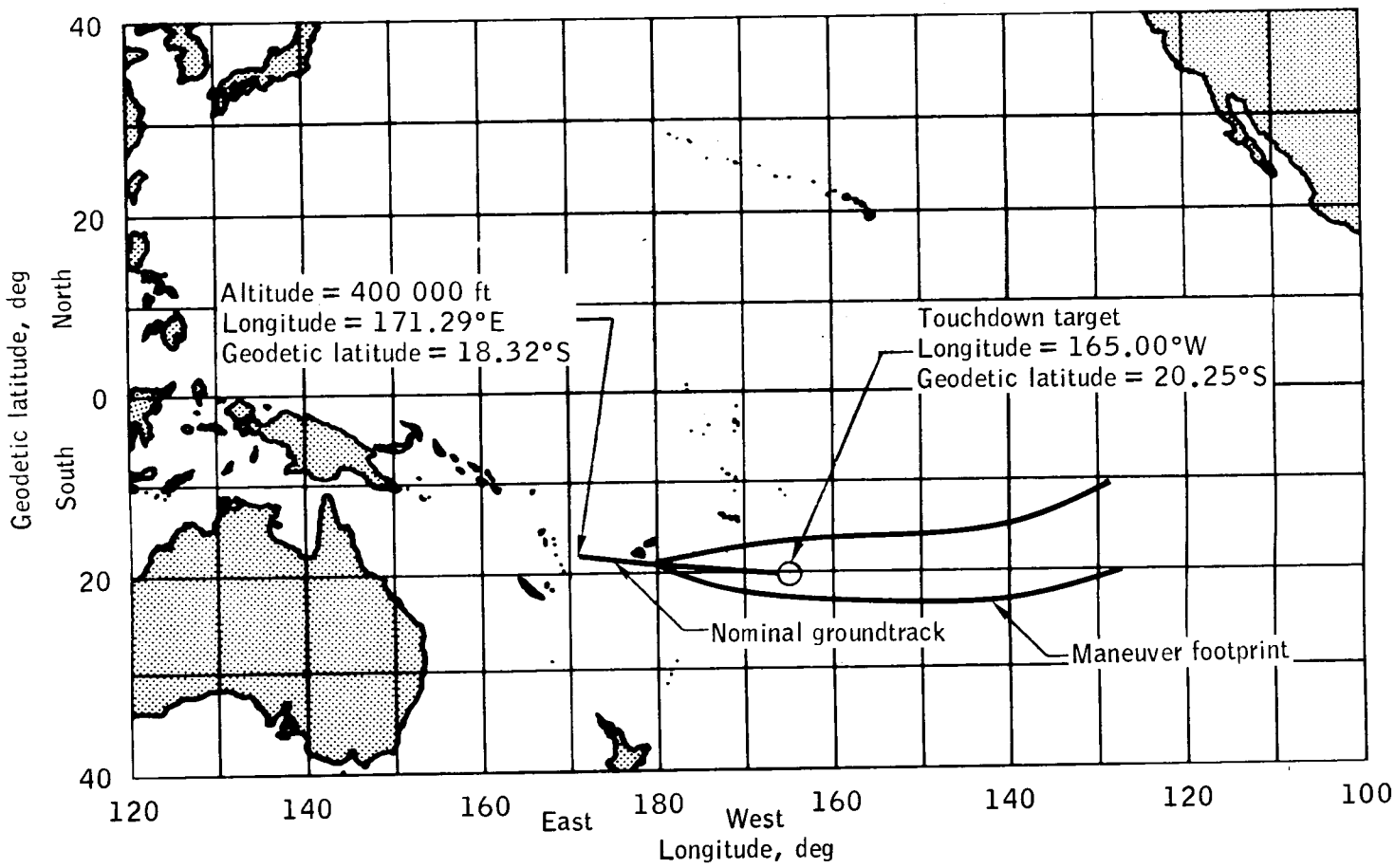


Figure 5.16-2.- Maneuver footprint and nominal groundtrack.

