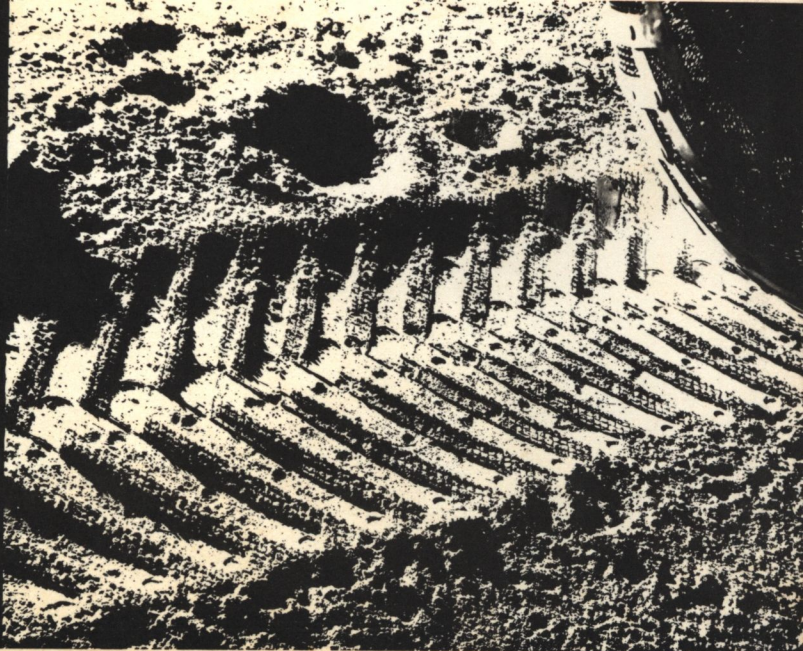


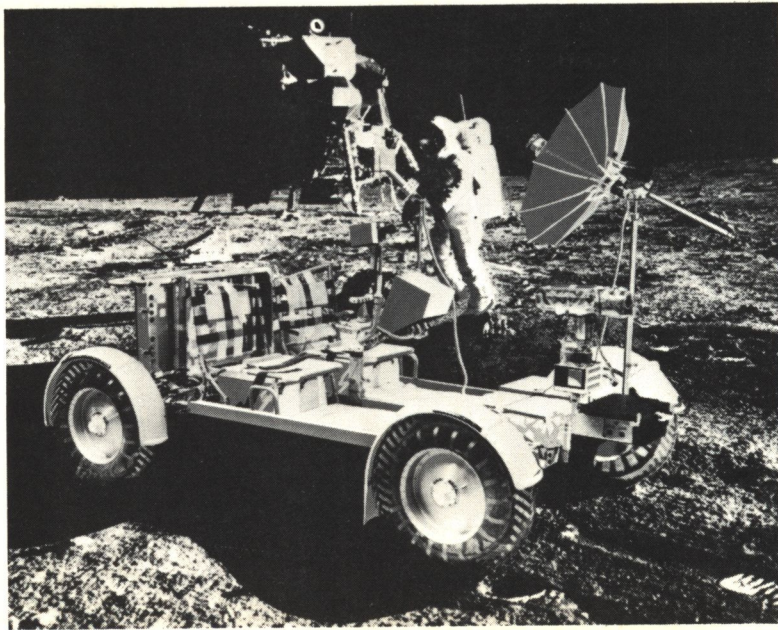


LUNAR ROVING VEHICLE

APOLLO 15

AS 510 CM 112 LM 10
G&N 217 G&N 614





GM PUTS THE "ROVE" IN LUNAR ROVING VEHICLE

The General Motors Delco Electronics Division facility of Santa Barbara, Calif., supplied nearly everything that moves on the Lunar Roving Vehicle.

As mobility systems subcontractor to the U.S. National Aeronautics and Space Administration's prime contractor — The Boeing Company — for the LRV, Delco Electronics supplied the special wire mesh wheels, four-wheel traction drive systems, suspension, steering and brakes, hand controller, and drive control electronics. The GM facility also built the complete "1-G" astronaut training vehicle.

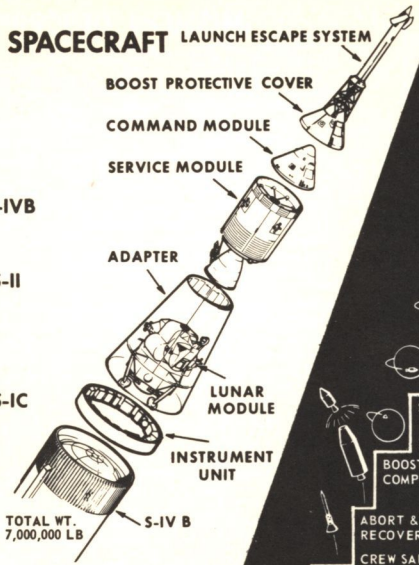
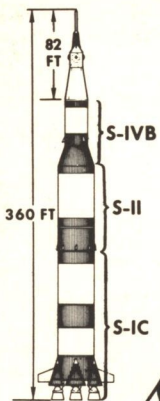
And it is the Lunar Roving Vehicle's mobility which will enable the astronauts to cover more area than was covered on all three previous Apollo moon landing missions. They will be able to travel over the lunar surface faster and easier, carry heavy and bulky experiments to precise locations, and return with over twice the amount of rock and soil samples as on earlier missions.

LUNAR ROVING VEHICLE MOBILITY SPECIFICATIONS

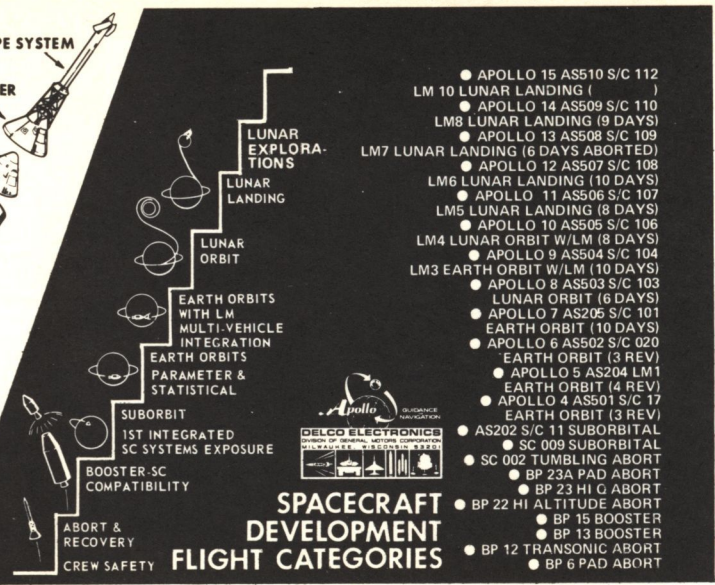
| | |
|-------------------|--|
| Wheelbase | 7' 5" |
| Overall Width | 6' 9" |
| Overall Length | 10' 2" |
| Weight (Unloaded) | 460 lbs - 1G (76 lbs - 1/6G) |
| Weight (Loaded) | 1,540 lbs - 1G (255 lbs - 1/6G) |
| Wheel Motors | 1/4 hp DC brush-type |
| Drive | Harmonic Drive, 80:1 reduction |
| Suspension | Double torsion bar |
| Spring rate | 15 lbs per inch |
| Jounce | 6" |
| Rebound | 4" |
| Steering | Double Ackermann |
| Controls | "T" handle hand controller for steering, speed control and braking |
| Wire Mesh Wheels | One ply .033 dia wire Titanium inner bump stop Titanium tread strips |
| Diameter | 32" |

| | |
|---------------------------|--|
| Width | 9" |
| Deflection (Loaded) | 1.75" |
| Loading | 63 lbs (lunar) |
| Ground Pressure | 0.6 psi (lunar) |
| Weight | 12 lbs |
| Shock Absorbers | Specially designed hydraulic |
| Battery Power | 2 silver-zinc 33-41 Vdc (non-rechargeable) |
| Brakes | Shoe-drum |
| Turning Radius | 10' 2" |
| (front & rear turning) | |
| Ground Clearance | 14" |
| Step Obstacle Climb | 12" |
| Roll Stability | 45 degrees |
| Climb/Descend Slope | 25 degrees |
| Crevasse Crossing | 28" |
| (both wheels in crevasse) | |
| Top Speed | 8.7 mph |
| Maximum Range | 57 Statute Miles (92 km) |

APOLLO SPACECRAFT LAUNCH ESCAPE SYSTEM



TOTAL WT.
7,000,000 LB



SPACECRAFT DEVELOPMENT FLIGHT CATEGORIES

- APOLLO 15 AS510 S/C 112
- LM 10 LUNAR LANDING ()
- APOLLO 14 AS509 S/C 110
- LM8 LUNAR LANDING (9 DAYS)
- APOLLO 13 AS508 S/C 109
- LM7 LUNAR LANDING (6 DAYS ABORTED)
- APOLLO 12 AS507 S/C 108
- LM6 LUNAR LANDING (10 DAYS)
- APOLLO 11 AS506 S/C 107
- LM5 LUNAR LANDING (8 DAYS)
- APOLLO 10 AS505 S/C 106
- LM4 LUNAR ORBIT W/LM (8 DAYS)
- APOLLO 9 AS504 S/C 104
- LM3 EARTH ORBIT W/LM (10 DAYS)
- APOLLO 8 AS503 S/C 103
- LUNAR ORBIT (6 DAYS)
- APOLLO 7 AS205 S/C 101
- EARTH ORBIT (10 DAYS)
- APOLLO 6 AS502 S/C 020
- EARTH ORBIT (3 REV)
- APOLLO 5 AS204 LM1
- EARTH ORBIT (4 REV)
- APOLLO 4 AS501 S/C 17
- EARTH ORBIT (3 REV)
- AS202 S/C 11 SUBORBITAL
- SC 009 SUBORBITAL
- SC 002 TUMBLING ABORT
- BP 23A PAD ABORT
- BP 23 HI C ABORT
- BP 22 HI ALTITUDE ABORT
- BP 15 BOOSTER
- BP 13 BOOSTER
- BP 12 TRANSONIC ABORT
- BP 6 PAD ABORT

