NEWS

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Monday, April 14, 1969

APOLLO 10 BRIEFING

PARTICIPANTS:

GEORGE H. HAGE, Deputy Apollo Program Director, NASA Headquarters

COLONEL THOMAS McMULLEN, Assistant Mission Director

WILLIAM J. O'DONNELL, Assistant Public Affairs Officer, OMSF, NASA

O'DONNELL: Good afternoon.

Before we begin with our briefing, I would like to make a couple of announcements.

First, there will be printed transcripts provided of the briefing. If you are interested in receiving one of these transcripts, please address a government envelope with your own address. You will find the envelopes in the lobby.

The second announcement is that a briefing on the NASA portion of President Nixon's amended fiscal 1970 Budget will be held tomorrow, Tuesday, April 15, at 5:00 p.m., Eastern Standard Time, at the NASA Headquarters Auditorium, sixth floor, FOB 6, 400 Maryland Avenue, Southwest.

To begin this afternoon's activities we will have the Apollo 10 mission briefing by Mr. George Hage, who is the Apollo Mission Director, also Deputy Director of the Apollo Program.

With Mr. Hage is Colonel Tom McMullen, Assistant Mission Director.

George.

HAGE: Thank you.

Ladies and gentlemen, we will present the Apollo 10 mission briefing today in three parts. I will start it out with a discussion of the mission up to the point of rendezvous. Colonel McMullen will discuss the details of the rendezvous. And I will take the mission from that point on back to recovery.

As many of you know, Apollo 10 is proceeding well towards a launch readiness on May 18. The launch time planned is 11:49 a.m., Eastern Standard Time.

The flight readiness test was successfully completed on schedule last Thursday, April 9.

We have two major remaining events prior to our launch readiness status. General Phillips' flight readiness review will be conducted at Kennedy on the 22nd of this month. The final test, as in previous missions, is the countdown demonstration test that is scheduled to start on the 27th of this month, with completion of the first part involving the flowing of all the cryogenic propellants on the 2nd of May, followed by a crew participating part of the countdown demonstration test on the 3rd of May.

With those introductory comments, I would like to have the first slide, please.

(Slide)

The Apollo 10 is composed of the configuration items shown on the left:

Saturn launch vehicle SA505.

Command service module 106.

LM-4.

The spacecraft lunar module adapter No. 13.

And we will be using the Colossus 2 and the Luminary programs in the guidance computers of the two spacecraft, respectively.

This will be the first launch from Launch Complex 39-B.

The crew assignments. Colonel Tom Stafford is the Commander. Commander John Young is the Command Module Pilot. Commander Gene Cernan is the Lunar Module Pilot. The backup crews are listed there.

Next slide, please.

(Slide)

The organizational structure of the mission is, as on previous missions, with support from launch operations, the launch direction being under R. A. Petrone and Mr. Donnelly.

F Mission

APOLLO
AS-505
LUNAR MISSION DEVELOPMENT

CONFIGURATION

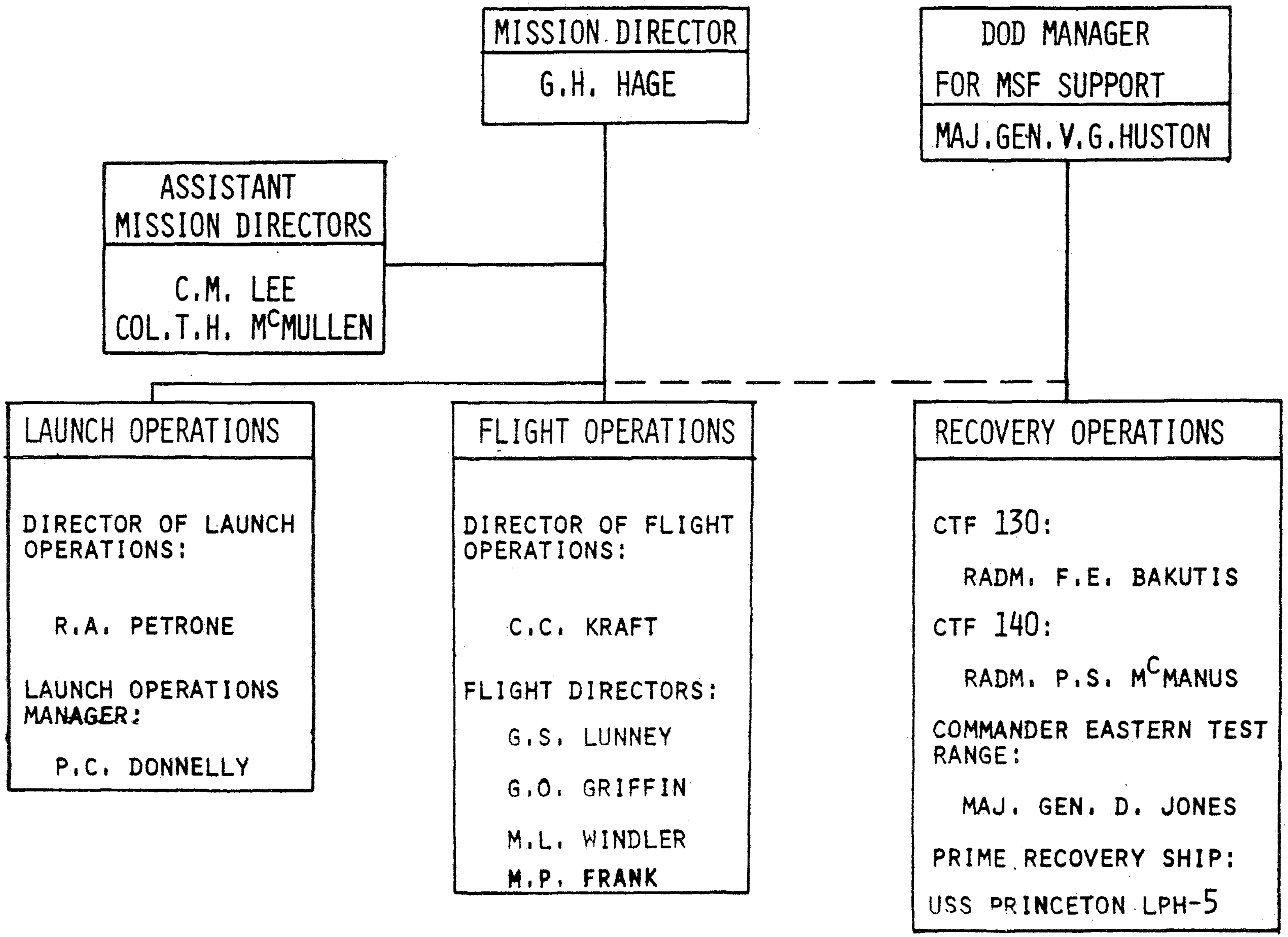
Launch Vehicle	SA-505
Command Module	CM-106
Service Module	SM-106
Lunar Module	LM-4
S/C-LM Adapter	SLA-13
Onboard Programs	Colossus II, Luminary I (Rev.69)
Launch Complex	LC 39 B

Mission Director	G. H. Hage
Launch Director	R.A. Petrone
Flight Director	G.S. Lunney
Mission Engineer (MAO)	G.P. Chandler Jr.

CREW ASSIGNMENTS

	PRIME	BACKUP	SUPPORT
Commander (CDR)	T.P. Stafford	L.G. Cooper	J.H. Engle
Command Module Pilot (CMP)	J.W. Young	D.F. Eisele	C.M. Duke
Lunar Module Pilot (LMP)	E.A. Cernan	E.D. Mitchell	R.E. Evans

MISSION OPERATIONS ORGANIZATION



The flight operations are under the direction of Chris Kraft at Houston, with these four flight directors (indicating) under the direction of Glenn Lunney.

The DOD recovery forces this time involve Task Force 130 and Task Force 140, with the prime recovery ship being the USS Princeton, which is a landing pad helicopter.

Next slide, please.

(Slide)

Now, the ground rules and guidelines for this mission are summarized here. One of the important ones is to lay this mission out as closely in a time line sense as the G mission or the first lunar landing mission No. 11.

We have five possible launch days across the eight-day period from the 18th through the 25th of May. It will be targeted to achieve most favorable lighting on the prime Apollo G landing sites 2, 3, 4 and 5.

We programmed the latter two days in the mission with some compromise in the lighting to give the additional flexibility of going an additional two days, the 24th and 25th, in the event that some problem prevents us from going on our earlier planned date of the 18th.

There will be a daylight launch and landing and recovery.

TLI -- translunar injection -- will be targeted for a free return circumlunar with a low point or perigee with the moon of 60 nautical miles and with an earth return perigee of 20 nautical miles.

We will use a two-stage lunar orbit injection as we did on Apollo 8, 60 by 170 miles on the first orbit, circularizing after two orbits to a 60 by 60 situation.

Next slide, please.

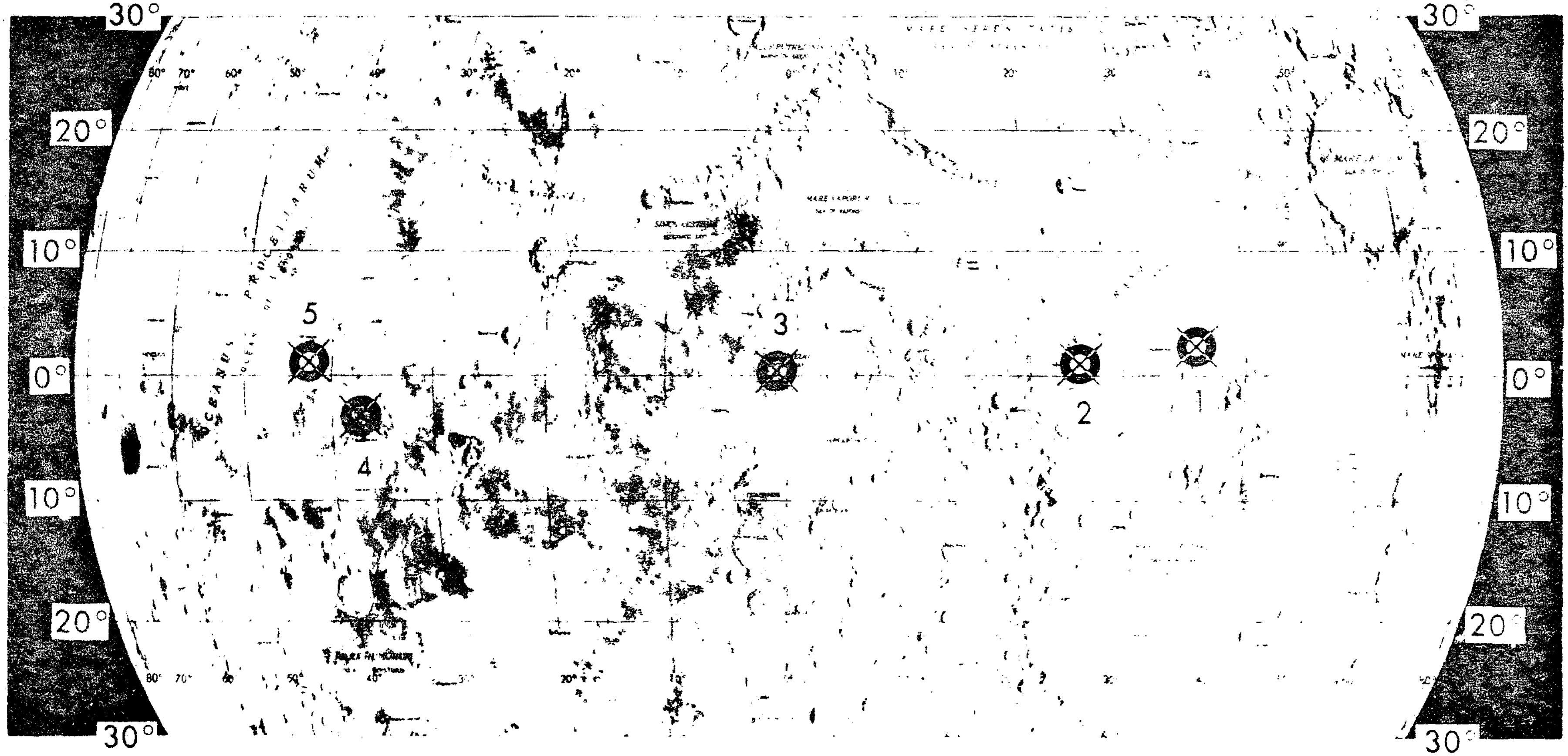
(Slide)

F MISSION DESIGN GROUND RULES AND GUIDELINES

- ENTIRE MISSION TO FOLLOW THE G MISSION TIMELINE AS CLOSELY AS POSSIBLE
- 5 POSSIBLE LAUNCH DAYS ACROSS 8 DAY PERIOD WITH 1,3,6,7,8 TYPE SPACING
- LAUNCH WILL BE TARGETED TO ACHIEVE MOST FAVORABLE LIGHTING FOR PRIME G SITES 2,3,4, AND 5
- THE TWO ADDITIONAL LAUNCH DAYS PAST THE NORMAL G WINDOW ARE TARGETED TO THE LAST G SITE - ACCEPTING HIGH SUN ELEVATIONS AT SITE 5
- DAYLIGHT LAUNCH AND LANDING
- TLI TARGETED FOR FREE RETURN CIRCUMLUNAR
    - LUNAR PERIGEE 60 N. MI.
    - EARTH-RETURN PERIGEE 20 N. MI.
- TWO STAGE LOI TWO REVS IN 60 BY 170 CIRCULARIZE TO 60 BY 60

MPAD 4992 S

APOLLO CANDIDATE LUNAR LANDING SITES



This chart depicts the changes that occur in launch time and the launch window as a function of the five days, the 18th through the 25th, in which we are prepared to launch. The earliest launch opportunity, as I previously mentioned, is at 11:49 on the 18th, the last opportunity being at 4:40 in the afternoon on the afternoon of the 25th.

The spread or time with these windows is a function of the azimuthal constraints launching out of Cape Kennedy.

The landing sites, as I previously indicated, that go with each of these launch opportunities are shown here, and this will be the expected lighting angle between the sun and the local horizontal at each of those landing sites when the spacecraft -- when the LM -- arrives in its low orbit pass 50,000 feet over the landing site selected for that mission.

As you note, on the last opportunity we have been willing to accept a slight degradation or higher lighting angle in order to have the flexibility of going on that day.

Next slide, please.

(Slide)

This chart here I think in a schematic way depicts the generic elements of the mission. And we have launch from ETR going into orbit with the opportunity for an S-IVB TLI burn -- I'm having a little trouble with this pointer -- right there either on the second or third orbit.

The fundamental differences that I wanted to highlight in showing the key events of the mission, as racked up here, are that the mission is slightly more than eight days in duration, assuming launch on the first opportunity at 11:49. One other point is that from the time of undocking on the fourth day until we bring the spacecraft back together is about eight hours and ten minutes. This compares with an undocked period of about six hours on the Apollo 9 mission.

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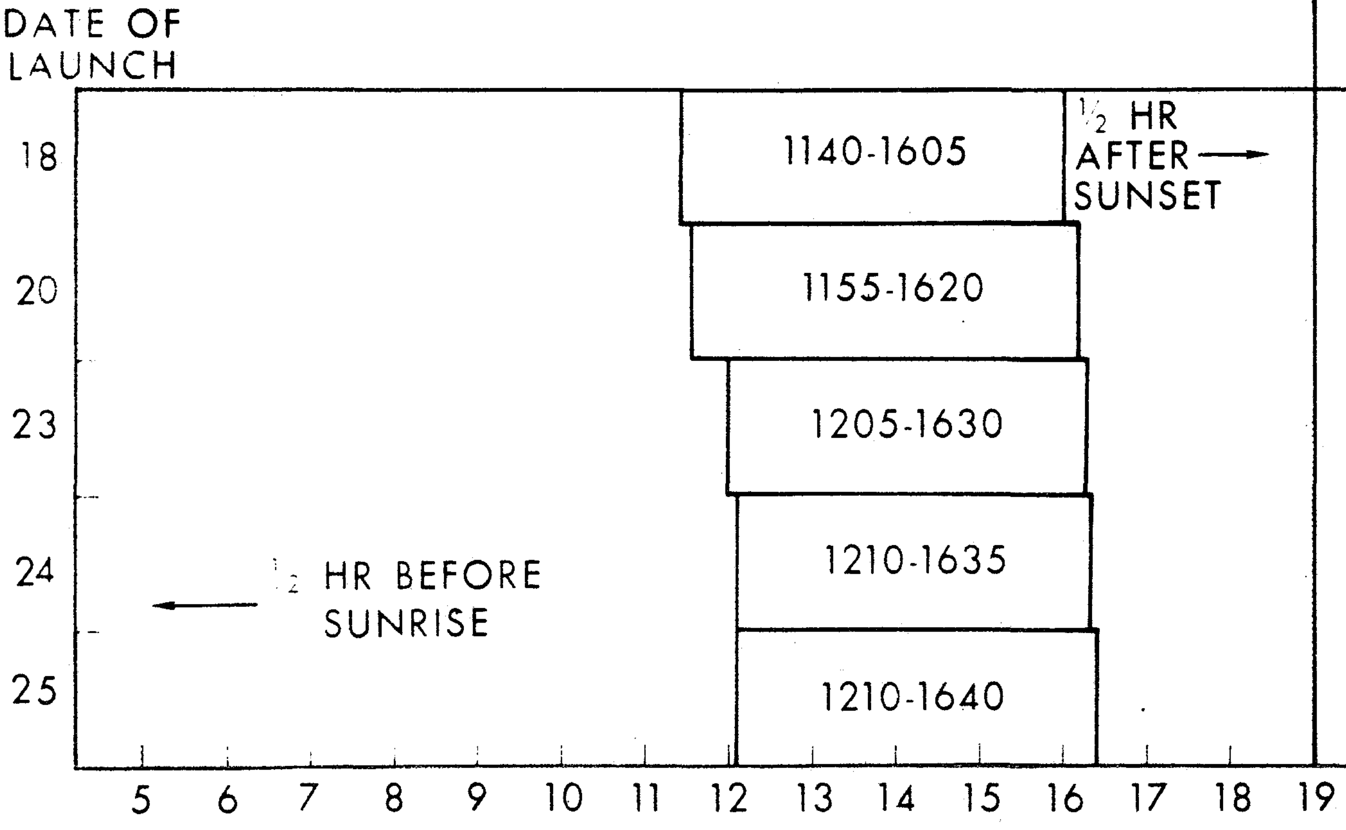
(Slide)

