The CM Pilot will transfer the lunar surface equipment stowage bags into the LM one at a time. The equipment transferred will then be bagged using the "buddy system" and transferred back into the CM where the equipment will be stowed. The only equipment that will not be bagged at this time are the crewmen's space suits and flight logs.

Following the transfer of the LM crew and equipment, the spacecraft will be separated and the three crewmen will start the return to earth. The separated LM contains the remainder of the lunar exposed equipment.

COMMAND MODULE OPERATIONS

Through the use of operational and housekeeping procedures the CM cabin will be purged of lunar surface and/or other particulate contamination prior to earth atmosphere entry. These procedures start while the LM is docked with the CM and continue through entry into the earth's atmosphere.

The LM crewmen will doff their space suits immediately upon separation of the LM and CM. The space suits will be stowed and will not be used again during the transearth phase unless an emergency occurs.

Specific periods for cleaning the spacecraft using the vacuum brush have been established. Visible liquids will be removed by the liquid dump system. Towels will be used by the crew to wipe surfaces clean of liquids and dirt particles. The three ECS suit hoses will be located at random positions around the spacecraft to insure positive ventilation, cabin atmosphere filtration, and avoid partitioning. During the transearth phase, the CM atmosphere will be continually filtered through the ECS lithium hydroxide canister. After about 63 hours operation, essentially none (10^{-90} percent) of the original contaminates will remain.

RECOVERY OPERATIONS

Following landing and the attachment of the flotation collar to the CM, the swimmer in a Biological Isolation Garment (BIG) will open the spacecraft hatch, pass three BIG's into the spacecraft, and close the hatch.

The crew will don the BIG's and then egress into the liferaft. The hatch will be closed immediately after egress. Tests have shown that the crew can don their BIG's in less than 5 minutes under ideal sea conditions. The spacecraft hatch will be open only for a few minutes. The spacecraft and crew will be decontaminated by the swimmer using a liquid agent. Crew retrieval will be accomplished by helicopter transport to the carrier. Subsequently, the crew will transfer to the Mobile Quarantine Facility. The spacecraft will be retrieved by the aircraft carrier.

BIOLOGICAL ISOLATION GARMENT

The BIG's will be donned in the CM just prior to egress and helicopter pickup and will be worn until the crew enters the Mobile Quarantine Facility aboard the primary recovery ship.

The suit is fabricated of a light weight cloth fabric which completely covers the wearer and serves as a biological barrier. Built into the hood area is a face mask with a plastic visor, air inlet flapper valve, and an air outlet biological filter.

Two types of BIG's are used in the recovery operation. One is worn by the recovery swimmer. In this type garment, the inflow air (inspired) is filtered by a biological filter to preclude possible contamination of support personnel. The second type is worn by the astronauts. The inflow gas is not filtered, but the outflow gas (respired) is passed through a biological filter to preclude contamination of the air.

MOBILE QUARANTINE FACILITY

The Mobile Quarantine Facility (MQF) is equipped to house six people for a period up to 10 days. The interior is divided into three sections — lounge area, galley, and sleep/bath area. The facility is powered through several systems to interface with various ships, aircraft, and transportation vehicles. The shell is air and water tight. The principal method of assuring quarantine is to filter effluent air and provide a negative pressure differential for biological containment in the event of leaks.

Non-fecal liquids from the trailer are chemically treated and stored in special containers. Fecal wastes will be contained until after the quarantine period. Items are passed in or out of the MQF through a submersible transfer lock. A complete communications system is provided for intercom and external communications to land bases from ship or aircraft. Emergency alarms are provided for oxygen alerts while in transport by aircraft, for fire, loss of power, and loss of negative pressure.

Specially packaged and controlled meals will be passed into the facility where they will be prepared in a microwave oven. Medical equipment to complete immediate postlanding crew examination and tests are provided.

LUNAR RECEIVING LABORATORY

The final phase of the Back Contamination Program is completed in the Manned Spacecraft Center Lunar Receiving Laboratory (LRL). The crew and spacecraft are quarantined for a minimum of 21 days after lunar liftoff and are released based upon the completion of prescribed test requirements and results. During this time the CM will be disinfected. The lunar samples will be quarantined for a period of 50 to 80 days depending upon the results of extensive biological tests. The LRL serves four basic purposes:

- The quarantine of the lunar mission crew and spacecraft, the containment of lunar and lunar-exposed materials, and quarantine testing to search for adverse effects of lunar material upon terrestrial life.

- The preservation and protection of the lunar samples.

- The performance of time-critical investigation.

- The preliminary examination of returned samples to assist in an intelligent distribution of samples to principal investigators.

The LRL has a vacuum system with manually operated space gloves leading directly into a vacuum chamber at pressures of 10^{-7} torr (mm of mercury). It has a low-level counting facility with a background count an order of magnitude better than other known counters. Additionally, it is a facility that can handle cabinets to contain extremely hazardous pathogenic material.

The LRL covers 83,000 square feet of floor space and includes several distinct areas. These are the Crew Reception Area (CRA), Vacuum Laboratory, Sample Laboratories (Physical and Bioscience), and an administrative and support area. Special building systems are employed to maintain air flow into sample handling areas and the CRA to sterilize liquid waste and to incinerate contamination air from the primary containment systems.

The CRA provides biological containment for the flight crew and 12 support personnel. The nominal occupancy is about 14 days but the facility is designed and equipped to operate for considerably longer if necessary.

The biomedical laboratories provide for the required quarantine tests to determine the effect of lunar samples on terrestrial life. These tests are designed to provide data upon which to base the decision to release lunar material from quarantine.

Among the tests:

A. Germ-free mice will be exposed to lunar materials and observed continuously for 21 days for any abnormal changes. Periodically, groups will be sacrificed for pathologic observation.

B. Lunar material will be applied to 12 different culture media and maintained under several environmental conditions. The media will then be observed for bacterial or fungal growth. Detailed inventories of the microbiol flora of the spacecraft and crew have been maintained so that any living material found in the sample testing can be compared against this list of potential contaminants taken to the moon by the crew or spacecraft.

C. Six types of human and animal tissue culture cells will be maintained in the laboratory and, together with embryonated eggs, will be exposed to the lunar material. Based on cellular and/or other changes, the presence of viral material can be established so that special tests can be conducted to identify and isolate the type of virus present.

D. Thirty-three species of plants and seedlings will be exposed to lunar material. Seed germination, growth of plant cells, or the health of seedlings will then be observed, and histological, microbiological, and biochemical techniques will be used to determine the cause of any suspected abnormality.

E. A number of lower animals will be exposed to lunar material. These specimens include fish, birds, oysters, shrimp, cockroaches, houseflies, planaria, paramecia, and euglena. If abnormalities are noted, further tests will be conducted to determine if the condition is transmissible from one group to another.

STERILIZATION AND RELEASE OF THE SPACECRAFT

Postflight testing and inspection of the spacecraft is presently limited to investigation of anomalies which happened during the flight. Generally, this entails some specific testing of the spacecraft and removal of certain components of systems for further analysis. The timing of postflight testing is important so that corrective action may be taken for subsequent flights.

The schedule calls for the spacecraft to be returned to port where a team will deactivate pyrotechnics, flush and drain fluid systems (except water). This operation will be confined to the exterior of the spacecraft. The spacecraft will then be flown to the LRL and placed in a special room for storage, sterilization, and postflight checkout.

CONTINGENCY OPERATIONS

GENERAL

If an anomaly occurs after liftoff that would prevent the space vehicle from following its nominal flight plan, an abort or an alternate mission will be initiated. Aborts will provide for an acceptable flight crew and CM recovery while alternate missions will attempt to maximize the accomplishment of mission objectives as well as providing for an acceptable flight crew and CM recovery. Figure 36 shows the Apollo 11 contingency options.

ABORTS

The following sections describe the abort procedures that may be used to return the CM to earth safely following emergencies that would prevent the space vehicle from following its normal flight plan. The abort descriptions are presented in the order of mission phase in which they could occur.

Launch

There are six launch abort modes. The first three would result in the termination of the launch sequence and a CM landing in the launch abort areas.

Mode I - The Mode 1 abort procedure is designed for safe recovery of the CM following an abort initiated between Launch Escape System arming and Launch Escape Tower jettison. The procedure would consist of the Launch Escape Tower pulling the CM off the launch vehicle and propelling it a safe distance downrange. The resulting landing point would lie between the launch site and approximately 520 NM downrange.

Mode II - The Mode II abort could be performed from the time the Launch Escape Tower is jettisoned early during second-stage burn until the full-lift CM landing point reaches 3200 NM downrange. The procedure would consist of separating the CSM from the launch vehicle, separating the CM from the SM, and then letting the CM free fall to entry. The entry would be a full-lift, or maximum range trajectory, with a landing on the ground track between 440 and 3200 NM downrange.

Mode III - The Mode III abort procedure could be performed from the time the full-lift CM landing range reaches 3200 NM downrange until orbital insertion is achieved. The procedure would consist of separating the CSM from the launch vehicle and then, if necessary, performing a retrograde burn with the SPS so that the half-lift CM landing point is no farther than 3350 NM downrange. Since a half-lift entry would be flown, the CM landing point would be approximately 70° NM south of the ground track between 3000 and 3350 NM downrange.

APOLLO 11 NOMINAL MISSION EVENTS AND CONTINGENCY OPTIONS

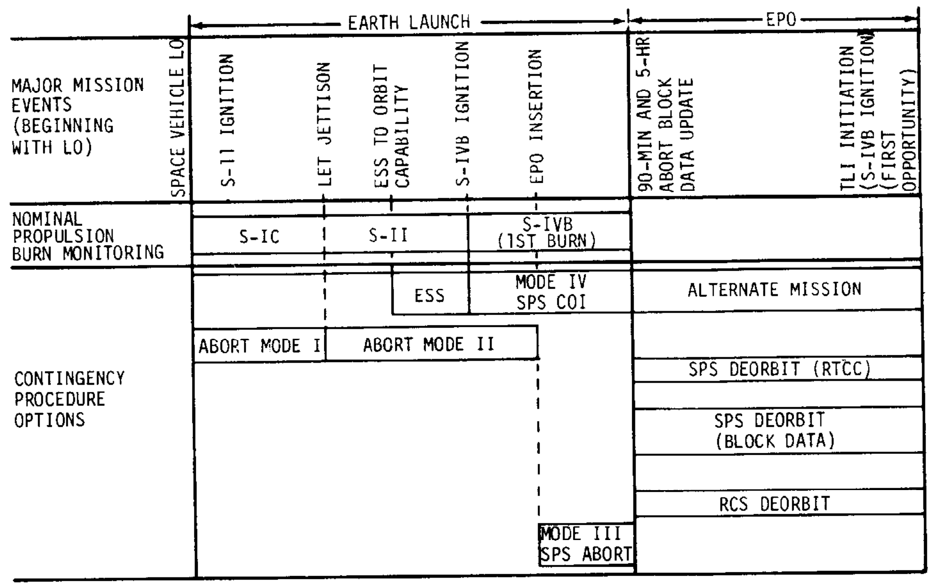

Fig. 36

APOLLO 11 NOMINAL MISSION EVENTS AND CONTINGENCY OPTIONS (CONTINUED)

	TLI BURN	T AND D	TRANSLUNAR COAST
MAJOR MISSION EVENTS (BEGINNING WITH LO)	SPACE VEHICLE LO; TLI (S-IVB CO)	CSM SEPARATION	LM EXTRACTION; LOI-29 HR; LOI-20 HR; LOI-5 HR; LOI (PC)
NOMINAL PROPULSION BURN MONITORING	S-IVB (2ND BURN)		
CONTINGENCY PROCEDURE OPTIONS	ALTERNATE MISSION	ALTERNATE MISSION	ALTERNATE MISSIONS
			SPS OR RCS TO MPL-FLYBY (RTCC OR BLOCK DATA) 60 N. MI $< H_F <$ 1500 N.MI. ; SPS OR RCS TO PRIME CLA (RTCC OR BLOCK DATA)
			DPS OR RCS TO MPL-FLYBY (RTCC OR BLOCK DATA) 60 N. MI $< H_P <$ 1500 N. MI ; DPS OR RCS TO PRIME CLA (RTCC OR BLOCK DATA)
	90-MIN SPS ABORT (BLOCK DATA)	TLI+4 HR ABORT (BLOCK DATA)	SPS DIRECT WITHOUT LM TO PRIME CLA (RTCC) ; SPS AT PC + 2 HR TO ANY CLA (RTCC OR BLOCK DATA)
			DPS AT PC + 2 HR TO ANY CLA (RTCC OR BLOCK DATA)
	10-MIN SPS ABORT (ONBOARD)		SPS DIRECT WITH LM TO ANY CLA (RTCC)
			SPS DIRECT WITHOUT LM TO PRIME CLA (BLOCK DATA-P37)

Fig. 36(continued)

APOLLO 11 NOMINAL MISSION EVENTS AND CONTINGENCY OPTIONS (CONTINUED)

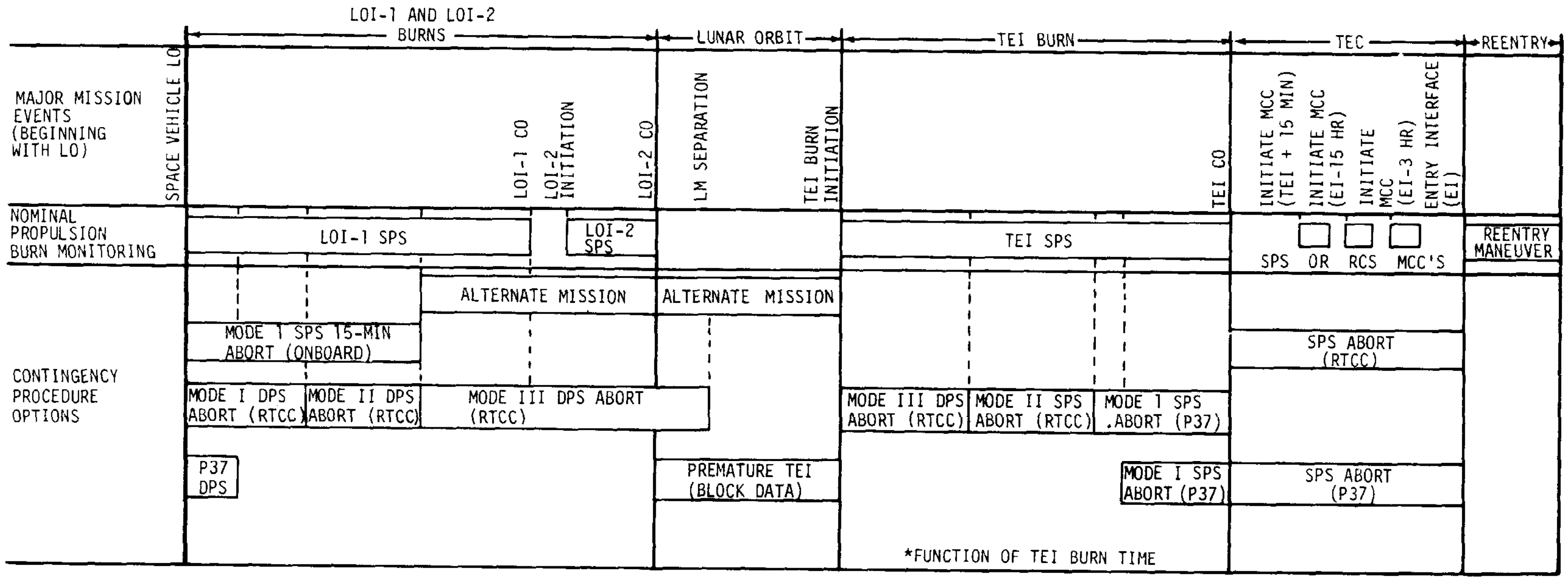

Fig. 36(continued)

These three descriptions are based on aborts initiated from the nominal launch trajectory. Aborts from a dispersed trajectory will consist of the same procedures, but the times at which the various modes become possible and the resultant landing points may vary.

The following launch abort procedures are essentially alternate launch procedures and result in insertion of the spacecraft into a safe earth orbit. These procedures would be used in preference to Modes II and III above unless immediate return to earth is necessary during the launch phase.

Mode IV and Apogee Kick - The Mode IV abort procedure is an abort to earth parking orbit and could be performed any time after the SPS has the capability to insert the CSM into orbit. This capability begins approximately 8 minutes 30 seconds GET. The procedure consists of separating the CSM from the launch vehicle and, shortly afterwards, performing a posigrade SPS burn to insert the CSM into earth orbit. This means that any time during the S-IVB burn portion of the launch phase the CSM has the capability to insert itself into orbit if the S-IVB should fail. Apogee kick is a variation of the Mode IV abort wherein the SPS burn to orbit would be performed at, or near, the first spacecraft apogee. The main difference between the two is the time at which the posigrade SPS burn is performed.

