FRO

| APOLLO 12 | |
|---|---|
| LM G&N DICTIONARY | |
| PART NO | S/N |
| SKB32100075-361 | 1002 |

Basic Date ___ October 6, 1969
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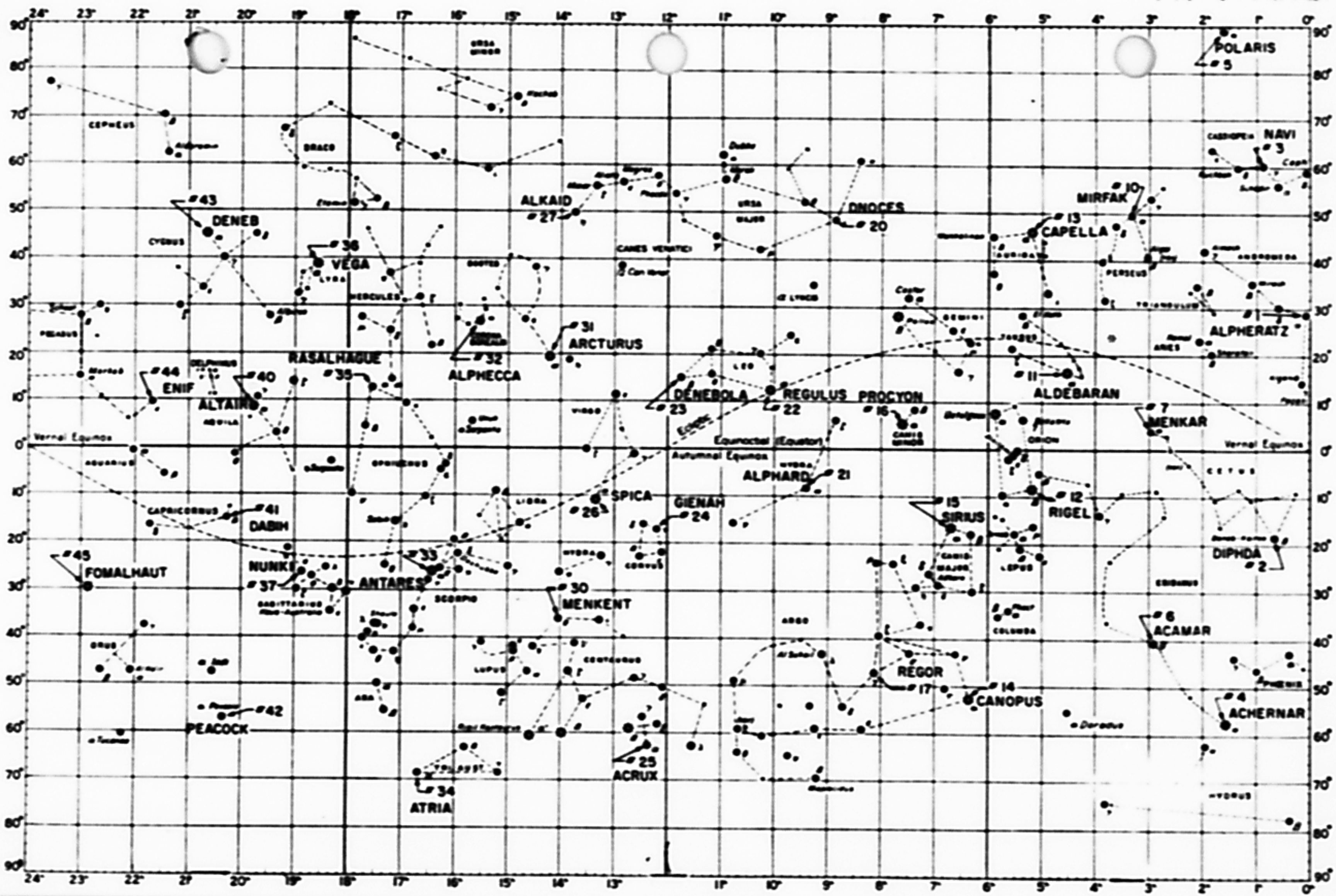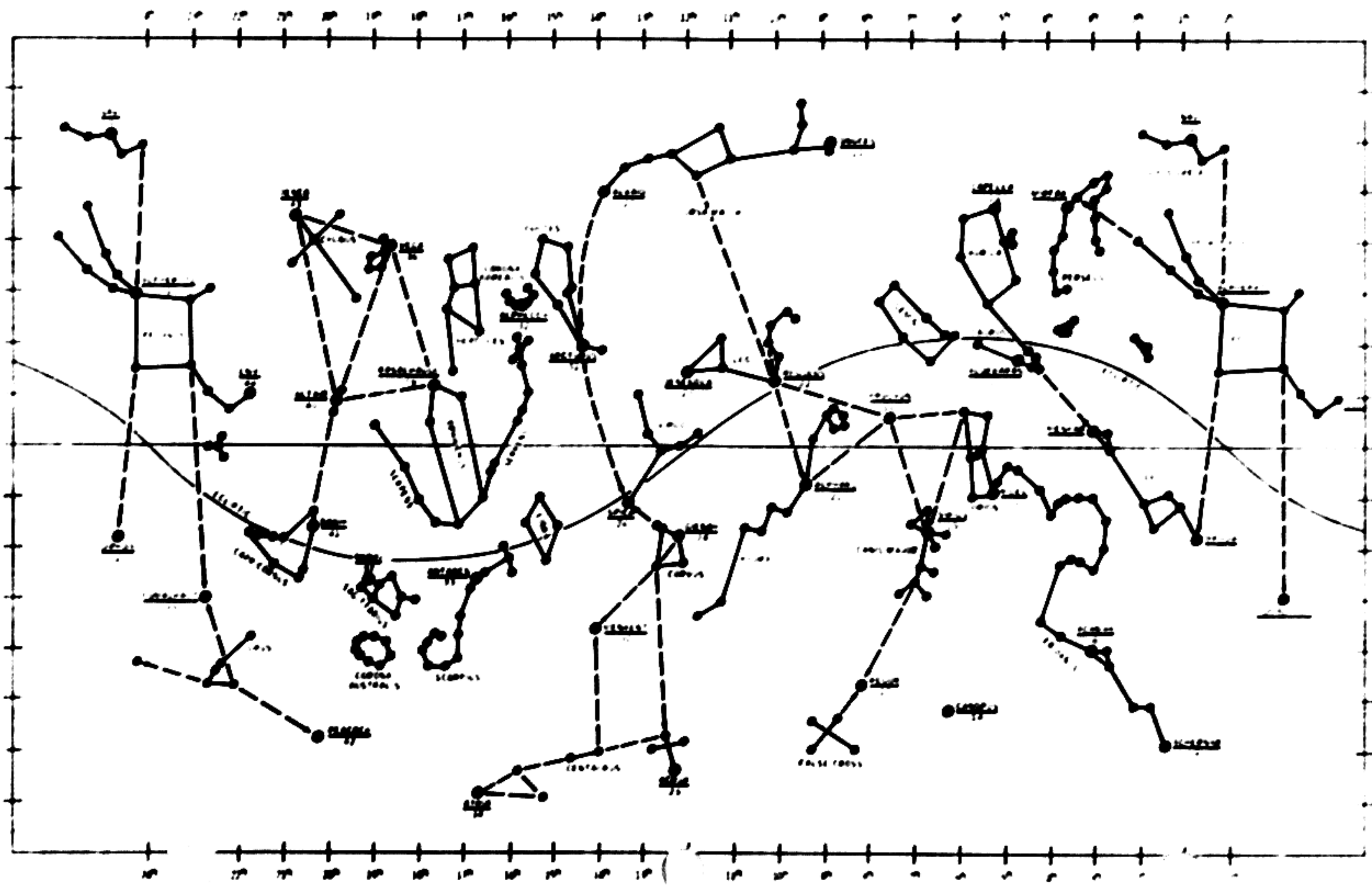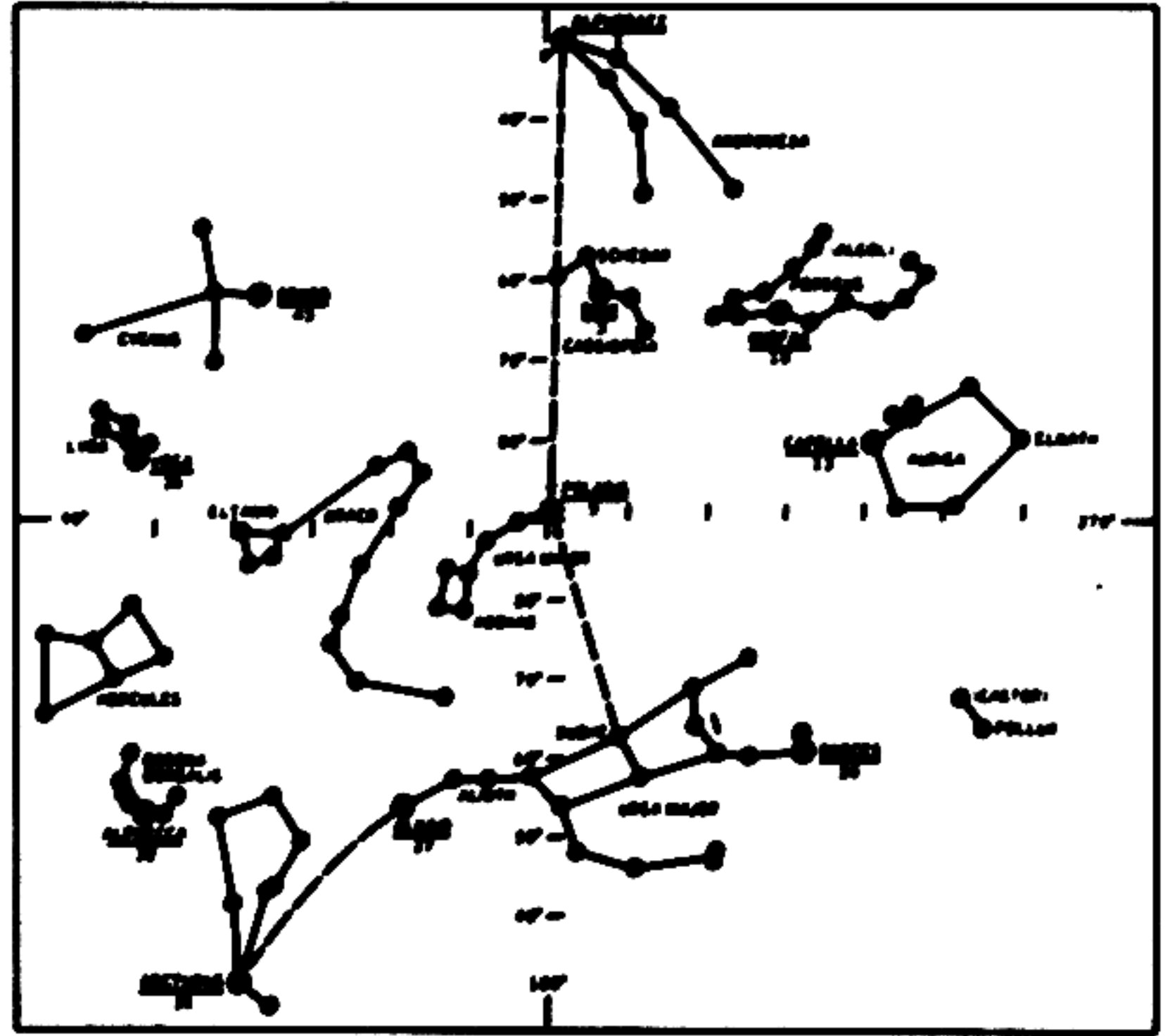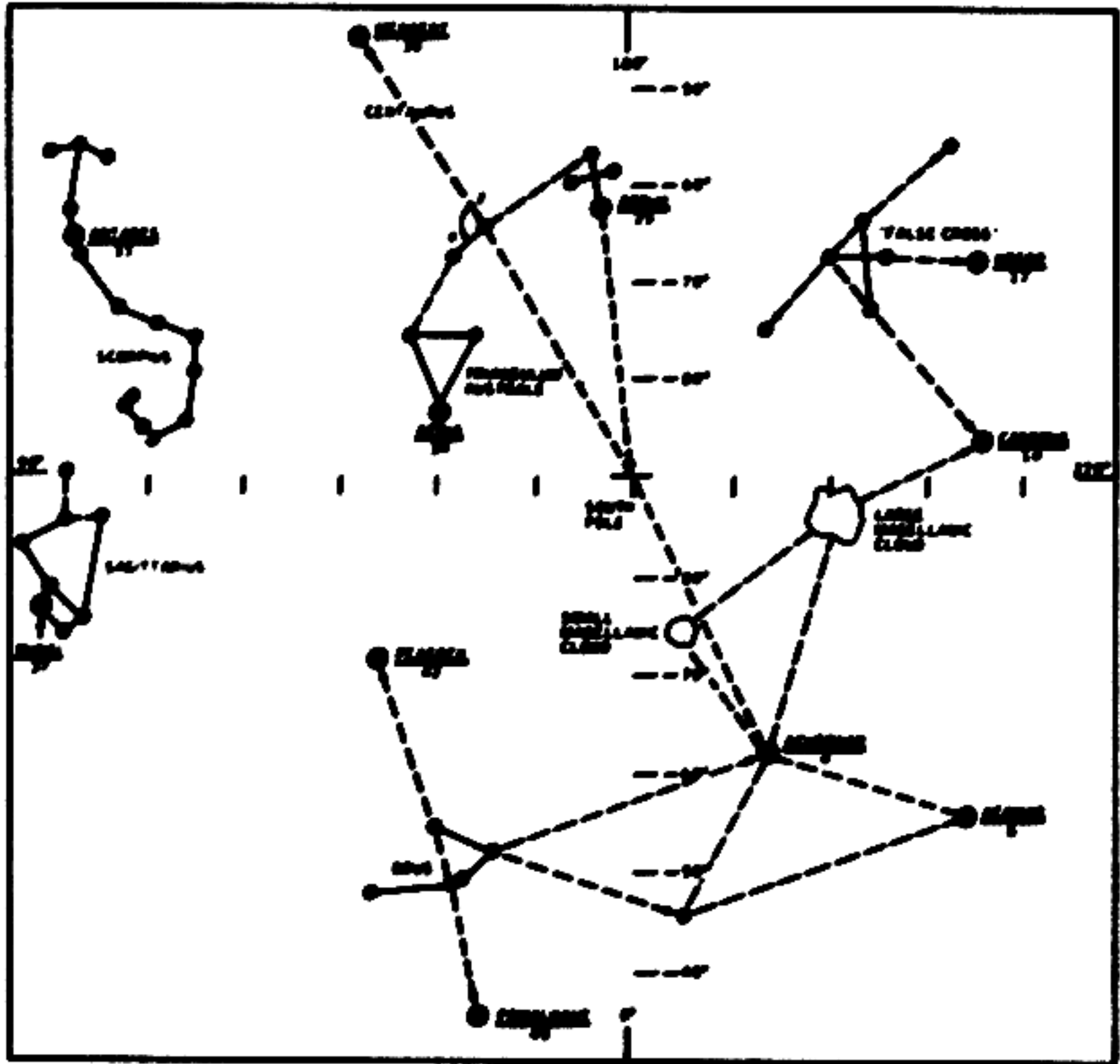
PGNS-1