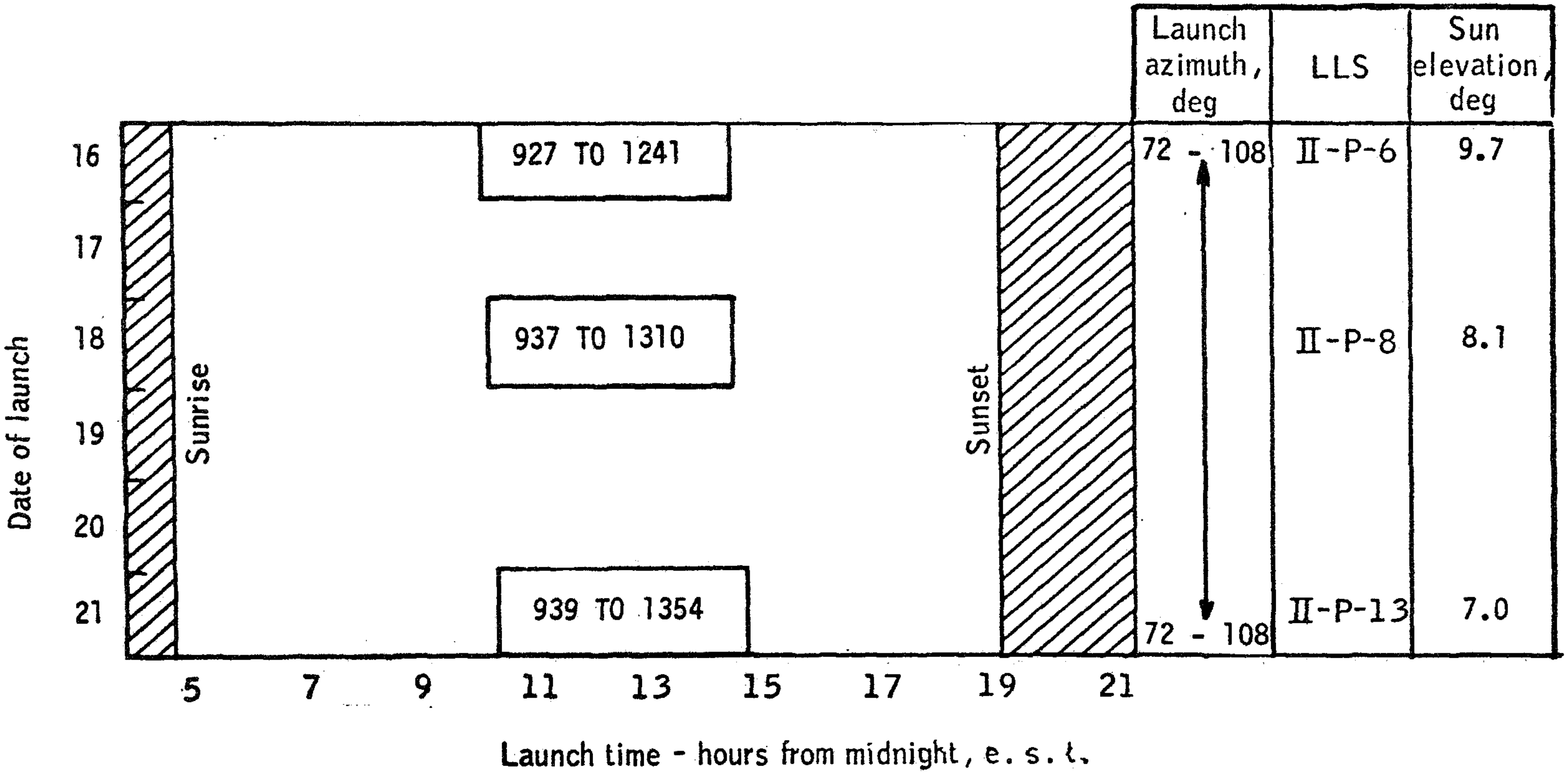
LAUNCH WINDOW SUMMARY
PACIFIC INJECTION



DATE OF LAUNCH	LAUNCH AZIMUTHS	LLS*	SUN EL AT LLS
18	72-108°	2	11.4
20		3	10.9
23		4	10.3
24		5	17.0
25	72-108°	5	28.0

*LLS - LUNAR LANDING SITE

PRELIMINARY LAUNCH WINDOW SUMMARY, JULY 16 - JULY 22, PACIFIC INJECTION



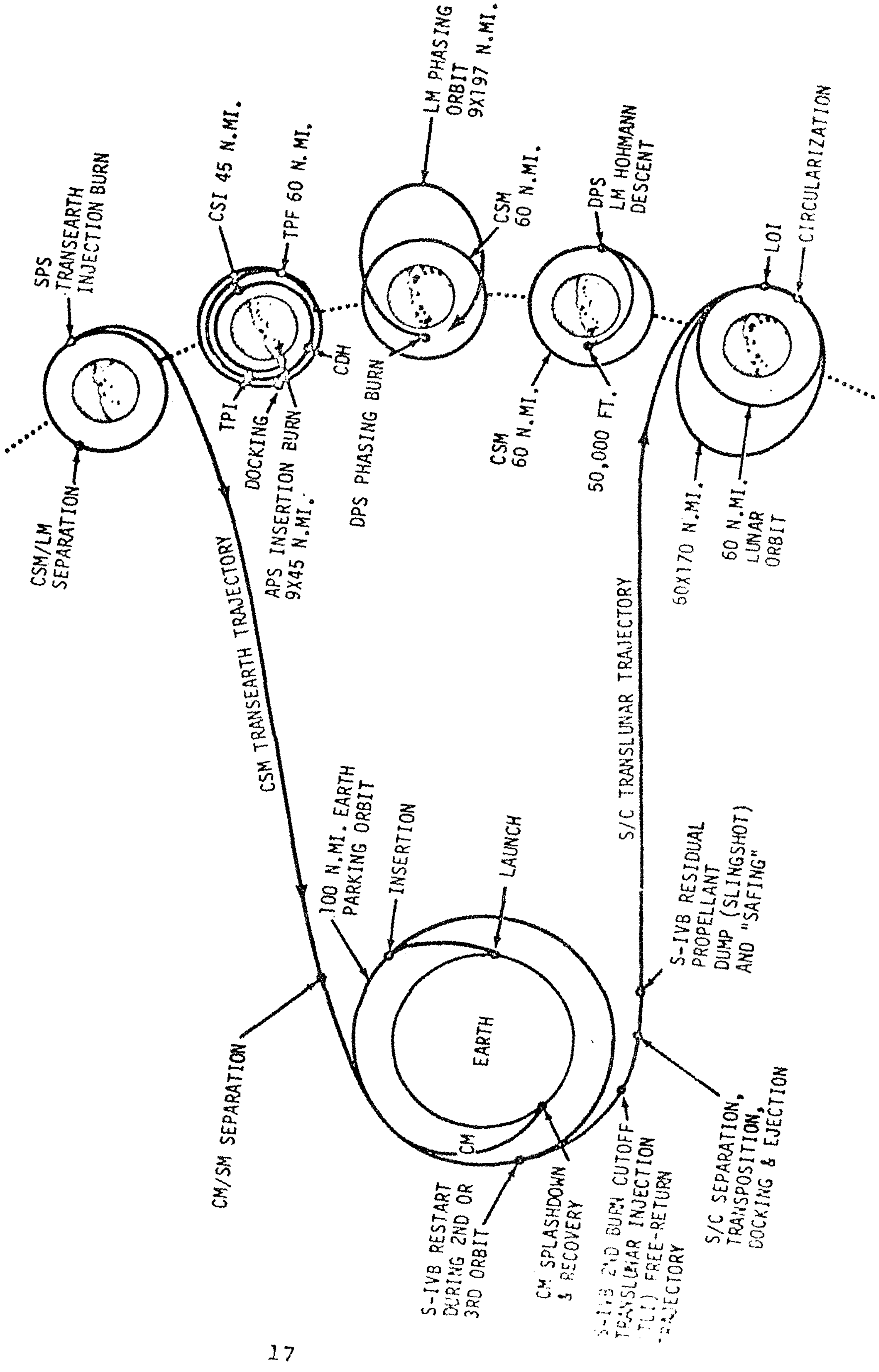
MISSION SUMMARY MAY 18, 72° - 1

	DAYS: HRS: MIN: AFTER LAUNCH
LAUNCH	00:00:00
TRANSLUNAR INJECTION	00:02:34
LOI-1	03:04:49
LOI-2	03:09:07
UNDOCKING	04:02:30
DOI	04:03:54
PHASING	04:05:06
INSERTION	04:07:03
DOCKING	04:10:40
APS BURN TO DEPLETION	04:13:04
TEI	05:18:26
TOUCHDOWN	08:00:08

MISSION SUMMARY MAY 18, 72° - 1

LAUNCH TIME	11:49 E.S.T.
EARTH PARKING ORBIT COAST TIME	2HR 22MIN
TRANSLUNAR INJECTION BURN DURATION	5MIN 20SEC
TRANSLUNAR FLIGHT TIME	74HR 10MIN
TOTAL FREE-RETURN CIRCUMLUNAR FLIGHT TIME	149HR 51MIN
LOI-1 BURN DURATION	5MIN 51SEC
LOI-1 ΔV	2856 FPS
LOI-2 BURN DURATION	14.5SEC
LOI-2 ΔV	137 FPS
DOI - Δt FROM LOI-1	24HR
PHASING	DOI + 1HR 12MIN
INSERTION	DOI + 3HR 07MIN
RENDEZVOUS	DOI + 6HR 15MIN
APS BURN TO DEPLETION	DOI +~9HR
LANDMARK TRACKING AND ORBITAL NAVIGATION	DOI + 19HR
TRANSEARTH INJECTION BURN DURATION	2MIN 58SEC
TRANSEARTH INJECTION BURN ΔV	3694 FPS
TRANSEARTH FLIGHT TIME	53HR 25MIN
INERTIAL VELOCITY AT 400 000 FEET	36 325 FPS
TOTAL MISSION TIME	8DAYS 0HR 08MIN

FLIGHT PROFILE



Now, after the translunar injection burn, the spacecraft prepare for transposition and docking. The first event that occurs is the command module initiates the deployment of the spacecraft LM vehicle panels which are blown away pyrotechnically. The command module proceeds away from the S-IVB, does a 180-degree maneuver, comes back in, docks with the lunar module, and then the two of them back away from the S-IVB.

Next chart, please.

(Slide)

This is then a configuration of the two spacecraft in the dock configuration throughout the translunar phase of the mission.

Next slide, please.

(Slide)

Now, after the two spacecraft have successfully accomplished the transposition and docking and have separated an acceptable distance away from the S-IVB, the S-IVB will be passivated and put into a slingshot maneuver which in effect causes it to traverse a trajectory as shown here, wherein the gravity field of the moon is used to force that vehicle into a permanent solar orbit.

Next slide, please.

(Slide)

The time variation that we anticipate as a function of launch day and the time in the window when we launch, this being the beginning on a particular day and this the end (indicating), varies from a minimum of 75.2 hours to 69.3 hours on the last day of the window.

That difference is largely a result of the fact that the moon's orbit around the earth is not circular but elliptical, and therefore the distance is a variable depending on the day of the month that we launch.

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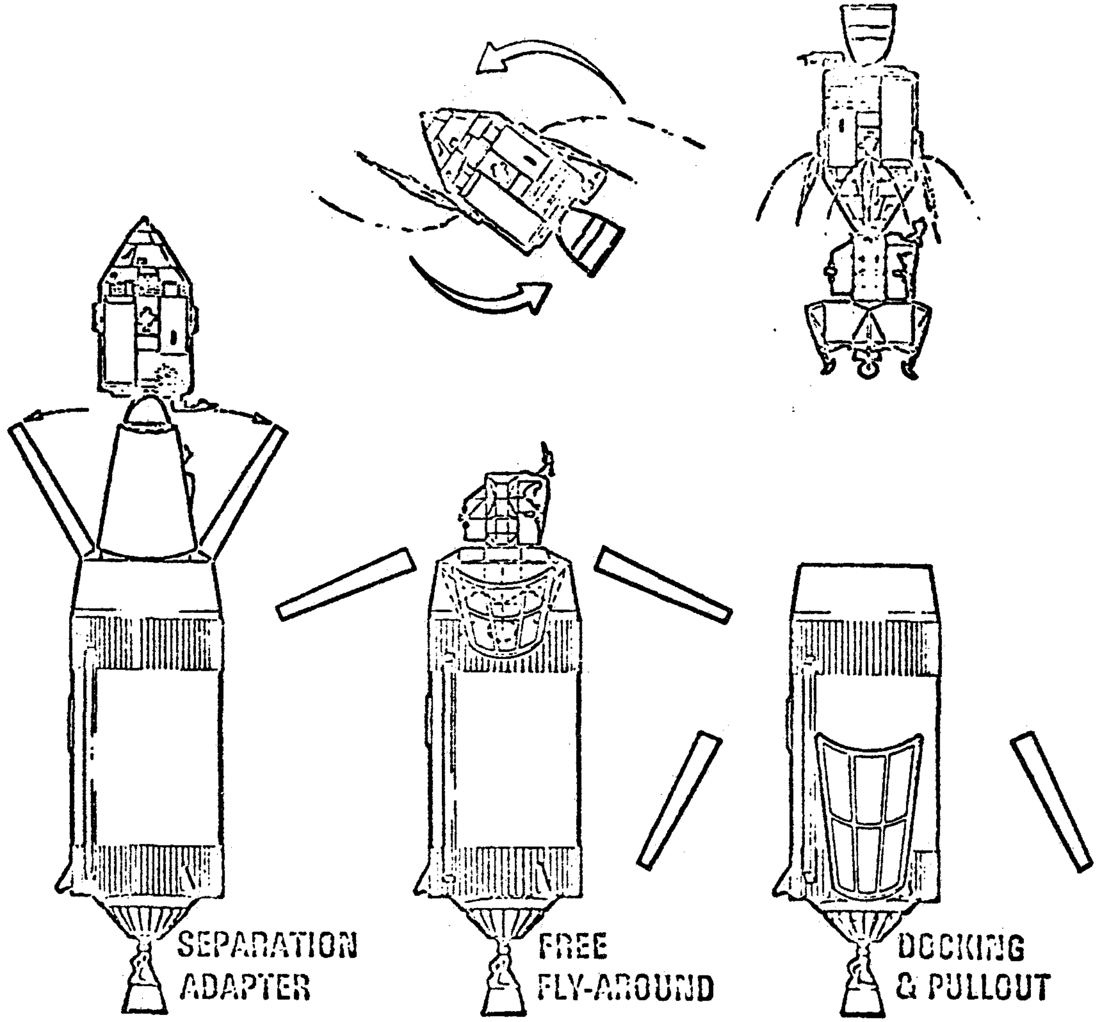
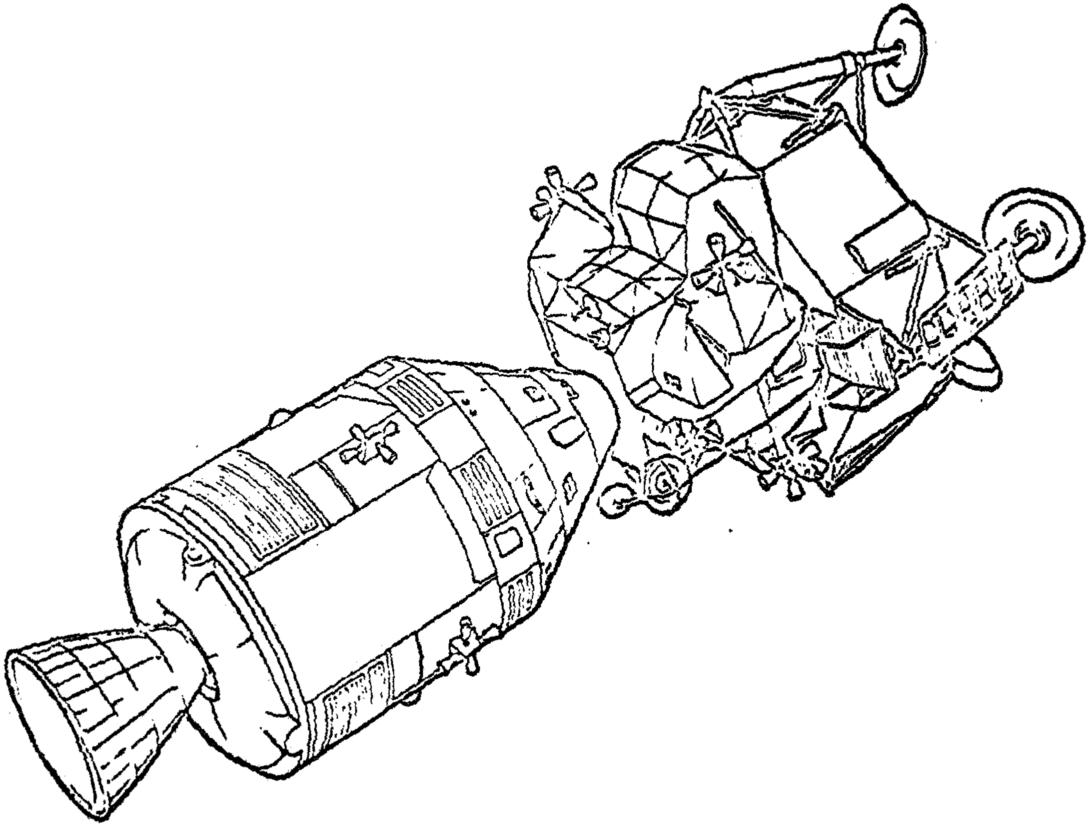
TRANSPOSITION & DOCKING



APOLLO SPACECRAFT
TRANSLUNAR CONFIGURATION



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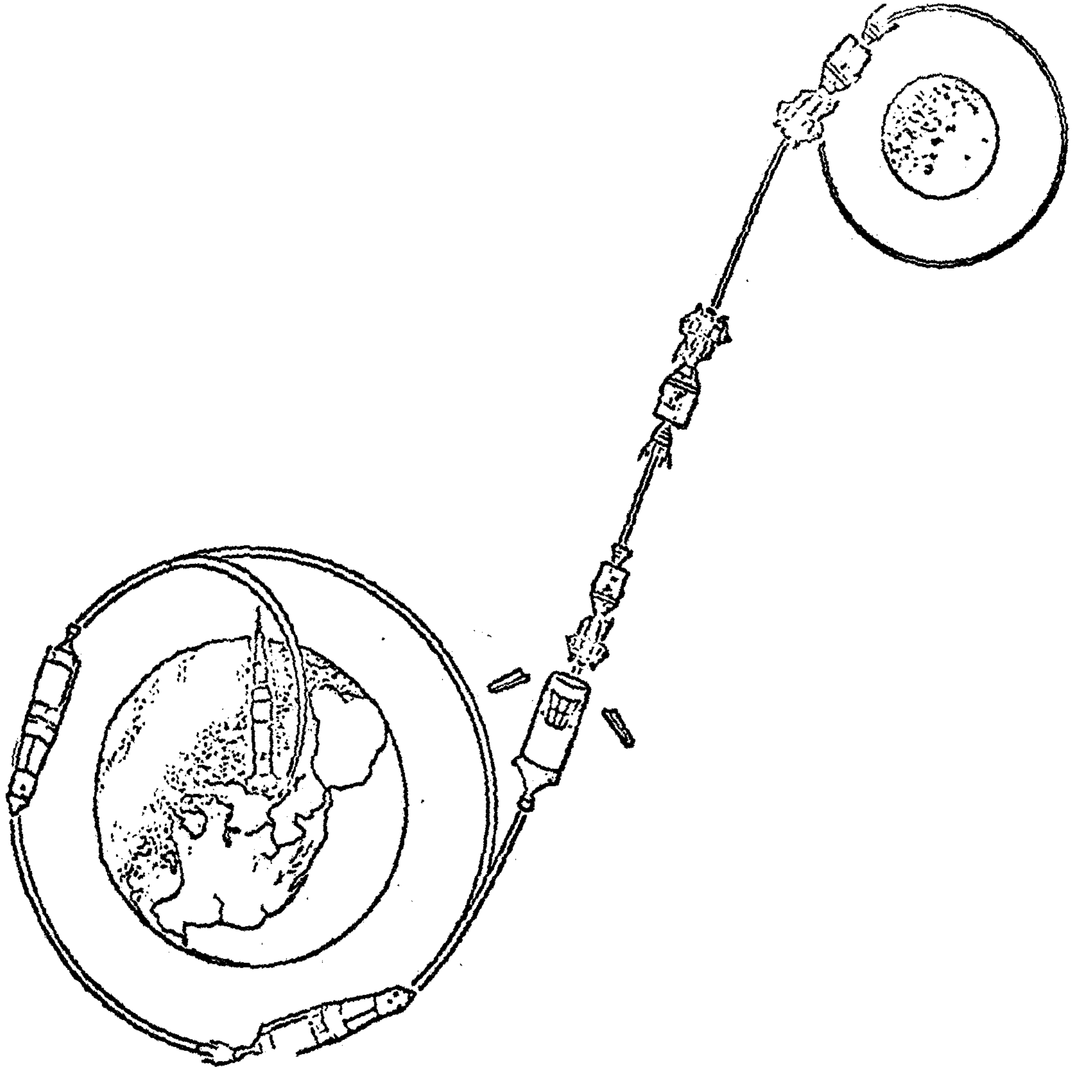
TRANSLUNAR



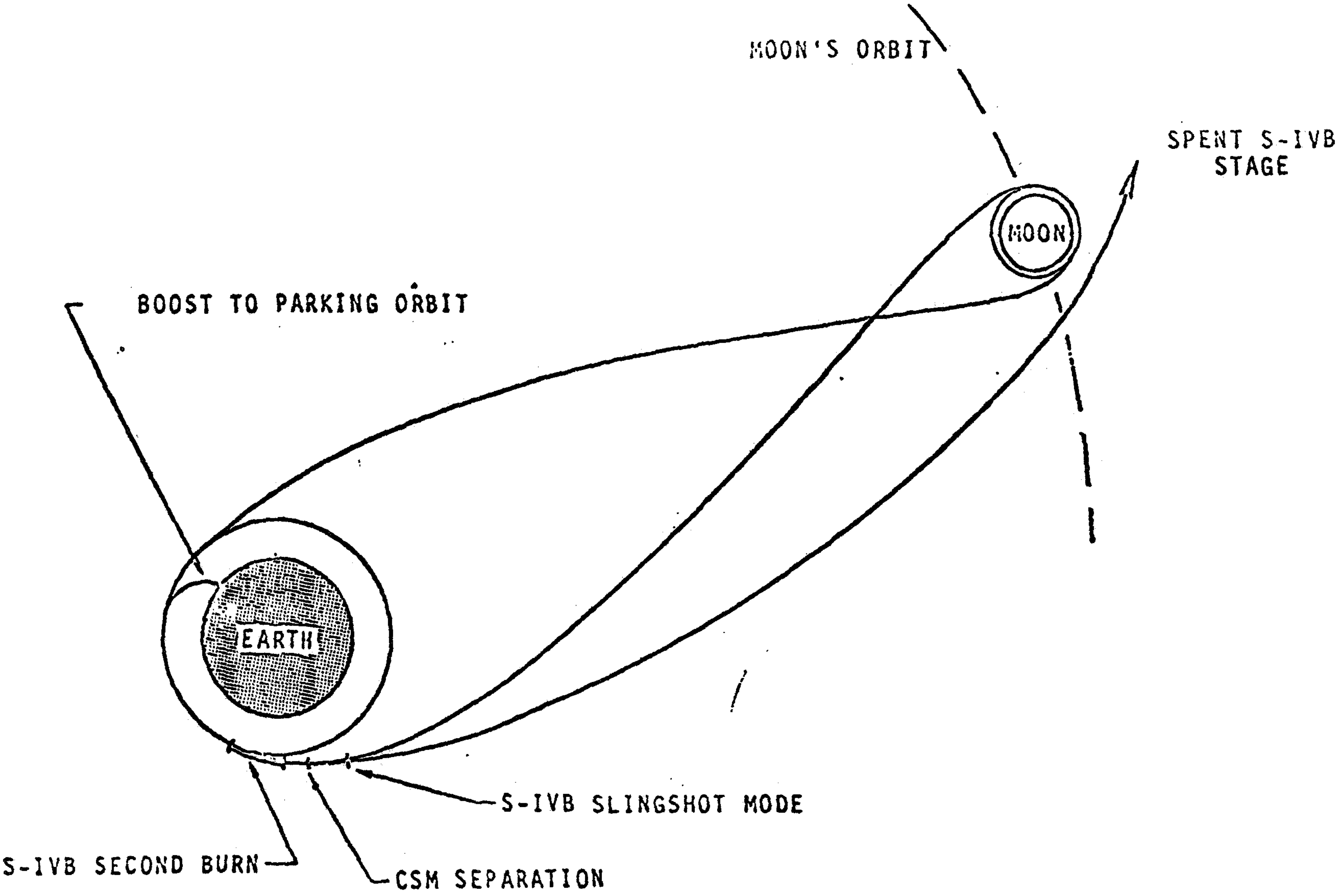


FIGURE 7-1 AS-505F/APOLLO-10 MISSION PROFILE

CIRCUMLUNAR FREE RETURN

MAY	18	20	23	24	25
TRANSLUNAR FLIGHT TIME, HR	75.2 ↓ 75.5	74.9 ↓ 75.1	70.6 ↓ 71.3	70.0 ↓ 70.2	69.1 ↓ 69.3

Next slide, please.

(Slide)

One interesting chart that I thought we would show today is a plot of the velocity of the two spacecraft after the translunar injection burn as it decreases, as we move away from the earth, until finally we reach the point where the moon's gravitational influence actually starts to speed the combination back up again prior to the time that we do the lunar orbit injection burn.

As you can see, that range of speed varies from about 25,000 miles per hour at the time we leave the earth to a low of something in the order of something less than 500 miles per hour, and then finally back up to something like 8,000 miles per hour at time of injection.

This mission profile is planned, as was Apollo 8, with four midcourse corrections going out, three coming back. And I mentioned previously that we will use the two-step injection into the final circular orbit around the moon.

Our expected time of duration in lunar orbit is slightly more than 61 hours.

Next slide, please.

