NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FINAL

APOLLO 13

LUNAR SURFACE PROCEDURES

PREPARED BY

LUNAR SURFACE OPERATIONS OFFICE
MISSION OPERATIONS BRANCH
FLIGHT CREW SUPPORT DIVISION

MARCH 16, 1970

MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

This document has been compiled from a circa 1970 multi generation photocopy held in a municipal library.

It was of poor quality with numerous extraneous marks and missing text.

Additionally, a number of pages appear to be missing and blank pages were not copied.

In so far as possible, Photoshop© was utilized to straighten and correct the page anomalies.

However, Traverse charts in section 3.6 and 3.7 were of very poor quality and could not be restored to an acceptable standard.

An extant chart from another source showing an overview of the planned traverses has been included for reference.

Section 3.2 had a number of missing pages (Cuff Checklists), however by using another document, replacement pages have been created.

Where other missing or blank pages appear to have been located, a page indicating this has been inserted into the document.

FINAL EDITION

APOLLO 13

LUNAR SURFACE PROCEDURES

MARCH 16, 1970

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APOLLO 13

LUNAR SURFACE PROCEDURES

PREFACE

This document has been prepared for the Flight Crew Support Division, Flight Crew Operations Directorate, Manned Spacecraft Center, Houston, Texas by General Electric, Apollo Systems, Houston Operations. The information contained within this document represents the Lunar Surface Procedures for Apollo 13, Mission H-2, the third manned lunar landing mission.

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INTRODUCTION

1.0 INTRODUCTION

This edition of the Apollo 13 Lunar Surface Procedures is used to document the planning for lunar surface EVA operations on Mission H-2, to describe the crew equipment interfaces, and to document the manner in which lunar surface mission requirements are planned to be implemented.

The nominal plan is for a set of two two-man EVA periods during the planned 33.5 hour stay time of the LM vehicle on the lunar surface. Each EVA is planned for four hours activity beginning with depressurization of the LM and ending with repressurization. Several alternative orders of operations will be included in this document, to cover off-nominal cases, such as higher--than-anticipated workloads and thus shorter PLSS time to consumables redline, difficulties in placement or deployment of experiments resulting in time lost, and malfunction of an EMU before EVA which occasions a single-man EVA contingency.

EMU operations and procedures (including contingency) are not covered in this document.

Detailed photographic and TV camera operations are covered in Reference (6), but are integrated herein in a summary manner.

This document includes both timeline and detailed timeline procedures data. Timelines are essentially task flow analyses along a time base, showing the points of interaction between the two crewmen. The detailed procedures simply list, in sequence of performance, the steps required to carry out each of the tasks identified in the timeline. It is in the detailed procedures that the crew/equipment interfaces are revealed. Both timelines and detailed procedures present the CDR's and the LMP's tasks side-by-side so that no confusion will exist as to which crewmen is doing what, or how the two cooperate in the operations on the lunar surface.

The procedures herein are responsive to the Mission Requirements for SA508/CSM-109/LM-7 H-2 Type Mission (Reference 2) currently in effect as of the date of this document.

SECTION 2.0

MISSION PLAN

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2.0 MISSION DESCRIPTION

The following information is from the "Mission Requirements, SA-508/CSM-109/LM-7, H-2 Type Mission, Lunar Landing", MSC, 10 November 1969.

2.1 Mission Objectives

The primary mission objectives have been assigned to this mission by the Office of Manned Space Flight (OMSF) in the Apollo Flight Mission Assignments Directive; these are to:

1) Perform selenological inspection, survey and sampling of materials in a preselected region of the Fra Mauro Formation.
2) Deploy and activate ALSEP
3) Develop man's capability to work in the lunar environment.
4) Obtain photographs of candidate exploration sites

The following lunar surface experiments have been assigned to this mission by OMSF:

1) S-059 Lunar Field Geology
2) S-031 Passive Seismic Experiment
3) S-037 Heat Flow Experiment
4) S-038 Charged Particle Lunar Environment Experiment
5) S-058 Cold Cathode Gauge Experiment
6) M-515 Lunar Dust Detector
7) S-080 Solar wind composition
8) S-184 Lunar Surface Close-up photography

Experiments 2) through 6) are part of the ALSEP III package. Detailed objectives have been derived from the OMSF-assigned primary objectives, placed in order of priority, and detailed to the extent necessary for mission planning.

Experiments are detailed and assigned priority only in the event that they require crew action or otherwise impact the mission timeline, trajectory, training or hardware.

2.2 Mission Priorities

The detailed lunar surface objectives and experiments are listed below in their order of priority. These priorities should be used for mission planning. The Television Coverage objectives will be performed in conjunction with several of the other objectives. The associated operations will take place at various points in the timeline. Hence, these objectives cannot be assigned any specific priority in the list below.

Priority	Detailed Objectives and Experiments	
-	B	Television Coverage
1	C	Contingency Sample Collection
2	ALSEP III	Apollo Lunar Surface Experiments Package
3	D	Selected Sample Collection
4	S-059	Lunar Field Geology
5	G	EVA Communication System Performance
6	H	Lunar Soil Mechanics
7	S-184	Lunar Surface Closeup Photography
8	S-080	Solar Wind Composition

2.3 EVA Mission Requirements

The stay time on the lunar surface is open ended and the planned maximum will not exceed 33.5 hours. After checkout of the LM to assess its launch capability the LM will be depressurized to allow egress to the surface. The nominal plan will provide for two periods of approximately four hours each for simultaneous EVA by both astronauts. The radius of operations is constrained to be within the limits imposed by the purge capability of the oxygen purge system. The planned lunar surface activities will include the following major items in order of priority:

1) Photography through the LM cabin window
2) Contingency sample collection
3) EVA evaluation
4) LM inspection
5) Deployment of experiments
6) Selected sample collection
7) Lunar field geology

Television transmission will be provided as early as praticable during the EVA period.

Photography will be employed throughout the EVA to document the activities and observations.

2.4 Site Description*

The Fra Mauro landing site lies in an elongate valley bordered by north-south trending ridges. These ridges are the Fra Mauro formation and are thought to be ejecta from the Imbrium Basin, 500 kilometers to the north. Although the area around the landing site is likely mantled by post-Imbrian volcanics, several large craters are thought to have penetrated this mantle and to have excavated Fra Mauro material, e.g., Cone and Sunrise craters. The scientific objectives at this site are to sample both material from the Fra Mauro and material from the overlying mantle. It is expected that the Fra Mauro material will be older than the samples returned by Apollo's 11 and 12. A petrofabric analysis should confirm or disprove the theory that Fra Mauro is Imbrian Ejecta. Analysis of the mantle material may yield a clearer picture of the moon's period of active volcanism. These ages may be comparable to the ages of the Apollo 11 and 12 mare ages.

*This section by Anthony England, Ph.D., Apollo 13 Mission Scientist

2.5 Lunar Surface Activity for 33.5 Hour Stay

The nominal plan is for the Commander and the Lunar Module Pilot to remain on the lunar surface for approximately 33.5 hours. A summary timeline for the lunar surface stay is presented in Fig. 2-1. Immediately after landing on the lunar surface, the crew will perform post landing LM systems integrity checks to establish lunar stay capability. Upon establishing stay capability, the crew will verbally describe the landing site and, with MSFN assistance, determine their exact landing site location. This period of time will also be used to make any real-time changes to EVA 1, should any landing site errors, local surface anomalies, or other off nominal conditions impact planned EVA 1 procedures. A short eat period preceeds EVA preparations which includes LM systems and cabin equipment configuration for EVA conditions. PLSS/OPS donning and checkout consume the last hour prior to EVA 1, which commences with depressurization of the LM cabin approximately 4 hours after lunar touchdown. A detailed discussion of EVA 1 is contained in section 3.1.1.

Upon completion of EVA 1, the crew will configure the LM systems for pressurized operation, doff their helmets, gloves and PLSS/OPS' and settle down to make the LM home for approximately the next 14 hours. An hour eat period is followed by recharging the PLSS consumables (battery , LiOH canister, O2 and H2O), preparing them for use during EVA 2. The crew debriefing of their EVA 1 experiences follows. During this time, the crew will further discuss EVA 1 findings with Houston, as well as surface conditions that affect EVA 2 planning. Houston will utilize this data to finalize EVA 2 planning and discuss any changes with the crew after their 8 hour rest/sleep period. The crew will eat following the rest period and then finalize their EVA 2 plans with Houston. The EVA preparation activity prior to EVA 2 is very similar to EVA 1, including collecting items for jettison. EVA 2 commences with cabin depressurization at approximately 24 hours after lunar touchdown. A detailed discussion of EVA 2 is contained in section 3.1.2.

Upon completion of EVA 2, the crew will connect up to the LM ECS, doff their PLSS/OPS' and prepare to jettison their now excess gear. After their equipment jettison and cabin repressurization, the crew will stow and secure all loose equipment preparatory to lunar liftoff. An hour EVA 2 debriefing and eat period will precede the prelaunch LM systems checkout. This systems checkout will conclude with guidance system configuration for liftoff. The crewmen will don their helmets and gloves at T-30 minutes in the countdown and perform final LM system checks. Lunar liftoff will occur approximately 33.5 hours after touchdown, concluding the lunar surface activity for the third manned lunar landing mission.

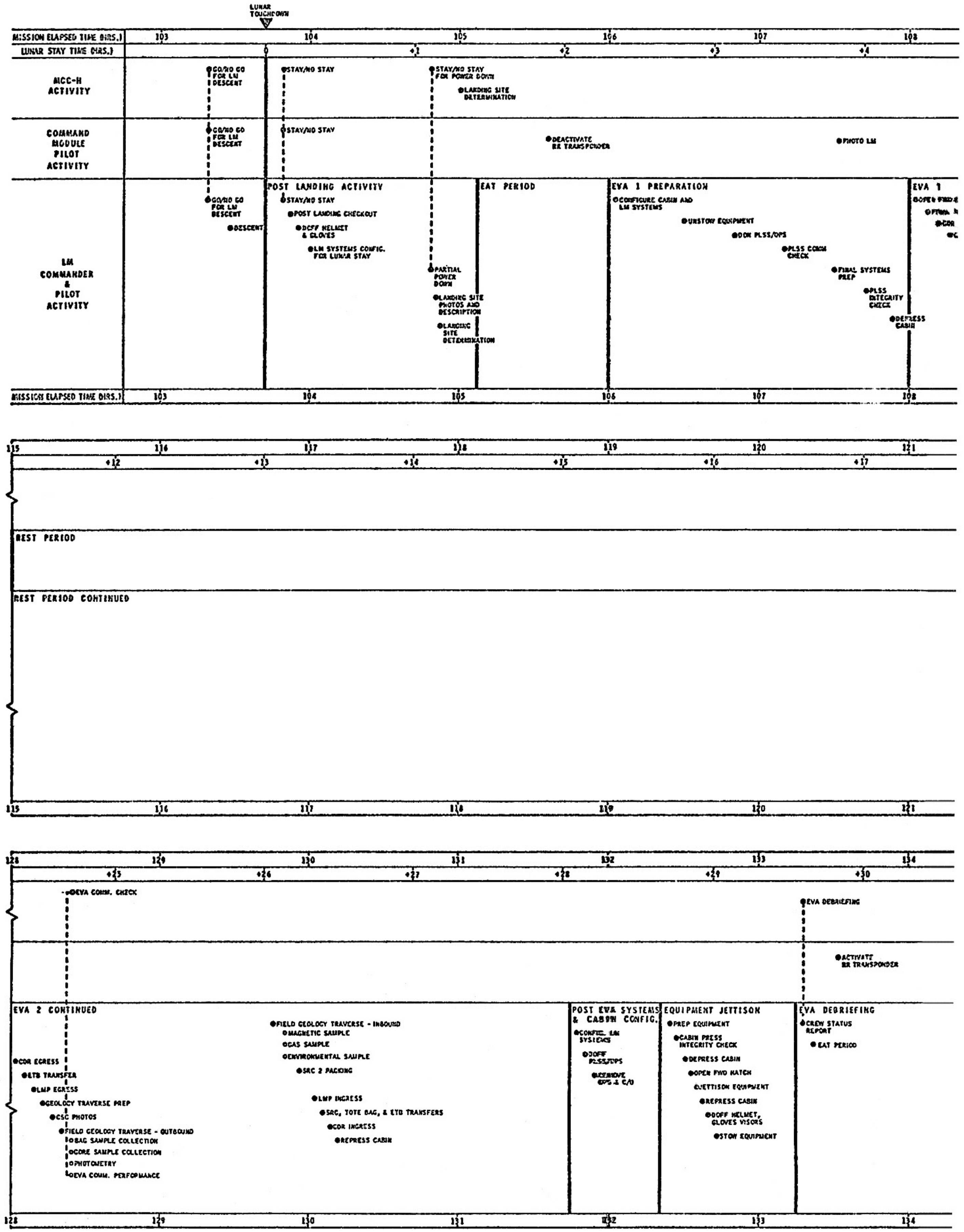

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TABLE 2-1

LOOSE EQUIPMENT LEFT ON THE LUNAR SURFACE

A. JETTISONED DURING EVA 1

1 Jettison Bag containing:

. Lunar Surface Sequence Camera bag

. 2 OPS stowage pallets

. 3 LM armrests

B. DISCARDED ON THE LUNAR SURFACE EVA 1

. Miscellaneous pip pins and fastenings

. Thermal covers and top cap, S-Band Erectable Antenna

. TV Camera Bracket

. ALSEP RTG Dome Removal Tool and Fuel Transfer Tool

. PSE Girdle

. ALSEP Subpallet

. ALSD parts

. HFE Parts and Probe Box

C. OPERATIONAL EQUIPMENT DEPLOYED AND LEFT ON EVA 1

. Flag

. TV Camera (Also B & W backup camera)

. S-Band Erectable Antenna

. ALSEP: PSE, CPLE, CCGE, HFE

D. JETTISONED DURING EVA 2

1 Jettison Bag containing:

. 2 Hammocks

. 1 LM ECS LiOH Cartridge and bracket

1 Fwd. LHSSC containing:

. 2 PLSS batteries

. 2 PLSS LiOH Cartridges

. Food Waste

. Urine Bags

1 Lunar Equipment Conveyor

TABLE 2-1 (Continued)

LOOSE EQUIPMENT LEFT ON THE LUNAR SURFACE

E. DISCARDED ON THE LUNAR SURFACE EVA 2

- Tote Bag
- Hand Tool Carrier with bag dispensers
- Lunar Hand Tools
- Closeup Camera
- Lunar Surface Sequence Camera (potential)
- Hoe/shovel
- Polarizing Filter

F. JETTISONED AFTER EVA 2

1 Jettison Bag containing:

- ETB
- 70 mm Camera, 2 brackets, 2 handles, 2 triggers
- 1 armrest

1 LHSSC containing:

- 2 RCU's
- Unused Defecation Bags
- 2 Retractable Tethers
- Food waste
- Urine Bags

2 PLSS's with straps (exc. lower adjust.)

G. LEFT ON LUNAR SURFACE AFTER LUNAR LAUNCH

1 LM Descent Stage

SECTION 3.0

NOMINAL LUNAR EVA

3.0 NOMINAL LUNAR SURFACE EVA

3.1 EVA General Description

The nominal plan is for the two LM crewmen to spend eight hours out on the lunar surface in their EMU's, or 16 manhours of EVA time. This is divided into two periods of four hours each, separated by a housekeeping, sleep, and eat period, of about fourteen hours. The nominal landing configuration for the LM is with the ladder on the +Z landing strut down sun, facing west.

Figure 3-1 is the nominal EVA 1 summary timeline which assumes that the Goldstone or Parks 210-foot antennas are not available for LM-Earth communications throughout all of EVA 1. This situation requires primary consideration be given to early deployment and activation of the Erectable S-Band Antenna. Figure 3-2 is the nominal EVA 2 summary timeline.

3.1.1 EVA 1

The first lunar surface excursion on Apollo 13 commences with depressurization of the LM ascent stage cabin. The forward hatch is opened by the LMP, following which the CDR assumes a kneeling posture facing away from the hatch. He backs out of the hatch in a prone posture. The lunar equipment conveyor (LEC) is dropped by the CDR. The CDR checks for adequate voice communication and telemetry transmission as soon as he is clear of the hatch opening. The LMP then hands the jettison bag to the CDR, who tosses it off to his right, between the +Z and -Y struts. The CDR completes the platform procedures by deploying the MESA. He does this by pulling a release loop. The CDR ascertains proper MESA deployment and then descends the ladder to ground.

As soon as the LMP has handed the jettison bag to the CDR, he busies himself with photography, using his 70mm electric data camera and the 16MM Surface Sequence Camera. The CDR's 70mm electric data camera has previously been readied for transport to the surface.

The CDR begins a familiarization procedure as soon as he reaches the surface. As soon as he feels confident to perform a transport procedure with the LEC, the 70mm data camera is transferred to the surface. This camera is the only still camera on the surface during EVA 1. The CDR commences his preliminary photography of the surface as part of the familiarization.

Following this, the CDR takes the Contingency Sampler out of his suit pocket, deploys it, and scoops up 1 or 2 pounds of lunar material. The contingency sampler is temporarily placed on the +Z secondary struts.

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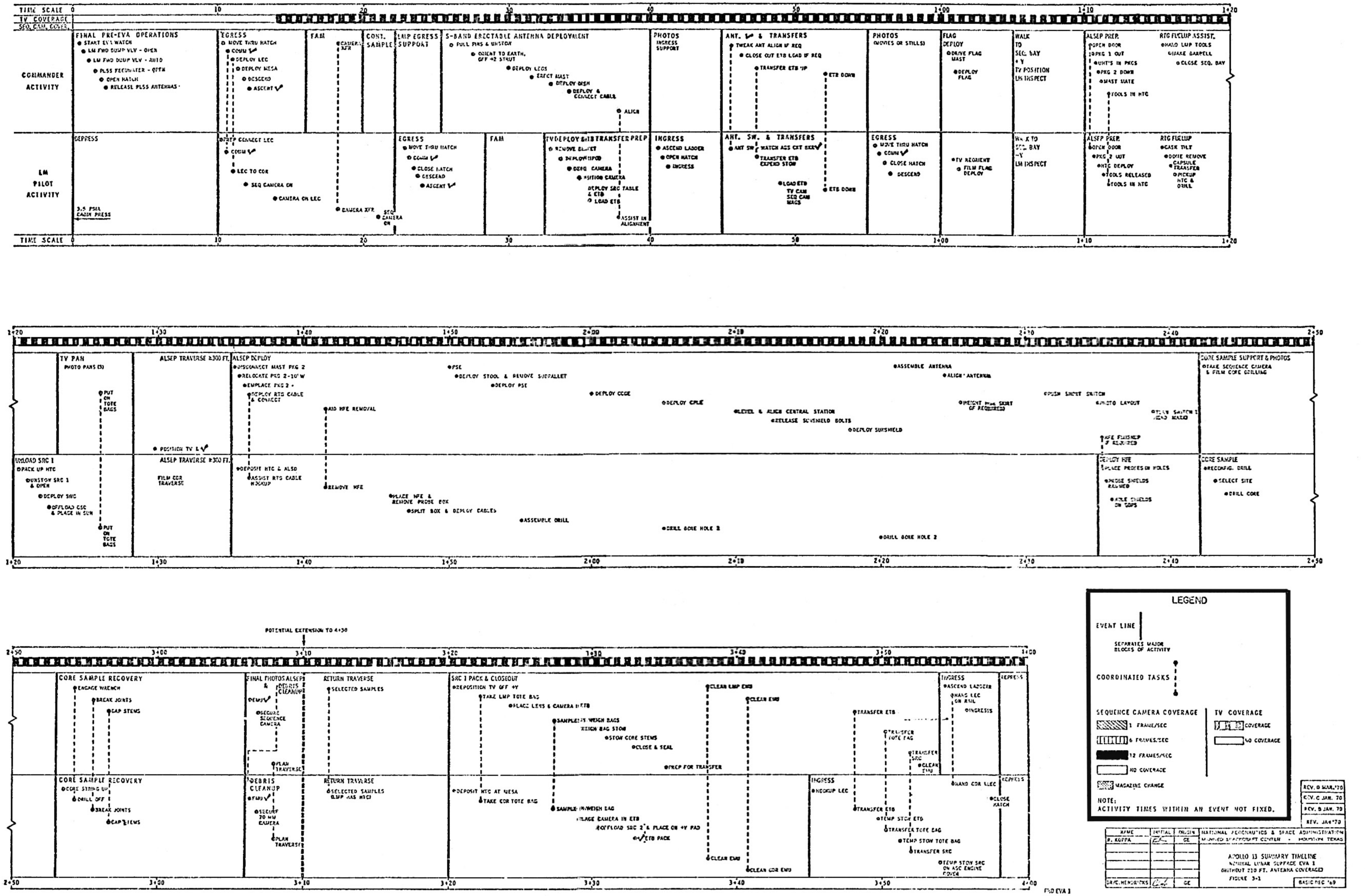
APOLLO 13 SUMMARY TIMELINE
NOMINAL LUNAR SURFACE EVA 1
(WITHOUT 210 FT. ANTENNA COVERAGE)



The LMP egresses at this point, going through the same steps as the CDR, except for the MESA deploy and jettison bag discard. He leaves the LM hatch slightly ajar and leaves a 70mm camera by the door as backup to the surface camera.

As soon as the CDR assures himself that the LMP has safely egressed, he proceeds to quad I to unstow the S-band erectable antenna. This unit is carried to the vicinity of the +Z strut for deployment.

The LMP goes through a familiarization sequence which includes taking the 70mm data camera from the CDR. He documents some of the early S-band antenna deployment procedures, then begins his first task, unloading and assembling the TV camera. The MESA blanket is peeled off the MESA, and the tripod is removed. The TV camera stowage box is opened and the camera removed for attachment to the tripod. The 100-foot camera cable is unreeled from the right side of the MESA, following which the camera is placed approximately 50 feet off the +Y strut. The LMP places the 70mm camera on the now empty TV bracket and begins the preparation for transfer of portable life support system (PLSS) expendables to the ascent stage. This involves unfolding the table from the front of the MESA, and hanging the equipment transfer bag (ETB) from it. The ETB is stowed under the folded-up table before launch. The ETB contains two extra weigh bags and a packaged 100-foot safety line. These are stowed on the MESA, and two PLSS LiOH canisters and two PLSS batteries are loaded into the ETB, together with the contingency sample bag, which is removed from its handle at this point. The LMP is on call during this sequence to assist the CDR in S-band antenna alinement by steadying it during that procedure. As soon as the S-band erectable antenna is deployed on its tripod, connected to its 30-foot cable, and alined, the LMP ingresses the LM. If any part of the PLSS expendables preparation is unfinished at this point, the CDR picks this up after the LMP is inside the LM ascent stage. The LMP turns the antenna switch to S-band erectable antenna position, checks receiver signal strength on the AGC display, and checks the TV camera circuit breaker. Television transmission is verified from MCC. If signal strength is not up to par, the CDR may be requested to experiment with changing the antenna alinement.

The CDR then picks up the LEC and connects it to the packed ETB. The bag is transferred to the ascent stage on the LEC. The LMP pulls down on the strap of the LEC as it goes through the pulley secured to the alinement optical telescope (AOT) bar. The LMP receives the ETB and unloads the PLSS expendables and contingency sample bag. These are temporarily stowed, and the ETB is passed back to the surface on the LEC. The 16mm camera, two extra magazines, a backup black and white TV camera, and a traverse map are transferred to the surface in the ETB. The CDR unstows the 16mm sequence camera from the ETB and photographs the LMP egress, if possible. The LMP egresses once again, closes the hatch, and descends to the ground.

Both men participate in deployment of the American flag, as required. The LMP may find it necessary to re-aim the TV camera to cover the flag deployment ceremony. The sequence camera may also be used during this period.

The two crewmen then proceed to the Scientific Equipment (SEQ) Bay (Quad II). The CDR goes by way of the +Y strut, picking up the TV and repositioning it to cover SEQ Bay activities. He notes and photographs any anomalies or unusual features on the LM, and documents LM foot pad penetration DPS erosion, and bell clearance. The LMP does the same kind of inspection, but around the -Y side. He has the sequence camera.

The crewman who reaches the SEQ Bay first opens the bay door by manipulating two lanyards. The door opens like an overhead garage door to reveal packages 1 and 2 of the Apollo Lunar Scientific Experiment Package (ALSEP). A small horizontally moving door swings out to shield the crewmen from the hot Radioisotope Thermoelectric Generator (RTG) cask on the left of the SEQ Bay.

The LMP removes Package 2 as soon as the door is open. The packages can be removed like a suitcase from a shelf, or they can be removed on an extendable boom and lowered to the surface on a cable, by means of a ratchet device.

The LMP takes the package to the vicinity of the fuel cask and unstows the hand tool carrier (HTC) and sets it up. This becomes a receptacle for the ALSEP tools which are next removed from package 2. Package 2 contains the HTC, the Apollo Lunar Surface Drill (ALSD) the ALSEP tools and the RTG. Meanwhile, the CDR removed package 1 from SEQ Bay. This package contains all of the experiment units - the Passive Seismic Experiment (PSE), the Cold Cathode Gauge Experiment (CCGE), the Charged Particle Lunar Experiment (CPLE) and the Heat Flow Experiment (HFE).

The CDR aids the LMP in unstowing the tools from Package 2 as soon as Package 1 is on the ground. The ALSD is also on Pkg. 2. It comes off and is placed on a foot pad (probably -Z), following which a universal hand tool (UHT) is inserted in a socket in package 2 and the package is lowered by the CDR to a horizontal position on the surface.

The LMP meanwhile lowers the RTG fuel cask on the left side of the SEQ Bay to a horizontal position and uses a special tool to remove the dome of this cask. Another special tool then engages and releases the RTG fuel capsule inside the cask. The capsule is transferred to the RTG of package 2 and heat up of the generator begins.

The LMP, as soon as he fuels the RTG, picks up the ALSD and the HTC and proceeds back around the LM to the MESA.

The CDR pushes the deployment booms back inside the SEQ Bay, closes the SEQ Bay doors, and returns package 2 to an upright position. He has previously taken two mast sections out of the tool holder on Pkg. 2 and locked them together. These will ultimately be the ALSEP antenna mast, but their first purpose is a carry handle. The two ALSEP packages are joined bar-bell fashion by the mast. The CDR then performs a TV panorama sequence and his three photographic panoramas.

Meanwhile the LMP has unloaded Sample Return Container (SRC) No. 1 from the MESA, placed it on the table, and opened it. Inside are six core sample drill stems, caps for the stems, and supplies for the "selected sample" the crew will perform after ALSEP is deployed. These items, plus tools from the MESA, are loaded into the HTC. The solar wind composition experiment is deployed, and the close-up stereo camera (to be used in EVA 2) is placed in the sun to preserve its battery capability.

The crewmen meet at the MESA and each installs the other's sample collection bag (tote bags). These were stowed in the MESA.

Both crewmen then proceed 300 or more feet in as westerly a direction as possible to a suitable ALSEP deployment area. The ALSEP deployed in relation to LM is depicted in Fig. 3-3. Detailed deployment geometry and constraints are shown in Fig. 3-4.

Once at the ALSEP deploymemt site the LMP deposits his burden at the approximate spot of the Heat Flow Experiment deployment. He aids the CDR in emplacing the RTG-bearing Pkg. 2 and helps connect the power cable to Pkg. 1. Pkg. 1 is then placed on the surface in a rough N-S alignment, and the LMP removed the HFE. He withdraws to the HFE deployment area unreeling the cable as he goes. He places the electronics package along an E-W line, and disassembles the HFE probe packages. By deploying the probe cables he can ascertain where to place the bore holes in which the probes will be placed. He then assembles the ALSD and commences the implantation of the two bore strings.

The CDR assists the LMP in removal of the HFE package, then prepares for PSE deployment. The PSE rests on a small stool which the CDR places 10 ft. east of package 1. A small hole is gouged out of the surface under the stool. The PSE is removed from package 1 and placed on the stool. All of these experiments are secured to their ALSEP package by special quick-release fasteners called "boyd bolts". The boyd bolts are released by the UHT. The CDR places the PSE on the stool, aligns it to the east, and deploys a thermal skirt. The completely deployed PSE resembles a sombrero, with the thermal skirt forming the hat brim. The CDR levels the PSE with reference to a spirit level mounted on the top, and reports a suncompass reading to Houston.

He returns to the Central Station (package 1) and removes the CCGE. This unit must be isolated from the rest of the ALSEP experiments, since it is a delicate atmosphere sensor, so it is deployed some 60 feet SW of the central station.

The upside-down (as stowed) CPLEE is next to come off the Central Station. This solar partical sensor is placed on smoothed ground 10 ft. due south of the central station. This leaves the central station base clear save for the antenna aiming mechanism, the antenna and the dust detector.

The CDR releases the boyd bolts that hold down the top of the Central Station and assists the top into its raised configuration which reveals the Central Station sunshield. He mounts the antenna mast, places the aiming mechanism (a gimbal device with leveling & alignment provision) on the mast, and the antenna on the aiming mechanism. The antenna is leveled and aligned to predetermined values.

The CDR completes ALSEP deployment by pushing a button which releases a dummy load across the RTG leads and permits power up of Central Station electronics. The station requires several minutes to come up to full power for transceiver operation. The CDR turns a special switch at ground request to initiate operation. If necessary, the CDR can also switch on the auxiliary ALSEP transmitter "B" and can cycle the four experiments with a third switch. The switches are actuated by manipulation of the UHT.

During the pause for power up, the CDR photographs the various experiments, the general layout and the area The last is accomplished with a photo panorama. If the LMP has encountered difficulties in drilling the HFE bore holes, the CDR will deploy the HFE probes (short tubes of sensors and heaters jointed in the center) placing them down the holes as soon as the LMP has finished implanting the bore stem sections of which the holes are composed. The CDR photographs the bore stem ends with the HFE probe wires in them, and the HFE electronics box to complete ALSEP documentation.

During the CDR activities described above, the LMP has been drilling the two bore holes into the lunar surface. The ALSD is a rotary - percussive drill. The drill has a quick release chuck which drives sections of hollow fibreglas - boron stems down into the regolith. The sections are added one at a time (after an initial two which include the closed bit) to a depth of 3 meters, or nearly ten feet, for each of the two bore holes. The stems remain empty, because the bit is closed, and the material is pushed aside or passes up the outside of the stem string to the surface on helical threads on the outside of each section. The twelve sections (six per hole) are stowed in a special rack, part of the ALSD package. The two HFE heat probes are pushed to the bottom of these holes with the extendable Emplacement Tool. Special covers and sunshields are also placed in each hole with this tool. The tool has graduations on it so that the crewman can report the depth of the probe, and the height above the surface of the topmost (final section) bore stem.

The LMP then removes the quick - release chuck from the ALSD and couples two of the core sample stems onto the drill drive shaft. These stems feature an open bit to permit taking a core sample. The core stems are made of molybdenum, and couple with threaded ends, unlike the bore stems which are friction-fit.

When coupled in a string of six and driven into the surface, a sample nearly 8 feet deep can be taken. The core sample string is drilled through an orifice in a treadle which is also part of the ALSD package. This treadle premits clockwise rotation of the string; counter-clockwise string rotation results in a clutch engaging the stem which prevents further rotation in that direction. The LMP steps on the treadle as he drills down through it. The treadle holds the emplanted stem captive while the drill is removed by manual counter rotation (powered rotation is clockwise only) to allow addition of another stem to the string. If possible, the CDR will film the core stem drilling procedure with the sequence camera.

When the required six core stems are in the surface, the CDR assists the LMP in withdrawing the string from the surface. The two crewmen attempt to raise the string by tugging upward on the drill. Failing that, the drill power is actuated sufficient to break the soil cohesion as the string is raised. When 2 stems are visible, the CDR takes a special Stilson wrench from the ALSD rack and engages the topmost stem section such that the drill head can be removed and discarded. The treadle then is engaged and the joint between the topmost and fifth section is loosened (but not separated) using the wrench. The wrench is then used to twist the 5th section clockwise and thus release the treadle. The string is then raised until the next section joint is within reach, and the joint loosening procedure repeated, until the string is out of the ground and all 5 joints have been broken loose. If special difficulties such as the treadles jamming with rock fragments are encountered, and extra wrench (stowed on the MESA) is available in the HTC.

The drill end is capped as soon as practicable after the drill is removed. The bit end is likewise capped, as soon as it comes out of the surface. These caps are Teflon and friction-fitted. They are marked alphabetically, "A" going on top and "B" on the bit end of the string. The crewmen then start at the upper end of the string, either manually or with the wrenches separating the stems one by one, capping each as it comes loose from the string, and stowing all in the HTC pouch. The cap markings and order are reported to Houston during this procedure so that the core structure can later be restored in the Lunar Receiving Laboratory at MSC.

The crewmen remove all drill equipment from the vicinity of the HFE area and request Houston for a prediction of EVA time left, and EMU operational status from telemetry data. As status is being uplined, they take a last look at the ALSEP area and rest preparatory to the return traverse. The CDR takes the 70mm, the LMP the sequence camera.

The return traverse to the LM affords opportunity to collect selected samples - interesting rocks, glassy fragments, fine material as they are encountered during the return trip. If additional time is available over the four hours nominal, a westerly traverse will be made, the traverses as a function of time are shown in Fig 3.6 . Samples are documented prior to and after being gathered according to the procedures shown in Fig 3-5. Rocks are placed in the tote bags or in the HTC pouch. (The LMP places samples in the CDR's tote bag, the CDR places samples in the LMP's bag). If fine-grain or rock fragments are gathered, a dispenser of small sample bags is available to hold these samples.

When the two crewmen regain the LM, the TV camera is repositioned to record closeout activities and cover 2nd EVA egress. This will be done by the CDR, since the LMP carries the HTC.

The LMP takes his tote bag off the CDR and holds it for offload by the CDR. The crew will examine some samples between EVA's and relay advance geological information, which may have a bearing on the 2nd EVA Lunar Field Geology experiment. These samples are left in the CDR's tote bag. Both cameras and all magazines go into the ETB for transfer into the Ascent stage.

The CDR unloads the samples from the tote bags into two special weigh bags placed on a scale. These weigh bags and scales were stowed in SRC 1. He seals and places the weigh bags in SRC 1. He may fill one of the weigh bags with rocks and fine material from around the LM, if weight is short of maximum. Finally the core stems are placed in the SRC and this "rock box" is sealed. (See Fig. 3-5 for inbound SRC 1 contents).

During this period the LMP removed the second SRC from the MESA and places it on the +Y pad in the sun. He covers it with a thermal shroud salvaged from the S-Band erectable antenna. This procedure ensures a proper between-EVA thermal environment for the SRC, to protect the integrity of the Indium seal.

The CDR assists the LMP to clean off his EMU with a special brush: the LMP mounts the ladder and ingresses the Ascent stage. The CDR checks the ETB for proper contents, and readies the ETB for transfer. The ETB was left hooked to the LEC at the beginning of the EVA. The LMP tugs the ETB into the ascent stage, guided by the CDR.

The hook end of the LEC is returned to the CDR, who fastenes the hooks onto the tote bag. The tote bag is transferred to the ascent stage, where it is stowed by the LMP. In like manner SRC 1 is transferred to the ascent stage. The CDR then cleans his EMU as best he can and mounts the ladder.

When he is on the platform, the LMP hands him the pulley end of the LEC which he secures to the platform rail, ready to support EVA 2. The CDR moves through the hatch, the hatch is closed, and the repressurizing procedure initiated, thus concluding EVA 1.

3.1.2 EVA 2

The second EVA period commences with depressurization, following which the LMP opens the forward hatch for CDR egress. The CDR assumes a kneeling position, legs out the hatch, and moves through the hatch to lie prone on the LM platform. As soon as he is secure, he hands the LMP the hook/pulley end of the LEC and descends the ladder to the surface.