MISSION DESCRIPTION

| MISSION | ASTRONAUTS | LAUNCH DATE | ELAPSED TIME | TOTAL U.S. MANNED HOURS IN SPACE |
|--------------------|----------------------------|---------------|--------------|----------------------------------|
| | | | HR:MIN:SEC | |
| Mercury-Redstone 3 | Shepard | May 5, '61 | 00:15:22 | 00:15:22 |
| Mercury-Redstone 4 | Grissom | July 21, '61 | 00:15:37 | 00:30:59 |
| Mercury-Atlas 6 | Glenn | Feb. 20, '62 | 04:55:23 | 05:26:22 |
| Mercury-Atlas 7 | Carpenter | May 24, '62 | 04:56:05 | 10:22:27 |
| Mercury-Atlas 8 | Schirra | Oct. 3, '62 | 09:13:11 | 19:35:38 |
| Mercury-Atlas 9 | Cooper | May 15, '63 | 34:19:49 | 53:55:27 |
| Gemini-Titan III | Grissom-Young | Mar. 23, '65 | 04:53:00 | 63:41:27 |
| Gemini-Titan IV | McDivitt-White | June 3, '65 | 97:56:11 | 259:33:49 |
| Gemini-Titan V | Cooper-Conrad | Aug. 21, '65 | 190:55:14 | 641:24:17 |
| Gemini-Titan VII | Borman-Lovell | Dec. 4, '65 | 330:35:31 | 1302:35:19 |
| Gemini-Titan VI-A | Schirra-Stafford | Dec. 15, '65 | 25:51:24 | 1354:18:07 |
| Gemini-Titan VIII | Armstrong-Scott | Mar. 16, '66 | 10:41:26 | 1375:40:59 |
| Gemini-Titan IX-A | Stafford-Cernan | June 3, '66 | 72:21:00 | 1520:22:59 |
| Gemini-Titan X | Young-Collins | July 18, '66 | 70:46:39 | 1661:56:17 |
| Gemini-Titan XI | Conrad-Gordon | Sept. 12, '66 | 71:17:08 | 1804:30:33 |
| Gemini-Titan XII | Lovell-Aldrin | Nov. 11, '66 | 94:34:31 | 1993:39:35 |
| Apollo 7 Saturn 1B | Shirra-Eisele-Cunningham | Oct. 11, '68 | 260:06:18 | 2773:58:29 |
| Apollo 8 Saturn V | Borman-Lovell-Anders | Dec. 21, '68 | 147:00:11 | 3214:59:02 |
| Apollo 9 Saturn V | McDivitt-Scott-Schweickart | Mar. 3, '69 | 241:00:53 | 3938:01:41 |
| Apollo 10 Saturn V | Stafford-Young-Cernan | May 18, '69 | 192:03:23 | 4514:11:50 |
| Apollo 11 Saturn V | Armstrong-Aldrin-Collins | July 16, '69 | 195:18:35 | 5100:07:35 |
| Apollo 12 Saturn V | Conrad-Gordon-Bean | Nov. 14, '69 | 244:36:24 | 5833:56:47 |
| Apollo 13 Saturn V | Lovell-Swigert-Haise | April 11, '70 | 142:54:44 | 6262:40:59 |
| Apollo 14 Saturn V | Shepard-Roosa-Mitchell | Jan. 31, '71 | 216:02:50 | 6910:49:29 |
| Apollo 15 Saturn V | Scott-Worden-Irwin | July 26, '71 | | |

- Manned: Prime Crew Back-up Crew
 David S. Scott (CDR) Richard F. Gordon, Jr. (CDR)
 Alfred M. Worden (CMP) Vance D. Brand (CMP)
 James B. Irwin (LMP) Harrison H. Schmitt (LMP)
- Eighth Manned Saturn V Mission
- Fifth Lunar Landing Mission - First Lunar Rover Mission
- Planned Duration of Apollo 15 - 295 hours
- Booster - Saturn V Booster #AS510
- Spacecraft - CSM # 112 and LM # 10
- Block II G & N System # 217 - LM G & N System # 614

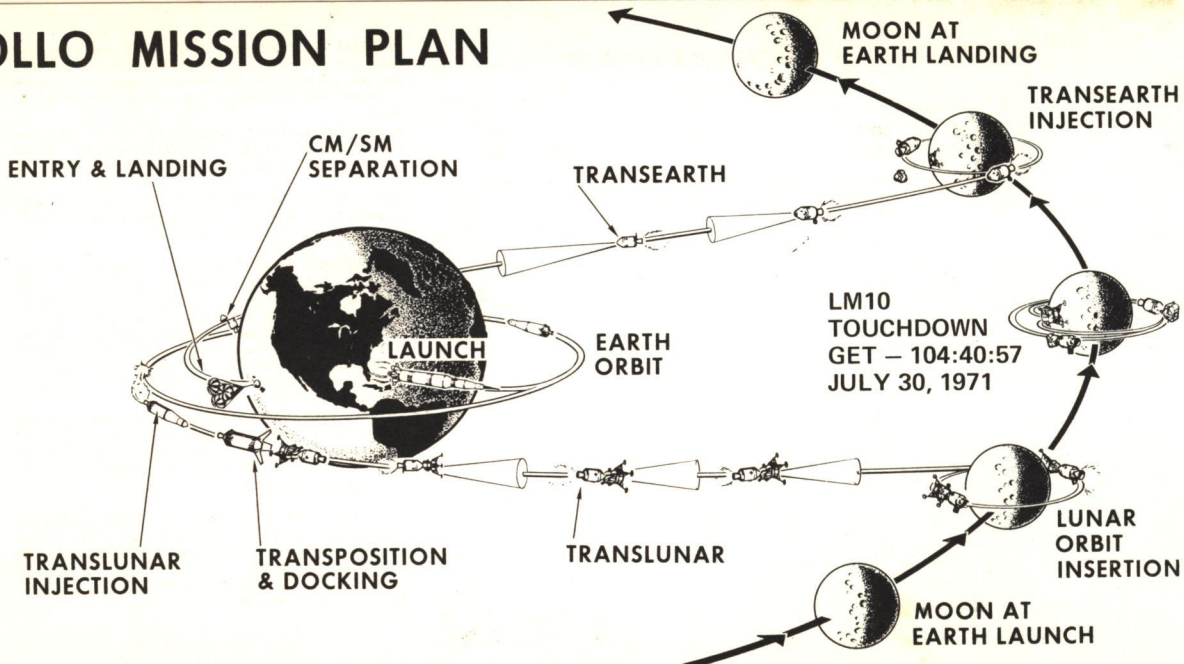
The Apollo 15 Mission is an Apollo Lunar Rover Mission and is targeted for the Hadley North Landing Site in the Apennine Region. The mission will be no longer than 13 days. Lunar Surface activities will cover one (1) SEVA of 30 minutes and three (3) EVA's of 7 hours each. The Lunar Surface Stay will be 67 hours.

Objectives of this Mission include:

- Emplace and activate surface experiments.
- Perform Selenological inspection, survey and sampling in the Hadley Apennine Highland Region.
- Traverse the Lunar Surface aboard the Lunar Rover Vehicle.



APOLLO MISSION PLAN

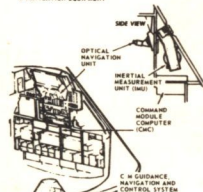
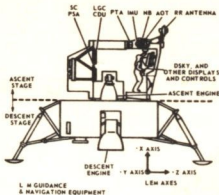


LM GUIDANCE and NAVIGATION EQUIPMENT.....

CM GUIDANCE, NAVIGATION and CONTROL SYSTEM

THE APOLLO GUIDANCE AND NAVIGATION SYSTEM IS COMPOSED OF THREE BASIC SUBSYSTEMS: INERTIAL, OPTICAL AND COMPUTER.

1. The inertial guidance subsystem is composed of inertial measurement unit (IMU) and associated equipment. This subsystem performs three major functions: (A) Measures changes in spacecraft attitude; (B) Measures spacecraft velocity due to thrust; and (C) Assists in generating steering signals.
2. The optical navigation subsystem is composed of a space sextant and a scanning telescope. Sightings on celestial bodies and landmarks on the moon and earth are used by the computer subsystem to determine the spacecraft's position and velocity and to align the inertial reference within the IMU.
3. The command module computer (CMC) provides five major functions: (A) Calculates steering signals and engine discreties necessary to keep the spacecraft on the required trajectory; (B) Positions the stable member in the IMU to a coordinate system defined by precise optical measurements; (C) Positions the optical unit to celestial objects; (D) Conducts limited malfunction isolation of the G&N system by monitoring the level and rate of system signals; and (E) Supplies pertinent spacecraft condition information to the display and control panel.



INERTIAL MEASUREMENT UNIT (IMU) and associated equipment performs three major functions; (A) Measures changes in LM attitude, (B) Assists in generating steering commands, and (C) Measures LM velocity changes due to thrust.

ALIGNMENT OPTICAL TELESCOPT (AOT) - Provides star sighting data which is manually inserted into the LM Guidance Computer for establishing the inertial reference.

NAVIGATION BASE (NAV BASE) - Provides an accurate mounting base for the Alignment Optical Telescope (AOT) and the Inertial Measurement Unit.

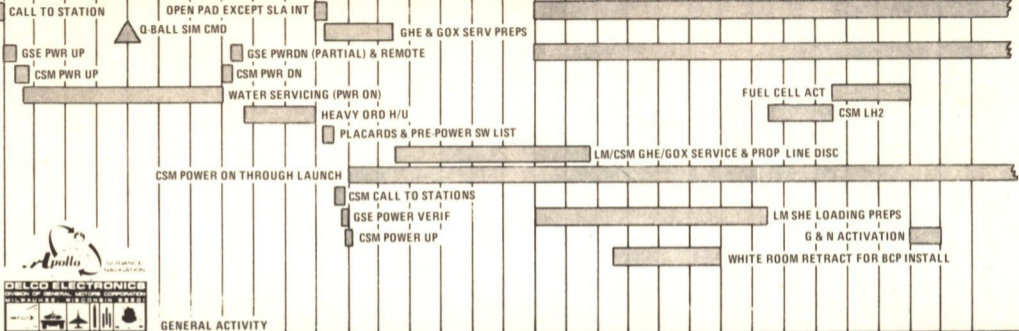
LM GUIDANCE COMPUTER (LGC) - Performs four major functions: (A) Calculates steering signals and engine discreties necessary to keep the LM on the required trajectory, (B) Positions the stable member in the IMU to a coordinate system defined by precise optical measurements, (C) Conducts limited malfunction isolation of the PGNCs by monitoring the level and rate of system signals and (D) Supplies pertinent LM condition information to the display and control panels.

DISPLAY AND KEYBOARD (DSKY) - Provides a two-way communication link between the operator and the LGC and the following functions may be performed: (A) Loading of data into the LGC and (B) Display of data and system configuration to the operator.

COUPLING DATA UNIT (CDU) - The CDU, an all-electronic device, is used as an interface element between the following: (A) The inertial subsystem and computer subsystem and (B) The computer subsystem and the controls. This unit functions primarily as an analog to digital or digital to analog converter.