(Slide)

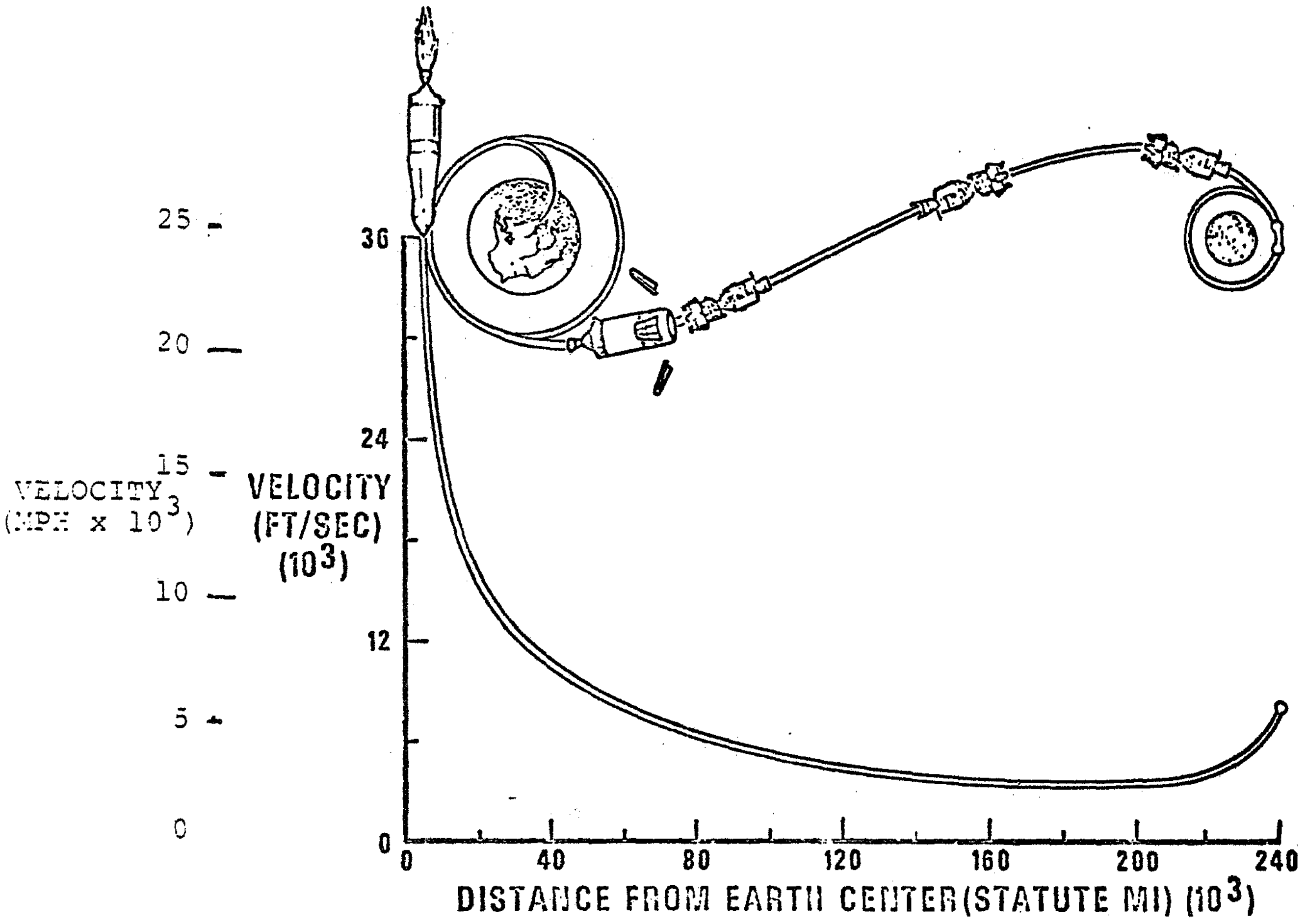
I have already covered the two-stage lunar orbit insertion discussion. Both of the burns involved are fixed attitude burns, in that the vehicle is lined up with a particular orientation to inertial space, and then burned until the required velocity is attained.

After the final midcourse maneuver as the spacecraft is coming in towards the moon, the vehicle is rotated as shown here in a direction such that when the insertion burn is made the service propulsion engine causes a retrograde or slowing down of the vehicle to place it in this orbit.

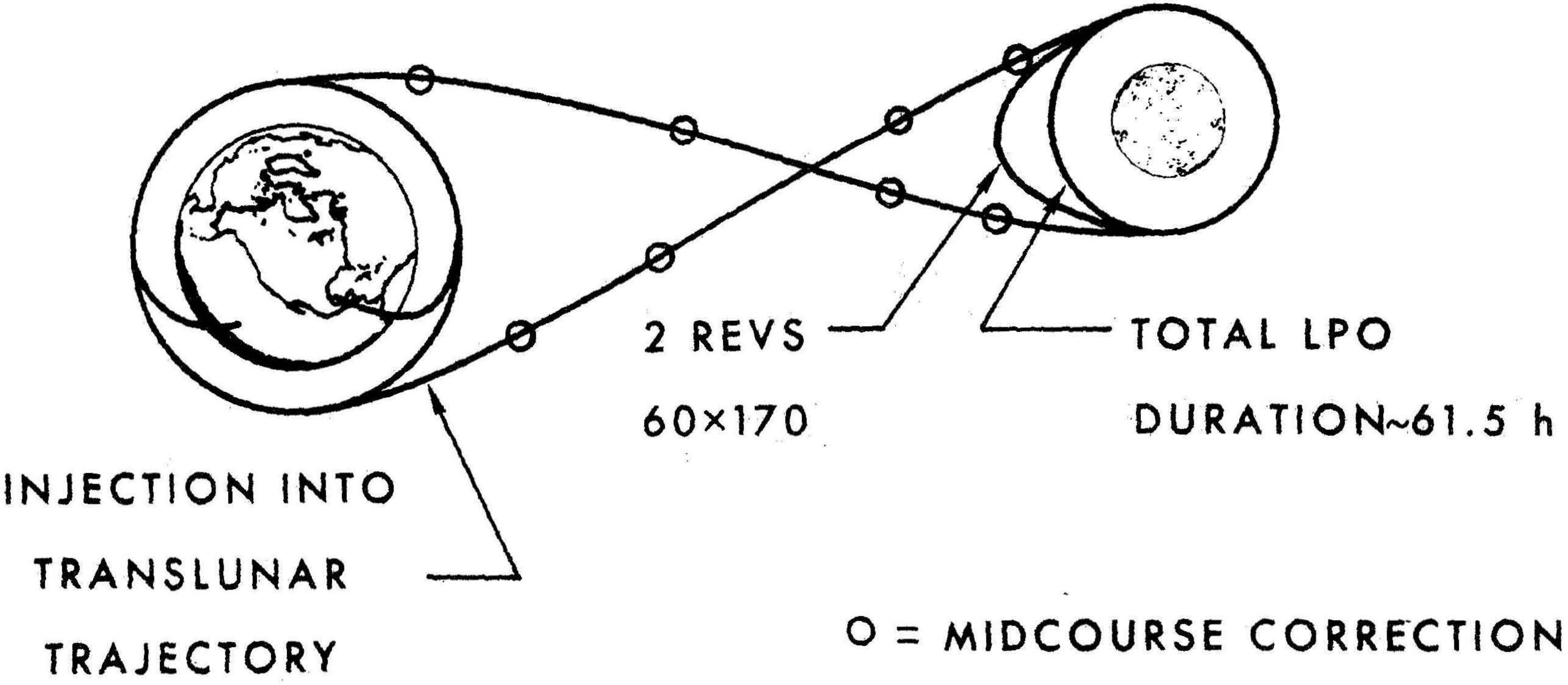
Again on the side away from the earth the circularizing maneuver is made to find the place to get to the 60 nautical mile orbit.

Next slide, please.

TRANSLUNAR VELOCITY PROFILE



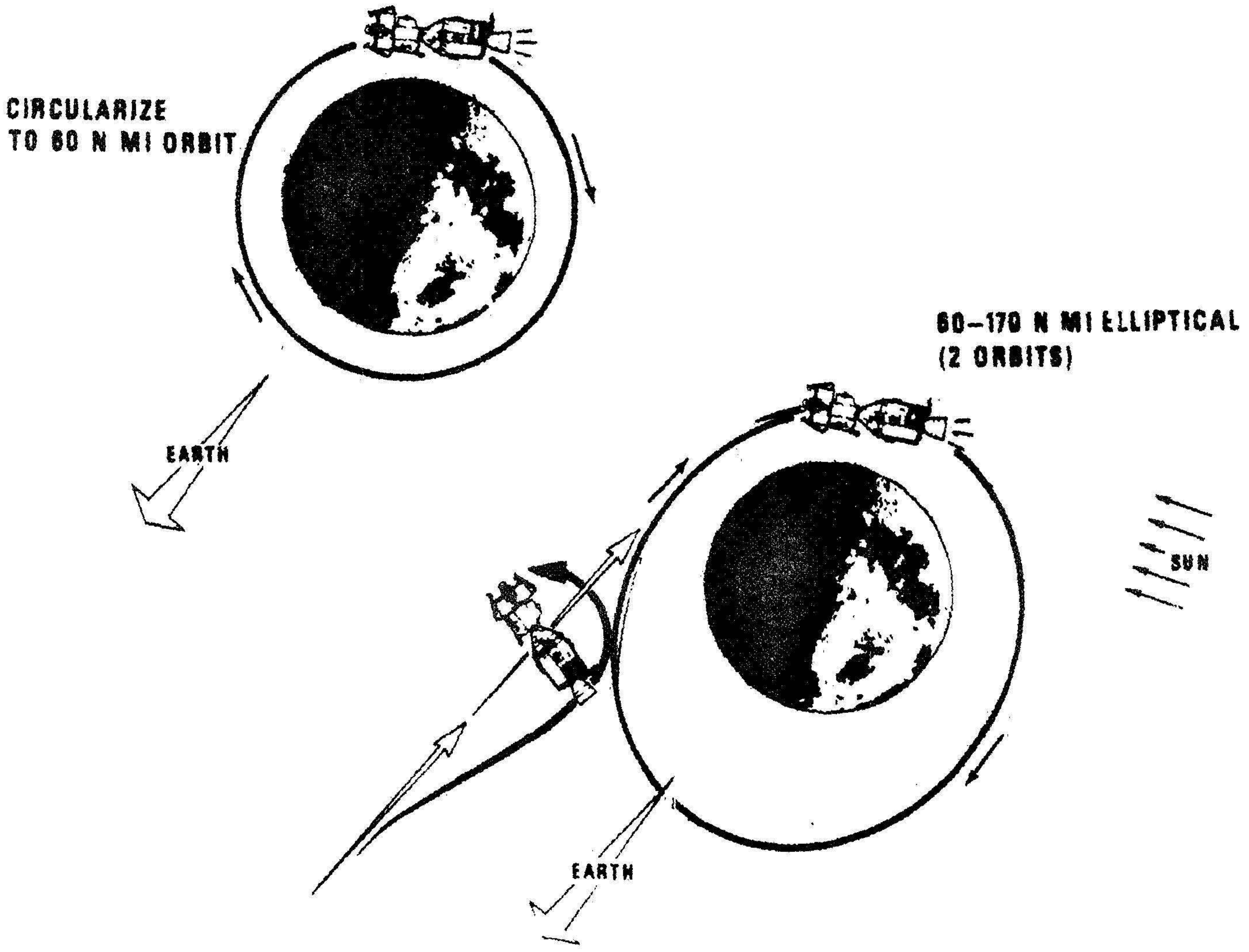
MISSION PROFILE



LUNAR ORBIT INSERTION

- TWO-STAGE:
    - LOI(1)—60 × 170 WITH PLANE CHANGE
    - LOI(2)—60 × 60 IN PLANE
- FIXED ATTITUDE BURNS

LUNAR ORBIT INSERTION



(Slide)

Now, in order to acquaint you all with some of the acronyms that we use quite broadly on the program, I have listed some of the key ones in the next slide. Let me take just a moment here to go through them briefly to give you a chance to read them.

I think most of you are familiar with MSFN, the Manned Spaceflight Network.

LOS means we have lost communication with the spacecraft because it has gone behind the moon.

AOS is when we acquire it again.

DPS is descent propulsion system of the lunar module.

APS is the ascent propulsion system of the lunar module.

DOI is the descent orbit insertion that the lunar module makes in its move down towards the 50,000-foot altitude.

CSI is one of the rendezvous maneuvers called concentric sequence initiation, which Colonel McMullen will discuss in more detail, as will he discuss CDH or constant differential height maneuvers.

TPI is approaching the final phase of the rendezvous, the so-called terminal phase initiation.

PC here is used as plane change, since there is always some small residual plane change required to bring the two spacecraft back together in the same inertial plane.

Next slide, please.

Now, this chart emphasizes two points. We have worked very hard on the F mission to make the time line from the time the spacecraft go into the first lunar orbit until they come back out on their way home as close as we can to the lunar landing G mission. And, as you will see, the first 30-some hours of these two missions are planned to be identical.

KEY

MSFN - MANNED SPACEFLIGHT NETWORK

LOS - LOSS OF MSFN SIGNAL

AOS - ACQUISITION OF MSFN SIGNAL

DPS - DESCENT PROPULSION SYSTEM

APS - ASCENT PROPULSION SYSTEM

DOI - DESCENT ORBIT INSERTION

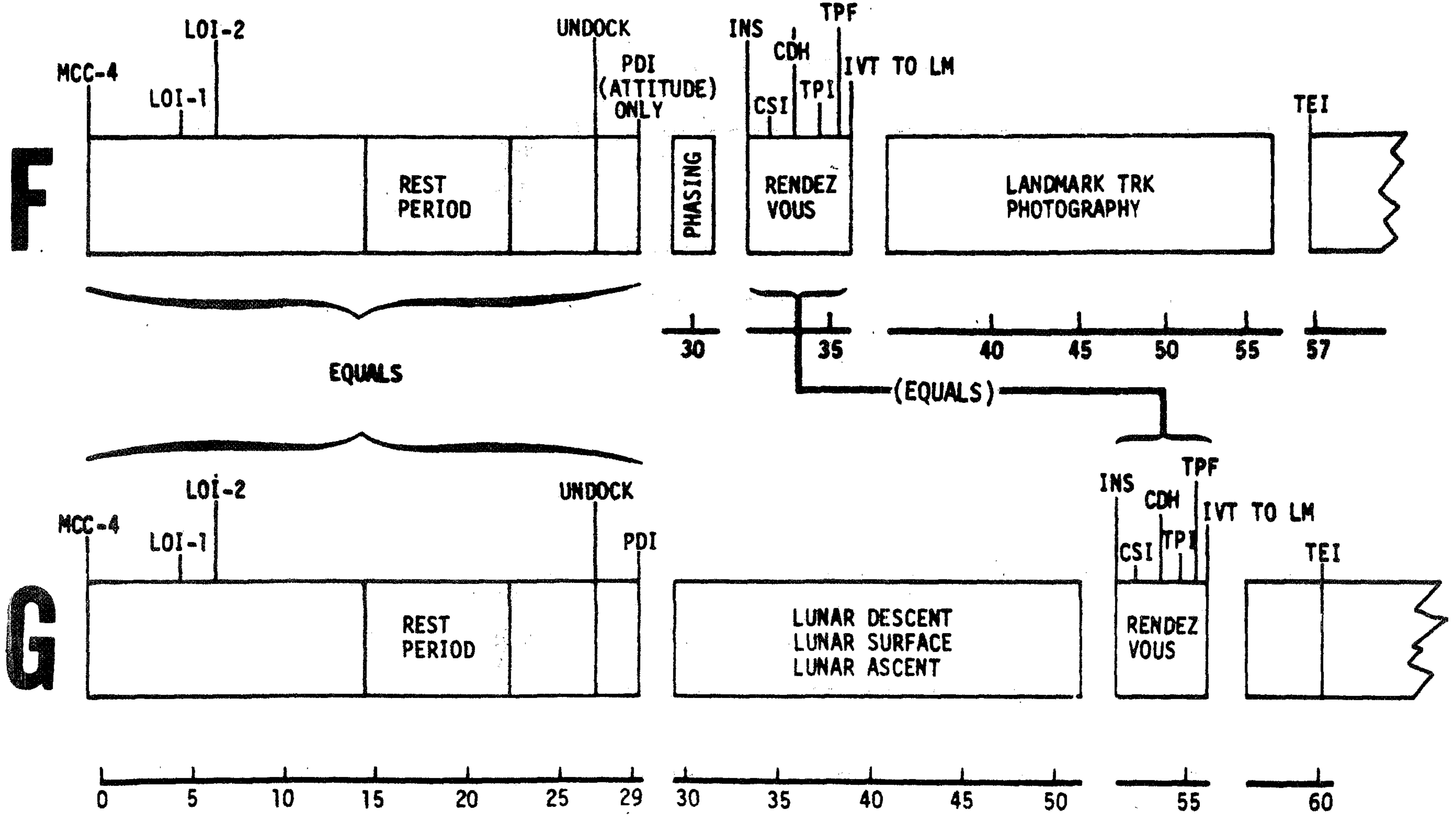
CSI - CONCENTRIC SEQUENCE INITIATION

CDH - CONSTANT DIFFERENTIAL HEIGHT

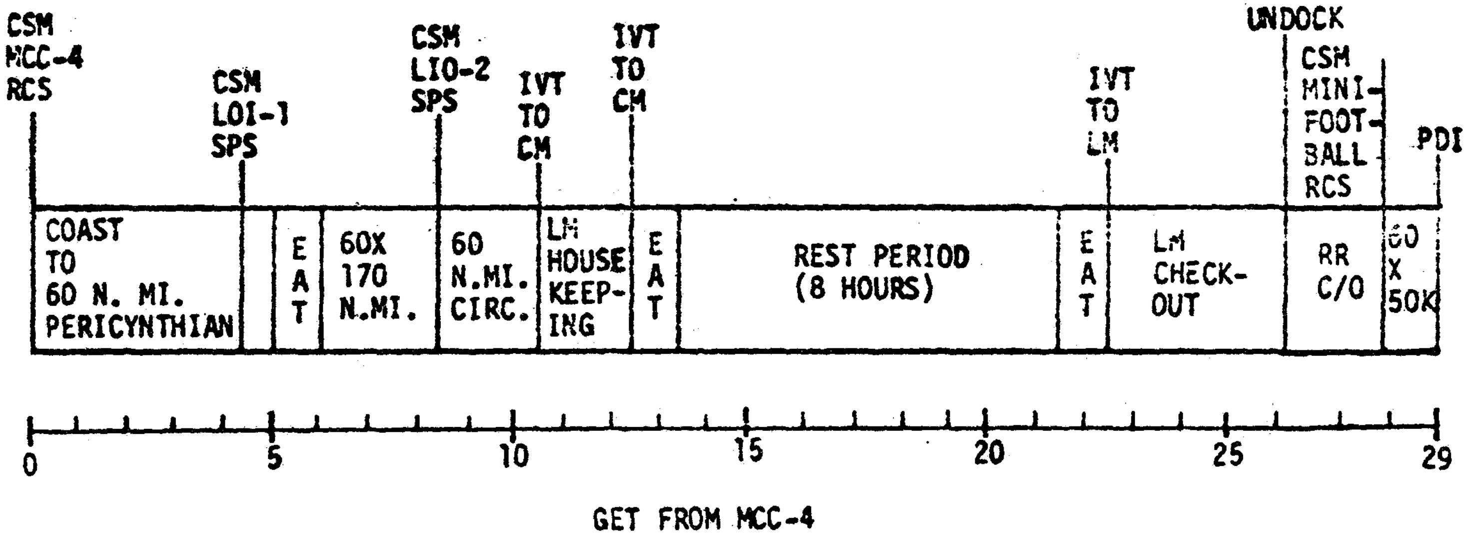
TPI - TERMINAL PHASE INITIATION

PC - PLANE CHANGE

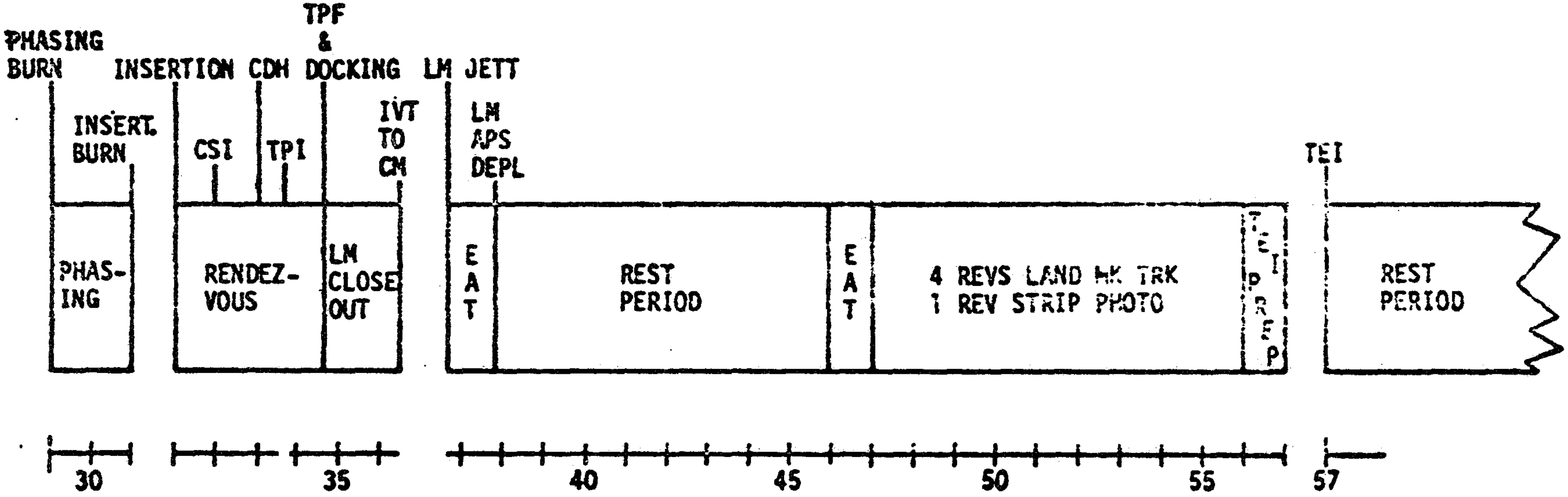
F/G MISSIONS LUNAR ACTIVITY COMPARISON



F MISSION LUNAR ACTIVITY



F MISSION LUNAR ACTIVITY
(CONCLUDED)



I would also point out that we have arranged this mission such that the rendezvous for the two missions are as close to identical as we can make them.

The one unique feature in the F mission is that we have a phasing burn earlier and special only to the F mission which earlier in the lunar orbit time line sets up conditions so that a rendezvous can be conducted here rather than here (indicating) in the time line under the same conditions of lighting and other parameters relative to that orbital geometry exercise.