S-IVB Early Staging - Under normal conditions, the S-IVB is inserted into orbit with enough fuel to perform the TLI maneuver. This capability can be used, if necessary, during the launch phase to insure that the spacecraft is inserted into a safe parking orbit. After approximately 6 minutes 30 seconds GET, the S-IVB has the capability to be staged early and achieve orbit. The CSM/LM could then remain in earth orbit to carry out an alternate mission, or, if necessary, return to the West Atlantic Ocean after one revolution.

S-IVB Early Staging to Mode IV - Should it become necessary to separate from a malfunctioning S-II stage, the S-IVB could impart sufficient velocity and altitude to the CSM to allow the SPS to be used to place the CSM into an acceptable earth orbit. The procedure is a combination of S-IVB early staging and Mode IV procedures. This means that at any time after 5 minutes 30 seconds GET the S-IVB/SPS combination may be utilized to boost the CSM into a safe earth orbit.

Earth Parking Orbit

Once the S-IVB/CSM is safely inserted into earth parking orbit, a return-to-earth abort would be performed by separating the CSM from the S-IVB and then utilizing the SPS for a retrograde burn to place the CM on an atmosphere-intersecting trajectory. After entry, the CM would be guided to a preselected target point, if available. This procedure would be similar to the deorbit and entry procedure performed on the Apollo 7 and Apollo 9 flights.

Translunar Injection

Ten-Minute Abort — There is only a remote possibility that an immediate return-to-earth will become necessary during the relatively short period of the TLI maneuver. However, if it should become necessary the S-IVB burn would be cut off early and the crew would initiate an onboard-calculated retrograde SPS abort burn. The SPS burn would be performed approximately 10 minutes after TLI cutoff and would ensure a safe CM entry. The elapsed time from abort initiation to landing would vary from approximately 20 minutes to 5 hours, depending on the length of the TLI maneuver performed prior to S-IVB cutoff. For aborts initiated during the latter portion of TLI, a second SPS burn called a midcourse correction would be necessary to correct for dispersed entry conditions. Since this abort would be used only in extreme emergencies with respect to crew survival, the landing point would not be considered in executing the abort. No meaningful landing point predictions can be made because of the multiple variables involved including launch azimuth, location of TLI, the duration of the TLI burn prior to cutoff, and execution errors of the abort maneuvers.

Ninety-Minute Abort — A more probable situation than the previous case is that the TLI maneuver would be completed and then the crew would begin checking any malfunctions that may have been evident during the burn. If, after the check, it becomes apparent that it is necessary to return to earth, an abort would be initiated at approximately TLI cutoff plus 90 minutes. Unlike the previous procedure, this abort would be targeted to a preselected landing location called a recovery line. There are three recovery lines spaced around the earth as shown in Figure 37. This abort would be targeted to either the Mid-Pacific or the Atlantic Ocean recovery line. The abort maneuver would be a retrograde SPS burn followed by a midcourse correction, if necessary, to provide the proper CM entry conditions.

Translunar Coast

The CSM/LM will be in the translunar coast phase of the mission for approximately 3 days. The abort procedure during this time would be similar to the 90-minute abort. Abort information specifying a combination of SPS burn time and CSM attitude would be sent to the crew to be performed at a specific time. The longitude of the landing is determined by the time of abort and the abort trajectory. Therefore, fixed times of abort that will result in a landing on the Mid-Pacific recovery line will be selected during translunar coast. Because of the earth's rotation, a landing on the Mid-Pacific line can be accomplished only during one time interval for each 24-hour period. For this reason, a time critical situation may dictate targeting the abort to one of the other two recovery lines in order to minimize the elapsed time from abort to landing. The order of priority for the recovery lines is: (1) Mid-Pacific line, (2) Atlantic Ocean line, and (3) Indian Ocean line. Although the longitudes of the recovery lines are different, the latitude of landing will remain at approximately the latitude at which TLI occurred.

RECOVERY LINES

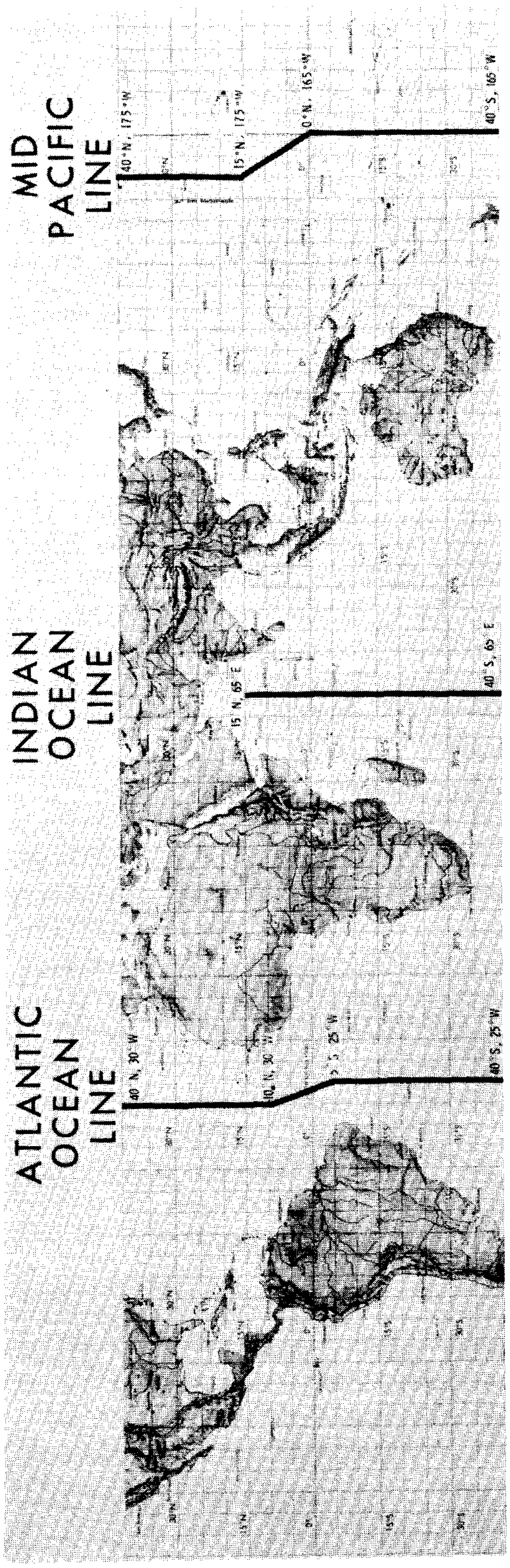

Fig. 37

As the distance between the spacecraft and the moon decreases, the capability for return to earth increases. This continues until some time after the spacecraft reaches the moon's sphere of influence (basically, the point in the trajectory where the moon's influence on the spacecraft equals that of the earth) after which the return to earth becomes less for a circumlunar abort than for a direct return-to-earth abort.

Lunar Orbit Insertion

Should early termination of the LOI burn occur, the resulting abort procedure would be one of three modes classified according to length of burn before termination. Each abort mode would normally result in return of the CM to the Mid-Pacific recovery line. These modes are briefly discussed below.

Mode I - The Mode I procedure would be used for aborts following SPS cutoffs from ignition to approximately 1.5 minutes into the LOI burn. This procedure would consist of performing a posigrade DPS burn approximately 2 hours after cutoff to put the spacecraft back on a return-to-earth trajectory.

Mode II - The Mode II procedure would be used for aborts following SPS shutdown during the interval approximately between LOI ignition plus 1.5 minutes and LOI ignition plus 3 minutes. This abort maneuver is performed in two stages. First, a DPS burn would be executed to reduce the lunar orbital period and to insure that the spacecraft does not impact on the lunar surface. After one orbit, a second DPS burn would place the spacecraft on a return-to-earth trajectory.

Mode III - The Mode III procedure would be used for aborts following shutdowns from approximately 3 minutes into the burn until nominal cutoff. After 3 minutes of LOI burn, the spacecraft will have been inserted into an acceptable lunar orbit. Therefore, the abort procedure would be to let the spacecraft go through one or two lunar revolutions prior to doing a posigrade DPS burn at pericynthion. This would place the spacecraft on a return-to-earth trajectory targeted to the Mid-Pacific recovery line.

Lunar Orbit

An abort from lunar orbit would be accomplished by performing the TEI burn early. Should an abort become necessary during the LM descent, ascent, or rendezvous phases of the mission, the LM would make the burns necessary to rendezvous with the CSM. If the LM were unable to complete the rendezvous, the CSM would, if possible, perform a rescue of the LM. In any case, the early TEI would normally target the CM to the Mid-Pacific recovery line.

Lunar Module Powered Descent

Aborts for the powered descent phase are controlled by the Primary Guidance and Navigation System (PGNS) abort program or the Abort Guidance System (AGS), depending on the operational status of the DPS and the PGNS. If both the PGNS and DPS are operational, the abort is initiated by pushing the "Abort" button. The DPS abort will continue under PGNS control until either orbit insertion or engine cutoff due to DPS failure or propellant depletion. If DPS cutoff occurs and the velocity-to-be-gained (V_G) is less than 30 fps, the DPS will be staged manually and the RCS will be used to complete the orbit insertion of the LM. If V_G is greater than 30 fps, the "Abort Stage" button is pushed. This stages the Descent Stage, and ignites the APS engine. The desired insertion orbit will then be obtained using the APS.

If the DPS has failed, the abort will be performed using the APS. As above, the procedure is to push the "Abort Stage" button.

If the PGNS is not operational, the abort is controlled by the AGS. For an operational DPS, the thrust level is controlled manually, and the steering is controlled by the AGS. If the DPS is not operational or becomes inoperative with a V_G greater than 30 fps, the DPS will be staged manually, and the RCS will be used to insert the LM.

If both the PGNS and AGS have failed, a manual abort technique, using the horizon angle for a reference, will be used.

Lunar Stay

After LM touchdown if an early abort is required there are two preferred liftoff times. The first is actually a 15-minute span of time beginning at PDI (touchdown to touchdown plus 3 minutes). The second is at PDI plus 21.5 minutes (touchdown plus about 9.5 minutes). Both of these aborts will place the LM into a 9 x 30-NM orbit acceptable for LM-active rendezvous. Here again, an extra orbit and CSM dwell orbit are used to improve the rendezvous phasing and conditions in the former case and two revolutions are added in the latter case.

The above times may be adjusted somewhat in real-time to account for possible variations in the CSM orbit. Subsequently during the lunar stay, the preferred liftoff time is whenever the phasing is optimum for rendezvous. This occurs once each revolution shortly after the CM has passed over the site. The nominal rendezvous is performed with this phasing.

In the unlikely event of a catastrophic APS failure calling for an immediate liftoff, rendezvous following liftoff at any time could be performed within performance and time constraints. However, this contingency is considered highly unlikely and the rendezvous phasing is fairly poor during some periods. Due to the low probability of such an abort, highly developed operational plans for such are not being promulgated.

Aborts will proceed under the control of the PGNS, if operating, otherwise under control of AGS. A manual guidance scheme is being developed to provide backup in the event of both PGNS and AGS failure. This backup uses the Flight Director Attitude Indicator, if available, for attitude reference; otherwise, the horizon is used for reference.

Lunar Module Powered Ascent

Three types of aborts are available for the powered ascent phase. If the PGNS fails, the abort will require switching to the AGS. If the APS fails, the abort will be performed using the RCS for insertion provided the engine failure occurs within the RCS insertion capability. If both the PGNS and AGS fail, the abort will be performed by the crew using manual control.

Transearth Injection

The abort procedures for early cutoff of the SPS during the TEI burn are the inverse of the LOI abort procedures except that the abort would be performed by attempting to reignite the SPS. For SPS cutoff during the interval between TEI ignition and ignition plus 1.5 minutes, the Mode III LOI abort procedure would be used. For SPS cutoff between TEI ignition plus 1.5 minutes and TEI ignition plus 2 minutes, the Mode II LOI abort procedure would be used. If the SPS should be shut down from TEI ignition plus 2 minutes to nominal end of TEI, abort Mode I would be performed, except that the 2-hour coast period would be deleted.

Transearth Coast

From TEI until entry minus 24 hours, the only abort procedure that could be performed is to use the SPS or the SM RCS for a posigrade or retrograde burn that would respectively decrease or increase the transearth flight time and change the longitude of landing. After entry minus 24 hours, no further burns to change the landing point will be performed. This is to ensure that the CM maintains the desired entry velocity and flight path angle combination that will allow a safe entry.

Entry

If during entry, the Guidance, Navigation, and Control System (GNCS) fails, a guided entry to the end-of-mission target point cannot be flown. In this case, the crew would use their Entry Monitor System (EMS) to fly a 1285-NM range. The landing point would be approximately 39 NM uprange of the guided target point and 75 NM north of the ground track. If both the GNCS and EMS fail, a "constant g" (constant deceleration) entry would be flown. The landing point would be approximately 240 NM uprange of the guided target point and 75 NM north of the ground track.

ALTERNATE MISSION SUMMARY

The two general categories of alternate missions that can be performed during the Apollo 11 Mission are (1) earth orbital, and (2) lunar. Both of these categories have several variations which depend upon the nature of the anomaly causing the alternate mission and the resulting systems status of the LM and CSM. A brief description of these alternate missions is contained in the following paragraphs.

Earth Orbital Alternate Missions

Alternate 1 - CSM-Only Low Earth Orbit

Condition/Malfunction: LM not extracted, or S-IVB failed prior to 25,000-NM apogee, or SPS used to achieve earth orbit.

Perform: SPS LOI simulation (100 x 400-NM orbit), MCC's to approximate lunar timeline and for an approximate 10-day mission with landing in 150°W Pacific recovery area.

Alternate 2 - CSM-Only Semisynchronous

Conditon/Malfunction: S-IVB fails during TLI with apogee ≥25,000 NM, LM cannot be extracted.

Perform: SPS phasing maneuver for LOI tracking, LOI simulation, SPS phasing maneuver to place perigee over Pacific recovery zone at later time, SPS semi-synchronous orbit, and further MCC's to approximate lunar timeline.

Alternate 3 - CSM/LM Earth Orbit Combined Operations with SPS Deboost

Condition/Malfunction: TLI does not occur or TLI apogee <4000 NM, TD&E successful.

Perform: SPS maneuver to raise or lower apogee for orbit lifetime requirements if necessary, simulated LOI to raise or lower apogee to 400 NM, simulated DOI (in docked configuration), simulated PDI, SPS maneuver to circularize at 150 NM, a limited rendezvous (possibly CSM-active), and further SPS MCC's to complete lunar mission timeline.

Alternate 4 - CSM/LM Earth Orbit Combined Operations with DPS/SPS Deboost

Condition/Malfunction: S-IVB fails during TLI, SPS and DPS in combination can return CSM/LM to low earth orbit without sacrificing LM rescue (4000 NM < apogee ≤ 10,000 NM).

Perform: SPS phasing maneuver, simulated DOI, PDI to lower apogee to about 4000 NM, SPS phasing (simulated MCC) maneuver to insure tracking for LOI, SPS maneuver to circularize at 150 NM, a limited rendezvous (possibly CSM-active), SPS maneuver to complete lunar mission, timeline, and achieve nominal 90 x 240-NM, end-of-mission orbit for an approximate 10-day mission with landing in 150°W Pacific recovery area.

Alternate 5 - CSM/LM Semisynchronous

Condition/Malfunction: SPS and DPS in combination cannot place CSM/LM in low earth orbit without sacrificing LM rescue, SPS propellant not sufficient for CSM/LM circumlunar mission.

Perform: SPS phasing maneuver (to place a later perigee over an MSFN site), SPS LOI (approximately semisynchronous), SPS phasing maneuver if necessary to adjust semisynchronous orbit, docked DPS DOI, docked DPS PDI simulation, SPS phasing to put perigee over or opposite recovery zone, SPS to semisynchronous orbit, and further MCC's to approximate lunar mission timeline.

Lunar Alternate Missions

Alternate 1a - DPS LOI

Condition/Malfunction: Non-nominal TLI such that: continuation of nominal mission, including CSM/LM LOI and TEI with SPS, is No-Go; but CSM/LM LOI Go with DPS LOI-1.

Perform: TD&E, SPS free-return CSM/LM, DPS LOI-1, and SPS LOI-2, after LOI-2, plane change for site coverage, photography and tracking of future landing sites, high-inclination orbit determination, SPS DOI with CSM/LM for three revolutions.

Alternate 1b - CSM Solo Lunar Orbit

Condition/Malfunction: Non-nominal TLI such that: CSM/LM LOI No-Go, CSM-only LOI Go.

Perform: TD&E, SPS free-return CSM/LM, LM testing during TLC and DPS staging, SPS plane changes in lunar orbit for additional site coverage, photography and tracking of future landing sites, high-inclination orbit determination, SPS to 60 x 8-NM orbit for three revolutions.

Alternate 1c - CSM/LM Flyby

Condition/Malfunction: Non-nominal TLI, such that: CSM/LM Flyby Go, CSM/LM LOI No-Go, CSM-only LOI No-Go.

Perform: TD&E, LM testing near pericynthion, docked DPS maneuver to raise pericynthion, DPS staging, and SPS for fast return.

Alternate 2 - CSM-Only Lunar Orbit

Condition/Malfunction: Failure to TD&E.