## STAR LIST

| NO | STAR NAME (Numerical) | STAR NAME (Alphabetical) | NO |
|----|----|----|----|
| 00 | Planet | Acamar | 6 |
| 1 | Alpheratz | Achernar | 4 |
| 2 | Diphda | Acrux | 25 |
| 3 | Navi | Aldebaran | 11 |
| 4 | Achernar | Alkaid | 27 |
| 5 | Polaris | Alphard | 21 |
| 6 | Acamar | Alphecca | 32 |
| 7 | Menkar | Alpheratz | 1 |
| 10 | Mirfak | Altair | 40 |
| 11 | Aldebaran | Antares | 33 |
| 12 | Rigel | Arcturus | 31 |
| 13 | Capella | Atria | 34 |
| 14 | Canopus | Canopus | 14 |
| 15 | Sirius | Capella | 13 |
| 16 | Procyon | Dabih | 41 |
| 17 | Regor | Deneb | 43 |
| 20 | Dnoces | Denebola | 23 |
| 21 | Alphard | Diphda | 2 |
| 22 | Regulus | Dnoces | 20 |
| 23 | Denebola | Earth | 47 |
| 24 | Gienah | Enif | 44 |
| 25 | Acrux | Fomalhaut | 45 |
| 26 | Spica | Gienah | 24 |
| 27 | Alkaid | Menkar | 7 |
| 30 | Menkent | Menkent | 30 |
| 31 | Arcturus | Mirfak | 10 |
| 32 | Alphecca | Moon | 50 |
| 33 | Antares | Navi | 3 |
| 34 | Atria | Nunki | 37 |
| 35 | Rasalhague | Peacock | 42 |
| 36 | Vega | Planet | 00 |
| 37 | Nunki | Polaris | 5 |
| 40 | Altair | Procyon | 16 |
| 41 | Dabih | Rasalhague | 35 |
| 42 | Peacock | Regor | 17 |
| 43 | Deneb | Regulus | 22 |
| 44 | Enif | Rigel | 12 |
| 45 | Fomalhaut | Sirius | 15 |
| 46 | Sun | Spica | 26 |
| 47 | Earth | Sun | 46 |
| 50 | Moon | Vega | 36 |

Basic Date ____ October 6, 1969
Changed ____

LM-6

STARS, PROG

## PROGRAMS

NO.

| | |
|---|---|
| 00 | LGC Idle |
| 06 | LGC Power Down |
| 12 | Powered Ascent |
| 20 | Rendezvous Navigation |
| 21 | Ground Track Determination |
| 22 | Lunar Surface Navigation |
| 25 | Preferred Tracking Attitude |
| 27 | LGC Update |
| 30 | External $\Delta V$ |
| 32 | CSI Pre-Thrust |
| 33 | CDH Pre-Thrust |
| 34 | TPI Pre-Thrust |
| 35 | TPM Pre-Thrust |
| 40 | DPS Thrust |
| 41 | RCS Thrust |
| 42 | APS Thrust |
| 47 | $\Delta V$ Monitor |
| 51 | IMU Orientation Determination |
| 52 | IMU Realign |
| 57 | Lunar Surface Align |
| 63 | Braking Phase |
| 64 | Approach Phase |
| 65 | Landing Phase (Auto) |
| 66 | Landing Phase (ROD) |
| 67 | Landing Phase (MANUAL) |
| 68 | Landing Confirmation |
| 70 | DPS Abort |
| 71 | APS Abort |
| 72 | CSM CSI Targeting |
| 73 | CSM CDH Targeting |
| 74 | CSM TPI Targeting |
| 75 | CSM TPM Targeting |
| 76 | Target $\Delta V$ |

Basic Date _____ October 6, 1969

Changed _____

VERBS

| | |
|---|---|
| 01 | Display Octal Comp 1 in R1 |
| 02 | Display Octal Comp 2 in R1 |
| 03 | Display Octal Comp 3 in R1 |
| 04 | Display Octal Comp 1&2 in R1&R2 |
| 05 | Display Octal Comp 1,2&3 in R1,R2&R3 |
| 06 | Display Decimal in R1 or R1,R2 or R1, R2,R3 |
| 07 | Display DP Decimal in R1&R2 |
| 11 | Monitor Octal Comp 1 in R1 |
| 12 | Monitor Octal Comp 2 in R1 |
| 13 | Monitor Octal Comp 3 in R1 |
| 14 | Monitor Octal Comp 1&2 in R1&R2 |
| 15 | Monitor Octal Comp 1,2&3 in R1,R2&R3 |
| 16 | Monitor Decimal in R1 or R1,R2 or R1,R2,R3 |
| 17 | Monitor DP Decimal in R1&R2 |
| 21 | Load Component 1 in R1 |
| 22 | Load Component 2 in R2 |
| 23 | Load Component 3 in R3 |
| 24 | Load Component 1&2 in R1&R2 |
| 25 | Load Component 1&2&3 in R1&R2&R3 |
| 27 | Display Fixed Memory |
| 30 | Request Executive (P00 only) |
| 31 | Request Waitlist (P00 only) |
| 32 | Recycle |
| 33 | Proceed |
| 34 | Terminate |
| 35 | Test Lights (P00 only) |
| 36 | Request Fresh Start |
| 37 | Change Program |
| 40 | Zero CDU's (Specify N20 or N72) |
| 41 | Coarse Align CDU's (Specify N20 or N72) |
| 42 | Fine Align IMU |
| 43 | Load FDAI Error Needles (test only) |
| 44 | Terminate Continuous Designate (V41N72 Option 2) |
| 47 | Initialize AGS (R47) |
| 48 | Load DAP Data (R03) |
| 49 | Start Crew Defined Maneuver (R62) |
| 50 | Please Perform |
| 52 | Mark X |

VERBS

| | |
|---|---|
| 53 | Mark Y |
| 54 | Mark X or Y |
| 55 | Increment LGC Time (Decimal) |
| 56 | Terminate Tracking (P20,P22,&P25) |
| 57 | Call LR Update |
| 58 | Inhibit LR Update |
| 59 | Command LR To Pos. 2 (Don't Use In Ave G) |
| 60 | Display Attitude Rates On Error Needles (NON AGS) |
| 61 | Display DAP Attitude Error |
| 62 | Display Total Attitude Error |
| 63 | Start RR/LR Self-Test |
| 64 | Start S-Band Antenna Routine (R05) |
| 65 | Disable U,V Jets During DPS Burns |
| 66 | Set LM State Vector into CSM State Vector |
| 67 | W-Matrix Monitor |
| 69 | Cause Restart |
| 70 | Update Liftoff Time (P27) |
| 71 | Universal Update Load Block Addresses (P27) |
| 72 | Universal Update Load Singular Addresses(P27) |
| 73 | Update LGC Time (Octal) (P27) |
| 74 | Initialize Eraseable Dump via Downlink |
| 75 | Enable U,V Jets During DPS Burns |
| 76 | Set Min Impulse Mode in DAP |
| 77 | Set Rate Command/Attitude Hold Mode in DAP |
| 78 | Start LR Spurious Test (R77) |
| 79 | Stop LR Spurious Test (R77) |
| 80 | Update LM State Vector |
| 81 | Update CSM State Vector |
| 82 | Request Orbit Parameter Display (R30) |
| 83 | Rendevous Parameter Display (R31) |
| 85 | Display RR LOS Az and El |
| 89 | Start Rendezvous Final Attitude Maneuver (R63) |
| 90 | Request Rendezvous Out of Plane Display (R36) (Non Ave G) |
| 91 | Display Banksum (P00 Only) |
| 92 | Start IMU Performance Test (P07) (non-flight) |
| 93 | Enable W-Matrix Initialization (Clear Rendf'n) |
| 95 | Inhibit State Vector Update (P20 or P22) |
| 96 | Interrupt Integration and Go to P00 |
| 97 | Perform Engine Fail Procedure (R40) |
| 99 | Enable Engine Ignition |

October 6, 1969

Basic Date _____ Changed _____

LM-6

## NOUN LIST V - Can Be Called At Any Time For Valid Data

| | | | |
|---|---|---|---|
| 01V | Address to be Specified (Frac) | | .XXXXX |
| 02V | Address to be Specified (Whole) | | XXXXX. |
| 03 | Address to be Specified (Degree) | | .01° |
| 04 | Gravity Error Angle | | .01° |
| 05 | Angular Error/Difference | | .01° |
| 06 | Option Code | | Octal |
| | Desired Option | | Octal |
| | Data | | Octal |
| 07 | Flag Word Operator | ECADR | Octal |
| | | BIT ID | Octal |
| | | Action | Octal |
| 08V | Alarm Data | | Octal |
| 09V | Alarm Codes | | Octal |
| 10V | Channel to be Specified | | Octal |
| 11 | TIG CSI/T(APOAPSIS) | | hrs,min,.01sec |
| 12 | Option Code (Extended Verbs Only) | | Octal |
| | Desired Option | | Octal |
| 13 | TIG CDH | | hrs,min,.01sec |
| 14 | Checklist (Internal to LGC) | | XXXXX. |
| 15 | Increment Address | | Octal |
| 16 | Time of Event (Extended Verbs Only) | | |
| | | | hrs,min,.01sec |
| 18 | Desired Maneuver To FDAI RPY Angles | | .01° |
| 20V | ICDU Angles Y,P,R (OG,IG,MG) | | .01° |
| 21V | PIPA PULSES | | XXXXX. |
| 22 | New ICDU Angles Y,P,R,(OG,IG,MG) | | .01° |
| 24 | Delta Time For LGC Clock | | hrs,min,.01sec |
| 25 | Checklist (Used With V50) | | Octal |
| 26 | Prio/Delay, ADRES, BBCON | | Octal |
| 27V | Self Test ON/OFF | | |
| 32 | Time From Perigee | | hrs,min,.01sec |
| 33 | TIG | | hrs,min,.01sec |
| 34 | Time of Event | | hrs,min,.01sec |
| 35 | Time From Event | | hrs,min,.01sec |
| 36V | LGC Clock Time | | hrs,min,.01sec |
| 37 | TIG TPI | | hrs,min,.01sec |
| 38 | Time of State Being Integrated | | hrs,min,.01sec |
| 40 | Time From Ignition/Cutoff | | min-sec |
| | VG | | .1fps |
| | ΔV (Accumulated) | | .1fps |