In the case of the G mission, of course, we have this block of time set out for the descent, the lunar surface activities, and return back to lunar orbit.

We have transposed that with this block of time on the F mission (indicating) and will use this to provide additional photography and landmark tracking of certain selected key landmarks on the lunar surface.

One other point. I apologize for an error on this chart. We should have started our time bar here at LOI-1 instead of the last midcourse maneuver, and then that plus the fact that we left out a little block of time here (indicating)-- It turns out that the time in orbit from LOI until TEI is actually a little over 61 hours. So there is an error in that time scale.

With those comments, I would like to ask Tom McMullen to lead you through the steps in the rendezvous maneuvers.

McMULLEN: Thank you, George.

Can we go to the next slide, please.

(Slide)

As I go through the discussion here, I would like to emphasize the point that Mr. Hage has already made -- the great deal of effort that has gone into making the maneuvers at lunar distance during this mission similar to those we will actually be performing on lunar landing mission next time.

Let me explain a little bit the slide before we also get into discussing maneuvers themselves.

You can see we have two plots of the spacecraft, this one down here and this one up here. The one on the right-hand side is what you would see if you were standing off somewhere in space and looking at the moon with the two spacecraft going around. So you can imagine yourself somewhere out in space, say on the earth, with good eyes, and have ability to see this amount of detail.

The scale, of course, is not quite true, in that the orbits are shown quite a bit higher or larger with respect to the size of the moon.

We have the moon divided into different colors here. The solid shows when both the spacecraft and the lunar surface are in darkness. The next two pie-shaped areas show when the spacecraft is illuminated by the sun but the surface still is dark. And, of course, on the upper right-hand side, both the spacecraft and the lunar surface are illuminated.

Over on the lower left here we have a plot which shows the relative motion of the two vehicles to each other, and on this one you can imagine that you are sitting on top of the command and service module and watching the LM maneuver about you.

Okay. So now I think we are ready to go ahead and discuss the first maneuver, and it is the separation maneuver. It is quite similar to the separation maneuver we made on the Apollo 9 mission just completed. It consists of a small radial burn by the command and service module using the service reaction control system. This is two-and-a-half feet per second. And it gives the command and service module a small increment of downward velocity.

This does not change the period of the command and service module, so the lunar module and command and service module are still going around the moon and will complete one orbit in the same length of time. However, it does provide a maximum of about 1.8 nautical miles between the two and about a half a mile in height.

And here we see that although the burn is made by the command and service module, it would appear to the command and service module as though the lunar module were going up and behind it.

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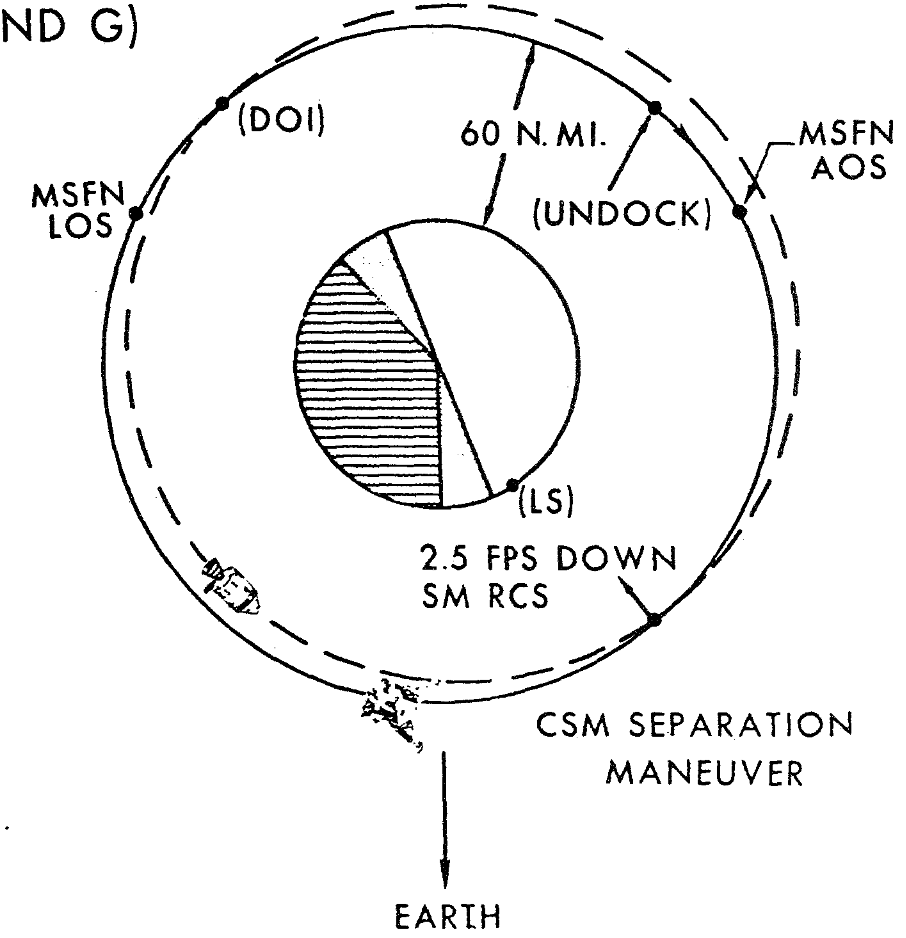
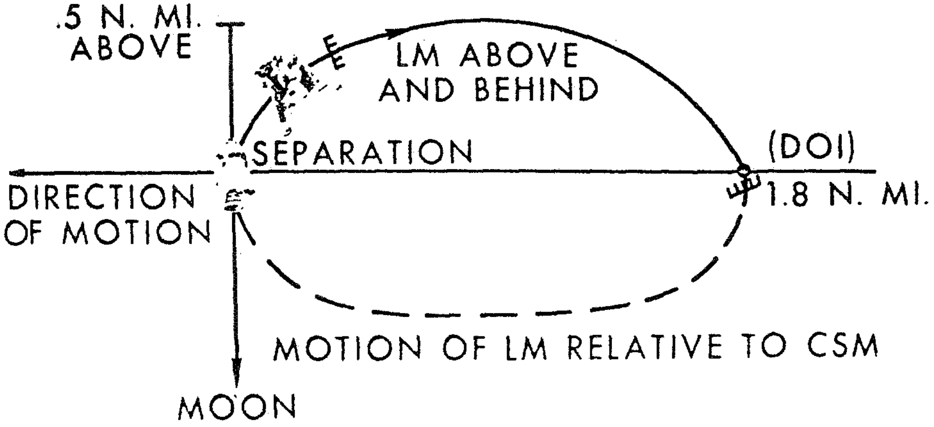
SEPARATION
(SAME FOR F AND G)

☐ SURFACE DARKNESS

▨ SC DARKNESS





And after this small burn, the two vehicles will separate, and as the lunar module drifts up and behind the command and service module, certain checks will be made to be sure we want to proceed.

And if we decide not to proceed, we just without any further burns continue on around this maneuver line here until the two are back together, and a very small burn, and they would again be back in the same orbit.

However, if the systems look good, the rendezvous appears to be working satisfactorily, at this point then we will perform our descent orbit insertion burn.

Next slide, please.

(Slide)

The descent orbit insertion burn is a maneuver that is performed by the lunar module descent propulsion system. It starts up with the rocket engine throttled up to 10 per cent for about 15 seconds, and then the throttle is advanced to 40 per cent for the remainder of the burn, which is about another 11 seconds.

At the end of this burn, the two vehicles will be in the orbits as shown here with the lunar module descending downward closer to the lunar surface and the command and service module continuing on around this fairly circular orbit.

One of the other points I should have mentioned is we show on these charts the point at which the Manned Spaceflight Network will acquire and lose sight of the lunar module as it goes behind the moon.

Also, on the relative motion plot here now, we see the separation burn is this small dotted line right here to a different scale than we saw previously. And then we also see the descent orbit -- the results of the descent orbit insertion -- as the lunar module now moves down, passes directly underneath the command and service module by about 20 nautical miles' difference, and then proceeds on down where it reaches a distance of 52 nautical miles below the command and service module.

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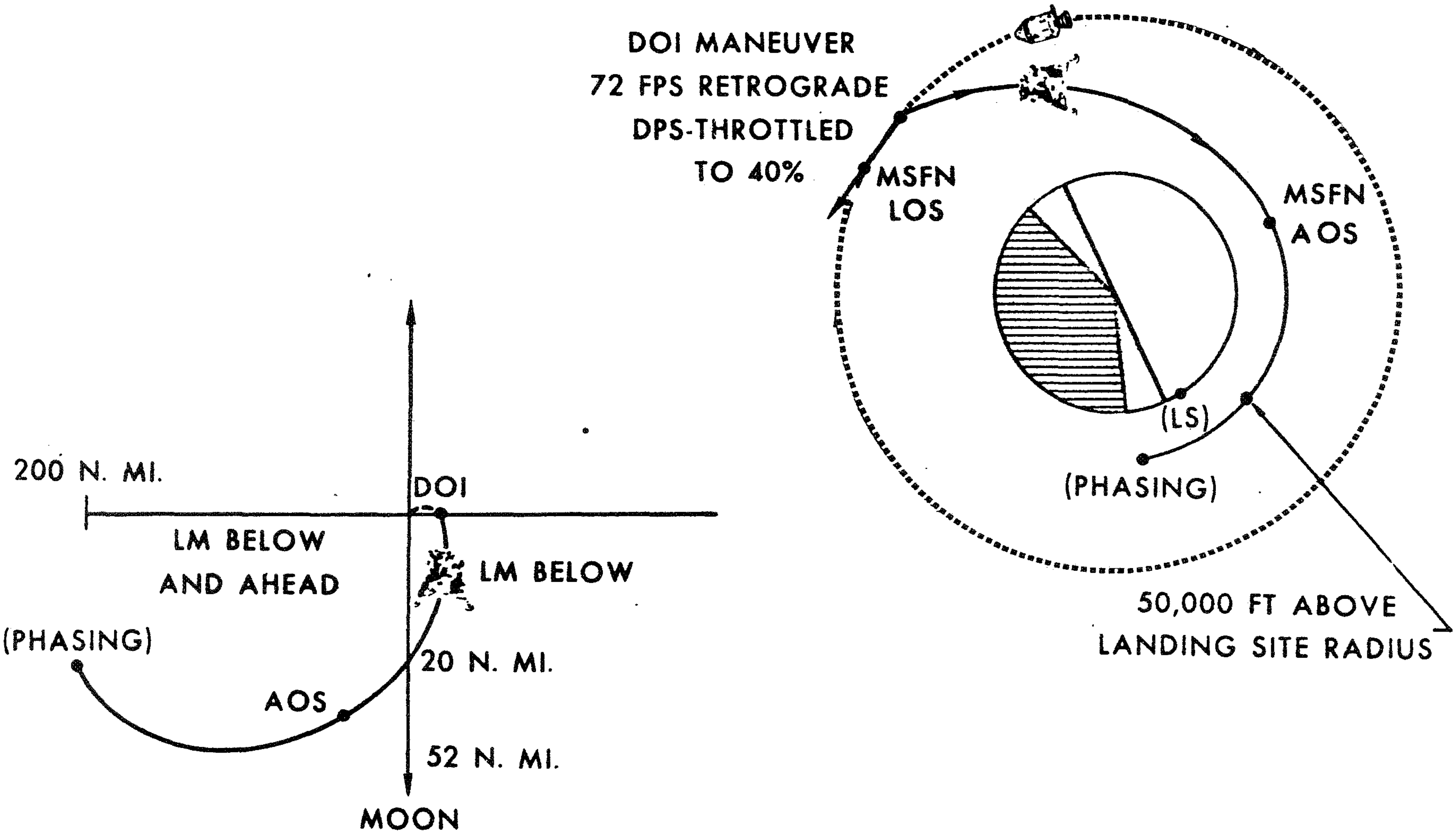
DESCENT ORBIT INSERTION

(SAME ON F AND G)



Okay. In the course of the burn it is hoped to bring the lunar module down to a point that is 50,000 feet or about eight nautical miles above the landing site.

Okay. Next chart, please.

(Slide)

Here we have a picture, a series of pictures, of the lunar module as it passes over the lunar surface. And proceeding from left to right as we start out, we see that the lunar module is moving with the engine side facing forward and the astronauts looking down towards the lunar surface. And about minus 600 seconds they will yaw the vehicle around so they look out of the front of the vehicle facing up. And this is to permit several things, one to be similar to the way it is going to be handled on the lunar landing mission, but primarily to permit us to initiate a landing radar checkout.

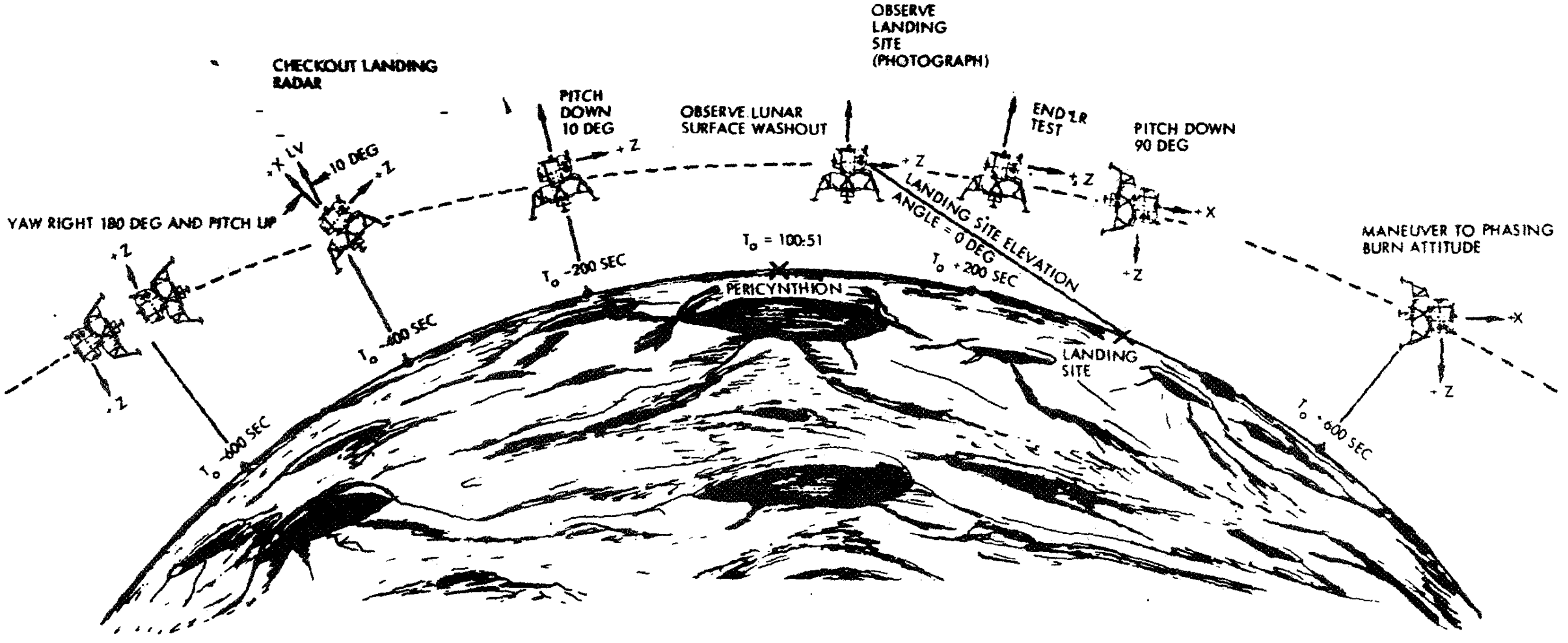
As you know, this is one system that we haven't really had a good check on to date on a spacecraft flight test. And this checkout will begin with the vehicle in this attitude, and as we get down to the minus 400 seconds or pericynthion, or the closest point of passage to the lunar surface, the vehicle will pitch around to where its vertical axis is 10 degrees inclined from the local vertical, and at this time we should be getting a lock on from all four trackers of the landing radar.

The landing radar tests will continue as the vehicle continues and makes another small attitude change here, pitch down 10 degrees, so this vertical axis is now aligned with the local vertical.

As they pass on around, they will also pass a point where the astronauts' line of sight to the landing site is parallel to the rays of the sun as it comes in, so they will have some opportunity to measure the surface washout.

And then as they pass on over the landing site, they will pitch the vehicle over so they will be looking vertically down and have a chance to get some good both optical and photographic tracks of the landing site.

NEAR LUNAR SURFACE ACTIVITY



Okay. The next maneuver they will be making will be the phasing burn which Mr. Hage mentioned a moment ago.

Can we go to the next chart, please?

(Slide)

As he mentioned, the purpose of the phasing burn is the point that we initiate the phasing burn-- I'm sorry. A little bit before we would have done this phasing burn we would have started the power descent on the lunar landing. In this case, however, we just fly over the landing site, and we get to this point, and we perform a phasing burn which is to get us back into position with respect to the command and service module to perform rendezvous identical with what we will be doing on the lunar landing mission.

So the phasing burn is again performed with the descent propulsion system. It is a posigrade maneuver to increase velocity, hence increase the aposynthion distance specifically with the point in mind of increasing the period of the orbit so that the LM which is now in front of and below the CSM can wind up in a position behind and below the CSM.

We see that the descent propulsion system is again throttled to 10 per cent, this time for about 26 seconds, and then the throttle is advanced to the fixed throttle which is about 92.5 per cent thrust for the remainder of the burn, which is about another 15 seconds.

The apocynthion distance or height is 194 nautical miles above the lunar surface. And then as the vehicle coasts back down, it will find itself behind the command and service module at this point. The lunar module will be staged such that the descent stage will be cast off and will wind up with the ascent stage, and, of course, the ascent propulsion system uncovered for our next burn.

Next chart.

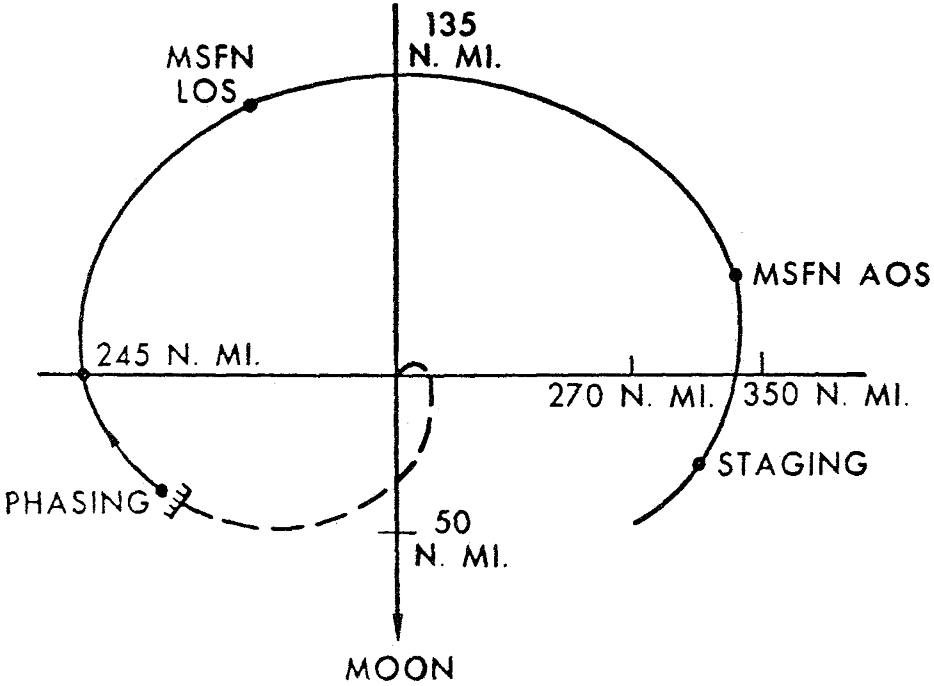
(Slide)

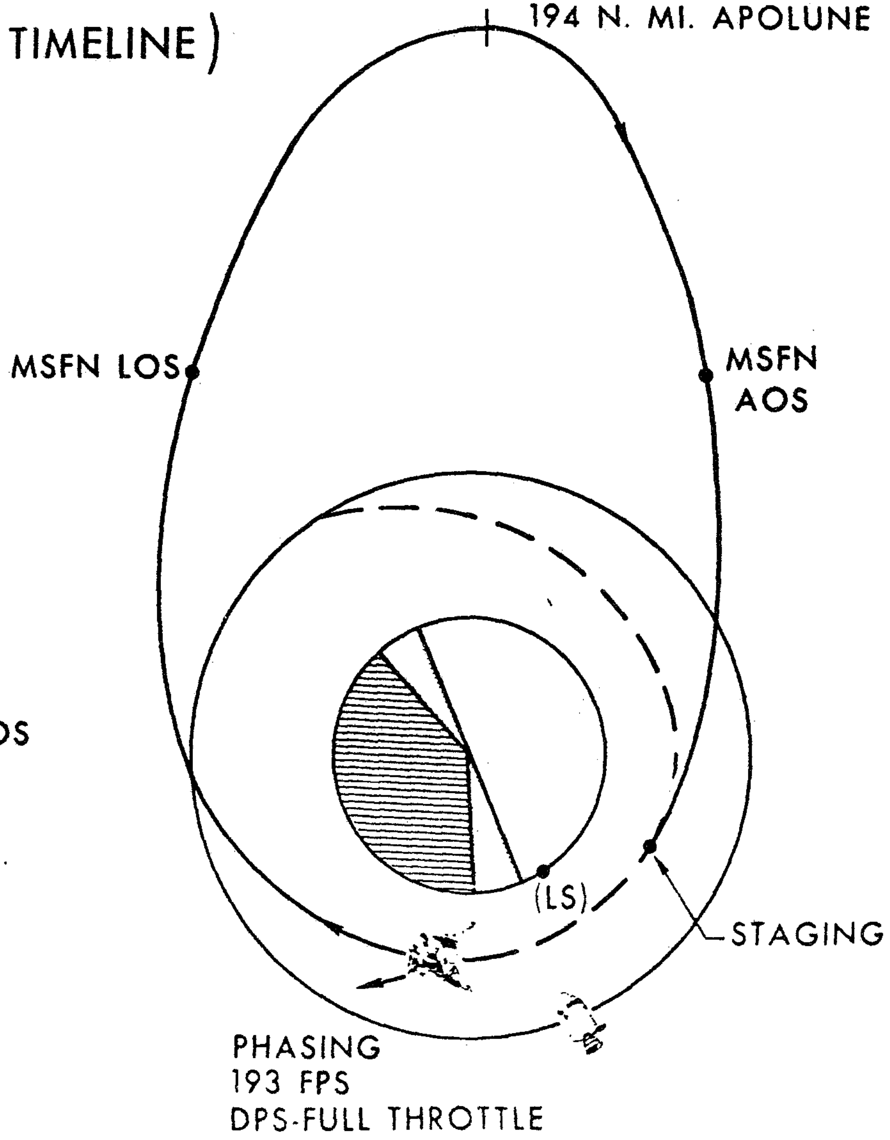
The next burn is somewhat similar to what we will be doing on the lunar landing mission. However, in this case we are, of course, in orbit already, as opposed