Perform: CSM-only lunar orbit mission, SPS plane change in lunar orbit for additional site coverage, photography and tracking of future landing sites, high-inclination orbit determination, SPS to 60 x 8-NM orbit for three revolutions.

Alternate 3a - DPS TEI

Condition/Malfunction: LM No-Go for landing, but DPS Go for a burn.

Perform: SPS DOI to place CSM/LM in 60 x 8-NM orbit, three revolutions of tracking and photography, SPS circularization in 60 x 60-NM orbit, DPS TEI, SPS MCC for fast return.

Alternate 3b - DPS No-Go for Burn

Condition/Malfunction: LM No-Go for landing, and DPS No-Go for a burn.

Perform: CSM-only plane change for site coverage. Then follow same profile as Alternate 1b, above.

Alternate 4 - TEI With Docked Ascent Stage

Condition/Malfunction: CSM communications failure in lunar orbit.

Perform: TEI and keep LM as communication system. If DPS available, perform DPS TEI as in Alternate 3a. If Descent Stage jettisoned, perform SPS TEI with Ascent Stage attached.

CONFIGURATION DIFFERENCES

The space vehicle for Apollo 11 varies in its configuration from that flown on Apollo 10 and those to be flown on subsequent missions because of normal growth, planned changes, and experience gained on previous missions. Following is a list of the major configuration differences between AS-505 and AS-506.

SPACE VEHICLE	REMARKS
Command/Service Module (CSM-107)	
• Provided a short SPS main propellant sump tank.	To overcome potential delay in availability of scheduled tank.
• Changed insulation on hatch tunnel.	
Lunar Module (Ascent Stage) (LM-5)	
• Provided for first usage of EVA antenna (VHF).	Required for lunar landing mission.
• Incorporated Extravehicular Communication System (EVCS) into the PLSS.	Provides simultaneous and continuous telemetry from two extravehicular members, duplex voice communication between earth and one or both of the two extravehicular members, and uninterruptable voice communications between the crew members.
• Provided a Liquid Cooling Garment (LCG) heat removal subsystem.	Enhances mission success.
• Modified 22 critical stress corrosion fittings.	Enhances mission success.
Lunar Module (Descent Stage)	
• Modified the base heat shield.	Reduces the lunar landing fire-to-touchdown problem. Enhances mission success.
• Modified 11 critical stress corrosion fittings.	Enhances mission success.
• Added RCS plume deflectors for each of the lower four RCS thrusters.	To withstand increased firing time for RCS thrusters.

• Provided for first mission usage of erectable antenna (S-band).	Lunar landing mission requirement.
• Provided a modified gimbal drive actuator (polarizer and armature removed, added a new brake material and sleeve).	Enhances system performance.

Spacecraft-LM Adapter (SLA-14)

• (No significant differences.)

LAUNCH VEHICLE	REMARKS
Instrument Unit (S-IU-506)	
• (No significant differences.)	
S-IVB Stage (SA-506)	
• (No significant differences.)	
S-II Stage (S-II-506)	
• Deleted research and development (R&D) instrumentation and retained operational instrumentation only.	Basic requirement.
S-IC Stage (SA-506)	
• Retained operational instrumentation only.	Weight reduction of 5900 pounds results from deletion of R&D instrumentation.

MISSION SUPPORT

GENERAL

Mission support is provided by the Launch Control Center (LCC), the Mission Control Center (MCC), the Manned Space Flight Network (MSFN), and the recovery forces. The LCC is essentially concerned with prelaunch checkout, countdown, and with launching the SV, while MCC located at Houston, Texas, provides centralized mission control from liftoff through recovery. The MCC functions within the framework of a Communications, Command, and Telemetry System (CCATS); Real-Time Computer Complex (RTCC); Voice Communications System; Display/Control System; and a Mission Operations Control Room (MOCR) supported by Staff Support Rooms (SSR's). These systems allow the flight control personnel to remain in contact with the spacecraft, receive telemetry and operational data which can be processed by the CCATS and RTCC for verification of a safe mission, or compute alternatives. The MOCR is staffed with specialists in all aspects of the mission who provide the Mission Director and Flight Director with real-time evaluation of mission progress.

MANNED SPACE FLIGHT NETWORK

The MSFN is a worldwide communications and tracking network which is controlled by the MCC during Apollo missions. The network is composed of fixed stations (Figure 38) and is supplemented by mobile stations (Table 5) which are optimally located within a global band extending from approximately 40° south latitude to 40° north latitude. Station capabilities are summarized in Table 6. Figure 39 depicts communications during lunar surface operations.

The functions of these stations are to provide tracking, telemetry, updata, and voice communications both on an uplink to the spacecraft and on a downlink to the MCC. Connection between these many MSFN stations and the MCC is provided by NASA Communications Network (NASCOM). More detail on mission support is in the MOR Supplement.

TABLE 5

MSFN MOBILE FACILITIES

Ships	Location	Support
USNS VANGUARD	25°N 49°W	Insertion
USNS MERCURY	10°N 175.2°W	Injection
USNS REDSTONE	2.25°S 166.8°E	Injection
USNS HUNTSVILLE	3.0°N 154°E	Entry (tentative)

APOLLO RANGE INSTRUMENTATION AIRCRAFT

Eight Apollo Range Instrumentation Aircraft (ARIA) will be available to support the Apollo 11 Mission in the Pacific sector. The mission plan calls for ARIA support of translunar injection on revolution 2 or 3 and from entry (400,000-foot altitude) to recovery of the spacecraft and crew after landing.

TABLE 6

MSFN CONFIGURATION, APOLLO 11 MISSION

STATION TYPE AND NAME	B		PAFB	CNV	MLA	CIF	MIL					GBI	GBM	GTK	ANT	ANG	BDA	CYI	MAD	MADX	ASC	ACN	
	C																						
TYPE EQUIPMENT	A																						
TRACKING																							
C-Band Radar			X	X	X									X	X		X				X		
USB							X						X			X	X	X	X	X		X	
TELEMETRY																							
VHF Links						X	X					X	X			X	X	X				X	
USB						X	X						X			X	X	X	X	X		X	
Data Processor						X	X						X			X	X	X	X	X		X	
Data Remoting						X	X						X			X	X	X	X	X		X	
Bio-Med Remoting							X						X			X	X	X	X	X		X	
Display																							
COMMAND																							
USB Update							X						X			X		X	X	X		X	
Cmd Processor							X						X			X	X	X	X	X		X	
Cmd Remoting							X						X			X	X	X	X	X		X	
Cmd Destruct				X								X		X	X		X						
A/G VOICE																							
VHF							X						X			X	X	X					
USB							X						X			X	X	X	X	X		X	
TV																							
USB							X						X			X	X	X	*X	X		X	
SPAN																		X					

STATION TYPE AND NAME	PRE	TAN	CRO	HSK	HSKX	GWM	PARKES 210 ft.	HAW	CAL	GDS	GDSX	GYM		TEX	GDS 210 ft.		INS.	INJ.	INJ.	RE-EN.		A/RIA
TYPE EQUIPMENT																						
TRACKING																						
C-Band Radar	X	X	X					X	X								X	X	X	X		
USB			X	X	X	X		X		X	X	X		X			X	X	X	X		
TELEMETRY																						
VHF Links		X	X			X		X				X		X			X	X	X	X		X
USB			X	X	X	X	X	X		X	X	X		X	X		X	X	X	X		X
Data Processor			X	X	X	X		X		X	X	X		X			X	X	X			
Data Remoting			X	X	X	X		X		X	X	X		X			X	X	X	X		
Bio-Med Remoting			X	X	X	X		X		X	X	X		X			X	X	X			
Display																				X		
COMMAND																						
USB Update			X	X	X	X		X		X	X	X		X			X	X	X			
Cmd Processor			X	X	X	X		X		X	X	X		X			X	X	X			
Cmd Remoting			X	X	X	X		X		X	X	X		X			X	X	X			
Cmd Destruct																						
A/G VOICE																						
VHF		X	X			X		X	X			X		X			X	X	X	X		X
USB			X	X	X	X	X	X		X	X	X		X	X		X	X	X	X		X
TV																						
USB			X	*X	X	X	*X	X		*X	X	X		X	*X			X	X			
SPAN			X																			

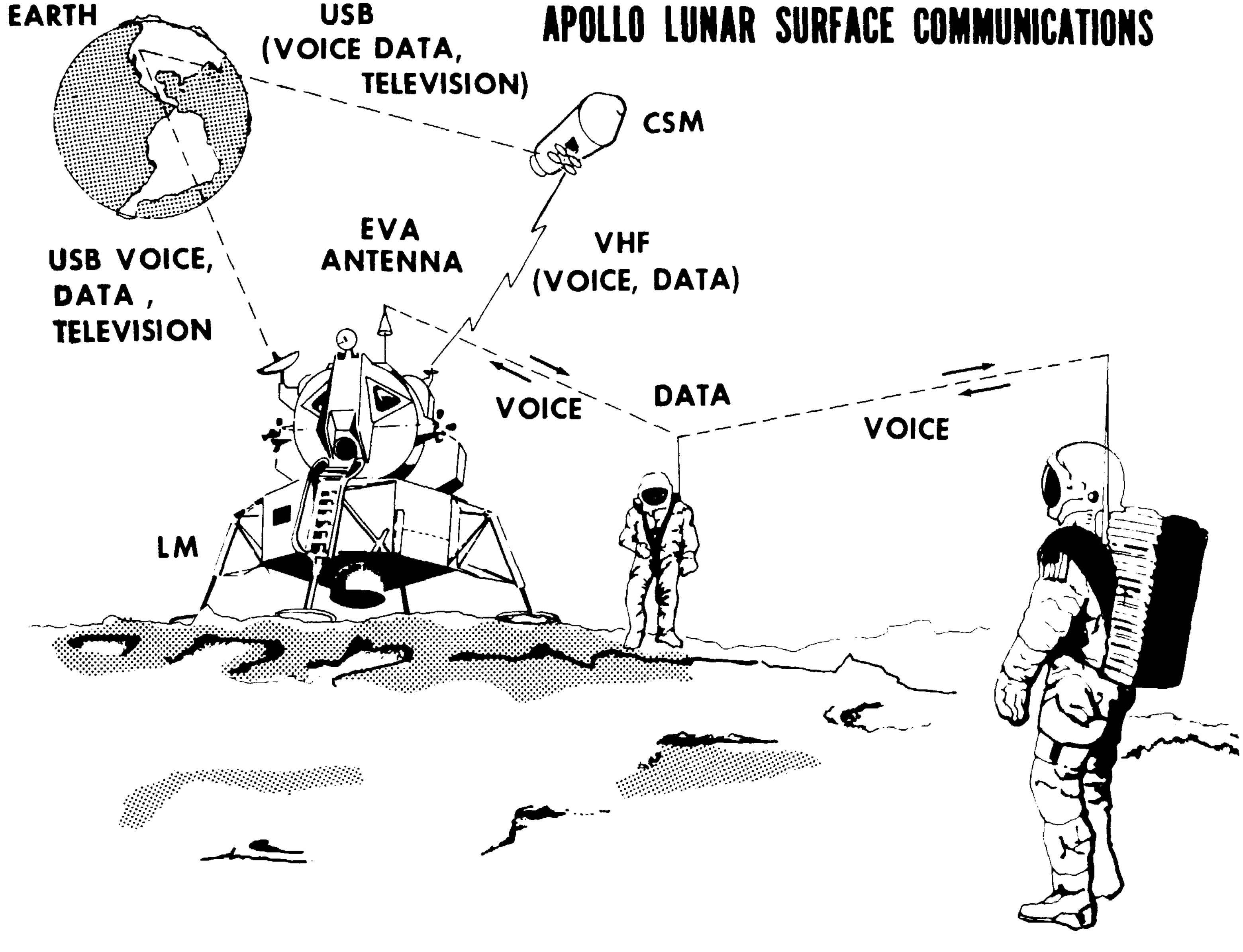

Fig. 39

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RADAR COVERAGE DURING LUNAR ORBIT PERIODS FOR LAUNCH DATE OF JULY 16

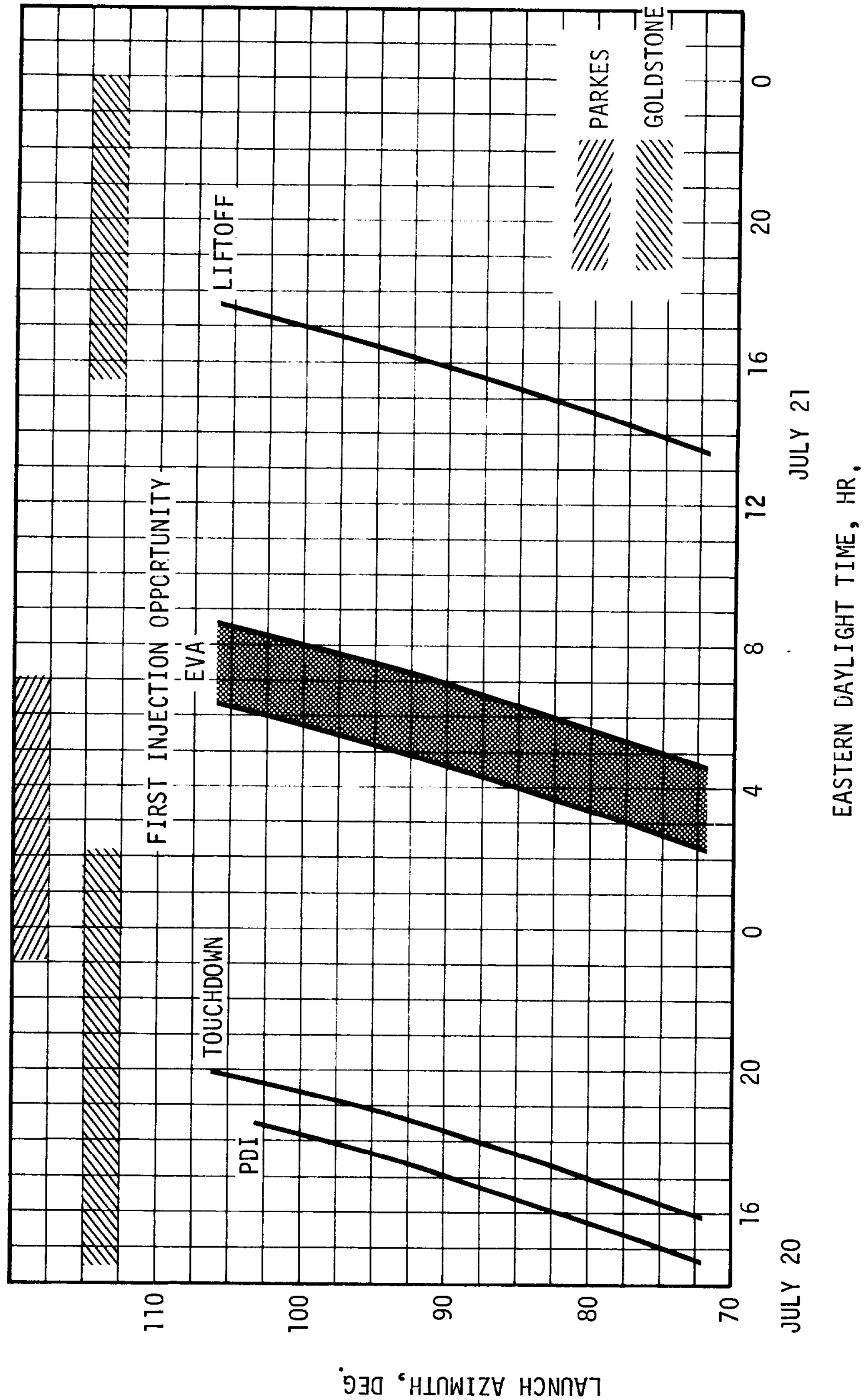

Fig. 40

RECOVERY SUPPORT PLAN

GENERAL

The Apollo 11 flight crew and Command Module (CM) will be recovered as soon as possible after landing, while observing the constraints required to maintain biological isolation of the flight crew, CM, and materials removed from the CM. After locating the CM, first consideration will be given to determining the condition of the astronauts and to providing first-level medical aid when required. The second consideration will be the recovery of the astronauts and CM. Retrieval of the CM main parachutes, apex cover, and drogue parachutes, in that order, is highly desirable if feasible and practical. Special clothing, procedures, and the Mobile Quarantine Facility (MQF) will be used to provide biological isolation of the astronauts and CM. The lunar sample rocks will also be isolated and returned to the Manned Spacecraft Center within 30 hours as specified by NASA.

The recovery forces will also be capable of salvaging portions of the space vehicle in case of a catastrophic failure in the vicinity of the launch site. Specific components to be recovered will be identified after the fact. After a normal launch, if items such as portions of the first stage of the launch vehicle or the Launch Escape System (LES) are found, they should be recovered if possible. If it appears that the items are too large or unsafe for retrieval, the Mission Control Center will be contacted for guidance before recovery is attempted.