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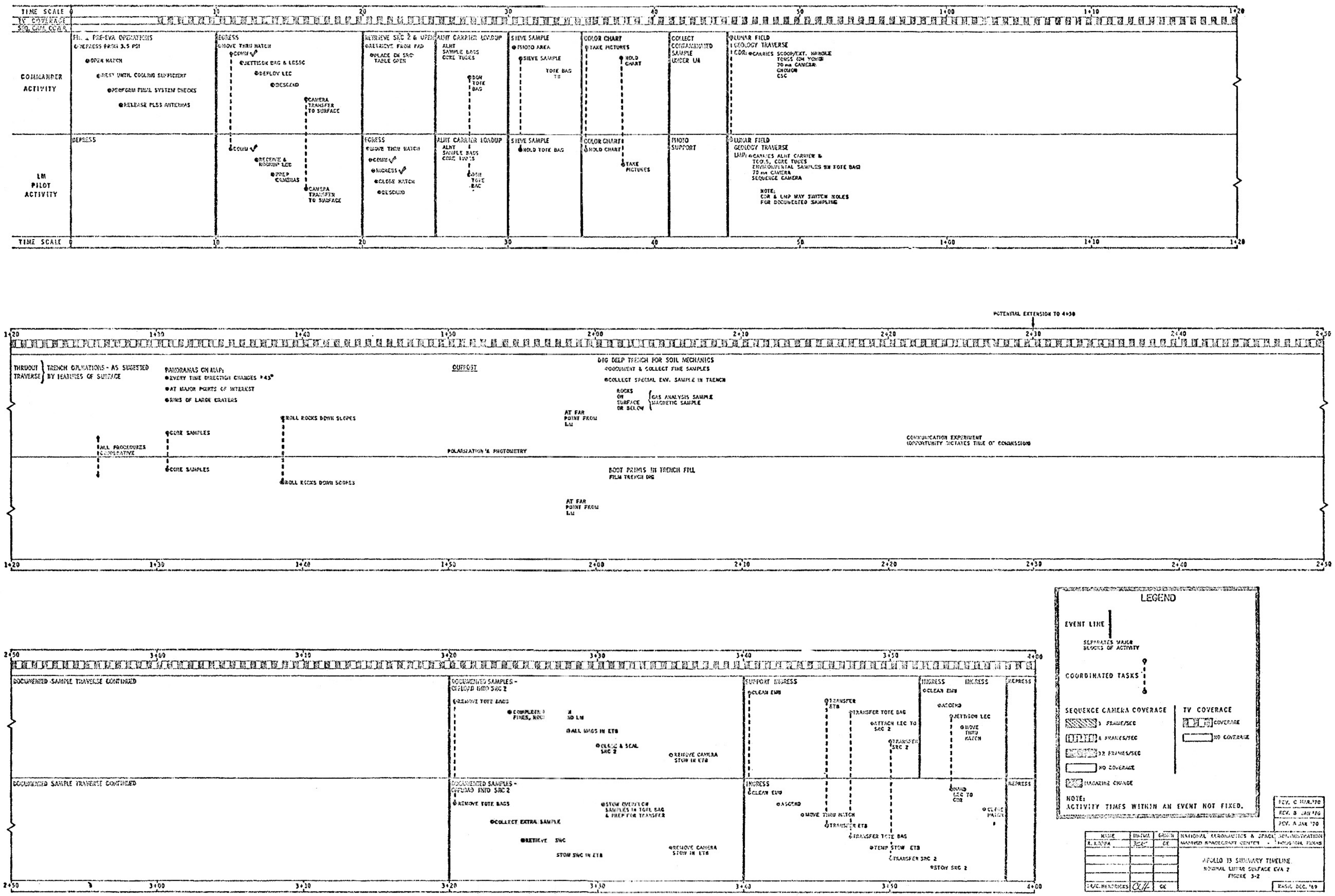
Of Poor Quality

APOLLO 13 SUMMARY TIMELINE
NOMINAL LUNAR SURFACE EVA 2



The LMP hangs the LEC pulley from the overhead handhold and attaches the ETB to the hooks on the LEC preparatory to lowering the bag to the lunar surface. The bag contains the three cameras (2-70mm data cameras and the surface sequence camera) extra/magazines, and the lunar traverse map. As soon as this transfer is effected, the LMP joins the CDR on the surface. As before, the hatch is left slightly ajar precluding pressure buildup forcing the hatch closed.

The CDR proceeds to retrieve the second SRC from the pad whence it was left on the previous EVA. It is placed on the MESA SRC table, clamped and opened. The LMP brings the Hand Tool Carrier close by the MESA as the CDR unpacks another 35 bag dispenser, a set of three core tubes, three special sample containers, a new pair of weigh bags, and a solar wind experiment bag. The weigh bags and the solar wind bag go on the MESA, the dispenser and core tubes go onto the HTC.

Next the HTC receives its complement of tools, including a large two-piece hoe/shovel for use in digging trenches. The vertical-seeking photography reference tool, the gnomon, is also taken off the MESA and stowed on the HTC. (See Fig. 3-5).

Both crewmen proceed to install the PLSS-mounted packs, called "tote bags" on each other. The LMP's carry pouch (a pocket attached to the tote bag) contains the 100-ft safety tether, a filter, and the special sample containers. The CDR's pouch receives the extra 70mm and 16mm film magazines.

While the CDR was loading the HTC, the LMP retrieved the Closeup Stereo Camera (CSC) from its place in the sun where it rested between EVA's, deployed the skirt, or light shroud, and took some trial pictures in the vicinity of the LM. The CDR will nominally hand-carry this unit out on the geology traverse.

Both crewmen check the HTC and their packs for completeness. The surface sequence (16mm) camera is stowed in the HTC pouch. The traverse map is placed in a special pocket on the HTC. The HTC is usually carried by the LMP.

The crew then proceeds to assemble the large scoop to the extension handle, take one of the two spare weigh bags (stowed in the ETB at launch) and go to a representative area of ground near the LM. The large scoop has a 0.5 cm sieve attachment. The crew sieves material for 5 minutes and deposits residual rocks and chips in the weigh bag. This bag is sealed and stowed in the ETB.

The crew proceeds to calibrate their film (Black and white SO 267) and obtain photometric data by taking a series of photographs of a special contrast chart carried on the HTC.

The next sample taken is the so-called "contaminated sample" under the LM itself. This is a sample of fine material scooped by the CDR with the small scoop. The sample is photographically documented and placed in a small bag, the number of which is reported to Houston. This is rebagged inside another small bag and the sample is also deposited in the ETB.

The events of the next three hours or so are dependent upon the sites and traverse selected between the crew and the geology team supporting the flight. The number and kinds of samples taken, and sites visited, are governed by the traverse map if the landing site is known. Although much depends on on-the-spot decisions by the crew, the nominal traverse is shown in Fig. 3.7 .

During the traverse, the crew carries on a running commentary on what they are seeing and doing. They report all movements between samples, noting directions and distance with regard to the LM. Every now and then the LMP and CDR read each other's film counter to Capcom to permit those keeping track of the film budget and records to update and correct their records.

Changes of direction, or advance to a new leg of the traverse occasion a 12 to 14 picture photo panorama, which serves to satisfy the backsite-to-the LM requirement as well.

When an area is encountered in which obstructions exist between the two crewmen and the LM, the CDR (who, it will be remembered, has the relay link with the LM) attempts to test the communication capability of the EMU EVCS system by moving behind or into this obstruction. This could be a fault escarpment, crater wall, large boulder, hill, or other surface feature.

During the traverse the astronauts dig several small holes of trenches to gain an understanding of surface structure, mechanial properties, and to obtain subsurface samples (See Fig. 3-5). They also take several core samples. These samples are taken by attaching a core tube to the extension handle and driving the tube into the ground by striking the extension handle end with the hammer.

All samples are taken in a prescribed manner (see Fig. 3-3 & 3-5). When the candidate sample site is identified by either the CDR or the LMP, the CDR places the gnomon is close proximity to the sample. He takes a stereo pair of photos cross-sun at 5 feet while the LMP walks up to the sample site. Either before or after sampling the LMP takes a picture at a distance of 15 feet or so, the horizon or a prominent landmark in the background, with the camera focussed at 74 feet. The LMP will endeavor to be within 45 degrees of a cross-sun orientation for this photograph.

He takes a second down sun picture focussed on the sample at 5 feet. The CDR or LMP picks up the sample by tongs, scoop, or hand. If the sample is small enough, or is fine material, it goes into a sample bag, and the bag number is reported. Otherwise it is placed unbagged in one of the tote bags. The CDR finishes the documentation by taking a cross-sun photo of the sample site at 5 feet. Where characteristics of the sample in situ or material/surface conditions near the sample justify it, the closeup Stereo Camera (CSC) is also used. The documentation photographs provide the required CSC picture localization information. The CSC user reports the frame number and the orientat on of the camera (there is a sun compass on top) each time the camera is used. The CDR then picks up the gnomon and walks ahead to the next sample site. If an area larger than that covered by one photograph at a distance of five feet is to be samples (e.g., the bottom of a crater), a series of stereo photos will be taken at 15 feet, as required, while the LMP takes one or more down-sun. These photos are supplemented by 5 foot pictures as required to document individual samples.

The criteria whereby samples are taken are described in the Lunar Field Geology Detail Test Objective in the Mission Requirements (Ref. 2).

The CDR performs a photographic experiment using a special polarizing filter which he attaches to his camera (See Fig. 3-3). He takes pictures of different kinds of rocks and distant surfaces at various sun phase angles and filter settings, co-varying both. The crew takes samples of some of the rocks that are so photographed.

One of these areas will be designated as the "outpost" or most distant spot from the LM (See traverse map, Fig. 3.7 .) The crew rests briefly, and then sets about performing several experiments. They collect a selected variety of rocks from the surface for the Gas Analysis Sample. Two or three surface microbreccias and crystalline rocks are picked up for the Magnetic Sample. Both of these samples go into special "mini-SRC's," small can-like containers with their own sealing capabilities.

The crew digs a two-foot-deep trench using their special hoe/shovel. This is for the Soil Mechanics experiment found in the Mission Requirements. (Ref. 2). The trench site is carefully documented by comments and photos before, during and after the "deep trench" is dug (See Fig. 3-5). The crew takes documented samples from the top, bottom, sides, and any areas where discontinuities or contacts between dissimilar materials, textures, or hues occur. To close out this experiment the LMP makes a boot imprint in the middle of the piled-up material removed from the trench, and this imprint is photographed and discussed. The closeup camera is freely used here to document the deep trench. Fines are collected in the bottom of the trench for the Special Environmental Sample, the third of the special samples. This sample also goes in a can-like sealed container.

The CDR will dig the deep trench while the LMP makes a motion picture of this operation with the sequence camera. The sequence camera has been used during the traverse as required to film rocks rolling down crater walls, astronaut movement over the surface, sampling techniques, and special problems which lend themselves to motion picture documentation, such as HTC carrying difficulties, if any. The sequence camera has three magazines available, which yield about 23 minutes of movies at 12 fps. The camera is discarded when the third magazine is expended.

The closeup camera has also been used on targets of opportunity. during the traverse, according to the criteria set forth in its Detail Test Objective (Ref. 2). The film cassette is extracted from the camera and stowed in a tote bag pouch for return to the LM. When the film capacity (100 pairs) is reached the camera is left on the lunar surface.

With visits to the rest of the sites on the traverse following the same sampling procedures as described for the outbound part of the traverse, the crew makes their way back to the LM.

The LMP deposits the HTC near the MESA, and then pauses while the CDR removes his loaded tote bag. The LMP performs this service for the CDR, then holds the bags open so the CDR can extract the samples and place them in a weigh bag. The first weigh bag is filled with bagged samples. If any space remains, unbagged samples are put in. The second weigh bag is similarly filled. Larger rocks or other samples not placed in the SRC are stowed in one of the tote bags and the bag readied for transfer.

The special environment and gas analysis sample containers are placed in the SRC. The core tubes complete the offload from the geology traverse into the SRC. The LMP takes down and rolls up the solar wind experiment. This device is bagged and placed in the ETB. The CDR closes and seals the SRC. (See Fig. 3-5 for inbound SRC 2 contents).

Both crewmen place their data cameras, all film magazines with the sieve, contaminated, and extra samples in the ETB.

The CDR cleans the LMP's EMU as much as possible, and the LMP climbs the LM ladder. He moves through the hatch and hooks up the LEC to the overhead hand hold. The CDR checks the ETB contents for a final time, and then supports the LMP's hauling the ETB into the Ascent stage. The ETB is detached and placed out of the way, then the LMP returns the empty hooks of the LEC to the CDR, who attaches them to the tote bag. The bag is transported into the cabin and placed on the Ascent engine cover. The SRC is then transported on the LEC to the ascent stage. The CDR cleans his EMU, while the LMP detaches the LEC and makes ready for CDR ingress.

The CDR climbs the ladder to the platform, tosses away the end of the LEC that the LMP hands him through the hatch, and enters the cabin. The LMP closes the hatch door, and the repressurization cycle is started to end the second and final EVA on Apollo 13.

3.2 Detailed EVA Timeline Procedures

3.2.1 EVA 1

The detailed timeline procedures for EVA 1 are shown on the following format sheets.

The crew EVA cuff checklist pages which correspond approximately to the timeline increment are shown on the lefthand facing sheets.

CDR

PLSS H_2O TO LM H_2O (192)

- LOOSEN PGA TORSO TIEDOWN
- PUMP OFF
- LMP DISCONNECT PLSS H_2O
- ✔ PGA CONNECTOR UNLOCKED
- LMP CONNECT LM H_2O
- CB(16) ECS: LCG PUMP-CLOSED

LM H_2O (192) TO PLSS H_2O

- CB(16) ECS: LCG PUMP-OPEN
- LMP DISCONNECT LM H_2O
- LMP CONNECT PLSS H_2O
- PUMP ON
- TIGHTEN PGA TORSO TIEDOWN

DATE; 3/16/70

LMP

PLSS H_2O TO LM H_2O (192)

- LOOSEN PGA TORSO TIEDOWN
- PUMP OFF
- CDR DISCONNECT PLSS H_2O
- ✔ PGA CONNECTOR UNLOCKED
- CDR CONNECT LM H_2O
- CB (16) ECS: LCG PUMP-CLOSED

LM H_2O (192) TO PLSS H_2O

- CB(16) ECS: LCG PUMP-OPEN
- CDR DISCONNECT LM H_2O
- CDR CONNECT PLSS H_2O
- PUMP ON
- TIGHTEN PGA TORSO TIEDOWN

DATE: 3/16/70

MISSION: APOLLO 13, H-2
EVA: 1

DATE: 16 MARCH 1970

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+00	DEPRESS CABIN FROM 3.5 PSI			
		NOTE: DETAILED PROCEDURES ARE PRESENTED IN "LUNAR SURFACE CHECKLIST" "EQUIPMENT PREP EVA 1" SECTION			
		OPEN HATCH			
	0+10	MOVE THRU HATCH			

CREW EVA CUFF CHECKLIST

CDR

DATE: 3/12/70

CDR - EVA 1

CDR EGRESS

0+10 PULL SAFETY & DEPLOY MESA [JETTISON BAG TO CDR

TOSS BAG TO -Y AREA
DROP LEC TO GND.

ASCENT ✓

0+18 FAM

CAMERA TRANSFER [TRANSFER

LM ✓ & REPORT

CONTINGENCY SAMPLE

STOW INTACT ON STRUT

PHOTO AREA

0+25 LMP EGRESS AID [EGRESS

TEMP STOW 70 MM CAM OR GIVE TO LMP [FAM

EGRESS

LMP

EGRESS

LMP - EVA 1

0+10 PASS JETTISON BAG TO CDR [EGRESS

PASS LEC TO CDR

0+18 PHOTO FAM [FAM

CAMERA TRANSFER

PHOTO CONTING SAMP.

SHADE f2.8 @ 1/60, 12 fr

SUN f8 @ 1/60, 12 fr

0+25 EGRESS

70 MM CAMERA IN DOORWAY

CLOSE HATCH

ASCENT ✓

FAM - TAKE 70 MM CAMERA FROM CDR - PLACE ON FOOT PAD

DATE: 3/12/70

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CREW EVA CUFF CHECKLIST

CDR

S-BAND

0+30 S-BAND DEPLOY (+Z) [FAM
ORIENT TOWARDS EARTH
SAVE THERMAL COVER [TV
STEADY LEG FOR DISH
DEPLOY & DUCK
CONNECT CABLE
CALL LMP TO ASSIST

ANTENNA ALIGN
WATCH PLSS ANT/DISH
0+45 FINISH ETB PREP [INGRESS
DEPLOY TABLE
UNSTOW ETB - TAKE OUT BAGS & SAFETY - STOW ON MESA
LOAD IN ETB -
LiOH CANS
PLSS BATTS
CONT SAMPLE BAG

HOOK UP LEC

DATE: 3/12/70

LMP

TV DEPLOY

0+32 TV DEPLOY [S-BAND
RELEASE MESA SNAPS
PEEL MESA
UNSNAP ADAPTER
TRIPOD DEPLOY
PULL 2 SNAPS TV BOX STRAP
RELEASE 2 LENS STRAPS
SET LENS f:44 & CAP LENS, ALSC SW-PEAK
TV ON TRIPOD
UNSTOW CABLE
POSITION 50 FT. OFF +Y
SET LENS -
f:44; DIST:50; ANGLE:25
UNCAP LENS
CAUTION KEEP LENS ≥ 45° TO SUN

DATE: 3/12/70

DATE: 3/12/70

START ETB PREP [S-BAND
DEPLOY TABLE
UNSTOW ETB - TAKE OUT BAGS & SAFETY - STOW ON MESA
LOAD IN ETB -
- LiOH CANS
- PLSS BATTS
- CONT. SAMPLE BAG

HOOK UP LEC
ASSIST CDR ANT. ALIGN

0+45 INGRESS
[S-BAND ✓
TV CKT BKR ✓
S-BAND - LUNAR STAY
TRACK MODE - OFF [ETB PREP
TRANSFER ETB (UP) [TRANSFER

MISSION: APOLLO 13, H-2

EVA: 1

DATE: 16 MARCH 1970

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
PLACE 70MM CAMERA ON FOOTPAD	0+30	DEPLOY MAST SECTION		FAM	S-BAND ANTENNA DEPLOY
		EXTEND LEGS			
REMOVE MESA COVER		CHECK ANTENNA ORIENTATION		TV-DEPLOY	
UNSTOW & ERECT TV TRIPOD TV LENS f:44 AND CAPPED UNSTOW & MOUNT TV ON TRIPOD UNSTOW TV CABLE		DEPLOY LEGS REMOVE & PLACE COVER TO ONE SIDE LIFT ANTENNA ONTO LEGS			
CARRY TV (50! +Z/+Y) to VIEW MESA, S-BAND & FLAG UNCAP TV LENS		REMOVE AND DISCARD LIFT BAR AND RIB PROTECTOR			
ERECT MESA TABLE ATTACH ETB TO MESA TABLE		UNSTOW TRIGGER & DEPLOY DISH (DUCK)		ETB PREP & S-BAND	
STOW WEIGH BAGS & SAFETY LINE ON MESA ASSIST CDR WITH ANT ALIGNMENT (STEADY LEGS)		UNSTOW AND CONNECT ANTENNA CABLE ROUGH ALIGN ANTENNA			
		FINE ALIGN ANTENNA			
START ETB LOADING	0+40				PHOTO
ASCENT LADDER		PHOTO & GUIDE LMP INGRESS		INGRESS	
OPEN HATCH					
INGRESS		FINISH ETB PREP			ETB PREP
		UNSTOW PLSS BATTS & LiOH CANS AND PLACE IN ETB		S-BAND ANT. SW - ON	
ANTENNA SW - WATCH AGS CHECK TV CIRCUIT BREAKER		REMOVE SAMPLE FROM SCRC HANDLE & PLACE IN ETB			
		CLOSE ETB TOP FLAP ATTACH LEC TO ETB			
		ADJUST ANTENNA FINE ALIGN (IF REQ'd)			S-BAND
PULL ETB INTO LM	0+50	TRANSFER ETB INTO LM			

CREW EVA CUFF CHECKLIST

CDR

DATE: 3/12/70

	S-BAND ALIGN	[ANT. SW.
	TRANSFER ETB TO LMP	
	HANG ETB ON SIDE MESA	[MAG FOR EXPEND
	PUT ON MOVIE CAMERA	
1+00	PHOTOS	[EGRESS
	LMP EGRESS	
	MOVIES OR STILLS	
	GIVE MOVIE CAMERA TO LMP	
	FLAG DEPLOY	
	UNSTOW FROM MESA	[TV REORIENT FILM CDR
	UNSTOW HAMMER	
	DRIVE MAST	
	EXTEND HORIZ. ROD	
	PLACE IN MAST	
	PUT ON 70 MM CAMERA (ON FOOTPAD)	
	CAP TV LENS & PICK UP TV	

FLAG DEPLOY

LMP

TRANSF.

	OFFLOAD CONSUMABLES	
	STOW BATTS (OPS AREA)	
	STOW CANS (ASC. ENG. COVER)	
	STOW CONT. SAMP (BOTTOM BOOT)	
	IN ETB - SEQ. CAM, 2 MAGS, TV CAM, AND MAP	
	TRANSFER ETB (DOWN)	
1+00	EGRESS	
	CAMERA IN DOORWAY	
	CLOSE HATCH	
	DESCEND	
	TAKE MOVIE CAMERA	
	FLAG DEPLOY	[UNSTOW
	TV REORIENT	
	FILM CDR - SEQ CAM	

DATE: 3/12/70

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970

EVA: 1

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ. CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
PULL ETB INTO LM	0+50	TRANSFER ETB INTO LM		ETB TRANSFER	ETB TRANSFER
REMOVE ETB CONTENTS & STOW					
PACK IN ETB: 16MM CAM, 16 MM MAGS(2), B&W TV CAM & MAP					
ASSIST ETB TRANSFER		TRANSFER ETB TO SURFACE STOW ETB ON MESA TABLE SIDE			
MOVE THRU HATCH		OFFLOAD 16 MM CAMERA & INSTALL ON RCU		EGRESS	PHOTOS
CLOSE HATCH (CAMERA IN DOORWAY)					
DESCEND LADDER		FILM LMP DESCENT			
		16 MM CAM TO LMP			
GET 16 MM CAM FROM CDR	1+00	REMOVE FLAG FROM LM (MESA AREA)		FLAG DEPLOY	FLAG DEPLOY
		REMOVE HAMMER FROM MESA			
FILM CDR		DRIVE LOWER FLAG POLE INTO SURFACE			
REORIENT TV TO VIEW FLAG IF GND REQUIRES		DEPLOY FLAG AND INSERT UPPER POLE INTO LOWER SHAFT			
TAKE 16 MM CAMERA INSPECT QUAD IV REPORT DPS EROSION & BELL CLEARANCE		TAKE 70 MM CAMERA-INSPECT QUAD III REPORT DPS EROSION & BELL CLEARANCE		LM INSPECTION	LM INSPECTION
INSPECT QUAD I					
INSPECT QUAD II		(REPOSITION TV CAMERA 25 ft to VIEW SEQ BAY IF GND. DIRECTS) INSPECT QUAD II			
OPEN SEQ BAY DOORS	1+10	OPEN SEQ BAY DOORS			

CREW EVA CUFF CHECKLIST

CDR

SEQ BAY

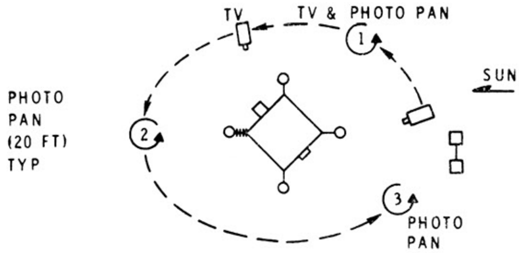
DATE: 3/12/70

1+10 WALK TO SEQ BAY [TO SEQ BAY
VIA +Y - LM INSPECT
TV REPOSITION TO SEQ BAY
(f:44 DIST:25 ANGLE:25) & UNCAP
KEEP STRUTS OUT OF PICTURE
ALSEP PREP
OPEN DOOR (WHITE)
PKG 1 OUT
HANDLE UP
TOOLS OFF PKG 2 & IN HTC
DRILL OFF
PLACE ON PAD
RTG FUELUP
PUTTERS IN PKGS
PKG 2 DOWN TO FUEL
[TO MESA
MAST TOGETHER - ✔ LOCK
MAKE DUMBBELL

TO DEPLOY ALSEP
BOOM: Pull White Till Pkg Clear; Ratchet Stripes To Gnd; Pull Pin Hockey Stick
MANUAL: Pull Release; Pull String; Haul Out Pkg; Pull Pin Hockey Stick

DATE: 3/12/70

BOOMS IN
SHUT DOORS (STRIPES)
1+25 TV PAN - AT f:44 UNLESS GND ADVISES
PHOTO PANS



GET DUMBELL - MEET LMP
PUT ON TOTE BAGS
1+30 TRAVERSE > 300 FT WEST

PHOTOS

LMP

DATE: 3/12/70

1+10 WALK TO SEQ BAY [TO SEQ BAY
VIA -Y - LM INSPECT.
ALSEP PREP
OPEN DOOR (WHITE)
PKG 2 OUT
HANDLE UP
PULL 4 PINS
HTC DEPLOY
TOOLS IN HTC
DRILL OFF
PLACE ON PAD
SEQ CAM IN HTC
RTG FUELUP
TILT CASK & REMOVE DOME [PKG 2 DOWN
CAPSULE INTO RTG
TAKE HTC & DRILL TO MESA

TO DEPLOY ALSEP
BOOM: Pull White Till Pkg Clear; Ratchet Stripes To Gnd; Pull Pin Hockey Stick
MANUAL: Pull Release; Pull String; Haul Out Pkg; Pull Pin Hockey Stick

SEQ BAY

SRC

SOLAR WIND IN LiOH HOLE
CSC IN SUN
1+25 MESA TO HTC [TV, PHOTO PANS
MAP, TONGS, GNOMON
EXT. HANDLE, HAMMER
WRENCH
SAFETY LINE IN LMP TOTE BAG
UNLOAD SRC 1
SCALE & BAG ON MESA
IN HTC - CORE STEMS
BAG DISPENSER
CORE STEM CAPS
SEAL ORGANIC SAMPLE, PADS TO SIDE
B & W TV CAM IN SRC HOLE
✔HTC CONTENTS
DEPLOY SOLAR WIND IF FEASIBLE (+Y 60 FT.)
REORIENT TV
PUT ON TOTE BAG
2 16 MM MAGS CDR TOTE BAG
PICK UP HTC & DRILL
1+30 TRAVERSE >300 FT. WEST
TAKE MOVIES OF CDR

DATE: 3/12/70

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 1

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ. CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
OPEN SEQ BAY DOORS	1+10	OPEN SEQ BAY DOORS STOW LANYARD		ALSEP OFFLOAD - RTG FUEL UP	ALSEP OFFLOAD - RTG FUEL UP
REMOVE & LOWER PKG #2					
DISCONNECT LANYARD & BOOM STOW LANYARD REPOSITION PKG #2		STOW BOOM #2 REMOVE & LOWER PKG #1			
REMOVE AND EXPAND ALHTC RELEASE TOOLS & PLACE IN HTC		DISCONNECT LANYARD & BOOM STOW LANYARD			
REMOVE DRILL		REPOSITION PKG #1			
		UHT'S IN PKG'S			
DEPLOY CASK TILT LANYARD TILT CASK AND STOW LANYARD		STOW BOOM #1 MATE MAST			
REMOVE AND DISCARD DOME/DRT		PASS DRT TO LMP			
ENGAGE & CHECK FTT		PASS FTT TO LMP			
WITHDRAW FUEL CAPSULE & FUEL RTG - REPORT TEMP		POSITION PKG #2 FOR RTG FUELING			
DISENGAGE FTT & DISCARD	1+20	ATTACH CARRY BAR TO PKGS #1 AND #2			
CARRY ALHTC & DRILL TO MESA AREA DEPLOY SOLAR WIND DEPLOY CS CAM PLACE IN SUN				OFF LOAD SRC AND MESA	
MESA TOOLS TO HTC: TONGS, GNOMON, EXTENSION HANDLE, HAMMER & WRENCH		CLOSE SEQ BAY DOORS			
UNLOAD SRC 1: SCALE AND WEIGH BAG ON MESA, LOAD IN HTC - CORE STEMS (6), BAG DISPENSER & CORE STEM CAPS		OBTAIN TV PANORAMA & SPECIAL INTEREST VIEWS			
PLACE SRC PAD TO SIDE SEAL ORGANIC SAMPLE(LEAVE IN SRC) MAP FROM ETB TO HTC		OBTAIN PANORAMAS - 70MM CAM (3 PANS: AT 20 FT RADIUS - OFF QUAD II, QUADIII, AND +Z STRUT)			PHOTO AND TV PANORAMA
CHECK HTC CONTENTS					
TOTE BAG & PLACE SAFETY LINE IN POUCH					
B&W TV IN SRC 1 HOLE		DIRECT TV TO MESA AREA (40 ft +Z/+Y)			
DEPLOY CDR TOTE BAG-PLACE 16 MM MAGS IN POUCH- INSTALL ON CDR PLSS		INSTALL TOTE BAG ON LMP PLSS			
CARRY ALHTC & DRILL TO ALSEP SITE >300 ft WEST	1+30	CARRY ALSEP TO DEPLOYMENT SITE:CHECK TV COVERAGE AND DIRECT TO SITE			

CDR

ALSEP DEPLOY

DATE; 3/16/70

1+35 ALSEP DEPLOY
- DISCON MAST FROM PKG 2 } PUTTERS
- RELOC PKG 2 10 FT. WEST } NORTH
- 70 MM CAM TO LMP
- EMPLACE PKG 2
- REPORT TEMPS ON ALL EQUIP.
- DEPLOY HORSE COLLAR & CONNECT CABLE
- READ AMPS
- DO NOT PUSH SHORT BUTTON
- EMPLACE PKG 1 & EYEBALL ALIGN
- GET TONGS FROM LMP

1+45 AID HFE REMOVAL [HFE REMOVAL
- LEAN TONGS & MAST ON PKG 1
- DEPLOY PSE STOOL (DIG HOLE)
- REMOVE SUBPALLET, STOW MAST
- DEPLOY PSE (PULL OFF BOLTS) LEVEL, REPORT DEGREES

LMP

DATE; 3/16/70

ALSEP DEPLOY

1+35 ALSEP DEPLOY
- DEPOSIT HTC & DRILL VICINITY DRILL SITE [PKG 1 & 2 POSITION
- 16 MM CAM IN HTC
- PLACE DRILL ON HTC
- TAKE TONGS TO CDR
- REMOVE CDR 70 MM CAMERA
- HELP CDR WITH HOOKUP
- TAKE MAST OFF PKG 1 & STOW

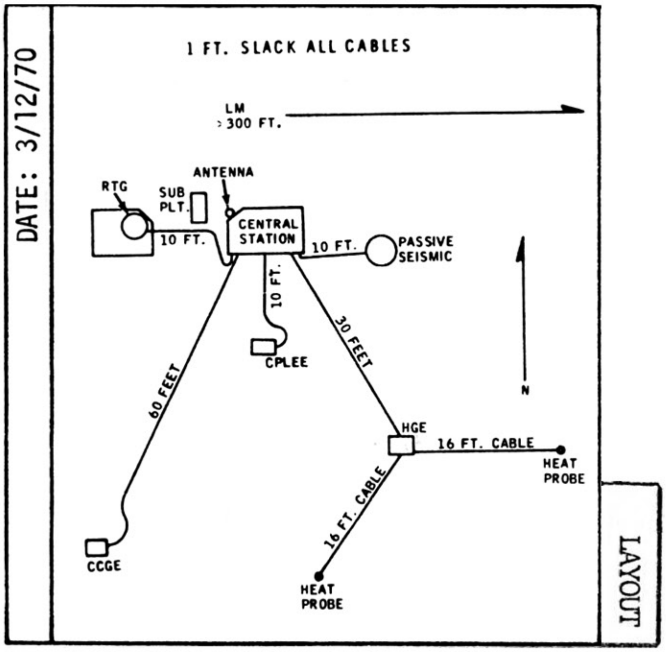
1+45 REMOVE HFE
- RETURN TO HTC & DRILL EYEBALL ALIGN ELECT. E-W
- DETACH PROBE BOX & SPLIT
- LEAN 1/2 BOX ON HFE ELECT.