33

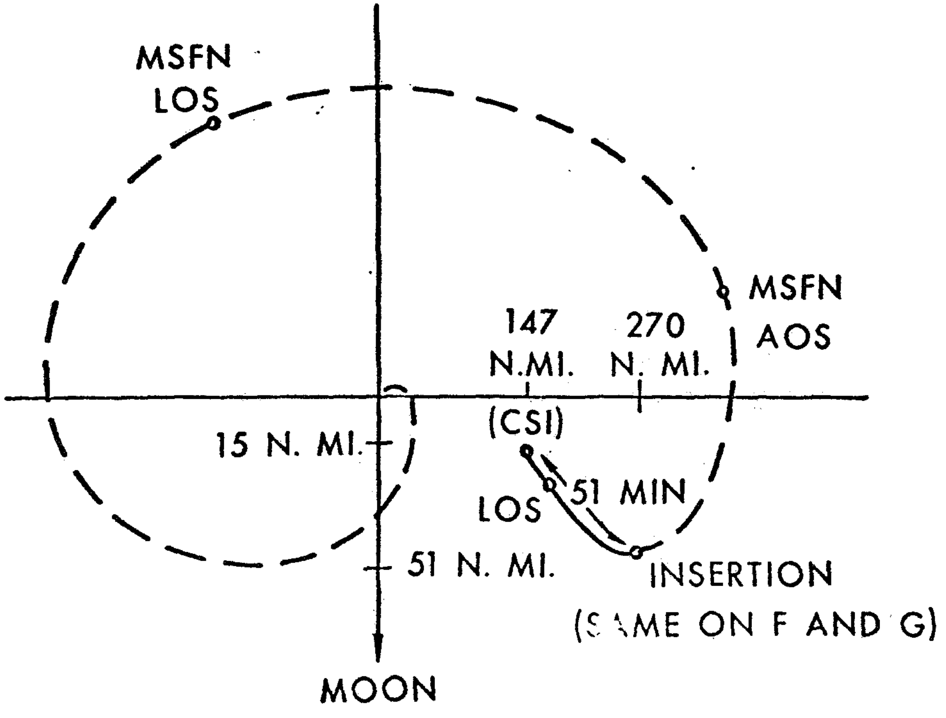
MPAD 4984 S

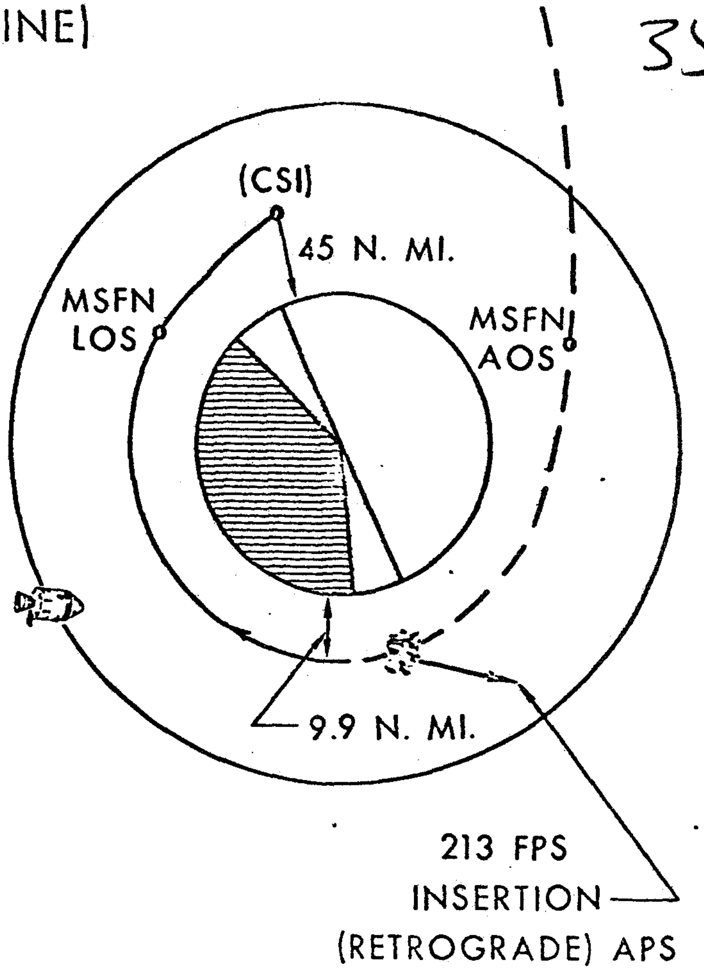
PHASING
(DEPART G TIMELINE)





INSERTION
(RESUME G TIMELINE)





to lifting off the lunar surface, and we have a problem of subtracting out velocity as opposed to we will be adding at this point on the lunar landing.

We will need to subtract off some of the velocity that we added previously in order to have our apolune or apocynthion height of 45 nautical miles. So this is the point we are talking about up here 45 nautical miles above the lunar surface.

As a brief recap over here on the relative motion plot, you can see the phasing maneuver took place way up, and we pass behind as we pass through the . . . distance above the CSM and drop behind and again below, so we are at this point here where again we are ready to subtract out some velocity and move ourselves up to a point 15 nautical miles below the command and service module circular orbit.

This burn will be performed by the ascent propulsion system which is an unthrottleable engine, 213 foot per second subtraction of velocity.

May we have the next slide, please.

(Slide)

The next maneuver is the concentric sequence initiation, and, as pointed out earlier, it occurs at a height above the lunar surface of 45 nautical miles, so we are now 15 miles below the command and service module orbit. And this is an addition of velocity so as to raise the apocynthion from its 50,000 feet original distance up to again 45 nautical miles so we are now in circular orbit below the command and service module.

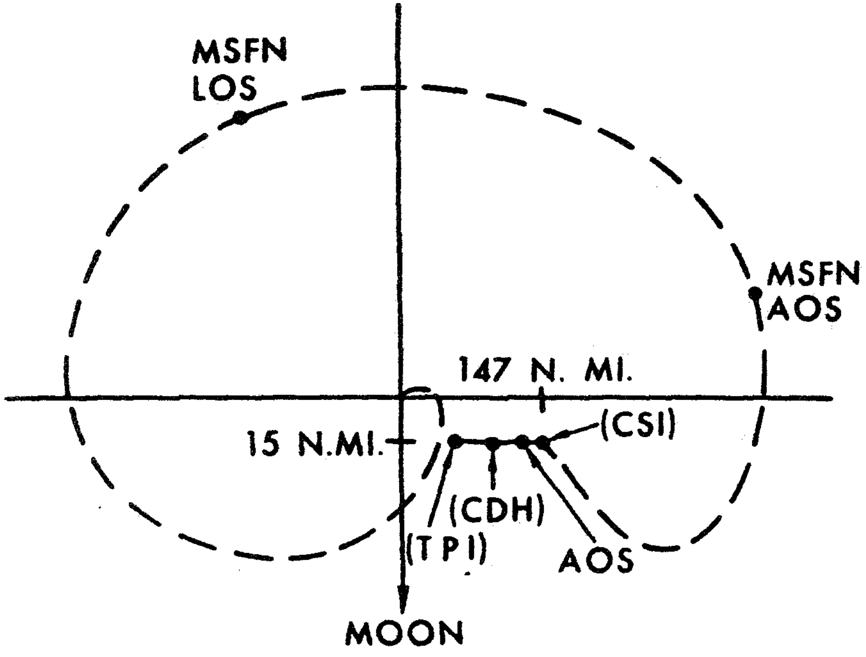
This is done by the lunar module RCS, and it is a small burn, about 50 feet per second.

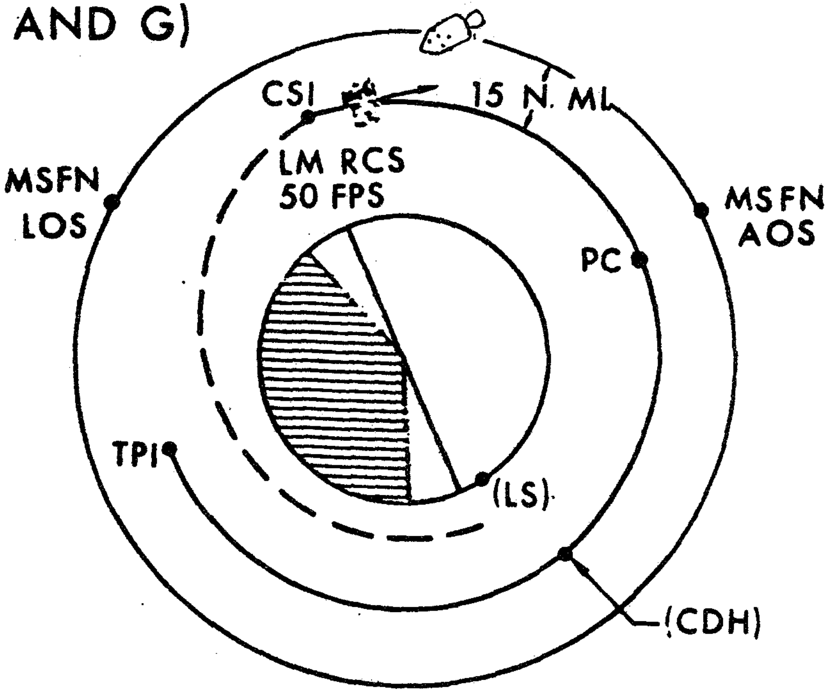
Okay. The next burn that we will discuss-- I guess I should point out over here on this relative motion plot that now this circular orbit will appear as a straight line as we maintain our 15 nautical mile distance below the CSM.

MPAD 4981 S

CONCENTRIC SEQUENCE INITIATION

(SAME ON F AND G)





As you all know, there may be some requirement for a plane change, and the only time you can change from one plane to another is when you are passing through the point along the line at which those two planes coincide. So in order to force that point to occur down here at our constant differential height maneuver, we make a small plane change here if required, and nominally it will be zero, but, at any rate, it could be some some value, to force the plane that the lunar module is in to cross the plane of the command and service module at this point.

Okay. We can go to the next slide.

(Slide)

We will discuss the constant differential height burn. And this is nominally about six feet per second and again performed by the lunar module reaction control system. And this can provide any plane change again required to ensure that the final rendezvous maneuvers are co-planer -- that is, the two vehicles are in the same plane -- and also for any height adjustment required.

And again we are back over here on the relative motion plot with an expanded scale, and you can see how as we press on around the trajectory course, the terminal phase initiate point, that we are a constant height below the orbit of the CSM.

Okay. Then we can see on this slide and as we get around to this point we are about-- Our elevation angle from the lunar module up to the command and service module is about 26 degrees. We will perform a burn essentially along that line of sight. And this will raise the height of the lunar module's orbit around the lunar surface to 60 miles, which will let us coincide with the orbit of the command and service module.

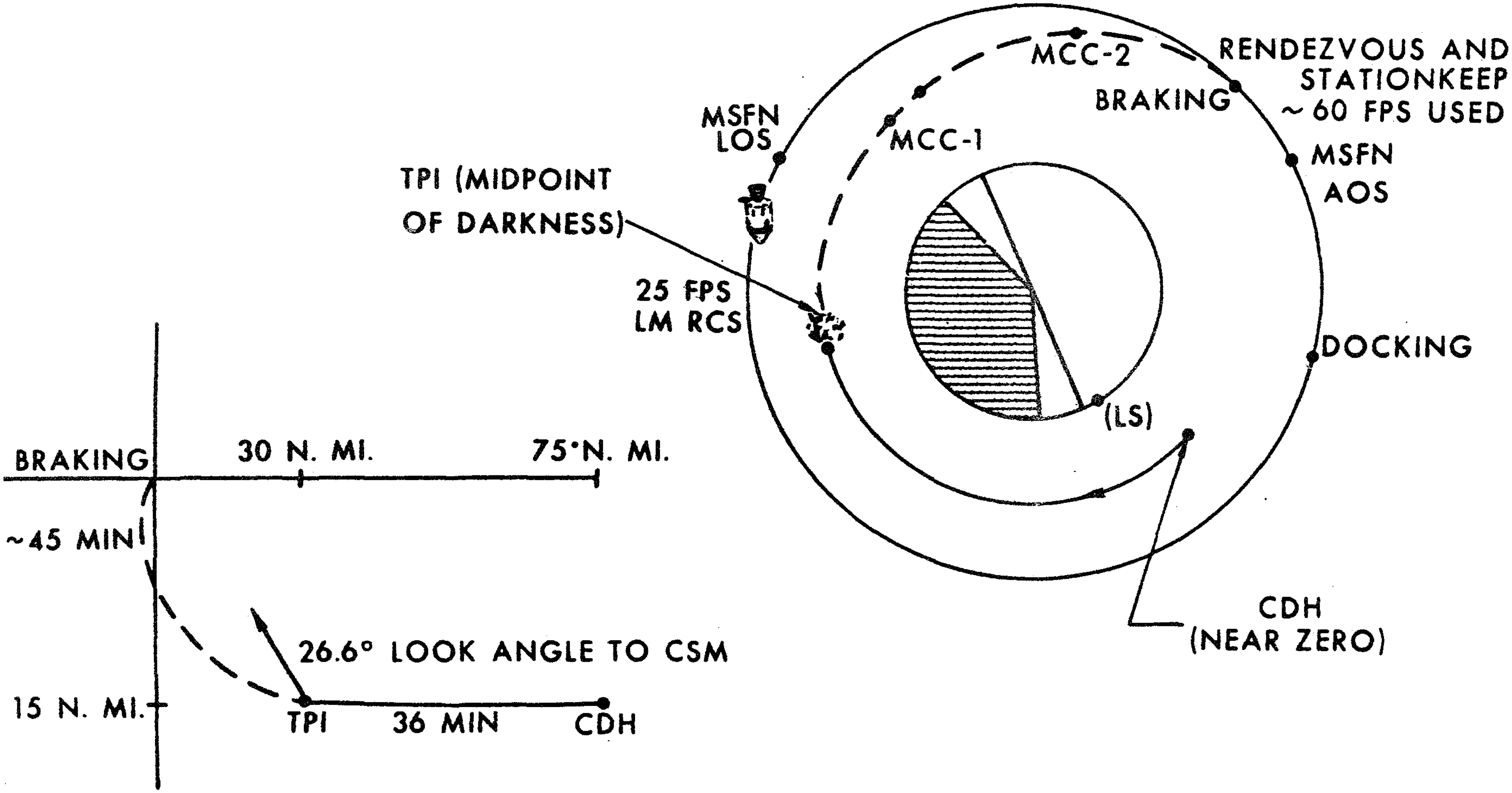
And, of course, using on-board systems, any corrections that are required will be made at these midcourse correction points as the rendezvous progresses.

And then the first of the series of three braking maneuvers almost simultaneously will be performed at this

MPAD 4980 S

CONSTANT DIFFERENTIAL HEIGHT AND TERMINAL PHASE

(SAME ON F AND G)



point for total delta V used during the braking process of 30 to 32 feet per second, and again it will be performed using the lunar module reaction control system.

So we have the lunar module being the active spacecraft during the rendezvous.

Of course, the purpose of the braking maneuver is to circularize the lunar module's orbit in exactly the same orbit as the command and service module.

And then at this point we will go ahead and dock the two vehicles, this time I believe using the command and service module as the active spacecraft.

Okay. Then, at that point, we will go ahead and transfer the crew back from the lunar module into the command and service module.

Can we go to the next chart, please.

(Slide)

And here we see the LM being jettisoned after the crew has transferred back. And this 90 E is about 90 degrees east longitude on the lunar surface.

And then as the two vehicles come around, the command and service module will make a small burn to separate the two, about two feet per second, and it is about 45 degrees off from the lunar module.

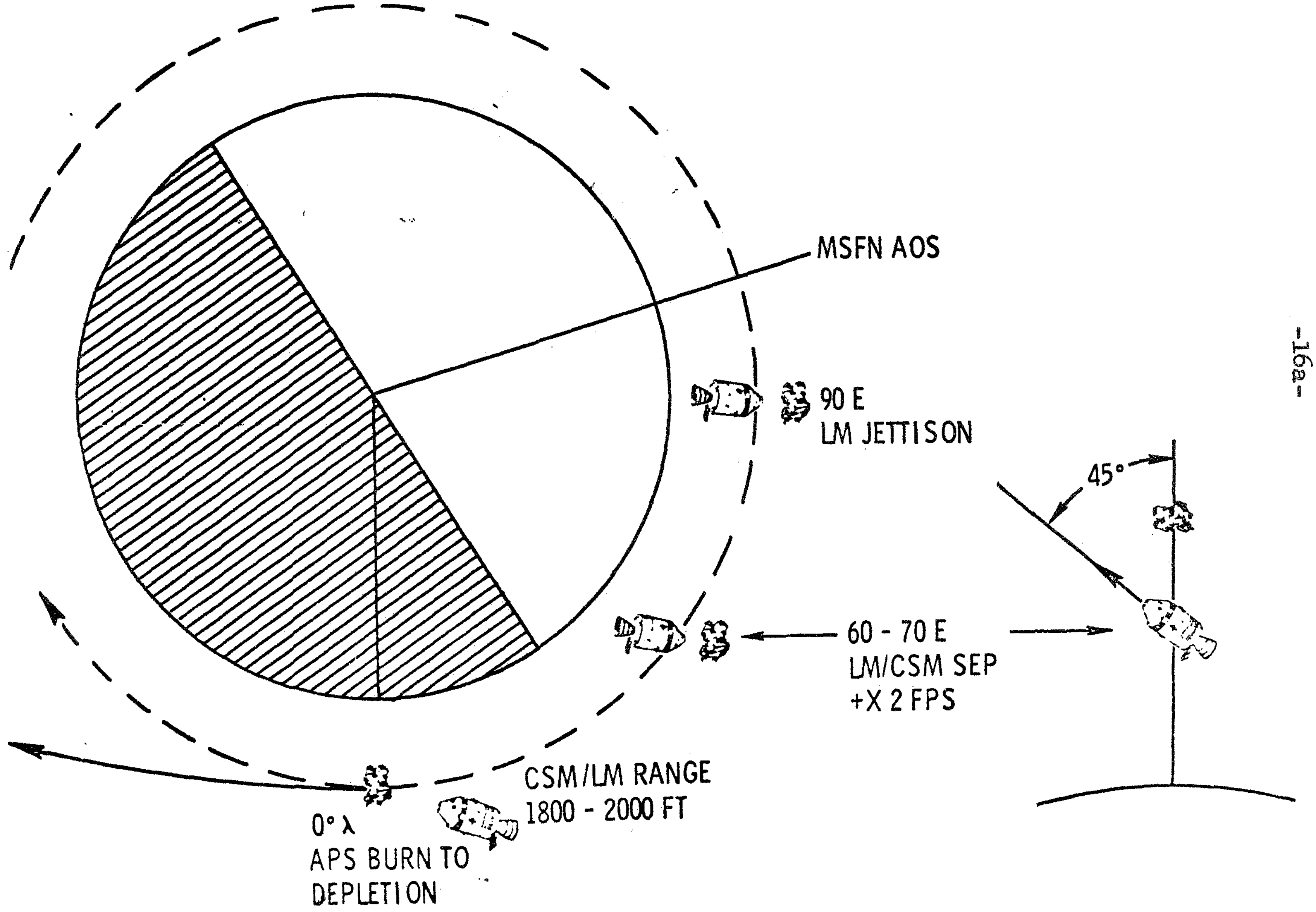
As we pass on around on the zero degrees longitude, which is, of course-- The earth is directly down this distance. The ascent propulsion system will again be lit to perform an APS burn to depletion.

This is performed on the abort guidance system. All the other maneuvers we have seen have been performed on the primary aviation guidance system on the LM.

On this one, in order to get the check on the actual switching. . . We are adding approximately 3,800 feet

MPAD 4087 V

F MISSION LM JETTISON TO APS DEPLETION BURN



per second to the ascent stage, and it will pass on out of the lunar sphere of influence and go into an orbit about the sun, no longer entering into our problem.

That's about all I have to say on the ascent maneuvers. Mr. Hage will be back to brief you on the rest of the mission.

HAGE: At this point Colonel McMullen has brought us up through the busy five days that we had on Apollo 9. Subsequent to completing the rendezvous and the ascent burn and the LM ascent stage unmanned, the crew will spend several orbits doing landmark sighting. Let me describe what that is.

Next slide, please.

(Slide)

One of the most precise ways that we have of locating not only in latitude and longitude but elevation specific landmarks such as a lip of a crater or a small protuberance on the surface of the moon is to view that landmark with the optical tracking system aboard the command module and at discrete points along the orbit about every 15 degrees or so record into the computer the precise angles that the optical system had to be set at in order to view that landmark right in the cross-hairs of the telescope.