APOLLO 15 LAUNCH COUNTDOWN

GENERAL ACTIVITY



PRELAUNCH

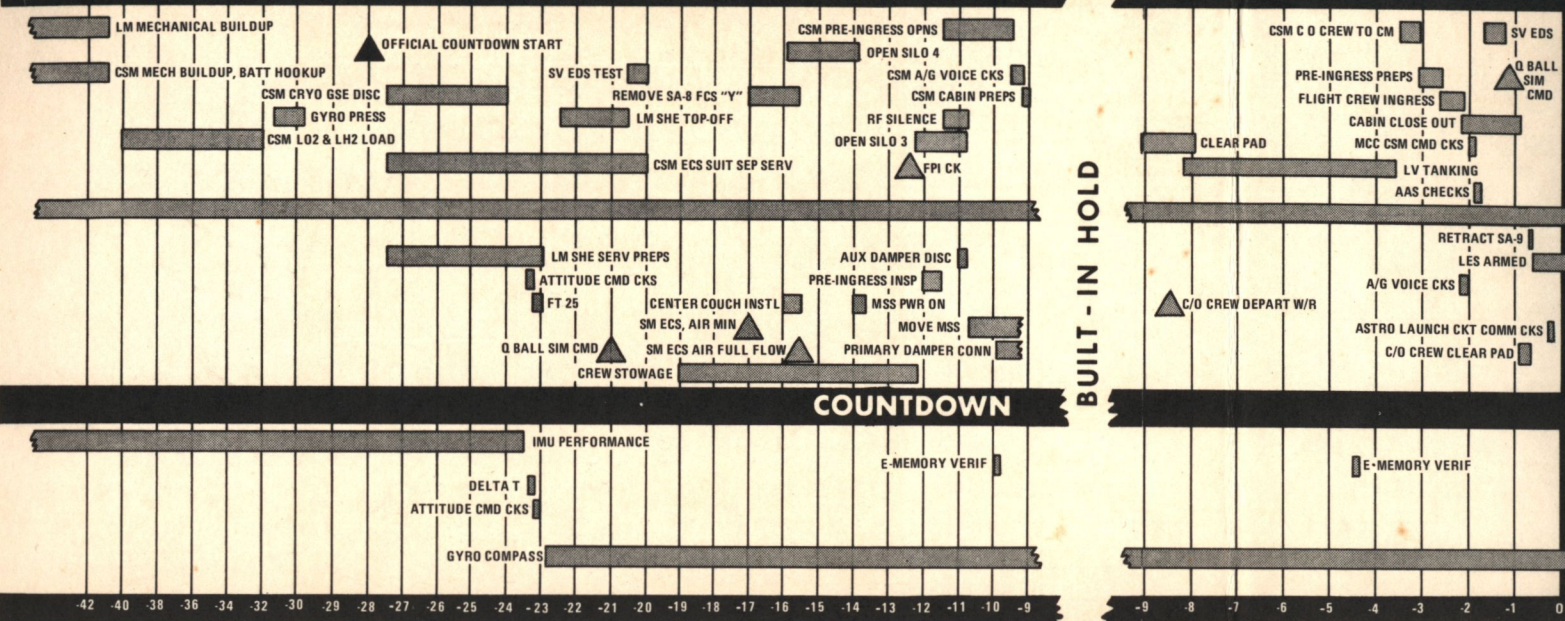
MIDLAUNCH

G&N



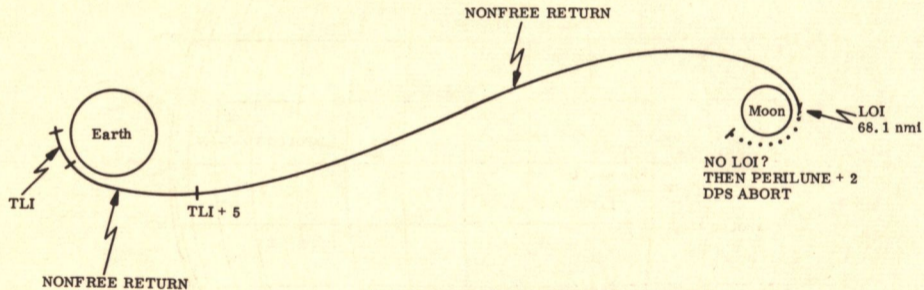
-106 -104 -102 -100 -98 -96 -94 -92 -90 -88 -86 -84 -82 -80 -78 -76 -74 -72 -70 -68 -66 -64 -62 -60 -58 -56 -54 -52 -50 -48 -46 -44 -42

SEQUENCE OF MAJOR EVENTS



| EVENT | TIME HR:MIN:SEC G.E.T. | TIME HR:MIN:SEC C.D.T. |
|-------------------------------|------------------------------|------------------------------|
| JULY 26, 1971 | | |
| LAUNCH | 00:00:00 | 08:34 |
| EARTH ORBIT INSERTION | 00:11:54 | 08:45:54 |
| TRANSLUNAR INJECTION | 02:49:52 | 11:23:52 |
| S-IVB SEPARATION | 03:20:29 | 11:54:29 |
| DOCKING | 03:30:29 | 12:04:29 |
| JULY 29, 1971 | | |
| LUNAR ORBIT INSERTION (LOI) | 78:31:14 | 15:05:14 |
| DESCENT ORBIT INSERTION (DOI) | 83:39:32 | 19:13:32 |
| JULY 30, 1971 | | |
| CSM CIRCULARIZATION | 101:34:55 | 14:08:55 |
| DESCENT | | |
| PDI | 104:28:54 | 17:02:54 |
| LANDING | 104:40:57 | 17:14:57 |
| ASCENT AUGUST 2, 1971 | | |
| LM LIFT-OFF | 171:37:23 | 12:11:23 |
| LM INSERTION | 171:44:39 | 12:18:39 |
| RENDEZVOUS | | |
| TPI | 172:29:39 | 13:03:39 |
| BRAKING | 173:10:46 | 13:44:46 |
| DOCKING | 173:30:00 | 14:04:00 |
| LM JETTISON | 177:20:45 | 17:54:45 |
| AUGUST 4, 1971 | | |
| TRANSEARTH INJECTION | 223:46:47 | 16:17:47 |
| AUGUST 7, 1971 | | |
| ENTRY INTERFACE | 294:58:20 | 15:32:20 |
| SPLASHDOWN | 295:11:45 | 15:45:45 |

APOLLO 15 TRANSLUNAR TRAJECTORY

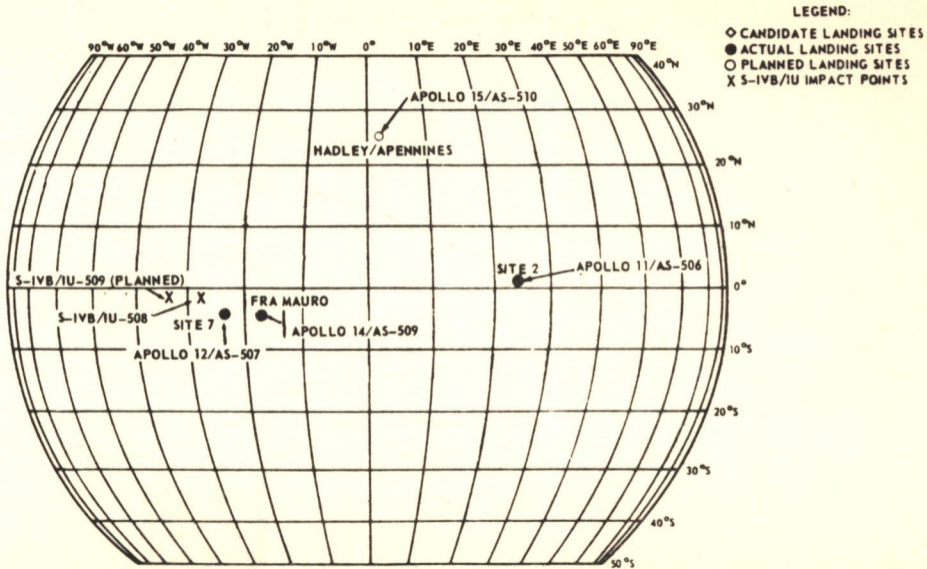


FOR FREE RETURN TRAJECTORY RECOVERY:

1. USE CSM RCS UP TO TLI + 5
2. USE LM DPS IF SPS FAILS AT LOI

QUICK RETURN TRAJECTORIES (CSM/SPS) DETERMINED IN REAL TIME

APOLLO 15 LANDING SITE



APOLLO 15 MISSION EVENTS (CSM)

| G.E.T. HR:MIN:SEC | EVENT |
|----------------------|---|
| | LAUNCH - 9:34 A.M. E.D.T. JULY 26, 1971 8:34 A.M. C.D.T. |
| 00:11:50 | SECO |
| 00:48:00 | P52 REALIGN |
| 2:49:58 | TLI B.T. 5 MIN 56 SEC |
| 3:21:00 | SCM/SIVB SEP |
| 3:31:00 | DOCKING |
| 4:16:00 | CSM/LM EJECTION B.T. 3 SEC |
| 4:39:00 | SIVB EVASIVE BURN |
| 5:29:00 | P52 REALIGN |
| 5:41:00 | P52 REALIGN |
| 8:06:00 | P23 CISLUNAR NAV |
| 8:16:30 | P23 CISLUNAR NAV |
| 9:22:00 | P23 CISLUNAR NAV |
| 11:02:30 | P52 REALIGN |
| 11:21:00 | P30 DELTA V |
| 11:35:00 | P40/P41 SPS/RCS THRUST |
| 11:55:54 | MCC 1 |
| 30:05:00 | P52 REALIGN |
| 30:20:00 | P30 DELTA V |
| 30:33:00 | P40/P41 SPS/RCS THRUST |
| 30:55:54 | MCC 2 |
| 34:05:00 | IVT TO LM - LMP |
| 34:09:30 | IVT TO LM - CDR |
| 36:02:00 | IVT TO CSM LMP & CDR |
| 36:24:30 | P20 OPTICS TRACKING |
| 55:02:30 | P52 REALIGN |
| 55:51:00 | P30 DELTA V |
| 56:10:45 | P40/P41 SPS/RCS THRUST |
| 56:31:14 | MCC 3 |
| 57:09:00 | P20 OPTICS TRACKING |
| 58:01:30 | LMP/CDR IVT LM FOR HOUSEKEEPING |
| 59:51:00 | LMP/CDR TO CSM |
| 72:45:30 | P52 REALIGN |
| 72:58:00 | P30 DELTA V |

| G.E.T. HR:MIN:SEC | EVENT |
|----------------------|--|
| 73:11:00 | P40/P41 SPS/RCS THRUST |
| 73:31:14 | MCC 4 |
| 75:21:00 | P52 ALIGN |
| 75:34:30 | P52 ALIGN |
| 77:40:00 | P30 DELTA V |
| 78:04:00 | P40 SPS THRUST |
| 78:31:14 | LOI BIT 6 MIN 32 SEC 170 X 58 N/M |
| 80:00:00 | P52 LOI ORIENT |
| 80:05:00 | P52 LDG SITE ORIENT |
| 80:10:00 | P52 OPTICS TRACKING |
| 82:00:00 | P52 LDG SITE ORIENT |
| 82:39:32 | DOI BT 22.9 SEC (58.4 X 9.6) |
| 83:25:00 | P47 THRUST MONITOR |
| 95:35:00 | P52 LDG SITE ORIENT |
| 95:43:00 | P52 DOI TRIM ORIENT |
| 95:49:30 | P30 DELTA V |
| 96:08:00 | P40 TRIM |
| 96:52:00 | P24 LDMK TRACKING |
| 97:19:00 | P52 (IF DOI TRIM NOT PERFORMED) |
| 97:25:00 | P52 LDG SITE ORIENT |
| 97:50:00 | LMP IVT TO LM |
| 98:08:00 | CDR IVT TO LM |
| 99:53:00 | P30 DELTA V |
| 100:08:00 | P41 TRIM |
| 100:13:56 | UNDOCKING & SEP B.T. 3.3 SEC 58.9 X 8.4 N/M |
| 100:34:00 | P20 LDMK TRACKING |
| 100:41:00 | P24 L/S LDMK TRACKING |
| 100:53:00 | P52 LDG SITE ORIENT |
| 101:03:00 | P30 DELTA V |
| 101:06:30 | P40 TRIM |
| 101:34:55 | CSM CIR B.T. 3.9 SEC (64.7 X 54.5) |
| 102:13:00 | P24 LDMK TRACKING |