MISSION: APOLLO 13, H-2 DATE: 16 MARCH, 1970

EVA: 1

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
CARRY ALHTC & DRILL TO ALSEP SITE > 300 FT WEST	1+30	CARRY ALSEP TO DEPLOYMENT SITE:CHECK TV COVERAGE		TRAVERSE TO ALSEP SITE	TRAVERSE TO ALSEP SITE
FILM CDR WITH 16 MM CAMERA DURING TRAVERSE					
NOTE: REST ENROUTE		NOTE: REST ENROUTE			
DETERMINE HFE LOCATION AND TENTATIVE BOREHOLE LOCATION		REPORT COMPLETION OF TRAVERSE		ALSEP PKG 1 & 2 IMPLACEMENT	ALSEP PKG 1 & 2 IMPLACEMENT
PUT DOWN ALHTC AND DRILL		SURVEY SITE TO DETERMINE ALSEP EXPERIMENTS LOCATION			
TAKE TONGS TO CDR					
DISCONNECT MAST - PKG 1		DISCONNECT MAST - PKG 2 RELOCATE PKG 2 10 FT WEST			
STOW MAST ON SUBPALLET					
		GIVE LMP 70 MM CAMERA EMPLACE PKG 2 REMOVE RTG CABLE REEL BOYD BOLTS			
HOLD DOWN PKG. 2					
	1+40	DEPLOY CABLE - DISCARD REEL			
ASSIST CABLE HOOK-UP		REPORT AMPS AND CONNECT CABLE			
		TILT PKG #1			
		ALIGN PKG #1 (EYEBALL)			
RELEASE HFE BOYD BOLTS		RELEASE HFE BOYD BOLTS		HFE DEPLOY	HFE DEPLOY
LIFT HFE FROM C/S					
		AID HFE REMOVAL WITH UHT HANDLE			
CARRY HFE TO DEPLOY SITE (30FT S-E OF C/S)					
70 MM CAM IN HTC ALIGN HFE ELECT. BOX DETACH PROBE BOX AND SPLIT LEAN 1/2 BOX ON HF ELECT.					
DEPLOY HFE PROBE CABLE	1+50	DEPLOY PSE			

CDR



LMP

DRILL

DATE: 3/12/70

DEPLOY HFE CABLES & LOCATE HOLES
(LEAVE PROBES IN BOXES)

1+55 <u>DRILL ASSEMBLY</u>

<u>BORE HOLE DRILLING</u>

TO RELEASE STEM - 1/4 TURN CCW
CW BACK, BLIP DOWN, BLIP UP

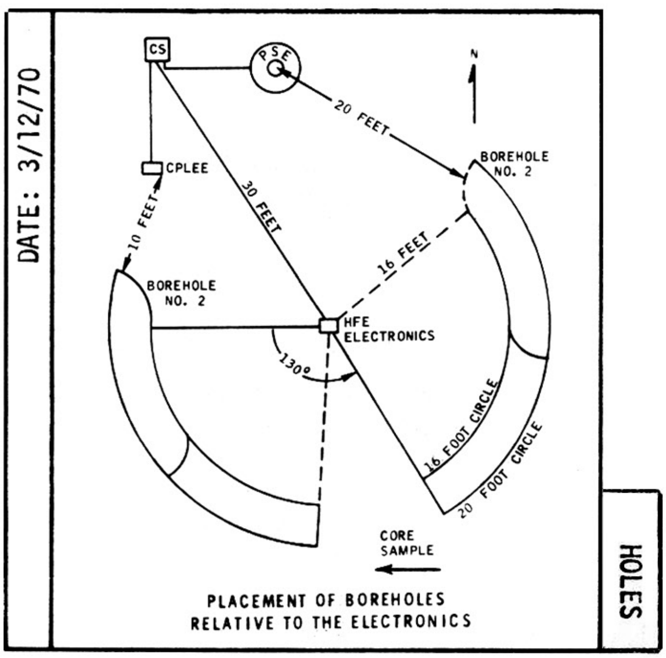
<u>HFE DEPLOY</u>

REPORT RAMMER MARKS (INNER/OUTER)
PROBE, HOLE SHIELD, TOP SHIELD
VERIFY ELECT ALIGN
[PHOTO ALSEP

<u>CORE SAMPLE</u>

CCW TO LOCK TREADLE. BREAK JOINTS-
WRENCH CCW ABOVE JOINT, CW BELOW,
THEN RAISE STRING. CAP TOP & BIT
- WIPE STEMS
REPORT CAPS & STEM ORDER
START AT TOP & WORK DOWN TO BIT
ADVISE HOUS - THROW DRILL
ALL DRILL DEBRIS >8 FT. SE
STRIP GLOVES

RAMMER DOWN CORE HOLE



MISSION: APOLLO 13, H-2 DATE: 16 MARCH, 1970
EVA: 1

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
DEPLOY HFE PROBE CABLE	50	DEPLOY PSE		DEPLOY HFE PROBE	PSE DEPLOY
LOCATE 1st BORE HOLE (2X DIA NEAREST CRATER)		REMOVE PSE STOOL (PKG 2) IMPLACE PSE STOOL (10 FT EAST OF PKG 1 - SCOOP HOLE WITH UHT AS REQUIRED)			
REPOSITION HTC AND DRILL (IF REQUIRED)		REMOVE SUBPALLET (PKG 2)			
		RELEASE PSE BOYD BOLTS REMOVE PSE - PULL OFF BOLTS - CARRY TO PSE STOOL			
PLACE DRILL ON HTC					
ASSEMBLE DRILL PUSH SWITCH TO TEST		REMOVE GIRDLE - PLACE PSE ON STOOL		ASSEMBLE DRILL	
PULL PIN 1 PULL PIN 2		DEPLOY THERMAL SKIRT			
TURN LOCK 3-CCW REMOVE TURN LOCK 4-CCW-REMOVE & PULL LANYARD		LEVEL PSE			
PUSH RACK LEG FROM CLIP-EXTEND & LOCK LEGS & BRACE		REPORT LEVEL & ALIGNMENT			
REMOVE AND INSTALL DRILL HANDLE TO POWER HEAD		EMU CHECK			
REMOVE RACK-EXTEND 3rd LEG & PLACE RACK ON SURFACE	2+00	RELEASE CCGE BOYD BOLTS & REMOVE CCGE (PKG 1)			CCGE DEPLOY
PULL PIN 5-SWING COLLAR UP		PULL PIN ON REEL			
RESET CHUCK-REMOVE DRILL CHECKLIST REMOVE DRILL REMOVE COVER FROM STEM RACK & RELEASE VELCRO STRAP		PLACE CCGE ON LUNAR SURFACE (60 FT SOUTH/WEST CENTRAL STATION)			
ASSEMBLE ONE STEM SET (WITH BIT) & INSTALL IN CHUCK		CHECK LEVEL & ALIGN (UHT IS GNOMON)			
ASSEMBLE 2nd STEM SET-PLACE IN RACK BIT DOWN					
BORE HOLE DRILLING		RELEASE CPLE BOYD BOLTS & REMOVE CPLE (PKG 1)		DRILL BORE HOLE	CPLE DEPLOY
INSERT DRILL BIT INTO SURFACE		PULL PIN AND ROTATE CPLE (180°) WHILE HOLDING UHT			
REMOVE THERMAL SHROUD		EMPLACE CPLE (10 FT SOUTH)			
PUSH INWARD ON BOTH HANDLE SECTION & DRILL TO HEIGHT OF 28 TO 30 INCHES		LEVEL AND ALIGN CPLE (USE UHT AS GNOMON)			
	2+10	CENTRAL STATION			

CDR

ALSEP

DATE: 3/12/70

REMOVE CCGE & PULL PIN ON
REEL. DEPLOY 60 FT. SW.
PUTTER IS GNOM
DEPLOY C PLE (PULL PIN) TAMP
DIRT, PUTTER IS GNOM

2+10 GNOM & BUBBLE ALIGN PKG 1
FREE ANT. CABLE
RELEASE ALL SUNSHIELD BOLTS
(INNER LAST)
✓CORNERS & DEPLOY SUNSHIELD
(WATCH ANT. AIM BOX)
MAST IN SOCKET & ASSEMBLE ANT.

ALIGN ANT: LEVEL, SHADOW,
AZ 16.13 ELEV 6.40
✓ALIGN
PICK UP BOLTS & WEIGHT
PSE SKIRT (IF REQUIRED)

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 1

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	2+10	CENTRAL STATION DEPLOY ANTENNA CABLE		DRILL 1st BORE HOLE	DEPLOY CENTRAL STATION
		START FRONT CENTER AND RELEASE BOYD BOLTS			
RELEASE STEM-1/4 TURN-CCW -CW BACK, BLIP DOWN, BLIP UP					
RESET ADAPTER - INSTALL NEW STEM TO IMPLANTED STEM - FIT POWER HEAD ADAPTER TO STEM					
		RELEASE TWO INNER BOYD BOLTS RELEASE CENTER BOYD BOLT & RAISE SUNSHIELD			
REPEAT DRILLING UNTIL 6 STEMS ARE IMPLANTED IN LUNAR SURFACE					
		REMOVE CURTAIN COVERS &DISCARD			
		CHECK CURTAINS PROPERLY DEPLOYED & VELCROED TO PALLET			
RETRIEVE HALF BOX FROM HFE ELECTRONICS		RETRIEVE & INSTALL ANTENNA MAST			INSTALL AND ALIGN ALSEP ANTENNA
DEPLOY HFE PROBE CABLE		RELEASE AIMING MECHANIXM BOYD BOLTS & REMOVE			
	2+20			LOCATE - DRILL 2nd BORE HOLE	
LOCATE 2nd BORE HOLE		INSTALL GIMBAL ON MAST REMOVE HOUSING & DISCARD			
RETRIEVE DRILL & RACK		INSTALL ANTENNA CHECK C/S ALIGNMENT			
DRILL 2nd BORE HOLE AS PER FIRST BORE HOLE PROCEDURES		LEVEL ANTENNA			
		ALIGN ANTENNA			
		ENTER ANTENNA AZIMUTH 16.13 ENTER ANTENNA ELEVATION 6.40			
		CHECK ANTENNA LEVEL & ALIGN			
		CHECK EMU			
	2+30	WEIGH PSE SKIRT IF REQ'D WITH BOYD BOLTS			

(IF HFE NOT DEPLOYED)

DEPLOY HFE

REPORT RAMMER MARKS (INNER/OUTER)
PROBE & HOLE SHIELD

EMPLACE HOLE COVER

2+35 ACTIVATE CEN STA [HFE DEPLOYED

(WATCH AMPS) PRESS
BUTTON

TURN SW 1 (GND MARK)

PHOTO LAYOUT ——→ [CORE DRILL

ALL 1/250TH

GET MOVIE CAMERA

FILM LMP DRILLING

CORE SAMPLE REMOVAL [CORE REMOVAL

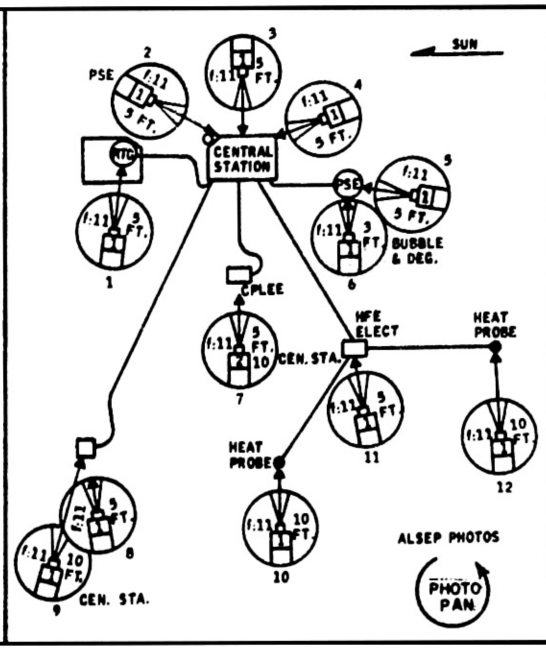
REPORT CAPS & STEM ORDER
START AT TOP & WORK DOWN TO BIT
WIPE STEMS
ALL DRILL DEBRIS > 8 FT SE
STRIP GLOVES

3+05 EMU ✔

PHOTOS

DATE: 3/12/70

DATE: 3/12/70



PHOTOS

MISSION: APOLLO 13, H-2 DATE: 16 MARCH, 1970

EVA: 1

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ. CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	2+30			DRILL BORE HOLE	ACT. CEN. STAT.
		ACTIVATE CENTRAL STATION REPORT SHORT SW AMPS DEPRESS SHORTING SW CHECK AMPS ZERO			
NOTE: IF CDR IS AHEAD OF TIMELINE-CDR DOES HFE PROBE DEPLOY		NOTE: IF CDR IS AHEAD OF TIME LINE - CDR DOES HFE PROBE DEPLOY			HFE PROBE
HFE PROBE DEPLOY REMOVE PROBE FROM BOX INSERT PROBE INTO BORE HOLE REMOVE EMPLACEMENT TOOL FROM BOX & EXTEND-CHECK LOCKED				HFE PROBE INSTALLATION	
ENGAGE CABLE WITH EMPLACEMENT TOOL (ABOVE INTERNAL THERMAL SHIELD)		PHOTOGRAPH ALSEP DEPLOYMENT NOTE: 12 PHOTOS AND PHOTO PAN			PHOTO ALSEP DEPLOYED
INSERT IMPLACEMENT TOOL INTO BORE HOLE AND REPORT MARKS					
REMOVE EMPLACEMENT TOOL & PLACE TOP SHIELD OVER BOREHOLE					
TAKE EMPLACEMENT TOOL TO 1st BORE HOLE AND IMPLACE PROBE AS ABOVE	2+40				
		GET SEQUENCE CAMERA			
CORE SAMPLE RETRIEVE DRILL & WRENCH FROM RACK-PLACE WRENCH IN HTC				SET UP FOR CORE DRILLING	
RELOCATE DRILL AND HTC TO CORING SITE (100 FT WEST)		ALSEP FINAL CHECK NOTE: ASTRO SW 1 TURNON ON GND. REQUEST			
REMOVE ADAPTER CHUCK FROM DRILL (ROTATE ADAPTER-CCW) PLACE TREADLE ON SURFACE					PHOTO LMP
COUPLE BIT STEM AND CORE STEM					
THREAD STEMS TO DRILL		FILM & PHOTO LMP			
LIFT DRILL AND PLACE CORE BIT INTO TREADLE					
ENERGIZE DRILL (TO LOWER LIMIT)	2+50				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 1

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
REMOVE DRILL FROM STEM (CCW)	2+50				
NOTE: ADD CORE STEMS AND CONTINUE DRILLING UNTIL ALL 6 STEMS ARE IMPLANTED					
LIFT DRILL BLIP IF REQ'D		ASSIST LMP WITH CORE STEM REMOVAL			
REMOVE DRILL FROM STEM (CCW)		ENGAGE STEM WITH WRENCH			
CAP STRING TOP REPORT CAP LETTER					
ROTATE STEM CW AND MOVE STRING UP FROM LUNAR SURFACE USING WRENCH - BREAK JOINTS		AT EACH JOINT, ENGAGE WRENCH BELOW JOINT CCW TO LOCK TREADLE, ABOVE CCW TO BREAK JOINT, BELOW CW TO RELEASE TREADLE		CORE STEM RETRIEVAL	CORE STEM RETRIEVAL
CAP BIT-REPORT CAP LETTER					
USE BOTH WRENCHES IF REQ'D TO UNCOUPLE STEMS FROM TOP DOWN-REPORT CAP LETTERS WIPE STEMS		CAP CORE STEM AND REPORT CAP LETTERS & ORDER (TO TOP TO BOTTOM)			
	3+00				
PUT EMPLACEMENT TOOL DOWN CORE HOLE & REPORT					
RELOCATE DRILL DEBRIS 8 FT AWAY FROM HFE					
PLAN TRAVERSE		PLAN TRAVERSE (USE MAP IN HTC)		TRAVERSE PREP	TRAVERSE PREP
BEGIN TRAVERSE	3+10	BEGIN TRAVERSE			

CREW EVA CUFF CHECKLIST

CDR

RETURN

DATE: 3/12/70

3+10 RETURN TRAVERSE

COLLECT SELECTED SAMPLES -
PHOTO STEREO OR CROSS SUN
BEFORE & 1 SHOT AFTER

ROCKS - 75%

FINES - 25% (OR 10 LBS.)

3+20 OR END TRAV. CAP LENS & REPOINT TV AT MESA

UNCAP TV LENS — SRC 2 & CSC OFFLOAD

LOAD IN ETB:

MAP
CAMERAS
LENS

OFFLOAD SAMPLES FROM
TOTE BAGS INTO WEIGH BAGS

STOW WEIGH BAG IN SRC 1

MESA WEIGH BAG ON SCALE

FILL BAG WITH SAMPLES, SOIL, ROCKS
& STOW (USE SIEVE)

STOW CORE STEMS

REMOVE SRC SEAL

LMP

RETURN

DATE: 3/12/70

3+05 EMU ✓

3+10 RETURN TRAVERSE

TAKE MOVIE CAMERA

COLLECT SELECTED SAMPLES

PHOTO DOWN SUN BEFORE

LANDMARK SHOT X SUN -
(BEFORE OR AFTER)

ROCKS - 75%

FINES - 25% (OR 10 LBS.)

DATE: 3/12/70

3+20 OR END TRAV. SRC 1 PACK

PLACE HTC AT MESA

OFFLOAD SAMPLES FROM TOTE BAGS

PLACE RETURN ITEMS CDR TOTE

CLOSE CDR TOTE -
PLACE ON FOOTPAD
✓ MAGS IN POUCH

REMOVE SRC 2 - PLACE ON +Y FOOTPAD
SHADY SIDE, LID DOWN SUN

PLACE S-BAND ANT COVER SRC 2

3+30 LOAD ETB OR CHECK:

MAP

HAND LENS

CAMERAS

DEPLOY SOLAR WIND (+Y 60 FT.)

(UNLESS DONE)

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 1

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
BEGIN TRAVERSE	3+10	BEGIN TRAVERSE		RETURN TO LM TRAVERSE	RETURN TO LM TRAVERSE
		(NOTE: AS SOON AS EMU EXPED UPDATE RECEIVED)			
COLLECT SELECTED SAMPLES REPORT BAG NUMBERS (IF 35 BAG DISPEN. USED)		COLLECT SELECTED SAMPLES			
DESCRIBE SAMPLE		PHOTO SAMPLE AREAS CROSS SUN (STEREO PR BEFORE AND 1 SHOT AFTER)			
PHOTO DOWN SUN AND LOCALIZATION SHOT					
		REPOSITION TV +Y/50FT TO VIEW MESA - GND GIVES SETTINGS			
SRC 1 PACK PLACE HTC AT MESA TAKE CDR TOTE BAG AND HOLD FOR OFFLOAD	3+20	SRC 1 PACK		STOW ETB	LOAD AND SEAL SRC
		OFFLOAD TOTE BAG TRANSFER CONTENTS TO WEIGH BAG ON SCALE			
STOW CAMERAS MAGS & LENS IN ETB		STOW CDR TOTE BAG ON FOOTPAD			
OFFLOAD SRC 2 PLACE ON +Y FOOTPAD LID DOWN SUN		TAKE LMP TOTE BAG & OFF LOAD SELECTED SAMPLES INTO WEIGH BAG (USE 2nd WEIGH BAG AS REQUIRED)		SRC 2 OFFLOAD	
RETRIEVE S-BAND COVER & PLACE OVER SRC 2		HANG LMP TOTE BAG ON MESA			
		SEAL & STOW WEIGH BAGS IN SRC			
PLACE RESIDUAL SAMPLES IN CDR TOTE BAG					
		STOW CORE STEMS IN SRC			
	3+30 -30	REMOVE SRC SEAL PROTECTOR			

CREW EVA CUFF CHECKLIST

CDR

DATE: 3/12/70

3+35	<u>CLOSE SRC 1</u>	
	RETURN ITEMS & SAMPLES IN CDR TOTE BAG	
	HANG LMP TOTE BAG ON MESA	
3+40	CLEAN EMU'S	[INGRESS
	<u>LEC TRANSFERS</u>	
	TRANSFER ETB	[ETB, TOTE BAG & SRC STOW
	TRANSFER CDR TOTE BAG	
	TRANSFER SRC 1	
	TONGS IN HTC	
	HTC IN SUN	
3+52	<u>EVA TERMINATION</u>	
	CLEAN EMU	
	ATTACH LEC TO PORCH	[LEC TO CDR
	INGRESS	
	RAISE EV VISOR	
4+00	<u>REPRESS</u>	

LMP

DATE: 3/12/70

	<u>EVA TERMINATION</u>	
	CLEAN EMU	[TRANSFER PREP
	TONGS IN HTC	
3+40	INGRESS	
	RAISE EV VISOR	
	LEC PREP	
	<u>LEC TRANSFERS</u>	
	STOW ETB & TOTE BAG	
	STOW SRC 1	
		[ASCENT
	HAND OUT LEC TO CDR	
3+52		[INGRESS
4+00	REPRESS	

MISSION: APOLLO 13, H-2 DATE: 16 MARCH, 1970
EVA: 1

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
CHECK ETB LOAD	3+30 -30	REMOVE SRC SEAL PROTECTOR		DEPLOY SOLAR WIND	PACK AND SEAL SRC
		PACK AND SEAL SRC			
REMOVE SOLAR WIND(IF NOT DONE EARLY) CARRY TO DEPLOYMENT SITE EXTEND STAFF & DEPLOY FOIL IMPLANT STAFF IN SURFACE		RETURN ITEMS IN CDR TOTE BAG			
ASSIST CDR					
		FILL BAG WITH ROCKS AROUND LM IF SHORT			ETB PACKING
		PULL DRAW STRING TO CLOSE BAG AND VELCRO FLAP TOTE BAG ON FOOTPAD			
TONGS IN HTC				INGRESS	
REMOVE DUST BRUSH (MESA) & ASSEMBLE		CHECK CONTENTS OF ETB & CLOSE			
CLEAN CDR EMU	3+40 -20				
		CLEAN LMP EMU			
ASCEND TO PLATFORM					
INGRESS		GUIDE LMP INGRESS			
RAISE EV VISOR HOOK UP LEC					
CHECK EMU & LM SYSTEMS				ETB TRANSFER	ETB TRANSFER
PULL ETB INTO LM		ETB TRANSFER			
REMOVE ETB FROM LEC					
STOW ETB		TRANSFER HOOKS TO SURFACE LEC HOOK-UP TO TOTE BAG			
	3+50 -10				

MISSION: APOLLO 13, H-2

EVA: 1

DATE: 16 MARCH, 1970

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
PULL TOTE BAG INTO LM STOW TOTE BAG	3+50 -10	TRANSFER TOTE BAG TO LM		LM CABIN ACTIVITY	SRC TRANSFER
		TRANSFER LEC HOOK TO SURFACE			
		ATTACH LEC TO SRC			
PULL SRC INTO LM REMOVE SRC FROM LEC		TRANSFER SRC INTO LM RECONFIGURE TV PLACE TONGS IN HTC & HTC IN SUN			
STOW SRC ON ENG COVER END UP		RECLEAN EMU - BRUSH ON MESA			INGRESS
PASS LEC TO CDR		ASCEND TO PLATFORM			
		STOW LEC ON PLATFORM (HANG UP ON PLAT-RAIL)			
CLOSE HATCH		INGRESS RAISE EV VISOR REPRESSURIZE CABIN			
	4+00 -0	END 1ST EVA			

3.2.2 EVA 2

The detailed timeline procedures for EVA 2 are shown on the following format sheets.

The crew EVA cuff checklist pages which correspond approximately to the timeline increment are shown on the lefthand facing sheets.

DISTANCE ESTIMATION

IF LM TOP TO PAD:

WIDE AS EARTH - 620 FT.

ECLIPSED BY THUMB - 350 FT.
(ARM'S LENGTH)

IF LM CLUSTER TO CLUSTER:

WIDE AS EARTH - 350 FT.

ECLIPSED BY THUMB - 200 FT.
(ARM'S LENGTH)

IF ASCENT STAGE - TOP TO INTERFACE:

WIDE AS EARTH - 280 FT.

ECLIPSED BY THUMB - 160 FT.
(ARM'S LENGTH)

DIST

3/12/70

MAP

MISSION: APOLLO 13, H-2
EVA: 2

DATE: 16 MARCH 1970

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+00	DEPRESS CABIN FROM 3.5psi			
		NOTE: DETAILED PROCEDURES ARE PRESENTED IN "LUNAR SURFACE CHECKLIST" "EQUIPMENT PREP EVA 2" SECTION			
		OPEN HATCH			
	0+10	MOVE THRU HATCH			

CREW EVA CUFF CHECKLIST

CDR

DATE: 3/12/70

EGRESS

CDR - EVA 2

0+10 CDR EGRESS
JETTISON BAGS
HAND LEC TO LMP
DESCEND
ETB TRANSFER DOWN

PUT 70 MM CAMERA ON RCU

0+20 GET SRC 2 [LMP EGRESS

PLACE ON TABLE & OPEN

BRING HAND TOOL CARRIER
TO MESA

LMP

DATE: 3/12/70

EGRESS

LMP - EVA 2

ETB CONTENTS
2 CAMERAS, 3 MAGS (B&W)
1 MOVIE CAMERA, 3 MAGS
POLARIZING FILTER
MAP
JETTISON BAGS TO CDR
HOOK UP LEC
0+15 ETB TRANSFER DOWN

0+20 EGRESS
- CLOSE HATCH
- DESCEND

- PUT 70 MM CAMERA ON RCU

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES
	0+10	CDR EGRESS
		MOVE THRU HATCH
PASS JETTISON BAG & LHSSC TO CDR		JETTISON BAG & LHSSC
HOCK-UP LEC		HAND LEC TO LMP
CHECK ETB CONTENTS-2 70 MM CAM, 1 SEQ CAM, 2 70 MM MAG, 2 16 MM MAG, MAP FILTER		DEPLOY LEC DESCEND TO LUNAR SURFACE
ATTACH ETB TO LEC		
ETB TRANSFER		ETB TRANSFER - DOWN
STOW LEC		
VERIFY CB CONFIGURATION AND VOX SENSITIVITY		STOW ETB ON MESA
		PUT 70MM CAM ON RCU
EGRESS MOVE THRU HATCH	0+20	GET SRC 2 FROM FOOTPAD
PULL HATCH TO		PLACE SRC 2 ON MESA TABLE
DESCEND TO SURFACE		RETRIEVE HAND TOOL CARRIER & PLACE AT MESA
PUT 70MM CAM ON RCU		OFF LOAD SRC 2 WEIGH BAGS IN LID PLACE IN HTC: CORE CAPS 35 BAG DISPENSER CORE TUBES
RETRIEVE CSC - DEPLOY SKIRT TAKE NEAR LM PHOTOS TO CHECK CAMERA		
STOW TOOLS IN HTC		CLOSE ORGANIC SAMPLE PLACE IN SRC
ATTACH TOTE BAG TO CDR & PLACE 70MM MAG AND 2 16MM MAGS IN POUCH		STOW TOOLS IN HTC ATTACH TOTE BAG TO LMP & PLACE SAFETY LINE,FILTER, GAS ANALYSIS, SPEC ENVIRON., & MAGNETIC SAMPLE CONTAINERS IN BAG POUCH
TONGS ON YO-YO		
16MM CAM & MAP IN HTC		TONGS ON YO YO
SIEVE SAMPLE	0+30	SIEVE SAMPLE

SEQ CAM

TASK FUNCTION

LMP	CDR
ETB TRANSFER	EGRESS
LM CHECK	ETB TRANSFER
EGRESS	SRC OFFLOAD AND HTC PREP
TRAVERSE PREP	

CREW EVA CUFF CHECKLIST

CDR

SRC

0+25 SRC OFFLOAD
GAS, SPEC ENVIRON, MAG SAMPLES IN LMP TOTE BAG POUCH
CORE CAPS IN CLIP HTC
35 BAG DISPENSER IN HTC
CORE TUBES IN HTC RACK
CLOSE ORG. SAMPLE - BACK IN SRC

ITEMS FOR HTC
FOXHOLE SHOVEL, HAMMER, GNOM, MAP

PUT TOTE BAG ON LMP
SAFETY LINE & FILTER IN POUCH
TONGS ON YOYO [TOTE BAG ON CDR
70 MM CAMERA ON RCU [TOTE BAG ON CDR
ASSEMBLE SMALL SCOOP & EXT HANDLE
GET CSC & HAVE MESA BRUSH NEAR

THERMAL DEGRADATION SAMPLE
SAMPLE 1: CSC 1 SIDE, THEN DIRT ON SAMPLE. CSC BOTH SIDES.
BRUSH OFF SAMPLE, CSC BOTH SIDES

DATE: 3/12/70

DATE: 3/12/70

(HOLDS SAMPLES
SAMPLE 2: DIRT ON SAMPLE, CSC BOTH SIDES
SMALL SCOOP EXT HANDLE IN HTC

SIEVE SAMPLE 5 MINUTES
SELECT & PHOTO TYPICAL AREA
COLLECT INTO EXTRA WEIGH BAG
SEAL BAG & STOW IN ETB

CONTAMINATED SAMPLE (UNDER QUAD 3)
TAKE X SUN STEREO BEFORE
COLLECT FINES & DOUBLE BAG
TAKE X SUN PHOTO & STOW IN ETB

COLOR CHART (LMP HOLDS)
PLACE GNOMON NEAR ROCK
POSITION CHART DOWN SUN 5 FT.
TAKE 4 PHOTOS: f:5.6, 8, 11, 16
TAKE 1 PHOTO f:11 45° AZIMUTH
HOLD CHART FOR LMP
TAKE CSC CAMERA & START TRAVERSE

LMP

0+25 GET CSC CAMERA
DEPLOY SKIRT
TAKE LM VICINITY CSC PHOTOS
0+27 PUT TOTE BAG ON CDR
RIG LENS BRUSH ON HTC
TONGS ON YO YO
SAFETY & FILTER IN LMP TOTE
0+30 MOVIE CAMERA IN HTC

THERMAL DEGRADATION SAMPLE
SAMPLE 1: BAG IN CDR TOTE
UNBAG & UNFOLD - HOLD OUT
SHAKE WHEN DIRTY - HOLD OUT
HOLD WHEN BRUSHED & CSC [CSC & BRUSH
REFOLD & REBAG
SAMPLE 2: UNBAG & UNFOLD
SHAKE WHEN DIRTY - HOLD OUT
REFOLD & REBAG [CSC
BAG IN ETB

DATE: 3/12/70

DATE: 3/12/70

SPARE MAGS IN CDR TOTE
SIEVE SAMPLE 5 MINUTES
SELECT & PHOTO TYPICAL AREA
COLLECT INTO EXTRA WEIGH BAG
SEAL BAG & STOW IN ETB

CONTAMINATED SAMPLE (QUAD 3)
TAKE DOWN SUN BEFORE
HOLD BAG FOR CDR & DOUBLE BAG
STOW IN ETB (CDR MAY DO)

COLOR CHART
GET FROM HTC & HOLD FOR CDR
GIVE TO CDR & CHANGE PLACES
POSITION CHART DOWN SUN 5 FT.
TAKE 4 PHOTOS: f:5.6, 8, 11, 16
TAKE 1 PHOTO f:11 45° AZIMUTH
GET CHART & STOW IN HTC

PICK UP HTC & START TRAVERSE

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
SIEVE SAMPLE ASSEMBLE SIEVE/SCOOP TO XT HANDLE TAKE WEIGH BAG HOLD BAG FOR CDR	0+30	SIEVE SAMPLE PHOTO AREA SIEVE SAMPLE - REPORT NO. SCOOP FULLS DEPOSIT RESIDUE IN WEIGH BAG PROCEDURE - SIEVE OPEN SCOOP CLOSE SIEVE SHAKE OPEN SIEVE DUMP INTO BAG SCOOP ETC.		SIEVE SAMPLE	SIEVE SAMPLE
SEAL & STOW BAG IN ETB; SIEVE/SCOOP ON MESA PLACE GNOMON & HOLD OUT PHOTOMETRIC CHART SHOOT PHOTOMETER CHART DWN SUN TAKE 4 PHOTOS AT 5 FT NORMAL TO CHART (F: 5.6,8,11,16) 1 PHOTO F:11 AT 45° AZIMUTH		SHOOT PHOTOMETRIC CHART DWN SUN TAKE 4 PHOTOS AT 5 FT NORMAL TO CHART (F: 5.6,8,11,16) 1 PHOTO F:11 AT 45° AZIMUTH RETRIEVE CHART HOLD FOR LMP		PHOTOMETRIC CHART	PHOTOMETRIC CHART
STOW CHART IN HTC PHOTO DWN SUN PREPARE BAG & REPORT NO. DOUBLE BAG SAMPLE PLACE IN ETB PICK UP HTC	0+40	GIVE CHART TO LMP ASSEMBLE SCOOP/XT HANDLE CONTAMINATED SAMPLE (UNDER QUAD 3) GNOMON PHOTO STEREO PR X SUN COLLECT SAMPLE GNOMON ON HTC RETAIN SCOOP/XT HANDLE PICK UP CSC		CONTAM SAMPLE	CONTAM SAMPLE
START TRAVERSE		START TRAVERSE		START TRAVERSE	START TRAVERSE
	0+50				

NOTE: REPORT -
ALL MOVEMENTS INCLUDING
DIRECTION BETWEEN SAMPLES
LOCATION WRT LM
ALL PHOTOS
SAMPLE BAG NUMBERS
OBSTRUCTION WRT LM - CDR TRY
COMM NO LOS TO LM

BOTH

TRAVERSE REQMNTS

DATE: 3/12/70

TRAVERSE
REPORT:
ALL MOVEMENTS INCLUDING DIRECTIONS BETWEEN SAMPLES
LOCATION WRT LM
PHOTOS OTHER THAN NOMINAL
SAMPLE BAG NUMBERS
OBSTRUCTIONS WRT LM- GET BEHIND & TRY COMM (CDR) LMP PHOTO OBSTRUCTION, CDR, LM

PHOTOS
PAN AT EACH LEG, SITE, DIRECTION CHANGE--MAP SHOWS NOMINAL
CSC CAMERA PICTURES-PIGGY BACK ON DOC. SAMP. AS REQUIRED
REPORT ORIENT & FRAME NO.

CRATER DOCUMENTATION
SERIES OF SAMPLES RADIALLY FROM CENTER

DATE: 3/12/70

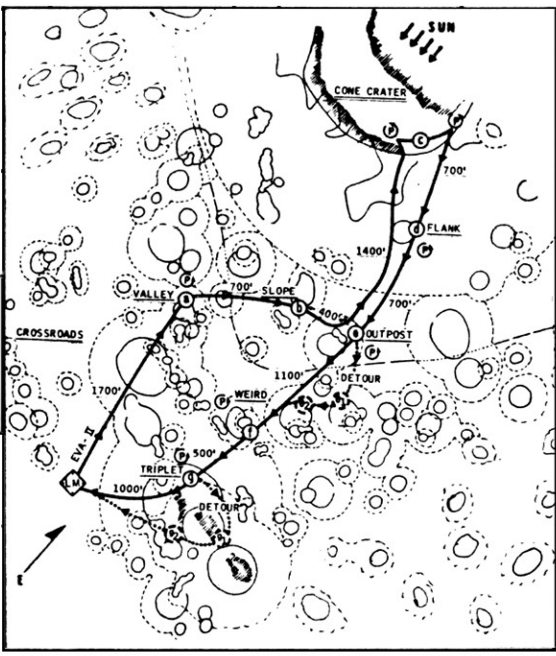
CORE SAMPLES (SINGLE & DOUBLE)
TAKE ON SURFACE ONLY(SEE MAP)
BEFORE: REPORT S/N TUBE(S)
DRIVE TUBE(S) & PHOTO X SUN 15 FT
AFTER: PHOTO X SUN STEREO 5 FT

TRENCHES
PHOTO SITE X SUN, DOWN SUN
DIG DOWN SUN OFF 10° f:5.6,1/125
DOCUMENTED SAMPLES BOTTOM-TOP
FILL, BOTTOM, TOP, SIDES,DISCONS
CSC CAMERA PHOTOS BOTTOM
RESET 70 MM CAMERA 1/250

COLLECT 1 LARGE ROCK- FOOTBALL
USE COLOR CHART
COLLECT FILLET MAT'L & ROCK
DOCUMENT & USE CSC CAMERA
SAMPLE ROCK TRAIL
FINES IN & BESIDE-CHIP FROM ROCK
USE CSC CAMERA
SAMPLE CRATER RIM CRESTS

BOTH

MAP



DATE: 3/12/70

DATE: 3/12/70

VALLEY:	DOC. SAMP, PAN SURF CHARACT.	[7 MIN.
SLOPE:	DOC. SAMP, CORE PATTERNED GND COMPARE WITH VALLEY	[10 MIN.
CONE:	2 PANS RIM 300 FT. BASE POLARIZED PIX ROLL BOULDER -24 fps MOVIE BOULDER TRACKS & RADIAL VARIATIONS, TRY COMM.	[30 MIN.
FLANK:	DOC. SAMP & PAN COMPARE ROCKS W/CONE	[7 MIN.
OUTPOST:	DO CUFF CK LIST	[30 MIN.
WEIRD:	DOUBLE CORE MULT. EJECTA DOC. SAMP SUPERIMPOSED ORIGIN ELONG. CRATER	[15 MIN.
TRIPLET:	DOC. SAMP, PAN PATTERNED GND	[7 MIN.