LAUNCH PHASE

During the time between LES arming and parking orbit insertion, the recovery forces are required to provide support for landings that would follow a Mode I, II, or III launch abort

Launch Site Area

The launch site area includes all possible CM landing points which would occur following aborts initiated between LES arming and approximately 90 seconds GET. Figure 41 shows the launch site area and recovery force deployment. Recovery forces in the launch site area will be capable of meeting a maximum access time of 30 minutes to any point in the area. This support is required from the time the LES is armed until 90 seconds after liftoff. However, prior to LES arming, the launch site forces are required to be ready to provide assistance, if needed, to the Pad Egress Team, and, after T plus 90 seconds, they are required to be prepared to provide assistance to the launch abort area recovery forces. In addition to the 30-minute access time, the launch site recovery forces are required to have the capability to:

APOLLO 11 LAUNCH SITE AREA AND FORCE DEPLOYMENT

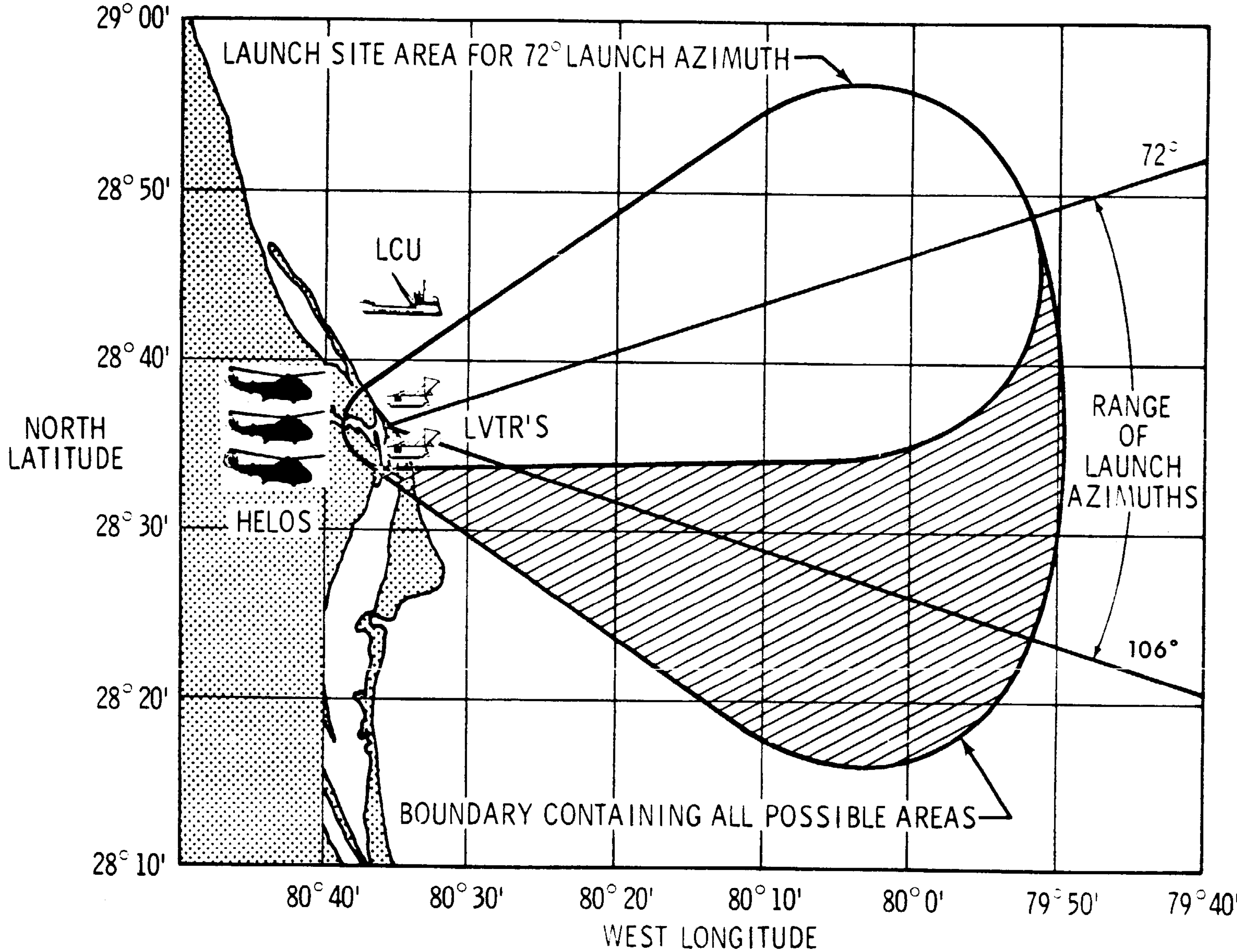

Fig. 41

a. Provide firefighting units that are capable of containing hypergolic fuel fires.

b. Upright the CM.

c. Transport the flight crew from any point in the area to the Patrick AFB hospital.

d. Transport the CM to a deactivation site.

e. Provide debris location, mapping, and recording assistance for a salvage operation.

Launch Abort Area

The launch abort area is the area in which the CM would land following an abort initiated during the launch phase of flight, after approximately 90 seconds GET. The launch abort area shown in Figure 42 includes all possible CM landing points following a launch abort from any launch azimuth. The launch abort landing area is divided into two sectors: A and B. These sectors are used to differentiate the level of recovery support available in the area. Sector A is all the area in the launch abort area that is between 41 and 1000 nautical miles (NM) downrange of the launch site. Sector B is all the area in the launch abort area that is between 1000 and 3400 NM downrange of the launch site.

The primary responsibility of launch abort forces is to locate and recover the astronauts and retrieve the CM within the required access and retrieval times should a landing occur in the launch abort area. The forces required, their staging bases, and access times are listed in Table 7.

Two secondary recovery ships and three search and rescue aircraft will be positioned in the launch abort area as shown in Figure 42. Ship and aircraft stations in the launch abort area will sweep to the south each day during the launch window as the launch azimuth changes from 72° to 106°. Recovery ships and aircraft are positioned for optimum coverage of the 72° launch azimuth. Launch abort aircraft are required to provide a 4-hour access time to any launch azimuth. Retrieval time in Sector A will be 24 hours. Sector B will be considered as a contingency retrieval area; therefore, retrieval will be as soon as possible. HC-130 aircraft will be on station ten minutes prior to predicted landing time. Recovery forces providing immediate launch abort support will be released after translunar injection (TLI).

EARTH PARKING ORBIT PHASE

Earth parking orbit (EPO) secondary landing areas (SLA's) are configured to include target points and associated dispersion areas with low-speed entries from near-earth orbits. These areas are selected to provide recovery support at suitable time intervals throughout the EPO phase of the mission. The SLA is a 210-NM long by 80-NM wide

LAUNCH ABORT AREA AND FORCE DEPLOYMENT

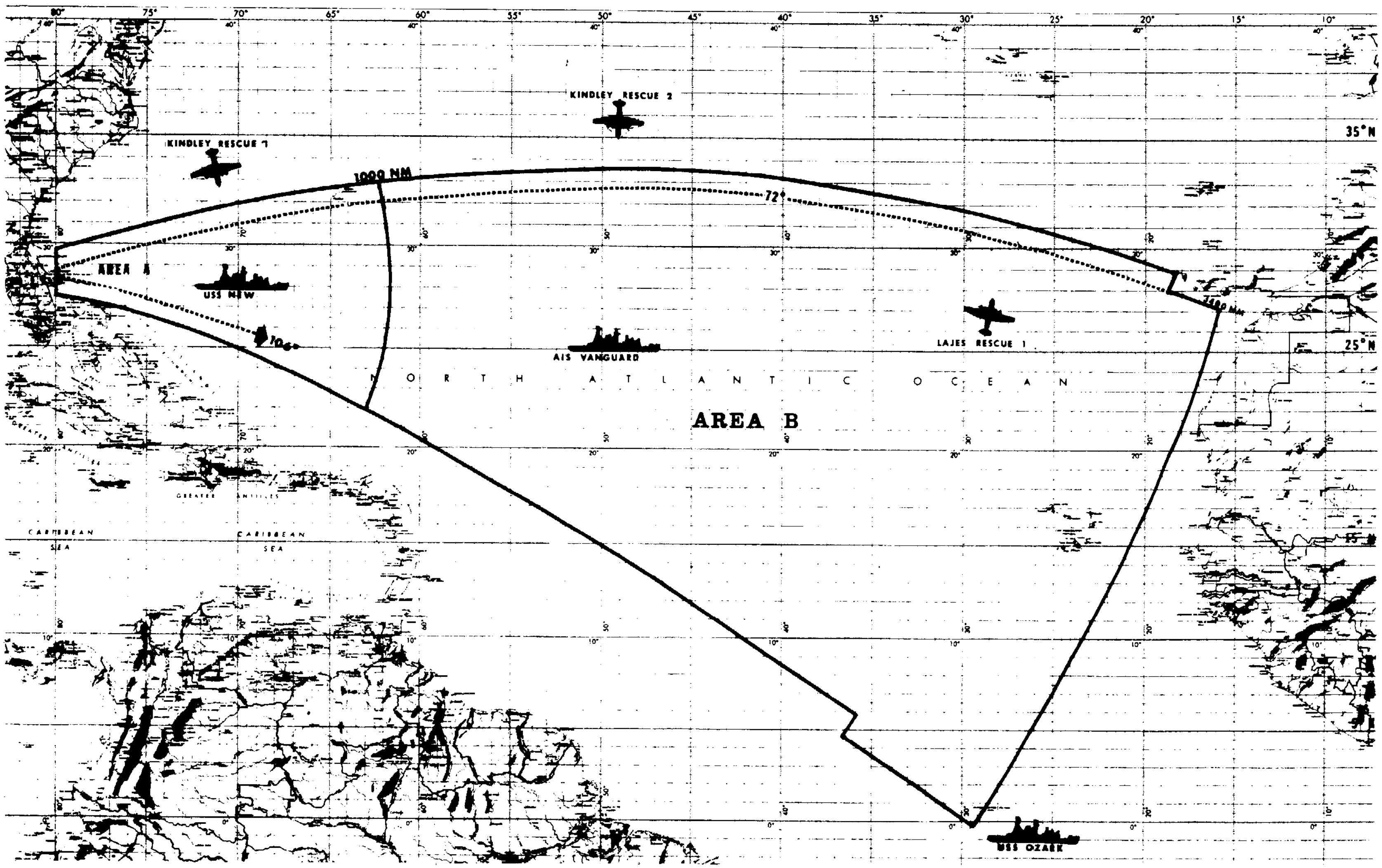

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Fig. 42

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TABLE 7

RECOVERY FORCE REQUIREMENTS

LAUNCH ABORT AREA

AREA OR ZONE	DESCRIPTION	RETRIEVAL TIME (HR) SHIP	ACCESS TIME (HR) A/C	SHIP			HC-130 AIRCRAFT		
				STA	POSITION	TYPE	STA	NO	POSITION
LAUNCH ABORT	Sector A: From launch site to 1000 NM downrange. 50 NM north of 072° azimuth and 50 NM south of 106° azimuth.	24	4	1	28°00'N 70°00'W	DD	A1	1	32°35'N 71°00'W
	Sector B: From 1000 NM to 3400 NM downrange. 50 NM north of 072° azimuth and 50 NM south of 106° azimuth.	ASAP	4	2	25°00'N 49°00'W	AIS	B1	1	35°00'N 49°05'W
							C1	1	27°35'N 28°25'W

NOTE 1: Ship positions shown are for 072° azimuth launch on 16 July. As launch azimuth increases, ships will proceed south.

NOTE 2: Aircraft positions shown are for 072° azimuth launch on 16 July. As launch azimuth increases, aircraft will proceed south and maintain their relative position to the changing ground track.

dispersion ellipse oriented along the entry ground track and centered on the target point. For the Apollo 11 Mission, EPO SLA's will be required for four revolutions and are selected in two general locations called recovery zones. See Figure 43 for locations and Table 8 for access and retrieval times and forces required. If the TLI maneuver is not completed and a long duration earth orbital mission is flown, Zone 2, located in the East Atlantic Ocean, will also be activated. For landings during this phase of the mission, one HC-130 aircraft will be stationed 50 NM abeam of the target point.

The contingency landing area for this phase includes all the earth's surface between 34°N and 34°S latitude, except the launch abort, earth orbital, and deep space SLA's, and the end-of-mission planned landing area. The forces required, their staging bases, and access times are listed in Table 8.

DEEP SPACE PHASE

Deep space SLA's are designed to include the target point and dispersion area associated with a high-speed entry from space. These areas are selected to provide recovery support at suitable time intervals throughout the translunar, lunar orbit, and transearth phases of the mission. Deep space SLA's are located along or near ship-supported recovery lines which are spaced to provide varying return times as shown in Figure 44.

For the Apollo 11 Mission, these areas are defined as the areas where a landing could occur following translunar coast aborts targeted to the Mid Pacific Line (MPL) (line 4), and any abort after TLI targeted to the Atlantic Ocean Line (AOL) (line 1). USS HORNET and two aircraft (HC-130's) are required to provide secondary landing area support for the MPL, and USS OZARK and two aircraft (HC-130's) are required for the AOL. The two ships will move along lines 1 and 4 to maintain the latitude of the moon's declination in the opposite hemisphere. Table 9 shows the approximate location of this point for each day's launch window. Actual positions required for each day will be published in the appropriate task force operations order.

The only time the ship's position is critical is during the first few hours after TLI. The minimum time between abort initiation and landing for these aborts will be approximately 11 hours for the AOL and 13 hours for the MPL. After these times, the return time becomes greater leaving sufficient time to position the ship at the CM target point. At entry minus 35 hours, if the CM is still targeted to the MPL, USS OZARK will be released.

Aborts made to the MPL or AOL after TLI require, within the high-speed entry footprint, an access time of 14 hours and retrieval time of 24 hours to any point in the area.

For deep space aborts to the MPL, one HC-130 aircraft will be stationed 200 NM uprange and 100 NM north of the ground track, one 200 NM north of ground track, and one abeam of the target point and 50 NM north of the ground track. Minimum alert

APOLLO 11 EARTH PARKING ORBIT RECOVERY ZONES

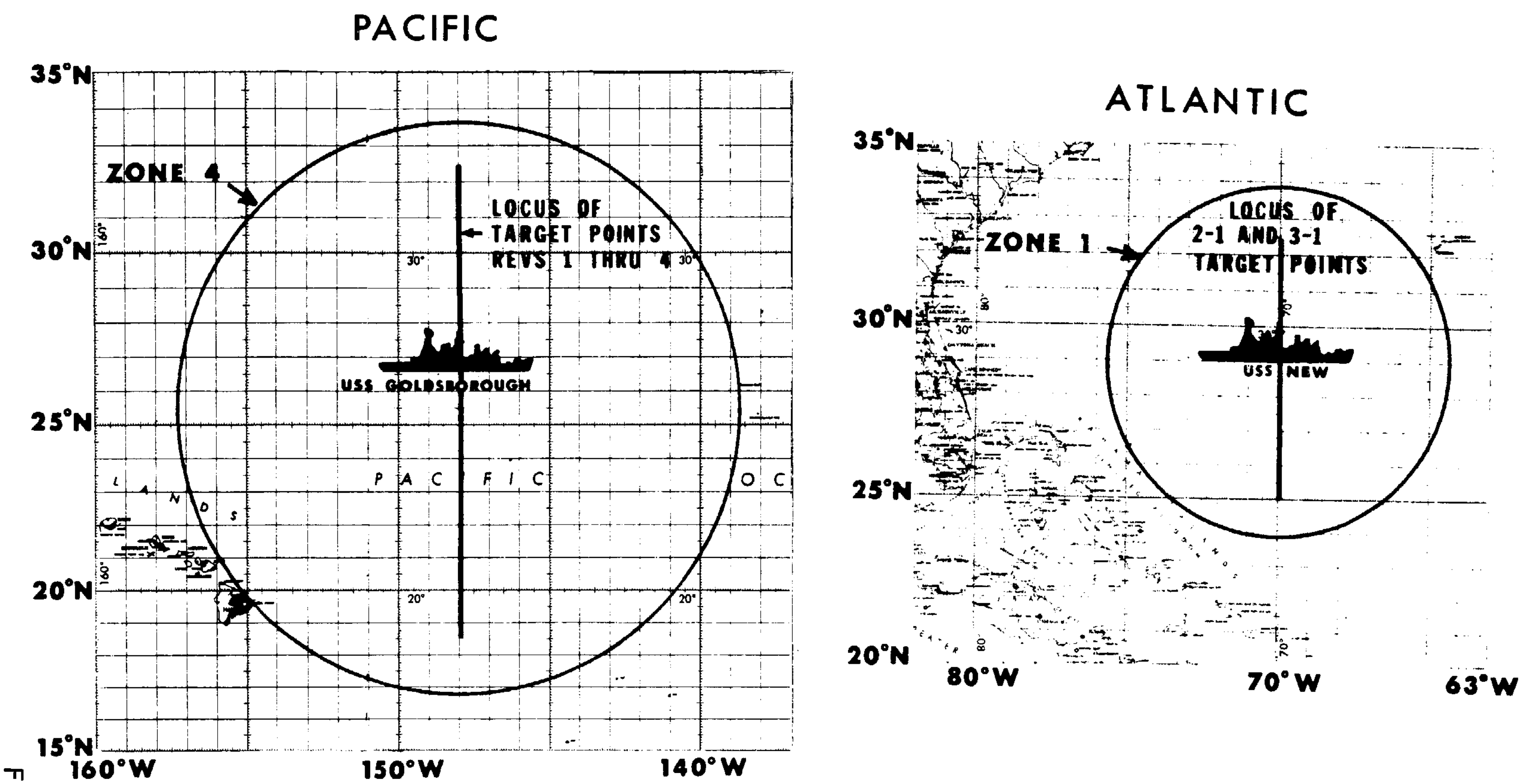

Fig. 43

TABLE 8

RECOVERY FORCE REQUIREMENTS

EARTH ORBITAL PHASE

SECONDARY LANDING AREAS

RECOVERY ZONES	RETRIEVAL TIME (HR) SHIP	ACCESS TIME (HR) A/C	SHIP		HC-130 AIRCRAFT	
			TYPE	POSITION	NO	STAGING BASES
1. 300 NM radius of 29°00'N, 70°00'W	24	6	DD	32°31'N 70°00'W	2	Kindley AFB, Bermuda
4. 510 NM radius of 25°30'N, 148°00'W	24	6	DD	25°30'N 148°00'W	2	Hickam AFB, Hawaii