| G.E.T. HR:MIN:SEC | EVENT |
|----------------------|---------------------|
| 102:24:30 | P20 OPTICS TRACKING |
| 102:34:00 | P24 L/S LDMK |
| 102:54:30 | P52 LDG SITE ORIENT |
| 103:02:00 | P52 COAS CALIB |
| 103:09:00 | P20 OPTICS TRACKING |
| 105:00:30 | P52 LDG SITE ORIENT |
| 105:05:00 | P20 CMC MODE AUTO |
| 106:11:30 | P24 LM VISUAL |
| 106:20:00 | P20 |
| 106:31:00 | P24 LM TRACKING |
| 106:41:00 | P20 OPTICS TRACKING |
| 109:01:00 | P52 L/S ORIENT |
| 109:05:30 | P20 CMC MODE AUTO |
| 109:52:30 | P20 OPTICS TRACKING |
| 111:23:00 | P20 OPTICS TRACKING |
| 119:01:00 | P52 L/S ORIENT |
| 119:06:00 | P20 CMC MODE AUTO |
| 119:11:00 | P20 OPTICS |
| 121:35:00 | P20 OPTICS |
| 123:04:00 | P20 OPTICS |
| 124:05:00 | P20 OPTICS |
| 125:31:00 | P20 OPTICS |
| 126:35:00 | P52 L/S ORIENT |
| 126:39:30 | P20 CMC MODE AUTO |
| 130:32:30 | P52 L/S ORIENT |
| 130:38:00 | P20 CMC MODE AUTO |
| 131:30:30 | P20 OPTICS |
| 133:01:00 | P20 OPTICS |
| 140:42:00 | P52 L/S ORIENT |
| 140:46:00 | P20 CMC MODE AUTO |
| 140:54:00 | P20 OPTICS |
| 144:25:30 | P20 OPTICS |
| 145:46:00 | P20 OPTICS |
| 147:10:00 | P20 OPTICS |
| 148:12:00 | P52 L/S ORIENT |
| 148:22:00 | P20 CMC MODE AUTO |
| 152:18:00 | P20 OPTICS |
| 152:37:00 | P52 L/S ORIENT |

| G.E.T. HR:MIN:SEC | EVENT |
|----------------------|-------------------------------|
| 152:42:00 | P20 CMC AUTO |
| 162:07:00 | P52 L/S ORIENT |
| 162:12:00 | P20 CMC MODE AUTO |
| 162:30:00 | P20 OPTICS |
| 164:15:20 | P52 L/S ORIENT |
| 164:20:00 | P52 PLAIN CHANGE |
| 164:30:00 | P30 DELTA V |
| 164:59:00 | P40 TRIM |
| 166:03:30 | P52 (LIFT OFF ORIENT) |
| 166:12:00 | P20 OPTICS |
| 169:15:20 | P20 LDMK TRACKING |
| 169:31:30 | P24 L/S LDMK |
| 170:01:00 | P52 (LIFT OFF ORIENT) |
| 170:06:30 | P52 COAS/CALIB |
| 171:37:24 | LM LIFTOFF |
| 171:52:00 | P34 TRIM |
| 172:20:00 | P40 SPS |
| 172:30:00 | P35 TRIM |
| 172:42:00 | P35 FINAL |
| 172:43:00 | P41 RCS |
| 172:45:00 | P76 LM TARGET DELTA V |
| 172:47:00 | P35 TRIM |
| 172:58:00 | P41 SPS |
| 173:00:00 | P76 LM TARGET DELTA V |
| 173:02:00 | P79 RENDEZVOUS FINAL PHASE |
| 173:31:00 | P47 IMU ORIENT |
| 173:30:00 | DOCKING |
| 176:30:00 | CDR IVT TO CSM |
| 176:45:00 | LMP IVT TO CSM |
| 177:20:00 | LM JETTISON |
| 177:25:45 | CSM SEPARATION |
| 177:46:00 | P20 OPTICS |
| 189:24:00 | P20 OPTICS |
| 190:16:00 | P52 IMU REALIGN |
| 190:22:00 | P20 CMC MODE AUTO |
| 191:01:00 | P20 OPTICS |
| 194:30:00 | P20 OPTICS |
| 195:45:00 | GEGENSCHEIN PHOTOS |

| G.E.T. HR:MIN:SEC | EVENT |
|----------------------|----------------------------------|
| 196:22:00 | P20 OPTICS |
| 196:44:00 | PHOTOS LUNAR MARIA |
| 197:40:00 | P52 IMU REALIGN |
| 200:02:00 | P20 OPTICS |
| 200:31:00 | P20 OPTICS |
| 201:36:00 | P20 OPTICS |
| 201:51:00 | P52 IMU ALIGN |
| 201:55:00 | P20 CMC AUTO |
| 202:01:00 | P20 OPTICS |
| 202:30:00 | P20 OPTICS |
| 211:45:00 | P52 IMU ALIGN |
| 211:51:00 | P20 CMC AUTO |
| 211:58:00 | P20 OPTICS |
| 215:08:00 | PHOTO ARISTARCHUS PLATEAU |
| 215:53:00 | P20 OPTICS |
| 216:22:00 | PHOTO TGT (HUMBOLT) |
| 217:03:00 | PHOTO TGT (LUNAKHOD) |
| 219:20:00 | P52 IMU ORIENT |
| 221:25:51 | SHAPING BURN 3.4 SEC 77.6 X 57.5 |
| 222:36:13 | SUBSATELLITE JETTISON |
| 223:18:00 | SXT STAR CHK |
| 223:24:00 | P40 TRIM |
| 223:46:06 | TEI - B.T. 2 MIN 17.8 SEC |
| 226:00:00 | P52 IMU ALIGN - TEI ORIENT |
| 226:10:00 | P52 IMU ALIGN |
| 227:50:00 | P20 OPT |
| 236:05:00 | P52 IMU ORIENT |
| 236:25:00 | P23 CISLUNAR NAV |
| 238:46:06 | MCC 5 |
| 241:30:00 | CMP DON EVA EQUIP |
| 241:50:00 | CABIN DEPRESS |
| 241:55:00 | HATCH OPENING |
| 242:00:00 | CMP EGRESS242 |
| 242:12:00 | RETRIEVE MAPPING EQUIP |
| 242:40:00 | REMOVE TV/DAC |
| 242:45:00 | INGRESS |
| 242:55:00 | CABIN REPRESS |
| 247:40:00 | P20 OPTICS |

| G.E.T. HR:MIN:SEC | EVENT |
|----------------------|------------------------|
| 250:50:00 | P52 IMU ALIGN |
| 251:12:00 | P23 CISLUNAR NAV |
| 251:20:00 | P23 CISLUNAR NAV |
| 252:00:00 | P20 OPTICS |
| 262:50:00 | P52 IMU ALIGN |
| 263:20:00 | P23 CISLUNAR NAV |
| 263:27:00 | P23 CISLUNAR NAV |
| 264:10:00 | P20 OPTICS |
| 267:35:00 | P52 IMU ALIGN |
| 267:50:00 | P23 CISLUNAR NAV |
| 268:00:00 | P23 CISLUNAR NAV |
| 272:05:00 | P52 IMU REALIGN |
| 272:20:00 | P30 DELTA V |
| 272:35:00 | P40/P41 SPS/RCS THRUST |
| 272:58:20 | MCC 6 |
| 273:10:00 | P23 CISLUNAR NAV |
| 273:20:00 | P23 CISLUNAR NAV |
| 277:10:00 | P20 OPTICS |
| 288:52:00 | P52 IMU REALIGN |
| 289:05:00 | P23 CISLUNAR NAV |
| 291:03:00 | P52 IMU REALIGN |
| 291:12:00 | P52 IMU REALIGN |
| 291:35:00 | SXT STAR CHK |
| 291:40:00 | P40/P41 SPS/RCS THRUST |
| 291:58:20 | MCC 7 |
| 292:05:00 | P23 CISLUNAR NAV |
| 292:15:00 | P23 CISLUNAR NAV |
| 293:25:00 | P52 IMU REALIGN |
| 294:35:00 | P61 ENTRY PREP |
| 294:43:00 | P62 CM/SM SEP |
| 294:58:20 | EI (400 K) |
| 295:00:32 | P64 - P67 |
| 295:04:10 | GUIDANCE TERM |
| 295:06:07 | DROUGE |
| 295:06:56 | MAIN |
| 295:11:46 | SPLASH |

APOLLO 15 MISSION EVENTS (LM)

| G.E.T. HR:MIN:SEC | EVENT |
|----------------------|----------------------------------|
| 97:50:00 | LMP IVT TO LM |
| 98:08:00 | CDR IVT TO LM |
| 99:00:00 | IMU REALIGN |
| 100:12:00 | P47-THRUST MONITOR |
| 100:13:56 | CSM/LM UNDOCK |
| 100:43:00 | PITCH TO OBSERVE LANDING SITE |
| 101:00:00 | P52 IMU REALIGN |
| 101:35:00 | P76 TGT CSM DELTA V |
| 102:20:00 | LANDING RADAR C/O |
| 102:50:00 | P52 IMU REALIGN |
| 103:35:00 | MNVR TO PDI ATT |
| 104:20:00 | P63 BRAKING PHASE |
| 104:28:54 | PDI B.T 12 MIN 2.1 SEC |
| 104:38:00 | P66 (ROD) |
| 104:40:57 | LM TOUCHDOWN |
| 105:00:00 | P57 SURFACE ALIGN |
| 105:40:00 | LGC TO STANDBY |
| 106:10:00 | SEVA |
| 106:40:00 | END SEVA |
| 120:00:00 | CDR EGRESS |
| 120:15:00 | LMP EGRESS |
| 120:20:00 | LRV DEPLOY |
| 120:25:00 | LRV SETUP |
| 121:10:00 | LRV NAV INITIALIZE |
| 121:15:00 | DRIVE TO CHECKPOINT |
| 121:35:00 | DRIVE TO STATION 1 |
| 122:00:00 | DRIVE TO STATION 2 |
| 122:50:00 | DRIVE TO STATION 3 |
| 123:10:00 | DRIVE TO LM |
| 124:00:00 | DRIVE TO ALSEP SITE |