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES
	0+50	
		<u>TYPICAL DOCUMENTED SAMPLE COLLECTION</u>
PLACE ALHTC		PLACE GNOMON IN VICINITY OF SAMPLE
TAKE 15 FT PHOTO OF SAMPLE & HORIZON (CAN BE DONE AFTER SAMPLE) CROSS SUN		TAKE STEREO PAIR (CROSS SUN)5 FT *
PHOTO SAMPLE (DOWNSUN) 5 FT		
DEPLOY BAG IN DISPENSER (IF REQUIRED)		COLLECT SAMPLE & DESCRIBE
DESCRIBE SAMPLE		PLACE SAMPLE IN BAG
SEAL BAG & REPORT NUMBER		PHOTO SITE (CROSS SUN)
STOW SAMPLE		COMMENCE SEARCH NEXT SAMPLE
	1+00	
		*USE CSC CAMERA HERE WHERE REQUIRED REPORT ORIENTATION FRAME NO.
PICKUP HTC & CONTINUE TRAVERSE		PICKUP GNOMON & CSC CAM AND CONTINUE TRAVERSE
	1+10	

SEQ CAM

TASK FUNCTION

LMP: TYPICAL DOCUMENTED SAMPLE COLLECTION

CDR: TYPICAL DOCUMENTED SAMPLE COLLECTION

Blank Page

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	1+10				CSC CAMERA PHOTOS
		CHECK COMM PERFORMANCE			
SHOOT 15 FT (74 FT FOCUS) HORIZON/LANDMARK PHOTO OF CSC TO DOCUMENT POSITION		TAKE CSC CAM PHOTOS AT TARGETS OF OPPORTUNITY			
		<u>TYPICAL CORE TUBE SAMPLE COLLECTION</u>		TYPICAL CORE TUBE SAMPLE	TYPICAL CORE TUBE SAMPLE
	1+20				
PLACE ALHTC		PLACE GNOMON UP SUN			
ASSEMBLE CORE TUBE/HANDLE REPORT NUMBER & HOLD UPRIGHT ON SURFACE		REMOVE HAMMER FROM HTC DRIVE TUBE INTO SURFACE			
PHOTO TUBE & HORIZON CROSS SUN @ 15 FT (CDR MAY DO)		STOW HAMMER			
REMOVE CORE TUBE & CAP REMOVE HANDLE & STOW STOW SAMPLE IN HTC		PHOTO TUBE & HORIZON CROSS SUN @ 15 FT (LMP MAY DO) PHOTO SITE CROSS SUN (STEREO PAIR) 5 FT			
	1+30				

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
	1+30				
	TYPICAL TRENCH PROCEDURE				
PHOTO SITE DOWN SUN READY SEQ CAM & FILM		PLACE GNOMON UP SUN PHOTO SITE CROSS SUN ASSEMBLE SHOVEL & DIG 10° OFF DOWN SUN		TYPICAL TRENCH PROCEDURE	TYPICAL TRENCH PROCEDURE
	NOTE: ALL PHOTOS 70MM CAM AT F:5.6 1/125 AFTER TRENCH DUG				
	1+40	FINISH DIGGING			
STAND DOWN SUN AT EDGE OF TRENCH (ACT AS REFLECTOR) PHOTO UP SUN		PHOTO STEREO PR CROSS SUN BOTH SIDES & DOWN SUN			
	TAKE DOCUMENTED SAMPLES (STND 4) BOTTOM TO TOP FILL, SIDES, DISCONTINUITIES + CSC CAMERA PICTURES OF BOTTOM, OTHER FEATURES				
	1+50				

CREW EVA CUFF CHECKLIST

BOTH

OUTPOST

DATE: 3/25/70

1. COLLECT GAS ANALYSIS SAMPLE (SMALL CAN): SEVERAL CLEAN ROCKS, GLASSES, SPLATTERED ROCKS, VARIETY DESIRED, DOCUMENT COLLECTION AS USUAL
2. COLLECT MAGNETIC SAMPLE (TEFLON CAN) 2-3 ROCKS MICROBRECCIA & CRYSTALLINE DOCUMENT COLLECT AS USUAL
3. DIG DEEP TRENCH (SOIL MECH.)
   DOCUMENT BEFORE. THEN f:5.6, 1/125
   DIG 2 FT. DEEP 10° OFF DWN SUN
   DOCUMENT BEFORE SAMPLING:
   LMP STAND DWN SUN EDGE TRENCH
   CDR STEREO PR CROSS SUN BOTH SIDES, THEN 1 SHOT DWN SUN
   LMP 1 SHOT UP SUN

DATE: 3/12/70

COMMENT ON SOIL PHYSICAL, MECH PROPS

TAKE ICAMERAMPLES BOTTOM TO TOP, SIDES, DISCONS, FILL. CSC CAMERA IN BOTTOM, SIDES

DOCUMENT BOOT PRINT IN FILL

4. COLLECT SPEC. ENVIRON SAMPLE (LARGE CAN): FINE-BOTTOM DEEP TRENCH - DOCUMENT COLLECTION
5. (LMP) a. USE CSC CAMERA
   b. RADIAL FINE SAMPLES SW OUTPOST CRATER - 3 @ 10 FT. INTERVALS - PHOTO AFTER
6. (CDR) GO BEHIND ROCK OR INTO CRATER TO TEST COMM.
7. USE COLOR CHART WITH LARGE ROCKS, COLOR CONTRASTS

OUTPOST

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	1+50				
	2+00			OUTPOST	OUTPOST
GAS ANALYSIS SAMPLE COLLECTION				GAS ANALYSIS SAMPLE	GAS ANALYSIS SAMPLE
		PLACE GNOMON UP SUN			
PLACE ALHTC PHOTO SAMPLE DOWN SUN		PHOTO SAMPLE CROSS SUN STEREO PAIR			
RETRIEVE SAMPLE CONTAINER (LMP TOTE BAG POUCH)		COLLECT SAMPLE			
OPEN GASC		PLACE SAMPLE IN GASC			
REMOVE SEAL PROTECTOR CLOSE AND SEAL GASC					
STOW SAMPLE IN TOTE BAG POUCH		PHOTO SITE CROSS SUN			
TAKE LOCALIZING PHOTO (IF REQ'D)					
MAGNETIC SAMPLE COLLECTION				MAGNETIC SAMPLE	MAGNETIC SAMPLE
PROCEED AS ABOVE		PROCEED AS ABOVE			
	2+10				

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	TASK FUNCTION (SEQ CAM / LMP / CDR)
	2+10		
	SOIL MECHANICS		LMP: SOIL MECHANICS - TRENCHING; CDR: SOIL MECHANICS - TRENCHING
PLACE HTC PHOTO SITE DOWN SUN		PLACE GNOMON UP SUN PHOTO SITE CROSS SUN	
ASSEMBLE TRENCHING TOOL RETRIEVE SESC FROM TOTE BAG		DIG TRENCH 10° OFF SUN LINE - 2 FT DEEP	
OPEN SESC			
PHOTO CDR 16MM CAM			
NOTE: FINISHED TRENCH DOCUMENTED AS ON PAGE 57			
REMOVE SEAL PROTECTOR & SEAL SESC		FILL SESC WITH SUB-SURFACE MATERIAL (DOCUMENTED SAMPLE)	
STOW SESC IN TOTE BAG POUCH			
	2+20	PHOTO BOOT PRINT IN FILL	
NOTE: TAKE OTHER DOCUMENTED SAMPLES AS REQUIRED BOTTOM, TOP, SIDES, FILL, DISCONTINUITIES USE CSC CAMERA TO DOCUMENT BOTTOM, OTHER FEATURES			
		POLARIMETRY PHOTOS ~~LOCATE ROCK CLUMP~~	LMP: POLARMETRIC
1 PHOTO DOWN SUN AT 15 FT & 10° PHASE ANGLE			
	2+30	ATTACH POLAR FILTER	

POLAR

POLARIMETRIC AREA SAMPLE

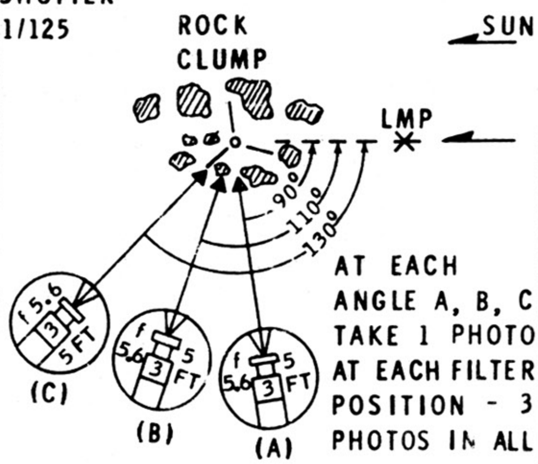
1. LOCATE CLUMP OF ROCKS
2. GNOMON IN CLUMP
3. TELL LMP PHOTO ROCKS DOWN SUN BEFORE & AFTER SAMPLING
4. ATTACH FILTER & RESET CAMERA f5.6,1/125
5. GO TO CROSS SUN 5 FT (A)
6. PERFORM STEPS A, B, C
7. COLLECT DIFFERENT KINDS OF ROCKS IN CLUMP (AT LEAST 4)
8. TAKE FAR SHOTS & DISCARD FILTER
9. RESET CAMERA 1/250

DATE: 3/12/70

DATE: 3/12/70

POLARIMETRIC AREA SAMPLE

SHUTTER
1/125



AT EACH ANGLE A, B, C TAKE 1 PHOTO AT EACH FILTER POSITION - 3 PHOTOS IN ALL

REPORT FILTER POSITION EACH SHOT

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
CSC CAMERA PICTURES UNDISTURBED SURFACE (LEVEL/SLOPE) SURFACE PATTERNS-STRIATIONS ROCK SURFACES - FISSURES, CLEVAGES, BEDDING, CRYSTAL-IZATION, COLOR CONTRASTS	2+30	ATTACH POLAR FILTER 9 PHOTOS 5 FT AT 90°, 110°, 130°, PHASE ANGLE		CSC PHOTOS	POLARIMETRIC PHOTOS
SMALL CRATERS ON ROCKS & SURFACES		FAR POLARIMETRY PHOTOS MOVE TO RIM OF CRATER PHOTO FAR WALL PHOTO (3 FILTER POS) REPEAT ~100 FT AROUND RIM			
WHEN MAG EXHAUSTED: REMOVE CSC CAMERA CASSETTE & STOW IN HTC		REMOVE FILTER & DISCARD TAKE DOCUMENTED SAMPLE OF ROCK IN AREA			
DISCARD CSC CAMERA	2+40				
TAKE SAMPLES ON REST OF TRAVERSE AS APPLICABLE		TAKE SAMPLES ON REST OF TRAVERSE AS APPLICABLE		TRAVERSE	TRAVERSE
TAKE PHOTOS, CSC CAMERA: UNEXPECTED FEATURES (TAKE SAMPLE) GLASSY FEATURES (TAKE SAMPLE) ROCK/SOIL JUNCTION (UP/DWN HILL)					
	2+50				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
	2+50			RETURN TRAVERSE	RETURN TRAVERSE
DISCARD SEQ CAMERA WHEN 3RD FILM PACK IS USED AND STOW FILM IN TOTE BAG POUCH	3+00	DISCARD SEQ CAMERA WHEN 3RD FILM PACK IS USED AND STOW FILM PACK IN TOTE BAG POUCH			
	3+10				

CREW EVA CUFF CHECKLIST

CDR

DATE: 3/12/70

CLOSEOUT

3+20 EVA CLOSEOUT

PLACE WEIGH BAG ON SCALE
TAKE OFF LMP TOTE BAG
BAGGED SAMPLES IN WEIGH BAG
SEAL WEIGH BAG 1 & STOW
[TAKE OFF CDR TOTE BAG]
WEIGH BAG 2 ON SCALE
BAGGED & UNBAGGED SAMPLES IN WEIGH BAG
SEAL WEIGH BAG 2 & STOW
STOW REMAINING SAMPLES IN TOTE BAG
SPECIAL, GAS SAMPLES IN SRC
[SOLAR WIND ROLLED]
MAG SAMPLE IN TOTE BAG

LMP

DATE: 3/12/70

CLOSEOUT

3+20 EVA CLOSEOUT

- ○ REPOSITION TV OFF + Y
  [REMOVE TOTE BAG]
- ○ HOLD TOTE BAG FOR OFFLOAD
- ○ TAKE OFF CDR TOTE BAG & HOLD FOR OFFLOAD
- ○ HAND HTC SAMPLES TO CDR
- ○ CSC CAM MAG IN ETB
- ○ TAKE DOWN SOLAR WIND - BAG & PUT IN ETB
- ○ CAMERA IN ETB
- ○ SPARE MAG IN ETB
- ○ SEQ CAMERA MAGS (3) IN ETB
- ○ MAP IN ETB
- ○ COLLECT EXTRA BAG 50 FT FROM LM
- ○ SEAL & STOW IN ETB OR TOTE BAG

MISSION: APOLLO 13, H-2
EVA: 2

DATE: 16 MARCH 1970

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	3+10			END TRAVERSE	END TRAVERSE
REPORT TRAVERSE COMPLETE					
EVA CLOSEOUT CAMERA IN ETB	(-40) 3+20	EVA CLOSEOUT CAMERA IN ETB		SRC AND ETB PREP	SRC AND ETB PREP
		PLACE WEIGH BAG ON SCALE REMOVE LMP TOTE BAG			
HOLD TOTE BAG FOR OFFLOAD		STOW SAMPLES IN WEIGH BAG			
REMOVE CDR TOTE BAG AND HOLD FOR OFFLOAD					
		SEAL WEIGH BAG 1 & STOW IN SRC			
TAKE DOWN SOLAR WIND - BAG AND STOW SWC IN ETB		PLACE WEIGH BAG 2 ON SCALE			
		STOW SAMPLES IN WEIGH BAG			
		SEAL WEIGH BAG 2 AND STOW IN SRC			
PLACE 16MM MAGS IN ETB PLACE 70MM MAGS IN ETB LOAD CSC CAM MAG IN ETB	3+30	STOW REMAINING SAMPLES IN TOTE BAG INCLUDING MAGNETIC SAMPLE PLACE TOTE BAG ON FOOT PAD			

CDR

CLOSEOUT

DATE; 3/16/70

MAP IN ETB
CORE TUBES IN SRC
REMOVE SRC SEAL [COLLECT
CLOSE & SEAL SRC [EXTRA BAG
COLLECT EXTRA BAG 50 FT. FROM LM
CAMERAS (2) IN ETB
EXTRA MAG IN ETB
SEQ CAMERA MAGS (3) IN ETB

3+40 CSC CAM MAG IN ETB [INGRESS
✓ETB LIST (FLAP) &
PREP FOR TRANSFER
TRANSFER ETB & TOTE [ETB &
TRANSFER SRC 2 [SRC STOW
EVA TERMINATION
CLEAN EMU - TAKE OFF TONGS
JETTISON LEC
3+52 INGRESS [LEC TO CDR
4+00 REPRESS

LMP

CLOSEOUT

DATE: 3/16/70

TAKE OFF TONGS

3+40 EVA TERMINATION
CLEAN EMU [TRANS
INGRESS [PREP
HOOKUP LEC

3+47 LEC TRANSFERS
STOW ETB STOW TOTE BAG
STOW SRC 2
[ASCENT
HAND OUT LEC TO CDR
3+52 [INGRESS

4+00 REPRESS

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	(-30) 3+30				
RETRIEVE EXTRA WEIGH BAG AND COLLECT SAMPLES $\geq$ 50 FT OF THE LM		STOW IN SRC: SPECIAL, GAS SAMPLES		ENGINEERING SAMPLE COLLECTION	SRC AND ETB LOADING AND CLOSE OUT
		CORE TUBES			
		CLOSE & SEAL SRC			
SEAL & STOW WEIGH BAG IN ETB					
DISCARD TONGS ASSEMBLE BRUSH				INGRESS	
EVA TERMINATION	(-20) 3+40				
CLEAN CDR EMU		CLEAN LMP EMU			
ASCEND TO PLATFORM					
INGRESS		CHECK ETB CONTENTS (LIST ON FLAP)			
		CLOSE ETB FLAP			
CHECK EMU & LM		CHECK LEC-ETB HOOK UP			
		REST-CHECK EMU		ETB & SRC TRANSFER	ETB & SRC TRANSFER
PULL ETB INTO LM		TRANSFER ETB INTO LM			
REMOVE ETB FROM LEC		TRANSFER LEC HOOKS TO SURFACE			
STOW ETB		HOOK LEC TO TOTE BAG			
PULL TOTE BAG INTO LM		TRANSFER TOTE BAG INTO LM			
	(-10) 3+50				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
REMOVE TOTE FROM LEC	(-10) 3+50			ASSIST CDR INGRESS	LEC TRANSFER
		TRANSFER LEC HOOKS TO SURFACE			
STOW TOTE BAG					
		HOOK LEC TO SRC			
PULL SRC INTO LM		TRANSFER SRC INTO LM			
		DISCARD TONGS			
STOW SRC		CLEAN EMU			
		ASCEND TO PLATFORM			
ASSIST CDR INGRESS					INGRESS
		INGRESS			
CLOSE HATCH					
REPRESS CABIN		REPRESS CABIN		CABIN REPRESS AND EVA TERMINATION	CABIN REPRESS AND EVA TERMINATION
END 2ND EVA	(-0) 4+00	END 2ND EVA			

3.3 Photography Data

The following illustration summarizes pertinent lunar surface photography and area of activity data relative to astronaut lunar surface procedures.

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3.4 ALSEP Deployment and Equipment Data

The following illustration summarizes pertinent ALSEP data relative to lunar surface deployment considerations.

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3.5 Geology Data

The following illustration summarizes pertinent lunar surface geology data relative to the astronaut's field geology expeditions.

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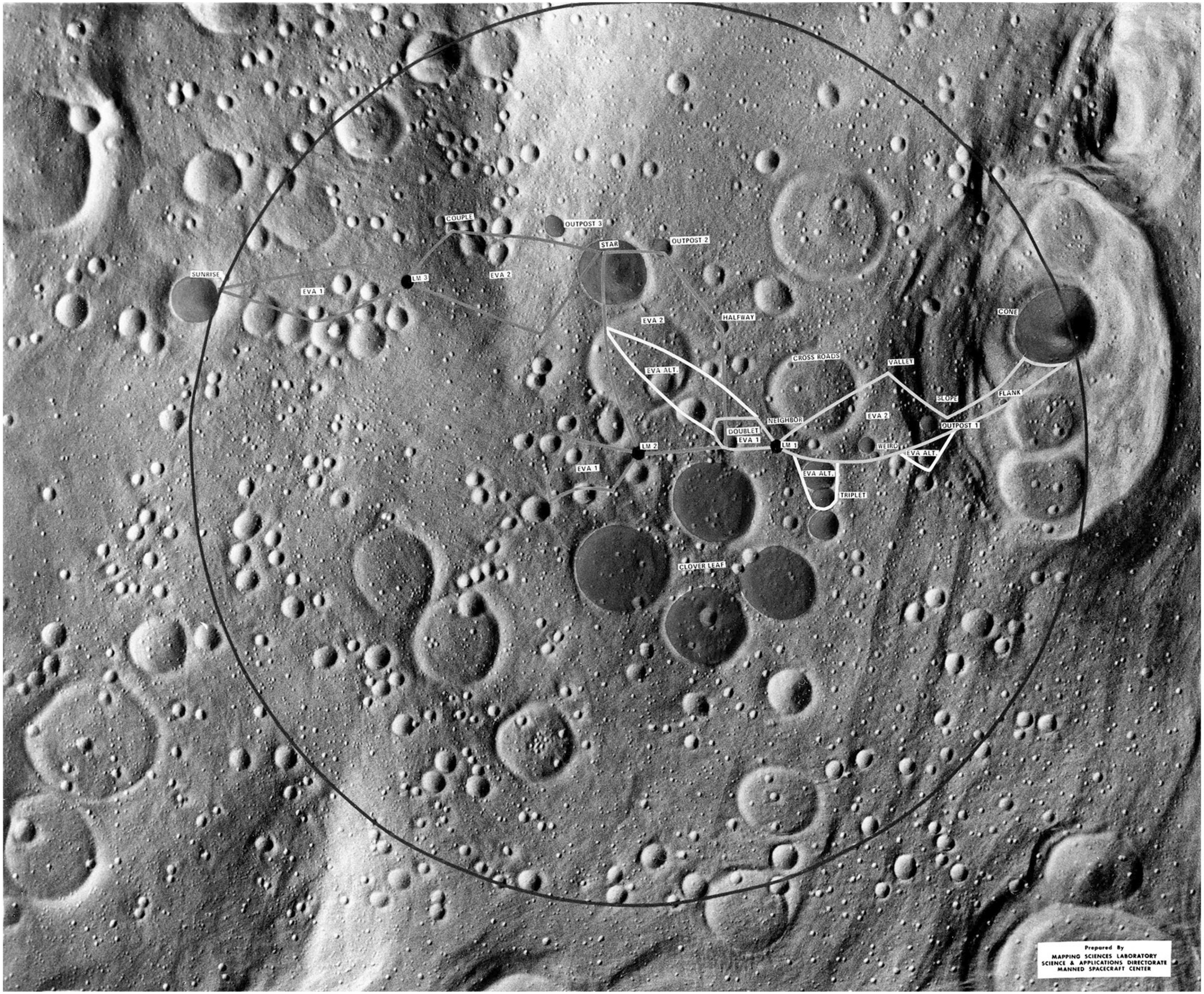
COUPLE
OUTPOST 3
STAR
OUTPOST 2
SUNRISE
LM 3
EVA 2
EVA 1
EVA 2
HALFWAY
CONE
EVA ALT.
CROSS ROADS
VALLEY
SLOPE
FLANK
NEIGHBOR
EVA 2
DOUBLET
EVA 1
OUTPOST 1
LM 2
LM 1
WEIRD
EVA ALT.
EVA 1
EVA ALT.
TRIPLET
CLOVER LEAF
Prepared By
MAPPING SCIENCES LABORATORY
SCIENCE & APPLICATIONS DIRECTORATE
MANNED SPACECRAFT CENTER

3.6 EVA 1 Traverses

The following illustrations depict the nominal EVA 1 traverses for ALSEP deployment and the traverse to other locations in the event of EVA 1 extension, for each of three landing sites in the Fra Mauro area. Each map has on the facing page tabular data which is printed on the back of the flight version of the map. These are observational and sampling guidelines provided by the Principal Investigators for the Lunar Field Geology experiment.

LANDING SITE #1, EVA 1

STATION	TASKS	ADDITIONAL INFORMATION
A	•ALSEP deployment •Do cuff checklist	•On intercrater area underlain predominantly by older regolith between Copernican craters
w Star rim	•Selected sample •Pan	•Rim of large older (#1) crater. Probably penetrated regolith into Fra Mauro unit of subdued ridge •Most likely site on traverse to collect possible Fra Mauro samples
x Doublet (N)	•Selected sample	•On rim of #1 crater--crater may penetrate through regolith into underlying Smooth unit
y Doublet (S)	•Selected sample	•On rim of younger (#3) crater •Intermediate exposure age--penetrates into or through older crater ejecta
z	•Selected sample	•Relatively undisturbed regolith •Possible samples with older exposure ages

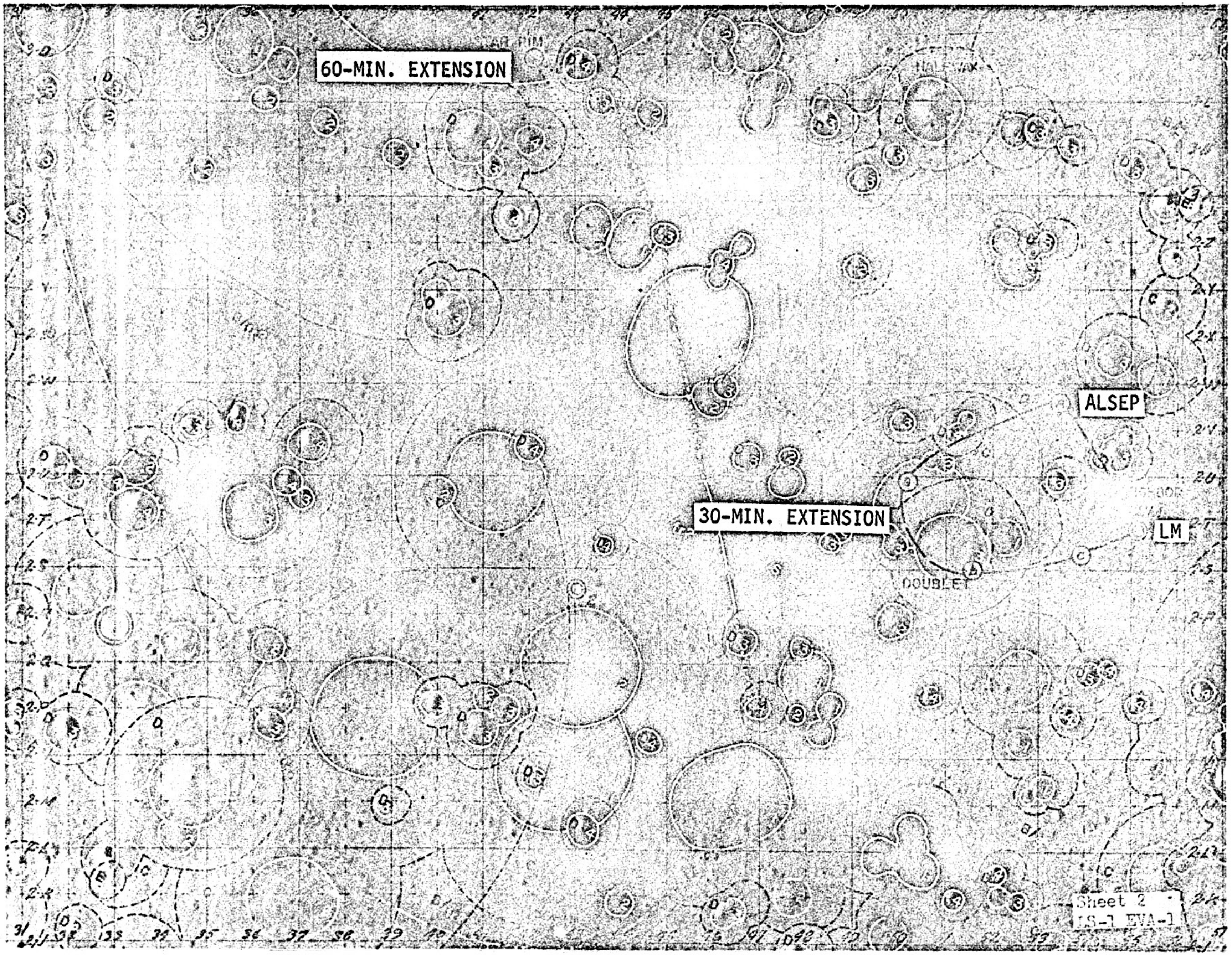

FIGURE 3-6: NOMINAL EVA 1 TRAVERSE (LANDING SITE 1, FRA MAURO)

LANDING SITE #2, EVA 1

STATION	TASKS	ADDITIONAL INFORMATION
A	•Deploy ALSEP	
h	•Selected sample	•#4 crater may excavate material from Smooth unit, beneath regolith
i	•Selected sample	•#1 crater may excavate material from ridge unit, beneath regolith
j	•Selected sample	•Cluster of moderately young (#3) craters.

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LANDING SITE #3, EVA 1

STATION	TASKS	ADDITIONAL INFORMATION
A	•Deploy ALSEP	
y Sunrise rim	•Selected sample	•Blocky rim of fresh, large crater--penetrates below fine fragmental layer probably excavated material from Smooth unit; possibly from under Smooth unit •Note: Sunrise rim very high priority--if time does not permit adequate sampling during first EVA, EVA 2 traverse should be adjusted to include Sunrise rim
z	•Selected samples #3 crater rim and in smooth areas back to LM	

FIGURE 3-6B: NOMINAL EVA I TRAVERSE (LANDING SITE 3, FRA MAURO)

3.7 EVA 2 Traverse

The following illustrations depicts the nominal EVA 2 traverses for landing sites 1, 2, and 3 in the same fashion as Section 3.6, EVA 1 traverses.

LANDING SITE #1 EVA 2

STATION	TASKS	ADDITIONAL INFORMATION
a. Valley	•Documented sample •Pan •Observe characteristics of surface	•Ejecta from (#1) crater on Smooth unit •Smooth unit; to be compared with Ridgey unit next station •Next traverse crosses contact between Smooth and Ridgey units
b. Slope (south of Slope crater rim)	•Documented sample •Single core in patterned ground •Compare with surface at Valley	•Patterned ground in Ridgey unit •Comparison of Ridgey unit and Smooth unit
c. Cone Rim	•Examine, describe, photograph boulders •Collect rock and soil samples •Two pans on rim ≥ 300 ft. baseline •Polarized pictures f:5.6, 1/125; across cone, and of sample area •Roll boulder, take 24 fps movie, crew movement, pan west, pan crater •Look for boulder tracks inside and outside	•Large boulders may be from Fra Mauro •Contacts may be visible in crater wall •Panoramas with wide base stereo
c-d	•Watch for radial variations in materials	
d. Flank	•Documented sample •Pan •Contrast rock types, sizes, shapes with Cone	•#4 crater may penetrate Cone ejecta
e. Outpost-1	•Do cuff checklist •Sample radially, SW of Outpost, 3 documented soil samples at 10 ft. intervals •Collect documented football rock on return	•#4 crater near buried contact •Crater may penetrate either Ridgey or Smooth unit
	Alternate traverse part e	
e.-1	•Documented samples	•#2 crater near buried contact
e.-2	•Documented samples •Contrast rock types at previous stations to establish contact	•#2 crater near buried contact
f. Weird	•Double core through multiple ejecta blanket •Pan •Documented sample of material from superposed craters •Observe elongate shape #3 crater for origin	•#3 crater may penetrate into Smooth unit materials •Elongate shape of #3 crater may reflect structure or composite of multiple craters
g. Triplet	•Documented sample •Pan •Observe patterned ground	•Large #2 crater may penetrate into underlying Smooth unit, either Fra Mauro breccia or younger volcanic rock •Largest crater sampled in Smooth unit
	Alternate traverse part g	
g.-1	•Documented samples •Pan	
g.-2	•Documented sample	

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Source Document

LANDING SITE #2, EVA 2

STATION	TASKS	ADDITIONAL INFORMATION
k	•Documented sample •Pan •Core	•Small younger (#4) crater in Ridgey unit on margin of larger older (#1) crater. May sample blanket of deeper ejecta •Good opportunity to observe possible patterned ground on irregular ridge slopes
k-m	•Observations on character relative to slope of patterned ground	
m	•Documented sample •Pan	•Small (#4) crater in cluster of #4 craters which may cut through ejecta blanket of Star crater
w Star rim	•Documented sample •Double pan ≥ 300 ft. between points •Core	•Rim of major deep older crater superimposed on approximate location of contact between Ridgey unit and smooth unit •Possible sample site of Fra Mauro materials •Ejecta may be different on east rim of crater than on west rim due to superposition of crater on Ridgey-Smooth unit contact
n Star center	•Documented sample on rim of young crater •Polarized pictures f:5.6, 1/125; to N wall of Star, and of sample area •Observe characteristics of surface	•Fresh young crater (#6) in bottom of major older crater (Star) which may penetrate to Fra Mauro
n-o	•Look for surface changes that may be related to approximate contact between Ridgey and Smooth units	•Ejecta on east side may be different than on west side of Star crater
o Outpost-2	•Do cuff checklist •Document sample •Pan •Sample radially, SE of Outpost crater, 3 documented soil samples at 25 ft. intervals •Compare surface materials with those of Star •Collect documented football rock on return	•Well-defined crater (#4) in Smooth unit with good younger ejecta blanket overlying older regolith of Smooth unit •Material may be different from that at Star
p Halfway	•Documented sample •Pan	•Prominent younger (#4) crater well out into Smooth unit •May provide good sample of excavated Smooth unit
q	•Documented sample •Core •Observe possible patterned ground, compare with any patterned ground on traverse leg from LM to Star	•Relatively undisturbed older regolith on Smooth unit •May provide samples with older exposure ages
r Doublet (N)	•Documented sample	•Small crater (#3) superimposed on rim of larger older (#1) crater •Possible deep sample of Smooth unit
s Doublet (S)	•Documented sample •Pan •Bulk sample, especially rock fragments, if sample yield has been small. Collect from as large an area as practical	•Superimposed craters in Smooth unit •Possible deep sample of Smooth unit •Next leg of traverse will cross approximate contact between Ridgey and Smooth unit

FIGURE 3-7A: NOMINAL EVA 2 TRAVERSE (LANDING SITE 2, FRA MAURO)

LANDING SITE #3, EVA 2

STATION	TASKS	ADDITIONAL INFORMATION
a. Plain	•Documented samples •Pan •Look for patterned ground	•Subdued older (#1) crater in Smooth unit; may have excavated Smooth unit materials from depth •Smooth unit; to be compared with Ridgey unit next two stations
a-b Traverse	•Look for surface changes that may be related to geologic contact	•Traverse crosses approximate contact between Smooth unit and possible Fra Mauro unit
b. Contact	•Documented samples •Core •Pan •Compare with surface at Plain	•Small crater (#3) superimposed on rim of older crater (#1) •Core sample may penetrate through #3 into #1 ejecta •Comparison of Smooth unit with Ridgey unit
c. Ridge	•Documented samples •Pan •Patterned ground, fillet development, fragment rounding	•Rim of subdued (#1) crater •May penetrate regolith into Fra Mauro unit •Comparison of regolith surface with that of previous stations
d. Star crater rim	•Documented samples •Pan •Patterned ground, fillet development, fragment rounding	•Rim of large old (#1) crater which may penetrate into Fra Mauro unit •Superimposed small craters may reexcavate and invert rim deposits of large crater
d-e Traverse	•Look for changes in fragments, fillets, and patterned ground	•Patterned ground, fillet and fragment distribution may change on traverse down into crater
e. Star Center	•Documented sample •Core •Stereo pan with 100 ft. baseline •Polarimetry sequence	•Small bright crater (#16) in center of old Star crater •#6 crater excavates old crater fill, possibly including Fra Mauro •Possible large difference in exposure ages between #6 ejecta and underlying materials
f. Outpost-3	•Do cuff checklist activities •Pan from rim •Watch for football size rock; collect and document	•Pans at Star rim and Outpost-3 provide wide-base stereo at good vantage points
g. Couple	•Documented samples •Pan •Sample radially, SE of #4 crater, 3 soil samples at 10 ft. intervals	•Radial sample may determine horizontal zonation of different materials around small crater

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SECTION 4.0

CONTINGENT PLANS

4.0 CONTINGENT PLANS

4.1 General Description

In lunar manned operations it is expected that the EVA timeline will vary a small amount due to the new environment as well as small changes that occur in equipment operation. If the activity timeline or equipment operation changes sufficiently that the flexibility of the timeline or equipment cannot compensate to accomplish the planned activities, a contingency plan must be used to continue the EVA.

This section is devoted to pre-mission variations in EVA timeline and contingency EVA planning. The procedures to resolve unexpected equipment operation or malfunction are found in detail in Appendix 5.3.2.

Since it is not possible to define specific plans for every possible contingency, real time resolution of problems and timeline planning must be depended on during the mission using a pre-mission developed timeline guide. The exception to this rule is predefined possible contingencies in which time is too short to respond to a problem and continue through the EVA expediently. The pre-mission timelines provided in this section that could fall in this category are one man-EVA 1, one man-EVA 2, minimum time EVA and EVA termination timelines used in conjunction with the Timeline Guide. It is expected that the guidelines provided under these categories will provide a base from which the mission EVA timelines may be modified as required to conduct the EVA's effectively.

4.1.1 EVA 1-One Man

The possibility always exists that only one Extravehicular Mobility Unit is operable to support EVA--that the PLSS, OPS, EVCS, or some other system of the EMU precludes lunar surface operations for both men. One crewman must remain on LM ECS umbilicals while the other performs what is otherwise a nominal four-hour (or even more) EVA. Another possibility is that some subsystem of the LM has degraded sufficiently that continuous monitoring and manual intervention is required to maintain system integrity. Any of these situations occasions a full-time one-man EVA on the lunar surface.

EVA 1 requires the CDR to be the crewman to perform EVA tasks. The training program on Apollo 13 was of necessity so structured as to make the CDR an ALSEP system specialist, and the LMP a specialist on the operation of the Apollo Lunar Surface Drill (ALSD). Thus, if malfunctions occur in the CDR's EMU on EVA 1, it will be necessary for him to use LMP substitutes to accomplish the EVA.