EARTH ORBITAL AND DEEP SPACE

CONTINGENCY LANDING AREA

DESCRIPTION	ACCESS TIME HR A/C	A/C READINESS	A/C NO.	STAGING BASES
All area outside the launch site, launch abort, primary and secondary landing areas between 40°N 15°S. For earth orbital phase, latitude limits are 34°N and 34°S.	18	See Tab A to Appendix VII	2 2 2 2 2 1 2	Bermuda (May be released after TLI) Ascension Island Lajes/Moron (May be released after TLI) Mauritius Island Hickam AFB, Hawaii Andersen AFB, Guam (SAR Alert) Howard AFB, Canal Zone

DEEP SPACE TYPICAL SECONDARY LANDING AREA AND FORCE DEPLOYMENT

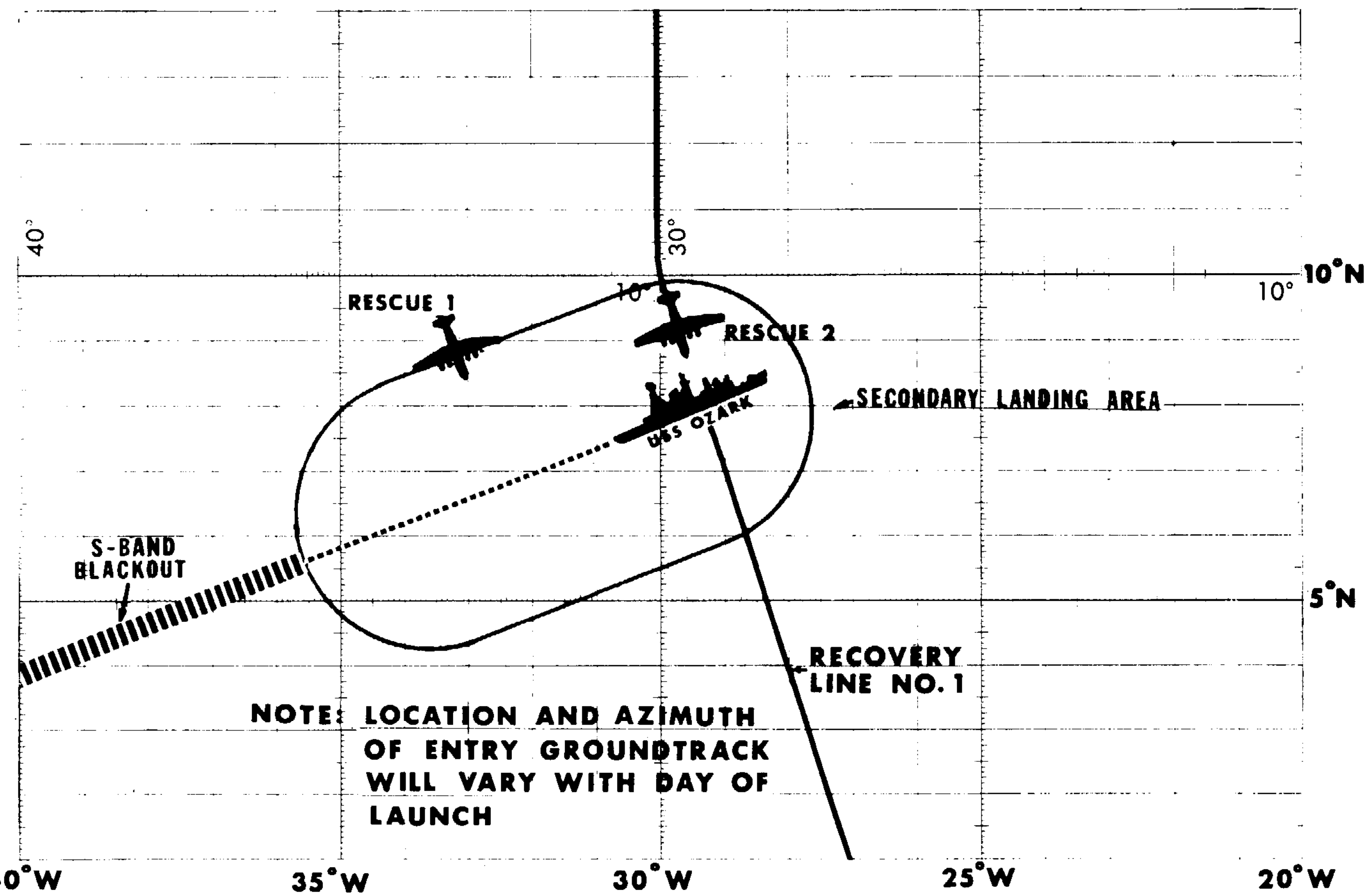

Fig. 44

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posture for HC-130 aircraft is listed in Table 10. Table 11 shows the access and retrieval times and forces required to support the deep space SLA's.

The contingency landing area for the deep space phase of the mission is associated with very low probability of a CM landing and requires land-based recovery aircraft support only. For Apollo 11, the deep space contingency landing area is all the area in a band around the earth between 40°N and 15°S outside the primary and secondary landing areas. The forces required, their staging bases, and access times are shown in Table 8.

TABLE 9

RECOVERY SHIP LOCATIONS, DEEP SPACE PHASE

Launch Date	Mid-Pacific Line USS HORNET	Atlantic Ocean Line USS OZARK
16 July	03°00'S, 165°00'W	01°00'S, 26°25'W
18 July	09°30'N, 171°10'W	11°00'N, 30°00'W
21 July	25°30'N, 175°00'W	24°00'N, 30°00'W

END-OF-MISSION PHASE

The normal end-of-mission (EOM) landing area will be selected on or near the MPL (line 4) located in the Mid-Pacific Ocean as shown in Figure 45. The latitude of the target point will depend on the declination of the moon at transearth injection and will be in the general range of 11° N to 29°N for the July launch window. The target point will normally be 1285 NM downrange of the entry point. Forces will be assigned to this area, as listed in Table 11, to meet the specified access and retrieval times. These forces will be on station not later than 10 minutes prior to predicted CM landing time.

If the entry range is increased to avoid bad weather, the area moves along with the target point and contains all the high probability landing points as long as the entry range does not exceed 2000 NM. Access and retrieval times quoted for the primary landing area will not apply if entry ranges greater than 2000 NM are flown during the mission.

TABLE 10

HC-130 MINIMUM ALERT POSTURE

STAGING BASE	LAUNCH TO PARKING ORBIT INSERTION	PARKING ORBIT INSERTION TO TLI	AFTER TLI*	REMARKS
Pease	Aircraft A airborne in Launch Abort Area	1 aircraft with 1/2 hr reaction time. Aircraft A or B can provide support while returning to home base	Aircraft can be released after TLI	
Kindley	Aircraft B airborne in Launch Abort Area		Aircraft can be released after TLI	
Lajes	Aircraft C airborne in Launch Abort Area	Aircraft returning to home base	Aircraft can be released after TLI	
Ascension	Not Required	1 aircraft with 2 hr reaction time	2 aircraft with 1/2 hr reaction time until TLI + 4 hrs	Aircraft can return to home base after TLI + 35 hours. Aircraft can be released at entry minus 37 hours if CM is still targeted to MPL.
Mauritius	Not Required	1 aircraft with 2 hr reaction time	1 aircraft with 6 hr reaction time until TLI plus 14 hrs	Aircraft can be released at entry minus 56 hours if CM still targeted to MPL.

*Reaction times are designed to provide required support during first few hours after TLI for any possible mission launched during the July launch window. After TLI the mission trajectory will have been established and more relaxed reaction times will be possible based on the minimum return time. These minimum return times will be passed to recovery forces as they are identified.

TABLE 11

RECOVERY FORCE REQUIREMENTS

DEEP SPACE PHASE

MID-PACIFIC LINE 4

RECOVERY ZONES	RETRIEVAL TIME (HR) SHIP	ACCESS TIME (HR) A/C	SHIP		HC-130 AIRCRAFT	
			TYPE	POSITION	NO	STAGING BASES
A 125 NM circle centered 275 NM uprange A 125 NM circle centered 25 NM uprange from the target point connected by two tangential lines	24	14	CVS	At TP, latitude dependent on launch day	2	Hickam AFB, Hawaii. One A/C 200 NM uprange and 100 NM north of ground track. One A/C 200 NM downrange of TP and 100 NM north of ground track.
ATLANTIC OCEAN LINE 1						
Same as Mid-Pacific Line	24	14	MCS-2	Same as Mid-Pacific Line	2	Ascension. One HC-130 200 NM uprange at TP and 100 NM north of ground track. One HC-130 abeam of TP and 50 NM north of ground track.

DEEP SPACE PRIMARY LANDING AREA

MPL DESCRIPTION	RETRIEVAL TIME (HR) SHIP	ACCESS TIME (HR) A/C	DEPLOYMENT				
			SHIP			AIRCRAFT	
			NO.	TYPE	POSITION	NO.	POSITION
Same as Mid-Pacific line	Crew 16 CM 24	2	1	CVS	At TP, latitude dependent on launch day (as updated)	4 2 1 1	Helos (*) HC-130 (*) E-1B (AIR BOSS) EC-135 (ARIA)

TYPICAL PRIMARY LANDING AREA AND FORCE DEPLOYMENT

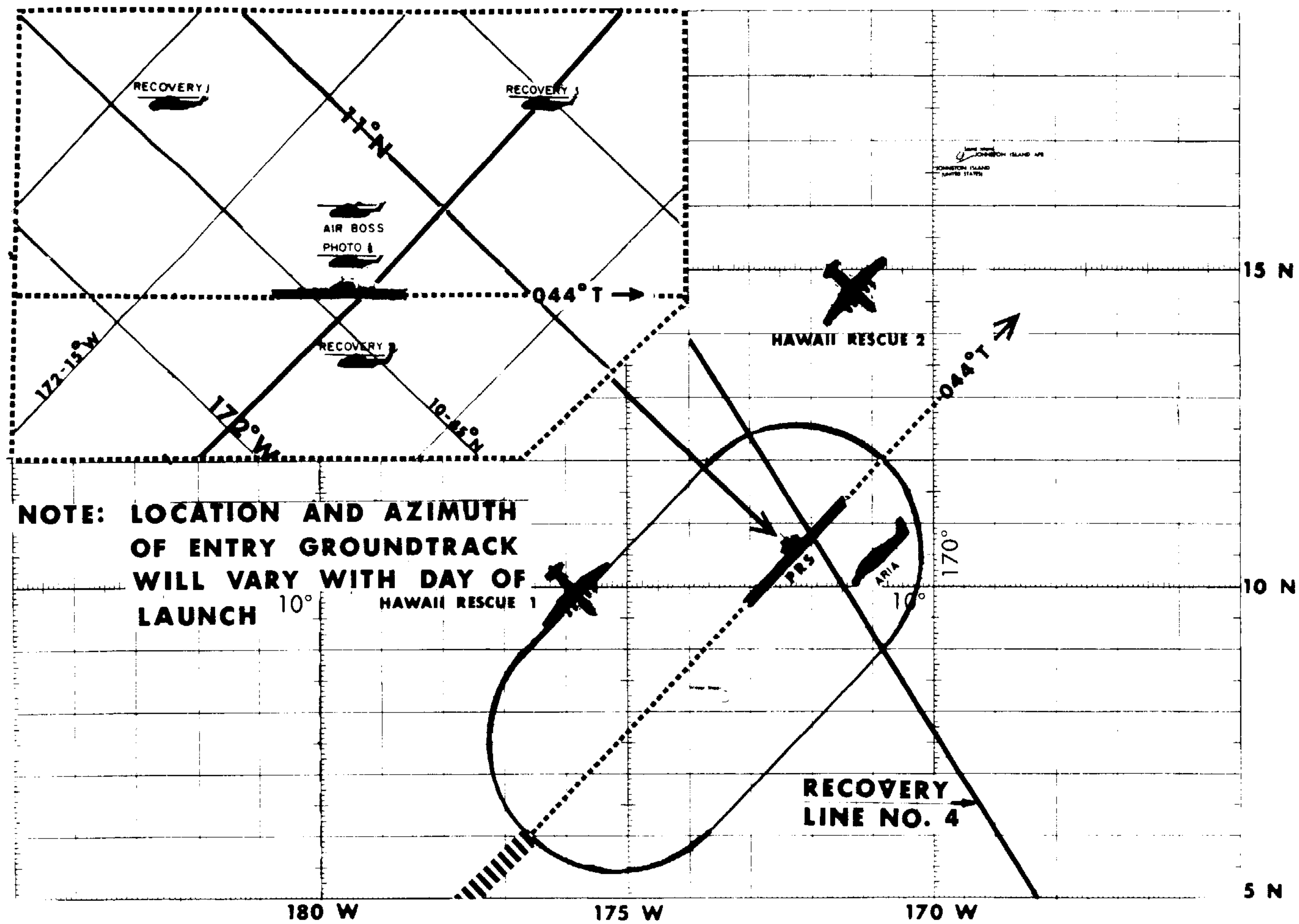

Fig. 45

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The recovery forces in the primary landing area will be capable of meeting:

- A maximum access time of 2 hours to any point in the area.
- A maximum crew retrieval time of 16 hours to any point in the area.
- A maximum CM retrieval time of 24 hours to any point in the area.

The recovery forces assigned to the primary landing area are:

- USS HORNET will be on the EOM target point.
- Three SARAH-equipped helicopters, each carring a three-man swimmer team, to conduct electronic search are required. At least one of the swimmers on each team will be equipped with an underwater (Calypso) 35mm camera. NASA will furnish the equipment and film and will brief the swimmers concerning employment and coverage required.
- One helicopter to carry photographers as designated by the NASA Recovery Team Leader assigned to USS HORNET in the vicinity of the target point.
- One aircraft to function as communications relay, stationed overhead at the scene of action.
- One fixed-wing or rotary-wing aircraft over USS HORNET to function as on-scene commander.
- One HC-130 aircraft with operational AN/ARD-17 (Cook Tracker), 3-man pararescue team, and complete Apollo recovery equipment will be stationed 200 NM uprange from the target point and 100 NM north of the CM ground track at 25,000 feet.
- One HC-130 aircraft with operational AN/ARD-17, 3-man pararescue team, and complete Apollo recovery equipment will be stationed 200 NM downrange from the target point and 100 NM north of the CM ground track at 25,000 feet.
- Prior to CM reentry, one EC-135 Apollo Range Instrumentation Aircraft will be on station near the primary landing area for network support.

FLIGHT CREW

FLIGHT CREW ASSIGNMENTS

Prime Crew (Figure 46)

Commander (CDR) - Neil A. Armstrong (Civilian)
Command Module Pilot (CMP) - Michael Collins (Lt. Colonel, USAF)
Lunar Module Pilot (LMP) - Edwin E. Aldrin, Jr. (Colonel, USAF)

Backup Crew (Figure 47)

Commander (CDR) - James A. Lovell, Jr. (Captain, USN)
Command Module Pilot (CMP) - William A. Anders (Lt. Colonel, USAF)
Lunar Module Pilot (LMP) - Fred Wallace Haise, Jr. (Civilian)

The backup crew follows closely the training schedule for the prime crew and functions in three significant categories. One, they are fully informed assistants who help the prime crew organize the mission and check out the hardware. Two, they receive nearly complete mission training which becomes a valuable foundation for later assignments as a prime crew. Three, should the prime crew become unavailable, they are prepared to fly as prime crew up until the last few weeks prior to launch. During the final weeks before launch, the flight hardware and software, ground hardware and software, and flight crew and ground crews work as an integrated team to perform ground simulations and other tests of the upcoming mission. It is necessary that the flight crew that will conduct the mission take part in these activities, which are not repeated for the benefit of the backup crew. To do so would add an additional costly and time consuming period to the prelaunch schedule, which for a lunar mission would require rescheduling for a later lunar launch window.