| G.E.T. HR:MIN:SEC | EVENT |
|----------------------|-------------------------|
| 124:30:00 | EXPERIMENTS DEPLOY |
| 126:10:00 | FLAG DEPLOY |
| 126:30:00 | LMP INGRESS |
| 126:40:00 | CDR INGRESS |
| 139:40:00 | EVA 2 PREP |
| 141:20:00 | CDR EGRESS |
| 141:35:00 | LMP EGRESS |
| 141:50:00 | LRV NAV INITIALIZATION |
| 142:00:00 | DRIVE TO STATION 4 |
| 143:00:00 | DRIVE TO STATION 5 |
| 144:30:00 | DRIVE TO STATION 6 |
| 145:20:00 | DRIVE TO STATION 7 |
| 146:10:00 | DRIVE TO STATION 8 |
| 147:15:00 | DRIVE TO LM |
| 147:45:00 | LMP INGRESS |
| 148:05:00 | CDR INGRESS |
| 161:55:00 | PREP FOR EVA 3 |
| 162:00:00 | CDR EGRESS |
| 162:10:00 | LMP EGRESS |
| 162:30:00 | LRV NAV INITIALIZE |
| 162:32:00 | DRIVE TO STATION 9 |
| 163:50:00 | DRIVE TO STATION 10 |
| 164:00:00 | DRIVE TO STATION 11 |
| 164:25:00 | DRIVE TO STATION 12 |
| 165:20:00 | DRIVE TO STATION 13 |
| 166:10:00 | DRIVE TO STATION 14 |
| 166:50:00 | DRIVE TO LM |
| 167:35:00 | LMP INGRESS |
| 167:50:00 | CDR INGRESS |
| 168:50:00 | P57 LUNAR SURFACE ALIGN |
| 169:30:00 | P22 LUNAR SURFACE NAV |

| G.E.T. HR:MIN:SEC | EVENT |
|----------------------|---|
| 170:55:00 | P57 IMU REALIGN |
| 171:37:23 | LUNAR LIFTOFF B.T. 7 MIN 15.2 SEC (45.6 X 9.0) |
| 172:25:00 | P42 APS THRUST |
| 172:30:00 | P35 TRANSFER PHASE MCC |
| 172:44:39 | MCC 1 |
| 172:55:00 | P41 RCS THRUST |
| 172:59:39 | MCC 2 |
| 173:15:39 | BRAKING |
| 173:30:00 | DOCKING |
| 176:30:00 | CDR IVT TO CSM |
| 176:45:00 | LMP IVT TO CSM |
| 177:20:45 | LM JETTISON |
| 177:25:45 | CSM SEPARATION |
| 179:05:37 | LM DEORBIT |

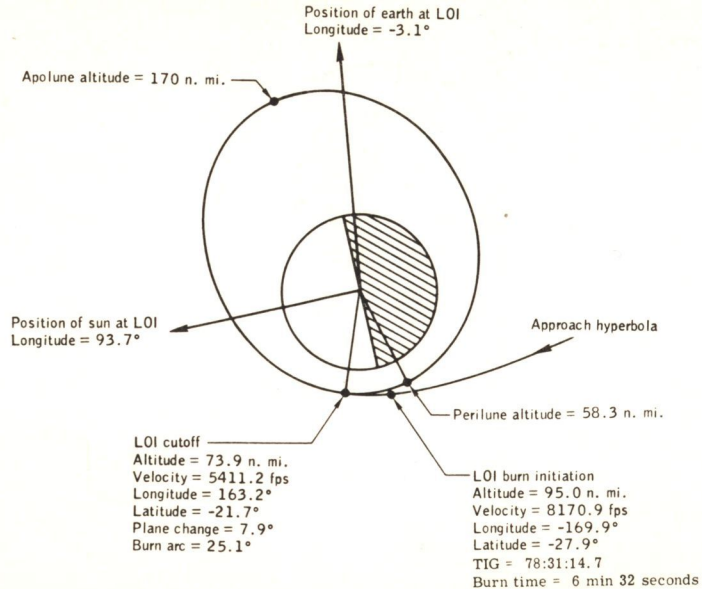
CSM BURN SCHEDULE

| BURN/ MNVR | GETI/ BURN TIME | ΔV_R (FPS) | ULLAGE/ ΔV (FPS) | REFSMMAT | RESULTANT HA & HP | REMARKS |
|--------------------|-------------------------------|-----------------------|-----------------------------|----------------------|----------------------|----------------------|
| TLI | 2:49:58 5 MIN 57.5 SEC | 10004.1 | | LAUNCH | | S-IV BURN |
| CSM/LM EJECTION | 4:16:00 3 SEC | 0.4 | — | LAUNCH | | RCS BURN |
| MCC-1 | 11:55:54 | — | — | PTC | | NOM ZERO |
| MCC-2 | 30:55:54 | — | — | PTC | | NOM ZERO |
| MCC-3 | 56:31:14.7 | — | — | PTC | | NOM ZERO |
| MCC-4 | 73:31:14.7 | — | — | PTC | | NOM ZERO |
| LOI | 78:31:14.7 6 MIN 32 SEC | 2997.9 | NOT REQ'D | LOI | HA 170.0 HP 58.3 | SPS BURN |
| DOI | 82:39:32.6 22.9 SEC | 207.6 | 4 JET 11 SEC | LDG SITE | HA 58.4 HP 9.6 | SPS BURN |
| BAILOUT BURN | 82:26:16.9 10.2 SEC | 94.0 | 4 JET 16 SEC | LDG SITE | HA 71.0 HP 3.9 | SPS BURN |
| DOI | 96:17:00 | | | LS OR PC AS REQ'D | | SPS BURN NOM ZERO |
| UNDOCK & SEP | 100:13:56.1 3.3 SEC | 1.0 | — | LDG SITE | HA 59.8 HP 8.4 | RCS BURN |
| CSM CIRC | 101:34:55.1 3.9 SEC | 70.8 | 4 JET 14 SEC | LDG SITE LDG SITE | HA 64.7 HP 54.5 | SPS BURN |
| LOPC | 165:12:50.6 16.5 SEC | 308.6 | 4 JET 15 SEC | PLANE CHANGE | HA 59.8 HP 59.2 | SPS BURN |
| CSM SEP | 177:25:45 6.4 SEC | 1.0 | — | LIFT-OFF | HA 59.9 HP 58.7 | RCS BURN |
| TEI | 223:43:47.6 1 MIN 39.0 SEC | 3046.7 | 4 JET 12 SEC | TEI | | SPS BURN |
| MCC-5 | 223:46:06 | — | — | PTC | | NOM ZERO |
| MCC-6 | 272:58:20 | — | — | PTC | | NOM ZERO |
| MCC-7 | 291:58:20 | — | — | ENTRY | | NOM ZERO |
| EI | 294:58:20 | | | | | |

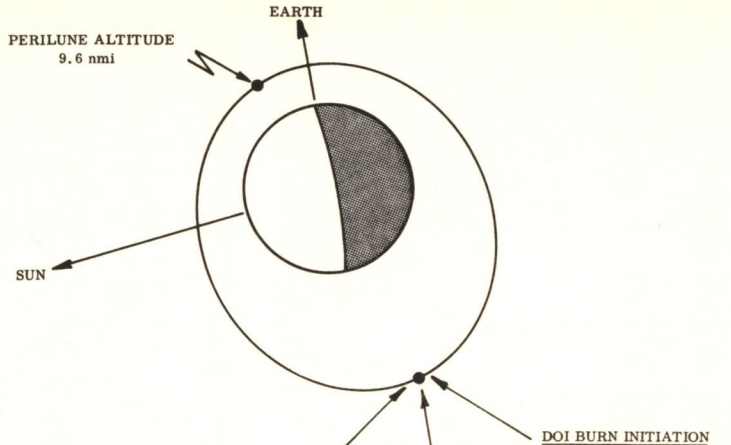
LM BURN SCHEDULE

| BURN/ MNVR | GETI/ BURN TIME | ΔV_R (FPS) | ULLAGE/ ΔV (FPS) | REFSMMAT | RESULTANT HA & HP | REMARKS |
|---------------|-------------------------------|-----------------------|-----------------------------|----------|----------------------|----------|
| PDI | 104:28:54.8 12 MIN 2.1 SEC | 6700.0 | 4 JET 7.5 SEC | LDG SITE | — | DPS BURN |
| ASCENT | 171:37:23.9 7 MIN 15.2 SEC | 6055.5 | N/A | LIFT-OFF | HA 45.6 HP 9.00 | APS BURN |
| TPI | 172:29:39.1 2.6 SEC | 73.6 | 4 JET 10.0 SEC | LIFT-OFF | HA 61.5 HP 43.9 | APS BURN |
| LM DEORBIT | 179:06:22.7 1 MIN 22.3 SEC | 195.4 | N/A | LIFT-OFF | | RCS BURN |

LOI GEOMETRY



DOI GEOMETRY



PERILUNE ALTITUDE
9.6 nmi

EARTH

SUN

DOI BURNOUT

| | |
|---------------|--------------|
| ALTITUDE | 58.4 nmi |
| VELOCITY | 5,283.7 ft/s |
| BURN DURATION | 22.9 seconds |
| BURN ARC | 1.2 degrees |
| ΔV | 207.6 ft/s |
| PERILUNE | 9.6 nmi |
| APOLUNE | 58.4 nmi |

APOLUNE 58.4 nmi

DOI BURN INITIATION

| | |
|----------|--------------|
| ALTITUDE | 58.4 nmi |
| VELOCITY | 5,491.4 ft/s |
| PERILUNE | 58.4 nmi |
| APOLUNE | 169.8 nmi |
| TIG | 82:39:32.6 |