NOUNS

LM-6

| | | |
|---|---|---|
| 41 | Target Azimuth (Non-Flight) | .01° |
| | Elevation | .001° |
| 42 | Apogee | .1nm |
| | Perigee | .1nm |
| | ΔV (Required) | .1fps |
| 43 | Latitude (+North) | .01° |
| | Longitude (+East) | .01° |
| | Altitude | .1nm |
| 44 | Apogee | .1nm |
| | Perigee | .1nm |
| | TFF | min-sec |
| 45V-R1 | Marks | XXXXX. |
| | TFI Of Next/From Last Burn | min-sec |
| | MGA | .01° |
| 46V | Digital Autopilot Configuration | Octal |
| 47V | LM Weight | lbs |
| | CSM Weight | lbs |
| 48V | Engine Gimbal Pitch Trim (+ Only) | .01° |
| | Engine Gimbal Roll Trim  (+ Only) | .01° |
| 49 | ΔR | .1nm |
| | ΔV | .1fps |
| | Source Code | 0000X. |
| 51 | S-Band Antenna | |
| | Pitch | .01° |
| | Yaw | .01° |
| 52 | Central Angle of Active Vehicle | .01° |
| 54 | Range | .01nm |
| | Range Rate | .1fps |
| | Theta | .01° |
| 55 | No. of Apsis Crossings (or Precision Offsets) | |
| | | 0000X. |
| | Elevation Angle | .01° |
| | Central Angle | .01° |
| 56 | RR LOS   Azimuth | .01° |
| | Elevation | .01° |
| 58 | Perigee Alt. (Post TPI) | .1nm |
| | ΔV TPI | .1fps |
| | ΔV TPF | .1fps |
| 59 | ΔV LOS Fwd/Aft (+FWD) | .1fps |
| | ΔV LOS Rt/Left (+RT) | .1fps |
| | ΔV LOS Up/Dn (+DN) | .1fps |

NOUNS

| | | |
|---|---|---|
| 60 | V (Horizontal) (Always +) | .1fps |
| | H DOT (+ Increasing H) | .1fps |
| | H | ft |
| 61 | TG | min-sec |
| | TFI | min-sec |
| | Crossrange | .1nm |
| 62 | VI | .1fps |
| | TFI | min-sec |
| | ΔV Accumulated | .1fps |
| 63 | VI | .1fps |
| | H DOT (+ Increasing H) | .1fps |
| | H | ft |
| 64 | TR/LPD | Sec/deg |
| | H DOT (+ Increasing H) | .1fps |
| | H | ft |
| 65V | Sampled LGC Time, Hrs | hrs |
| | Min | min |
| | Sec | .01sec |
| 66V-R2 | LR Slant Range | ft |
| | LR Position | 00001/00002 |
| 67 | LR VX | fps |
| | VY | fps |
| | VZ | fps |
| 68 | Slant Range to LS | .1nm |
| | TG Braking | min-sec |
| | LR Alt-Comp Alt (ΔAlt) | ft |
| 69 | Ldg Site Correction Comp Z,X,Y | ft |
| 70 | AOT Detent/Star Code | Octal |
| 71 | AOT Detent/Star Code | Octal |
| 72V | RR Trunnion Angle | .01° |
| | RR Shaft Angle | .01° |
| 73 | Desired RR Trunnion Angle | .01° |
| | Desired RR Shaft Angle | .01° |
| 74 | TFI | min-sec |
| | Yaw | .01° |
| | Pitch | .01° |
| 75 | ΔH (CDH) | .1nm |
| | ΔT (CDH-CSI/TPI-CDH)(Modular 60) | min-sec |
| | ΔT (TPI-CDH/TPI-Nom TPI)(Modular 60) | min-sec |
| 76 | V (HOR) | .1fps |
| | V (VERT) | .1fps |
| | Crossrange | .1nm |

Basic Date __October 6, 1969__
Changed __October 17, 1969__

LM-6

| 77 | ΔT to Engine Cutoff | min-sec |
|----|---------------------|---------|
|    | Velocity Normal To CSM Plane | .1fps |
| 78 | RR Range | .01nm |
|    | RR Range Rate | fps |
|    | TFI | min-sec |
| 79 | Cursor Angle | .01° |
|    | Spiral Angle | .01° |
|    | Detent Position | 0000X |
| 80 | Data Indicator | XXXXX. |
|    | Omega | .01° |
| 81 | ΔVX (LV) (+ Fwd) | .1fps |
|    | ΔVY (LV) (+ Rt) | .1fps |
|    | ΔVZ (LV) (+ Dn) | .1fps |
| 82 | ΔVX (LV) (+ Fwd) | .1fps |
|    | ΔVY (LV) (+ Rt) | .1fps |
|    | ΔVZ (LV) (+ Dn) | .1fps |
| 83 | ΔVX (LM) (+ Up) | .1fps |
|    | ΔVY (LM) (+ Rt) | .1fps |
|    | ΔVZ (LM) (+ Fwd) | .1fps |
| 84 | ΔVX (Other Vehicle) + (RXV)XR | .1fps |
|    | ΔVY (Other Vehicle) + (VXR) | .1fps |
|    | ΔVZ (Other Vehicle) + (-R) | .1fps |
| 85 | VGX (LM) (+ Up) | .1fps |
|    | VGY (LM) (+ Rt) | .1fps |
|    | VGZ (LM) (+ Fwd) | .1fps |
| 86 | VGX (LV) (+ Fwd) | .1fps |
|    | VGY (LV) (+ Rt) | .1fps |
|    | VGZ (LV) (+ Dn) | .1fps |
| 87 | Backup Optics LOS   Azimuth (+ Rt) | .01° |
|    | Elevation (+ Up) | .01° |
| 88 | Celestial Body Vector    X | .XXXXX |
|    | Y | .XXXXX |
|    | Z | .XXXXX |
| 89 | Latitude (+ North) | .001° |
|    | Longitude/2 (+ East) | .001° |
|    | Altitude | .01nm |
| 90 | Rendezvous Out of Plane Parameter Y | .01nm |
|    | YDOT | .1fps |
|    | PSI | .01° |
| 91 | Alt | 10nm |
|    | Vel | fps |
|    | Flt Path Angle | .01° |

| 93 | Δ Gyro Torquing Angles | X | .001° |
| | | Y | .001° |
| | | Z | .001° |
| 97 | System Test Inputs | | XXXXX. |
| 98 | System Test Results | | XXXXX. |
| | | | .XXXXX |
| | | | XXXXX. |
| 99 | W-Matrix: RMS Position | | ft |
| | RMS Velocity | | .1 fps |
| | Radar Bias Angle | | mr |

## V50 N25 CHECKLIST CODES

| RI Code | FUNCTION |
|---------|----------|
| 00013 | Key In Normal Or Gyro Torque Coarse Align |
| 00014 | Recheck or Exit Fine Align Option |
| 00015 | Star Acquisition |
| 00062 | Power Down LGC |
| 00201 | Select RR LGC Mode |
| 00203 | Select PGNS, AUTO,&AUTO THROTTLE |
| 00205 | Slew RR For Manual Acquisition |
| 00500 | Switch LR Antenna to Position 1 |

## N06 or N12 OPTION CODES

| 00001 | Specify IMU Orientation | 1 = Preferred |
| | | 2 = Nominal |
| | | 3 = REFSMMAT |
| | | 4 = Landing Site |
| 00002 | Specify Vehicle | 1 = LM |
| | | 2 = CSM |
| 00003 | Specify Tracking Attitude | 1 = Preferred |
| | | 2 = Other |
| 00004 | Specify Radar | 1 = RR, 2 = LR |
| 00006 | Specify RR Coarse Align Option | 1 = Lock On |
| | | 2 = Continuous Designate |
| 00010 | Specify Alignment Mode | 0 = Anytime |
| | | 1 = REFSMMAT + 1G |
| | | 2 = 2 Bodies |
| | | 3 = 1 Body + 1G |

| 00012 | Specify CSM Orbit Option | 1 = No Orbit Change |
|---|---|---|
| | | 2 = Change Orbit To Pass Over LM |

## V05 N09 ALARM CODES

20105 P **AOT Mark System In Use
       Reselect P5X

00107 P More Than 5 Mark Pairs (5 Marks On Surface)
       Continue

00111 P Mark Missing
       Restart Mark Sequence

00112 P Mark or Mark Reject Not Being Accepted
       Continue

00113 H No Inbits
       Continue

00114 P Mark Made But Not Desired
       Mark Correct Axis (X or Y) Continue

00115 P No Marks in Last Pair to Reject
       Continue

00206 P Zero Encode Not Allowed With Coarse
       Align & Gimbal Lock
       Coarse Align To 0,0,0 Then V40N20E

00207 P/H ISS Turn On Request Not Present For 90 sec
       CB(11) IMU OPR - Open, Wait 3 Min, & Reclose
       If Alarm Recurs And No ISS Warning, Continue

00210 P/H IMU Not Operating
       CB(11) IMU OPR - Open, Wait 3 Min, & Reclose
       V36E, Consult MSFN, Continue

00211 H Coarse Align Error
       If P51, P52, or P57 in Progress, Record Gyro
       Torquing Angles and Perform Fine Align
       Check in P52, P57
       If P51 or P52 Not In Progress
       Reduce Spacecraft Drift, Continue

00212 H PIPA Fail, But PIPA is Not Being Used
       Go to ISS MALFUNCTION PROCEDURES

00213 H IMU Not Operating With Turn-On Request
       See 00210

00214 P/H Program Using IMU When Turned OFF
       Terminate Program

| | | |
|---|---|---|
| 00217 | H | Bad Return From Stall Routine |
| | | Reinitiate Current Program |
| | | If Alarm Recurs, ISS Mode |
| | | Switching Failure |
| 00220 | P | IMU Not Aligned |
| | | Align or If Aligned, Set REFSMMAT FLAG |
| 00401 | I | Desired Gimbal Angles Yield Gimbal Lock |
| | | Call N22, MNVR if MGA 85° or Realign IMU |
| 00402 | P | FINDCDUW Routine Not Controlling Attitude |
| | | GUID CONT - AGS |
| 00404 | I | Defined Star Not Available In Any Detent |
| | | See P57/6 |
| 00405 | I | Two Stars Not Available |
| | | See P52/6 |
| 00421 | I | W-Matrix Overflow |
| | | Notify MSFN |
| 20430 | I | **Acceleration Overflow In Integration |
| | | Notify MSFN |
| 00501 | I | RR Antenna Out of Present Mode Limits |
| | | See P20/8 |
| 00502 | I | Bad Radar Gimbal Angle Input |
| | | Redo V41N72 |
| 00503 | I | Radar Antenna Designate Fail |
| | | See P20/8 or P22/5 |
| 00510 | P | Radar Auto Descrete Not Present |
| | | RR Mode - LGC, Continue |
| | | CB(11) RR(2) - CLOSE |
| 00511 | P | LR Not In Pos1 (P63) or 2(P64) |
| | | LDG ANT-DES (Hover) Wait 10 sec,AUTO |
| 00514 | P | RR Out Of Auto Mode While In Use |
| | | RR MODE - LGC or V56E |
| 00515 | H | RR CDU Fail Discrete Present |
| | | Notify MSFN, Continue |
| 00520 | P/H | RADARUPT Not Expected At This Time |
| | | Continue |
| 00521 | I | Could Not Read Radar, See P20/8 |
| 00522 | P | LR Position Change |
| 00523 | P | LR Ant Not In Position 2, V58E, PRO |
| | | LDG ANT - HOVER |
| 00525 | I | ΔTHETA >3° |
| | | See P20/8 or P22/5 |
| 00526 | I | Range >400 Miles.Terminate P20 |

00527 I    LOS Not In Mode II Coverage (P22) or
           Vehicle Mnvr Required (P20)
              Terminate If P22
              In P20, Mnvr
00530 I    LOS Not In Mode II Coverage On Surface
           After 600 sec
              Reselect P22
00600 I    Imaginary Roots On First Iteration
              See P32/4 or P72/4
00601 I    Perigee Altitude (Post CSI) <35,000 ft
           (Lunar Orbit)
              See P32/4 or P72/4
00602 I    Perigee Altitude (Post CDH) <35,000 ft
           (Lunar Orbit)
              See P32/4 or P72/4
00603 I    CSI To CDH Time  10 Min
              See P32/4 or P72/4
00604 I    CDH To TPI Time <10 Min Or TIG CDH > TIG TPI
              See P32/4 or P72/4
00605 I    Number Of Iterations > 15
           Program Cannot Converge On CSI Solution
              See P32/4 or P72/4
00606 I    ΔV Exceeds Max
              See P32/4 or P72/4
20607 I **No Solution From Time-Theta or Time-Radius
00611 I    No TIG For Given Elevation Angle
              See P33/2, P34/3, P73/4, P74/2
00701 I    Illegal Option Code Selected
              V32E Reselect Option
00777 H    PIPA Fail Caused The ISS Warning
              Go To ISS Malfunction Procedure
01102 H    LGC Self Test Error
              Call N08 & Record For MSFN
21103 I **Unused CCS Branch Executed
              Copy N08, Notify MSFN, Continue
31104 H  *Delay Routine Busy
              Reselect Extended Verb
01105 H    Downlink Too Fast
              If Alarm Recurs, Downlink Failure
01106 H    Uplink Too Fast
              If Alarm Recurs, Uplink Failure