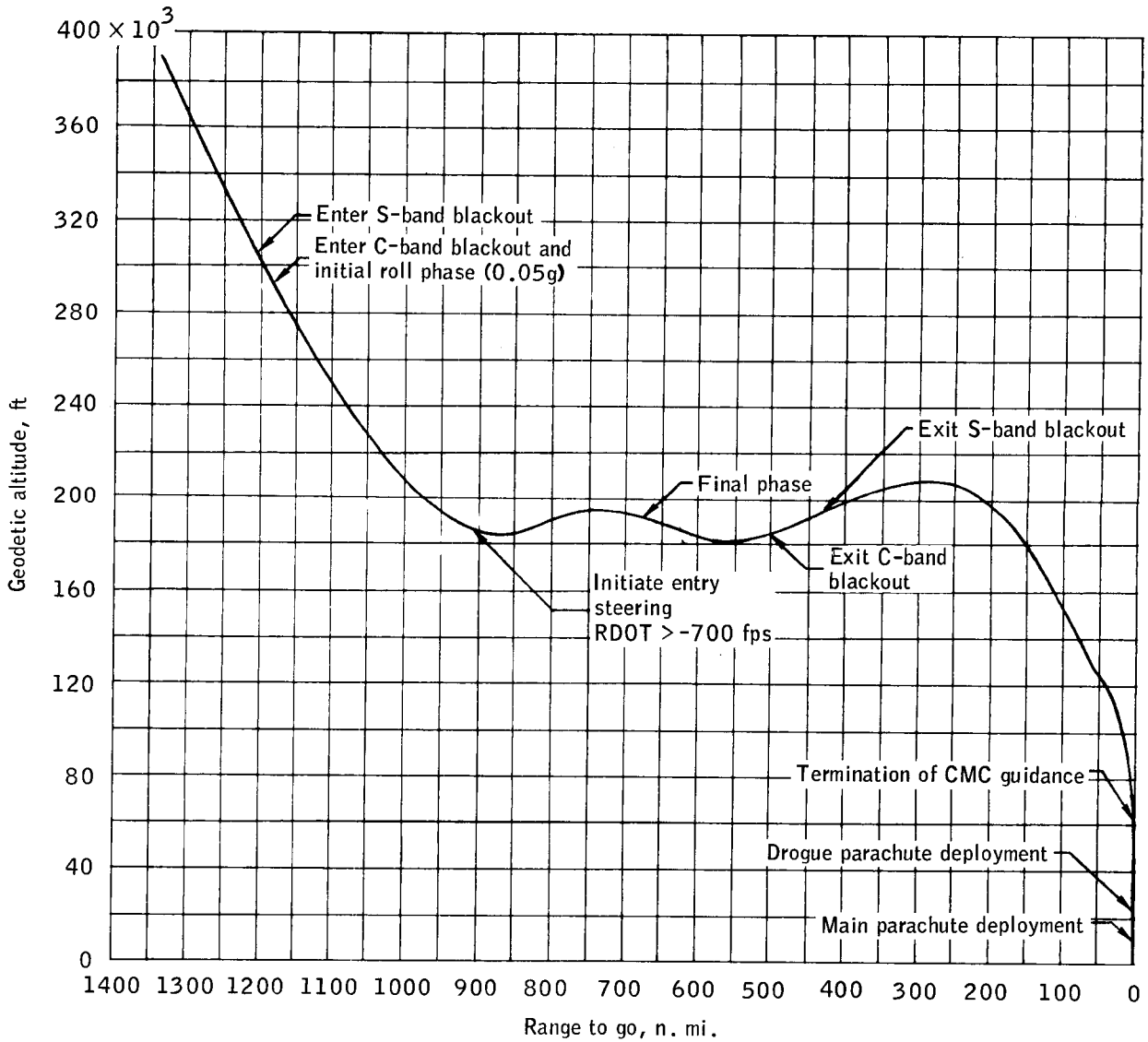


Figure 5.16-3.- Geodetic altitude versus range to go.

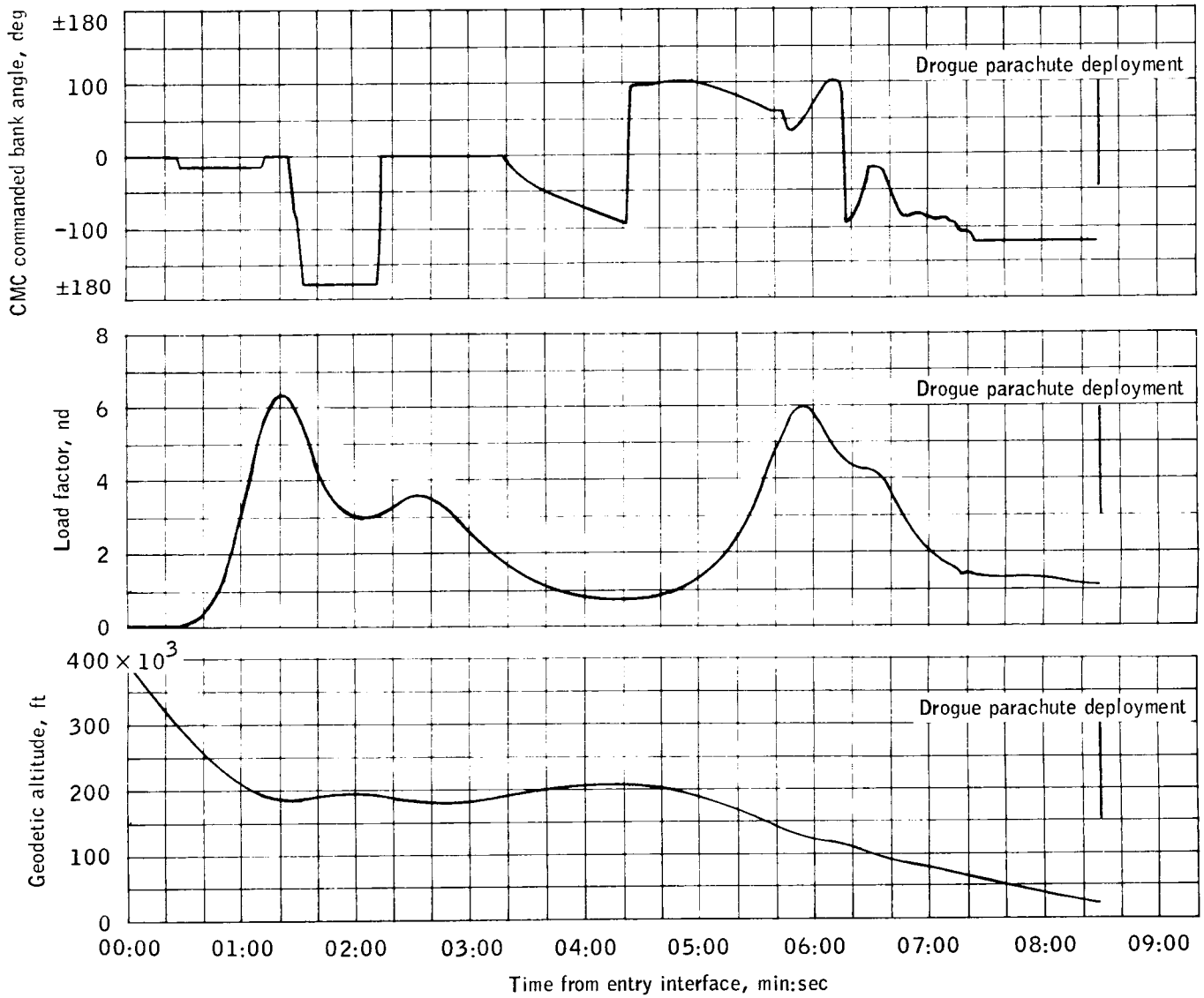


Figure 5.16-4.- CMC commanded bank angle, load factor, and altitude time histories.