DESCENT and ASCENT EVENTS

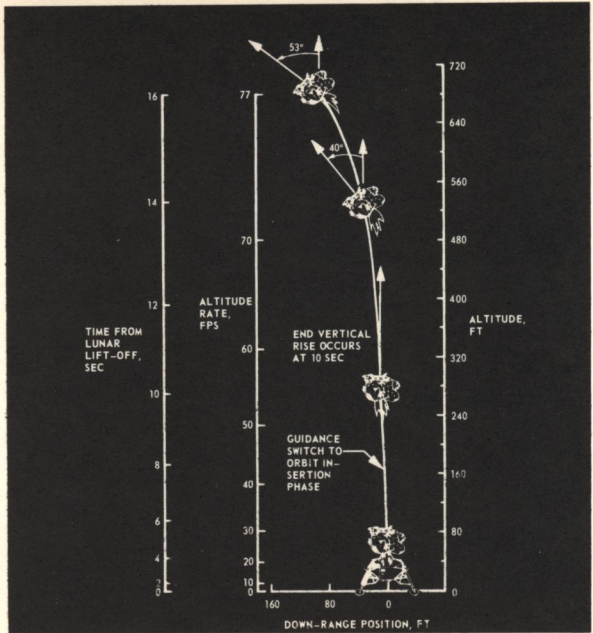
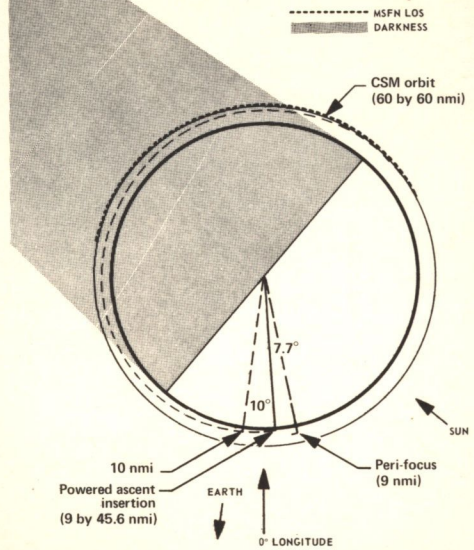
| EVENT | TIME HR:MIN:SEC G.E.T. | TIME HR:MIN:SEC C.D.T. | DATA SUMMARY |
|----------------------------------|------------------------------|------------------------------|---|
| DESCENT ORBIT INSERTION (DOI) | | July 29, 1971 | |
| Burn Initiation | 82:39:32.5 | 19:13:32.5 | Mass, 1b 76 363.6 Altitude Above LLS Radius, nmi 58.4 Selenographic Latitude, deg -25.3 Selenographic Longitude, deg -148.7 Perilune Altitude Above LLS Radius, nmi 58.4 Apolune Altitude Above LLS Radius, nmi 169.8 Velocity, fps 5 491.4 |
| Burn Termination | 82:39:55.4 | 19:13:55.4 | Altitude Above LLS Radius, nmi 58.4 Selenographic Latitude, deg -25.4 Selenographic Longitude, deg -150.0 Selenographic Inclination, deg 26.0 Burn Duration, sec 22.9 Inertial Burn arc, deg 1.2 Plane Change, deg 0.0 ΔV , fps 207.6 Velocity, fps 5 283.7 SPS Propellant Used, 1b 1 553.1 Orbital Period, hr:min:sec 01:53:58.9 Perilune Altitude Above LLS Radius, nmi 9.6 Apolune Altitude Above LLS Radius, nmi 58.4 Revolution 2 |
| CSM/LM UNDOCK AND SEP | 100:13:56.0 | July 30, 1971 12:47:56.0 | Selenographic Latitude -6.0 Selenographic Longitude, deg 110.5 Revolution Number 12 |
| CIRCULARIZATION (CSM) | | | |
| Burn Initiation | 101:34:55.1 | 14:08:55.1 | Mass, 1b 37 918.0 Selenographic Latitude, deg -23.6 Selenographic longitude, deg -146.0 Selenographic Inclination, deg 26.1 Altitude Above LLS, nmi 59.0 Perilune Altitude Above LLS, nmi 8.6 Velocity, fps 5 280.8 Revolution Number 12 |
| Burn Termination | 101:34:59.0 | 14:08:59.0 | ΔV , fps 70.8 Burn Duration, sec 3.9 Altitude Above LLS, nmi 59.0 Perilune Altitude Above LLS, nmi 54.5 Apolune Altitude Above LLS, nmi 64.7 |

| EVENT | TIME HR:MIN:SEC G.E.T. | TIME HR:MIN:SEC C.D.T. | DATA SUMMARY |
|----------------------------|------------------------------|------------------------------|--|
| | | | Velocity, fps 5 351.5 SPS Propellant Consumed, 1b 264.9 Burn arc, deg 0.2 Orbital Period, hr:min:sec 01:58:31.1 Revolution Number 12 Altitude Above LLS, ft 50 086.2 Velocity, fps 5 575.7 Revolution Number 14 |
| PDI (DPS Ignition Time) | 104:28:54.8 | 17:02:54.8 | |
| High Gate (P63 to P64) | 104:38:18.8 | 17:12:18.8 | Altitude Above LLS, ft 7 028.6 Velocity, fps 329.8 Altitude Above LLS, ft 694.4 Velocity, fps 79.4 |
| Low Gate | 104:39:36.8 | 17:13:36.8 | Altitude Above LLS, ft 206.1 Velocity, fps 10.7 |
| Vertical Descent | 104:40:16.8 | 17:14:16.8 | Altitude Above LLS, ft 6 697.6 ΔV , fps 722.1 Burn Duration, sec 18 387.9 DPS Propellant Consumed, 1b 14 Revolution Number 26.1 Selenographic Latitude, deg 3.65 Selenographic Longitude, deg |
| LM Landing | 104:40:57.0 | 17:14:57.0 | |
| ASCENT | | August 2, 1971 | |
| LM Lift-Off | 171:37:23.9 | 12:11:23.9 | Mass, 1b 10 873.1 Selenographic Latitude, deg 26.1 Selenographic Longitude, deg 3.65 Revolution Number 48 |
| LM Insertion | 171:44:39.1 | 12:18:39.1 | Mass, 1b 5 913.3 ΔV , fps 6 055.5 Burn Duration, sec 435.2 Latitude, deg 27.9 Longitude, deg -7.6 Altitude Above LLS, ft 59 936.3 Perilune Altitude Above LLS, ft 54 848.4 Apolune Altitude Above LLS, ft 277 065.2 |
| RENDEZVOUS | | | |
| TPI (APS Ignition) | 172:29:39.1 | 13:03:39.1 | Burn Duration, sec 2.6 ΔV , fps 51.8 Propellant Used, 1b 30.8 Resultant h_d/h_p , nmi 61.5/43.9 Range at Cutoff, nmi 32.5 Range Rate at Cutoff, fps -134.3 Propulsion System APS Revolution Number 48 |

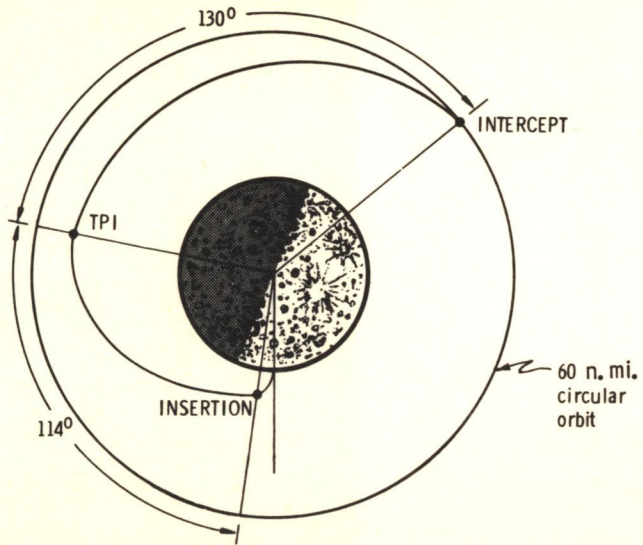
| EVENT | TIME HR:MIN:SEC G.E.T. | TIME HR:MIN:SEC C.D.T. | DATA SUMMARY |
|------------------------|------------------------------|------------------------------|---|
| Braking | 173:10:46.3 | 13:44:46.3 | Burn Duration, sec 28.6 ΔV , fps 31.6 Propellant Used, 1b 20.4 Range at Final Braking, nmi 0.01 Range Rate at Final Braking, fps - 0.22 h_a/h_p at Final Braking, nmi 59.6/59.1 Propulsion System LM RCS Revolution Number 49 |
| Docking LM Jettison | 173:30:00.0 177:20:45.4 | 14:04:00.0 18:04:27.4 | Selenographic Latitude, deg 23.4 Selenographic Longitude, deg 11.4 Revolution Number 51 |
| CSM/LM SEPARATION | | | |
| Burn Initiation | 177:25:45.0 | 17:59:45.0 | Revolution Number 51 |
| Burn Termination | 177:25:51.4 | 17:59:51.4 | Mass, 1b 36 523.1 ΔV , fps 1.0 Burn Duration, sec 6.4 Selenographic Latitude, deg 18.6 Selenographic Longitude, deg 25.6 Altitude Above LLS Radius, nmi 59.5 Perilune Altitude Above LLS Radius, nmi 58.6 Apolune Altitude Above LLS Radius, nmi 59.8 Plane Change, deg 0.0 Selenographic Inclination, deg 28.9 Velocity, fps 5 347.7 Revolution Number 51 |
| LM Deorbit | 179:05:37.0 | 19:39:37.0 | Mass, 1b 5 345.6 ΔV , fps 201.2 Burn Duration, sec 85.3 Selenographic Latitude, deg -7.3 Selenographic Longitude, deg 76.0 |
| LM Impact | 179:30:47.9 | 20:04:47.9 | Mass, 1b 5 228.0 Selenographic Latitude, deg 26.3 Selenographic Longitude, deg 1.8 Velocity, fps 5 566.1 CSM Revolution Number 52 |
| SHAPING BURN | | | |
| Burn Initiation | 221:25:51.6 | Aug 4, 1971 13:59:51.6 | Mass, 1b 36 280.9 Altitude Above LLS Radius, nmi 62.6 Selenographic Latitude, deg 13.9 Selenographic Longitude, deg -111.8 Perilune Altitude Above LLS, nmi 54.9 Apolune Altitude Above LLS, nmi 63.4 |

| EVENT | TIME HR:MIN:SEC G.E.T. | TIME HR:MIN:SEC C.D.T. | DATA SUMMARY |
|--|------------------------------|------------------------------|--|
| Burn Termination | 221:25:55.0 | 13:59:55.0 | Selenographic Inclination, deg 28.6 Velocity, fps 5 331.1 Revolution Number 73 Selenographic Latitude, deg 13.8 Selenographic Longitude, deg -112.0 Perilune Altitude Above LLS, nmi 57.5 Apolune Altitude Above LLS, nmi 77.6 Burn Duration, sec 3.4 Inertial Burn arc, deg 0.2 Plane Change, deg 0.0 ΔV , fps 64.2 SPS Propellant Used, 1b 229.8 Velocity, fps 5 353.2 |
| SUBSATELLITE JETTISON | | | |
| | 222:36:12.7 | 15:10:12.7 | Altitude Above LLS Radius, nmi 67.0 Selenographic Latitude, deg -0.4 Selenographic Longitude, deg 41.4 Velocity, fps 5 329.7 Perilune Altitude Above LLS, nmi 57.7 Apolune Altitude Above LLS, nmi 77.3 Revolution Number 74 |
| TRANSEARTH INJECTION | | | |
| Burn Initiation | 223:46:06.1 | Aug 4, 1971 16:20:06.1 | Mass, 1b 35 950.0 Altitude Above LLS Radius, nmi 72.6 Selenographic Latitude, deg -14.3 Selenographic Longitude, deg -167.8 |
| TRANSEARTH COAST, MIDCOURSE MANEUVERS | | | |
| MMC-5 | TEI plus 17 hr | Aug 5, 1971 09:22:23.9 | Geodetic Altitude, nmi \approx 173 500 |
| MMC-6 | EI minus 22 hr | Aug 6, 1971 17:32:20.0 | Geodetic Altitude, nmi \approx 102 400 |
| MMC-7 | EI minus 3 hr | Aug 7, 1971 12:32:20.0 | Geodetic Altitude, nmi \approx 25 000 |
| CM/SM Sep | EI minus 15 min | 15:17:20.0 | Geodetic Altitude, nmi 1 951.6 |
| ENTRY INTERFACE | 294:58:20.0 | 15:32:20.0 | Transearth Coast Time, hr 71.2 Inertial Velocity, fps 36 097.2 Geodetic Altitude, nmi (ft) 65.77(399 622) Inertial Flight-Path Angle, deg -6.49 Geodetic Latitude, deg 14.3 Longitude, deg -174.95 Equatorial Inclination (Ascending), deg 40 |
| CM LANDING | 295:11:45.6 | 15:45:45.6 | Geodetic Latitude, deg 26.119 Longitude, deg -158.00 |