01107 H    Phase Table Failure
           Perform:1.   V74 LGC DOWNLINK
                   2.   P27 As Necessary
                   3.   V48 As Necessary
                   4.   Reestablish REFSMMAT via P51
           If FRESH START Recurs, LGC FAILURE
31201 P  *Executive Overflow - No Vac. Areas
           Reselect Extended Verb or Continue Program
31202 P  *Executive Overflow - No Core Sets
           See 31201
31203 P/I*Waitlist Overflow - Too Many Tasks
           See 31201
21204 P/I**Waitlist, Var Delay, Fix delay, Longcall,
           Or Delay Job Called With Zero Or Negative
           ΔT
           Copy N08, Notify MSFN, Continue
31206 P  *Two Jobs Try To Sleep in PINBALL
           See 31201
31207 P  *No Vac Area For Marks
           Reselect P51 or P52
31210 P  *Two Routines Using Device at Same Time
           Reselect Extended Verb or Prog When Device
           No Longer In Use
           Record N08, Notify MSFN, Continue
31211 P  *Illegal Interrupt of Extended Verb
           Reselect P51 or P52
01301 I    ARCSIN-ARCCOS Input Angle Too Large
           Copy N08, Notify MSFN, Continue
21302 I **SQRT Called With Negative Argument
           See 01301
01406 I    Bad Return From Rootpsrs
  (** 21406 - Occurs In P63 Ign Algorithm)
01407 P    VG Increasing
           See P40/IGN or P42/IGN
01410 P/I Unintentional Overflow in Guidance,
           Contact MSFN
01412 I    Descent Ignition Algorithm Non-Converging
           Consult MSFN
21501 P **Illegal Internal Use of PINBALL
           See 01301
31502 P  *Illegal Flashing Display
           See 01301
01520 P    V37 Request Not Permitted At This Time
           Reselect V37

Basic Date _____ October 6, 1969

Changed _____

LM-6

| | | |
|---|---|---|
| 01600 | H | Overflow in Drift Test |
| | | Perform V36E |
| 01601 | H | Bad IMU Torque |
| 01703 | P | TIG Slipped |
| 01706 | P | P40 Selected But Staged |
| | | P42 Selected But Not Staged |
| | | See P40/1 or P42/1 |
| 32000 | P | *DAP Still In Progress At Next TIME5/RUPT |
| | | RSET, GUID CONT - AGS Then PGNS; If Alarm |
| | | Recurs, V36E, Reinitialize LGC |
| 02001 | I | Jet Failures Have Disabled Y-Z Trans |
| | | Change Quad Isol Valve or Use |
| | | Alternate Control Mode |
| 02002 | I | Jet Failures Have Disabled X Trans |
| | | See 02001 |
| 02003 | I | Jet Failures Have Disabled P Rotation |
| | | See 02001 |
| 02004 | I | Jet Failures Have Disabled U-V Rotation |
| | | See 02001 |
| 03777 | H | ICDU Fail Caused the ISS Warning |
| | | Go to ISS Malfunction Procedures |
| 04777 | H | ICDU, PIPA Fails Caused the ISS Warning |
| | | Go to ISS Malfunction Procedures |
| 07777 | H | IMU Fail Caused The ISS Warning |
| | | Go to ISS Malfunction Procedures |
| 10777 | H | IMU, PIPA Fails Caused The ISS Warning |
| | | Go to ISS Malfunction Procedures |
| 13777 | H | IMU, ICDU Fails Caused The ISS Warning |
| | | Go to ISS Malfunction Procedures |
| 14777 | H | IMU, ICDU, PIPA Fails Caused The ISS Warning |
| | | Go to ISS Malfunction Procedures |

*Generates Software Restart (3XXXX)
**Abort Code, Program Goes To ROO. (2XXXX)


P - Procedure Caused Alarm
I - Input Data Caused Alarm
H - Hardware Status Caused Alarm


Alarms for V05N09
R1 First Alarm After RSET
R2 Second Alarm After RSET
R3 Most Recent Alarm

## GENERAL SYSTEM CHECKOUT

1    Go To P00 By One of the Following:
       V37E 00E or
       V96E or
       V36E V96E (Wait 15 sec Before P00E )

       Simultaneously Press RSET And
         MARK REJECT (GO JAM)

       V37E 00E

## REASONABLENESS CHECK

1    V82 With Both Options

2    V83

3    P21 NAV CHECK

4    P52 Check Auto Optics Positioning
    IF NOMINAL:
      Continue
    IF NOT NOMINAL:
      Perform P27 Update

5    LGC SELF-TEST

## P06 (F 50 25 00062)

1    PRO to STBY Then
    PRO to F 37 or
    V21 N10E, 13E, 0E
    V37E 00E

2    V37E 51E
    PRO
    V37E 00E

3    V25 N07E, 77E, 10000E, 1E

### P63

1    V37E 00E
     V25 N07E, 102E, 200E, E

### V30 OR V31

1    Record N26,
     Notify MSFN
     V74E
     Perform General System Checkout

### V36

1    If Unstaged V21 N01E 3000E, 2343E
     Perform General System Checkout If Necessary

### V92 (POO ONLY)

1    V37E 00E
     V93E

### GO JAM

1    V74 when Convenient (See V36)

### STAR CODE >50

1    Perform General System Checkout

6          16 77          TG,V(Y)                              (min-sec,.1fps)
                          N85E

7          16 85          VG XYZ (LM)                              (.1fps)

                          VGX=200fps  SYS A MAIN SOV - OPEN
                                      SYS B MAIN SOV - OPEN
                                      SYS A ASC FEED 2-CLOSE
                                      SYS B ASC FEED 2-CLOSE
                                      CRSFD              -CLOSE

                          VGX=100fps, ENG ARM - OFF

           APS
           OFF            NULL COMPONENTS
                          KEY REL

8          F 16 63        VI,HDOT,H                            (.1fps,ft)
                          ABORT STAGE - Reset
                          ENG STOP - Push Then Reset

                          Note VI   _____
                               HDOT _____
                               H    _____
                          PRO

9          F 16 85        VG XYZ (LM)                              (.1fps)
                          (DISPLAY ORB PARAM) V82E To 10
                          (TERM) PRO To 11

10         F 16 44        APO ALT, PER ALT, TFF      (.1nm,min-sec)

                          Note HA  _____
                               HP  _____
                               TFF _____
                          PRO To 9

11         F 37

## P20 RENDZ NAV

1           V37E 20E
        (TO TERM-V56E)
        (SV OPTION, V80E LM, V81E CSM, V95E NONE)

2  (If Pointing Error <10°, To 4; Mnvr With No Display)
    F 50 18   REQUEST MNVR TO FDAI RPY ANGLES   (.01°)
        (AUTO or TRIM) GUID CONT - PGNS
                        MODE CONT:  PGNS - AUTO
            PRO
        (MAN)  MODE CONT:  PGNS - ATT HOLD
            MNVR
            PRO To 2
        (BYPASS)  ENTR To 4 (To 9 If Entered From
                            9 Via V32E)
                         (To 6 If Entered From
                            6 Via ENTR)

3      06 18   AUTO MNVR TO FDAI RPY ANGLES        (.01°)
            Monitor Auto Mnvr To 2

4               RR MODE: LGC To 7
                        (To 8 If Entered From 6
                          or 9 via PRO)
                SLEW or AUTO To 5

5   F 50 25   00201 RR ACQ MODE
        (AUTO)     RR MODE LGC
            PRO To 4
        (MAN)     ENTR

6   F 50 25   00205 SLEW RR For LOCK-ON
        (LOCK)    RR MODE-LGC:
                NO TRACK Lt - Off, Wait 10 sec
            PRO To 4
        (NO LOCK) MNVR
            ENTR To 2

                *F 05 09 501 RR OUT OF MODE LIMITS*
                *         (REQUEST MNVR)  V32E To 2*

7    F 50 72    TRUN, SHFT                              (.01°)
                Confirm Main Lobe Lock-On
          (ACQUIRE MAIN LOBE)
                RR MODE - SLEW
                Slew To Peak AGC
                RR MODE - LGC
          (ACCEPT) PRO

8    NO TRACK LITE

          OUT  DSKY BLANKS, RR TAKING MARKS
               (RAW RR DATA) V16N78E R,RDOT,TFI
                                   (.01nm,fps,min-sec)
                         KEY REL

               *F 05 09 00525 SV/RR LOS >3°        *
               *         PRO                       *
               *F 06 05 SV/RR LOS        (.01°)    *
               *     (REJECT) CK SIDE LOBE         *
               *             RR MODE-LGC           *
               *             V32E To 7             *
               *     (UPDATE) PRO To 8             *
               *                                   *
               *F 06 49 ΔR,ΔV,Code(.1nm,.1fps,     *
               *                  0000X)           *
               *           X=1, RANGE              *
               *           X=2, RDOT               *
               *           X=3, SHAFT }            *
               *           X=4, TRUN }             *
               *    (REJECT PARTIAL MARK)V32E To8 *
               *    (REJECT TOTAL MARK) V34E To 8 *
               *     (MAN ACQ) RR MODE - SLEW      *
               *               Acquire             *
               *               RR MODE - LGC       *
               *               V32E To 4           *
               *     (UPDATE) PRO To 8             *
               *                                   *
               *F 50 18 (MNVR REQUEST) Go To 2    *

          ON   NO LOCK
     F 05 09   00503 RR NO DATA GOOD 30 SEC(or Desig.
                                          Fail)
          (REDESIG) V32E To 4
          (SEARCH)  PRO To 9

```
                *V05 N09E 00521 Could Not Read Radar    *
                *               KEY REL To 7            *
                *        00515 RR CDU FAIL DISCRETE     *
                *               PRESENT                 *
                *               KEY REL To 7            *
                *        00501 RR Ant. Out Of Mode Limits*
                *               RR To + Z               *
```

9    F 16 80    RR AUTO SEARCH, SEARCH CODE,      (.01°)
                R1   00000-SEARCH 42 sec/scan
                     11111-LOCK ON
                R2   LOS/+Z
             (LOCK)     PRO To 2
             (NO LOCK OR MAN ACQ) SLEW RR For LOCK-ON
                RR MODE - LGC
                NO TRACK Lt-Out, To 9
             (MNVR) V32E To 2

                   P21 GROUND TRACK DETERMINATION

1               V37E 21E
     F 04 06    R1 00002, SPECIFY VEHICLE
                R2 00001  LM
                   00002  CSM
                PRO

2    F 06 34    GET LAT, LONG              (hrs,min,.01sec)
                (Zero For Present Time)
          .     PRO

3    F 06 43    LAT, LONG, ALT               (.01°,.1nm)
             (N91 CALL) N91E
                F 06 91 ALT, VEL, FLT PATH }
                                            (10nm,fps,.01°)
                      KEY REL
             (INCREMENT GET 10 min) V32E To 2
             (TERM) PRO

4    F 37

```

## P22 LUNAR SURFACE NAVIGATION

1       V95E
        V37E22E
        (To TERM-V56E)
        (SV OPTION, V81E CSM, V95E NONE)
F 04 06  R1 00012 CSM ORBIT OPTION
         R2 00001 CSM WILL NOT CHANGE
                  ORBIT
            00002 CSM WILL CHANGE ORBIT


        (OPT 1)     To 3
        (OPT 2) PRO To 2

2  F 06 33   TIG ASC                 (hrs,min,.01 sec)
             PRO

3            V83E, Rng <400, PRO, PRO
             V16N38E
             When N38 = Present time and remains equal:
             V24N01E, 3424E
               Load MSFN supplied octal acq. time
    RR MODE - LGC To 5
            - SLEW or AUTO TRACK To 4

4  F 50 25   R1 00201 RR AUTO REQUEST
             RR MODE - LGC
             PRO

             *PROG Lt-On                               *
             *F 05 09 00530 CSM NOT IN MODE II*
             *              LIMITS YET            *
             *         (WAIT FOR CSM) PRO         *
             *         V37E 22E                   *
             *         (TERM) V56E                *

5            NO TRACK Lt:

             OUT DSKY BLANKS, RR TAKING MARKS
                 (P22 Continues To Run In Background)

Basic Date  October 6, 1969
Changed     October 23, 1969

LM-6

```
                    (RAW RR DATA) V16N78E R,RDOT,TFI
                                      (.01nm,fps,min-sec)
                               KEY REL


              *F 05 09 00525 SV/RR LOS >3°          *
              *         PRO                         *
              *F 06 05 SV/RR LOS (.01°)             *
              *         (REJECT) CHECK SIDE LOBE    *
              *                  RR MODE - LGC       *
              *                  V32E To 5          *
              *         (UPDATE) PRO Tc 3 or below*
              *F 06 49 ΔR,ΔV,Code(.1nm,.1fps,      *
              *                         0000X)      *
              *                  X=1, RANGE         *
              *                  X=2, RDOT          *
              *         (UPDATE) PRO To 5           *
              *         (REREAD) V32E To 5          *


         ON

  F 05 09    00503 RR DESIG FAIL
             (REDESIGN) ENTR To 3
             (SEARCH)   PRO To 6
             (TERM)     V56E

6  F 16 80   RR AUTO SEARCH, SEARCH CODE        (.01°)
             R1 00000 Search (42 sec/scan)
                11111 LOCK-ON
             R2 LOS/+Z                          (.01°)
             (NO LOCK) V56E
             (LOCK) PRO To 3