PRIME CREW BIOGRAPHICAL DATA

Commander (CDR)

NAME: Neil A. Armstrong (Mr.)

BIRTHPLACE AND DATE: Wapakoneta, Ohio; 5 August 1930.

PHYSICAL DESCRIPTION: Blond hair; blue eyes; height: 5 ft. 11 in.; weight: 165 lb.

EDUCATION: Received a Bachelor of Science degree in Aeronautical Engineering from Purdue University in 1955. Graduate School - University of Southern California.

APOLLO 11 PRIME CREW

NEIL A. ARMSTRONG

MICHAEL COLLINS

EDWIN E. ALDRIN JR.

Fig. 46

APOLLO 11 BACK-UP CREW

JAMES A. LOVELL JR.

WILLIAM A. ANDERS

FRED W. HAISE JR.

Fig. 47

ORGANIZATIONS: Associate Fellow of the Society of Experimental Test Pilots; Associate Fellow of the American Institute of Aeronautics and Astronautics; and member of the Soaring Society of America.

SPECIAL HONORS: Recipient of the 1962 Institute of Aerospace Sciences Octave Chanute Award; the 1966 AIAA Astronautics Award; the NASA Exceptional Service Medal; and the 1962 John J. Montgomery Award.

EXPERIENCE: Armstrong was a naval aviator from 1949 to 1952. In 1955 he joined NASA's Lewis Research Center (then NACA Lewis Flight Propulsion Laboratory) and later transferred to the NASA High Speed Flight Station (now Flight Research Center) at Edwards Air Force Base, California, as an aeronautical research pilot for NACA and NASA. In this capacity, he performed as an X-15 project pilot, flying that aircraft to over 200,000 feet and approximately 4000 miles per hour. Other flight test work included piloting the X-1 rocket airplane, the F-100, F-101, F-102, F-104, F-5D, B-47, the paraglider, the B-29 "drop" airplane, and others.

CURRENT ASSIGNMENT: Mr. Armstrong was selected as an astronaut by NASA in September 1962. He served as the backup Command Pilot for the Gemini 5 flight.

As Command Pilot for the Gemini 8 Mission, which was launched on 16 March 1966, he performed the first successful docking of two vehicles in space. The flight, originally scheduled to last 3 days, was terminated early due to a malfunctioning attitude system thruster, but the crew demonstrated exceptional piloting skill in overcoming this problem and bringing the spacecraft to a safe landing.

He subsequently served as backup Command Pilot for the Gemini 11 Mission and backup Commander for the Apollo 8 Mission. In his current assignment as Commander for the Apollo 11 Mission, he will probably be the first human to set foot on the moon.

Command Module Pilot (CMP)

NAME: Michael Collins (Lieutenant Colonel, USAF)

BIRTHPLACE AND DATE: Rome, Italy; 31 October 1930.

PHYSICAL DESCRIPTION: Brown hair; brown eyes; height: 5 ft. 11 in.; weight: 165 lb.

EDUCATION: Received a Bachelor of Science degree from the United States Military Academy at West Point, New York, in 1952.

ORGANIZATIONS: Member of the Society of Experimental Test Pilots.

SPECIAL HONORS: Awarded the NASA Exceptional Service Medal, the Air Force Command Pilot Wings, and the Air Force Distinguished Flying Cross.

EXPERIENCE: Collins chose an Air Force career following graduation from West Point. He served as an experimental flight test officer at the Air Force Flight Test Center, Edwards Air Force Base, California. In that capacity, he tested performance, stability, and control characteristics of Air Force aircraft — primarily jet fighters.

CURRENT ASSIGNMENT: Lt. Colonel Collins was one of the third group of astronauts named by NASA in October 1963. His first assignment was as backup Pilot for the Gemini 7 Mission.

As Pilot of the 3-day, 44-revolution Gemini 10 Mission, launched 18 July 1966, Collins shares with Command Pilot John Young in the accomplishments of that record-setting flight — a successful rendezvous and docking with a separately launched Agena target vehicle and, using the power of the Agena, maneuvering the Gemini spacecraft into another orbit for a rendezvous with a second, passive Agena. The spacecraft landed 2.6 miles from the USS GUADALCANAL and became the second in the Gemini Program to land within eye and camera range of a primary recovery ship.

He was assigned as Command Module Pilot on the prime crew for the Apollo 8 Mission but was replaced when spinal surgery forced a lengthy recuperation.

Lunar Module Pilot (LMP)

NAME: Edwin E. Aldrin, Jr. (Colonel, USAF)

BIRTHPLACE AND DATE: Montclair, New Jersey; 20 January 1930.

PHYSICAL DESCRIPTION: Blond hair; blue eyes; height: 5 ft. 10 in.; weight: 165 lb.

EDUCATION: Received a Bachelor of Science degree from the United States Military Academy at West Point, New York, in 1951 and a Doctor of Science degree in Astronautics from the Massachusetts Institute of Technology in 1963; recipient of an Honorary Doctorate of Science degree from Gustavus Adolphus College in 1967.

ORGANIZATIONS: Fellow of the American Institute of Aeronautics and Astronautics; member of the Society of Experimental Test Pilots, Sigma Gamma Tau (aeronautical engineering society), Tau Beta Pi (national engineering society), and Sigma Xi (national science research society); and a 32nd Degree Mason advanced through the Commandery and Shrine.

SPECIAL HONORS: Awarded the Distinguished Flying Cross with one Oak Leaf Cluster, the Air Medal with two Oak Leaf Clusters, the Air Force Commendation Medal, the NASA Exceptional Service Medal and Air Force Command Pilot Astronaut Wings, the NASA Group Achievement Award for Rendezvous Operations Planning Team, an Honorary Life Membership in the International Association of Machinists and Aerospace Workers, and an Honorary Membership in the Aerospace Medical Association.

EXPERIENCE: Aldrin was graduated third in a class of 475 from the United States Military Academy at West Point in 1951 and subsequently received his wings at Bryan, Texas in 1952.

He flew combat missions in F-86 aircraft while on duty in Korea with the 51st Fighter Interceptor Wing. At Nellis Air Force Base, Nevada, he served as an aerial gunnery instructor and then attended the Squadron Officers' School at the Air University, Maxwell Air Force Base, Alabama.

Following his assignment as Aide to the Dean of Faculty at the United States Air Force Academy, Aldrin flew F-100 aircraft as a flight commander with the 36th Tactical Fighter Wing at Bitburg, Germany. He attended MIT, receiving a doctorate after completing his thesis concerning guidance for manned orbital rendezvous, and was then assigned to the Gemini Target Office of the Air Force Space Division, Los Angeles, California. He was later transferred to the USAF Field Office at the Manned Spacecraft Center which was responsible for integrating DOD experiments into the NASA Gemini flights.

CURRENT ASSIGNMENT: Colonel Aldrin was one of the third group of astronauts named by NASA in October 1963. He has since served as backup Pilot for the Gemini 9 Mission, prime Pilot for the Gemini 12 Mission, and backup Command Module Pilot for the Apollo 8 Mission.

BACKUP CREW BIOGRAPHICAL DATA

Commander (CDR)

NAME: James A. Lovell, Jr. (Captain, USN)

BIRTHPLACE AND DATE: Cleveland, Ohio; 25 March 1928

PHYSICAL DESCRIPTION: Blond hair; blue eyes; height: 5 ft. 11 in.; weight: 170 lb.

EDUCATION: Attended the University of Wisconsin for 2 years; received a Bachelor of Science degree from the United States Naval Academy in 1952.

ORGANIZATIONS: Member of the Society of Experimental Test Pilots and the Explorers Club.

SPECIAL HONORS: Awarded the NASA Distinguished Service Medal, two NASA Exceptional Service Medals, the Navy Astronaut Wings, two Navy Distinguished Flying Crosses, and the 1957 FAI Delavauly and Gold Space Medals (Athens, Greece); co-recipient of the 1966 American Astronautical Society Flight Achievement Award and the Harmon International Aviation Trophy in 1966 and 1967; and recipient of the American Academy of Achievement Gold Plate Award and the New York State Medal for Valor in 1969.

EXPERIENCE: Lovell received flight training following graduation from Annapolis. He has had numerous assignments including a 4-year tour as a test pilot at the Naval Air Test Center, Patuxent River, Maryland. While there he served as program manager for the F4H weapon system evaluation. A graduate of the Aviation Safety School of the University of Southern California, he also served as a flight instructor and safety officer with Fighter Squadron 101 at the Naval Air Station, Oceana, Virginia.

CURRENT ASSIGNMENT: Captain Lovell was selected as an astronaut by NASA in September 1962. He has served as backup Pilot for the Gemini 4 flight and as backup Command Pilot for Gemini 9.

On 4 December 1965, he and Command Pilot Frank Borman were launched into space on the history-making Gemini 7 Mission. The flight lasted 330 hours 35 minutes, during which the following space "firsts" were accomplished: longest manned space flight; first rendezvous of two manned maneuverable spacecraft, as Gemini 7 was joined by Gemini 6; and longest multimanned space flight.

The Gemini 12 Mission, with Command Pilot Lovell and Pilot Edwin Aldrin, began on 11 November 1966. This 4-day 59-revolution flight brought the Gemini Program to a successful close.

Lovell served as Command Module Pilot for the epic 6-day journey of Apollo 8 — man's maiden voyage to the moon — 21-27 December 1968. Apollo 8 was the first "manned spacecraft" to be lifted into near-earth orbit by a 7.5 million pound thrust Saturn V Launch Vehicle, and every aspect of the mission went smoothly from liftoff to landing.

Having completed three space flights, Captain Lovell holds the endurance record for time in space with a total of 572 hours 10 minutes.

Command Module Pilot (CMP)

NAME: William A. Anders (Lieutenant Colonel, USAF)

BIRTHPLACE AND DATE: Hong Kong; 17 October 1933.

PHYSICAL DESCRIPTION: Brown hair; blue eyes; height: 5 ft. 8 in.; weight: 145 lb.

EDUCATION: Received a Bachelor of Science degree from the United States Naval Academy in 1955 and a Master of Science degree in Nuclear Engineering from the Air Force Institute of Technology at Wright-Patterson Air Force Base, Ohio, in 1962.

ORGANIZATIONS: Member of the American Nuclear Society and Tau Beta Pi.

SPECIAL HONORS: Awarded the Air Force Commendation Medal, Air Force Astronaut Wings, the NASA Distinguished Service Medal, and the New York State Medal for Valor.

EXPERIENCE: Anders was commissioned in the Air Force upon graduation from the Naval Academy. After Air Force flight training, he served as a fighter pilot in all-weather interceptor squadrons of the Air Defense Command.

After his graduate training, he served as a nuclear engineer and instructor pilot at the Air Force Weapons Laboratory, Kirtland Air Force Base, New Mexico, where he was responsible for technical management of radiation nuclear power reactor shielding and radiation effects programs.

CURRENT ASSIGNMENT: Lt. Colonel Anders was one of the third group of astronauts selected by NASA in October 1963. He has since served as backup Pilot for the Gemini 11 Mission.

Anders served as Lunar Module Pilot for the Apollo 8 Mission, which was launched 21 December 1968 and returned from its voyage around the moon on 27 December 1968. This epic 6-day flight was man's maiden voyage to the moon.

Lt. Colonel Anders has recently been nominated by the President to be Executive Secretary of the National Aeronautics and Space Council.

Lunar Module Pilot (LMP)

NAME: Fred Wallace Haise, Jr. (Mr.)

BIRTHPLACE AND DATE: Biloxi, Mississippi; 14 November 1933.

PHYSICAL DESCRIPTION: Brown hair; brown eyes; height: 5 ft. 9.5 in.; weight: 150 lb.

EDUCATION: Attended Perkinston Junior College (Association of Arts); received a Bachelor of Science with honors in Aeronautical Engineering from the University of Oklahoma.

ORGANIZATIONS: Member of the Society of Experimental Test Pilots, Tau Beta Pi, Sigma Gamma Tau, and Phi Theta Kappa.

SPECIAL HONORS: Recipient of the A. B. Honts Trophy as the outstanding graduate of class 64A from the Aerospace Research Pilot School in 1964; awarded the American Defense Ribbon and the Society of Experimental Test Pilots Ray E. Tenhoff Award for 1966.

EXPERIENCE: Mr. Haise began his military career in October 1952 as a Naval Aviation Cadet at the Naval Air Station in Pensacola, Florida.

He served as a tactics and all-weather flight instructor in the U.S. Navy Advanced Training Command at NAAS Kingsville, Texas, and was assigned as a U.S. Marine Corps fighter pilot to VMF-533 and 114 at MCAS Cherry Point, North Carolina, from March 1954 to September 1956. From March 1957 to September 1959, he was a fighter-interceptor pilot with the 185th Fighter Interceptor Squadron in the Oklahoma Air National Guard.

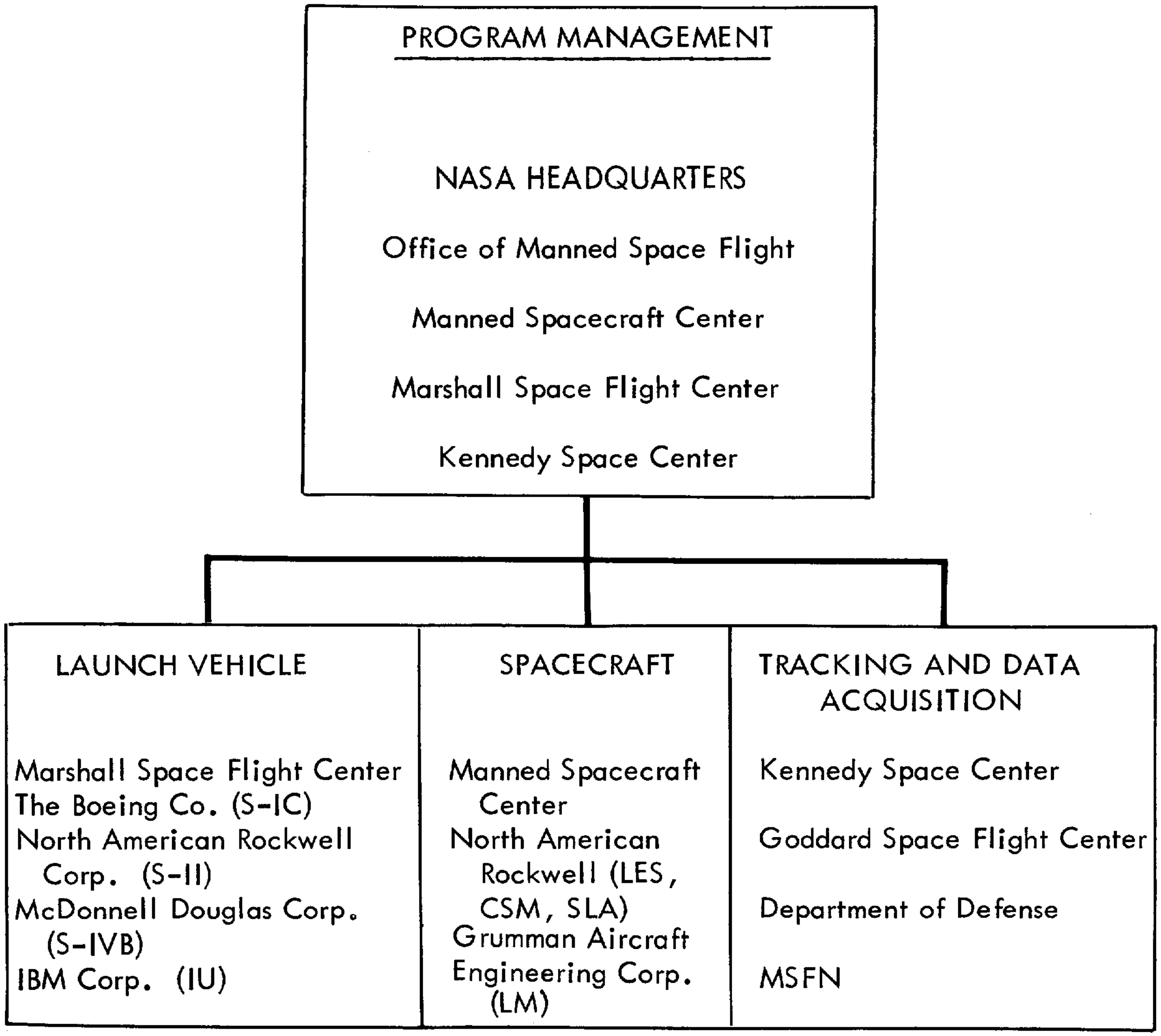
He served with the U.S. Air Force from October 1961 to August 1962 as a tactical fighter pilot and as Chief of the 164th Standardization-Evaluation Flight of the 164th Tactical Fighter Squadron at Mansfield, Ohio.