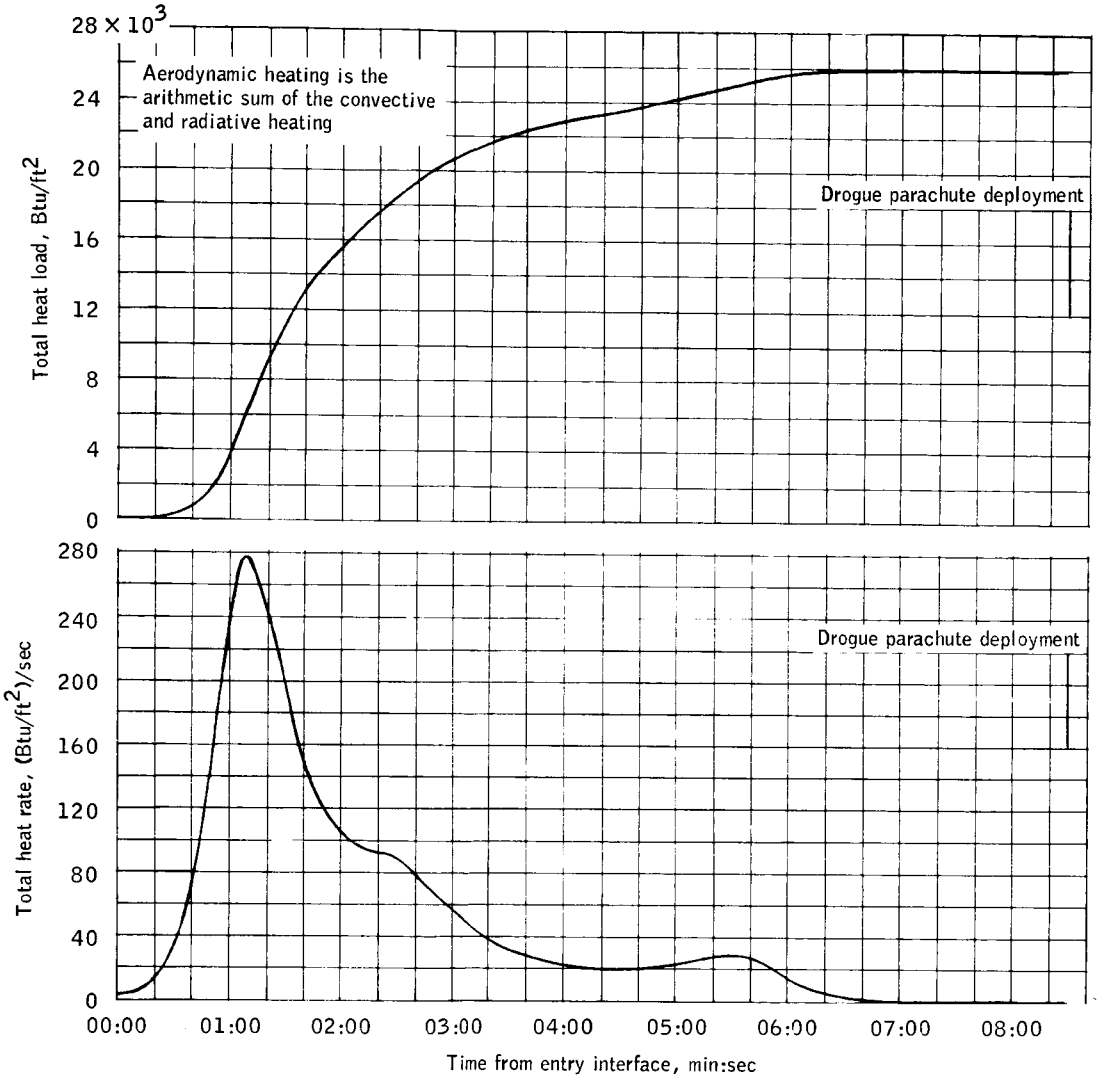


Figure 5.16-5.- Total aerodynamic heating rate and heat load time histories.