              *PROG Lt-On                 *
              *V05N09E 00527 CSM OUT      *
              *         OF MODE II LIMITS*
              *         (TERM) V56E       *
```

Basic Date. ) October 6, 1969
Changed

LM-6

## P25 PREFERRED TRACKING ATT

1       V37E 25E
        (To TERM - V56E)
F 50 18   REQUEST MNVR TO FDAI RPY ANGLES    (.01°)
        (AUTO or TRIM) GUID CONT - PGNS
                        MODE CONT:  PGNS - AUTO

        PRO
(MAN)       MODE CONT:  PGNS - ATT HOLD
            MNVR
        PRO To 1
(BYPASS)  ENTR To 3

2    06 18   AUTO MNVR TO FDAI RPY ANGLES      (.01°)
        Monitor Auto Mnvr, To 1

3       P25 Continues To Run
        In Background Until Terminated

        (RAW RR DATA) V16N78E R,RDOT,TFI
                            (.01nm,fps,min-sec)
                    KEY REL

## P27 LGC MANUAL UPDATE

1    (NOTE: For Auto Update, If V33 N02
            Displayed Key PRO; If V21 N02
            or N01 Displayed Key V34E)

2       V37E 00E

3       IF AGS OPERATING, 563 + 00000E

4       V70E Update Lift Off Time
      or V71E Load Consec Data
      or V72E Load Singular Data
      or V73E Increment LGC Time
        (Update Form Will Format Index Number,
        Address, Data & Component Identifier
        To Be Usable With The Following Pro-
        cedure)

5 F 21 01 R3 ADDRESS (Initially 1173)
      LOAD DATA IN R1 E (R3 Increments)

6 F 21 01 Repeat Step 5 For All Data

7 F 21 02 R3 Goes To 1167 When Data Load Complete

         TO REVIEW DATA
          V01 NOTE, 1173E
          R1 Data
          N15E (R3 1174)
          ENTR Verify Data For Remaining
                   Comps.

          KEY REL To 7

         TO CHANGE DATA
          Load Comp Identifier XX E
          Correct Data E
          Go To 7

         TO ACCEPT UPDATE
          V33E

8       P00 Displayed

## P30 EXTERNAL ΔV

1
   F 06 33   V37E 30E
              TIG                         (hrs,min,.01sec)
              PRO

2
   F 06 81   ΔV XYZ(LV)              (.1fps)
              PRO

3
   F 06 42   HA, HP, ΔV           (.1nm,.1fps)
              PRO

4
   F 16 45   M, TFI, MGA    (marks,min-sec,.01°)
              SET EVENT TIMER TO TFI
              PRO  (MGA Set To -00002 If No
                              REFSMMAT Set)

5
   F 37

## P32 CSI PRETHRUST

1
   F 06 11   V37E 32E
              TIG (CSI)/T(APOAPSIS)   (hrs,min,.01sec)
              PRO
              If Zero, T (APOAPSIS) Displayed

2
   F 06 55   APSIS CDH, TPI ELEVATION ANGLE,
              R3,0000Y               (+0000X,.01°)
                 For Y≠0,CDH At CSI+
                 Multiple Of 180° Specified
                 By R1(X)
              PRO

3
   F 06 37   TIG (TPI)         (hrs,min,.01sec)
              PRO

4
   F 16 45   MARKS, TFI,-00001     (marks,min-sec)
              (RECYCLE) V32E To 5
              (TERM MARKING) PRO

October 6, 1969   Basic Date   Changed

P30-P35

LM-6

```
                        *F 05 09 00600 No Intersection On    *
                        *              First Iteration        *
                        *        00601 POST CSI ALT <35,000 ft*
                        *        00602 POST CDH ALT <35,000 ft*
                        *        00603 TIG(CDH)-TIG(CSI)<10mi
                        *        00604 TIG(TPI)-TIG(CDH)<10min*
                        *        00605 NO SOL IN 15 TRIES      *
                        *        00606 ΔV CSI >1000fps In 2    *
                        *              Iterations              *
                        *        V32E To 1 Adjust Inputs       *
```

**P30-P35**

5   F 06 75   ΔH(CDH),ΔT (CDH-CSI),ΔT(TPI-CDH)
             PRO                          (.1nm,min-sec)

6   F 06 81   ΔV XYZ (LV) CSI                     (.1fps)
             (For Out-of-Plane Corr In Final Comp ONLY)
                         V90E
             F 06 16    GET EVENT      (hrs,min,.01sec)
                         PRO
             F 06 90    Y,YDOT,PSI   (.01nm,.1fps,.01°)
                 Record YDOT_____
                         PRO
             (Insert Neg YDOT In R2 Of ΔV CSI)
             PRO

7   F 06 82   ΔV XYZ (LV) CDH                     (.1fps)
             PRO (If Recycling To 4)

8   F 16 45   MARKS,TFI,MGA (-00002 If No REFSMMAT Set)
                                    (marks,min-sec,.01°)

             SET EVENT TIMER TO TFI
             PRO

9   F 37

**P33 CDH PRETHRUST**

1          V37E 33E
    F 06 13   TIG (CDH)              (hrs,min,.01sec)
            PRO

2     F 16 45   MARKS,TFI, -00001       (marks,min-sec)
          (RECYCLE) V32E To 3
          (TERMINATE MARKING)  PRO

                      *F 05 09 00611 NO TIG FOR   *
                      *         SPECIFIED ANGLE   *
                      *  (REDO)V32E To 1       *
                      *  (CONTINUE) PRO To 3    *

3     F 06 75   ΔH(CDH),ΔT(TPI-CDH),ΔT(TPI-NOMTPI)
            PRO                   (.1nm,min-sec)

4     F 06 81   ΔV XYZ (LV) CDH             (.1fps)
          (For Out-of-Plane Corr in Final Comp ONLY)
                  V90E
          F 06 16    GET EVENT    (hrs,min,.01sec)
              PRO
          F 06 90    Y,YDOT,PSI  (.01nm,.1fps,.01°)
            Record YDOT
            PRO
          (Insert Neg YDOT in R2 of ΔV CDH)
          PRO (If Recycling To 2)

5     F 16 45   MARK,TFI,MGA (-00002 If No REFSMMAT Set)
                      (marks,min-sec,.01°)
          SET EVENT TIMER TO TFI
          PRO

6     F 37

**P34 TPI PRETHRUST**

1          V37E 34E
    F 06 37   TIG (TPI)              (hrs,min,.01sec)
            PRO

Basic Date _____ October 6, 1969 _____ Changed _____

LM-6

2    F 06 55    N, ELEVATION ANGLE, CENTRAL ANGLE
                                          (0000X,.01°)
                  (00000 In R2 To Calc Elevation
                   Angle At TIG Time)
                  PRO

3    F 16 45    MARKS, TFI, -00001        (marks,min-sec)
                (RECYCLE) V32E
                (TERMINATE MARKINGS)   PRO

                                    *F 05 09  00611 NO TIG*
                                  *          FOR         *
                                  *          SPECIFIED   *
                                  *          ANGLE       *
                                  *          PRO To 1    *

4    F 06 37    TIG (TPI)                (hrs,min,.01sec)
                  PRO
                  (If Elevation Angle Computed By LGC
                   This Display Will Be Replaced By
                   F 06 55
                  PRO To 5)

5    F 06 58    HP,ΔV(TPI),ΔV(TPF)        (.1mm,.1fps)
                  PRO (If Recycling To 7)

6    F 06 81    ΔV XYZ (LV) TPI             (.1fps)
                  PRO

7    F 06 59    ΔV XYZ (LOS) TPI          (.1fps)
                  PRO (If Recycling To 3)

8    F 16 45    MARKS,TFI,MGA (-00002 If No REFSMMAT Set)
                                  (marks,min-sec,.01°)
                  SET EVENT TIMER TO TFI
                  PRO

9    F 37

                  P35 TPM PRETHRUST

1                V37E 35E
      F 16 45    MARK, TFI, -00001        (marks,min-sec)
                (RECYCLE) V32E To 3
                (TERM MARKING)   PRO

2    F 06 81    ΔV XYZ (LV) TPM                              (.1fps)
                PRO

3    F 06 59    ΔV XYZ (LOS) TPM                             (.1fps)
                PRO (If Recycling To 1)

4    F 16 45    MARKS,TFI,MGA (-00002 If No REFSMMAT Set)
                                    (marks,min-sec,.01°)
                SET EVENT TIMER TO TFI
                PRO

5    F 37

                <u>P40 DPS THRUST</u>

                GUID CONT                    -PGNS
                THR CONT                     -AUTO
                MAN THROT                    -CDR
                BAL CPL                      -ON
                ENG GMBL                     -ENABLE
                DES ENG CMD OVRD             -OFF
                TTCA (Both)                  -THROT (Min)
                PRPLNT QTY MON               -DES 1
                PRPLNT TEMP/PRESS MON        -DES 1
                HELIUM MON                   -SUPCRIT PRESS
                DAP                          -Set

1               V37E 40E

                            *F 05 09 01706 LM Staged*
                            *    (TERM) V37E42E, or   *
                            *            Reload DAP   *
     F 50 18    REQUEST MNVR TO FDAI RPY ANGLES    (.01°)
                (AUTO or TRIM) GUID CONT - PGNS
                            MODE CONT:  PGNS - AUTO
                PRO
          (MAN)     MODE CONT:  PGNS - ATT HOLD
                    MNVR
                PRO To 1
          (BYPASS)  ENTR To 3

2      06 18    AUTO MNVR TO FDAI RPY ANGLES       (.01°)
                Mon Auto MNVR To 1

3        06 40    TFI,VG, VM                (min-sec,.1fps)
                  MASTER ARM - ON (1st BURN)
                  SET EVENT TIMER TO TFI

                           *PROG Lt - On                    *
                           *V05 N09E 01703 TIG SLIPPED*
                           *  RSET,KEY REL                  *

   -:35           DSKY BLANKS
                  ENG ARM - DES

   -:30
        06 40     (AVE G ON)

   -:15           VERIFY ΔVM (R3) <00005

   -:07.5         Verify +X ULLAGE

   -:05
     F 99 40      ENG ON ENABLE
                  (AUTO) PRO (IGN WHEN TFI=:00sec)
                  (BYPASS) ENTR To DPS OFF

IGN      06 40    TFC, VG,ΔVM               (min-sec,.1fps)

                           *F 97 40                         *
                           * (RECYCLE ΔV MON) PRO           *
                           * (RECYCLE) ENTR To TIG -5       *
                           * (TERM) ENG ARM-OFF V34E To 5*
                           *                                *
                           * PROG Lt-On                     *
                           *  V05N 09E 01407 VG INCREAS- *
                           *                          ING   *
                           *  TERM BURN OR SWITCH           *
                           *  TO AGS                        *

DPS
OFF   F 16 40     TFC, VG,ΔVM               (min-sec,.1fps)
                  ENG STOP - Push
                  ENG ARM - OFF
                  PRO

P40-P47

4 F 16 85 VG XYZ (LM)  (.1fps)
     NULL COMPONENTS
     PRO

5 F 37  MASTER ARM  -OFF
     ENG STOP  -Reset
     PRPLNT QTY MON -OFF
     HELIUM MON -OFF

     <u>P41 RCS THRUST</u>

     TTCA (CDR) - JETS
     EVENT TIMER- Set
     DAP  - Set

1   V37E 41E
  F 50 18 REQUEST MNVR TO FDAI RPY ANGLES (.01°)
    (AUTO or TRIM) GUID CONT - PGNS
       MODE CONT: PGNS - AUTO
    PRO
  (MAN)  MODE CONT: PGNS - ATT HOLD
     MNVR
    PRO To 1
  (BYPASS) ENTR To 3

2  06 18 AUTO MNVR TO FDAI RPY ANGLES (.01°)
    Mon Auto Mnvr To 1

3  16 85 VG XYZ (LM)  (.1fps)
     *PROG Lt - On  *
     *V05N 09E 01703 TIG SLIPPED*
     *RSET, KEY REL  *

    MODE CONT: PGNS - ATT HOLD

 -:35  DSKY BLANKS

 -:30
  16 85 (AVE G ON)

 :00
 F 16 85 VG XYZ (LM)  (.1fps)
     NULL COMPONENTS
     PRO

4 F 37

LM-6

P42 APS THRUST

|                      |                |
|----------------------|----------------|
| HELIUM MON           | -ASC PRESS 2   |
| PRPLNT TEMP/PRESS MON | -ASC          |
| TTCA (CDR)           | -JETS          |
| DAP                  | -Set           |

1　　　　　V37E 42E
```
            *F 05 09 01706 LM NOT STAGED   *
            *  (TERM) V34E                  *
            *  (BYPASS) PRO To 1, Man Stage*
            *       At -:30                 *
```

2　F 50 18　REQUEST MNVR TO FDAI RPY ANGLES　(.01°)
　　　　　(AUTO or TRIM) GUID CONT - PGNS
　　　　　　　　　　MODE CONT:　PGNS - AUTO
　　　　　PRO
　(MAN)　　　MODE CONT:　PGNS - ATT HOLD
　　　　　MNVR
　　　　　PRO To 1
　(BYPASS)　ENTR To 3

3　　06 18　AUTO MNVR TO FDAI RPY ANGLES　　(.01°)
　　　　　Mon Auto Mnvr To 1

```
            *PROG Lt - On                   *
            *V05N 09E 01703 TIG SLIPPED     *
            *          RSET, KEY REL        *
```

4　　06 40　TFI,VG, VM　　　　　　　(min-sec,.1fps)
　　　　　EVENT TIMER-SET

-:35　　　DSKY BLANKS
　　　　　ENG ARM-ASC

-:30
　　06 40　(AVE G ON)

-:15　　　Verify ΔVM (R3) <00005