The contingency EVA 1--One man timeline (see figure 4-1) permits complete deployment of ALSEP and all its experiments. The only major loss to EVA 1 for the one-man case is the core sample. Although unaided core sample recovery is marginally feasible, it is very time-consuming and fatiguing, and would probably preclude any sample gathering on EVA 1. Therefore, selected sample collection is preserved with ALSEP deployment as the major objectives of this one-man EVA.

Another task which is eliminated from this one-man EVA 1 is erection of the S-band Erectable Antenna. The rationale here is that antenna erection on Apollo 12 was found to require two crewmen, and 210 ft antenna reception from the moon is available until nearly the end of EVA 1. Using the LM steerable antenna, the television transmission and PLSS data TM would be satisfactory for the primary TV coverage, which is at the beginning of EVA 1. Television usage is less important during ALSEP deployment, since this is done at a distance of 300 ft or more from the LM. Since EVA 2's traverse is in an easterly direction for the nominal landing site, the TV is of little use for most of EVA 2, for the camera cannot be pointed within 45 degrees of the sun. In any case, signal degradation without the erectable antenna and using the MSFN 85 ft antennas is not considered to be so serious that a fairly satisfactory picture cannot be obtained. For all these reasons, the 15 minute task of putting up the S-band antenna is dropped from the contingency EVA 1.

Note, too, that SRC 1 is not used on EVA 1, since its main contents are the six core stems for the drill. This SRC will play a role in EVA 2, however. If an extension were given on EVA 1 sufficient to gather a large number of samples, then real-time consideration would be given to packing these in SRC 1.

Some photography is curtailed, all the sequence camera work on the lunar surface, detail ALSEP photography (unless time permits) and LM inspection and photography are cut from EVA 1.

The LMP is occupied taking sequence camera and 70mm still photographs of the CDR as he goes about his EVA tasks. The LMP also performs the important function of reading the lunar surface checklist contingency procedures to the CDR as required, and perhaps verbally assisting the CDR in those tasks which are normally assigned to the LMP for the two-man EVA 1.

APOLLO 13 SUMMARY TIMELINE

CONTINGENCY EVA 1
ONE-MAN, 4 HOUR

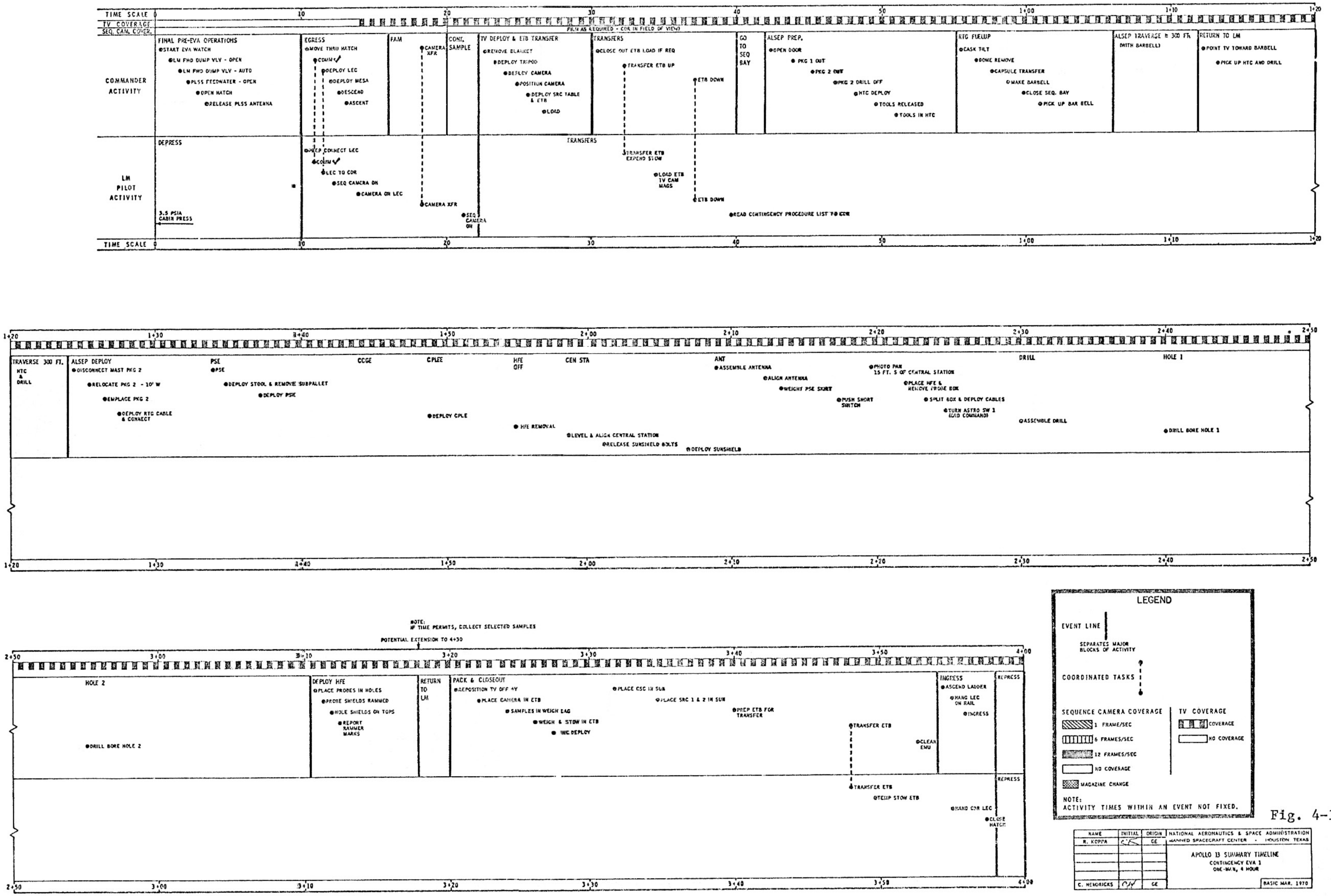

Fig. 4-1

4.1.2 EVA 2-One Man

This timeline, like EVA 1-One Man, assumes that only one crewman may egress the LM but he may spend the full time of four or more hours. The other crewman is confined to the ascent stage because an EMU subsystem is not working properly, or the LM requires a continuous monitoring. In the latter case, it should be noted, the crewman could be using a fully operative EMU, and hence be available at least for a short period, depending upon the gravity of the LM malfunction, for an emergency or difficulty that the EVA crewman might have.

The summary timeline for the contingency one-man full EVA 2 is given in Figure 4-2. A rather extensive geology traverse could be performed, with no major objectives curtailed. The crewman would probably not traverse as far from the LM as would be the case for a two-man traverse. Revision of the traverse map would probably be made prior to egress, with a set of recommendations from the Science Support Room to facilitate such revision. The number of samples would be less than for a two-man EVA, because no tote bags are available, and the crewman must carry all samples in the HTC. He must also, of course, make all of the documenting photographs. No attempt is made to carry the Closeup Stereo Camera, although some use of it around the LM would be made. As in EVA 1, the movie camera is not carried. A single 70mm camera is taken, with at least one extra magazine of film.

SRC 2 is utilized just as it is for a two-man EVA 2, to contain the documented samples. SRC 1 is also utilized to contain overflow from SRC 2 and for quasi-selected samples from the vicinity of the LM, if EVA 1 was a one-man EVA.

Either the CDR or the LMP could perform the EVA 2 one-man contingency case. As in EVA 1 the crewman inside the LM takes still and motion pictures of the EVA crewman and reads procedures as required.

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APOLLO 13 SUMMARY TIMELINE

CONTINGENCY EVA 2
ONE-MAN, 4 HOUR

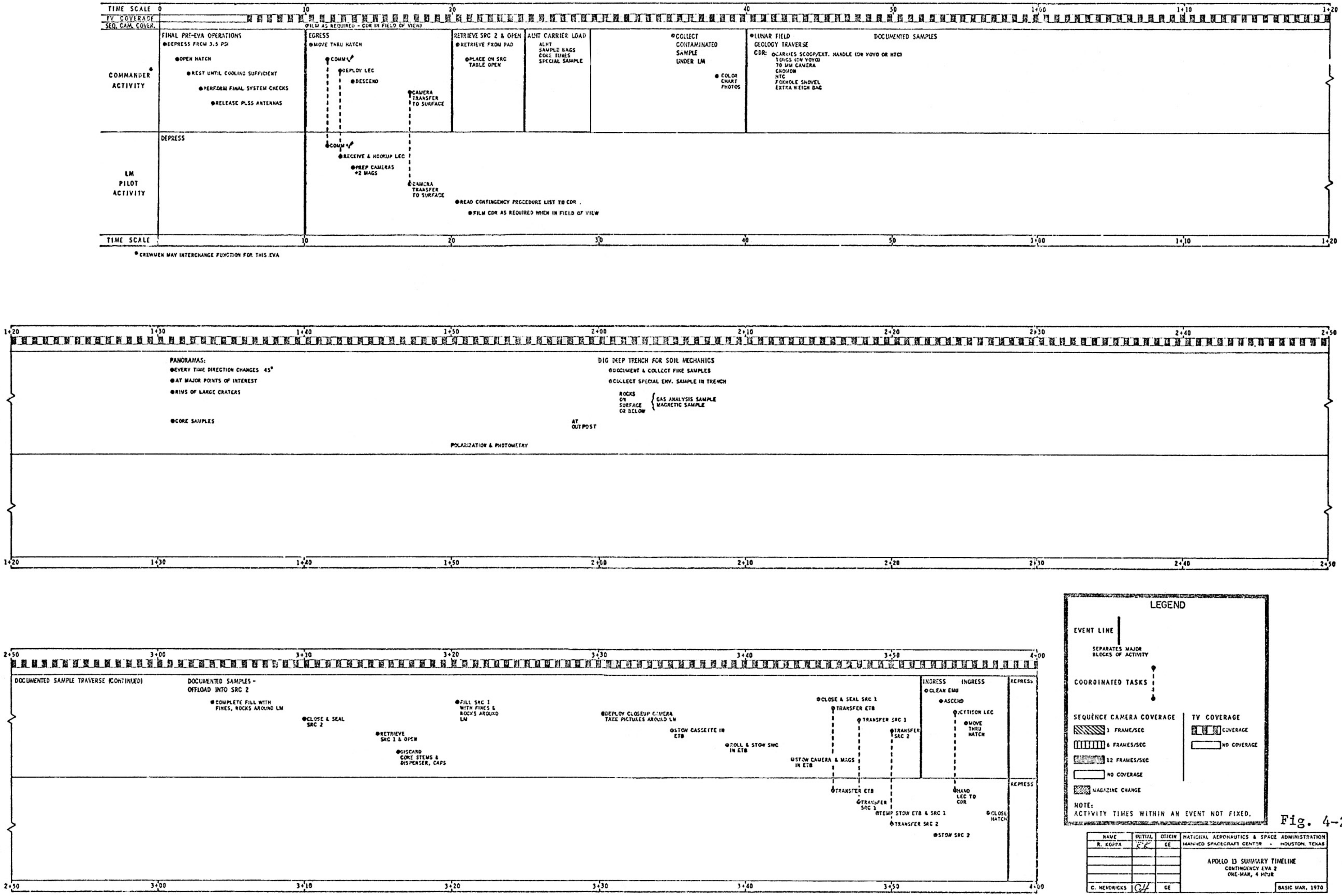

Fig. 4-2

4.1.3 Contingent EVA 1 - Minimum Time, One Man

For various reasons, on a lunar landing mission, only a very limited time may be available to accomplish one EVA. For such a situation the choice of objectives are, first, those with the highest priority and, secondly, those which can be accomplished in a short period of time and do not require the accomplishment of a previous task. The timeline (See Figure 4-3) presented here, referred to as the Contingent EVA 1 Minimum-Time, One-Man EVA, fits the above guidelines by providing for the implementation of the highest priority and basic objective of documenting the character of the landing site. This is done by collecting a surface sample (contingency sample) and describing as well as photographing the lunar surface texture and topography.

In this contingent EVA, for the environmental familiarization, the crewman will spend only enough time to assure himself that he can safely proceed with the EVA. After the contingency sample collection he will continue to become more adapted to the new environment as he conducts a limited EVA evaluation. Primarily, this EVA evaluation will involve a brief investigation to determine his general capabilities or limitations for conducting EVA tasks within the lunar environment. Photographs taken during this evaluation will be a postflight aid to the crewman's recall and the documentation of this activity. A limited site description, with very brief comments and several documentary photographs, can be made of the surface to the horizon. To conclude the surface activity the crewman will take a photographic panorama and possibly a few additional photographs of documentary value.

In conclusion, it should be mentioned that the crewman's surface activity will be confined mainly to an area where he can be monitored by the crewman inside the LM. Practically all of the activity can be documented with the sequence camera, and, if the communications capability exists, with the TV.

APOLLO 13 SUMMARY TIMELINE

CONTINGENT EVA 1
MINIMUM TIME, ONE MAN

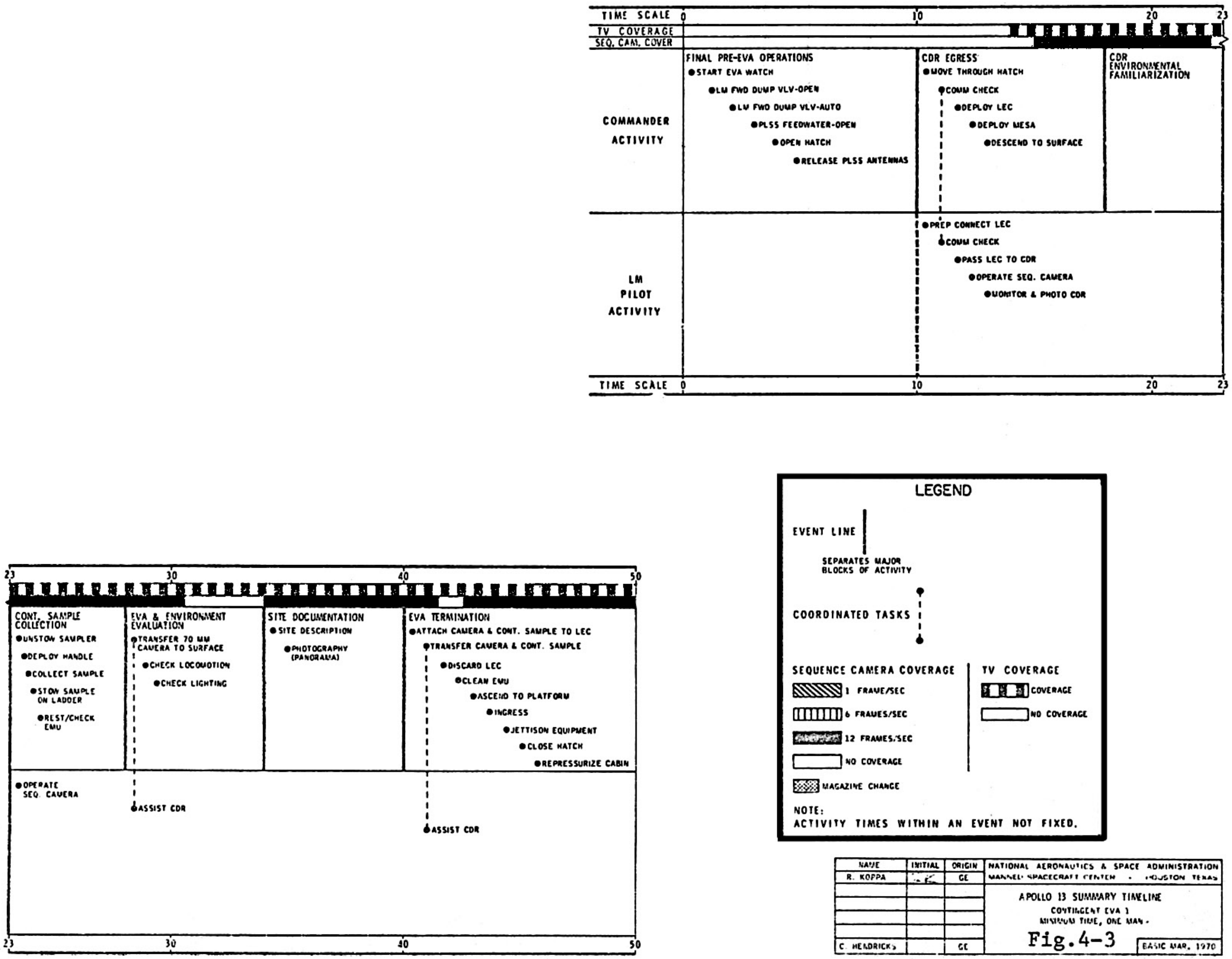

Fig.4-3

4.2 Detailed Contingency EVA Timeline Procedures

4.2.1 EVA 1-One Man

Pages 87-99 present step by step timeline procedures for EVA 1 in a format similar to that the crew would use from their Lunar Surface Checklist.

MISSION: APOLLO 13, H-2
EVA: 1 - ONE MAN CONTINGENCY

DATE: 16 MARCH 1970

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+00	DEPRESS CABIN FROM 3.5 PSI			
		NOTE: DETAILED PROCEDURES ARE PRESENTED IN "LUNAR SURFACE CHECKLIST" "EQUIPMENT PREP EVA 1" SECTION			
		OPEN HATCH			
	0+10	MOVE THRU HATCH			

MISSION: APOLLO 13, H-2
EVA: 1 - ONE MAN CONTINGENCY

DATE: 16 MARCH 1970

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+10	MOVE THRU HATCH			EGRESS
PREPARE LEC PASS JETTISON BAG TO CDR		COMM CHECK			
		TOSS JETT BAG -Y AREA			
PASS LEC TO CDR		DEPLOY LEC			
PHOTO CDR WITH 70MM CAMERA		DESCEND TO LADDER			
		DEPLOY MESA			
		DESCEND TO FOOT PAD			
PHOTO CDR WITH 70MM CAMERA		CHECK ASCENT (HOP UP) STEP TO LUNAR SURFACE CHECK AND DISCUSS MOBILITY AND STABILITY			
TRANSFER 70MM CAMERA		LEC CAMERA TRANSFER			FAM & CAM XFER
SEQ CAM ON (FILM CDR WHEN IN FIELD OF VIEW)		UNSTOW CONT. SAMPLE & DEPLOY HANDLE			
	0+20	COLLECT SAMPLE - STOW CSRC ON +Z STRUTS PHOTO CONTINGENCY SAMPLE AREA			CONT SAMP
		REMOVE MESA COVER			TV - DEPLOY
		UNSTOW & ERECT TV TRIPOD			
		UNSTOW & MOUNT TV ON TRIPOD UNSTOW TV CABLE			
		CARRY TV (50' +Z/+Y) TO VIEW MESA, S-BAND & FLAG			
		ERECT MESA TABLE ATTACH ETB TO MESA TABLE			ETB PREP
		STOW WEIGH BAGS ON MESA UNSTOW PLSS BATTS & LiOH CANS AND PLACE IN ETB			
		REMOVE SAMPLE FROM CSRC HANDLE & PLACE IN ETB			
	0+30				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970

EVA: 1 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+30	CLOSE ETB TOP FLAP ATTACH LEC TO ETB		ETB TRANSFERS	ETB TRANSFERS
ASSIST ETB TRANSFER		TRANSFER ETB INTO LM			
REMOVE ETB CONTENTS & STOW					
PACK B&W TV AND MAP IN ETB					
ASSIST ETB TRANSFER					
		TRANSFER ETB TO SURFACE STOW ETB ON MESA TABLE SIDE (B&W TV CAM & MAP)			
NOTE: READ PROCEDURES TO CDR				READ CHECKLIST	LM INSPECT
	0+40	TAKE 70MM CAM AND GO TO SEQ BAY			
		OPEN SEQ BAY DOORS			ALSEP OFFLOAD
		REMOVE & LOWER PKG #1			
		DISCONNECT LANYARD & BOOM STOW LANYARD REPOSITION PKG #1			
		STOW BOOM #1 REMOVE & LOWER PKG #2 DISCONNECT LANYARD & BOOM STOW LANYARD			
		REPOSITION PKG #2			
		STOW BOOM #2			
	0+50	REMOVE AND EXPAND ALHTC RELEASE TOOLS & PLACE IN HTC			

MISSION: APOLLO 13, H-2

EVA: 1 - ONE MAN CONTINGENCY

DATE: 16 MARCH 1970

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+50				
		REMOVE DRILL			ALSEP OFFLOAD
		UHT'S IN PKG'S			
		MATE MAST AND ATTACH TO PKG #1			
		TILT PKG 2 TO GROUND (FUELING) POSITION			
		CLOSE SEQ BAY DOORS			
NOTE: READ PROCEDURES TO CDR		DEPLOY CASK TILT LANYARD TILT CASK AND STOW LANYARD			RTG FUEL UP
	1+00	REMOVE AND DISCARD DOME/DRT			
		ENGAGE & CHECK FTT			
		WITHDRAW FUEL CAPSULE & FUEL RTG - REPORT TEMP			
		DISENGAGE FTT & DISCARD TILT PKG 2 UPRIGHT & ATTACH TO MAST TO MAKE BAR BELL			
		CARRY ALSEP TO DEPLOYMENT SITE			ALSEP TRAVERSE
		NOTE: REST ENROUTE			
	1+10	REPORT COMPLETION OF TRAVERSE			

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 1 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
	1+10	REPORT COMPLETION OF TRAVERSE			RETURN TO LM TRAVERSE
		RETURN TO LM			
		REPOSITION TV TO VIEW ALSEP SITE			
		GO TO SEQ BAY			
NOTE: READ PROCEDURES TO CDR		CARRY ALHTC & DRILL TO ALSEP SITE >300 FT WEST			HTC & DRILL TRAVERSE
	1+20				
		SURVEY SITE TO DETERMINE ALSEP EXPERIMENTS LOCATION			
		DISCONNECT MAST - PKG 1			ALSEP PKG 1 & 2 IMPLACEMENT
		RELOCATE PKG 2 10 FT WEST			
		DISCONNECT MAST - PKG 2			
		EMPLACE PKG 2 & STOW MAST			
		REMOVE RTG CABLE REEL BOYD BOLTS			
		DEPLOY CABLE - DISCARD REEL			
		REPORT AMPS AND CONNECT CABLE			
	1+30				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 1 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
	1+30	TILT PKG #1			
		ALIGN PKG #1 (EYEBALL)			
		DEPLOY PSE			PSE DEPLOYMENT
		REMOVE PSE STOOL (PKG 2) IMPLACE PSE STOOL (10 FT EAST OF PKG 1 - SCOOP HOLE WITH UHT AS REQUIRED)			
		RELEASE PSE BOYD BOLTS REMOVE PSE - PULL OFF BOLTS - CARRY TO PSE STOOL			
NOTE: READ PROCEDURES TO CDR		REMOVE GIRDLE - PLACE PSE ON STOOL DEPLOY THERMAL SKIRT			
	1+40	LEVEL PSE			
		REPORT LEVEL & ALIGNMENT			
		RELEASE CCGE BOYD BOLTS & REMOVE CCGE (PKG 1)			CCGE DEPLOY
		PULL PIN ON REEL			
		PLACE CCGE ON LUNAR SURFACE (60 FT SOUTH/WEST CENTRAL STATION) CHECK LEVEL & ALIGN			
		RELEASE CPLE BOYD BOLTS & REMOVE CPLE (PKG 1)			
	1+50	PULL PIN AND ROTATE CPLE (180°) WHILE HOLDING UHT			

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EVA: 1 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
	1+50	EMPLACE CPLE (10 FT SOUTH)			CPLE DEPLOY
		LEVEL AND ALIGN CPLE (USE UHT AS GNOMON)			
		RELEASE HFE BOYD BOLTS			HFE REMOVAL
		LIFT HFE FROM C/S			
		CARRY HFE TO DEPLOY SITE (30 FT S-E OF C/S)			
		DETACH PROBE BOX AND LEAN ON HFE			
		CENTRAL STATION: LEVEL & ALIGN			DEPLOY CENTRAL STATION
NOTE: READ PROCEDURES TO CDR		DEPLOY ANTENNA CABLE			
	2+00	START FRONT CENTER AND RELEASE BOYD BOLTS			
		RELEASE TWO INNER BOYD BOLTS			
		RELEASE CENTER BOYD BOLT & RAISE SUNSHIELD			
		REMOVE CURTAIN COVERS & DISCARD			
		CHECK CURTAINS PROPERLY DEPLOYED & VELCROED TO PALLET			
		RETRIEVE & INSTALL ANTENNA MAST			
		RELEASE AIMING MECHANISM BOYD BOLTS & REMOVE			
	2+10				

MISSION: APOLLO 13, H-2

EVA: 1 - ONE MAN CONTINGENCY

DATE: 16 MARCH 1970

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	TASK FUNCTION (CDR)
	2+10	INSTALL GIMBAL ON MAST REMOVE HOUSING & DISCARD	INSTALL & ALIGN ALSEP ANTENNA
		INSTALL ANTENNA CHECK C/S ALIGNMENT	
		LEVEL ANTENNA	
		ALIGN ANTENNA	
		ENTER ANTENNA AZIMUTH 16.13 ENTER ANTENNA ELEVATION 6.40	
		WEIGHT PSE SKIRT (IF REQ'D)	
		CHECK ANTENNA LEVEL & ALIGN	
		CHECK EMU	ACT. CEN. STAT. & PHOTO PAN
NOTE: READ PROCEDURES TO CDR		ACTIVATE CENTRAL STATION REPORT SHORT SW AMPS DEPRESS SHORTING SW CHECK AMPS ZERO	
	2+20	PHOTO PAN 15 FT SOUTH OF CENTRAL STATION	
		TAKE HTC & DRILL TO HFE SITE	
		ALIGN HFE ELECTRONICS BOX	HFE DEPLOY
		SPLIT PROBE BOX & LEAN 1/2 BOX ON HF ELECT.	
		DEPLOY HFE PROBE CABLE (BOX WITHOUT EMPLACE TOOL)	
		(ASTRO SW 1 TURN ON AT GND REQUEST)	
		LOCATE 1ST BORE HOLE (2X DIA NEAREST CRATER)	
		REPOSITION HTC AND DRILL (IF REQUIRED)	
	2+30	ASSEMBLE DRILL	

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EVA: 1 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ. CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	2+30	ASSEMBLE DRILL PUSH SWITCH TO TEST PULL PIN 1 PULL PIN 2 TURN LOCK 3-CCW REMOVE TURN LOCK 4-CCW-REMOVE & PULL LANYARD PUSH RACK LEG FROM CLIP- EXTEND & LOCK LEGS & BRACE REMOVE AND INSTALL DRILL HANDLE TO POWER HEAD REMOVE RACK-EXTEND 3RD LEG & PLACE RACK ON SURFACE PULL PIN 5-SWING COLLAR UP RESET CHUCK-REMOVE DRILL REMOVE COVER FROM STEM RACK & RELEASE VELCRO STRAP ASSEMBLE ONE STEM SET (WITH BIT) & INSTALL IN CHUCK ASSEMBLE 2ND STEM SET-PLACE IN RACK BIT DOWN			ASSEMBLE DRILL
NOTE: READ PROCEDURES TO CDR	2+40	BORE HOLE DRILLING INSERT DRILL BIT INTO SURFACE REMOVE THERMAL SHROUD PUSH INWARD ON BOTH HANDLE SECTION & DRILL TO HANDLE HEIGHT OF 28 TO 30 INCHES RELEASE STEM-1/4 TURN-CCW -CW BACK, BLIP DOWN, BLIP UP RESET ADAPTER - INSTALL NEW STEM TO IMPLANTED STEM - FIT POWER HEAD ADAPTER TO STEM REPEAT DRILLING UNTIL 6 STEMS ARE IMPLANTED IN LUNAR SURFACE			DRILL 1st BORE HOLE
	2+50				

MISSION: APOLLO 13, H-2

DATE: 16 MARCH 1970

EVA: 1 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	2+50	RETRIEVE HALF BOX (WITH EMPLACEMENT TOOL) FROM HFE ELECTRONICS DEPLOY HFE PROBE CABLE			LOCATE 2nd DRILL SITE AND DRILL BORE HOLE
		LOCATE 2ND BORE HOLE			
		RETRIEVE DRILL & RACK			
		DRILL 2ND BORE HOLE AS PER FIRST BORE HOLE PROCEDURES			
NOTE: READ PROCEDURES TO CDR					
	3+00				
		HFE PROBE DEPLOY			
	3+10				

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EVA: 1 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	3+10	REMOVE PROBE & INSERT INTO BORE HOLE			HFE PROBE INSTALLATION
		REMOVE TOOL & EXTEND-CHECKLOCKED			
		ENGAGE CABLE ABOVE INTERNAL THERMAL SHIELD			
		INSERT TOOL AND REPORT MARKS			
		REMOVE TOOL; PLACE TOP SHIELD			
		REPORT TOOL MARK FROM GND TO TOP OF BORE			
		PROCEDE AS ABOVE FOR 2ND PROBE			
		SHOOT STEREO PR BORE HOLES TO CEN STA.			
		RELOCATE DRILL DEBRIS >8 FT SE			
NOTE: READ PROCEDURES TO CDR	3+20 (-40)	RETURN TRAVERSE (COLLECT SELECTED SAMPLES IF EVA EXTENDED TO 4+30)			RETURN
		REPOSITION TV +Y/50 FT TO VIEW MESA-GND GIVES SETTINGS			
		PLACE 70MM CAM IN ETB			ETB PACKING
		ATTACH WEIGH BAG FROM MESA TO SCALE			
		SAMPLES FROM HTC INTO WEIGH BAG			
		LENS FROM HTC TO ETB			
	3+30 (-30)	HTC IN SUN			

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EVA: 1 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ. CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	3+30 (-30)	REMOVE SOLAR WIND			DEPLOY SWC
		CARRY TO DEPLOYMENT SITE			
		EXTEND STAFF & DEPLOY FOIL			
		IMPLANT STAFF IN SURFACE			
		REMOVE CSC - DEPLOY HANDLE AND PLACE DOWN SUN (NW/15FT)			DEPLOY CSC
NOTE: READ PROCEDURES TO CDR		OFFLOAD SRC 2 & PLACE ON +Y FOOTPAD (LID DOWN SUN)			
		OFFLOAD SRC 1 & PLACE LID DOWN SUN			DEPLOY SRC'S
		COLLECT SAMPLES FROM LM AREA & PLACE IN WEIGH BAG			
	3+40 (-20)				
		FINISH FILLING WEIGH BAG WITH LOOSE MATERIAL*			COLLECT NEAR LM SAMPLES CLOSE OUT
		CLOSE BAG AND PACK IN ETB			
		CHECK CONTENTS OF ETB 70MM CAM LENS WEIGH BAG(S)			
		CLOSE ETB FLAP AND HOOK-UP TO LEC			
ETB INTO ASCENT STAGE		ETB TRANSFER		ETB XFER	
REMOVE ETB FROM LEC	3+50 (-10)				

*COULD LOAD UP TOTE BAG INSTEAD OF WEIGH BAG & TRANSFER INTO LM

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970

EVA 1 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
STOW ETB CONTENTS	3+50 (-10)				
		REMOVE BRUSH FROM MESA			BRUSH SUIT
		BRUSH LEGS-FRONT OF SUIT			
		CLEAN EMU			
PASS LEC TO CDR		ASCEND TO PLATFORM			INGRESS
ASSIST CDR INGRESS		STOW LEC ON PLATFORM (HANG UP ON PLAT-RAIL)			
		INGRESS			
CLOSE HATCH		REPRESSURIZE CABIN			
	4+00	END 1ST EVA			

4.2.2 EVA 2-One Man

Pages 101-113 present step-by-step timeline procedures for EVA 2 in a format similar to that the crew would use from their Lunar Surface Checklist.