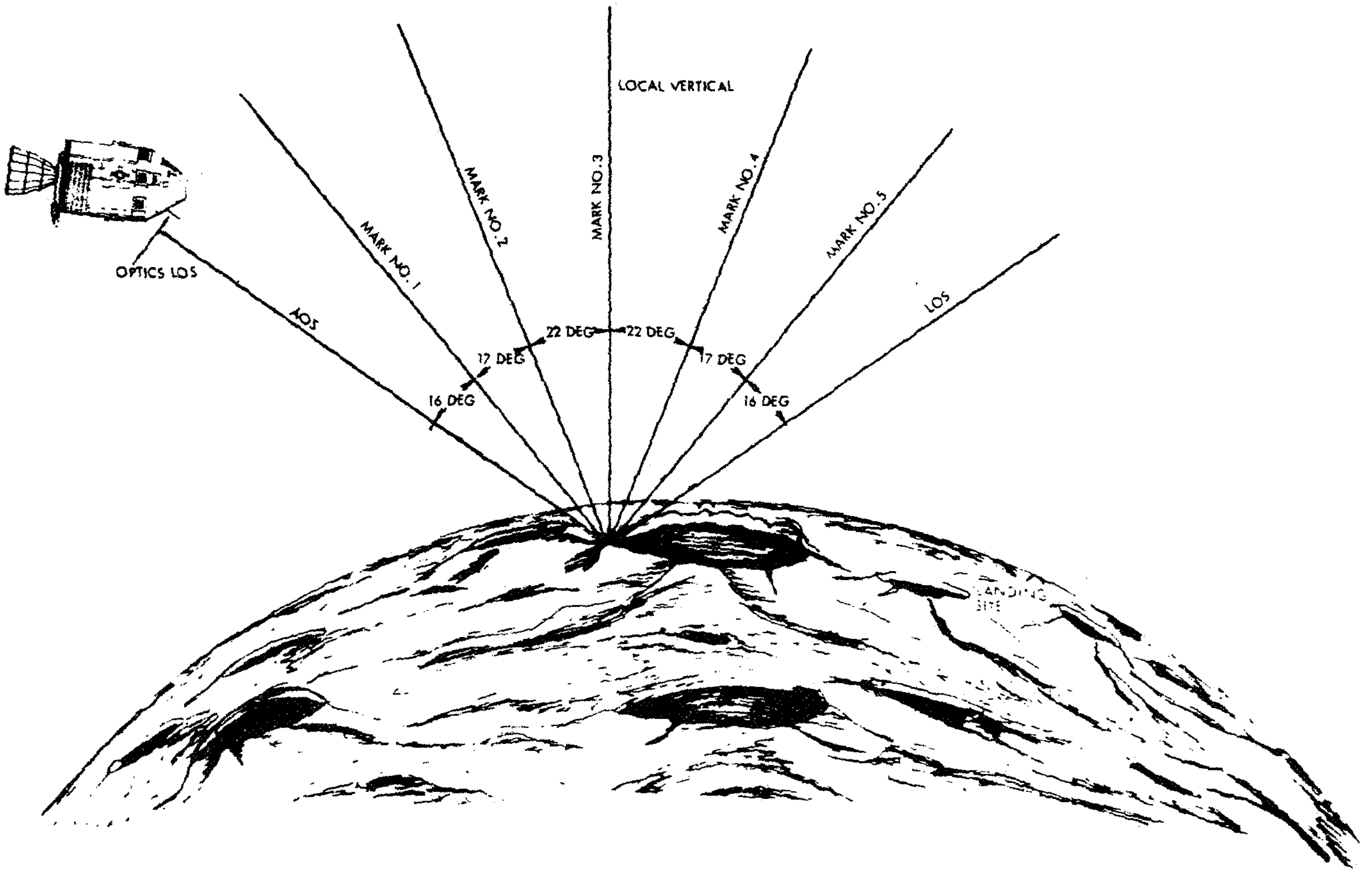
With that angular information and the Manned Spaceflight Network tracking information of what the orbit of the command and service module was during that specific pass over a landmark, it is fairly straightforward by conventional surveying trigonometry to precisely solve for the altitude and the latitude and longitude of that specific landmark.

As I mentioned, the crew will spend several orbits conducting those kind of exercises, complemented by additional photography.

Next slide, please.

(Slide)

NEAR LUNAR SURFACE ACTIVITY



Now, the transearth injection is very similar to that that we had on Apollo 8. Our time in orbit is about double what we had on Apollo 8. We are targeting for the same general landing area 165 degrees west longitude, which is an area west and south of Hawaii.

We are not attempting to control the latitude as we did not on previous flights.

Our normal entry angle is as shown, and I will discuss that in a little more detail.

We will use whatever residual propulsive capacity we have in the service module to reduce the return time from the moon.

And all of the transearth injection burns and the midcourse burns will be done with a fixed attitude of the command service module.

Next slide, please.

(Slide)

Now, this is the configuration which you are all familiar with of the vehicle coming home from the moon, antenna deployed as shown.

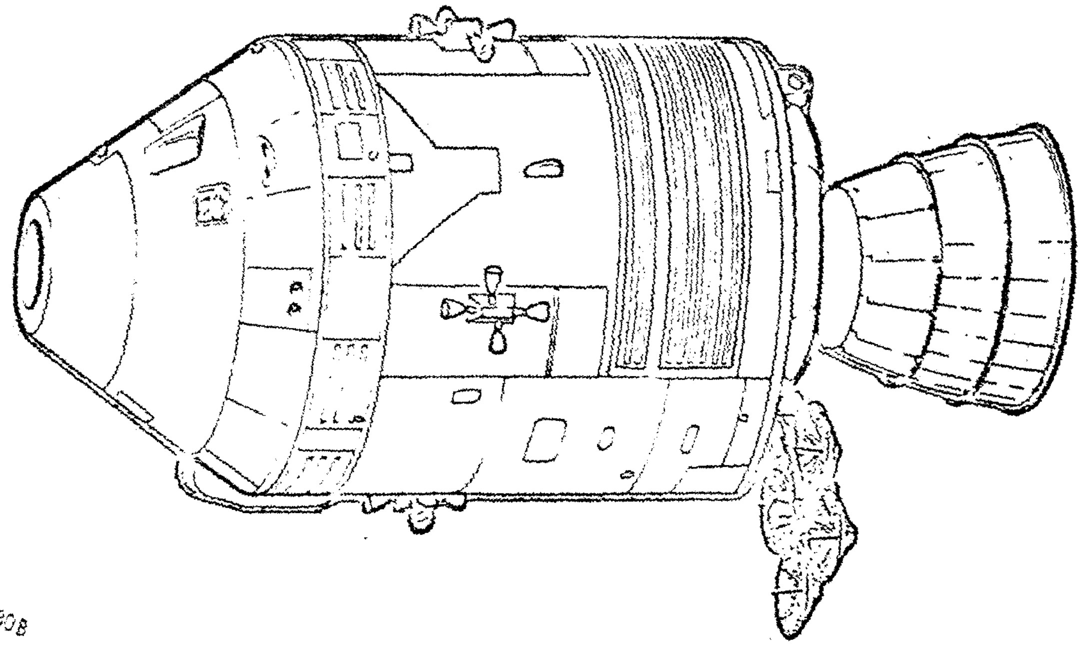
I thought I would comment just briefly here on a diagram that I think gives you a pretty good representation of what happens if you don't have capability of making midcourse corrections.

Each and any one of these propulsion burns wind up with some residual errors to that that was specifically planned. If one permits those errors to propagate without correction, then we find that we have a diverging cone on that trajectory. So we set certain mission rules to permit that to grow within acceptable limits, and then we make a midcourse correction and bring the vehicle back on trajectory and track it and watch for evidence of errors in that midcourse correction, until finally we find the vehicle on an acceptable path leading to the final separation of the command module and entering into the narrow entry corridor.

MPAD 4990 S

TRANSEARTH INJECTION

- NOMINALLY EXECUTED ~ 61.5 HR AFTER LOI-1
- TARGETED LANDING LONGITUDE = 165°W
- LANDING LATITUDE NOT DIRECTLY CONTROLLED
- TARGETED ENTRY PATH ANGLE ≈ -6.5
- RETURN TIME ASAP WHEN ΔV AVAILABLE
- RETURN INCLINATION $<40°$
- FIXED ATTITUDE BURN



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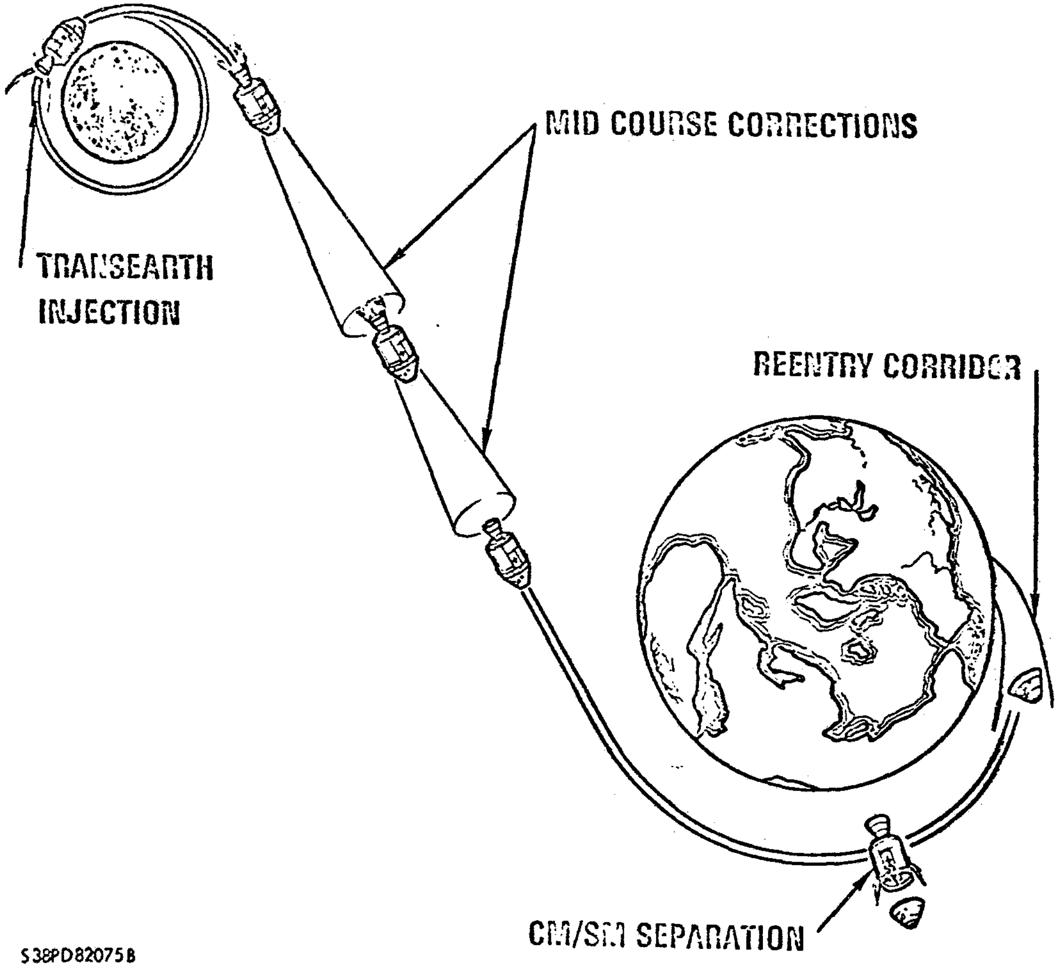
TRANSEARTH & REENTRY



You may remember on Apollo 8 the transearth injection burn was so precise that we could have, if we had elected to, essentially let the vehicle come home without any further maneuvers. We did decide to make a small trim burn about halfway home.

Next chart, please.

(Slide)

This chart gives you some feel for the variation in total mission time in hours, where 192 here represents eight calendar days. And, as you can see, it is a little over eight calendar days if we launch right at the beginning of the first launch window on the 18th.

The time of the mission can vary from this limit of 187 hours up to this limit which is something in excess of 197 hours, or, in other words, a possible variation of as much as ten hours depending on which day and which part of the launch window we get on.

Next slide, please.

(Slide)

The entry is typical of that that we demonstrated on Apollo 8. We have capability for a very large reentry maneuver footprint, 1,200 to 2,500 nautical miles. We will nominally target for 1,350.

This tends to enhance our ability to make a good reentry in the event that we have to use one of the backup control modes or guidance mode.

We will allow for weather avoidance in the recovery area by targeting for a change in the vehicle trajectory about one day prior to reentry if the weather in the recovery area looks like it is beyond acceptable limits.

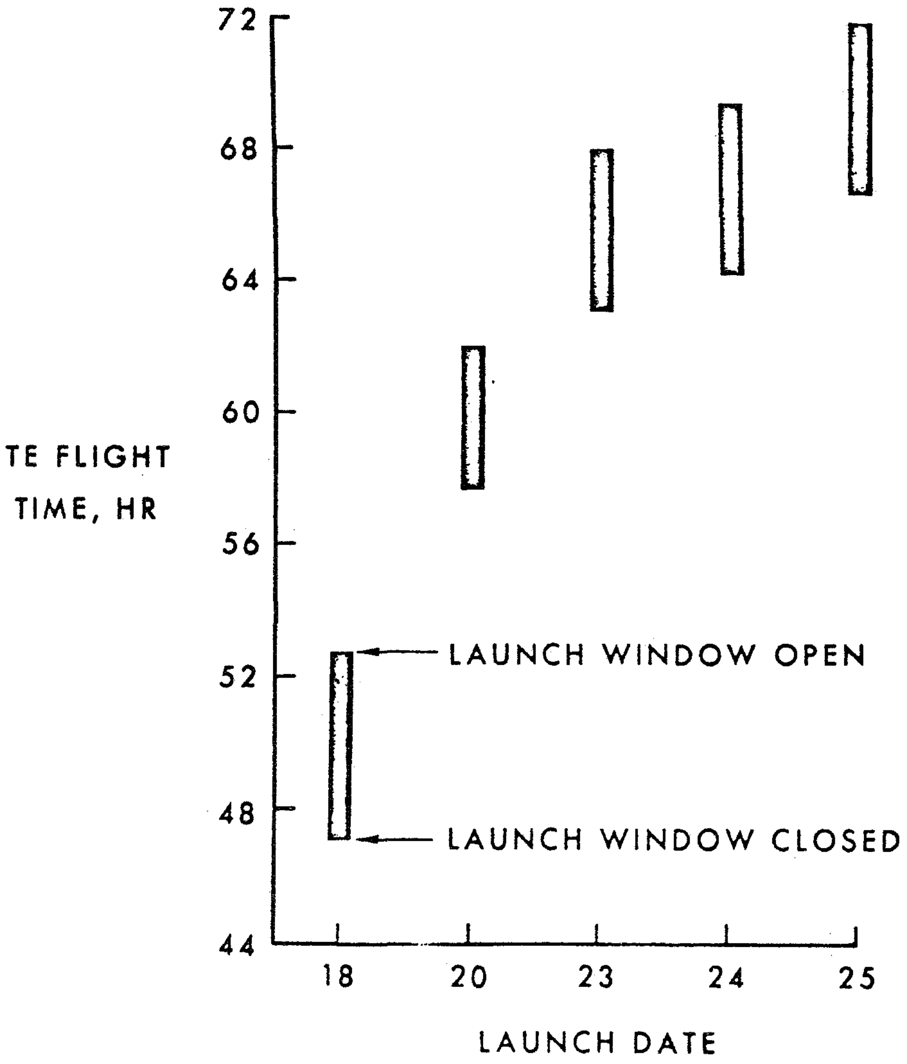
Next slide, please.

(Slide)

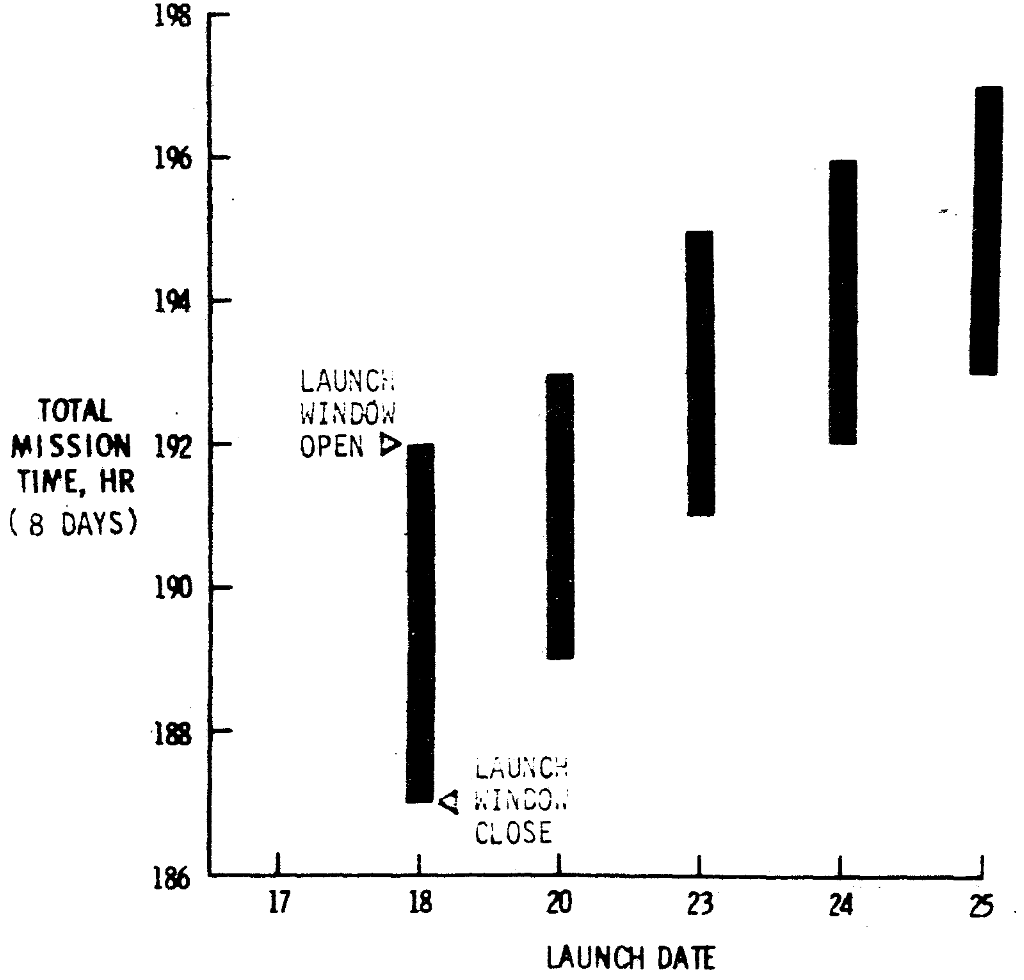
A little bit more about the reentry corridor. It's nominally six-and-a-half degrees flight path angle to the local horizontal of the atmosphere at the point that you

MPAD 4993 S

TRANSEARTH SUMMARY MAY 1969



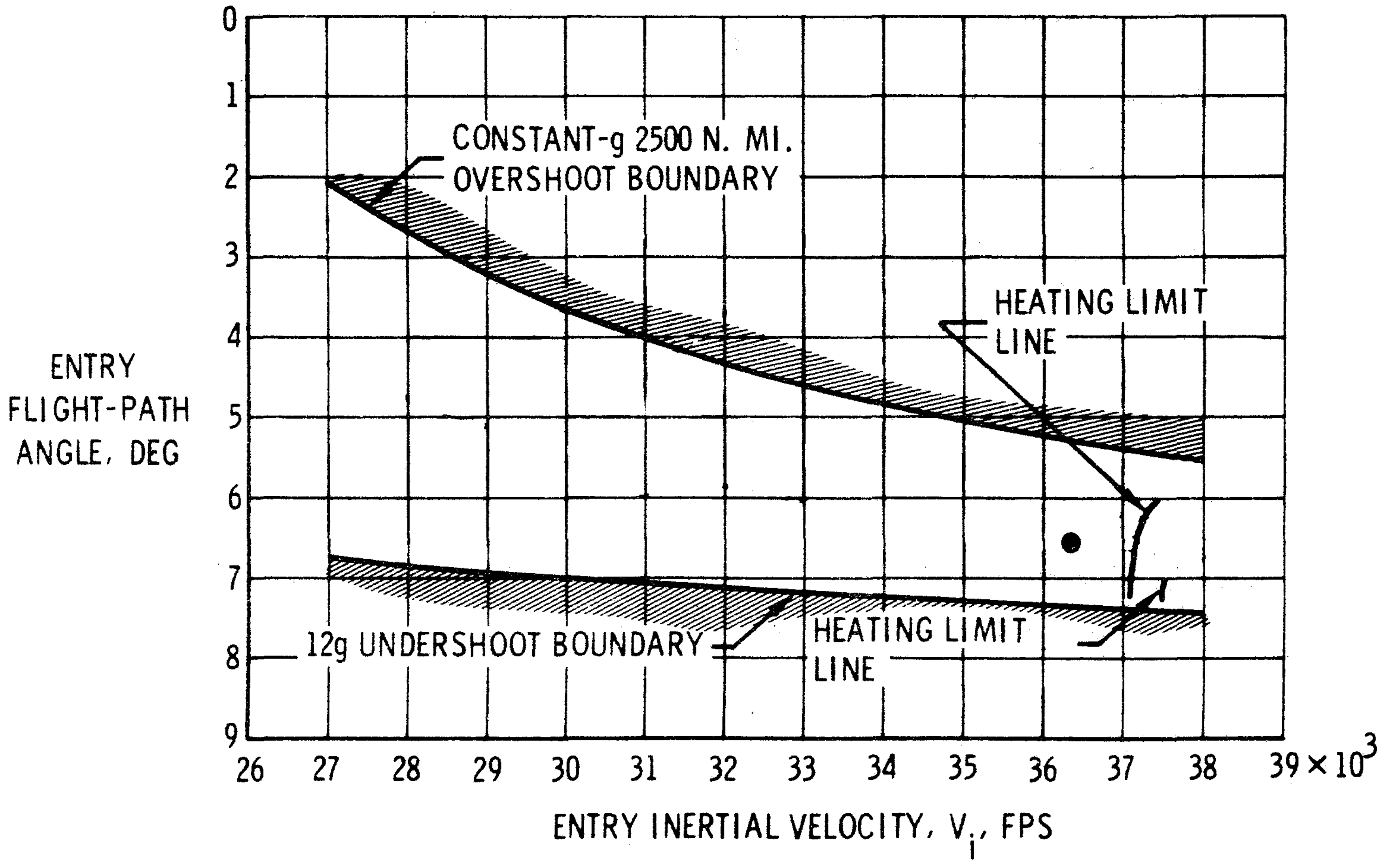
TRANSEARTH SUMMARY MAY 1969
(CONCLUDED)



ENTRY

- ENTRY RANGE CAPABILITY - 1200 TO 2500 N. MI.
- NOMINAL ENTRY RANGE - 1350 N. MI.
- SHORT RANGE SELECTED FOR NOMINAL MISSION BECAUSE:
    - RANGE FROM ENTRY TO LANDING CAN BE SAME FOR PRIMARY AND BACKUP CONTROL MODES
    - PRIMARY MODE EASIER TO MONITOR WITH SHORT RANGE
- WEATHER AVOIDANCE, WITHIN ONE DAY PRIOR TO ENTRY, IS ACHIEVED USING ENTRY RANGING CAPABILITY TO 2500 N. MI.
- UP TO ONE DAY PRIOR TO ENTRY USE PROPULSION SYSTEM TO CHANGE LANDING POINT

ENTRY CORRIDOR



2698

first enter into sensible atmosphere, this six-and-a-half degrees plus or minus approximately one degree at the velocities that we will be returning from the moon, roughly 36,000 feet per second.