Haise was a research pilot at the NASA Flight Research Center at Edwards, California, before coming to Houston and the Manned Spacecraft Center; and from September 1959 to March 1963, he was a research pilot at the NASA Lewis Research Center in Cleveland, Ohio. During this time he authored the following papers which have been published: a NASA TND, entitled "An Evaluation of the Flying Qualities of Seven General-Aviation Aircraft;" NASA TND 3380, "Use of Aircraft for Zero Gravity Environment, May 1966;" SAE Business Aircraft Conference Paper, entitled "An Evaluation of General-Aviation Aircraft Flying Qualities," 30 March-1 April 1966; and a paper delivered at the tenth symposium of the Society of Experimental Test Pilots, entitled "A Quantitative/Qualitative Handling Qualities Evaluation of Seven General-Aviation Aircraft," 1966.

CURRENT ASSIGNMENT: Mr. Haise is one of the 19 astronauts selected by NASA in April 1966. Haise served as backup Lunar Module Pilot for Apollo 8.

MISSION MANAGEMENT RESPONSIBILITY

Title	Name	Organization
Director, Apollo Program	Lt. Gen. Sam C. Phillips	NASA/OMSF
Director, Mission Operations	Maj. Gen. John D. Stevenson (Ret)	NASA/OMSF
Saturn V Vehicle Prog. Mgr.	Mr. Lee B. James	NASA/MSFC
Apollo Spacecraft Prog. Mgr.	Mr. George M. Low	NASA/MSC
Apollo Prog. Manager KSC	R. Adm. Roderick O. Middleton	NASA/KSC
Mission Director	Mr. George H. Hage	NASA/OMSF
Assistant Mission Director	Capt. Chester M. Lee (Ret)	NASA/OMSF
Assistant Mission Director	Col. Thomas H. McMullen	NASA/OMSF
Director of Launch Operations	Mr. Rocco Petrone	NASA/KSC
Director of Flight Operations	Mr. Christopher C. Kraft	NASA/MSC
Launch Operations Manager	Mr. Paul C. Donnelly	NASA/KSC
Flight Directors	Mr. Clifford E. Charlesworth Mr. Eugene F. Kranz Mr. Glynn S. Lunney Mr. Milton L. Windler	NASA/MSC
Spacecraft Commander (Prime)	Mr. Neil A. Armstrong	NASA/MSC
Spacecraft Commander (Backup)	Captain James A. Lovell, Jr.	NASA/MSC


PROGRAM MANAGEMENT
NASA HEADQUARTERS
Office of Manned Space Flight
Manned Spacecraft Center
Marshall Space Flight Center
Kennedy Space Center
LAUNCH VEHICLE
Marshall Space Flight Center
The Boeing Co. (S-IC)
North American Rockwell Corp. (S-II)
McDonnell Douglas Corp. (S-IVB)
IBM Corp. (IU)
SPACECRAFT
Manned Spacecraft Center
North American Rockwell (LES, CSM, SLA)
Grumman Aircraft Engineering Corp. (LM)
TRACKING AND DATA ACQUISITION
Kennedy Space Center
Goddard Space Flight Center
Department of Defense
MSFN

ABBREVIATIONS AND ACRONYMS

AGS	Abort Guidance System
ALHT	Apollo Lunar Handtools
ALSCC	Apollo Lunar Surface Close-up Camera
AOL	Atlantic Ocean Line
AOS	Acquisition of Signal
APS	Ascent Propulsion System (LM)
APS	Auxiliary Propulsion System (S-IVB)
ARIA	Apollo Range Instrumentation Aircraft
AS	Ascent Stage
AS	Apollo/Saturn
BIG	Biological Isolation Garment
BPC	Boost Protection Cover
CCATS	Communications, Command, and Telemetry System
CD	Countdown
CDH	Constant Delta Height
CDR	Commander
CES	Control Electronics System
CM	Command Module
CMP	Command Module Pilot
COI	Contingency Orbit Insertion
CRA	Crew Reception Area
CSI	Concentric Sequence Initiation
CSM	Command/Service Module
DOI	Descent Orbit Insertion
DPS	Descent Propulsion System
DS	Descent Stage
EASEP	Early Apollo Scientific Experiments Package
ECS	Environmental Control System
EDS	Emergency Detection System
EDT	Eastern Daylight Time
EI	Entry Interface
EMU	Extravehicular Mobility Unit
EMS	Entry Monitor System
EOM	End-of-Mission
EPS	Electrical Power System
EPO	Earth Parking Orbit
EVA	Extravehicular Activity
EVCS	Extravehicular Communication System
GET	Ground Elapsed Time
GHe	Gaseous Helium
GNCS	Guidance, Navigation, and Control System
GOX	Gaseous Oxygen
H	Hybrid Trajectory
IMU	Inertial Measurement Unit
IS	Instrumentation System
IU	Instrument Unit
KSC	Kennedy Space Center

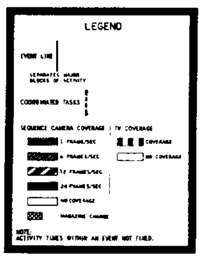
LC	Launch Complex
LCC	Launch Control Center
LCG	Liquid Cooling Garment
LES	Launch Escape System
LET	Launch Escape Tower
LH_2	Liquid Hydrogen
LiOH	Lithium Hydroxide
LM	Lunar Module
LMP	Lunar Module Pilot
LOI	Lunar Orbit Insertion
LOX	Liquid Oxygen
LPO	Lunar Parking Orbit
LRL	Lunar Receiving Laboratory
LRRR	Laser Ranging Retro-Reflector
LTA	Lunar Module Test Article
LV	Launch Vehicle
MCC	Midcourse Correction
MCC	Mission Control Center
MESA	Modularized Equipment Stowage Assembly
MOCR	Mission Operations Control Room
MOR	Mission Operation Report
MPL	Mid-Pacific Line
MQF	Mobile Quarantine Facility
MSC	Manned Spacecraft Center
MSFN	Manned Space Flight Network
MSS	Mobile Service Structure
NASCOM	NASA Communications Network
NM	Nautical Mile
OPS	Oxygen Purge System
PC	Plane Change
PDI	Powered Descent Initiation
PGNS	Primary Guidance and Navigation System
PLSS	Portable Life Support System
PRS	Primary Recovery Ship
PSE	Passive Seismic Experiment
PTP	Preferred Target Point
RCS	Reaction Control System
RR	Rendezvous Radar
R&D	Research and Development
RTCC	Real-Time Computer Complex
S&A	Safe and Arm
SAR	Search and Rescue
S/C	Spacecraft
SCS	Stabilization and Control System
SEA	Sun Elevation Angle
SEQ	Sequential System
SEQ	Scientific Equipment
SHe	Supercritical Helium
S-IC	First Stage

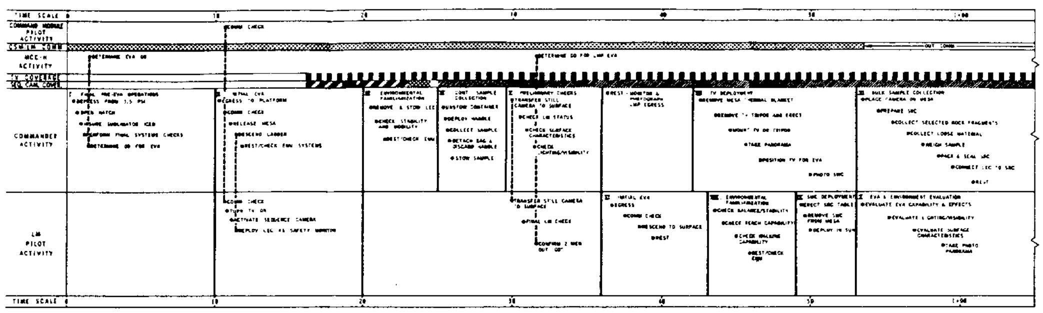
S-II	Second Stage
S-IVB	Third Stage
SLA	Spacecraft-LM Adapter
SLA	Secondary Landing Area
SM	Service Module
SPS	Service Propulsion System
SRC	Sample Return Container
SRS	Secondary Recovery Ship
SSR	Staff Support Room
SV	Space Vehicle
SXT	Sextant
SWC	Solar Wind Composition
TB	Time Base
TD&E	Transposition, Docking, and Ejection
T/C	Telecommunications
TEC	Transearth Coast
TEI	Transearth Injection
TLC	Translunar Coast
TLI	Translunar Injection
TPF	Terminal Phase Finalization
TPI	Terminal Phase Initiation
T-time	Countdown time (referenced to liftoff time)
TV	Television
USB	Uniform S-band
VAB	Vehicle Assembly Building
VG	Velocity-to-be-Gained
VHF	Very High Frequency

GPO 878-246

M-932-69-11

SUMMARY TIMELINE
NOMINAL LUNAR SURFACE EVA





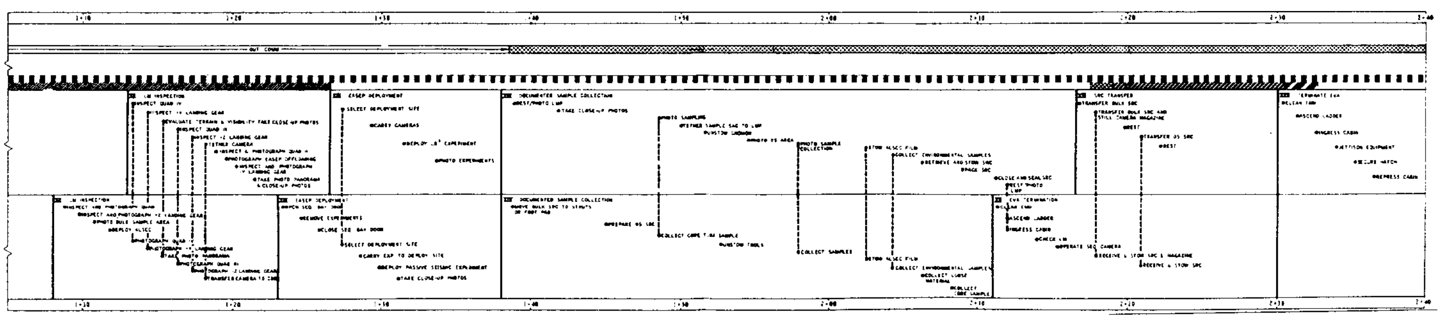


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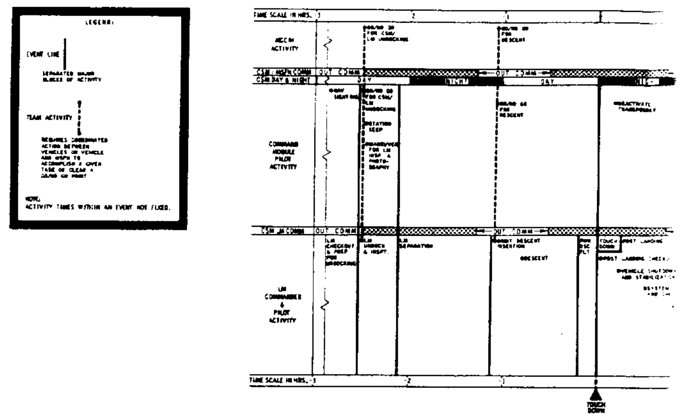
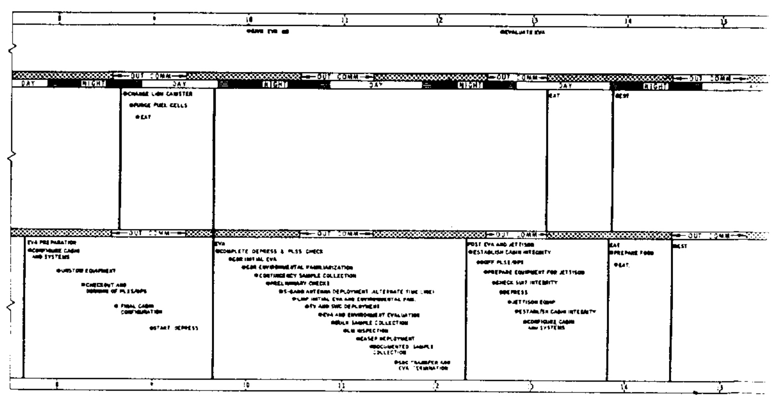
Fig. 2


LEGEND:
EVENT LINE
SEPARATED MAJOR BLOCKS OF ACTIVITY
TEAM ACTIVITY
NOTE:
ACTIVITY TIMES WITHIN AN EVENT NOT FIXED.
TIME SCALE IN HRS.
ACTIVITY
COMMAND MODULE PILOT ACTIVITY
CSM DAY & NIGHT
OUT COMM
DAY
NIGHT
STATION KEEP
FOR LM INSP & PHOTO-GRAPHY
LM CHECKOUT & PREP FOR UNDOCKING
UNDOCK & INSPT.
SEPARATION
DESCENT
DSC FLT
TOUCH DOWN
LM COMMANDER & PILOT ACTIVITY
TOUCH DOWN


OUT COMM
DAY
NIGHT
EVALUATE EVA
CHANGE LIOH CANISTER
PURGE FUEL CELLS
EAT
REST
EVA PREPARATION
CONFIGURE CABIN AND SYSTEMS
CHECKOUT AND
FINAL CABIN CONFIGURATION
START DEPRESS
EVA
COMPLETE DEPRESS & PLSS CHECK
CONTINGENCY SAMPLE COLLECTION
PRELIMINARY CHECKS
TV AND SWC DEPLOYMENT
EVA AND ENVIRONMENT EVALUATION
BULK SAMPLE COLLECTION
LM INSPECTION
EASEP DEPLOYMENT
DOCUMENTED SAMPLE COLLECTION
EVA TERMINATION
POST EVA AND JETTISON
ESTABLISH CABIN INTEGRITY
PREPARE EQUIPMENT FOR JETTISON
CHECK SUIT INTEGRITY
DEPRESS
JETTISON EQUIP
ESTABLISH CABIN INTEGRITY
CONFIGURE CABIN AND SYSTEMS
EAT
PREPARE FOOD
EAT
REST