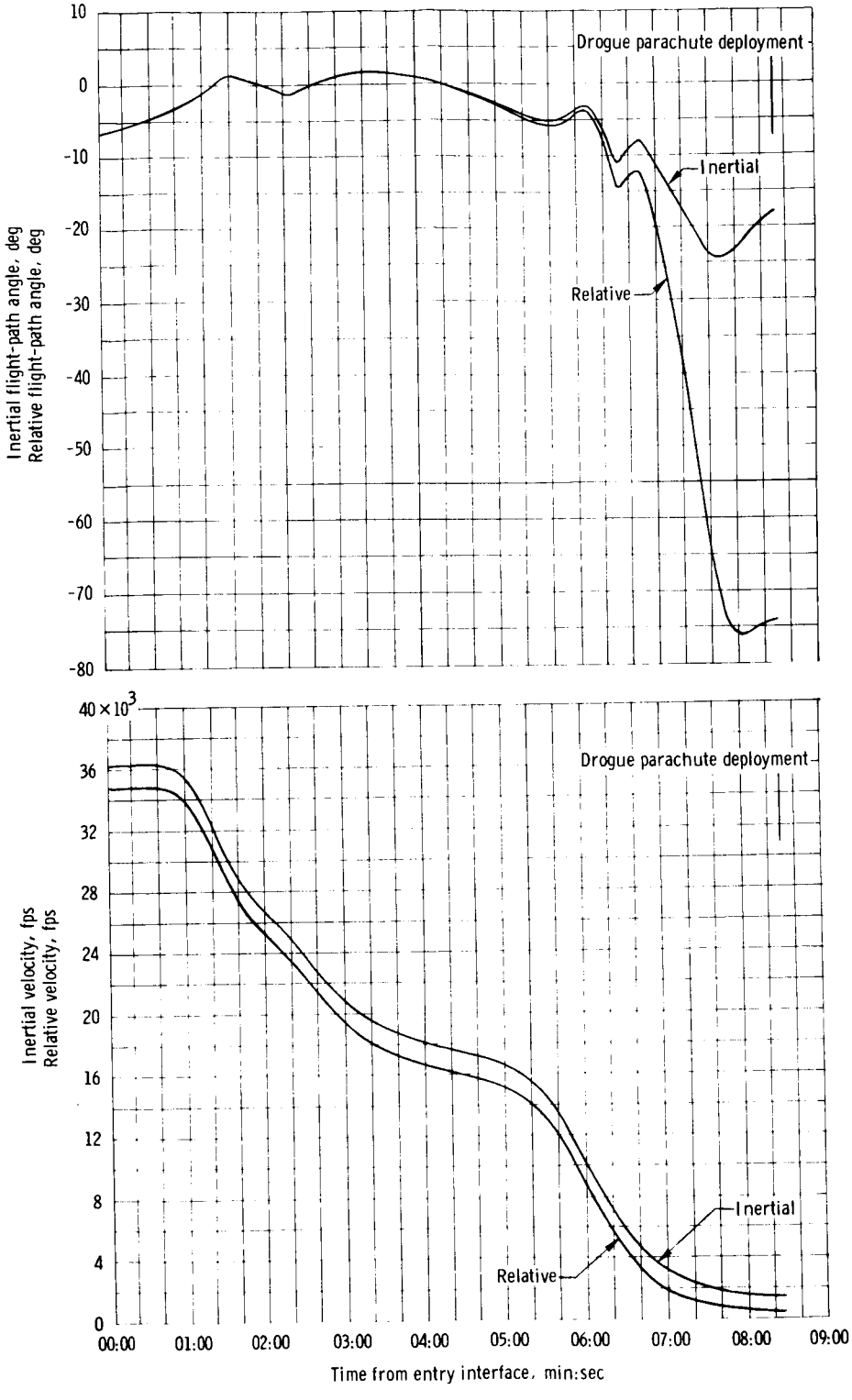


Figure 5.16-6. - Entry velocity and flight-path angle time histories.

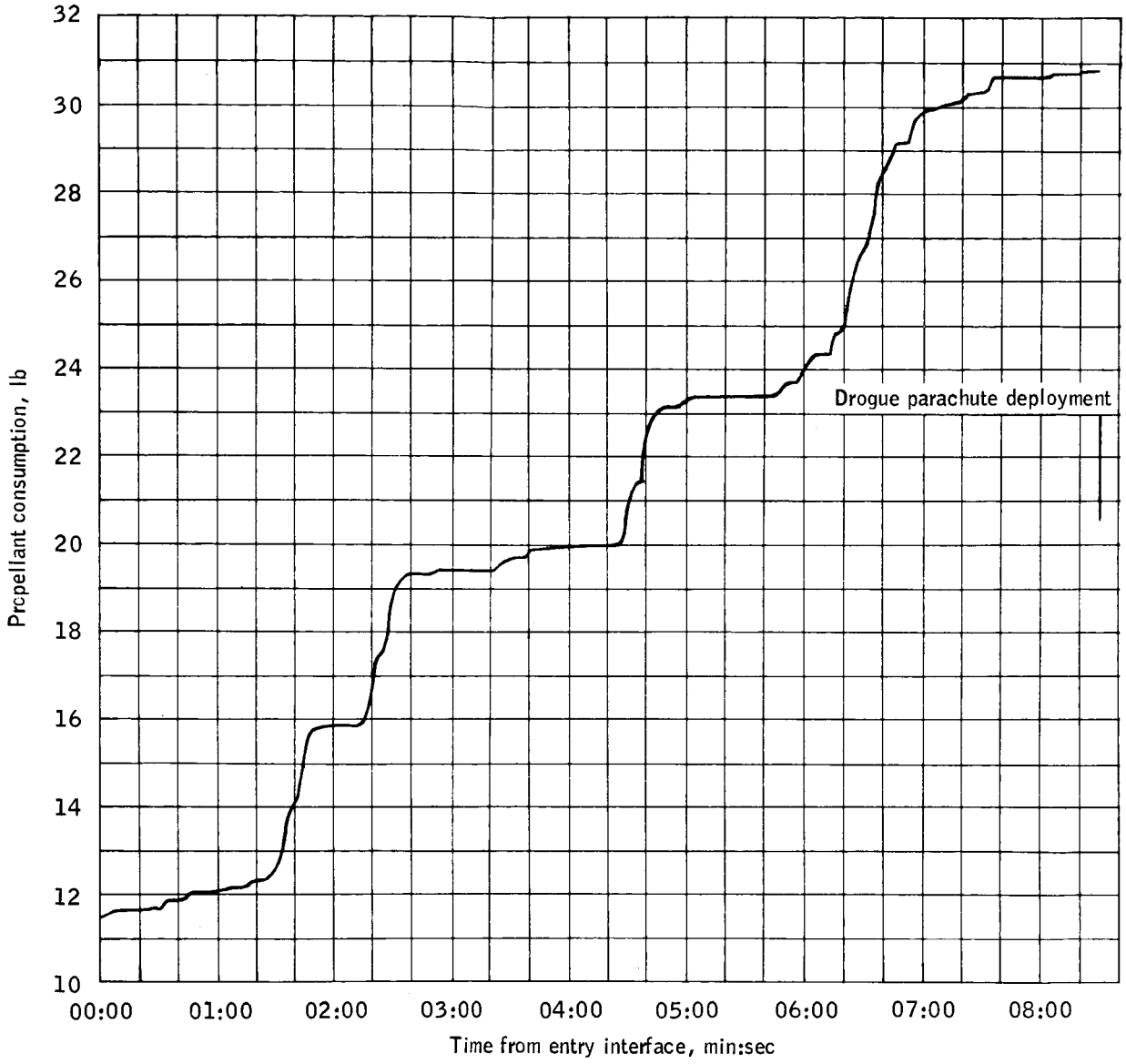


Figure 5.16-7.- Total propellant consumed from separation.