```
        -:05
          F 99 40     ENG ON ENABLE
        -:03.5          Verify +X ULLAGE
                     (V34E NO ULLAGE, ENG ARM-OFF, To 5)
                     (AUTO)PRO (IGN WHEN TFI=:00 sec)
                     (BYPASS)  ENTR To APS OFF


IGN      06 40     TFI, VG,ΔVM                    (min-sec,.1fps)


                               *F 97 40                       *
                               *(RECYCLE ΔV MON) PRO          *
                               *(RECYCLE) ENTR TO TIG -5      *
                               *(TERMINATE) ENG ARM-OFF       *
                               *               V34E To 5      *


APS
OFF   F 16 40     TFC, VG,ΔVM                     (min-sec,.1fps)
                  ENG ARM - OFF
                  PRO
                  HELIUM MON - OFF


5     F 16 85     VG XYZ (LM)                     (.1fps)
                  NULL COMPONENTS
                  PRO


6     F 37
```

### P47 ΔV MONITOR

```
1                 V37E 47E
                  (20 sec Delay Minimum)
      F 16 83     ΔV XYZ (LM)                     (.1fps)
                  (EXIT) PRO
                  (RECYCLE) V32E (Zeroes N83 Display)


2     F 37
```

## P51 IMU ORIENTATION

CB(11) AC BUS B: AOT LAMP-Close

1            V37E 51E
     F 50 25    R1 00015 MNVR TO ACQ STARS
          (To Coarse Align IMU To 0,0,0-ENTR)
          41 22 All Zeroes
          PRO

2     F 01 71    R1 00CDE (C)DETENT (DE)STAR CODE
          C 1-L, 2-F, 3-R, 4-RR, 5-CL, 6-LR
            7-COAS(+00000, +00000)FWD
                  (+00000, +09000)OVHD
          PRO
            (For C=7)
             F 06 87 AZ,EL           (.01°)
            PRO

3     F 54 71    MARK X(52) and Y(53)
          PRO
            (For DE=00
            F 06 88 CELESTIAL BODY VECTOR
                 Load Vector Values
                 PRO)
          (After 1st Star) To 2
          (After 2nd Star) To 4

4     F 06 05    R1 STAR ANGLE DIFFERENCE      (.01°)
          (RECYCLE) V32E To 1
          PRO

5     F 37      CB(11) AC BUS B: AOT LAMP-Open

## P52 IMU REALIGN

1            CB(11) AC BUS B: AOT LAMP-Close
           V37E 52E
     F 04 06    R1 00001 IMU ALIGN OPT
          R2 00001 PREF (0,0,0 Specified Attitude)
                 PRO To 4
             2 NOM (LV At Specified Time)
                PRO To 2
             3 REFSMMAT PRO To 6
             4 LANDING SITE PRO To 2

2    F 06 34    GET ALIGN                          (hrs,min,.01sec)
                (0,0,0 For Present Time)
                (TLAND FOR OPT 4)
                      (OPT 2) PRO To 4
                      (OPT 4) PRO To 3

3    F 06 89    LAT,LONG/2, ALT                    (.001°,.01nm)
                PRO

4    F 06 22    NEW ICDU ANGLES OG,IG,MG                  (.01°)
                (IF MGA NEAR GIMBAL LOCK, MNVR, Then V32E To 4)
                PRO

5    F 50 25    R1 00013 (COARSE ALIGN)
                (NORMAL) PRO To 6 NO ATT Lt-On Then Off
                (GYRO TORQUE) MODE CONT (PGNS)-ATT HOLD
                            V76E
                            ENTR

     16 20      PRESENT ICDU ANGLES OG,IG,MG              (.01°)
                When Torquing Complete To 14

6    F 50 25    R1 00015 SELECT STAR ACQUISITION MODE
                MNVR If Necessary
           (PICAPAR) PRO

                        *F 05 09 00405 NO PAIR    *
                        *(CREW SPECIFY) PRO To 7  *
                        *(PICAPAR) V32E To 6      *
           (MAN ACQ) ENTR

7    F 01 70    R1 00CDE (C)DETENT (DE)STAR CODE
                C 0 COAS CALIBRATION 1-L, 2-F, 3-R,
                                     4-RR, 5-CL, 6-LR
                      7-COAS(+00000, +00000)FWD
                            (+00000, +09000)OVHD
                (TERM) V34E
                      PRO
                          (For C=0 or 7
                           F 06 87 AZ,EL                  (.01°)
                          PRO)
                          (For DE=00
                           F 06 88 CELESTIAL BODY VECTOR
                                Load Vector Values
                                PRO)

8    F 50 18   REQUEST MNVR TO FDAI RPY ANGLES   (.01°)
            (AUTO OR TRIM) GUID CONT:   PGNS
                           MODE CONT:   PGNS - AUTO
            PRO
        (MAN)           MODE CONT:   PGNS - ATT HOLD
                           MNVR
            PRO To 8
        (BYPASS)  ENTR To 10 (If COAS CALIB, Go to 7)

9      06 18   AUTO MNVR TO FDAI RPY ANGLES   (.01°)
            Mon Auto Mnvr To 8

10   F 01 71   R1 00CDE (C)DETENT (DE)STAR CODE
            PRO
               (For C=7
                F 06 87 AZ,EL           (.01°)
                PRO)

11   F 54 71   MARK X(52) and Y(53)
            (After 1st Star) PRO To 7
            (After 2nd Star) PRO To 12
            (Redefine Star)  ENTER To 10
                    (For DE=00
                    F 06 88 CELESTIAL BODY VECTOR
                            Load Vector Values
                            PRO)

12   F 06 05   STAR ANGLE DIFFERENCE         (.01°)
            (REJECT) V32E To 14
            (ACCEPT) PRO

13   F 06 93   GYRO ANGLES X,Y,Z           (.001°)
            (TORQUE) V76E
                  PRO
            (NO TORQUE) V32E To 14

14   F 50 25   R1 00014
            (RECHECK) PRO To 6
            (EXIT)    ENTR

15   F 37      CB(11) AC BUS B: AOT LAMP-Open

## P57 LUNAR SURFACE ALIGNMENT

1              V37E57E

```
                    *PROG Lt - On                      *
                    *V05N09E   00210 IMU                *
                    *         NOT ON                    *
                    *CB(11) PGNS:  IMU OPR - Close*
                    *RSET & KEY REL, P57E              *
```

    F 04 06    R1 00001 IMU ALIGN OPT
               R2 00001 PREF   PRO To 3
                     3 REFSMMAT PRO To 3
                     4 LANDING SITE PRO To 2

2    F 06 34    T ALIGN                     (hrs,min,.01sec)
               (LDG SITE) T ALIGN = 0,0,0 For Present Time
               PRO

3    F 05 06    R1 00010 SPECIFY ALIGNMENT TECHNIQUE (A/T)
               R2 0000X
                   X = 0 Stored Attitude or REFSMMAT
                      1  REFSMMAT & Gravity
                      2  Celestial Bodies (2)
                      3  Gravity & Celestial Body (1)
               R3 00CD0
                   C = 0  No REFSMMAT Defined
                      1  REFSMMAT Defined
                   D = 0  No Stored Attitude
                      1  Stored Attitude Available

               (A/T 1 or 3) PRO To 4
               (A/T 0 or 2) PRO To 13

```
                    *PROG Lt - On                          *
                    *F 05 09   00701 REFSMMAT OR           *
                    *         ATTITUDE NOT AVAILABLE*
                    *(CHANGE A/T) V32E To 3                *
                    *(TERM) V34E, Select New Prog    *
```

LM-6

4           Determination of Lunar Gravity
ATTITUDE MON - PGNS
V16N20E Monitor Coarse Align      (.01°)
        R1 +04200
        R2 +31800
        R3 +03525
NO ATT Lt - On Then Off (Twice)
        *PROG Lt - On          *
        *V05N09E  00211 & 00217*
KEY REL

5   F 06 04   (+) GRAVITY ERROR ANGLE       (.01°)
                  (RECYCLE) V32E To 4
                  (TERM) V34E, Select New Prog
                  PRO (If A/T = 00001 or 00003
                      Go To 13)

6   F 01 70   R1 00CDE (C) DETENT (DE) STAR CODE
                  (DETENT) 1-L, 2-F, 3-R, 4-RR, 5-CL, 6-LR
                  PRO (Go to 8 If DE >45 or = 00)

                  *PROG Lt - On               *
                  *F 05 09  00404 Defined Star*
                  *         Not Available In   *
                  *           Any Detent      *
                  *(CREW SPECIFY) PRO To 8    *
                  *(LGC CALC N79) V32E To 6   *

7   F 06 79   CURSOR, SPIRAL, POSITION CODE   (.01°)
                  (REDEFINE STAR) V32E To 6
                  PRO

                  *PROG Lt - On             *
                  *V05N09E             *
                  *   20105 AOT Mark System*
                  *     In Use         *
                  *   31207 No VAC Area   *
                  *     For Marks      *
                  *   31211 Illegal     *
                  *     Interrupt of    *
                  *     Extended Verb   *
                  *V37E XXE           *

8  F 01 71  R1 00CDE (C) DETENT, (DE) STAR CODE
             PRO

9  F 54 71  MARK X OR Y
             (REDEFINE STAR) ENTER To 8
             MARK

10  F 06 79  CURSOR, SPIRAL, POSITION CODE     (.01°)
             (TERM) V34E, Select New Prog
             (RECYCLE) V32E To 9
             (MARKS COMPLETE) PRO

               (FOR DE = 00
                F 06 88 CELESTIAL BODY VECTOR
                      Load Vector Values
                      PRO)

             (After First Star) To 6 (If Option 00003
                         To 11)
             (After Second Star) To 11

11  F 06 05  STAR ANGLE DIFFERENCE        (.01°)
             (REJECT) V32E To 14
             (ACCEPT) PRO
             (TERM)  V34E

12  F 06 93  GYRO TORQUING ANGLES X,Y,Z    (.001°)
             (REJECT) V32E To 14
             (ACCEPT) PRO To 13a
             (TERM)  V34E

13          If Gyro Angles >5°
               F 06 22 ICDU ANGLES OG,IG,MG          (.01°)
                     PRO
                     NO ATT Lt - On Then Off
          If Gyro Angles <5°

13a          Monitor Gyro Torquing
             V16N93E                                 (.001°)
             KEY REL
             (If A/T 00002 OR 00003 & First Pass Through
                 Step 13) To 6
             (If A/T 00001 & First Pass Through
              Step 13) Go To 11, (If A/T 00000, Go To 14)

14   F 50 25   R1 00014 RECHECK or EXIT FINE ALIGN
               (RECHECK, A/T 00002 or 00003 Only) PRO To 6
               (TERM) V34E To 16

        Note: If Present A/T Is 00002 & A
        Previous P57 Used A/T 00001 or 00003,
        ENTER To Readout Present LM
                 Lunar Position (Step 15)

15   F 06 89   LAT, LONG/2, ALT            (.001°,.01nm)
               (TERM) V34E
               (ACCEPT) PRO

16   F 37

               P63 BRAKING PHASE

1              V37E 63E
                     *PROG Lt-On              *
                     *V05N09E 01412 IGN  *
                     *      ALGORITHM NOT *
                     *      CONVERGING     *
                     *   (TERM) V37E00E    *
                     *                     *

2    F 06 61    TG,TFI                                    (min-sec)
                R3, CROSSRANGE (-NORTH)                     (.1nm)
                SET EVNT THR TO 60-TFI
                N33E
     F 06 33    TIG                                  (hrs,min,.01sec)
                KEY REL
                PRO


3    F 50 25    R1 00014 PERFORM IMU FINE ALIGN
                (ACCEPT) PRO - See P52/6
                (BYPASS) ENTR


4    F 50 18    REQUEST MNVR TO FDAI RPY ANGLES      (.01°)
                (AUTO or TRIM) GUID CONT:  PGNS
                               MODE CONT:  PGNS - AUTO
                PRO
     (MAN)                     MODE CONT:  PGNS - ATT HOLD
                MNVR
                PRO To 4
     (BYPASS)   ENTR To 6


5       06 18   AUTO MNVR TO FDAI RPY ANGLES         (.01°)
                Mon Auto Mnvr To 4

                        *F 50 25      00500 LR        *
                        *       TO DESCENT POS        *
                        *LDG ANT-DES, 10 sec, AUTO*
                        *PRO                          *
                        *F 50 25   00203              *
                        *      GUID CONT - PGNS       *
                        *      MODE CONT(PGNS)-AUTO*
                        *      THR CONT - AUTO        *
                        *      PRO                    *
                        *                             *
                        *PROG Lt - On                 *
                        *V05 N09E    01703 TIG        *
                        *                 SLIPPED     *
                        *    V37E 00E EXIT P63         *

6  06 62 VI,TFI, VM   (.1fps,min-sec,.1fps)

59:25  DSKY BLANKS
     ENG ARM - DES

59:30
  06 62 AVE G ON

59:45  Verify ΔVM (R3) <00005

59:55
 F 99 62 ENG ON ENABLE
     VERIFY +X ULLAGE
     PRO
   (NO ULLAGE) V34E Exit P63

IGN  06 63 VI           (.1fps)
     H DOT(-DESCENT)    (.1fps)
     H(+ABOVE RLS)     (ft)
 +:05  DES ENG CMD OVRD - ON

       *(DPS ABORT) ABORT - PUSH  *
       *(APS ABORT) ABORT STAGE - PUSH*

40,000 ft V57E
F 06 68 SLANT RANGE, TG, ΔH(LR-LGC)
         (.1nm, min-sec, ft)
  (UPDATE) PRO
  (EXIT V57) V34E (To 06 63)

F 50 68 SLANT RANGE, TG, ΔH (LR-LGC)
         (.1nm, min-sec, ft)
  Verify ΔH Decreasing
  (STOP UPDATE) ENTR (To 06 68)
  (CONTINUE UPDATE) PRO (To 06 63)

  (MAN) MODE CONT:PGNS-ATT HOLD