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ. CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+00	DEPRESS CABIN FROM 3.5 psi			
		NOTE: DETAILED PROCEDURES ARE PRESENTED IN "LUNAR SURFACE CHECKLIST" "EQUIPMENT PREP EVA 2" SECTION			
		OPEN HATCH			
	0+10	MOVE THRU HATCH			

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+10	EGRESS		ETB TRANSFER	EGRESS
ASSIST CDR EGRESS		MOVE THRU HATCH			
PASS EQUIPMENT TO CDR		JETTISON EQUIPMENT			
HOOKUP LEC		HAND LEC TO LMP DEPLOY LEC			
LOAD ETB 70MM CAMERA 70MM MAGS MAP.		DESCEND TO LUNAR SURFACE			
COMM CHECK		COMM CHECK RECONFIGURE TV FOR EVA II			
ATTACH ETB TO LEC					ETB TRANSFER
ASSIST ETB TRANSFER		TRANSFER ETB DOWN			
PHOTO CDR AS ABLE		STOW ETB ON MESA		PHOTO CDR & READ PROCEDURES	
		70MM CAM ON RCU			
NOTE: READ PROCEDURES TO CDR	0+20	GET SRC 2 FROM FOOTPAD			SRC OFFLOAD AND HTC PREP
		PLACE SRC 2 ON MESA TABLE & OPEN			
		RETRIEVE HTC & PLACE AT MESA			
		OFF LOAD SRC 2 PLACE IN HTC: ONE WEIGH BAG GAS ANALYSIS SPECIAL ENVIR. MAGNETIC CONTAINER 35 BAG DISPENSER CORE TUBES & CAPS			
		CLOSE ORGANIC SAMPLE - IN SRC STOW TOOLS IN HTC & 70MM MAG & MAP TONGS ON YO YO			
	0+30				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970

EVA: 2 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+30	PROP UP PHOTOMETRIC CHART DWN SUN			PHOTOMETRIC
		TAKE 4 PHOTOS AT 5 FT NORMAL TO CHART (f: 5.6,8,11,16)			
		1 PHOTO f: 11 AT 45° AZIMUTH			
		RETRIEVE CHART & PLACE IN HTC			
		CONTAMINATED SAMPLE (QUAD 3) PLACE GNOMON PHOTO STEREO PAIR CROSS SUN			CONTAMINATED SAMPLE:
		PREPARE BAG			
		COLLECT SAMPLE			
		PLACE SCOOP ON HTC			
		DOUBLE BAG SAMPLE & REPORT NUMBERS & STOW			
NOTE: READ PROCEDURES TO CDR		PLACE GNOMON ON HTC			
	0+40	TRAVERSE			START TRAVERSE
		CDR CARRIES: TONGS (ON YO YO) 70MM CAMERA (ON RCU) HTC: - TRENCHING TOOL - GNOMON - EXTENSION HANDLE - SMALL SCOOP - WEIGH BAG - 3 CORE TUBES & CAPS - HAMMER - GAS, MAG & SPEC CONTAINERS - 35 BAG DISPENSER - 70MM MAG			
		NOTE: REPORT - ALL MOVEMENTS INCLUDING DIRECTION BETWEEN SAMPLES LOCATION WRT LM ALL PHOTOS SAMPLE BAG NUMBERS			
	0+50				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+50	NOTE: UNDERLINED ACTIVITIES OCCUR DURING THE TRAVERSE BUT NOT NECESSARILY AT THE TIMES SHOWN			
		<u>TYPICAL DOCUMENTED SAMPLE COLLECTION</u>			TYPICAL DOCUMENTED SAMPLE COLLECTION
		PLACE ALHTC			
		GNOMON NEAR SAMPLE			
		STEREO PAIR (CROSS SUN)			
		PHOTO SAMPLE (DOWN SUN)			
		DEPLOY BAG IN DISPENSER			
NOTE: READ PROCEDURES TO CMP		COLLECT SAMPLE, DESCRIBE & PLACE IN BAG			
		SEAL BAG AND REPORT NUMBER			
	1+00	STOW SAMPLE			
		PHOTO SITE AND HORIZON 15 FT CROSS SUN			
		PICKUP GNOMON & HTC AND CONTINUE TRAVERSE			
	1+10				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ. CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	1+10	NOTE: TAKE PANORAMAS - DIRECTION·CHANGES ≥ 45° MAJOR POINTS OF INTEREST RIMS OF LARGE CRATERS			
NOTE: READ PROCEDURES TO CDR					
	1+20				
	1+30				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970

EVA: 2 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	1+30	TYPICAL CORE TUBE SAMPLE COLLECTION			TYPICAL CORE TUBE SAMPLE
		PLACE HTC			
		PLACE GNOMON UP SUN			
		ASSEMBLE CORE TUBE/HANDLE-REPORT NUMBER			
		REMOVE HAMMER FROM HTC			
NOTE: READ PROCEDURES TO CDR		DRIVE TUBE INTO SURFACE			
		PHOTO TUBE & HORIZON CROSS SUN @ 15 FT			
	1+40	REMOVE CORE & CAP			
		REMOVE HANDLE & STOW			
		STOW SAMPLE IN HTC			
		PHOTO SITE CORSS SUN AT 5 FT (STEREO PAIR)			
	1+50				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ. CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	1+50				
		POLARIMETRY PHOTOS			
		LOCATE ROCK CLUMP & PLACE GNOMON			
		TAKE 1 PHOTO DWN SUN 15 FT			
		ATTACH POLARIZING FILTER, GO TO f5.6,1/125			
		MOVE TO CROSS-SUN 5 FT (90° PHASE ANGLE)			
		TAKE ONE PHOTO AT EACH OF 3 FILTER POSITIONS (L,C,R)			
		MOVE TO 110° PHASE ANGLE TAKE ONE PHOTO AT EACH OF 3 FILTER POSITIONS (L,C,R)			
NOTE: READ PROCEDURES TO CDR	2+00	MOVE TO 130° PHASE ANGLE TAKE ONE PHOTO AT EACH OF 3 FILTER POSITIONS (L,C,R)			
		GO TO RIM OF CRATER & TAKE ONE PHOTO AT EACH OF 3 FILTER POSITIONS (L,C,R) OF OPPOSITE WALL OF CRATER (SUNLIT)			
		DISCARD FILTER & RESET CAMERA TAKE DOCUMENTED SAMPLES OF ROCKS FROM CLUMP (USUAL PHOTO METHOD)			
	2+10				

MISSION: APOLLO 13, H-2
EVA: 2 - ONE MAN CONTINGENCY

DATE: 16 MARCH 1970

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ. CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	2+10	<u>SOIL MECHANICS</u>			
		PLACE HTC			
		PLACE GNOMON UP SUN			
		PHOTO SITE DOWN SUN			
		PHOTO SITE CROSS SUN			
		ASSEMBLE TRENCHING TOOL			
		DIG TRENCH 10° OFF SUNLINE - 2 FT DEEP			
		TRENCHING TOOL ON HTC			SOIL MECHANICS - TRENCHING
NOTE: READ PROCEDURES TO CDR		RETRIEVE SECS & SMALL SCOOP FROM HTC			
		FILL SECS WITH SUBSURFACE MATERIAL			
	2+20	REMOVE SEAL PROTECTOR & SEAL SECS & STOW			
		DOCUMENT SECS SAMPLE AREA			
		PHOTO BOOT PRINT IN FILL			
		DOCUMENT TRENCH: STEREO PAIR CROSS SUN BOTH SIDES; PHOTO DOWN SUN; PHOTO TO HORIZON OR LANDMARK			
		TAKE DOCUMENTED SAMPLES AS REQUIRED: BOTTOM, TOP, SIDES, FILL, DISCONTINUITIES, OTHER FEATURES			
	2+30				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970

EVA: 2 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	2+30	<u>GAS ANALYSIS SAMPLE (SMALL CAN)</u>			GAS ANALYSIS SAMPLE
		PLACE GNOMON UP SUN			
		PHOTO SAMPLE DOWN SUN			
		PHOTO SAMPLE CROSS SUN (STEREO PAIR)			
		RETRIEVE SAMPLE CONTAINER & OPEN			
		COLLECT SAMPLE & PLACE IN GASC			
		REMOVE SEAL PROTECTOR CLOSE & SEAL GASC			
NOTE: READ PROCEDURES TO CDR		STOW CONTAINER IN HTC			
		PHOTO SITE CROSS SUN			
		LANDMARK PHOTO (IF REQ'D)			
	2+40	<u>MAGNETIC SAMPLE (WHITE CAN)</u>			MAGNETIC SAMPLE
		PROCEED AS ABOVE			
	2+50				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ. CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	2+50	NOTE: COLLECT DOCUMENTED SAMPLES AS APPLICABLE DURING RETURN TO LM			RETURN TRAVERSE
NOTE: READ PROCEDURES TO CDR & PHOTO					
	3+00	REPORT TRAVERSE COMPLETE			SRC 2 CLOSE OUT
		EVA CLOSEOUT			
		PLACE IN SRC 2: CORE TUBES, MAG SAMPLE, GAS SAMPLE, SPEC SAMPLE, DOCUMENTED SAMPLES, FINES & ROCKS FROM AROUND THE LM			
	3+10	CLOSE & SEAL SRC 2 & PLACE ON LM FOOTPAD			

MISSION: APOLLO 13, H-2

EVA: 2 - ONE MAN CONTINGENCY

DATE: 16 MARCH 1970

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	3+10	CLOSE & SEAL SRC 2 & PLACE ON LM FOOTPAD			
		NOTE: IF SRC 1 NOT USED IN 1ST EVA			
		RETRIEVE SRC 1 & PLACE ON MESA TABLE			SRC 1 CLOSE OUT
		OPEN SRC 1 & PLACE SCALE ON MESA-WEIGH BAG ON SCALE			
NOTE: READ PROCEDURES TO CDR & PHOTO		DISCARD CORE STEMS AND CAPS			
	3+20	FILL SRC 1 WITH FINES & ROCKS FROM THE LM AREA			
	3+30				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: 2 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	3+30				
		DEPLOY CLOSE UP CAMERA & TAKE PICTURES AROUND THE LM		READ PROCEDURES AND PHOTO CDR	CLOSE UP CAMERA CLOSE OUT
		OFF LOAD CLOSE CAMERA FILM AND STOW CASSETTE IN ETB			
NOTE: READ PROCEDURES TO CDR & PHOTO					
		RETRIEVE SOLAR WIND - BAG & STOW IN ETB			RETRIEVE SWC
	3+40				
		STOW 70MM CAM & MAGS IN ETB			ETB CLOSE OUT
		REMOVE SEAL PROTECTOR-CLOSE & SEAL SRC 1			
		CLOSE ETB FLAP			
ASSIST ETB TRANSFER		TRANSFER ETB INTO LM		ASSIST TRANSFERS	TRANSFERS
STOW ETB		TRANSFER HOOKS TO SURFACE			
ASSIST SRC 1 TRANSFER		TRANSFER SRC 1 INTO LM			
STOW SRC 1		TRANSFER HOOKS TO SURFACE			
ASSIST SRC 2 TRANSFER	3+50	TRANSFER SRC 2 INTO LM			

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970

EVA: 2 - ONE MAN CONTINGENCY

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
ASSIST SRC 2 TRANSFER	3+50	TRANSFER SRC 2 INTO LM		ASSIST CDR INGRESS	INGRESS
DISCONNECT LEC		DISCARD TONG			
TEMP STOW SRC 2		CLEAN EMU			
		ASCEND TO PLATFORM			
HAND LEC TO CDR		JETTISON LEC			
ASSIST CDR INGRESS		MOVE THRU HATCH			
CLOSE HATCH					
REPRESS CABIN		REPRESS CABIN		CABIN REPRESS AND EVA TERMINATION	
END 2ND EVA	4+00	END 2ND EVA			

4.2.3 Detailed procedure-Minimum Time One-Man

Pages115-117present step-by-step timeline procedures for a minimum time--one-man EVA. The format on the following pages is similar to that the crew would use from their Lunar Surface Checklist.

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: ONE MAN - MINIMUM TIME

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ. CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+00	CHECK CABIN PRESSURE "ZERO" - OPEN HATCH, FEED WATER ON			
		NOTE: DETAIL PROCEDURES ARE PRESENTED IN "LUNAR SURFACE CHECKLIST"; "EQUIPMENT PREP EVA 1" SECTION			
	0+10	MOVE THRU HATCH			

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970
EVA: ONE MAN - MINIMUM TIME

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+10	MOVE THROUGH HATCH			
PREPARE LEC					
		CHECK INGRESS PROCEDURES			
PASS LEC TO CDR		DEPLOY LEC			
PHOTOGRAPH CDR		DESCEND TO LADDER DEPLOY MESA			
SEQ CAM ON		DESCEND TO FOOTPAD			
NOTE: o MONITOR & PHOTOGRAPHY CDR USING 70MM o READ PROCEDURES TO CDR		CHECK ASCENT PROCEDURES STEP TO SURFACE			
		CHECK & DISCUSS MOBILITY & STABILITY			
	0+20				
		REPORT LM STATUS			
CHANGE SEQ CAM MAG SEQ CAM ON		UNSTOW CSC & DEPLOY HANDLE			
		COLLECT SAMPLE			
		REMOVE SAMPLE FROM CSC			
ATTACH 70MM CAMERA TO LEC		HANG SAMPLE ON LADDER			
		REST/CHECK EMU			
ASSIST CDR		TRANSFER 70MM CAMERA TO SURFACE			
		ATTACH 70MM CAMERA TO EMU			
	0+30				

MISSION: APOLLO 13, H-2 DATE: 16 MARCH 1970

EVA: ONE MAN - MINIMUM TIME

LMP ACTIVITIES	EVA TIME	CDR ACTIVITIES	SEQ CAM.	TASK FUNCTION LMP	TASK FUNCTION CDR
	0+30				
		CHECK SURFACE LOCOMOTION CAPABILITY			
CHANGE SEQ CAM MAG					
SEQ CAM ON		DESCRIBE LANDING SITE			
		OBTAIN +Z PANORAMA			
	0+40				
ASSIST CDR		ATTACH 70MM CAMERA AND CONTINGENCY SAMPLE TO LEC			
CHANGE SEQ CAM MAG					
SEQ CAM ON		TRANSFER 70MM CAMERA AND CONTINGENCY SAMPLE INTO LM			
REMOVE 70MM CAMERA AND CONTINGENCY SAMPLE FROM LEC		CLEAN EMU			
		PULL LEC FROM LM & DISCARD			
		ASCEND LADDER			
		INGRESS			
		JETTISON EQUIPMENT & CLOSE HATCH			
		REPRESSURIZE CABIN			
	0+50	END OF EVA			

4.3 Contingency EVA Closeout Times

TBD

SECTION 5.0

APPENDIX

5.1 ABBREVIATIONS

ASC	ALSEP Central Station
ALHT	Apollo Lunar Handtool(s)
ALHTC	Apollo Lunar Hand Tool Carrier
ALSD	Apollo Lunar Surface Drill
ALSEP	Apollo Lunar Surface Experiments Package
A/S	Ascent Stage
BS	Bulk Sample
BTU	British Thermal Unit
CCGE	Cold Cathode Gauge Experiment
CCW	Counterclockwise
CDR	Commander
CM	Command Module
CPLEE	Charged Particle Lunar Environment Experiment
CSRC	Contingency Sample (Return Container)
CSC	Lunar Surface Close-up Camera
CSM	Command and Service Modules
CW	Clockwise
DD	Dust Detector (Experiment)
DPS	Descent Propulsion System
DRT	Dome Removal Tool
DS	Documented Sample
D/S	Descent Stage
ECS	Environmental Control System
EMU	Extravehicular Mobility Unit
ETB	Equipment Transfer Bag
EVA	Extravehicular Activity
FPS	Frame Rate (Sequence Camera)
FTT	Fuel Transfer Tool
HFE	Heat Flow Experiment
ITMG	Integrated Thermal-Meteroid Garment
LD	Lunar Day (TV Lens)
LEC	Lunar Equipment Conveyor
LHSSC	Left Hand Side Stowage Compartment
LM	Lunar Module
LMP	Lunar Module Pilot
LRL	Lunar Receiving Laboratory
MCC-H	Mission Control Center - Houston
MESA	Modularized Equipment Stowage Assembly (Descent Stage)
MSFN	Manned Spaceflight Network
OPS	Oxygen Purge System
PLSS	Portable Life Support System
PSE	Passive Seismic Experiment
RCS	Reaction Control System
RTG	Radioisotope Thermoelectric Generator
SC	Sequence Camera
S/C	Spacecraft
SEQ	Scientific Equipment (Bay) (Descent Stage)
SRC	Sample Return Container
SWC	Solar Wind Composition (Experiment S-080)
TV	Television
UHT	Universal Handling Tool
WA	Wide Angle (TV Lens)

5.2 Lunar Surface Operational Constraints

5.2.1 Introduction

The lunar surface operational constraints presented in this section are restricted to the flight crew operational constraints which are concerned with lunar surface extravehicular activity. The constraints presented here are further restricted to the lunar surface EVA constraints for the third Lunar landing mission. Excluded are spacecraft constraints except where those constraints have a direct bearing on the crew members during the EVA operations.

By definition, a lunar surface constraint is any limitation imposed on lunar equipment design, operational procedure or sequence, etc. due to an equipment, human or environmental characteristic.

5.2.2 Constraint Classification

The constraints are divided into five different categories. The activity or equipment being constrained determines the category of the constraint. The constraints which fall into two or more categories are classified as GENERAL.

Each constraint is also identified according to the impact on the mission that a violation of the constraint would produce. Only the direct results of the constraint violation are considered in determining the violation classification. Multiple malfunctions and the different possible contingencies are not considered. The constraints violation classification is enclosed in parentheses following the constraint.

5.2.2.1 Constraint Categories

Mission Operations:

Constraints on mission operations that are necessary due to considerations of a lunar surface activity.

Lunar Surface Operations:

Constraints on lunar surface operations that are necessary due to equipment design and/or the lunar environment.

Equipment Operation:

Constraints on equipment operation that are necessary due to the equipment design.

General:

Constraints that apply to two or more phases of the Apollo lunar landing mission.

5.2.2.2 Violation Classification

Critical:

A constraint that is necessary to prevent a compromise of mission safety. A violation of a critical constraint would jeopardize the safety of the crew or equipment essential to the completion of the mission.

Major:

A constraint that is necessary to prevent the compromise of the mission requirement.

Minor:

A constraint that cannot be classified as CRITICAL or MAJOR but is necessary to optimize lunar surface activities.

5.2.3 Lunar Surface Operations Constraints

Spacecraft Attitude:

Lunar surface EVA operations will not be conducted when the angle of the LM X-axis with the local gravity vector exceeds 15°. This attitude may arise from the combination of all factors such as asymetric compression of the landing gear struts and terrain conditions. (CRITICAL) (Provisional, documentation to substantiate is unavailable)

Landing Site Slope:

The maximum topographical slope on which lunar surface EVA operations will be conducted will be that which the astronaut can safely negotiate unassisted. This is presently established as 15°. (CRITICAL) (Reference: Unpublished report of test "Crewman Capability Investigation", by Dr. D. L. Lind, Astronaut, Partial Gravity Simulator, Building 5, MSC, November 8, 1968).

LM Forward (+Z) Hatch Operations:

The forward hatch may be left fully open during the EVA (up to 3 hours) provided: (CRITICAL) (GAEC LM Engineering Memorandum LMO-510-1201, April 24, 1969)

1) The cabin temperature, GF 1641T, must be between 60°F and 90°F at the beginning of the EVA,

2) The sun vector is outside a 65° cone about the +Z axis.

Otherwise, the limit is:

1) 15 minutes for hatch fully open or

2) For the duration of the EVA provided the door is no more than 3 inches from the closed position, using the door snubber device for control.

Forward Contamination Control:

Fecal bags and other human wastes will be processed with a disinfectant and double-bagged prior to jettisoning. It is preferred that these be returned to earth by transferring to the CSM. As alternatives the wastes will be stowed in the descent stage if possible. Otherwise, it will be left on the lunar surface. (MINOR)

Extravehicular Communications System:

The first crewman to the lunar surface will operate in the relay mode. For two-man EVA operations the dual mode is nominal. (MAJOR) (Reference: NASA, Land, C.K., "Performance Analysis of The Extravehicular Communication System", MSC Internal Note EB-R-68-14, May 16, 1969).

The fully unstowed PLSS antenna physically interferes with the S-band erectable antenna reflector during alignment operations. (MAJOR) (Reference: Slight, J. B., "S-band Erectable Antenna/EMU Physical Interference Test, "Memorandum EC 64-111, July 20, 1967).

OPS Metabolic Capability:

The maximum heat removal of the Oxygen Purge System (OPS) is about 950 BTU/HR average over the period in which the man is storing 300 BTU. The heat removal capacity of the OPS is 475 BTU's. (CRITICAL). (Reference: Zieglschmid, J. F. M.D.; Results Eighth Lunar Surface Operations Planning Meeting; June 7, 1968).

ALSEP Offloading

The ALSEP cannot be removed from the SEQ bay during the first excursion and deployed during the second excursion due to thermal considerations of the ALSEP equipment. (MAJOR) (Reference: Greider, H. R.; Sixth Lunar Surface Operations Planning Meeting, April 12, 1968).

LiOH Cannister

The LiOH Cartridge of the PLSS can be stored at temperatures within the limits of Fig. 4.5-29 of Apollo Operations Handbook, Vol. IV, EMU Data Book,Amend. 18 (7/3/69). LiOH efficiency is reduced if these limits are not reached or exceeded. The cartridge should not be exposed to an ambient pressure of less than 0.5 psia for more than 15 minutes (cartridge as stowed is sealed to the spacecraft environment. Exposure to ambient pressures less than 0.5 psia causes the water in the LiOH to vaporize which limits its use time in the EMU to 60 minutes maximum. (CRITICAL)

SEQ Bay

The Scientific Equipment Bay doors must be closed after the ALSEP is removed from the bay in order to maintain LM thermal control. (CRITICAL) (Reference: Discussion Between: GAEC Engineers and Lunar Surface Operations Office Engineers; July 25, 1967).

PLSS Battery

The PLSS battery and LiOH canister must be replaced subsequent to the first EVA and prior to the second EVA. Therefore, they must be unstowed from the descent stage and returned to the cabin during the first excursion. (CRITICAL) (Reference: CF32-9M-276; Lunar Surface Operations Office; Twentieth Lunar Surface Operations Planning Meeting, September 12, 1969).

5.2.4 Equipment Operation Constraints

Still Camera (Hasselblad):

Film Environment - The film magazine should not be exposed to vacuum conditions for periods in excess of 5 hours. The film temperature must be maintained in the range of 50-100°F. (MAJOR)

Sequence (Data Acquisition) Camera:

Magazine Temperature - The film magazine limits 130°F as indicated by temperature gage on side of magazine (MAJOR) (Ref: NASA R. Gerlach in Minutes Third Meeting Lunar Surface Operations Planning Meeting, 1/19/68).

Television Camera:

1) The black and white TV camera operating environment temperature range is 0 to 100°F (MAJOR) Reference: NASA, P. Coan in Minutes First Meeting Lunar Surface Operations Planning Meeting, November 17, 1967, also applies to item 2 below). Color TV camera temperature range - TBD.

2) The TV camera lens must not be pointed within 45° of the sun to avoid damage to vidicon tube screen. (MAJOR)

S-Band Erectable Antenna:

1) Line of Sight: The antenna requires unobstructed line of sight of the earth, free of any blockage of spacecraft elements or terrain. (CRITICAL) (Reference- NASA, S. Kelley, Minutes Second Lunar Surface Operations Planning Meeting, January 1, 1968; also applies to items 2 and 3 below).

2) Antenna Stability: The maximum equivalent pitch down reflector angle for tripod stability is 60°. This includes the actual pitch of the reflector to account for site location, correction for earth-moon undulations and terrain slope. The tripod design limit to terrain slope which can be manually compensated by tripod adjustment is 5°. (CRITICAL)

3) Cable Length: The antenna cable length outside the MESA is 30 feet. However, the usable length is determined after allowance is made to permit some lay of cable on surface to avoid pull on the antenna. The effective radius to deploy the antenna is then approximately 20 feet. (MINOR)

Apollo Lunar Surface Experiments Package (ALSEP) (See ref. 3)

The ALSEP will be deployed a minimum of 300 feet from the LM on the Z-axis. The 300 foot minimum distance to the emplacement area is due to the necessity of ALSEP deployment out of the LM ascent blast area. The walk to the deployment area is timed to prevent excess RTG warmup and thereby avoid thermal problems for the crewman. (MAJOR) (Reference: Weatherred, C. J.; Bendix Aerospace Systems Division; Letter - BX P. O. 1726-68-970-1918, May 8, 1968).

1) ALSEP Hold Points
The following list of hold points is provided. The sequence of the ALSEP deployment may be stopped after the completion of any one of the hold points, to be continued at some later time by going to the next series of tasks. (MAJOR) (Reference: Clayton, J. F.; Bendix Aerospace; Letter October 27, 1967).

1a) Remove Packages #1 and #2; close SEQ bay door; emplace ALSEP packages with experiments in and facing the sun.

1b) Tilt fuel cask; dome not removed.

1c) Tilt fuel cask; remove dome, do not defuel.

1d) Fuel RTG; carry ALSEP to deployment site; remove ALHT (if necessary) and subpallet from Package no. 2; carry Package no. 1 to implace site (do not deploy); interconnect RTG cable (do not actuate switch).

1e) Deploy Package No. 1 as well as Package No. 2; release and remove experiments; raise sunshield; deploy experiments (IF DESIRED).

1f) Deploy experiments and complete ALSEP tasks. A hold point exists after each experiment is deployed.

2) ALSEP Deployment
The ALSEP is deployed a minimum of 300 feet from the LM. The individual experiment constraints are as follows: (The Central Station/Package No. 1 is used as a reference with an imaginary clock superimposed on its top so that 12 o'clock falls on the back of the package). (MAJOR)

2a) RTG

PARAMETER	CONSTRAINT
Separation Between RTG and Central Station	9 to 13 feet. Limited by 13-foot cable. Hot RTG should be away from Central Station to avoid contact with astronaut, and to provide maximum heat radiation to free space.
RTG Orientation from Central Station	±20° East or west of Central Station as visually determined by astronaut to minimize thermal load on Central Station.
RTG Deployment Site	Horizontal site. Pallet must be horizontal ±10°, as visually determined by astronaut. No mechanical provisions for astronaut to level RTG. Astronaut will avoid craters and slopes which impede dissipation of heat from RTG.
RTG Alignment	No critical constraints. Astronaut will align so as to favor RTG cable exit toward Central Station.
Interrelation	RTG requires maximum view of space to maximize heat radiation. Astronaut will read ammeter on shorting switch box, connect RTG to Central Station, actuate switch.

2b) ALSEP Central Station

PARAMETER	CONSTRAINT
Central Station-to-LM Separation	300 to 1000 ft. This distance is required to keep ALSEP out of the LM ascent debris blast area.
Central Station Orientation from LM	Due West or East of LM, preferably West. Must not be deployed in shadow of LM.
Central Station Deployment Site	Approximately horizontal, as visually determined by astronaut to provide stable base for antenna. Astronaut must avoid craters and slopes which would degrade thermal control of unit.
Central Station Leveling	$\pm 2.5°$ of vertical as noted by astronaut on bubble level. Leveling procedure interacts with alignment procedure.
Central Station Alignment	$\pm 5°$ of East-West as aligned by astronaut using partial compass rose. Alignment affects thermal control capability of Central Station. Closed or curtained sides of Central Station must face East-West.
Interrelation	Central Station, as with most ALSEP subsystems, requires clear field-of-view for both thermal control and scientific data reasons. Central Station must not be shaded from the sun on the lunar surface prior to deployment. ALSEP design allows deployment when sun angle is between 7 and 45 degrees. ALSEP may be removed from LM when bottom of SEQ Bay is from 18 to 60 inches from lunar surface and with a 15 degree tilt in any direction.

2c) Central Station Antenna

PARAMETER	CONSTRAINT
Site Selection	Attached to Central Station
Antenna Leveling	$\pm 0.55°$ of vertical. Astronaut will use bubble level to adjust. Level adjustment interacts with alignment.
Antenna Alignment	$\pm 0.50°$ of East-West line, with reference to sun line. Astronaut will use sun dial to align.
Antenna Azimuth Setting	Astronaut will set dial to value indicated on Antenna Aiming Tables for landing site chosen.
Antenna Elevation Setting	Astronaut will set dial to value indicated on Antenna Aiming Tables for landing site chosen.
Special Requirements	1. Maximum Allowable Errors for Astronaut Alignment: A. Scale Setting: 0.25° B. Leveling: 0.50° C. Shadow Alignment: 0.70° D. Overall Mean: 1.16°

2d) PSE

PARAMETER	CONSTRAINT
PSE-to-Central Station Separation	8 to 10 feet. Limited by 10-foot cable. 8 feet minimum separation due to thermal heat from RTG.
PSE Orientation from Central Station	Due East or West of Central Station as visually determined by astronaut. Must be out of field-of-view of Central Station radiator.
PSE Deployment Site	Approximately level spot.
PSE Leveling	Must be coarse leveled by astronaut within ± 5 degrees of vertical. Five degrees is the limit of the automatic, fine-leveling gimbal system.
PSE Alignment	Astronaut must rough align within ± 20 degrees of lunar East, before opening PSE shroud, by pointing arrow on the sensor girdle towards the sun. Fine alignment will be performed by the astronaut after removing girdle and spreading the thermal shroud. Astronaut will read and record, to the nearest degree, the intersection of the shadow of thegnomon on the compass rose. Final azimuth alignment must be known within ± 5 degrees accuracy with reference to lunar North or South.
Interrelation	PSE must be no less than 10 feet from other units to minimize pickup of stray vibrations by PSE.

2e) CCGE

PARAMETER	CONSTRAINT
CCGE - Central Station Separation	50 to 60 feet from Central Station. Limited by 60-foot cable.
CCGE ORIENTATION FROM Central Station	Parallel to Central Station as visually determined by the astronaut.
CCGE Deployment Site	Approximately level spot. Unobstructed view in front of orifice.
CCGE Leveling	Must be leveled within ±3 degrees of vertical by use of bubble level.
CCGE Alignment	Astronaut must align CCGE within ±15 degrees of lunar East.
Interrelation	CCGE must be no less than 100 feet from the LM ascent stage.
Special Requirements	The CCGE gauge nozzle must point away from the LM and other subsystems.

2f) HFE

PARAMETER	CONSTRAINT
Spearation between HFE electronics package and Central Station	25-30 feet. Limited by 30-foot cable.
HFE electronics package orientation from Central Station	Approximately due south of the Central Station in a direction opposite to the line connecting the Central Station to the RTG.
HFE Electronics Package Deployment Site	Approximately level area, removed from any surface irregularities or rocks that might reflect sunlight directly onto the sunshield reflector of the electronics package.
HFE Electronics Package	Leveled to ± 12 degrees of vertical for maximum utilization of the thermal sunshield.
HFE Electronics Package Alignment	Aligned to within ± 5 degrees of the plane of the ecliptic or lunar equator.
Electronics Package to PROBE Separation	16-20 FEET. Limited by length cable.
Electronics package to Probe Orientation	See Figure 3-5.
Probe Deployment Site	See Table 3.1-7.
Probe Alignment	Within 15 degrees of vertical.
Probe to Probe Separation	Approximately 34-36 feet, as shown in Figure 3-5.
Interrelation	The HFE should be at least 10 feet from all other experiments and at least 20 feet from the PSE.

2g) HFE Probes

PARAMETER	CONSTRAINTS
Probe Deployment Site	It is desired that the Heat Flow probe holes be at least two diameters from craters or rocks two meters or more in diameter; however, local conditions may not permit satisfying this criterion. The minimum allowable distance from a crater or rock two meters or more in diameter is one diameter. Reference: Langster, M. and Perry, R. letter dated January 6, 1970.

2h) CPLEE

PARAMETER	CONSTRAINT
CPLEE-to-Central Station Separation	9 to 11 feet, limited by 11-foot cable.
CPLEE Orientation from Central Station	Generally South of Central Station. Minimum 10 feet, preferably 20 feet from RTG. Must avoid field-of-view of Central Station radiator. Orientation visually determined by astronaut.
CPLEE Deployment Site	Approximately level area, free of gross surface irregularities and rocks or boulders. Bottom of experiment should not touch the surface.
CPLEE Leveling	Within ± 2.5 degrees of vertical. Astronaut will level the CPLEE using bubble level. Leveling interacts with alignment.
CPLEE Alignment	Within ± 2 degrees of East-West sun line. Astronaut will align so that arrow on top of unit points East, then report, within +1 degree, the reading of the shadow of the handling tool on the partial compass rose.
Interrelation	Radioactive contaminants caused by other ALSEP Subsystems must be less than 0.1 count per second in all channels of CPLEE.

5.2.6 Equipment Design Constraints

Reach Limits:

1) The low reach limit to manually extract ALSEP packages from the SEQ bay is governed by the interference of the opened bay door. A minimum heigh for the opened door is 50 inches above the standing surface. (MAJOR) (Reference: NASA, Unpublished report "Lunar Surface Equipment Tests", Test Crewmen Dr. D. L. Lind and H. H. Schmitt, May 31, 1967; also 2 and 3 below).

2) The high reach limit to "push button" while wearing A5L suit is 76 inches. (MAJOR)

3) The high reach limit to "REACH HANDLE" while wearing A5L suit is 74 inches. (MAJOR)

Astronaut Pull Force:

1) The maximum two-hand pull force that can be applied by a free standing astronaut in an A6L suit is 27 pounds. (MAJOR) (Reference: NASA Unpublished Report "Crew Capabilities of Suited Astronaut Operating in Partial Gravity Simulator", Test Crewman Dr. D. L. Lind, Test Conductor C. Klabosh, November 8, 1968; also 2 below).

2) The maximum one-hand pull force that can be applied by a free standing astronaut in an A6L suit is 17 pounds. (MAJOR)

5.2.7 General Constraints

Skin Heat:

The maximum tolerable heat flow to a crewman's skin through suit contact is 18 BTU/FT minute. The pain threshold for heat applied to any part of the body is 113°F. (CRITICAL) NASA SP-3006

Body Heat Storage:

The amount of heat that can be planned for a crewmember to store in his body during Oxygen Purge System (OPS) operations is 300 BTU. (CRITICAL)

5.3 ALSEP and Scientific Equipment Procedures

5.3.1 Detailed Nominal Deployment Procedures

INDEX

1) ALHT CARRIER OFFLOAD AND DEPLOYMENT

(Package 2 is in position such that handle is uppermost)

1. Pull two silver pip pins holding carrier on pallet

2. Turn (CCW) and pull two green pins lanyarded to silver pins just removed

3. Grasp carrier by handle, pull up and tilt toward ground until carrier is free

4. Invert carrier and deploy center (vertex) leg

5. Deploy two side legs

6. Remove green clip from underside and discard

7. Turn and remove two gold colored pins from side of carrier

8. Right the carrier and unfold until detent in handle engages

9. Carry to vicinity of MESA and deposit on surface

2) ALSEP

a) CENTRAL STATION ERECTION

1. Use UHT to release antenna cable restraint and deploy cable

2. Use UHT to release following Boyd Bolts on Package No. 1:
3 on SW, walk around, 2 on SE; then
5 on S side; 2 on W side; 2 on NW side;

3. Use UHT to release following Boyd Bolts: CCW walk
2 on aiming mechanism housing; 3 on N side; 4 on E side

4. Proceed to N side of package; check for release of sunshade from pallet

5. Use UHT to release 2 Boyd bolts on antenna

6. Use UHT to release 2 northmost interior sunshield Boyd bolts

7. Use UHT to release center Boyd bolt

8. Use UHT to guide sunshield popup

9. Remove UHT and tether or stow

10. Complete sunshield deploy, using manual assist

11. Check for proper deployment of side curtains

12. Remove and discard 3 sunshield curtain covers

b) ANTENNA ERECTION & AIMING

1. Retrieve antenna mast (carry handle) from Subpallet

2. Return to Package No. 1

3. Install antenna mast on Package No. 1

4. Remove aiming mechanism housing from Package No. 1

5. Install aiming mechanism on antenna mast

6. Remove aiming mechanism restraining pull pin. (discard pin)

7. Remove aiming mechanism housing and packaging and discard

8. Grasp antenna and install on aiming mechanism

9. Receive azimuth and elevation settings

10. Enter azimuth

11. Enter elevation

12. Adjust leveling knobs, using bubble level

13. Observe sun compass, adjust alignment knob

14. Recheck level

c) CENTRAL STATION ACTIVATION

1. Use UHT to turn on Astronaut Switch No. 1

2. Request transmitter turn-on

3. Go to NW side of package No. 1

4. Check antenna orientation

5. Receive confirmation of good RF and data transmission if required

   SW. (2) turns on central power
   SW. (3) turns exp. (seq) to operate

d) CHARGED PARTICLE LUNAR ENVIRONMENT EXPERIMENT DEPLOYMENT (CPLEE)

1. Use UHT to release 3 Boyd bolts on CPLEE

2. Use UHT to remove CPLEE from Package No. 1.

3. Remove carry socket rotation pull pin and discard

4. Transport CPLEE 10 feet S of Package No. 1 and place CPLEE on surface

5. Level CPLEE, using bubble level

6. Align CPLEE, using shadow cast on dust cover

7. Disengage UHT and tether to EMU

e) COLD CATHODE GAUGE EXPERIMENT (CCGE) REMOVAL

1. Use UHT to release 4 Boyd bolts on CCGE

2. Remove CCGE from Package No. 1 with UHT

3. Transport CCGE to 10 feet SW of Package 1

4. Deposit CCGE on lunar surface, disengage UHT

f) COLD CATHODE GAUGE EXPERIMENT DEPLOYMENT

1. Engage UHT in CCGE carry socket

2. Lift CCGE and remove pull pin from CCGE cable reel (discard pin)

3. Transport CCGE 55 feet SW of Package No. 1

4. Lower CCGE to surface and level it, using bubble level

5. Align CCGE, using shadow cast on side of experiment package

6. Disengage UHT and tether to EMU

g) DRILL, APOLLO LUNAR SURFACE (ALSD)

A. Hole Boring for Heat Flow Experiment (HFE)

1. Transport ALSD and ALHTC to HFE site (30' SE of Central Station) and place both on surface.

2. Lift ALSD by carrying handle with left hand and place ALSD on ALHTC so that ALHTC pin engages hole in treadle stability block. Place treadle on ALHTC so that treadle velcro can readily engage velcro clipped to ALHTC handle

3. Hold left side of ALSD steady with left hand. Pull treadle velcro tab with right hand and engage treadle velcro strap with velcro on ALHTC handle.

4. Steady ALSD with left hand. Depress drill actuator switch with right index finger. Check for power head operation by observing spindle rotation.

5. Hold ALSD steady with right hand. Remove bore stem cover retention pin by pulling ring vertically (Pin No. 1).

6. Hold ALSD steady with right hand. Remove rack support pin by pulling ring horizontally and sharply to the left (Pin No. 2).

7. Rotate rack camloc 90° counterclockwise. Release camloc but do not rotate bracket. (Pin No. 3).

8. Hold ALSD steady with left hand. Rotate battery camlock 90° counterclockwise. Release camloc and lift vertically. Remove camloc and rack support PIN No. 2 by pulling release lanyard ring horizontally and sharply to the right (Pin No. 4)

9. Steady ALSD with left hand. Place middle fingers of right hand against leg #1 between stowage clip and leg foot pad. Push leg out of clip with fingers. Catch leg in left hand as it unfolds outward.

10. Grasp leg foot pad with right hand. Steady ALSD with left hand. Extend leg by pulling on pad. Check color coding as leg approaches locked position. Fully extend leg to locked position. Verify locked position by gently pulling and pushing leg. Release leg to permit full outward deployment.