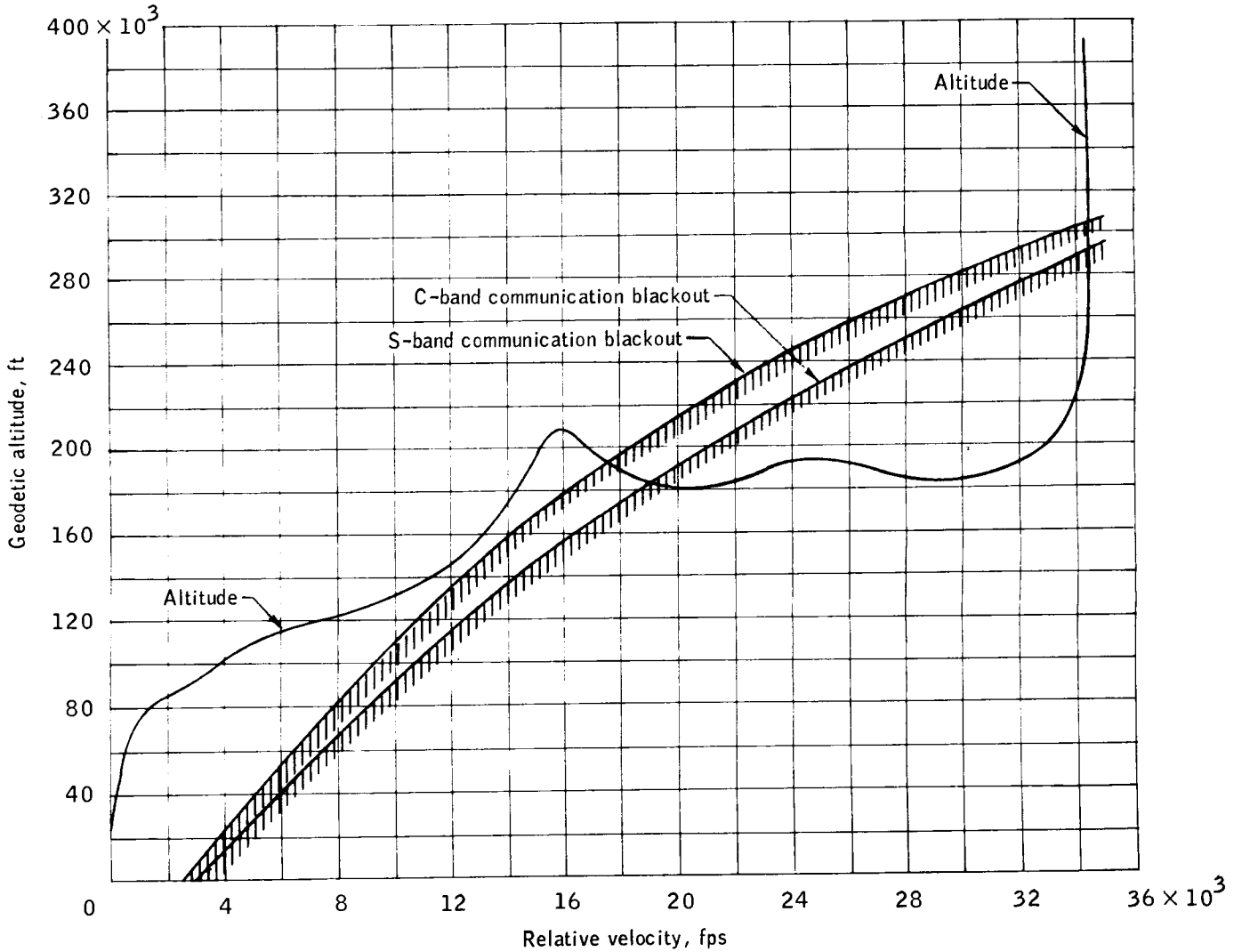


Figure 5.16-8.- Communication blackouts.