```
                              *ALT. & VEL Lt - On*
                              * RANGE/VELOCITY    *
                              * NOT GOOD          *
                              *PROGRAM Lt - On    *
                              * V05N09E           *
                              *  00511 LR Not in  *
                              *            Pos 1  *
                              *LDG ANT-DES,Wait   *
                              * 10sec, Then AUTO  *
```

+08:30        P64 DISPLAYED

              P64 APPROACH PHASE

1             P64 DISPLAYED

2     F 06 64 R1,TR/LPD,                          (sec-deg)
              R2 H DOT(-For Descent)              (.1fps)
              R3 H(+ Landing Site Radius)         (ft)

```
                        *F 05 09  00523 LR DID NOT*
                        *            ACHIEVE POS 2 *
                        *(CONTINUE) PRO           *
                        *                         *
                        *                         *
                        *(RECHECK) V32E           *
                        *                         *
                        *                         *
                        *(TERM R12) V34E          *
```

                        Monitor Attitude Change
                         To Enable Landing Site
                         Visibility.

         (MAN) MODE CONT:PGNS-ATT HOLD
         (TO USE LPD) PRO
         (Nominal Landing Site) To 5 When TR=0

3        06 64        Observe Nominal Landing Site
                       Using LPD And N64 LPD Display.

4      Redesignate Landing Site
        As Desired (+Pitch Redesignates
        Landing Site Toward LM)

5          P65 DISPLAYED

           ## P65 LANDING PHASE (AUTO)

1          P65 Displayed

2   F  06 60   V (HOR)                                    (.1fps)
               H DOT (-Descent)                           (.1fps)
               H (+ >LANDING SITE RADIUS)                   (ft)

               Monitor Attitude Maneuver To
                Local Vertical Attitude
                (+Z Downrange)
               H DOT (R2)= -00030
               MODE CONT: PGNS-ATT HOLD
                          or AUTO
        (ROD LANDING) MODE CONT: PGNS-ATT HOLD
                      ROD - Activate
                      To P66
        (MAN LANDING)  TTCA - Advance Until:
                       THRUST:  CMD=10%
                       THR CONT - MAN
                       To P67
        (AUTO LANDING) To 3

3            H(actual)= 5.6 ft    LUNAR CONTACT Lt - On
                                  MODE CONTROL - ATT HOLD
                                  ENGINE STOP  - Push
    TD+3:00                       PRO

             V37E 68E To P68

             ## P66 LANDING PHASE (ROD)

1            P66 Displayed
        (From P67)TTCA-Retard Gradually
                  THRUST IND(Left Side)-Monitor
                  (Maintain Constant Thrust/
                  Chamber Pressure)

LM-f

2    F  06  60    V(HOR)                                    (.1fps)
                  H DOT(-Descent)                           (.1fps)
                  H(+ >Landing Site Radius)                   (ft)
                       ROD - Input ROD As Desired

        (MAN LANDING)  TTCA - Advance Until:
                       THRUST IND: CMD=10%
                       THR CONT - MAN
                       To P67

3                 H(Actual)=5.6 ft LUNAR CONTACT Lt - On
                       ENGINE STOP - Push
     TD+3:00           PRO
                  V37E 68E To P68

                  <u>P67 LANDING PHASE (MANUAL)</u>

1                 P67 Displayed

2    F  06  60    V(HOR)                                    (.1fps)
                  H DOT (-Descent)                          (.1fps)
                  H(+ >Landing Site Radius)                   (ft)
        (ROD LANDING) THR CONT - AUTO
                       To P66

3                 H(actual)=5.6 ft LUNAR CONTACT Lt - ON
                       ENGINE STOP - Push
     TD+3:00           PRO
                  V37E 68E To P68

                  <u>P68 LANDING CONFIRMATION</u>

1                 V37E 68E

2    F  06  43    LAT(+NORTH),LONG(+EAST),ALT (.01°,.1nm)

                  RECORD LAT _____°

                           LONG _____°

                           ALT _____nm (Nominal zero)
                  PRO

3    F  37

**Left margin (rotated):** October 6, 1969

Basic Date _____

Changed _____

LM-6

**P70 DPS ABORT**

1       ABORT-PUSH (From P63,64,65,66,67)
```
                *F 50 25 R1 00203              *
                *      GUID CONT - PGNS        *
                *      MODE CONT:  PGNS - AUTO*
                *      THR CONT - AUTO         *
                *      PRO                     *
```

2    06 63   VI,H DOT,H                         (.1fps,ft)
                VI Increasing
                H DOT Remains Positive
                H Increasing

                H<25000-Monitor Attitude Mnvr To
                        Local Vertical With Windows
                        Downrange.   X-axis Override
                        Inhibited.
                H>25000-or H DOT >00400-Monitor Atti-
                        tude Mnvr To Abort Attitude
                        With Windows Downrange.
                        X-axis Override Restored.

        (To Monitor Time To Go And Crossrange Velocity)
                V16 N77E

     16 77   TG,V(Y)                            (min-sec,.1fps)
                N85E

3    16 85   VG XYZ (LM)                        (.1fps)
             (If Burn >400 sec,
                PDI+6:20
                        DES REG (2) - CLOSE)
                VGX = 100 fps
                        DES ENG CMD OVRD - OFF

DPS          NULL COMPONENTS
OFF          KEY REL

4    F 16 63  VI,HDOT, H                         (.1fps,ft)
                ENG STOP - Push
                ENG ARM - OFF
                ABORT - Reset
                PRO

**P70 DPS ABORT**

P70-P71

1    ABORT-PUSH (From P63,64,65,66,67)
```
                    *F 50 25 R1 00203          *
                    *    GUID CONT - PGNS      *
                    *    MODE CONT:  PGNS - AUTO*
                    *    THR CONT - AUTO       *
                    *    PRO                   *
```

2  06 63 VI,H DOT,H       (.1fps,ft)
       VI Increasing
       H DOT Remains Positive
       H Increasing

       H<25000-Monitor Attitude Mnvr To
         Local Vertical With Windows
         Downrange. X-axis Override
         Inhibited.
       H>25000-or H DOT >00400-Monitor Atti-
         tude Mnvr To Abort Attitude
         With Windows Downrange.
         X-axis Override Restored.

    (To Monitor Time To Go And Crossrange Velocity)
      V16 N77E

  16 77 TG,V(Y)      (min-sec,.1fps)
      N85E

3  16 85 VG XYZ (LM)      (.1fps)
    (If Burn >400 sec,
     PDI+6:20
         DES REG (2) - CLOSE)
     VGX = 100 fps
         DES ENG CMD OVRD - OFF

DPS   NULL COMPONENTS
OFF   KEY REL

4  F 16 63 VI,HDOT, H     (.1fps,ft)
      ENG STOP - Push
      ENG ARM - OFF
      ABORT - Reset
      PRO

Basic Date_ October 6, 1969
Changed October 31, 1969

LM-6

5      F 16 85   VG XYZ (LM)                          (.1fps)
                 (DISPLAY ORB PARAM) V82E
                 (TERM) PRO To 7

5      F 16 44   APO ALT,PER ALT,TFF      (.1nm,min-sec)
                 RECORD APO ALT _____ nm,

                           PER ALT _____ nm,

                               TFF _____ min-sec
                 PRO To 5

7      F 37


## P71 APS ABORT

1            ABORT STAGE -Push (From P63,64,65,
                                    66,67,70)
                        *F 50 25 R1 00203            *
                        *    GUID CONT - PGNS        *
                        *    MODE CONT: PGNS - AUTO  *
                        *    PRO                     *

APS
IGN    06 63   VI,H DOT,H                       (.1fps,ft)
               ENG START - Push
               ENG ARM - ASC
               If ENG STOP Lt - On
                    ENG STOP - Reset
               BAL CPL-ON
               SYS A&B ASC FEED 2 (2) - OPEN
               MAIN SOV(2)-CLOSE
               CRSFD - OPEN

               VI Increasing
               H DOT Remains Positive
               H Increasing

H<25000-Monitor Attitude Mnvr To Local
    Vertical With Windows Downrange.
    X-axis Override Inhibited.
H>25000 or H DOT>00400-Monitor Attitude
    Mnvr To Abort Attitude With Windows
    Downrange. X-axis Override
    Restored.


        (To Monitor Time To Go And Crossrange Velocity)
            V16 N77E

    16 77    TG,V(Y)                          (min-sec,.1fps)
             N85E

2   16 85    VG XYZ (LM)                          (.1fps)
             VGX = 200 fps,
                        MAIN SOV (2) - OPEN
                        SYS A&B ASC FEED 2(2)-CLOSE
                        CRSFD-CLOSE
             VGX - 100 fps,ENG ARM - OFF

                        *NO Cutoff               *
                        *  ABORT STAGE - Reset*

APS          NULL COMPONENTS
OFF          KEY REL

3   F 16 63  VI,H DOT,H                        (.1fps,ft)
             ENG STOP - Push Then Reset
             PRO

4   F 16 85  VG XYZ (LM)                          (.1fps)
             (DISPLAY ORB PARAM) V82E
             (TERM) PRO To 6

5   F 16 44  APO ALT,PER ALT,TFF              (.1nm,min-sec)
             RECORD APO ALT _____ nm,

                     PER ALT _____ nm,

                        TFF _____ min-sec
             PRO To 4

6   F 37

M-6

## P72 CSM CSI TARGETING

1
                **V37E 72E**
    F 06 11    TIG (CSI)/T(APOAPSIS)    (hrs,min,.01sec)
                PRO
                If Zero, T (APOAPSIS) Displayed

2    F 06 55    APSIS (CDH), E            (+0000X,.01°)
                R3, 0000Y
                  For Y ≠ 0, CDH At
                  CSI + Multiple Of 180°
                  Specified By R1(X)
                PRO

3    F 06 37    TIG TPI                (hrs,min,.01sec)
                PRO

4    F 16 45    M,TFI,MGA (-00001)  (marks,min-sec,.01°)
            (RECYCLE) V32E
            (TERMINATE MARKS) PRO