The limits of that entry corridor I think have been discussed before, but very briefly if we come in too shallow we find a situation where the spacecraft would skip back out of the atmosphere, and this is an unacceptable condition because you would wind up with the vehicle going into an orbit that would exceed the duration of the expendables aboard the command module.

The lower limit is one where you start to experience accelerations that are beyond the capability of the machinery and the crew if you come in too steeply.

There are a couple of other limits that have to do with the thermal capability of the heat shield. This long represents the total heat that the shield must dissipate in coming down through the atmosphere. This little one here is a heat rate limit. In other words, there is a limit to the total heat, and there is a limit to how much heat you can absorb in any given small increment of time.

Next slide, please.

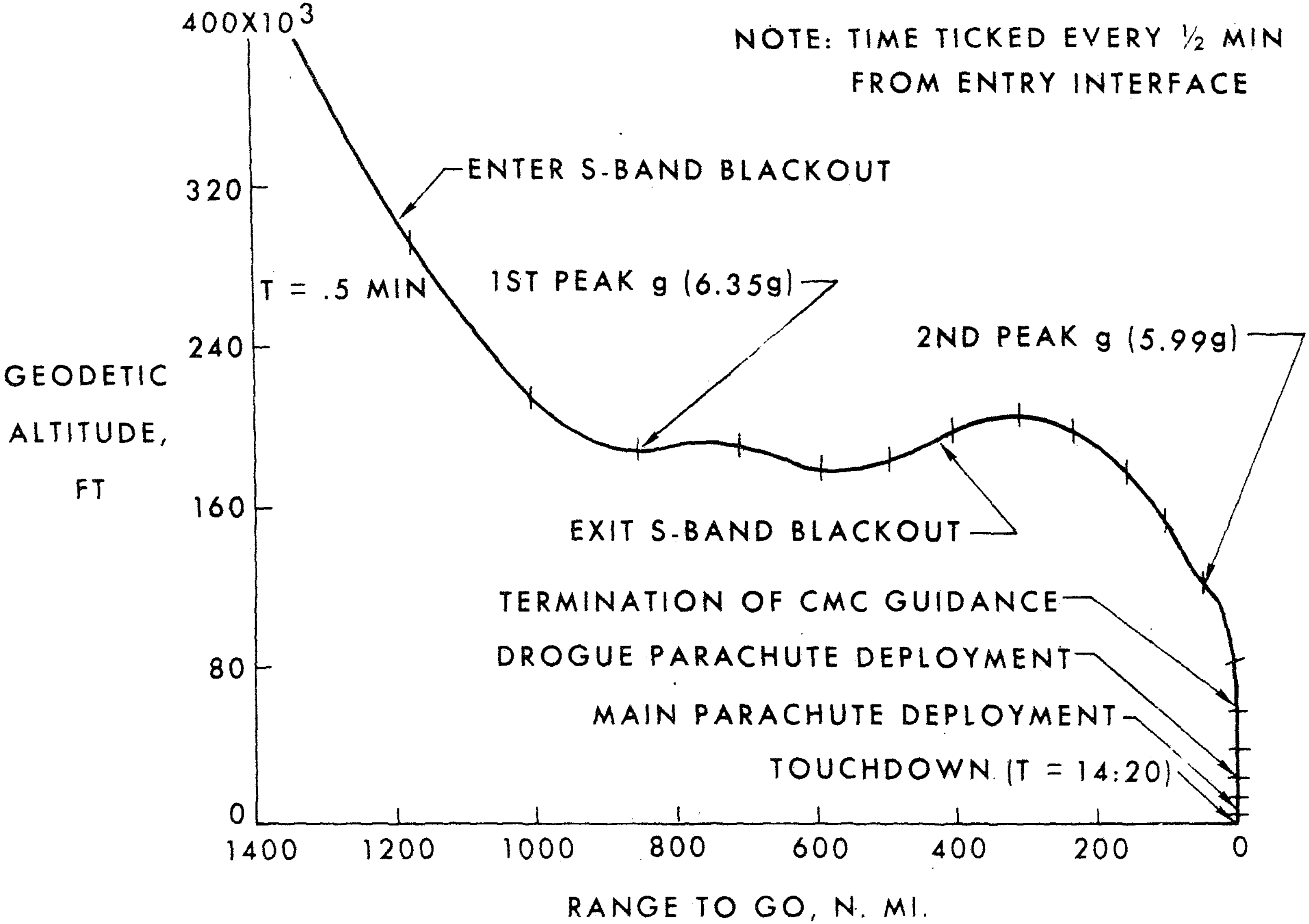
(Slide)

This is the plot of the reentry profile showing altitude in thousands of feet here versus range to go here in nautical miles. This is nominally called a constant g reentry. Starting at 400,000 feet these lines (indicating) represent approximately 30 seconds -- 30 seconds between these lines.

There are two peaks in this reentry trajectory, the peaks in the g load on the spacecraft, one in this region that gets up to about 6.3 pulse g and one at this point that gets up just short of 6 g.

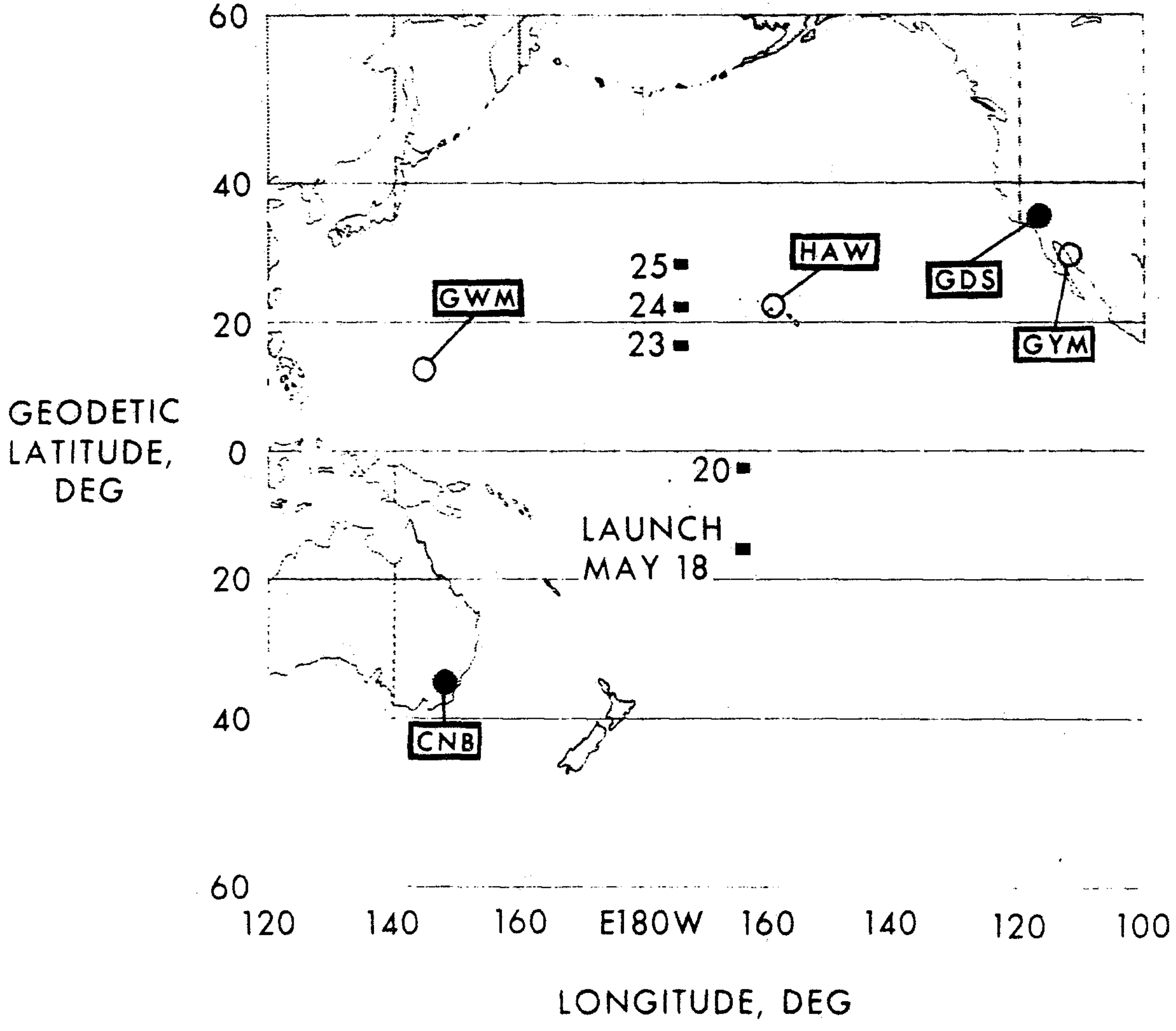
The vehicle then comes on down and we get drogue and main chute deployment with touchdown of a little over 14 minutes after we penetrate the sensible atmosphere.

GEODETIC ALTITUDE VERSUS RANGE TO GO



NOTE: TIME TICKED EVERY ½ MIN
FROM ENTRY INTERFACE

MAY WINDOW
NOMINAL RETURN LOCI



Next slide, please.

(Slide)

As I mentioned earlier, the nominal splashdown longitude is 165 degrees west longitude, just a little bit west of Hawaii and south. Further south on the 18th. Closer to Hawaii on the 20th.

And then to make sure we avoided the island group here around Hawaii, we moved over to 175 degrees west longitude on the 23rd, 24th, and 25th.

Next slide, please.

(Slide)

I would like to talk just briefly about some of the launch abort capability that we have in the system. It has been in the mission rules from the beginning of the program. We basically have four modes of abort during the launch phase, listed I through IV as shown here.

Their basic differences are:

Mode I abort uses launch escape tower.

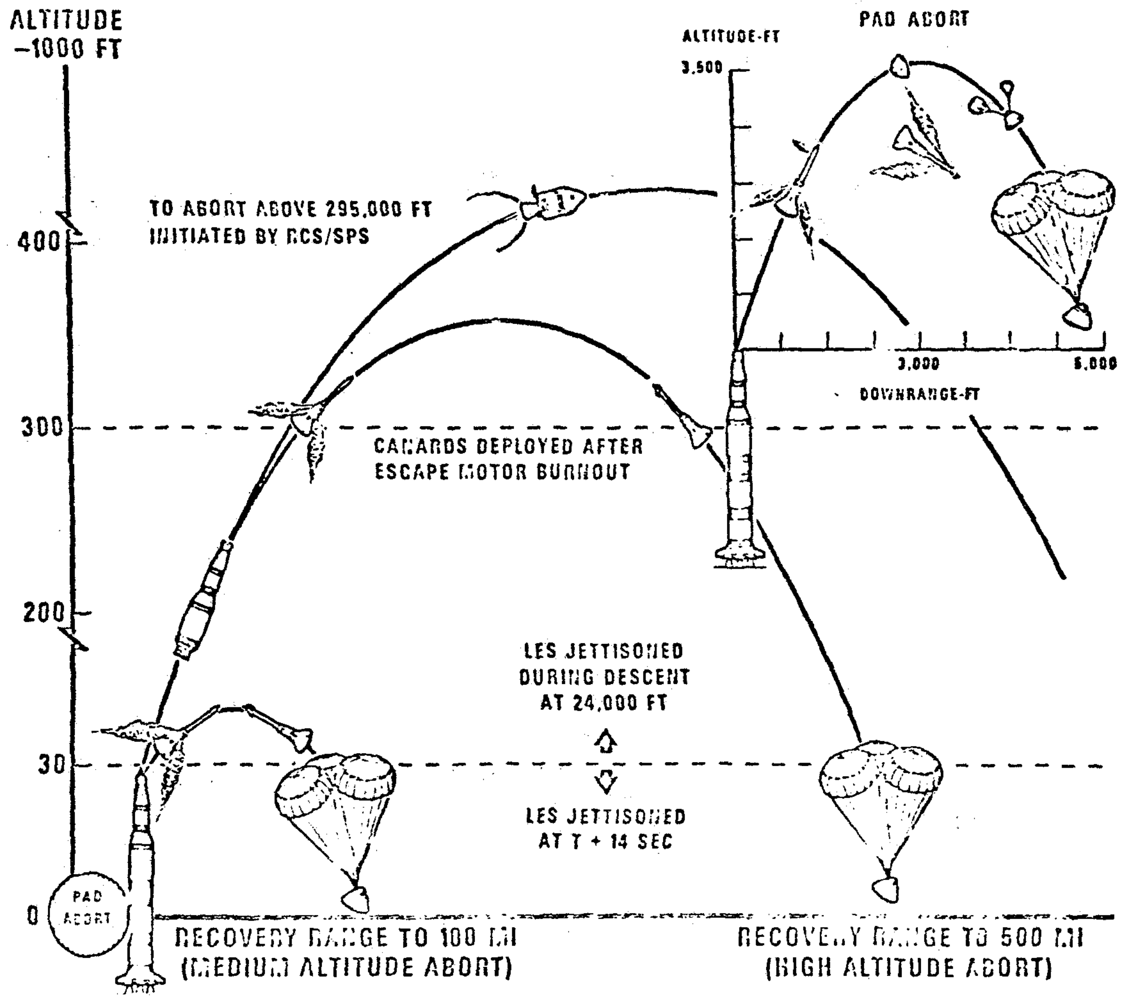
Mode II abort merely allows the command service module to use a little RCS thrust to get away from the launch vehicle and then it goes on and coasts, separates, and reenters at a suborbital velocity using the normal chute recovery.

Mode III abort is the higher velocity one which requires that we burn the SPS system in a retrograde way to slow the vehicle down for reentry.

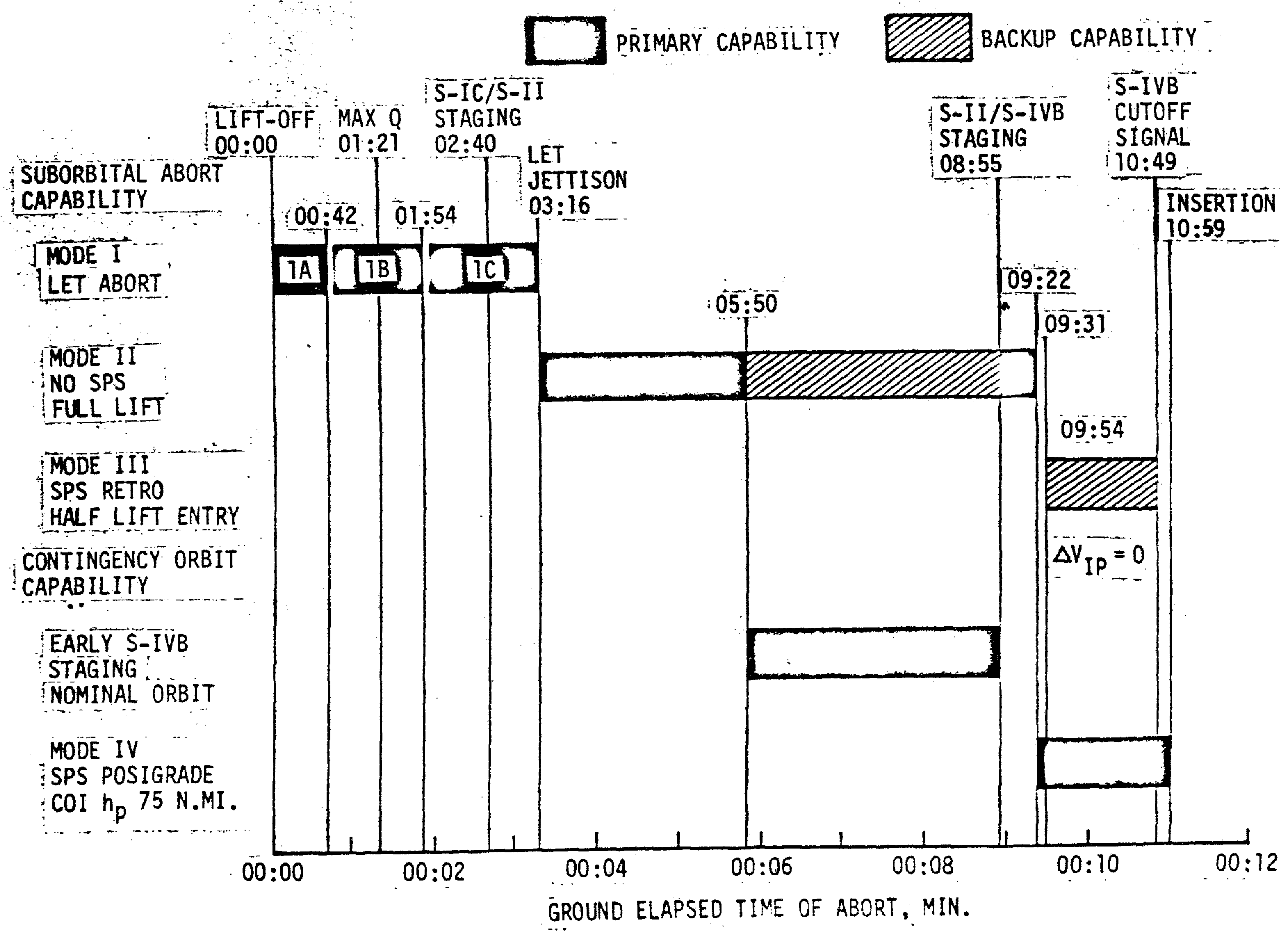
Finally, Mode IV is an abort mode where we use the capability of the S-IVB as shown here staging off the S-II earlier in the event we have a problem to carry the vehicle on up into orbit.

The capability starts at about a little short of six minutes into the launch phase.

ESCAPE TRAJECTORIES



LAUNCH TIMELINE AND CONTINGENCY CAPABILITY



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We also have capability if we have problems at this period of time to use the service propulsion system in an accelerating way to carry the vehicle on up into orbit.

The conclusion that we have come to is that when one gets up into these higher velocity portions of the launch phase, the safest type of abort is one into orbit, where you can take some time to sort out the problem and then perform the normal reentry.

Next slide, please.

(Slide)

This mission, like all previous missions, has involved a number of alternate mission classes that we are prepared to fly in the event of difficulty. There are four generic ones on this mission.

Like the 9 mission, we could be limited to a low earth orbit mission.

We might find ourselves with a translunar injection burn on the part of the S-IVB that either leaves us in a semi-synchronous earth orbit, which is very high apogee orbit, or one that is capable of taking circumlunar when we use the surface propulsion engine to put the little bit of extra energy required to get us out to the moon.

If that kind of an anomaly occurred, we may not be in position to go into lunar orbit.

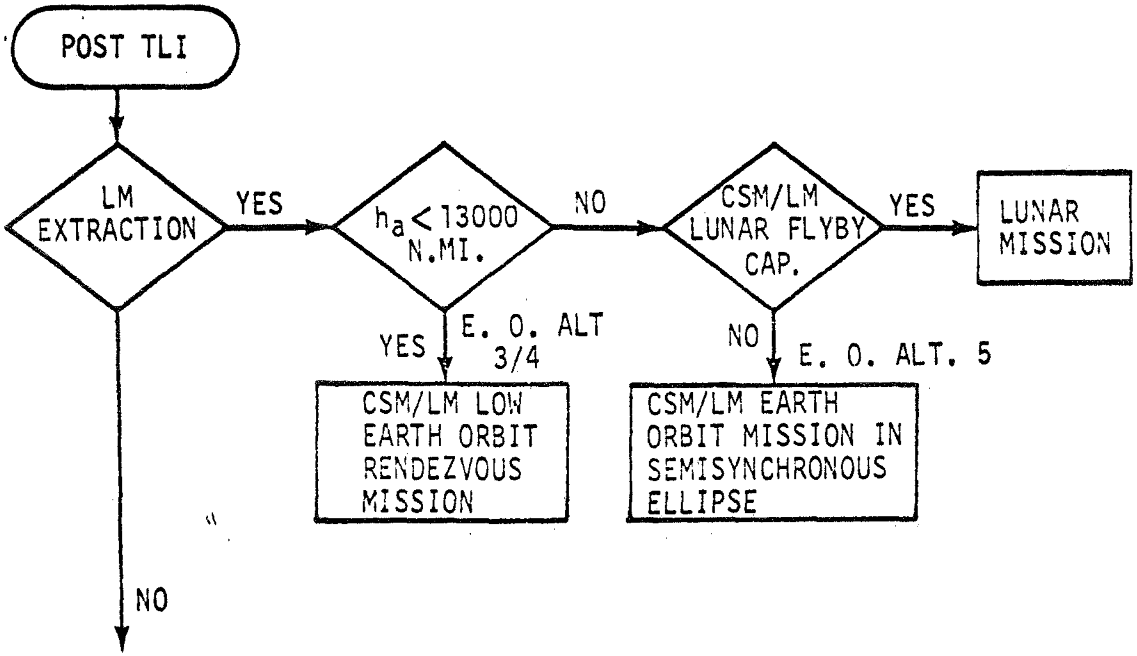
Obviously, the ultimate situation is lunar orbit option.

The analysis techniques that are employed in developing the rules by which the flight directors select which option to go into in the event of trouble are shown on the next slide, and this slide is a representative example of a logic diagram where we just took this one case where we completed the translunar injection burn and the next event is the LM extraction, and obviously the two options you have there are either, "Yes, we are able to," or "No."

ALTERNATE MISSION CLASSES

- LOW EARTH ORBIT
- SEMISYNCHRONOUS EARTH ALTERNATE
- CIRCUMLUNAR
- LUNAR ORBIT

MISSION F EARTH ORBIT ALTERNATE MISSIONS



If the answer is "yes" and we are able to complete the lunar module extraction, we follow this path.

If "no," we go down another path which has a similar structure to it.

Each one of these paths leads to a set of mission rules that lead to an alternate mission.

For example, if at the time of TLI we found that the burn was short and would result in a maximum altitude around the earth of around 13,000 miles, we would modify that orbit and come down to a CSM/LM low earth orbital rendezvous mission very similar to what we did on Apollo 9.

If the burn was greater than that required to get to 13,000 miles apogee, we would go on into this decision block (indicating) which looks at the capability of that TLI burn and could leave us either with the option to go into a lunar mission or go down into a mission which is a very high earth orbital mission that would not permit us to modify it back down to low orbital mission because of the limited delta V propellants aboard the service module.

Now, there is a whole family of these decision blocks that are used in developing the pyramid of alternate missions that fall below these three genetic categories.

Next slide, please.

(Slide)

I would like to talk just for a moment here about the Apollo 10 TV operational plans. I don't propose to go through and read this chart.

Just before coming down to the briefing, I was advised that the latest planning calls for a total of 11 different crew operations involving TV. They are scattered throughout the mission, and most of them are about 15 minutes in duration.