11. Steady ALSD with left hand. Grasp leg #2 foot pad with right hand. Extend leg by pulling on pad. Check color coding as leg approaches locked position. Fully extend leg to locked position. Verify locked position by gently pulling and pushing leg.

12. Remove handle and switch actuator assembly from stowage clips.

13. Grasp handle in right hand and fit handle fixed lock pin into battery receptacle. MAKE CERTAIN PIN IS FULLY ENGAGED.

14. Pull upward on handle with left hand making certain upper fixed pin remains fully engaged into the receptacle. Slap the bottom of the handle inward. Spring-loaded pin will engage and lock into lower receptacle. Ensure that handle is securely and positively locked in position.

15. Rotate rack camloc and bracket upward (away).

16. With left hand under upper bore stem retention bulkhead and right hand under lower bore stem retention bulkhead, lift rack vertically from treadle. Leg #3 will deploy downward. Extend pad manually if leg does not fully deploy.

17. With right hand, grasp jaw assembly of wrench. Hold rack in vertical position. With left hand grasp No. 3 leg foot pad. Extend leg by pulling on pad. Check color coding as leg approached locked position. Fully extend leg to locked position. Verify locked position by gently pushing and pulling the leg.

18. Rotate rack camloc and bracket fully inward. Place rack on surface.

19. Reset adapter. Push collet in. Depress spring-loaded key blocks and thread adapter fully into spindle.

20. Steady drill with right hand. Remove power head retention bracket pin by pulling ring horizontally and sharply to the left. (Pin No. 5). Rotate bracket (toward).

21. Remove power head and battery assembly from treadle by lifting on upper part of handle with right hand and simultaneously lifting on lanyard with left hand. Lift vertically and move horizontally to right slightly.

22. Transport rack and power head assembly to first HFE probe site. 16' SW of HFE site.

23. Place rack and power head on surface.

24. Remove bore stem cover.

25. Discard cover, making certain that it is at least six feet from heat flow probe hole.

26. Pull bore stem retention strap release tab.

27. Select one of the two bore stems with drill bit attached. These stems are identified by an orange stripe on inside of male taper. One is always stowed in the upper left position and the other in the upper right position. One set of six bore stems is marked with an exterior yellow stripe on each stem. Choose either set to begin operations.

28. Select a standard stem and fit to the selected bit stem.

29. Fit this double stem section to the power head adapter with the power head assembly on the surface. Firmly engage these stems. Lean on and push stems while rotating them clockwise into the adapter.

30. With Lanyard, lift power head assembly from surface. Do not lift with stems. Rotate assembly and place drill bit into surface.

31. Remove thermal shroud by pulling release ring. Discard shroud. Ensure that it is at least 6 feet from heat flow probe hole.

CAUTION: If, after removal of thermal shroud, ALSD operations are delayed for more than 30 minutes and the sun angle is less than 22° above the horizon, the shroud shall be replaced until resumption of dril operation.

32. Check verticality of bore stems (stems to be within 15° of vertical).

33. Energize power head by pushing inward on both handles. Drill to lower handle height limit.

34. Release adapter by rotating power head 90° counterclockwise and then rotate clockwise 90° to the normal drilling position. Energize power head for a few seconds and push down, then energize again and simultaneously lift power head vertically.

If the adapter does not release after first attempt, repeat procedure up to three times. After adapter release, de-energize power head prior to moving drill horizontally from stem to preclude contact of rotating retention clips and adapter with suit.

35. Reset adapter. This may be accomplished in either of the following ways:

- Place power head on surface. Reset collet by pushing it into adapter with palm of hand. Depress key block springs with thumb and index finger. Rethread adapter into spindle.

- Hold power head with left hand and push collet in with palm of right hand. Depress key block springs with thumb and index finger. Rethread adapter into spindle. Power head may be held vertically or horizontally.

36. Fit a standard bore stem to stem protruding from surface from the same set as the first two.

37. Fit power head adapter to this bore stem

38. Follow same procedures for the boring of the 2nd heat flow probe hole as for the first.

B. Hole Coring

1. Remove adapter from power head spindle using any of the following procedures:
   - With power head on surface, grasp adapter and rotate counterclockwise until free of spindle.

   - With power head on surface, insert slotted end of wrench into adapter. Rotate wrench until slots engage mating key in adapter. Grasping wrench by jaws, rotate counterclockwise until adapter is free of spindle.

   - Hold power head with either hand. Insert wrench and proceed as in above procedure.

   - When ALHTC is brought to coring site, use treadle as a working platform to perform removal task as indicated in first two procedures above.

2. Discard adapter, making certain that it is at least 6 feet from the heat flow probe.

3. Return to the HFE site. Transport ALHTC to a position between 6 and 9 feet east of the 2nd heat flow probe. Avoid cable from HFE site to probe.

4. Disengage treadle velcro from ALHTC arm velcro. Fold velcro, engage and place on treadle.

5. Remove treadle from ALHTC, rotate power head retention bracket to closed position. Drop treadle on surface in desired coring spot.

6. Remove wrench from rack and stow on ALHTC.

7. Remove core stem with bit from ALHTC sample bag.

8. Remove another core stem and couple to bit stem. Bring stems together such that initial contact is at an approximate 45° angle. Rotate into alignment and gently engage threads. Gently rotate until threads are fully engaged.

9. Thread this double core stem section into power head spindle Use same technique as for coupling core stems.

10. Lift and rotate power head assembly. Place core bit into treadle pilot while rotating power head clockwise until bit drops through lock.

11. Place a foot on treadle to stabilize it. Make certain treadle is reasonably level. Check verticality of core stems. Energize power head. Drill to lower handle height limit.

12. Keeping foot on treadle, rotate power head counterclockwise one and one-half turns and lift to disengage power head from core stem.

13. Place power head on surface.

14. Remove another core stem from sample bag and couple.

15. Thread this core stem section into stem protruding from surface.

16. Lift power head and fit to core stem. Initial contact to be about 45°. Rotate to vertical and gently rotate clockwise to engage threads. Continue rotating clockwise until threads are fully engaged (about 1-1/2 turns).

17. Repeat procedures 12 through 17. Drill to lower handle operating limit.

18. Rotate power head clockwise and then lift and contineu rotating power head clockwise. When handle is approximately at waist height, shift hands to under side of handle. Continue rotating power head clockwise and lifting until two stems clear treadle pilot. Do not energize power head unless retraction cannot accomplished manually. During this event keep treadle flat on surface. (Both crewmen will do this step, working together)

19. Remove wrench from ALHTC. Place foot on treadle. Engage wrench on first stem below power head. Hold wrench in one hand and rotate power head counterclockwise 1-1/2 turns and lift vertically free of core stem. Place power head on surface. (Both crewmen accomplish this and all steps following, working together)

20. Remove core stem cap retainer assembly containing eight caps from ALHTC. Caps come off square end of retainer assembly. Ensure caps are marked A-H. Cap the open core stem with Cap A. Return cap retainer assembly to ALHTC.

21. Remove wrench from ALHTC. Place foot on treadle. Make certain treadle is flat on surface. Rotate top core stem counterclockwise one-quarter turn to loosen joint.

22. Rotate core stem string clockwise. (It may be necessary to use wrench to loosen treadle lock.) Continue rotating core stem string clockwise and simultaneously lift vertically until another stem is withdrawn.

23. With wrench rotate second stem from top counterclockwise one-quarter turn to loosen joint.

24. Repeat steps 23 and 24 until last stem joint is loosened. Replace wrench on ALHTC. Remove first set of core stem caps (7 remaining).

25. Completely withdraw core stem string. Cap core stem bit (Cap B).

26. Lean core stem string against ALHTC or rack with bit end on surface.

27. Separate stems one at a time starting at the top (power head end). After first four stems are capped on both ends, remove second core stem cap retainer assembly from ALHTC. Place capped stems in ALHTC sample bag as they are capped.

28. Make certain all items to be left at core site are at least 6 feet from the heat flow probe.

h) HEAT FLOW EXPERIMENT DEPLOYMENT (HFE)

1. Using UHT, release 8 Boyd Bolts, 4 on Electronics, 4 on Probe Package.

2. Engage UHT in Heat Flow electonics package

3. Transport Heat Flow electronics package 30 feet SE of package No. 1.

4. Deposit electronics package on surface and disengage UHT.

5. Engage UHT in Heat Flow electronics carry socket

6. Raise package and remove Heat Flow Probe Package restraining pull pin (discard pin)

7. Use upper liftoff handle to separate Probe Package from Electronics Package

8. Using UHT, lower Electronics package to surface

9. Disengage and tether UHT (Optional)

10. Remove and discard first closure strap

11. Grasp lower liftoff handle

12. Remove second closure strap and discard

13. Use upper liftoff handle to separate 2 halves of heat flow probe package

14. Lean upper half of package against Heat Flow electronics package

15. Rotate emplacement tool holding device and attach to bottom of Hear Flow Probe Package

16. Grasping carrying strap, transport Probe Package to first hole (cable to probe will deploy as you walk)

17. Remove emplacement tool from holding device and temporarily stow

18. Remove the rest of cable from Probe Package

19. Pull ring to rotate sleeve containing probe assembly forward

20. Remove probe assembly from sleeve

21. Discard Probe Package (away from site, at least 8 feet)

22. Grasp probe assembly and remove sail cloth retaining first probe end piece

23. Remove sail cloth retaining second probe and piece (discard both cloths)

24. Position lower sunshield over spring on upper probe section

25. Unfold probe and insert lower half of probe in hole

26. Retrieve emplacement tool from temporary stowage

27. Place emplacement tool "crow's foot" over spring on upper probe section

28. Use emplacement tool to complete emplacement of probe in hole

29. Report first exposed marking on tool

30. Withdraw tool from hole, and take tool "crow's foot "off cable"

31. Use emplacement tool to retrieve cable near upper sunshield

32. Use emplacement tool to fully deploy upper sunshield over drill hole

33. Use emplacement tool to measure stem protrusion-report first exposed marking

34. Restow emplacement tool in rack

35. Return to Heat Flow electronics Package and retrieve upper half of probe package

36. Grasping carrying strap, transport probe package to second hole (cable to probe will deploy as you walk)

37. Remove the rest of cable from probe package

38. Pull ring to rotate sleeve containing probe assembly forward

39. Remove probe assembly from sleeve

40. Discard probe package (away from site, at least 8 feet)

41. Grasp probe assembly and remove sail cloth retaining first probe end piece

42. Remove sail cloth retaining second probe end piece (discard both cloths)

43. Position lower sunshield over spring on upper porbe section

44. Unfold probe and insert lower half of probe in hole

45. Retrieve emplacement tool from temporary stowage

46. Place emplacement tool "crow's foot" over spring on upper probe section

47. Use emplacement tool to complete emplacement of probe in hole

48. Report first exposed marking on tool

49. Withdraw tool from hole, and take tool "crow's foot" off cable

50. Use emplacement tool to retrieve cable near upper sunshield

51. Use emplacement tool to fully deploy upper sunshield over drill hole

52. Use emplacement tool to measure stem protrusion--report first exposed marking

53. Discard emplacement tool

54. Untether UHT and insert in Heat Flow electronics carry socket

55. Align electronics package, using shadow cast on side of package

56. Implant electronics package legs and realign if required

57. Disengage UHT and retether

i) PASSIVE SEISMIC EXPERIMENT DEPLOYMENT (PSE)

1. Unstow tethered UHT from EMU

2. Use UHT to remove boyd bolt on PSE Stool

3. Use UHT to remove PSE stool from subpallet

4. Grasp stool (retether UHT)

5. Proceed 10 feet E of package No. 1 and place PSE stool on surface

6. Unstow UHT from EMU and release 4 Boyd bolts on PSE

7. Use UHT to remove PSE from Package No. 1

8. Transport PSE to PSE Stool using UHT. Hover PSE over stool. Remove girdle and discard

9. Place PSE on stool and align, then remove UHT

10. Use UHT to deploy skirt

11. Use UHT to level PSE with Bubble level as reference. Report alignment using sun compass.

j) RADIOISOTOPE THERMOELECTRIC GENERATOR (RTG) FUEL CAPSULE UNLOADING

1. Remove cask rotation lanyard from inside of Protective Door

2. Holding fabric part of lanyard rotate cask to near-hroizontal position such that cask dome is within easy reach (first pull releases pins)

3. Pull cask lanyard out of way

4. Walk to ALSEP Package 2 and remove dome removal tool from subpalelt

5. Return to cask and insert tool in dome

6. Remove dome and discard dome with tool under LM

7. Walk back to ALSEP Package 2 and secure Fuel Transfer Tool (FFT)

8. Return to cast and insert FTT into fuel capsule head

9. Rotate tool handle to engage capsule and release capsule from cask

10. Withdraw tool and capsule from cask

11. Move to Package 2 (other crewman will have rotated it to loading position)

12. Insert capsule into RTG

13. Release tool (FTT) by counterrotating tool handle

14. Discard FTT under LM

k) RTG POWER CABLE DEPLOYMENT AND HOOKUP

1. Use UHT to release 3 Boyd bolts on RTG Cable Reel

2. Engage UHT in RTG Cable Reel carry socket

3. Using UHT, remove RTG cable reel from Package No. 2 and proceed to Subpallet (Power cable will deploy as you walk)

4. Remove shorting switch pull pin and discard

5. Grasp shorting switch assembly

6. Disengage UHT from RTG Power Cable Reel and discard reel

7. Stow UHT and move to Package No. 1

8. Report ammeter reading

9. Remove central station dust cover and discard

10. Mate power cable to central station and check indicator

3) CONTINGENCY SAMPLE COLLECTION

1. Remove contingency sampler from pocket

2. Discard Velcro retention strap

3. Assemble handle and secure cable in slot at end of handle

4. Extend bag using tab on bottom of bag

5. Take sample

6. Stow intact sampler and soil on LM strut

4) EXPENDABLES UNSTOWAGE

1. Unfold SRC Table, push down until clips engage on lower edge of MESA

2. Secure SRC Table level front and back with Velcro strap

3. Unfold and hang ETB on front of SRC Table

4. Pull pins on LiOH canister retainers, remove canisters

5. Place canisters in ETB

6. Pull pins on PLSS batteries

7. Pull up on PLSS battery tabs and place PLSS batteries in ETB

8. Close flap on ETB

5) FLAG DEPLOYMENT

1. Pull flag stowage pip pin

2. Lift the flag from its stowage

3. Walk to the deployment site. Push the lower section of the flag staff into the surface.

4. Remove the hammer from stowage by releasing the two tie-down snap straps and lifting the hammer from it MESA stowage location.

5. Using the hammer drive the lower section of the flag staff into the surface.

6. Deploy the horizontal shaft by first extending then rotating the shaft so it is perpendicular to the flag staff.

7. After the lower section has been driven into the surface, insert the upper section of the flag staff into the lower section.

6) MESA BLANKET REMOVAL

1. Unwrap Velcro strap from around TV lens

2. Pull up lower left edge of blanket

3. Ease blanket up over TV camera and let fall on R side of MESA

4. Pull back L side of blanket under MESA restraint strap and let fall on L side

5. Verify all side orifices on MESA clear of blanket

7) S-BAND UNSTOWAGE DEPLOYMENT

1. Walk to Quad I

2. Remove thermal shield

3. Remove Velcro straps and pull 2 pip pins at base of antenna

4. Grasp antenna by deployment bar and lift handle

5. Pull antenna out and down to clear LM

6. Unfold lift handle

7. Carry antenna by deployment bar to errection site (20 ft. from LM, clear view of Earth)

8. Place antenna vertically on surface, handle down, orientation arrow on top pointing toward Earth

9. Release 3 leg clamps

10. Depress (1 at a time) the 3 leg tips out of the top cap

11. Discard top cap and foam liner away from LM

12. Grasp antenna horn top plate and raise first sectiob of antenna feed support

13. Verify 1st section locked in detent CAUTION DO NO TOUCH HELIX ELEMENT

14. Extend 2nd antenna feed support section in same manner as 1st

15. Verify 2nd section fully extended and locked in detent

16. Extend antenna legs by pushing up on 2 loops on ends of legs. Extend to proper paint ring (determined by astronaut height and reach capability) and lock down clamps

17. Verify antenna toward Earth by arrow on rib support

18. Move to right by the deployment bar

19. Pull each of the 3 velcro straps loose-legs will fall to surface. Discard thermal cover.

20. Using both hands, lift antenna vertically from surface until the handle underneath can be grasped.

21. Continue to lift antenna until tripod detents enage and antenna is stable on 3 legs

22. Pull pip pin from bottom of deployment bar

23. Pull bar down and discard

24. Implant each leg in surface

25. Remove rib tip protector (it will slide down one of the legs to surface)

26. Uncoil reflector release cable from around antenna

27. Hold cable taut and in straight line to plunger

28. Remove trigger guard pin (discard pin)

29. Grasp antenna leg with free hand-position at arm's length from leg

30. Duck and squeeze release trigger to deploy dish

31. Walk to Left side, MESA

32. Release antenna cable connector by pulling Velcro tab and snap free

33. Pass cable connector under MESA retaining strap

34. Holding connector, walk back to left of antenna until cable is completely unwound from MESA (black and white wtrip visible)

35. Walk to antenna

36. Mate 2 connector parts, turn cable part clockwise (as viewed from cable end)

37. Move to crank location and unstow

38. Uncoil crank by passing it around and behind base

39. Rough align antenna in pitch (CCW=down)

40. Rough align in azimuth (pull out on crank to shift gears)

41. Press legs into surface

42. Check alignment by sighting along mast

43. Check alignment by using alignment sight

44. Fine align using crank as required

    IN = PITCH

    OUT = AZIMUTH

8) SEQ BAY DOOR OPENING

1. Remove thermal cover from door lanyard (R side of door)

2. Remove lower Velcro strap and grasp lanyard

3. Back away to position clear of door

4. Pull white part of lanyard to raise door

5. Verify door fully open and folded up over SEQ Bay

6. Verify lanyard untangled and temporarily stow on LM strut

7. Secure doors with Velcro strap if Quad II is low

9) ALSEP PACKAGE UNLOAD

1. Remove boom lanyard from package handle

2. Move to position 10 ft from package and in front of it

3. Pull white portion of boom lanyard until package unlocks and boom pulls package out to full extension (package will swing free of LM at back edge) of boom

4. By discrete pulls on black and white striped portion of lanyard, lower package to surface (assist package if required to achieve handle up position)

5. Release white portion of boom lanyard from base of package

6. Pull pip pin to free hockey stick

7. Release small lanyard from velcro on handle

8. Move package clear

9. Pull black and white striped portion of lanyard to retract boom

10) SEQ BAY DOOR CLOSING

1. Tuck hockey sticks, lanyards and cables inside SEQ Bay

2. Retrieve door lanyard from LM strut

3. Move to position clear of door

4. Pull black and white striped portion of lanyard until door is closed

5. Toss lanyard under LM

11) SOLAR WIND COMPOSITION (SWC) DEPLOYMENT

1. Release the two SWC tie-down snap straps and lift the SWC from the MESA

2. Carry the SWC to the deployment site 60 feet from the LM in Quad IV

3. Extend each section of staff until it locks. (red band should be visible) Apply a compressing force to each section to check sections locked

4. Extend shade cylinder and rotate toward red side of pivot point, i.e., red to red

5. Extend foil shade and hook to lower portion of staff

6. Press staff into surface with foil normal to sun (side marked SUN to SUN)

12) TV DEPLOYMENT

1. Release two snap tie-down straps

2. Lift the tripod from the MESA

3. Deploy the tripod legs and extend the center shaft

4. Set the tripod on the surface near the MESA

5. Release the cable connector snap tie-down strap

6. Release lens tie-down snap straps

7. Release the end snap on the camera tiedown snap strap

8. Using pip pin cable, pull the two top pip pins to open the camera stowage container

9. Open and rotate the top half of the camera stowage container forward and down.

10. Reset lens and put on lens cap

11. Deploy the TV camera handle

12. Lift the camera from the stowage container and lift the TV cable free of the MESA.

13. Insert the TV camera handle in the adapter ring on top of the TV tripod and tighten the ring

14. Pull the TV cable from its stowage cavity on the right side of the MESA.

15. Carry the TV to designated position

5.3.2 Detailed Equipment Contingency Procedures

APOLLO 13

ALSEP AND SCIENTIFIC EQUIPMENT

CONTINGENCY PROCEDURES

February 26, 1970

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GENERAL

For any malfunction on a scientific task: spend a maximum of 10 minutes on malfunction procedures, then abandon. Additional time may be allocated on certain malfunctions resulting in total ALSEP abandonment. This additional time will be a real time decision based on consumables and timeline constraints.

The sequence of the ALSEP deployment may be stopped after the completion of any one of the following hold points, to be continued at some time later by going to the next series of tasks.

Hold Points

1. Remove Packages #1 and #2; close SEQ bay door; emplace ALSEP packages with experiments in and facing the sun.

2. Tilt fuel cask; dome not removed.

3. Tilt fuel cask; remove dome, do not defuel.

4. Fuel RTG; carry ALSEP to deployment site; remove subpallet from Package No. 2; carry Package No. 1 to implace site (do not deploy); interconnect RTG cable (do not actuate switch).

5. Deploy Package No. 1 as well as package No. 2; release and remove experiments; raise sunshield; mount and aim antenna; deploy PSE.

6. Deploy experiments and complete ALSEP tasks. A hold point exists after each experiment is deployed.

Mission priorities for ALSEP experiment deployment have been defined as follows:

1 - Passive Seismic Experiment
2 - Heat Flow Experiment
3 - Cold Cathode Gauge Experiment
4 - Charged Particle Lunar Environment Experiment

SRC Configuration - Listed in the order of availability to the astronaut.

SRC #1

Spring Scale
Weigh Bags (2)
Drill Stem Caps in Retainers (2)
Drill Stem (6)
35 DSBD (Documented Sample Bag Dispenser)
Organic Control Sample

SRC #2

Weigh Bags (2)
SESC (Special Environmental Sample Container)
GASC (Gas Analysis Sample Container)
MSSC (Magnetic Shield Sample Container)
Core Tube Caps & Bracket Assy.
Core Tubes (3)
35 DSBD
Organic Control Samples
SWC Bag

Page Missing From

Source Document

For ETB transferred at end of 2nd EVA:

1. Magnetic Sample Container
2. Fuel Contamination Sample
3. Sieve Sample (in weigh bag)
4. Engineering Soil Sample (15 lb. extra sample in weigh bag)
5. SWC

MESA DEPLOYMENT

1. MESA release handle will not release.

   a. Attempt to free release handle by exerting side loads on pip pin.

   b. Attempt to reach cable from release handle to MESA. Pull on this cable or cable bell crank mechanism with hand to deploy MESA.

   c. Attempt to reach cable beyond bell crank and pull to deploy MESA.

2. Release handle releases, MESA does not deploy.

   a. Try repeated pulls on release handle.

   b. Manually deploy MESA from surface with lanyard.

   c. One crewman pull on MESA lanyard while other crewman pulls release handle.

   d. Remove thermal covering around MESA and attempt to retrieve shovel for use as tool to assist MESA deployment.

3. MESA fails to stop and hits lunar surface (lanyard breaks).

   a. Attempt to block up MESA with available rocks or SRC (on end).

   b. Attempt to tie up MESA if lanyard available.

2.

CONTINGENCY SAMPLE CONTAINER (CSC)

1. Handle comes off CSC before sampling, container falls on lunar surface.

    a. Attempt to retrieve with handle.

    b. Get tongs from MESA and retrieve bag from surface, then reinstall bag ring on handle.

2. Handle will not come off CSC after sampling.

    a. Remove clip

    b. If handle is stuck bend sampler handle toward cup ring until bag retaining pin is free of cup ring (approximately 90°) and remove bag.

MESA AND INITIAL ACTIVITIES

1. SRC table will not remain in proper position.

    a. Attempt to set on struts.
    b. Get assistance from other crewman to hold SRC during filling or to hold table.

2. Unable to erect Gnomon/broken leg.

    Place the gnomon at the first station indicated in the mission plan. Take the photographs for color reference indicated at that station and omit the gnomon afterwards.

3. Spring scale inoperative for measuring.

    Use the spring scale as a hook. Fill the weigh bag to the upper level.

4. Unable to attach extension handle to scoop.

    Hit locking collar with hammer and attempt to free locking mechanism.

5. Unable to attach sample bag to scale (torn bag).

    a. Use teflon hand hold strap and hang on scale or table.

    b. Hold in one hand, scoop with other.

    c. Obtain assistance from other crewman to hold bag during filling operation.

6. Unable to open SRC.

    a. Hit corners of SRC lid with hammer and attempt to pull lid free.

    b. If forced to abandon SRC #1 use MESA weigh bags for Selected Samples and transfer to LM ascent stage in Tote Bag.

       Abandon: ALSD Core Drilling Operation

    c. If forced to abandon SRC #2, use MESA weigh bags for Documented Samples and transfer to LM Ascent Stage in Tote Bag. The SWC is to be transferred in the ETB.

       Abandon: Drive tube core samples
       SESC
       GASC
       MSSC

7. Unable to latch SRC

   a. Check that spacer has been removed. If not, remove.

   b. Open and look for interference.

      (1) Relocate item, shake or pat to settle loaded weigh bag. If "O" ring out of groove, pull out and discard.

      (2) Remove excess packing material or sample and repack.

   c. If no apparent interference, close and engage other strap latch. If this latch will rotate to within 30° of being closed, place other hand on back of box to permit application of maximum closing pressure by a muscular squeezing action.

      (1) If this strap latches, try first latch again in the same manner.

      (2) If the second latch will not latch, bring it back to earth with 1 latch closed.

      (3) If still cannot latch at least one side, abandon SRC.

   d. Transfer samples in Tote Bags.

8. Unable to transfer SRC (or film magazine) via LEC

   a. Use LEC as a tether, attach SRC and pull it up from hatch.

   b. If possible climb ladder while holding SRC.

9. SRC Seal Area Dirty

   a. Use hand brush to clean seal.

   b. Close and latch.

10. Unable to open or seal Gas Analysis Sample Container (GASC) or Special Environmental Sample Container (SESC)

   a. Unable to open--hit rotation handle with hammer or bang against LM.

   b. Unable to seal--check/remove both seal protectors. Check/free lanyard if impeding proper lid manipulation.

   c. If unable to close: abandon.

SOLAR WIND COMPOSITION EXPERIMENT

CONTINGENCY	COURSE OF ACTION
1. Pole will not go into surface.	Lean against LM facing sun.
2. Pole partially extended.	(1) If pole is half or more normal length, continue experiment anyway. (2) Remove foil and use 6(2).
3. Reel not removable. No foil exposed to solar radiation.	Highly unlikely. Discard experiment.
4. Foil torn during extension.	Continue experiment anyway.
5. Foil comes off reel.	Hang foil on pole by lanyard.
6. Foil reel comes off poles.	(1) Reconnect to pole. (2) Hang foil on LM structure facing most available solar radiation.
7. Unable to re-roll foil by spring.	Roll by hand or fold as conveniently as possible for crewman.
8. No SWC Bag available.	Continue experiment anyway. Bag not mandatory. Attempt to put one sample bag over each end.
9. Deployment selection alternatives.	In full sunlight at least 6 feet from any shadow.

CONTINGENCY ACTION FOR APOLLO LUNAR SURFACE CLOSE-UP CAMERA

1. Problem: Cycle light does not come on after depressing trigger on first exposure.

   Corrective Action: Determine if red scale marks on camera top skirt are visible, indicating skirt is fully deployed. If marks are not visible depress camera skirt and release, noting if both latches are released. (NOTE: Occasionally the last skirt retaining latch released will catch in a secondary mode and not permit the skirt to fully extend and enable the camera.)

2. Problem: Cycle light does not come on after depressing trigger first time and red scale marks on camera skirt are visible.

   Probable Failure: Camera enable switch failed to actuate when skirt was extended.

   Corrective Action: Depress the black safety switch located to the left of the handle extension pole base and push camera down until skirt is fully retracted and then release. Repeat two times. Repeat exposure noting if flash discharges and cycle light comes on. If flash discharges and cycle light does not come on, cycle light has failed but camera is still operative. Continue photography allowing 10 seconds between exposures. If flash does not discharge discard camera.

3. Problem: Cycle light remains on for more than 10 seconds.

   Probable Failure: Capacity of Camera Batteries has fallen off because of excessive camera temperature (hot or cold) or film transport gears have jammed.

   Corrective Action: If cycle light goes off within 25 seconds continue photography. If cycle light does not go off after 25 seconds, remove cassette, if more than three pictures have been taken, and discard camera.

CONTINGENCY ACTION FOR REMOVAL OF TAKE-UP CASSETTE

Problem: Film attached to supply roll when take-up cassette is removed from camera.

Corrective Action: Rotate film cutter until it detents. Grasp film and cut by pulling it back against cutter blade. Stow cassette.

ALSEP DEPLOYMENT

(Malfunctions are outlined in upper case type.)

Open SEQ bay door:

a. Remove thermal cover from door lanyard.
b. Retrieve lanyard from right side of SEQ bay (remove lower velcro strap).
c. Move to position clear of door.
d. Pull white portion of lanyard to raise door.

SEQ BAY DOOR LANYARDS UNUSABLE

1. Lanyard free from cable, pull cable.

2. Lanyard melted and fused to Inconel--if unable to break free with hand pull, use hammer to free and pull cable (Step I).

SEQ BAY DOORS WILL NOT OPEN

1. No cable movement (worst case) pry open astronaut protection door and fail mechanism. (Step II) Pull on lanyard again. (Step III) Use hammer to chop hole in main door Inconel shield at center patch. (Step IV) Hook hammer behind cable and pull to release latch and open door while latch is pulled. (Step V) Continue to open door upward.

2. With small cable movement--doors are unlatched and can be open manually.

SEQ BAY DOOR PARTIALLY OPEN AND JAMMED

1. Continue pulling on lanyard. Get assistance to aid manually in raising door.

2. Discontinue lanyard use and manually.

e. Temporarily stow lanyard on strut.

f. If Quad II is in a low attitude, connect folded doors with velcro strap.

<u>Packages removed by booms</u>

<u>Remove Package 2</u>:

a. Retrieve boom lanyard from package (handle).

b. Move to position clear of package (approximately 10 feet).

c. Pull white portion of lanyard to unlock and move package from SEQ bay to fully extended boom position.

PACKAGE LATCHING MECHANISM WILL NOT FUNCTION

1. If lanyard pulls loose or mechanism jams, remove thermal covering from bottom of SEQ bay and attempt to move release mechanism lever forward.

2. Use hammer to pry outward from structure on right-hand link of latching mechanism forcing latch over center and releasing packages.

PACKAGE WILL NOT SLIDE ON RAILS

Get assistance from second crewman.

BOOM WILL NOT DEPLOY

Release hockey stick at boom interface and manually deploy package.

BOOM PARTIALLY DEPLOYED AND PACKAGE SWINGING FREE OR RATCHET FAILS

1. Package partially deployed still in bay on rails--support package and use manual deployment mode.

2. Ratchet fails--use two-man deployment: one supports, other pulls small lanyard to release hockey stick from boom.

d. Pull black and white striped portion of lanyard to lower package to surface.

e. Release white portion of lanyard from base of package.

WHITE PORTION OF DEPLOYMENT LANYARD WILL NOT RELEASE FROM BASE OF PACKAGE

1. Grasp release latch at base of package and twist in an effort to break the latch or the slot.

2. Cut lanyard with hammer against LM or rock to break or tear lanyard (webbing) loose.

f. Pull pip pin at carry handle to remove hockey stick.

   1. Apply additional force while rotating pin.

   2. Pull small lanyard (velcroed to handle) on package to release boom cable and lanyards. Reattach lanyard to velcro and leave hockey stick on package.

   3. Attempt to pull pin at boom interface and leave hockey stick on package.

g. Move package clear of SEQ bay.

h. Pull black and white striped lanyard to retract boom (or push boom back with hand).

   1. Attempt retraction by both crewmen working simultaneously, one pulling the lanyard and the second pushing on the boom (if within reach).

   2. Apply loads on end of the boom with the hammer while second crewman pulls lanyard.

<u>Packages removed by booms</u>

<u>Remove Package 1</u>:

a. Retrieve boom lanyard from package (handle).

b. Move to position clear of package (approximately 10 feet).

c. Pull white portion of lanyard to unlock and move package from SEQ bay to fully extend boom position.

PACKAGE UNLATCHING MECHANISM WILL NOT FUNCTION

   1. If lanyard pulls loose or mechanism jams remove thermal covering from bottom of SEQ bay and attempt to move release mechanism lever forward.

   2. Use hammer claw to pry outward from structure on right-hand link of latching mechanism forcing latch over center and releasing packages.

PACKAGE WILL NOT SLIDE ON RAILS

Get assistnace from second crewman.

BOOM WILL NOT DEPLOY

Release hockey stick at boom interface and manually deploy package.

BOOM PARTIALLY DEPLOYED AND PACKAGE SWINGING FREE OR RATCHET FAILS

1. Package partially deployed still in bay on rails--support package and use manual deployment mode.

2. Ratchet fails--use two-man deployment: one supports, the other pulls small lanyard to release hockey stick from boom.

d. Pull black and white striped portion of lanyard to lower package to surface.

e. Release white portion of lanyard from base of package.

WHITE PORTION OF DEPLOYMENT LANYARD WILL NOT RELEASE FROM BASE OF PACKAGE

1. Grasp release latch at base of package and twist in upward motion to break the latch or slot.

2. Cut lanyard with hammer against LM or rock to break or tear lanyard (webbing loose).

f. Pull pip pin at sunshield bracket to remove hockey stick

1. Apply additional force while rotating pin.

2. Pull small lanyard (velcroed to handle) on package to release boom cable and lanyards. Reattach lanyard to velcro and leave hockey stick on package.

3. Attempt to pull pin at boom interface and leave hockey stick on package.

g. Move package clear of SEQ bay.

h. Pull black and white striped lanyard to retract boom (or push boom back with hand).

BOOM DOES NOT RETRACT

1. Attempt retraction by both crewmen working simulataneously, one pulling the lanyard and the second pushing on boom (if within reach).

2. Apply loads on end of the boom with the hammer while second crewman pulls lanyard.

Manual Package Removal

Remove Package 2:

a. Pull ring on small lanyard on bottom of package, to release hockey stick from boom. Reattach lanyard to velcro.

PIN JAMMED OR LANYARD BREAKS

1. Attempt to pull pin at pin interface.

2. Remove package on boom.

3. Remove entire hockey stick by removing pull pin at carry handle interface after boom removal.

b. Remove deployment lanyard from package and pull white portion to unlock package from bay.

PACKAGE LATCHING MECHANISM WILL NOT FUNCTION

1. If lanyard pulls loose or mechanism jams, remove thermal covering from bottom of SEQ bay and attempt to move release mechanism lever forward.

2. Use hammer claw to pry outward from structure on right-hand link of latching mechanism forcing latch over center and releasing packages.

c. Release white portion of lanyard from base of package.

WHITE PORTION OF DEPLOYMENT LANYARD WILL NOT RELEASE FROM BASE OF PACKAGE

1. Grasp release latch at base of package and twist in an effort to break the latch or the slot.

2. Cut lanyard with hammer against LM or rock.

d. Move deployment lanyard to side clear of package.

e. Manually pull package clear of SEQ bay.

PACKAGE WILL NOT SLIDE ON RAILS

Using MESA Tools with assistance of second crewman, attempt to clear package.

f. Pull pip pin at carry handle to remove hockey stick.