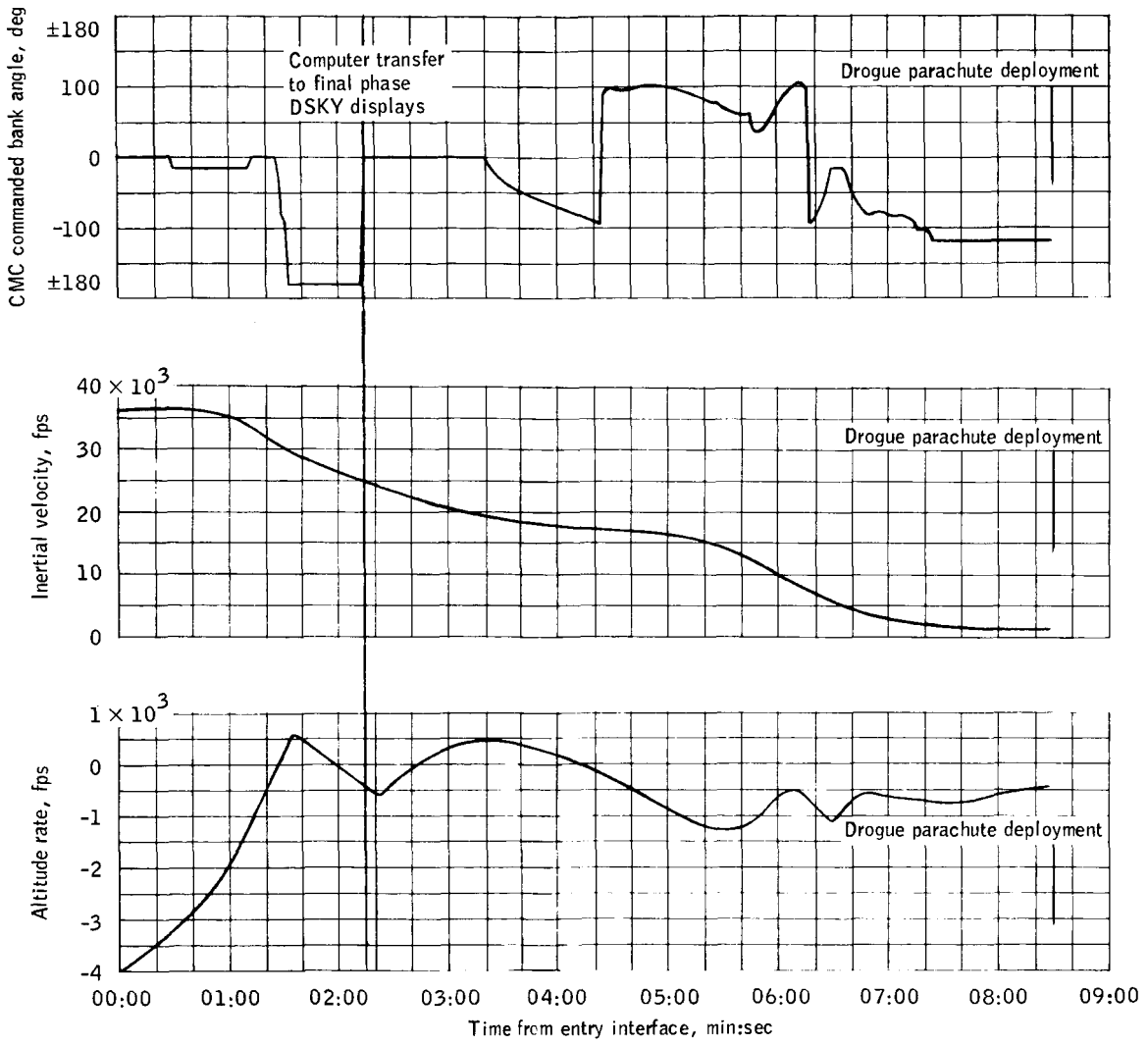


Figure 5.16-9.- Primary DSKY displays, VERB 06 NOUN 68.

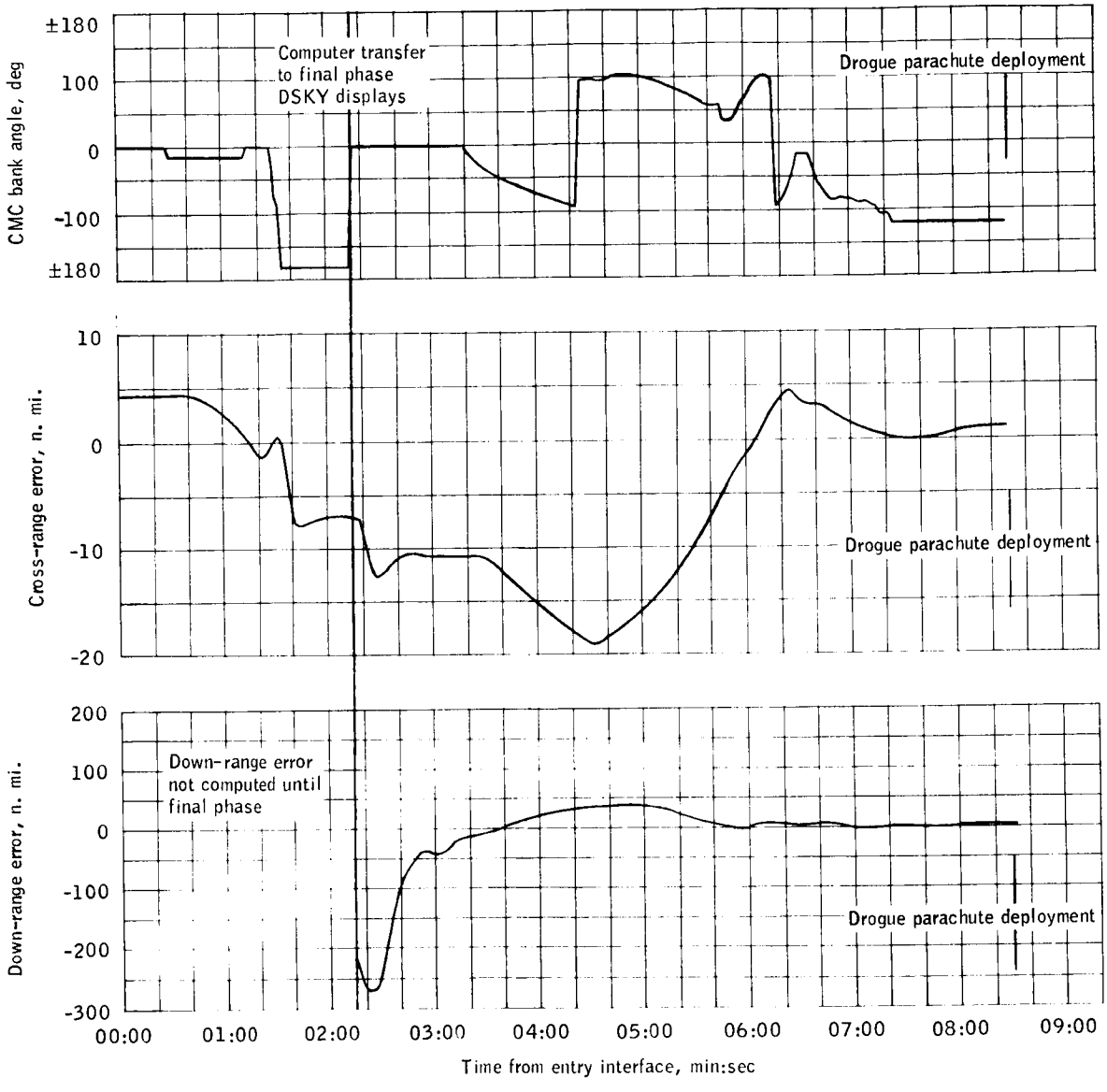


Figure 5.16-10.- DSKY displays (final phase), VERB 06 NOUN 66.