LM ASCENT

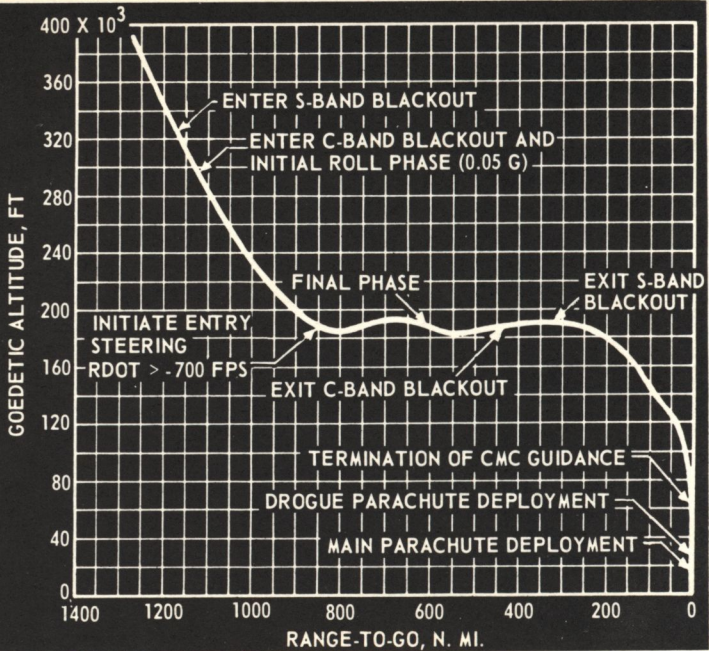


DIRECT RENDEZVOUS PROFILE

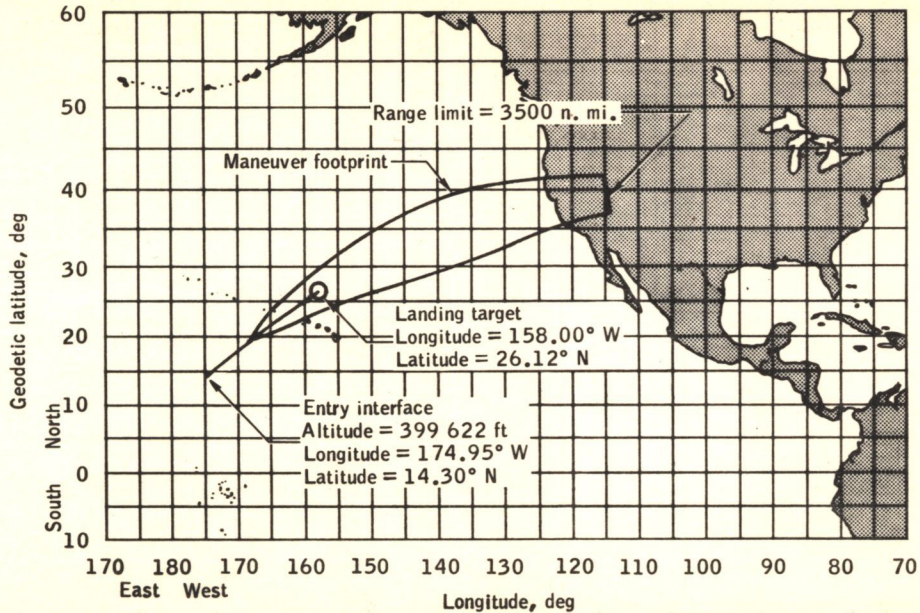


TYPICAL ENTRY SEQUENCE

| EVENT | TIME FROM 400 000 FT MIN:SEC |
|--|------------------------------------|
| ENTRY | 0:00 |
| ENTER S-BAND COMMUNICATION BLACKOUT | 0:18 |
| GUIDANCE CHANGES FROM P63 TO P64 LOAD FACTOR > 0.05 g | 0:29 |
| INITIATE CONSTANT DRAG CONTROL LOAD FACTOR > KA | 0:54 |
| MAXIMUM HEATING RATE | 1:10 |
| GUIDANCE INITIATE AT RDOT = -700 ft/sec | 1:20 |
| MAXIMUM LOAD FACTOR (FIRST) | 1:24 |
| SUBCIRCULAR VELOCITY | 2:10 |
| GUIDANCE CHANGE FROM P64 TO P67 | 2:12 |
| EXIT S-BAND COMMUNICATION BLACKOUT | 3:34 |
| MAXIMUM LAOD FACTOR (SECOND) | 5:42 |
| TERMINATION OF CMC GUIDANCE | 6:50 |
| DROGUES PARACHUTE DEPLOYMENT | 7:47 |
| MAIN PARACHUTES DEPLOYMENT | 8:36 |
| LANDING | 13:26 |



Maneuver footprint and nominal groundtrack.



COMPUTER PROGRAMS

| PHASE | PROGRAM NUMBER | PROGRAM TITLE |
|------------------------|----------------|--|
| Pre-Launch and Service | 00 | CMC Idling |
| | 01 | Prelaunch or Service-Initialization |
| | 02 | Prelaunch or Service-Gyro Compassing |
| | 03 | Prelaunch or Service-Optical Verification of Gyro Compassing |
| | 06 | GNCS Power Down |
| | 07 | Systems Test |
| | 11 | Earth Orbit Insertion Monitor (EOI) |
| Boost | 15 | TLI Initiate/Cutoff |
| Coast | 20 | Universal Tracking |
| | 21 | Ground Track Determination |
| | 22 | Orbital Navigation |
| | 23 | Cislunar Midcourse Navigation |
| | 24 | Rate-Aided Optics (Landmark Tracking) |
| | 27 | CMC Update |
| | 29 | Time-to-Longitude |
| Pre-Thrust Targeting | 30 | External Delta V |
| | 31 | Height Adjustment Maneuver (HAM) |
| | 32 | Co-elliptic Sequence Initiation (CSI) |
| | 33 | Constant Delta Altitude (CDH) |

| PHASE | PROGRAM NUMBER | PROGRAM TITLE |
|---------------|----------------|---|
| | 34 | Transfer Phase Initiation (TPI) |
| | 35 | Transfer Phase (TPF) |
| | 36 | Plane Change (PCM) |
| | 37 | Return to Earth (RTE) |
| | 40 | SPS |
| Thrusting | 41 | RCS |
| Alignment | 47 | Thrust Monitor |
| | 51 | IMU Orientation Determination |
| | 52 | IMU Realign |
| Entry | 53 | Back-up IMU Orientation Determination |
| | 54 | Back-up IMU Realign |
| | 61 | Entry - Preparation |
| | 62 | Entry-CM/SM Separation and Pre-entry Maneuver |
| | 63 | Entry Initialization |
| | 64 | Entry-Post 0.05G |
| | 65 | Entry-up Control |
| | 66 | Entry-Ballistic |
| | 67 | Entry-Final Phase |
| | Pre-Thrusting | 72 |
| 73 | | LM Constant Delta Altitude (CDH) Targeting |
| Other Vehicle | 74 | LM Transfer Phase Initiation (TPI) Targeting |
| | 75 | LM Transfer Phase (Midcourse) Targeting |
| | 76 | LM Target Delta V |
| | 77 | CSM Target Delta V |
| | 79 | Rendezvous Final Phase |

LGC PROGRAMS

| NUMBER | TITLE |
|---------------------|---------------------------------------|
| SERVICE | |
| P00 | LGC Idling |
| P06 | PGNS Power |
| P07 | Systems Test (Non-flight) |
| ASCENT | |
| P12 | Powered Ascent Guidance |
| COAST | |
| P20 | Rendezvous Navigation |
| P21 | Ground Track Determination |
| P22 | RR Lunar Surface Navigation |
| P25 | Preferred Tracking Attitude |
| P27 | LGC Update |
| PRETHRUSTING | |
| P30 | External Delta V |
| P32 | Co-elliptic Sequence Initiation (CSI) |
| P33 | Constant Delta Altitude (CDH) |
| P34 | Transfer Phase Initiation (TPI) |
| P35 | Transfer Phase Midcourse (TPM) |

| NUMBER | TITLE |
|------------------------------|---|
| THRUST | |
| P40 | DPS Thrusting |
| P41 | RCS Thrusting |
| P42 | APS Thrusting |
| P47 | Thrust Monitor |
| ALIGNMENTS | |
| P51 | IMU Orientation Determination |
| P52 | IMU Realign |
| P57 | Lunar Surface Alignment |
| DESCENT & LANDING | |
| P63 | Landing Maneuver Braking Phase |
| P64 | Landing Maneuver: Approach Phase |
| P66 | Rate of Descent Landing (ROD) |
| P68 | Landing Confirmation |
| ABORTS AND BACKUPS | |
| P70 | DPS Abort |
| P71 | APS Abort |
| P72 | CSM Co-elliptic Sequence Initiation (CSI) Targeting |
| P73 | CSM Constant Delta Altitude (CDH) Targeting |
| P74 | CSM Transfer Phase Initiation (TPI) Targeting |
| P75 | CSM Transfer Phase Midcourse (TPM) Targeting |
| P76 | Target Delta V |
| P77 | CSM Target Delta V |
| P99 | Guided RCS Burn (E-Memory Prog) |

VERB LIST

43 LOAD ERROR NEEDLES
 44 SET SURFACE FLAG
 45 RESET SURFACE FLAG
 47 LM SV INTO CSM SV
 54 COAS MARKING
 55 INCREMENT CMC TIME
 56 TERMINATE P20
 60 N17 = N20
 67 W MATRIX DISPLAY
 69 RESTART
 74 ERASABLE DUMP
 86 REJECT COAS MARK
 88 TERMINATE VHF MARKS
 94 RECYCLE ATT MNVR (P23)
 96 TERM SV INTEG (CALL P00)