PULL PIN JAMS

1. Apply additional force while rotating pin.

2. Leave hockey stick on package.

Manual Package Removal

Remove Package 1:

a. Pull ring on small lanyard at bottom of package to release hockey stick from boom. Reattach lanyard to velcro.

PIN JAMMED OR LANYARD BREAKS

1. Attempt to pull pin at pin interface.

2. Remove package on boom.

3. Remove entire "hockey stick" via pull pin at carry handle interface after boom removal.

b. Remove deployment lanyard from package and pull white portion to unlock package from bay.

PACKAGE LATCHING MECHANISM WILL NOT FUNCTION

1. If lanyard pulls loose or mechanism jams, remove thermal covering from bottom of SEQ bay and attempt to move release mechanism lever forward.

2. Use hammer claw to pry outward from structure on right-hand link of latching mechanism forcing latch over center and releasing packages.

c. Release white portion of lanyard from base of package.

WHITE PORTION OF DEPLOYMENT LANYARD WILL NOT RELEASE FROM BASE OF PACKAGE

1. Grasp release latch at base of package and twist in upward motion to break latch or the slot.

2. Cut lanyard with hammer against LM or rock to break or tear lanyard (webbing) loose.

d. Move deployment lanyard to side clear of package.

e. Manually pull package clear of SEQ bay.

PACKAGE WILL NOT SLIDE ON RAILS

Using MESA Tools with assistance of second crewman attempt to clear package.

f. Pull pip pin at carry handle to remove hockey stick

PULL PIN JAMS

1. Apply additional force while rotating pin.

2. Leave hockey stick on package.

REMOVE HAND TOOL CARRIER (HTC) AND DEPLOY

PULL PIN JAMS AT PALLET/HTC INTERFACE

1. Apply additional force while rotating pin with the aid of the second crewman.

2. Use MESA hammer to pry pin free.

3. Remove all accessible tools, stow on MESA and deploy subpackage #2 with HTC attached.

QUARTER TURN FASTENER JAMS OR WILL NOT RELEASE

1. Apply additional force while rotating 1/4 turn pins with the aid of second crewman.

2. Use MESA hammer to rotate or break fasteners.

3. Remove all accessible tools, stow on MESA and deploy subpackage 2 with HTC attached.

   Note: With HTC pull pins removed, the HTC can be partially removed at deployment site to provide better thermal view factor for RTG.

LEGS ON CARRIER WILL NOT EXTEND AND LOCK

Apply additional force with the aid of second crewman.

HAND TOOL CARRIER WILL NOT OPEN TO DEPLOYED POSITION

1. Request aid of second crewman.

2. Apply additional force with MESA hammer.

REMOVE SUBPALLET, DRILL AND TOOL RESTRAINING PULL PINS (4)

Remove one pull pin on drill, one pull pin on subpallet and the two pull pins on the forward tool bracket.

SUBPALLET PULL PIN JAMS

1. Apply side loads to drill while pulling pin.

2. Apply additional force on pin with MESA hammer.

DRILL PULL PIN JAMS

1. Apply side loads to drill in several directions while pulling pin. (CAUTION: Stop side loads as pin frees to prevent damage to battery.

2. Apply additional force on pin with MESA hammer.

3. Abandon drilling operation.

4. Remove bore stems and attempt to drive two stems into the surface using hammer later at deployment site.

LOWER FORWARD TOOL SUPPORT PULL PIN JAMS

1. Apply additional force on pin with MESA hammer.

2. Remove upper tool support pin and attempt to pry open the outer half to break the bracket off at the point where the pin is jammed.

3. Use MESA hammer to break bracket.

4. The tools can be removed by prying the bracket away far enough to gain access to the tools.

UPPER TOOL BRACKET PULL PIN JAMS

1. Apply additional force on pin with MESA hammer.

2. Remove lower tool support pin and attempt to pry open the outer half with MESA hammer breaking the bracket off at the point where the pin jammed.

3. The tools can be removed if the bracket is pried away far enough to gain access to the tools.

NOTE: ALSEP cannot be deployed without access to DRT, FTT and one UHT.

REMOVE OUTBOARD TOOL STOWAGE BRACKET AND DISCARD

REMOVE UHT's AND ENGAGE IN SUBPACKAGE #1 STOWAGE SOCKET AND SUBPACKAGE #2 STOWAGE SOCKET

TOOLS DO NOT ENGAGE IN STOWAGE/CARRY SOCKETS ON SUBPACKAGE #1 & #2

1. Stow in alternate socket on PSE, CCGE, or Subpallet.

2. LMP/CDR use YO YO to secure UHT's.

REMOVE DOME REMOVAL TOOL AND STOW IN HTC COLLECTION BAG

REMOVE FUEL TRANSFER TOOL AND STOW IN HTC COLLECTION BAG

<u>REMOVE ANTENNA MAST SECTIONS</u>

<u>CONNECT TWO ANTENNA MAST SECTIONS</u>

ANTENNA MAST SECTIONS DO NOT LOCK IN POSITION AFTER ENGAGED AND ROTATED

1. Separate mast sections, examine for obstructions, clean or dislodge spring by knocking masts together and re-connect.
2. Re-engage and carry in normal mode.
3. If unstable, use suitcase mode.

<u>CONNECT CARRY BAR TO KEYHOLE ON SUBPACKAGE #1</u>

CARRY BAR WILL NOT ENGAGE IN "KEY HOLE" SOCKET

1. Ensure flange on carry bar is free of debris; if not, clean by impact or with gloved hand.
2. Ensure "keyhole" socket is clean; if not, clean with available MESA tools or UHT.
3. If one of both sockets are unusable, CDR carry subpackage 1 and subpackage 2 in suitcase mode with the LMP carrying HTC, Drill and carry bar.

<u>REMOVE ALSD</u>

<u>ROTATE SUBPACKAGE #2 TO FUELING POSITION</u>

<u>RETRIEVE LANYARD FROM ASTRONAUT DOOR</u>

<u>ROTATE FUEL CASK</u>

LANYARD BREAKS OR PULLS AWAY FROM CAM LEVER

1. Use MESA tools hammer/extension as hook and pull forward on cam lever to release.
2. Abandon ALSEP.

CAM LEVER FAILS TO RELEASE THE UPPER TRUNION AFTER LEVER IS FULLY DEPLOYED

1. Use hammer/extension as hook on astronaut guard to break cask free at trunnions while second crewman pulls lanyard to tilt.

2. Abandon ALSEP.

LANYARD FAILS TO REMOVE SPLINE LOCK FROM CASK/DOME

1. Continue to release trunnion lock.

2. Rotate cask 45°.

3. Remove spline with MESA Tools.

4. Attempt to remove Dome with DRT /Hammer.

5. Abandon ALSEP.

CASK WILL NOT ROTATE WITH LANYARD

1. Verify upper trunnion release by attaching extension to MESA hammer, hook on astronaut guard and ensure that the cask is free of the upper trunnion.

2. Request aid of the second crewman CDR to apply forward and downward force with hammer and extension on the guard while the LMP attempts to rotate with the lanyard.

3. Continue to apply force to fail gear box if required.

4. Second crewman must support cask with the hammer/extension handle to the proper angle.

5. Abandon ALSEP.

RETRIEVE DOME REMOVAL TOOL FROM HTC

REMOVE CASK DOME

ENGAGING MECHANISM ON DRT DOES NOT LOCK DUE TO MECHANICAL FAILURE

1. Apply forward pressure and rotate, attempting to remove dome with side loading on the DRT so it will be removed with some assistance from the tool. (CAUTION: Stand clear of dome when finally released and removed).

2. Abandon ALSEP.

LOCK NUT ASSY. WILL NOT ROTATE

1. Apply additional force with hammer on the end of the DRT, side of cask and side of dome to "jar loose" the binding while continuing to rotate DRT.

2. Abandon ALSEP.

PRETENSION BANDS DO NOT RELEASE CAUSING EXCESSIVE LOADING ON DOME LOCKING LUGS

1. Use MESA hammer to free lugs at the lock nut assembly on the dome.

2. Abandon ALSEP.

RETRIEVE·FUEL TRANSFER TOOL FROM HTC

ENGAGE FTT TO CAPSULE AND REMOVE

ENGAGEMENT FINGERS DO NOT EXPAND (INOPERATIVE)

1. Visually inspect fingers for debris.

2. Request aid of 2nd crewman to apply additional force to FTT knob.

3. Apply impact pressure on knob by knocking on the LM landing gear.

4. Abandon ALSEP.

CAPSULE WILL NOT RELEASE FROM CASK BODY AFTER FTT IS ATTACHED AND LOCKED

1. Apply additional side loads, by wiggling on FTT while pulling capsule out.

2. Retract FTT, rotate 120^{o} and repeat task in all three positions.

3. Using MESA hammer apply impact force on side of cask body to free the capsule.

4. Using MESA hammer apply impact force on the end of the FTT to free the capsule.

5. Allow for back plate cool down (5-10 min.) and repeat task.

6. Abandon ALSEP.

TRANSFER CAPSULE TO RTG

FTT WILL NOT RELEASE FROM CAPSULE WHILE IN RTG BODY

1. Visually check engagement alignment.

2. Check for full outward travel of FTT fingers.

3. Apply additional force to release knob.

4. Leave FTT in place on the fueled RTG and while the CDR carries subpackage #2 in the barbell mode the LMP will monitor the RTG/Capsule during preparation for the traverse to the site.

ROTATE PKG #2 TO CARRY MODE

INSTALL CARRY BAR IN KEYHOLE SOCKET ON SUBPACKAGE #2

CARRY BAR FLANGE WILL NOT ENGAGE IN KEYHOLE

1. Ensure flange on carry bar is free of debris; if not, clean by impact or with gloved hand.

2. Ensure "keyhole" socket is clean; if not, clean with available MESA tools or UHT.

3. If one or both sockets are unusable, CDR carry SP 1 and SP 2 in suitcase mode. LMP carry HTC, drill and carry bar.

CLOSE SEQ BAY DOOR (IF OPENED MANUALLY, CLOSE MANUALLY)

a. Retrieve door lanyard.

b. Move to position clear of door

c. Pull black and white stripe portion of lanyard until door is closed.

SEQ BAY DOOR WILL NOT LOWER

Attempt to close manually.

SEQ BAY DOOR PARTIALLY CLOSE

Attempt to close manually.

d. Discard lanyard.

STOW MESA TOOLS, CORE STEMS AND CAPS ON HTC AND SECURE BORE STEMS ON DRILL

SELECT SITE FOR ALSEP DEPLOYMENT

Nominally greater than 300 feet west (12 o'clock) of LM in a level area. Alternate sites:

1. East greater than 300 feet (6 o'clock)

2. South greater than 300 feet (9 o'clock)

3. North greater than 300 feet (3 o'clock)

NOTE: Landing site analysis may provide additional inputs.

CARRY ALSEP TO DEPLOYMENT SITE

CDR - Pkg. #1 and Pkg. #2 in barbell carry

LMP - HTC and Drill

COMPLETE TRAVERSE, ORIENT SUBPACKAGE

DISENGAGE CARRY BAR FROM PKG. NO. 2 AND RELOCATE

CARRY BAR BINDS IN KEYHOLE SOCKET ON SUBPACKAGE #2

1. Ensure trigger release is operable.

2. If trigger is released, apply additional downward pressure while applying side loads to subpackage #2.

3. Request aid of CDR to lift subpackage #1.

4. With second crewman's UHT depress antenna lock and rotate subpackage #1 to separate masts. With single section attached to subpackage #2 continue as in #2 above.

5. Break mast section off at keyhole socket.

6. Emplace Pkg. #2 with 1/2 of mast section attached.

7. Attempt rough alignment with aiming mechanism mounted on sunshield.

ROTATE SUBPACKAGE #2 TO DEPLOYED POSITION

REMOVE RTG CABLE REEL

CABLE REEL BOYD BOLTS CANNOT BE RELEASED

1. Visually check (if possible) to see if bolt is released and not loose/raised due to side loading.

2. Check for spring loading on bolt.

3. Repeat release procedure, i.e., engage depress, rotate ccw 75°.

4. Insert UHT and apply downward pressure on center spline. Use hammer if necessary turn CCW to release.

5. If spline is depressed and bolt will not rotate, back off slightly CW then turn back CCW, and wiggle.

6. Visually check hex head on UHT, if broken, use second tool.

7. If procedure fails to release bolts; tilt package on carry handle side, and utilize UHT to unwind cable manually to expose shorting plug.

8. With the aid of the second crewman, release pull pin and retainers.

9. Lower package to lunar surface.

10. If unsuccessful abandon ALSEP.

REMOVE RTG POWER CABLE

CABLE REEL FALLS TO THE LUNAR SURFACE WHEN FINAL BOYD BOLT (bb) IS REMOVED

1. Retrieve cable reel with UHT handle, determine tempilabel temperature. If under 250° F. grasp reel assembly, connect UHT, and continue deployment.

2. If tempilabel indicates temperature over 250° F., request the aid of the second crewman (CDR) retrieve reel with UHT, deploy cable lay reel, assembly on subpackage #1 secure with UHT and continue.

SHORTING PLUG PULL PIN DOES NOT RELEASE

1. Apply additional force with hammer.

2. With pick end of hammer, tear away retainer assembly.

3. Attempt to separate cable from shorting switch.

4. Abandon ALSEP deployment.

CONNECT RTG POWER CABLE

SHORTING SWITCH CONNECTOR FAILS TO ENGAGE AND LOCK TO C/S

1. Check switch connector for proper orientation.

2. Check both connectors for debris on pins or C/S receptacle.

3. Depress outer flange of switch connector to ensure proper function (1/4" sliding action).

4. Reconnect applying additional downward pressure on the flange assembly with the LMP helping to provide additional stability. (LMP can aid by holding PLSS).

5. Manually separate the shorting switch from the cable, discard and connect cable directly to C/S.

6. Abandon ALSEP.

AMPERE GAUGE UNREADABLE DUE TO DEBRIS
OR
ARROW IN AMPERE GAUGE IS A ZERO (NO MOVEMENT)

Report condition and continue ALSEP deployment.

<u>DISCONNECT CARRY BAR AND STOW ON SUBPALLET TAPER FITTING</u>

CARRY BAR BINDS IN KEYHOLE SOCKET ON SUBPACKAGE #1

1. Ensure trigger release is operable.

2. If trigger is released, apply additional downward pressure while applying side loads to subpackage.

3. Request aid of CDR to lift subpackage.

4. With second crewman's UHT, depress antenna lock and rotate second mast section to separate masts. Stow 2nd mast section on subpackage #2.
   NOTE: With one half of mast attached to subpackage #1, emplacement may be difficult or impossible, in varying lunar surface.

5. Break off mast section as last resort, to allow for proper emplacement; i.e., level orientation.

<u>ROTATE SUBPACKAGE #1 TO DEPLOYED POSITION</u>

<u>REMOVE HEAT FLOW EXPERIMENT FROM SUNSHIELD</u>

BOYD BOLTS FAILS TO RELEASE

1. Proceed with boyd bolt corrective action page 24, Step 1-6.

2. If unreleased boyd bolt(s) is on probe box, clear sunshield, rip apart probe containers with MESA hammer, and attempt to retrieve emplacement tool and probes, and deploy probes next to C/S (10').

3. If unreleased boyd bolt(s) is on electronics package, attempt to pry experiment off mounts with MESA hammer and retrieve experiment.

4. Continue deployment by tearing loose cables from experiment to allow for sunshield erection.

5. In the event either the probe or the elctronics package cannot be removed, abandon ALSEP.
NOTE: Antenna deployment impossible without removal of HFE probe and brackets.

HF EXPERIMENT FALLS OFF UHT

1. Reorient experiment for engagement while on the lunar surface, reengage and continue deployment.

2. If unsuccessful, carry to site by leg.

REMOVE HF PROBES FROM ELECTRONICS PKG.

SEPARATE PROBE PACKAGES (SPLIT)

DEPLOY PROBE CONTAINERS NEAR BORE HOLE SITES

DEPLOY PSE STOOL

BOYD BOLT FAILS TO RELEASE

1. Proceed with boyd bolt corrective action, page 24, Steps 1-6.

2. Attempt to pry the retainer bracket assembly loose with MESA hammer.

3. If on rocky or hard surface, secure RTG cable reel assembly and emplace with flat (open) side up where stool would normally be deployed.

4. If on loose surface material, sink sensor into surface up to mounting lugs for maximum seismic coupling.

RELEASE SUBPALLET BOYD BOLTS (2)

BOYD BOLT DOES NOT RELEASE

1. Proceed with boyd bolt corrective action, page 24, Steps 1-6.

2. Leave subpallet on Subpackage #2.

REMOVE SUBPALLET FROM SUBPACKAGE #2

SUBPALLET BINDS ON PALLET AND WILL NOT COME OFF IN NORMAL MANNER USING UHT

1. Ensure the front portion of the subpallet has been raised (3/8") to clear the mounting stud.

2. Apply side loads kick with lunar boot (foot) as required to eliminate binding.

3. Assist the forward movement of the subpallet with the lunar boot making sure the mounting stud is clear.

4. With the second crewman's help, manually aid in removal by using the back support structure as additional lever.

DEPLOY PASSIVE SEISMIC EXPERIMENT

BOYD BOLTS DO NOT RELEASE ON PSE MOUNTS

1. Procedure as described for first Boyd Bolt on page 24, Steps 1-6.

2. Leave experiment on sunshield.

3. With UHT tear away or deploy cable from cable reel.

EXPERIMENT FALLS OFF UHT DUE TO ACCIDENTAL TRIGGERING OF UHT

1. Using UHT retrieve cable and gently lift experiment with cable. Secure mounting lug (tab) with hand and attempt to re-engage UHT in socket.

2. If UHT engagement fails pull shroud pin, discard shroud/skirt assembly and emplace experiment manually using gnomon.

NOTE: At 1/6 gravity skirt should not unfold and cause interference.

EXPERIMENT FALLS OFF STOOL WHILE LEVELING AFTER SKIRT FULLY DEPLOYED

1. Retrieve experiment with UHT handle hooked into gnomon opening and lift experiment.

2. Grasp thermal skirt and raise to a position to observe stool.

3. Lower experiment on stool.

THERMAL SHROUD WILL NOT LAY FLAT AT OUTER EDGE

1. Lay discarded ALSEP parts on shroud edge.

2. Lay lunar rocks on edge.

LUNAR DEBRIS DEGRADES READABILITY OF BUBBLE LEVELING INDICATOR AND ALIGNMENT INDEX ON SHROUD

1. Level by using the local surface area as a reference (PSE shadow).

2. Ensure ample picture coverage is obtained to verify experiment orientation.

RETRIEVE ALSD AND HTC AND MOVE TO FIRST HOLE SITE

PLACE ALSD ON HTC

CREWMAN EXPERIENCES DIFFICULTY ATTACHING DRILL ON HTC LOCKING PIN AND VELCRO CLIP

1. Examine mounting pin for debris, clean with glove or HTC brush.

2. Request aid of second crewman while mounting drill.

SECURE VELCRO STRAP ON TREADLE TO HTC

VELCRO (HOOK) WILL NOT STAY ATTACHED TO HTC CLIP

1. Clean hook and pile with HTC brush.

2. Reattach.

HTC UNSTABLE WITH DRILL SECURED ON TOP

Press down on ALSD with sufficient force to bury HTC legs into surface.

CHECK POWER HEAD OPERATION

POWER HEAD DOES NOT OPERATE (NO SPINDLE ROTATION)

1. Remove power head & check operation again.

2. Insert bore stem, rotate spindle of power head, recheck operation.

3. Use treadle assembly later on top of bore stem when driving stems into surface with hammer.

DEPLOY RACK SUPPORT LEGS

ATTACH HANDLE ASSEMBLY TO BATTERY

HANDLE FAILS TO LOCK PROPERLY

1. Ensure handle is free of interference.

2. Check alignment of handle.

3. Ensure that fixed pin is fully engaged and slap handle to engagement position with additional force.

4. Request second crewman to depress engagement pin (with thumb screw) and slap handle to engagement.

5. With the aid of the second crewman attempt drilling operations without the handle.

6. If unsuccessful use treadle assembly to drive bore stems. (Soil mechanics dependent).

CARRY RACK/TREADLE SEPARATION

RACK BINDS WHILE BEING REMOVED FROM TREADLE ASSEMBLY

1. Grasp rack in area where rack support legs converge.

2. Pull rack up while holding treadle assembly down on HTC.

POWER HEAD/TREADLE SEPARATION

THE POWER HEAD BRACKET JAMS CAUSING DIFFICULTY IN REMOVAL FROM THE TREADLE

Grasp bore stem near spindle with left hand and press down on treadle with thumb.

RETRIEVE BORE STEMS

BORE STEM IS DROPPED

1. Use HTC tongs.

2. Engage end of wrench into stem and lift.

ADAPTER RELEASE FROM BORE STEMS

ADAPTER RELEASE BINDS

Withdraw bore stem, with or without power, to position such that bore stem engaging adapter can be grasped by hand or wrench. Hold power head and rotate stem 90° clockwise or hold stem and rotate power head to 90° CCW. Drive bore stems to lower handle operating height. Pull power head vertically from stem.

COMPLETE DRILLING OPERATIONS

RETRIEVE HEAT FLOW PROBE BOX

EXTEND AND LOCK EMPLACEMENT TOOL

ONE OR MORE SECTIONS DO NOT LOCK IN EXTENDED POSITION

1. Rotate unlocked section and attempt to lock, apply additional force.

2. Restow unlocked section and attempt to lock again by applying additional force.

3. If only one section is inoperative, continue to use as is.

4. If more than one section is inoperative, discard tool.

FOOT ON EMPLACEMENT TOOL BREAKS OFF

None - use tool for emplacing probes w/o foot being careful not to damage probe.

EMPLACE HF PROBES

PROBE DOES NOT LOCK ON BOTTOM "HOOK" OF FIRST BORE STEM

1. Repeat downward pressure cycles to engage hook.

2. Emplace probe as deep in stem as possible utilizing emplacement tool.

3. Read depth on emplacement tool.

<u>FOLLOW SAME PROCEDURE FOR BORING SECOND HOLE AND EMPLACING PROBES</u>

<u>REMOVE BORE STEM ADAPTER (USE ALSD WRENCH IF REQUIRED)</u>

<u>HOLE CORING</u>

<u>RETRIEVE AND COUPLE CORE STEMS</u>

WRENCH IS DROPPED DURING RETRIEVAL FROM RACK

1. Use tongs from HTC to retrieve wrench.

2. Join two core stems, and engage end of handle in open end and lift.

CORE SECTIONS DO NOT ENGAGE AT MALE/FEMALE CONNECTIONS

1. Check axial alignment and attempt rearrangment.

2. If binding is severe, separate sections by pulling and wiggling, inspect for foreign material, and re-couple.

3. Request aid of second crewman.

4. Use wrench for added torque.

<u>ATTACH POWER HEAD TO CORE STEM</u>

POWER HEAD SPINDLE WILL NOT CONNECT TO CORE STEM

1. Check axial alignment and attempt re-engagement.

2. Slowly move the core stem about a point until a reduction of torque is felt and re-engaged.

3. Replace core stem and repeat Steps 1 and 2.

4. If spindle is damaged, termimate core drilling with power and use hammer to drive core in to surface.

<u>INSERT CORE STEM IN TREADLE</u>

CORE BIT HANGS UP IN TREADLE LOCK

1. Hold power head and rotate treadle assembly counterclockwise with foot.

2. Use wrench to secure core stem if it rotates in the spindle.

3. Repeat above procedure.

4. Remove power head from core stem, attempt to pull core stem from hole, invert core stem with treadle attached, and apply wrench to free core stem from treadle lock.

5. Terminate core drilling.

DECOUPLING POWER HEAD FROM CORE STEM

POWER HEAD SPINDLE BINDS ON MALE END OF CORE STEM AFTER DRILLING

1. Cradle handle assembly between thumbs and fore fingers and lift up and forward.

2. Align power head vertically.

3. Lift off core stem.

4. Use wrench to decouple power head and core stem and repeat Steps 1 thru 3.

5. Use hammer impact force to free binding.

COUPLING POWER HEAD TO CORE STEM

CREWMAN FINDS IT DIFFICULT TO COUPLE POWER HEAD TO CORE STEM

1. Hold power head spindle at approximately 45° to the core stem and rotate vertically until the power head bottom's out on the core stem threads.

2. Hold this alignment while turning the power head until full thread engagement is achieved.

NOTES:

1. ALSD drilling and coring operations shall be accomplished as soon as possible after ALSD removal from ALSEP Subpackage #2 pallet.

2. Drilling descent rate varies with subsurface material. Low density materials (pumice, conglomerate, etc) require 4 to 6 pounds axial force whereas high density material (basalt, scoria, etc.) require 10 to 15 pounds axial force. If drill string jamming begins to occur (detected by increasing torque forces), drilling descent rate should be reduced by a corresponding reduction of axial force. If severe jamming of the drill string is encountered, an upward force should be applied to the drill handle until torque forces return to normal.

DEPLOY COLD CATHODE GAUGE EXPERIMENT

BOYD BOLTS FAIL TO RELEASE

1. Proceed with boyd bolt corrective action as on page 24, Steps 1-6.

2. Attempt to deploy cable reel from CCGE cavity to allow for sunshield deployment.

CCGE CARRY SOCKET UNUSABLE (UHT WILL NOT LOCK)

Remove and carry experiment manually by sunshield assembly.

CABLE RETAINER PULL PIN JAMS

1. Apply additional force with MESA hammer.

2. If cable reel (pin) is not released deploy experiment as far from central station (20') as possible (until cable binds in reel).

CCG EXPERIMENT FALL OFF UHT

1. Reorient experiment for engagement while on the lunar surface, reconnect and continue deployment.

2. If unsuccessful, carry by sunshield to deployment site.

DEPLOY CHARGED PARTICLE LUNAR ENVIRONMENTAL EXPERIMENT

BOYD BOLTS FAIL TO RELEASE

1. Proceed with boyd bolt corrective action on page 24, Steps 1-6.

2. If unsuccessful, force cable reel free from retainer bracket and deploy sufficient cable to allow sunshield deployment.

CPLEE CARRY/REMOVAL SOCKET UNUSABLE. UHT WILL NOT LOCK IN SOCKET

1. Remove CPLEE manually by grasping leg.

2. Deploy cable from reel while grasping leg.

3. Emplace experiment while grasping thermal plate, using UHT (as required) to aid in emplacing unit upright.

4. Use UHT on thermal plate to align and level unit.

SWIVEL SOCKET PULL PIN JAMS

1. Apply additional force while supporting experiment on HTC.

2. If unsuccessful, disengage UHT, emplace experiment by grasping thermal plate, and use UHT to level and align experiment.

RELEASE SUNSHIELD BOYD BOLTS

BOYD BOLT(s) FAIL TO RELEASE

1. Visually check (if possible) to see if bolt is released and not loose/raised due to side loading.

2. Check for spring loading on bolt.

3. Repeat procedure, i.e., engage, depress, rotate CCW 75°.

4. Insert UHT and apply downward pressure on center spline. Use hammer if necessary; turn CCW to release.

5. If spline is depressed and bolt will not rotate, back off slightly CW then turn back CCW and wiggle.

6. Visually check hex head on UHT, if broken, use second tool.

7. Advance to the next series of boyd bolts and return to repeat Steps 1-6 above.

RF ANTENNA CABLE REEL LANYARD BREAKS

1. Use handle of UHT to engage (hook) restraining and bend/break restraint off the sunshield.

2. Deploy cable using UHT.

AIMING MECHANISM BOYD BOLTS FAIL TO RELEASE

1. Proceed with boyd bolt corrective action above.

2. If unsuccessful, break housing off mounting legs with side loading to gain access to aiming mechanism.

3. If unable to gain access to aiming mechanism, mount antenna on central station sunshield brackets and point antenna toward earth.

SUNSHIELD FAILS TO RAISE AFTER ALL BOYD BOLTS ARE RELEASED

1. Engage UHT in temporary stowage socket and raise sunshield manually with UHT as lever arm.

2. Check to see if curtain covers are jammed.

3. If sunshield does not raise, remove curtain retainers and mount antenna mast bracket on the bottom shoe of the structure bracket.

INSTALL MAST TO CENTRAL STATION

ANTENNA MAST BINDS ON SUBPALLET TAPER FITTING LIFTING SUBPALLET

Stand on subpallet and rotate mast while applying additional lifting force on lower half.

ANTENNA MAST MOUNT ON C/S COVERED WITH LUNAR DEBRIS

1. Clear area with lunar boot and compact surface.

2. Raise subpackage with sunshield to clear mount and lower to surface.

RETRIEVE AND MOUNT AIMING MECHANISM

AIMING MECHANISM FALLS OUT OF HOUSING ON LUNAR SURFACE

Retrieve mechanism with UHT handle and shake debris off, clean taper fitting with glove.

AIMING MECHANISM KNOBS WILL NOT ROTATE

1. Apply additional force with hand and hammer, being careful not to damage mechanism.

2. Remove antenna mast from C/S and push it into surface pointing at earth (rough alighment).

3. Adjust as required in real time communcation to capsule communicator.

MOUNT HELIX ANTENNA

CREWMAN DOES NOT FULLY SEAT ANTENNA INTO MECHANISM

1. Apply additional downward force.

2. Ensure cable outlet is properly oriented.

DEPRESS SHORTING SWITCH WITH UHT

SHORTING SWITCH IS DEPRESSED AND AMPERE GAUGE SHOWS NO DROP

1. Apply additional pressure.

2. Using UHT and second crewman drag C/S toward experiment, (2') rotate to 45° position.

a. Remove shorting switch connector from C/S.

b. Remove shorting switch from RTG cable and discard.

c. Reconnect RTG cable to C/S.

d. Lower package to surface, insuring cables are not under pallet.

e. Re-align C/S, antenna and experiments.

(Steps a through e may be performed in kneeling position).

<u>ROTATE ASTRONAUT SWITCH NO. 1 (left switch)</u>

DOWNLINK VERIFICATION TO MSFN (NEGATIVE)

1. Continue photos of ALSEP array deployed on surface +10 min.).

2. If directed by MSFN turn astronaut switch number 2 and 3.

3. If downlink is not established, check East alignment of antenna, bubble level, azimuth and elevation settings.

4. Check RF cable connection for mechanical damage (visually).

THE ALSEP TURN-ON SEQUENCE IS:

(1) Astronaut activates shorting plug switch immediately after deployment of the PSE, CCGE, CPLEE and central station.

(2) Crew will activate ASTRO switch #1 per direction from the ground. Switch #1 activation will be based on predicted availability of 38.2 watts from the RTG.

If the ground is unable to command a transmitter ON and/or experiments ON, the astronaut will turn on ASTRO switches #2 and/or #3 during EVA #1, when requested from the ground.

5.4 Equipment Decals

Figure 5-1 presents the equipment decals which the crew utilizes during their operations on the Lunar Surface. The following decals are shown:
(a) Equipment Transfer Bag
(b) S-Band Antenna
(c) 70 mm Lunar Surface Data Camera
(d) 16 mm Data Acquisition Camera (Surface)
(e) Drill Checklists
(f) TV Camera Bracket

EQUIPMENT TRANSFER BAG (ETB) DECAL

EVA 1			EVA 2	
1ST TRANS-UP	2ND TRANS-DOWN	3RD TRANS-UP	1ST TRANS-DOWN	2ND TRANS-UP
2-LIOH CANS 2-PLSS BATS 1-CONTINGENCY SAMPLE BAG	2-16MM MAG 1-BLACK/WHITE TV CAMR 1-SEQ CAMR+MAG 1-MAP	1-MAP 1-BRUSH/SCRIBE/LENS 1-70MM CAMERA 1-SEQ CAMR + MAG 2-16MM MAGS RETURN ITEMS	2-70MM CAMERA 1-70MM MAG 1-SEQ CAMR + MAG 2-16MM MAGS 1-MAP 1-POLAR FILTER	1-SOLAR WIND 2-70MM CAMR 1-70MM MAG 3-16MM MAGS 1-CSC CASSETTE 1-EXTRA SAMPLE 1-SIEVE SAMPLE 1-CONTAML SAMPLE RETURN ITEMS

TV CAMERA BRACKET DECAL (ON MESA)

CAUTION
BEFORE MOVING CAMERA
•LENS AT f 44
•FOCAL LENGTH 25 mm
•FOCUS TO INFINITY
•ALC TO PEAK
CAP OVER LENS

16MM LUNAR SURFACE DECAL (Decals on Mag & Battery Pack)

S-BAND ERECTABLE ANTENNA DECALS (Order of Use Shown by Number)

1} GROSS POINTING
UNLOCK LEGS
REMOVE PLATE/PAD

2} LOCK INNER MAST
LOCK OUTER MAST
EXTEND & LOCK LEGS
ALIGN
DEPLOY LEGS
REMOVE THERMAL COVER
LIFT ANTENNA

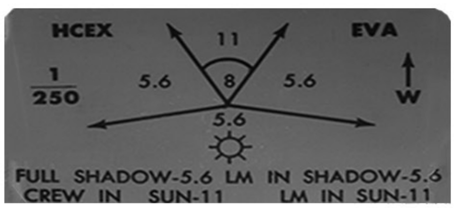
3} REMOVE BAR
REMOVE RIB/PROTECTOR
FREE LANYARD/TRIGGER
GRASP LEG AND DEPLOY
ATTACH CABLE
POINT ANTENNA
COMM CHECK

LUNAR SURFACE DRILL

PUSH SW TO TEST
PULL PIN 1 (TOP LEFT)
PULL PIN 2 (LEFT SIDE)
TURN LOCK 3 (BOTTOM RIGHT) CCW
TURN LOCK 4 (RIGHT SIDE) CCW
PULL FREE-THEN PULL LANYARD
PUSH RACK LEG FROM CLIP-EXTEND & LOCK LEGS & BRACE
REMOVE & INSTALL HANDLE-BLACK PIN UP FIRST
REMOVE RACK-EXTEND & LOCK 3RD LEG - PLACE RACK ON SURFACE
PULL PIN 5 (DRILL COLLAR) & SWING COLLAR UP
RESET CHUCK & REMOVE DRILL
REMOVE CHECKLIST & DISCARD

(Assembly Checklist)

70MM LUNAR SURFACE DATA CAMERA DECAL (Decal on Mag)



REMOVE THIS COVER & RELEASE VELCRO STRAP ON STEMS
ASSEMBLE 1 STEM SET & INSTALL IN CHUCK
MAKE UP 2ND STEM SET-REPLACE IN RACK-BIT DOWN
STOW TREADLE ON HAND TOOL CARRIER

(Bore Stem Rack Cover)

Figure 5-1

EQUIPMENT DECALS

5.5 References

(1) Office of Manned Space Flight; Apollo Flight Mission Assignments, document M-D MA5000-11, SE010-000-1, 11 July 1969

(2) Systems Engineering Division, ASPO; Mission Requirements, SA-508/CSM-109/LM-7, H-2 Type Mission, Lunar Landing, SPD9-R-053, MSC, 10 November, 1969.

(3) Lunar Surface Operations Planning Office, S&HD, Mission H-2/Apollo 13 Scientific Equipment Requirements, prepared by the General Electric Co., January 1970

(4) Flight Crew Support Division, FCOD; Apollo 13 Timeline, AS-508/CSM-109/LM-7, 1 December, 1969

(5) Lunar Surface Project Office; Flight System Familiarization Manual; The Bendix Corp. Aerospace Systems Division, 1 August, 1967 (Revised 15 April, 1969)

(6) Flight Crew Support Division, FCOD; Photographic and TV Procedures, Apollo 13, 15 January, 1970

(7) Lunar Surface Project Office; Familiarization and Support Manual for Apollo Lunar Surface Drill (ALSD); Martin Marcetta Corp., 14 November, 1969

NASA — MSC — Coml., Houston, Texas