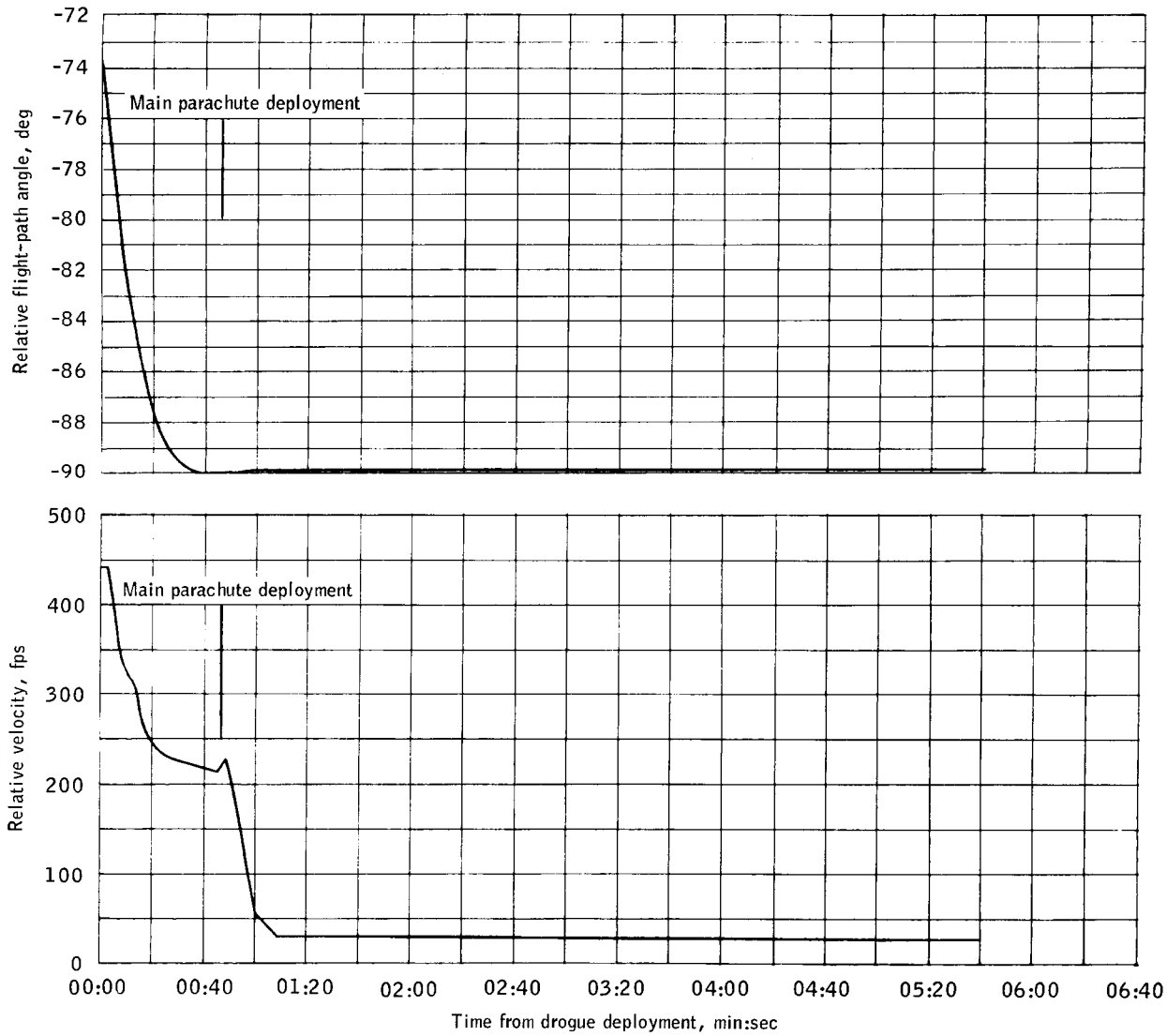


Figure 5.16-11.- Relative velocity and relative flight-path angle time histories from drogue parachute deployment.