As you will note here, it is our intent to fly an experiment involving color TV if we can develop it and get it prepared to fly in time to support this mission.

APOLLO 10 TV OPERATIONS PLAN

- OBJECTIVES
  - EXTERIOR VIEWS OF THE LUNAR SURFACE AND EARTH FROM LUNAR DISTANCE
  - INTERIOR VIEWS OF CREW AT THEIR OPTION
  - PROVIDES INFORMATION WHICH WILL ASSIST IN EVALUATION OF THE POTENTIAL USEFULNESS OF TV FROM LUNAR DISTANCE.
- EQUIPMENT USED (STOWED IN CM)
  - CM BLACK AND WHITE TV CAMERA (RCA)
  - CM COLOR TV CAMERA (WESTINGHOUSE)
  - WIDE ANGLE LENS (80° FOV)
  - 100 mm LENS (9° FOV)
  - ROTATING FILTER
- MISSION TIME LINE

PERIOD	VIEWS
TLC	INTERIOR - EXTERIOR (EARTH/MOON)
BETWEEN LOI_1 and LOI_2	LUNAR SURFACE
FORMATION FLYING DURING RENDEZVOUS	EXTERIOR - LM
POST RENDEZVOUS	EXTERIOR - LM
TEC	INTERIOR AND EXTERIOR (EARTH/MOON)

APOLLO 10 PHOTO OPERATIONS PLAN

CAMERAS:

HASSELBLAD	70MM	- LM & CM
MAUER	16MM	- LM & CM

ACTIVITY:

- TD & E
- LM INSPECTION
- LM ACTIVE RENDEZVOUS AND DOCKING
- SEXTANT PHOTOGRAPHY
- CREW ACTIVITIES
- GENERAL EXTERIOR
- LUNAR ORBITAL PHOTOGRAPHY
- LONG DISTANCE EARTH - MOON

If we are able to -- and my guess is that we have about a 50-50 chance of making it -- we would do most of the pictures with color TV rather than black and white.

This gives you a short rundown on the periods during the mission when we would be doing various kinds of television coverage. That list is typical. There are actually now planned, as I said earlier, 11 different TV periods of about 15 minutes' duration.

Next slide, please.

(Slide)

In addition to the color TV, we would be carrying the standard complement of Hasselblad still cameras and the Mauer 16 mm. movie cameras, both in the lunar and command modules.

These cameras will be used in consonance with the photographic flight plan that has been developed with the crew to cover these critical phases of the mission.

Next slide, please.

(Slide)

Now, in summary, I believe this one chart gives us on earth the best birdseye view of what is going to take place as a function of time from launch to insertion into lunar orbit through the various descent and rendezvous maneuvers of the two vehicles until finally the command and service module burns out of orbit and heads back for home.

This is a very close representation of the geometry in an angular sense, in that the moon will be travelling about through this kind of an orbit during the period of time that the two spacecraft are in the vicinity of the moon.

I think that with those comments on the mission that we plan to fly, I would like to open the session to questions. But before I do, I would like to point out that I have a movie which was prepared by MSC's Flight Planning Division which is an excellent movie on describing the geometry of launch windows and why they are the way they are.

I think it has been shown before possibly prior to the Apollo 8 mission, but if there are enough of you who are interested in seeing it, I think you might find it very good in clarifying some of these constraints that we have to live with in flying these missions that are a result of nature.

O'DONNELL: We will take a few questions from here, then go to Houston, and then return here.

QUESTION: On the launch phase, have there been any unmanned launches from 39-B, or is this the first time that pad will be used?

HAGE: 39-B has not had any previous launches off of it. This will be the first launch off of that pad.

The original planning for the Apollo facilities at Kennedy included two launch pads, and the philosophy behind this is I think a very obvious one, in that we found over the years that one launch pad is the wrong number in the event that the program had the misfortune to be faced with a catastrophic failure on the pad. Then there would be a very long delay in bringing one pad back up to an activated status.

So we have always planned to have two pads to support the actual lunar landing mission attempt.

O'DONNELL: Over here.

QUESTION: I understand there is a reason why this lunar module 4 could not land on the moon even if it was desired to do so. Would you explain that reason, Mr. Hage?

MR. HAGE: The lunar module being flown on this flight, LM 4, has a couple of deficiencies in its equipment that are partly a result of deciding that we were going to configure LM 5 and subsequent for the landing attempt and partly because we had planned to fly an F mission for some months and test the landing radar.

Now, let me expand on that a little bit. The landing radar on LM 4 has been augmented in such a way that we will be able to verify its operation flying through that low part of the orbit, about 50,000 feet as Colonel McMullen mentioned, and get a long track with a landing radar of about 800 seconds. Normally, the landing radar that would be used on a landing mission does not lock up in a sense on the surface of the moon until the vehicle gets down to something like 30,000 feet.

So this landing radar has been augmented to provide us with a good validation of the landing radar before we actually commit to a landing mission on the G mission.

One other change, which is one that we have control over. We have off-loaded roughly half the propellants in the ascent stage of the lunar module in order to more nearly represent the inertias and weights of the ascent stage during the rendezvous phase of the mission.

I am sure you can understand that the lunar module ascent stage is about half propellant and about half equipment. And when you take off from the moon the vehicle weighs approximately 10,000 pounds, and by the time you reach orbit and are ready to dock, it's almost down to 5,000 pounds. This is a very large change in weight and inertia, and we have off-loaded this vehicle to more nearly match the dynamic conditions of control that the crew will be faced with during the actual rendezvous and docking.

QUESTION: Several questions. What will the lighting of the moon be at the time of the launch? Will it be a half-moon? Crescent moon?

HAGE: Let's see if I have got that here. The first opportunity in July is on the 16th, and that is for the second prime target that I showed on that chart of the map of the moon. The sine elevation at that target will be about 10 degrees from the horizontal, and that target is about 30 degrees around from the easterlymost limb. If you are looking at the moon here it's about 30 degrees around. So you would have about a half-crescent.

McMULLEN: Put slide 29 up. I think we could see it. Slide 29 up, please.

HAGE: It will be a new crescent off of a new moon, and it will be about half-formed.

(Slide)

HAGE: Here's the direction to the earth. And, as you can see, you will see this little pie as lit by the sun, and that in effect will give you a new crescent, about a half-formed new crescent, halfway between a new moon and a half-moon.

QUESTION: And the other part of my question was: I didn't understand the reason behind the high apolune of 194 nautical miles. Because you don't have to go that high in the actual planned mission.

McMULLEN: That's correct. But, you see, we are starting off-- Let's see. The period of a body revolving about another one is a function of a lot of things, one of which is the size of the orbit, the semi-major axis. So when we start our descent orbit insertion, obviously we are cutting down the size of the semi-major axis. As a result, we are moving about the central body -- that is, about the moon -- faster than we were originally. And the lunar module winds up in front of the command and service module.

Now, this was not the condition we would have for rendezvous or for initiating rendezvous on the lunar landing mission. In fact, we'd start off with the lunar module behind.

So, obviously, somehow we have to get the lunar module back behind the command and service module. And using the same rule that we just discussed, we insert it into a real large orbit so the period of its rotation about the moon is very large, and, hence, it falls behind the command and service module. It winds up right at the same place that we started the maneuver, but it just is somewhat different relative to the command and service module.

QUESTION: I have trouble remembering the meaning or the purpose of the CSI and CDH maneuvers, and one reason I do is I don't understand the meaning of those words "concentric sequence initiation" with reference to the actual maneuver performed. And I was wondering if you could take a couple of minutes to explain the relation of the words to the maneuver.

McMULLEN: Okay. I'll try. Could we have Chart 36 up, please?

(Slide)

The concentric sequence initiation-- I guess I really can't turn the terms around, but the purpose of both the concentric sequence initiation burn and the constant differential height burn is to get us into a circular orbit at a constant height below the command and service module orbit.

So I guess a simple way to say it is to make sure we are in the same plane, that we are in a circular orbit behind and below the command and service module. The fact that we are below means that we are going around faster, and hence we will be catching up, so we want to start off from a position behind.

HAGE: May I help a little on that? One way to think about that is that the maneuver at this point which is labeled "concentric sequence initiation" does in fact, if it is a perfect maneuver, put this vehicle in an orbit that is circular and concentric within the CSM orbit -- if it is perfect.

QUESTION: You are making one orbit concentric to the other orbit?

HAGE: Right.

McMULLEN: Okay. I guess to carry it one further, the constant differential height is to ensure you maintain just that constant difference in height above the surface of the central body.

QUESTION: I have a couple of questions, one on the pericynthion. Can you give us in miles uprange of the actual landing site the point on the moon where the spacecraft will be closest and why it was adjusted that way? In other words, what MASCON problems you are trying to find, photography of more landing sites than just one, that kind of thing.

McMULLEN: I can answer the second one quite clearly. The distance or the point at which we arrive at pericynthion is determined by the geometry of the lunar landing mission. This is a fallout from trying to make this mission identical to the lunar landing mission, and ideally in the lunar landing mission we would at the point of pericynthion initiate a power descent.

That is to say, we would light the descent stage and continue to burn as we slow the vehicle down and control its descent down to a landing at the landing site.

Now, the distance ahead of the landing site I think is around 237 miles, something like that.

QUESTION: The second question is: You burn your ascent propulsion system engine to get rid of the ascent stage to test the abort guidance system. At JPL they made a proposal for a transponder in lunar orbit for about a month for Apollo Applications to track it continuously to resolve this MASCON problem. Was there any consideration ever given to using the ascent propulsion or the ascent stage -- that is, leaving it in lunar orbit after you have done some pro and con maneuvers, retro and posigrade and stuff like that?

HAGE: I can't specifically answer whether or not it was considered. I can comment on the fact that the battery capacity of the ascent stage is limited, and on Apollo 9, as I recall, after we had separated the ascent stage and put it in an unmanned mode and made a burn on the primary guidance system, we were able to get telemetry for something like nine hours, and then the battery went dead.

So in order to do what you suggested here I think it would have required modification of the spacecraft.

QUESTION: I understood you to say that there will be 11 TV options. Could you give us the TV time line again, the 11 points?

HAGE: I'd be glad to do that. I wonder if I might leave it here with Bill and you all can take it. It is a tentative list. I mean the times are tentative.

The crew will exercise some option on precisely when these windows open up. But there are 11 listed here.

QUESTION: The time will be in GET?

HAGE: Yes, ground elapsed time.

O'DONNELL: We will include those in the transcript.

QUESTION: What is the consideration in having the orbit 60 nautical miles and going down to 50,000 feet?

I realize 60 is what you're going to do on the lunar landing mission, but why would you decide on that on the lunar landing mission?

HAGE: In the various tradeoffs that have been made over the years and finally converging on the profile for the Apollo landing, one of these tradeoffs involves the amount of propulsive energy required to get into an orbit around the moon. The higher the orbit, the more energy you must take out of the service propulsion tanks to slow the vehicle down and get it into orbit.

Sixty miles turned out to be a good compromise for minimum energy with a reasonable height above the surface to accommodate guidance and control uncertainties.

So it is one of the typical kinds of engineering compromises that one goes through in minimizing energy and yet leaving enough margin for guidance uncertainties.

QUESTION: What about the 50,000 feet now?

HAGE: Well, that also is an energy consideration, in that the lunar module comes down from orbit, from the 60-mile orbit essentially with-- It initiates the orbit to come down to 50,000 feet with a very short burn. It takes very little energy at the time of separation to bring the vehicle down to 50,000 feet.

Fifty thousand feet is an altitude that was selected when considering the need for a radar to lock on to the surface of the moon and give updated information on precisely where the vehicle is relative to the surface of the moon, a compromise with how much propellant we have in the descent stage of the lunar module, since the whole maneuver, as Colonel McMullen mentioned, from the time you get to 50,000 feet until you land, is a powered burn, and so you want to keep that time as short as possible.

But, on the other hand, you have got to leave yourself enough altitude to make all the navigation fixes that are necessary with the radar and with the inertial system.

QUESTION: Knowing at this time the command module will be the active vehicle during docking, is this the result of the difficulty the lunar module commander had with being the active part in the docking of Apollo 9?

HAGE: I would have to say that the decision to use the command module for the actual docking is a direct result of having learned that it is easier to do with the command module, and we learned it on Apollo 9, although I would further have to say that there is a strong suspicion in the minds of the crews on the basis of their simulation work that that will probably turn out to be the preferred mode even before 9 was flown.

QUESTION: For how long will you be at 50,000 feet? There is a dotted line on the diagram. Could you with your pointer just continue that and show where it goes from there, for how long it would be there?

McMULLEN: Could we put slide 31 back up, please?

(Slide)

If you look at the slide, you can notice that the radio lines that pass from the surface of the moon up to the spacecraft are time-tagged. In other words, they start off here at the left at 600 seconds before reaching pericynthion and pass on down to zero at 100 hours and 51 minutes ground elapsed time, ascend up into the very large orbit, we will come back down again to roughly 50,000 feet.

HAGE: I think this diagram kind of exemplifies what Tom may have mentioned earlier. This shows the moon as being round, and it is -- almost. This orbit is elliptical. So the vehicle never is at a constant altitude. It starts out at higher than 50,000, comes down to 50,000, and then goes on up.

But it doesn't change altitude very fast over this strip of arc.

QUESTION: At this point, on that elliptical maneuver, if you have a spacecraft starting off at a fixed point on the surface of the moon in motion and if you were sitting on the moon and couldn't . . . (Inaudible). . . There were a number of options, like waiting for the command module to go around again, and a number of other things.

I have had it suggested to me that if the timing of this burn, or the intensity of it, is off by any appreciable amount that the business of getting the lunar module and the command module back together again would be enormously complicated. Would you comment on that?

McMULLEN: Well, I think we'd make a real-time adjustment to the phasing burn. A phasing burn is designed to do just exactly that -- to account for the difference in time of the two spacecraft passing some point. So that if we do have a problem getting the burn off, it will just be a matter of changing the amount of velocity change and hence the size of the orbit that we use for phasing, and that adjusts the time automatically.

QUESTION: Could you give me the total number of orbits the CSM will make around the moon, the number of orbits it will make with the LM detached and the time from TLI to LOI?

HAGE: Yes. As a rule of thumb, it is one orbit every two hours. That is a fairly accurate rule of thumb. It will be in orbit 61-1/2 hours, and roughly 30 orbits.

Let's see. The second part of your question was --

QUESTION: How many of those orbits will be with the LM detached?

HAGE: With the LM detached?

QUESTION: Yes.

HAGE: Well, the LM is detached for a little over eight hours, so that would be four orbits.

QUESTION: Another part was the length of time from TLI to LOI.

HAGE: TLI to LOI? TLI occurs at two hours and 34 minutes from launch, and TEI occurs at five days, 18 hours and 26 minutes from launch.

QUESTION: What about LOI?

QUESTION: Could you repeat those figures?

HAGE: Translunar injection, two hours and 34 minutes from launch. Lunar orbit insertion, the first orbit, the elliptical orbit, three days, four hours, and 49 minutes. And transearth injection, five days, 18 hours and 26 minutes.

QUESTION: Once the lunar module is detached and in its elliptical orbit, if the ascent engine fails is there any way that the command module can dock with the lunar module?

HAGE: Yes. Let me just comment on the mission philosophy. It is identical to the philosophy we had on Apollo 9. There is no situation during the separated rendezvous wherein there isn't a backup propulsion mode available in the event that the primary mode fails, such as using the RCS instead of the ascent propulsion, and on every maneuver the command module will be targeting for a mirror image maneuver, and in the event the LM ignition does not take place, the command and service module will in effect make a mirror image maneuver that would bring the two of them back together again.

So no single propulsion system failure would present a crew hazard, since there is always an alternate option way of getting the two vehicles together.

QUESTION: Could we have that GET chart up while we are talking?

HAGE: Sure. Chart 12, please.

(Slide)

O'DONNELL: These charts will all be included in the transcript, incidentally.

Let's switch now to Houston. When we come back, we will get some questions up in the back.

Does Houston have some questions?

QUESTION: A simple question. We did not have the benefit of the slides that you had in Washington. Will you give us throughout the entire mission the GET time for major operations? Would you give us the specific launch days and the specific times of the windows for each day? Would you give us the GET times for the TV?

O'DONNELL: Those all will be included in the transcripts that we will get out tomorrow. We will get them down to Houston just as soon as we can.

Do you have any more questions?

QUESTION: However, that doesn't help if we are writing a story tonight.

HAGE: Bill, can I suggest that these might be sent by telephone directly after the briefing?

O'DONNELL: All right. We will send them down by FAX machine. You should be getting them in another hour.

Okay. Back here now.

QUESTION: I'm interested in the earliest possible launch. As I recall, Mr. Hage gave us 11:49 p.m., E.S.T., making this the earliest possible launch, and then later he referred to a daylight launch and recovery. Will you clear this up for me, please?

HAGE: I'll try. 11:49 a.m. Eastern Standard Time on the 18th, which results in a daylight launch and a daylight recovery.

QUESTION: Isn't there some confusion first of all, George? You keep saying 11:49 Eastern Standard, and the country is on daylight. You mean 12:49 Eastern Daylight, don't you?

HAGE: You've got me on that one, Jules. I think this is standard time. I think this is computed in standard time. It has not been corrected for daylight yet.

QUESTION: Okay. Is there any chance at all of the TV camera, black and white or color, being operated from the LM during any of those low passes?

HAGE: No, the provisions for the TV system don't exist in the lunar module. The activities that the crew will be involved in during that phase of the mission are so demanding that we just didn't make provision for it.

QUESTION: There is no way of simply bracketing the camera on while they are doing their landmark sighting and --

HAGE: There are no electrical connections for the camera in LM-4.

QUESTION: Could someone summarize the number of burns that will be made while you are in lunar orbit and how many of these will take place out of sight of the earth?

HAGE: Both of the lunar orbit insertion burns, first the elliptical and then the circular orbit, are behind the moon. Colonel McMullen is going through the ones involved in lunar orbit.

McMULLEN: There will be a total of five LM burns that are out of sight of Manned Spaceflight Network and a total of five that we will be able to see from earth, so five we cannot and five we can.

QUESTION: The last five lunar module?

McMULLEN: All ten of those I gave were lunar module burns.

HAGE: Transearth injection burn is also from behind the moon, the one that brings them out on the way home.

McMULLEN: If you are keeping book on these, three of the burns I gave you were the braking maneuver, so we all wind up with numbers adding up to the right number of burns.

O'DONNELL: Let's get one question here and we'll switch to Houston.

QUESTION: I wonder if George Hage could give us a progress report on this experimental color TV camera that Westinghouse is supposed to be working with.

HAGE: We are quite optimistic that we will have it available on Apollo 10. I think the last validation test which will give us the go/no go will be during countdown demonstration when we can work it into the whole system, including the ground processing electronics through the network to Houston.

O'DONNELL: Okay. We will switch to Houston now.

Any questions in Houston?

(No response.)

All right. Back here in Washington. A couple more.

QUESTION: What happens to the . . . (Inaudible)? Are there any more burns to that to get it out?

HAGE: It will remain in that high elliptical orbit.

McMULLEN: We have no way of commanding the descent stage once we do the staging maneuver of the lunar module.

O'DONNELL: Okay. Back here.

QUESTION: . . . (Inaudible). . . Will there be any other women's names on the moon as a result of Apollo 10?

HAGE: The procedure by which landmarks on the moon are officially labeled is --

QUESTION: I'm talking about unofficial labelling.

HAGE: I would be surprised if there aren't, but I don't know of any specific ones.

QUESTION: In the case of alternate missions, for instance, the high elliptical orbit, is it impossible in that case to perform some kind of practice operations?

HAGE: No, that part of the plan-- It might be quite restricted in that we obviously don't want to get the two vehicles apart in a sense to an extent where we can't get them back together again, but we have exercised the alternate missions to take maximum advantage of LM operations.

QUESTION: On Apollo 8 without the LM you had a problem. How do the margins change now especially with respect to propellants on the SPS?

HAGE: Well, as you mentioned, the Apollo 8 margins were very comfortable because of the fact that we didn't carry an LM to the moon. The margins on Apollo 10 are also equally comfortable on the lunar module because we are not going to land.

So in my own view I kind of equate Apollo 8 command service module margins and LM-4 module margins as equal level.

In case of CSM Apollo 10, we will be operating at the same consumable margins that we will be operating Apollo 11 at. Those are comfortable. I believe the lowest one we have is something in the order of 10 per cent of the total, but I want to check that number. It's in that general vicinity. We have good margins planned into the CSM for the landing mission, and we will duplicate those conditions with the Apollo 10 flight.

QUESTION: George, could you discuss in a little more detail the changes that have been made to the landing radar? How much will the augmented equipment weigh? Are you confident that 50,000-foot data will be translatable to 30,000-foot data? And what kind of test program for the unit is scheduled?

HAGE: Before I get into the specifics of the changes on LM-4, John, just let me comment for a minute on the test program that is already taking place with the landing radar flying aircraft.

We have had literally hundreds of equivalent mission types of operation with the LM landing radar flying the aircraft over the complete spectrum of ranges that it will be expected to operate over. The only thing that is different is that the radar was working against the earth as a reflector instead of the moon.

Now, in order to fly LM-4 in a way that would give us the most information about the characteristics of the lunar surface that might be different than we anticipate, we have added essentially electrical pickoffs from the four beams of the radar that are fed out on telemetry systems, and we will read the signature that comes back from those four beams and use it as a means of correlating with what we have gotten from our aircraft tests.

So we think it is going to be a very meaningful test.

O'DONNELL: Any more questions?

Back here.

QUESTION: You said that the phase burn was designed to give similar lighting conditions for the rendezvous. Are there other parameters?

McMULLEN: Phasing burn will wind up with essentially the same lighting conditions since it will be occurring in essentially the-- It will wind up within positions to give us a rendezvous essentially above the same points on the lunar surface, so essentially the phasing burn coupled with the insertion burn-- At the completion of the insertion burn we should have conditions that are identical to what we will be seeing on the lunar landing mission at the completion of the launch and insertion into orbit from the lunar surface.

O'DONNELL: One more.

QUESTION: You mentioned the possibility of the command module going to rendezvous with the lunar module. Does this in any way compromise your ability to leave the lunar, get the command back?

HAGE: The service propulsion system propellant includes capability for that kind of rescue, and the margins we have are above and beyond that. That is designed in to the propellant.

O'DONNELL: Okay. Thank you very much, George and Tom.

We will now be switching over to Houston. We have some gentlemen standing by there.

(Whereupon, at 3:00 p.m., the briefing continued without transcription.)

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