6/24/69

M-932-69-11

LUNAR SURFACE ACTIVITY TIMELINE FOR 22-HOUR STAY

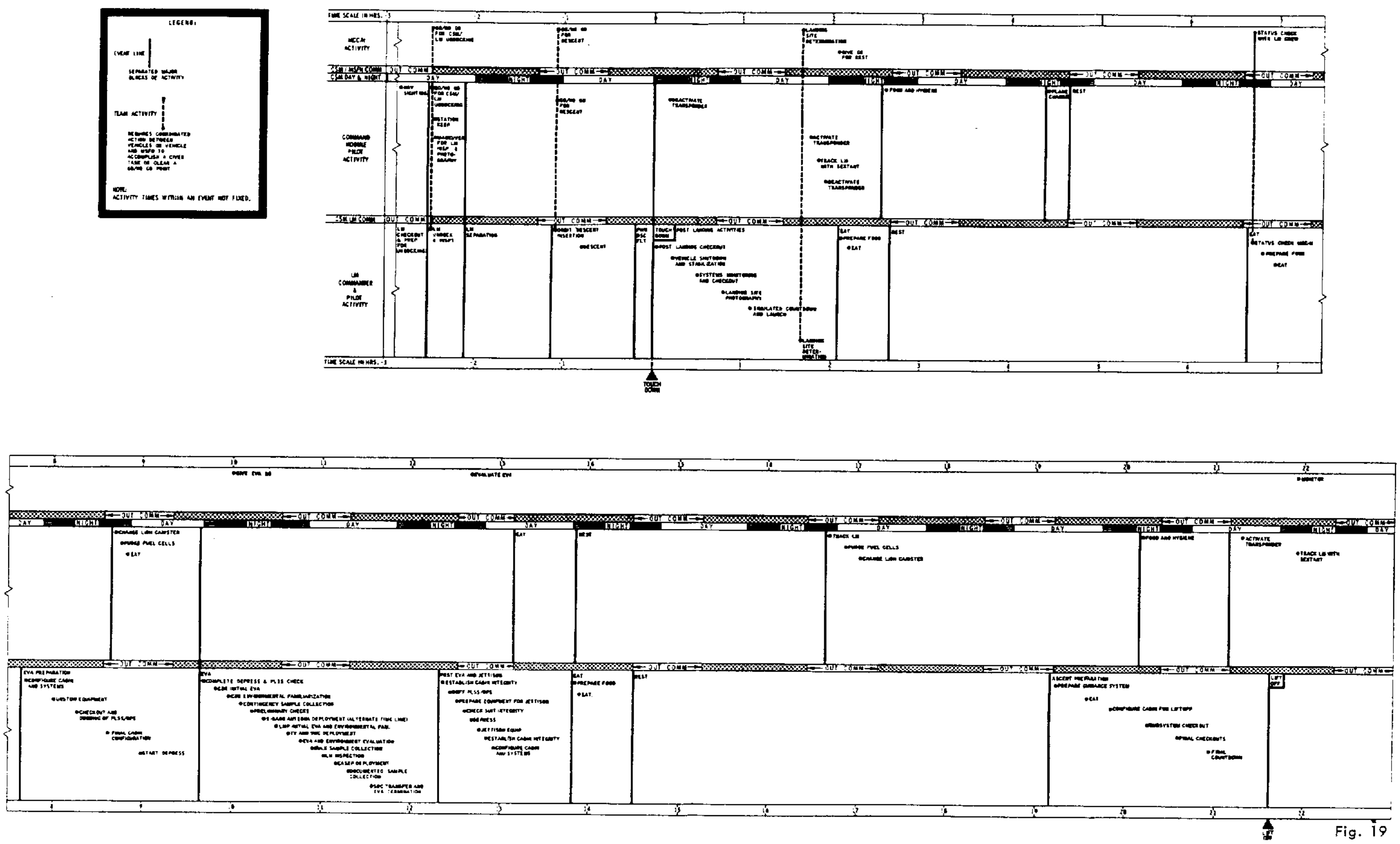
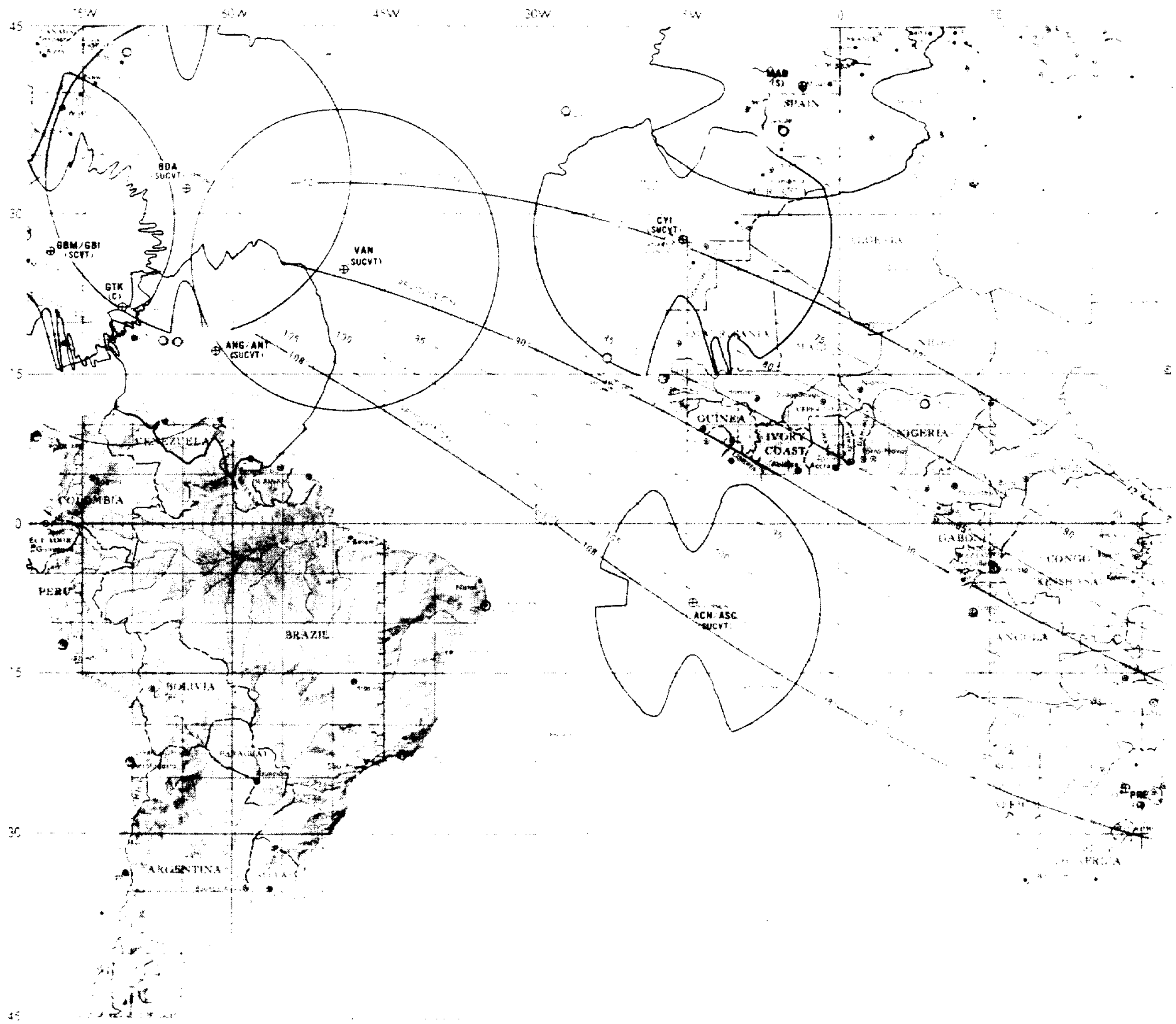


Fig. 19

6/24/69



EDITION 1, 19 JUNE 1969

PREPARED UNDER THE DIRECTION OF THE DEPARTMENT OF DEFENSE BY THE AERONAUTICAL CHART AND INFORMATION CENTER, UNITED STATES AIR FORCE FOR THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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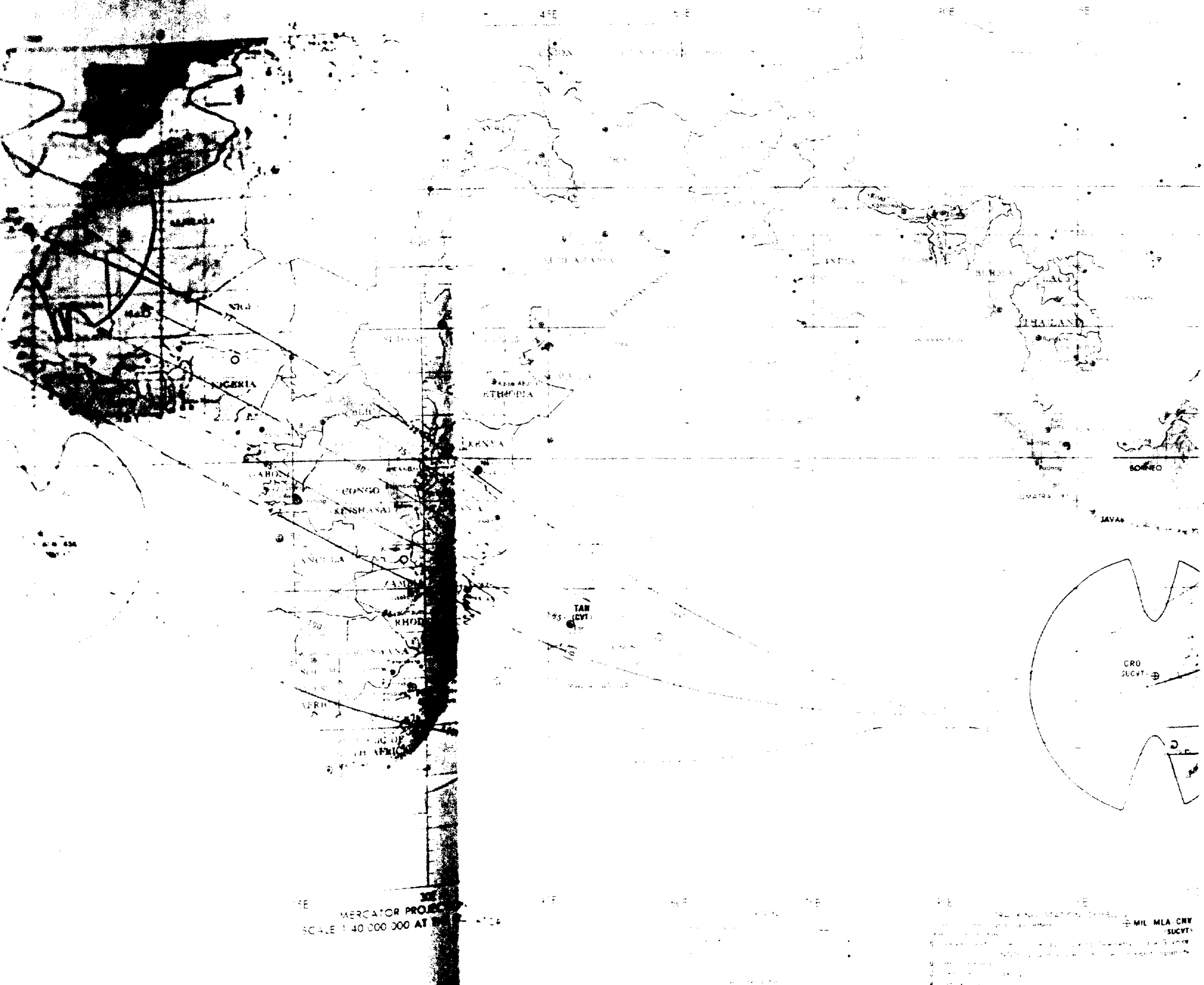
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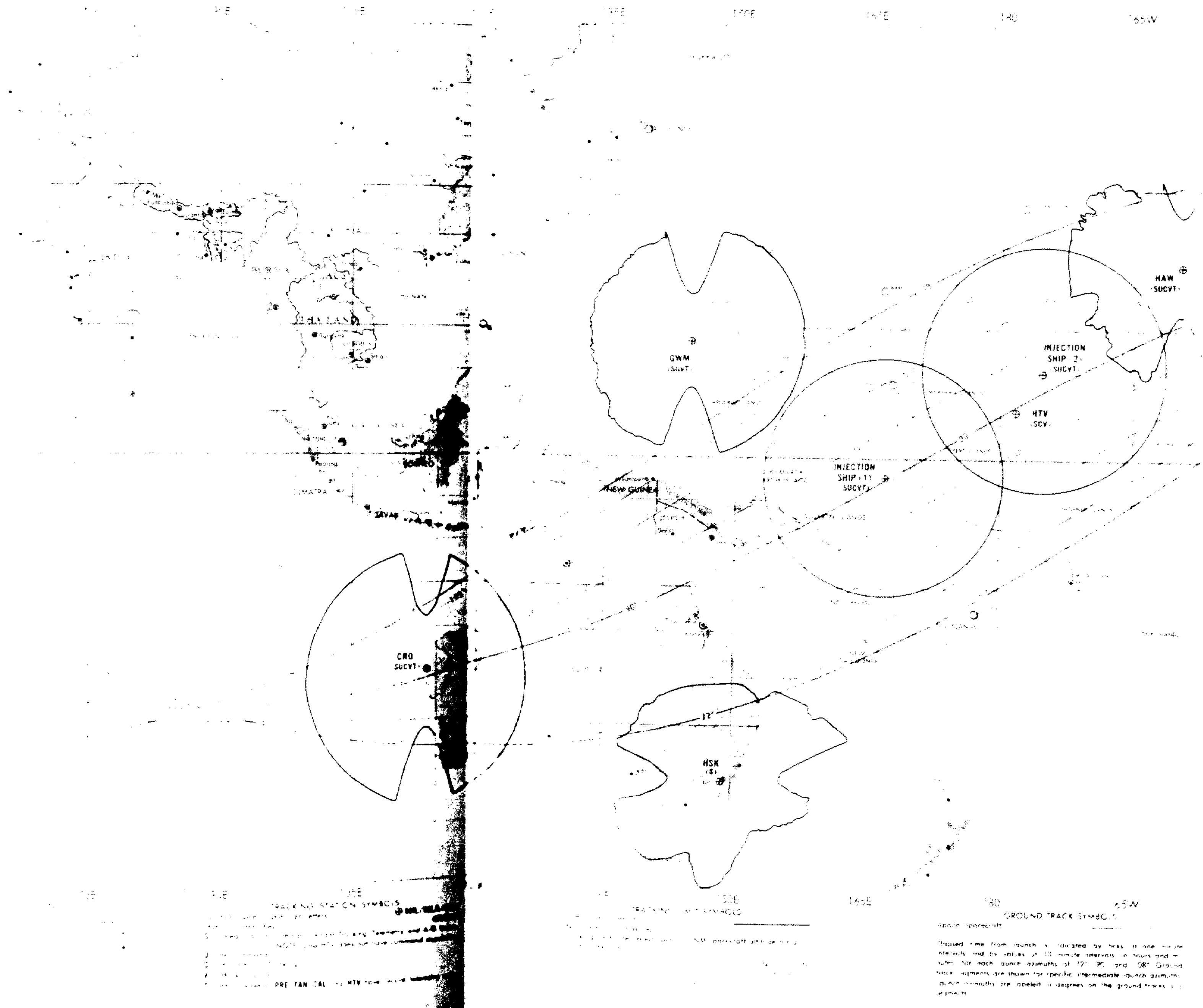
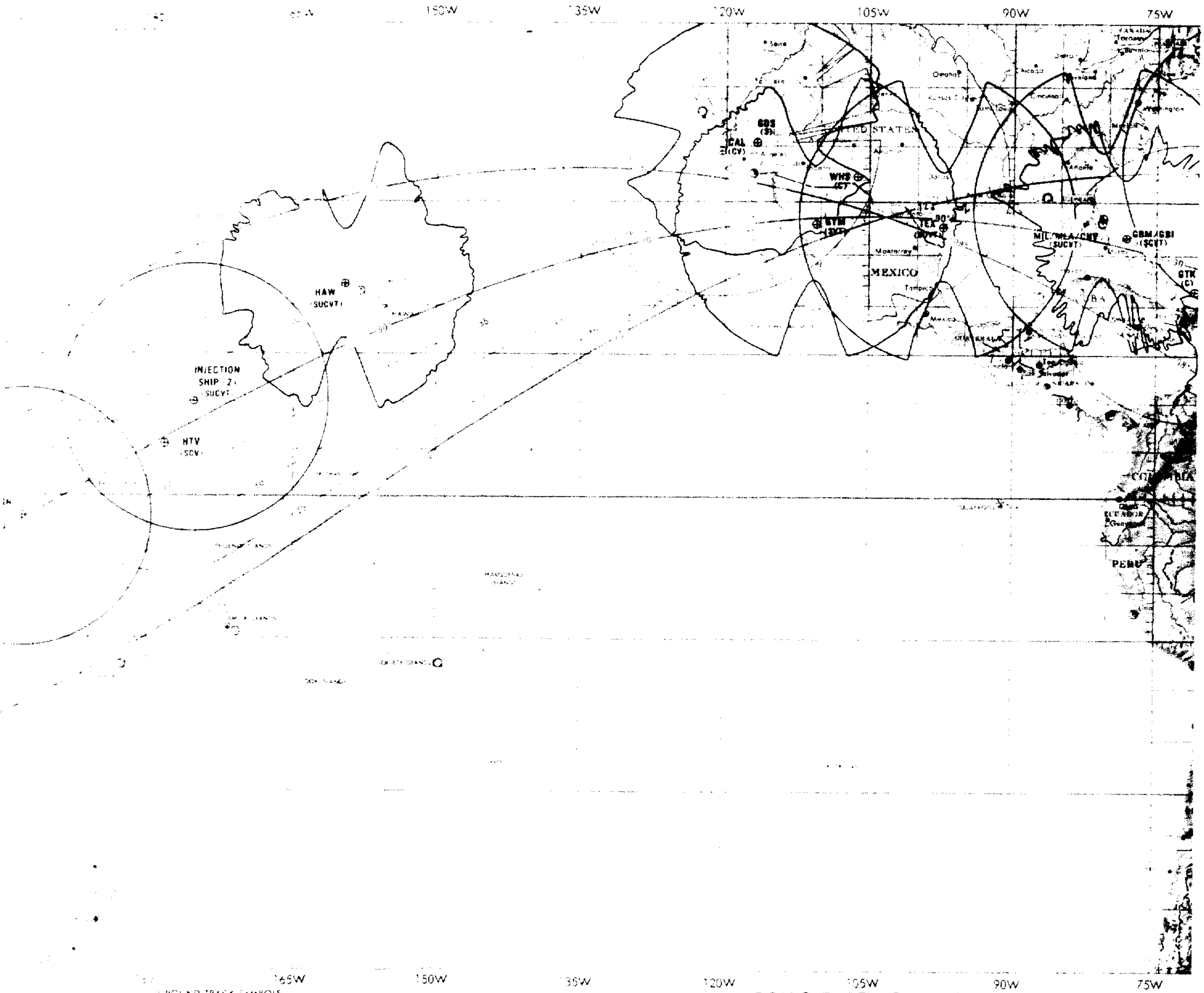
CONGO
ETHIOPIA
INDIA
BURMA
THAILAND
BORNEO
SUMATRA
JAVA
CRO
MIL MLA CNV


GWM
(SUVT)
HAW
(SUCVT)
INJECTION
SHIP (2)
SUCVT
HTV
(SCV)
INJECTION
SHIP (1)
SUCVT
CRO
SUCVT
HSK
(S)
12°
NEW GUINEA
THAILAND
BORNEO
SUMATRA
TRACKING STATION SYMBOLS
GROUND TRACK SYMBOLS
165W
180



GROUND TRACK SYMBOLS

[illegible] time from launch is indicated by ticks at one minute intervals and by values at 10 minute intervals in hours and minutes [illegible] launch azimuths of 72°, 90° and 108°. Ground [illegible] are shown for specific intermediate launch azimuths. [illegible] are labeled in degrees on the ground tracks and [illegible]

APOLLO EARTH ORBIT CHART (AEO)

Fig. 38

FOR JULY 1969 LAUNCH DATE