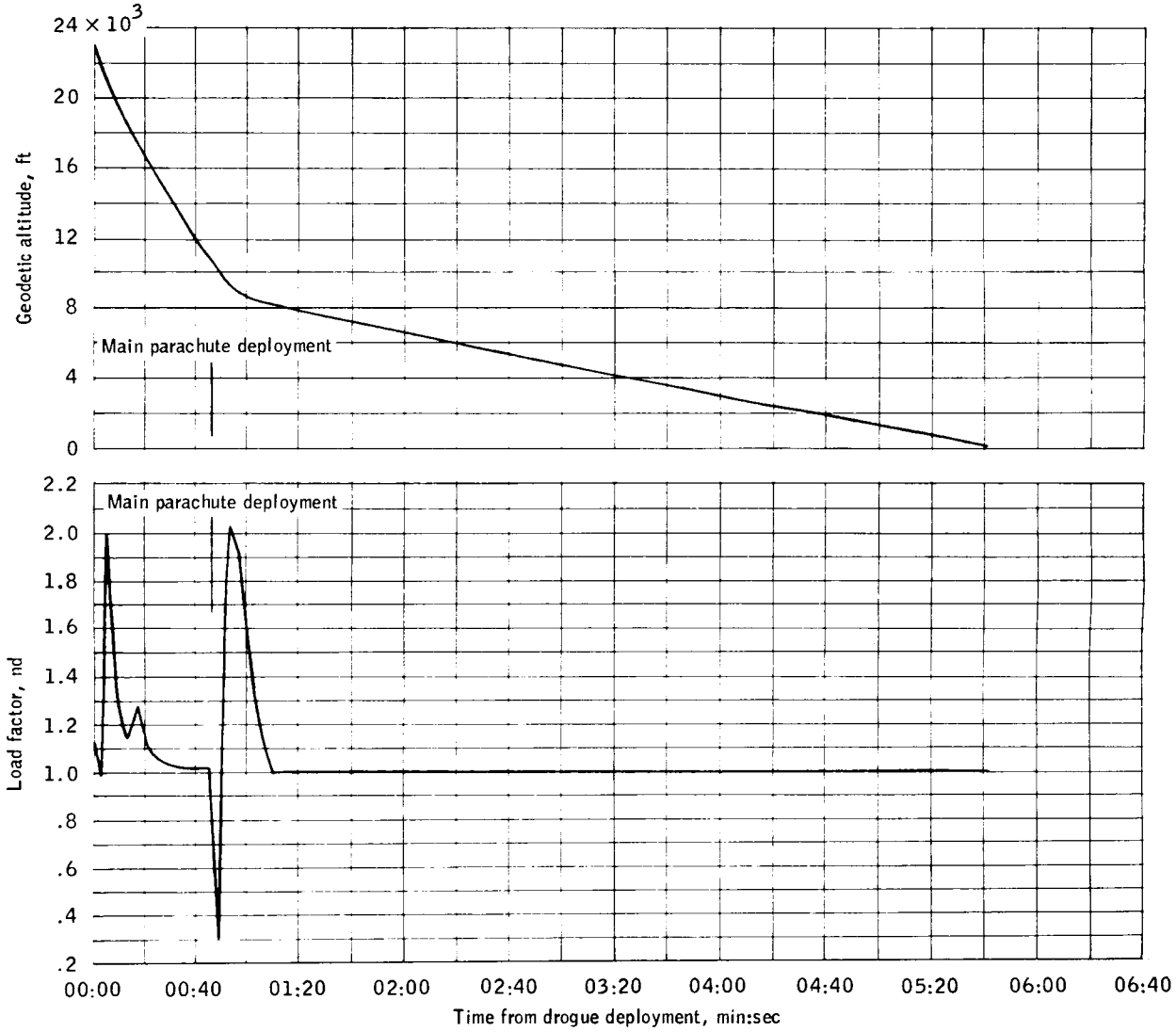
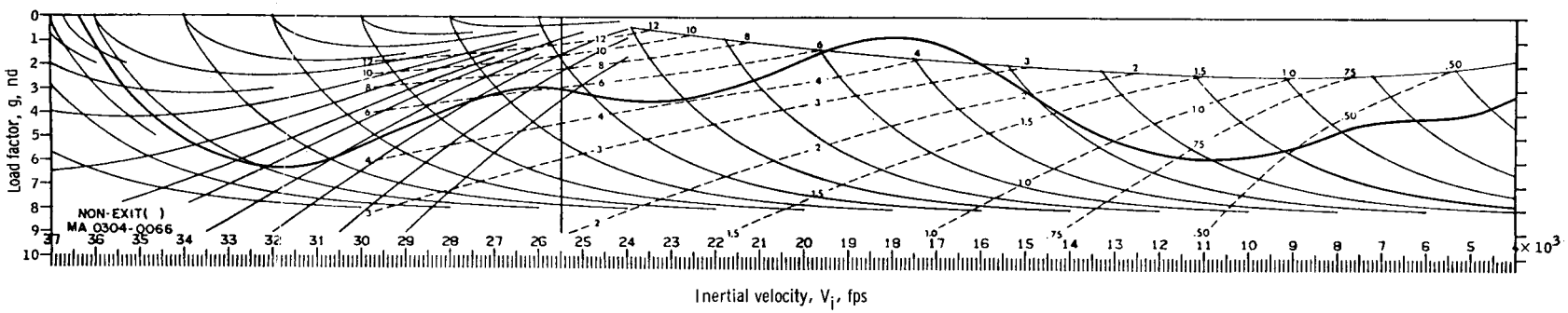
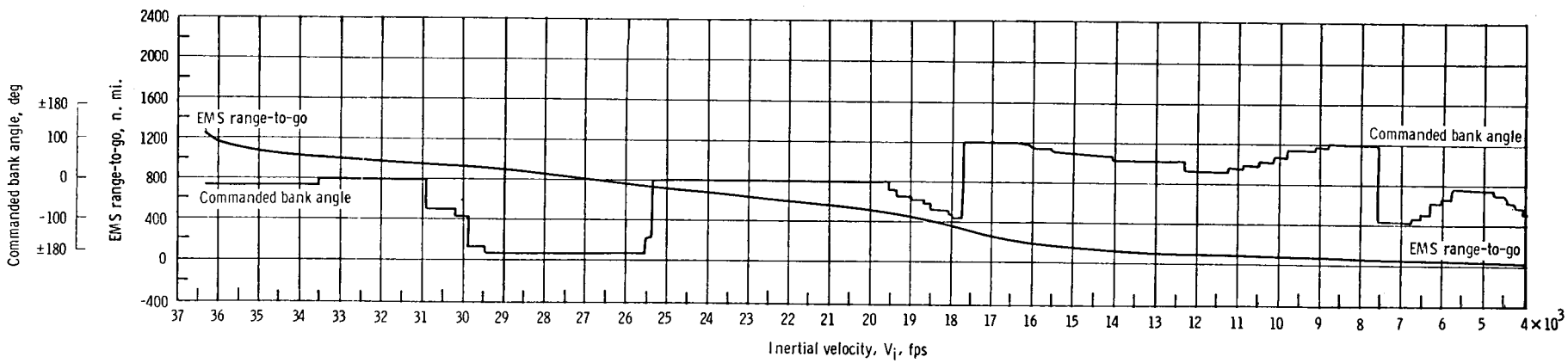


Figure 5.16-12.- Altitude and load factor time histories from drogue parachute deployment.



(a) Load factor versus inertial velocity



(b) CMC commanded bank angle and EMS range to go versus inertial velocity.

Figure 5.16-13. - EMS parameters.

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