37 TIG TPI
 38 STATE VECTOR TIME
 39 ΔT TRANSFER
 42 H.A - H.P - ΔV
 43 LAT - LONG - .H
 44 H.A - H.P - TFF
 49 $\Delta P.OS$ - $\Delta V.E.L$ - CODE
 51 HGA PIT.CH - HGA Y.AW
 52 ACTUAL .WT
 53 RANGE - R.R - P.HI
 54 RANGE - R.R - THE.TA
 55 CODE - ELEV ANG - .WT
 58 H.P - $\Delta VTP.I$ - $\Delta VTP.F$
 59 $\Delta VLOS.X$ - $\Delta VLOS.Y$ - $\Delta VLOS.Z$
 65 CMC TIME
 73 H(X10) - VEL - GAM.MA

NOUN LIST

05 ANG E.RR
 10 CHANNEL
 11 TIG CSI
 13 TIG CDH
 14 V CUTOFF TLI
 15 INCREMENT ADDRESS
 16 T EVENT (EXIT VERB)
 24 Δ CMC CLOCK TIME
 32 TF HP
 33 TIG
 34 T EVENT (PROGRAM)
 35 TF EVENT
 36 CMC TIME

75 ΔH CD.H - $\Delta T1$ - $\Delta T2$
 78 Y.AW - PIT.CH - OMICRON
 79 .RATE - .DB
 82 $\Delta VCDH$ LOCAL VERT
 85 VG CONTROL AXES
 87 CALIB SHAFT - T.RUN
 89 .LAT - LONG/2 - A.LT
 90 Y A.CT-Y DOT AC.T-Y DOT PAS.S
 91 PRESENT SHAFT - T.RUN
 92 COMMAND SHAFT - T.RUN
 93 TORQUING .ANG
 94 SHAFT - T.RUN
 95 TFI/TFC - VG - VI
 99 POS ERR. - VEL ERR - CODE

ALARM CODES (V05N09)

| | | | | | |
|---------|---------------------------------|-------|---|-------|--------------------------------|
| 00110 | MK REJECT ENTERED & IGNORED | 00602 | HP < 5.8 NM AFTER CDH | 14777 | ISS WARN-IMU,ICDU & PIPA FAIL |
| 00113 | NO INBITS (CH 16) | 00603 | CSI TIG TO CDH TIG ΔT < 10 MIN | 20430 | ORBITAL INTEGRATION STOPPED |
| 00114 | MORE MKS THAN DESIRED | 00604 | CDH TIG TO TPI TIG ΔT < 10 MIN | 20607 | NO CONIC SOLUTION |
| 00115 | V41N91 WITH OPTICS NOT IN CMC | 00605 | TOO MANY ITERATIONS | 20610 | ALTITUDE < 400K AT TIG (P37) |
| 00116 | OPTICS SW MOVED BEFORE 15 SEC | 00606 | CSI ΔV > 1000 LAST 2 ITERATIONS | 21204 | NEG OR ZERO WAITLIST CALL |
| 00117 | V41N91 BUT OPTICS NOT READY | 00611 | NO TIG FOR ELEV ANGLE GIVEN | 21206 | TWO DISPLAYS ATTEMPTED AT ONCE |
| 00120 | ZERO OPTICS FIRST | 00612 | WRONG SPHERE OF INFL AT TIG | 21210 | TWO PROGRAMS USING AT ONCE |
| 00121 | CDUS BAD DURING MK-REPEAT | 00613 | REENTRY ANGLE OUT OF LIMITS | 21302 | SQRT CALLED WITH NEG ARGUMENT |
| 00205 | PIPA SATURATED | 00777 | ISS WARNING-PIPA FAIL | 21501 | DSKY ALARM DURING INTERNAL USE |
| 00206 | CANNOT ZERO ICDU-WITH ALARMS | 01102 | CMC SELF TEST ERROR | 21502 | ILLEGAL FLASHING DISPLAY |
| 00207 | NEED 90 SEC FOR ISS TURN ON | 01105 | DOWNLINK TOO FAST | 21521 | KEYED POI AFTER LIFTOFF |
| 00210 | IMU NOT OPERATING | 01106 | UPLINK TOO FAST | 31104 | DELAY ROUTINE IS BUSY |
| 00211 | COARSE ALIGN ERROR > 2 DEG | 01107 | PHASE TABLE FAIL-ERASABLE BAD | 31201 | EXEC OVERFLOW-NO VAC AREAS |
| 00212 | PIPA FAIL BUT PIPA NOT IN USE | 01301 | ARCSIN/ARCCOS INPUT > ONE | 31202 | EXEC OVERFLOW-NO CORE SETS |
| 00213 | IMU NOT ON-TURN ON IMU | 01407 | VG INCREASING | 31203 | WAITLIST OVERFLOW-MANY TASKS |
| 00214 | PROGRAM USING IMU BUT IMU OFF | 01426 | IMU UNSATISFACTORY | 31211 | CANNOT INTERRUPT EXTENDED VERB |
| 00217 | COARSE ALIGN/TORQUING PROBLEM | 01427 | IMU POLARITY REVERSED | | |
| 00220 | IMU NOT ALIGNED/NO REFSMMAT | 01520 | V37 NOT PERMITTED NOW | | |
| 00401 | DESIRED MGA TOO LARGE | 01600 | OVERFLOW DURING DRIFT TEST | | |
| 00402 | DO SECOND MINKEY PULSE TORQUE | 01601 | BAD IMU TORQUE | | |
| 00404 * | TGT OUT OF VIEW (TRUN > 90 DEG) | 01703 | INSUF TIME TO INTEG-TIG SLIP | | |
| 00405 | STAR PAIR NOT AVAILABLE | 03777 | ISS WARNING-ICDU FAIL | | |
| 00406 | P20 NOT OPERATING | 04777 | ISS WARNING-ICDU & PIPA FAIL | | |
| 00421 | W MATRIX OVERFLOW | 07777 | ISS WARNING-IMU FAIL | | |
| 00600 | NO SOLUTION ON 1ST ITERATION | 10777 | ISS WARNING-IMU & PIPA FAIL | | |
| 00601 | HP < 5.8 NM AFTER CSI | 13777 | ISS WARNING-IMU & ICDU FAIL | | |

NOTE :

00404 * IS A PRIORITY ALARM
 2XXXX POODOO-NO RESTART LT-F37
 (AVE G ON OR EXT VERB -
 ACTS AS BAILOUT)
 3XXXX BAILOUT-NO RESTART LT-
 PROGRAM CONTINUES

ABBREVIATIONS

| | |
|----------------|--------------------------------|
| ACN | ASCENSION TRACKING STATION |
| AGS | ABORT GUIDANCE SYSTEM |
| ANG | ANTIGUA TRACKING STATION |
| AOS | ACQUISITION OF SIGNAL |
| APS | ASCENT PROPULSION SYSTEM |
| BDA | BERMUDA TRACKING STATION |
| BT | BURN TIME |
| CAL | CALIFORNIA TRACKING STATION |
| CDH | CONSTANT DIFFERENTIAL HEIGHT |
| CDR | COMMANDER |
| CES | CONTROL ELECTRONICS SYSTEM |
| CMC | COMMAND MODULE COMPUTER |
| CRO | CARNARVON TRACKING STATION |
| CSI | CONCENTRIC SEQUENCE INITIATION |
| CSM | COMMAND AND SERVICE MODULES |
| CYI | GRAND CANARY ISLAND |
| DAP | DIGITAL AUTOPILOT |
| DOI | DESCENT ORBIT INSERTION |
| DPS | DESCENT PROPULSION SYSTEM |
| EI | ENTRY INTERFACE |
| EMU | EXTRAVEHICULAR MOBILITY UNIT |
| EOI | EARTH ORBIT INSERTION |
| EPO | EARTH PARKING ORBIT |
| EVA | EXTRAVEHICULAR ACTIVITY |
| EVT | EXTRAVEHICULAR TRANSFER |
| FTP | FIXED THROTTLE POINT |
| GBM | GRAND BAHAMA TRACKING STATION |
| GDS | GOLDSTONE TRACKING STATION |
| g.e.t. | GROUND ELAPSED TIME |
| G.m.t. | GREENWICH MEAN TIME |
| G&N | GUIDANCE AND NAVIGATION |
| GYM | GUAYMAS TRACKING STATION |
| H _o | APOGEE ALTITUDE |
| HAW | HAWAII TRACKING STATION |
| H _p | PERIGEE ALTITUDE |
| IVC | INTERVEHICLE COMMUNICATIONS |
| IVT | INTRAVEHICULAR TRANSFER |
| LGC | LM GUIDANCE COMPUTER |
| LLM | LUNAR LANDING MISSION |
| LLS | LUNAR LANDING SITE |
| LM | LUNAR MODULE |
| LMP | LUNAR MODULE PILOT |
| LOI | LUNAR ORBIT INSERTION |
| LOS | LOSS OF SIGNAL |
| LPO | LUNAR PARKING ORBIT |

ABBREVIATIONS

| | |
|-------|---|
| LR | LANDING RADAR |
| MC | LM MIDCOURSE CORRECTION |
| MCC | MIDCOURSE CORRECTION |
| MER | MERCURY TRACKING SHIP |
| MGA | MIDDLE GIMBAL ANGLE |
| MIL | MERRITT ISLAND TRACKING STATION |
| MSFN | MANNED SPACE FLIGHT NETWORK |
| OGA | OUTER GIMBAL ANGLE |
| OPS | OXYGEN PURGE SYSTEM |
| PC | PLANE CHANGE |
| PDI | POWER DESCENT INITIATION |
| PGA | PRESSURE GARMENT ASSEMBLY |
| PGNCS | PRIMARY GUIDANCE & NAVIGATION CONTROL SUBSYSTEM |
| PLSS | PORTABLE LIFE SUPPORT SYSTEM |
| PRE | PRETORIA TRACKING STATION |
| PTC | PASSIVE THERMO CONTROL |
| RCS | REACTION CONTROL SUBSYSTEM |
| RDG | POSITION TARGET FOR LM DESCENT |
| RR | RENDEZVOUS RADAR |
| SECO | SIVB ENGINE CUT-OFF |
| SLA | SPACECRAFT LM ADAPTER |
| SPS | SERVICE PROPULSION SYSTEM |
| S-IC | SATURN IC, LV FIRST STAGE |
| S-II | SATURN II, LV SECOND STAGE |
| S-IVB | SATURN IVB, LV THIRD STAGE |
| TAN | TANANARIVE TRACKING STATION |
| TEC | TRANSEARTH COAST |
| TD&E | TRANSPOSITION & DOCKING & EXTRACTION |
| TEI | TRANSEARTH INSERTION |
| TEX | CORPUS CHRISTI TRACKING STATION |
| TLC | TRANSLUNAR COAST |
| TLI | TRANSLUNAR INJECTION |
| TPF | TERMINAL PHASE FINALIZATION |
| TPI | TERMINAL PHASE INITIALIZATION |
| TPM | TERMINAL PHASE MIDCOURSE |
| TVC | THRUST VECTOR CONTROL |
| VAN | VANGUARD TRACKING SHIP |
| ΔV | VELOCITY CHANGE (DIFFERENTIAL) |
| ΔVC | VELOCITY CHANGE AT ENGINE CUT-OFF |
| ΔR | POSITION CHANGE (DIFFERENTIAL) |



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