```
*F 05 09 00600 No Intersection On       *
*               First Iteration         *
*         00601 POST CSI ALT <35,000 ft *
*         00602 POST CDH ALT <35,000 ft *
*         00603 TIG(CDH)-TIG(CSI)<10min *
*         00604 TIG(TPI)-TIG(CDH)<10min *
*         00605 NO SOL IN 15 TRIES      *
*         00606 ΔV (CSI) >1000 fps IN 2 *
*               Iterations              *
*         V32E To 1  Adjust Inputs      *
```

5    F 06 75    ΔH(CDH),ΔT(CDH-CSI),ΔT(TPI-CDH)
                PRO                (.1nm,min-sec)

6    F 06 81    ΔVXYZ (LV) (CSI)           (.1fps)
                PRO

7    F 06 82    ΔVXYZ (LV) (CDH)           (.1fps)
                PRO

P72-P76

LM-6

8    F 16 45    M,TFI,MGA (-00002) (marks,min-sec,.01°)
            (RECYCLE) V32E To 5
            (TERMINATE) PRO To 9
            (FINAL PASS) SET EVENT TIMER TO TFI
                    PRO, Transmit Parameters To CSM

9    F 37


## P73 CSM CDH TARGETING

1            V37E 73E
     F 06 13    TIG CDH                    (hrs,min,.01sec)
            PRO To 4

2    F 06 75    ΔH(CDH),ΔT(TPI-CDH),ΔT(TIG TPI,P73-P72)
            PRO                        (.1nm,min-sec)

3    F 06 81    ΔVXYZ (LV) (CDH)                    (.1fps)
            (To Correct Out-Of-Plane Velocity)
            V90E
            F 06 16  T EVENT            (hrs,min,.01sec)
                    PRO

            F 06 90  Y,YDOT,PSI    (.01nm,.1fps,.01°)
                (RECYCLE) V32E To (F 06 16)
                    PRO
     PRO

4    F 16 45    M,TFI,MGA (-00001)  (marks,min-sec,.01°)
            (RECYCLE)        V32E To 2
            (TERMINATE)      PRO To 2
            (FINAL PASS)     SET EVENT TIMER TO TFI
                        PRO
                        Transmit Parameters To CSM

            *F 05 09 00611 NO TIG FOR EL ANGLE*
            *    (CONTINUE P73) PRO To 2
            *    (RECYCLE) V32E To 1 CHANGE TIG *
            *    (TERMINATE) V34E To 5          *

5    F 37

P72-P76

## P74 CSM TPI TARGETING

1          V37E 74E
      F 06 37    TIG TPI                (hrs,min,,01sec)
               PRO

2      F 06 55    N,E,CENTANG            (0000X,,01°)
               PRO
           (To Calculate E At TIG Time)
                 +00000 In R2

                                    *(Calculate E Only)      *
                                    *F 05 09   00611 NO SOL    *
                                    *             PRO To 1 Retarget*

3      F 16 45    N,TFI,MGA (-00001)  (marks,min-sec,,01°)
           (RECYCLE) V32E
           (TERMINATE MARKS) PRO
           (FINAL PASS,MGA,-00002) SET EVENT TIMER
                 PRO To 8
                 Transmit Parameters To CSM

4      F 06 37    TIG TPI                (hrs,min,,01sec)
               PRO
            (If E Computed, This Display
            Replaced By V06N55 As In 2 Above)

5      F 06 58    HP,ΔV(TPI),ΔV(TPF)       (.1nm,.1fps)
               PRO To 7 (Final Pass To 6)

6      F 06 81    ΔVXYZ (LV)                 (.1fps)
               PRO

7      F 06 59    ΔVXYZ(LOS)               (.1fps)
               PRO To 3

8      F 37

## P75 CSM TPM TARGETING

1
V37E 75E
F 16 45   M,TFI,MGA (-00001)  (marks,min-sec,.01°)
(RECYCLE) V32E To 3
(TERMINATE MARKS) PRO

2   F 06 81   ΔVXYZ (LV)                          (.1fps)
PRO

3   F 06 59   ΔVXYZ(LOS)                          (.1fps)
PRO

4   F 16 45   M,TFI,MGA (-00001)  (marks,min-sec,.01°)
(RECYCLE)V32E TO 3
(TERMINATE MARKS) PRO To 2
(FINAL PASS) (MGA,-00002) SET EVENT TIMER,
   PRO, Transmit Parameters To CSM
                  *V06N52E R1, ACTCENT   (.01°)
                  *If ACTCENT Between 170° And 190°
                  *   V37E 75E Retarget

5   F 37

## P76 TARGET ΔV

V37E 76E

1   F 06 33   TIG                          (hrs,min,.01sec)
PRO

2   F 06 84   ΔV(LV) XYZ                          (.1fps)
PRO

3   F 37

## V40 N20 ICDU ZERO

1     **V40 N20E**

       *PROG Lt - On        \*
       *V05 N09E 00206 ISS IN  \*
       * COARSE ALIGN & GIMBAL \*
       *       LOCK \*
       *Coarse Align To 0,0,0 Then \*
       * Reselect V40 N20  \*

     **NO ATT Lt - OFF**

2     **Wait 15 sec Then Continue Program In**
                **Progress**

## V41N20 COARSE ALIGN IMU

1     **V41N20E**
  F 21 22  **LOAD NEW ICDU ANGLES O,I,M**   **(.01°)**

2   41   **COARSE ALIGN**
       **NO ATT Lt - On**
       **FDAI Torques**

       *PROG Lt - On     \*
       *V05N09E  00211 COARSE \*
       *    ALIGN ERROR \*
       *V16N22E Compare N22 With\*
       *       N20 \*
       *Repeat V41N20   \*

## V41N72 COARSE ALIGN RR

1     **RR MODE - LGC**

2     **V41N72E**
  F 21 73  **RR TRUN,SHAFT**      **(.01°)**
       **Load Desired Trun and Shaft Angles**

3  F 04 12  **R1 00006 SPECIFY RR FUNCTION**
       **R2 00001 LOCK ON CSM**
         **00002 CONT DESIGN**
       **PRO**

4        41        COARSE ALIGN
              (To Monitor Driving In CONT DESIG MODE)
                    V16N72E RR TRUN, SHAFT                (.01°)

                         *PROG Lt - On                        *
                         *V05N09E 00502 BAD ANGLE INPUTS*
                         *         00503 NO DATA GOOD IN *
                         *               30 SEC DESIGN   *
                         *         00515 RR CDU FAIL      *
                         *               DISCRETE         *
                         *(TERM CONT DESIGN) V44E          *

          <u>V42 GYRO TORQUING</u>

1                   V76E (If MODE CONT (PGNS) - ATT HOLD)
                    V42E
     F 21 93        GYRO ANGLES (XYZ)                    (.001°)
                    Load Desired Angles

2        42         FINE ALIGN
                    Gyro Torquing (NO ATT Lt - Off)

          <u>V43 FDAI BIAS CHECK</u>

1                   MODE CONT:  PGNS - OFF

2                   V37E00E

3                   V43E
     F 21 22        LOAD NEW ICDU ANGLES YPR             (.01°)
                    FDAI Needles Deflect

4                   ENTR
     F 21 22        NEW ICDU ANGLES YPR                  (.01°)
                    Load (-) New ICDU Angles

5        43         Verify FDAI Needles Return To 0,0,0

## V47 AGS INITIALIZATION

|   |   |   |   |
|---|---|---|---|
| 1 |  | TLM-HI | |
|   |  | V16N65E | |
|   | 16 65 | LGC TIME | (hr,min,.01sec) |
|   |  | 377 + GET-PGNS/AGS BIAS TIME | (.1min) |
|   |  | ENTR-(At Correct PGNS Time) | |
|   |   |   |   |
| 2 |  | V47E | |
|   | F 06 16 | GET OF AGS CLOCK | |
|   |  | Load PGNS/AGS TIME BIAS | |
|   |   |   |   |
| 3 |  | 414 +1 | |
|   |   |   |   |
| 4 |  | PRO (32 Sec Elapse Before Step 5 Appears If CDU Zero Is Issued, Otherwise 20 Sec) | |
|   |   |   |   |
| 5 | F 50 16 | Downlink Complete | |
|   |  | PRO | |
|   |   |   |   |
| 6 |  | 400+3 AGS/PGNS ALIGN | |
|   |   |   |   |
| 7 |  | V83E | |
|   | F 16 54 | R,RDOT,THETA | (.01nm,.1fps,.01°) |
|   |   |   |   |
| 8 |  | 440R RANGE RATE (+2.5 fps) | (.1fps) |
|   |  | PRO | |

## V48 DAP CONFIGURATION

| | | |
|---|---|---|
| 1 | | V48E |
| | F 01 46 | DAP CONFIGURATION (ABCDE) |
| | | (CONFIG) A 1- ASCENT |
| | | 2- DESCENT |
| | | 3- DOCKED |
| | | (X-TRANS)B 0-2 JET RCS A, 1-2 JET RCS B, |
| | | 2-4 JET RCS A, 3-4 JET RCS B |
| | | (SCALE) C 0-Fine(4°/sec), 1-Normal (20°/sec) |
| | | (ATTDB) D 0-.3°, 1-1°, 2-5° |
| | | (RATE) E 0-.2°/sec, 1-.5°/sec,2-2°/sec |
| | | 3-10°/sec |
| | | PRO |

2    F 06 47    LM WT, CSM WT              (1b)
                      PRO (Terminates If Staged)

3    F 06 48    ENGINE GIMBAL TRIM PITCH, ROLL    (.01°)
                      ENG GMBL - ENABLE
                      ENG STOP - PUSH
                      ENG ARM - DES
            (TRIM) PRO (ENG GMBL Lt - On
                           When Gimbals Reach Limits)
            (EXIT) V34E

4    F 50 48    TRIM COMPLETE
                      Continue Interrupted Program
                      PRO
                      ENG ARM - OFF (ENG GMBL Lt-OFF)
                      ENG STOP - Reset

## V49 CREW DEFINED MANEUVER

1                V37E00E

2                V49E
    F 06 22    NEW ICDU ANGLES YPR              (.01°)
                      PRO

3    F 50 18    REQUEST MNVR TO FDAI RPY    (.01°)
            (AUTO OR TRIM) GUID CONT:  PGNS
                          MODE CONT:  PGNS - AUTO
                      PRO
            (MAN)  MODE CONT:  PGNS - ATT HOLD
                        MNVR
                      PRO To 3
            (BYPASS) ENTR (Exit V49)

4      06 18    AUTO MNVR TO FDAI RPY ANGLES
                      Mon Auto Mnvr To 3

## V55 INCREMENT LGC TIME

1           V55E

F 21 24   ΔT

            Record

            _____(hrs)

            _____(min)

            _____(sec)

            Load ΔT

## V64 S-BAND ANTENNA

1           V64E

F 06 51   S-BD PITCH, YAW                      (.01°)

            PRO

## V67 W-MATRIX ERROR DISPLAY

1           V67E

F 06 99   POS ERR, VEL ERR, RADAR BIAS ERR (ft,.1fps,

           (REINITIAL) V25E, Load Values              mr)

            PRO

## V74 LGC DOWNLINK

1           V74E (42 sec)

## V82 ORBIT PARAMETER DISPLAY

1           V82E (GO To 2 If AVE G-On)

F 04 12   R1 00002 SPECIFY VEHICLE

            R2 00001 LM

               00002 CSM

            PRO

2   F 16 44   HA,HP,TFF                  (.1nm,min-sec)

            (UPDATE) V32E (Not Required If AVE G-On)

            PRO

## V83 RENDEZVOUS PARAMETER DISPLAY

1           V83E

F 16 54   R,RDOT,THETA             (.01nm,.1fps,.01°)

        (EXIT)    PRO

## V85 RR LOS, ELEV DISPLAY

1           RR MODE - LGC

2           V85E
   F 16 56   AZ, ELEV                                    (.01)°
           (TERM) PRO

## V89 RENDEZVOUS FINAL ATTITUDE

1           V37E00E

2           V89E
   F 04 12   R1 00003 SPECIFY TRACKING ATTITUDE
           R2 00001 (+Z AXIS)
              00002 (+X AXIS)
           PRO

3  F 06 18   FINAL FDAI RPY ANGLES                       (.01°)
           (AUTO MNVR) PRO
           (RECALCULATE) V32E To 3

4  F 50 18   REQUEST MNVR TO FDAI RPY ANGLES             (.01°)
           (AUTO OR TRIM) GUID CONT:   PGNS
                         MODE CONT:  PGNS - AUTO
           PRO
   (MAN)   MODE CONT:  PGNS - ATT HOLD
           MNVR
           PRO To 4
   (BYPASS)  ENTR (EXIT V89)

5     06 18   AUTO MNVR TO FDAI RPY ANGLES              (.01°)
           Mon Auto Mnvr To 4

## V90 OUT-OF-PLANE DISPLAY

1           V90E
   F 06 16   GET EVENT                              (hrs,min,.01sec)
           (0, PRESENT TIME)
           PRO

2  F 06 90   Y,YDOT,PSI                        (.01nm,.1fps,.01°)
           (RECYCLE) V32E To 1
           (EXIT)    PRO

## PGNS TURN-ON AND SELF-TEST

1               If STBY Lt - On, PRO

2               CB(11) PGNS:  IMU OPR - Close
                    (NO ATT Lt - On 90 Sec)

3               V35E
      F 88 88    DSKY LIGHT CHECK
                 (Master Alarm, LGC & ISS Warning,
                  And ALL DSKY Lts - On, 8's In All
                  Registers, Lts And DSKY Reset In 5 Sec)
               NO ATT Lt - Off (Wait 20 Sec)
               RSET

4               V25N01E 1365E
      F 21 01    E,E,E

5               V15 N01E 1365E
        15 01     R1, R2, R3 All Zero

6               V21 N27E 10E (Test Fixed And Erasable
        15 01     R1 Number Of Errors             Memory)
               R2 Number Of Tests Started
               R3 Number Of Tests Successful
                  (Test Successful If R2$\geq$3 Within 78 sec)

```
*PROG Lt - On                        *
*            V05N09E 01102 SELF-*
*                    TEST ERROR      *
*N08E        Record For MSFN         *
*                                    *
*            R1 _____      *
*                                  *
*            R2 _____      *
*                                  *
*            R3 _____      *
```

V21 N27E OE TERMINATE SELF TEST

8              V91E BANKSUM
    F 05 01   R1 SUM OF BANK
               R2 BANK NO.
               R3 BUGGER WORD
       (NEXT BANK)  PRO (If |R2|R1 Record For MSFN)
       (TERM)       V34E

## PGNS ORDEAL INITIALIZATION

1              CB(11) AC BUS B:  ORDEAL - Close
              FLIGHT DISPLAYS:  ORDEAL - Close
              FDAI 1 or 2 - ORB RATE
              EARTH/LUNAR - LUNAR

2              V82E
    F 04 12   R1 00002 SPECIFY VEHICLE
              R2 00001 LM
              PRO

3    F 16 44   HA,HP, TFF                 (.1nm,min-sec)
              Average HA & HP
              ALT SET - Set
              PRO

4              V83E
    F 16 54   R, RDOT, THETA       (.01nm,.1fps,.01°)
              MODE - HOLD/FAST
              SLEW - To THETA
              MODE - OPR/SLOW
              PRO

## PIPA BIAS CHECK

1              EVENT TIMER - Zero
              Rates <.1°/sec With No Thruster Firing

2              V25N21E, E, E, E/EVENT TIMER - START

3              V06E
     06 21     XYZ PIPA COUNTS             (+XXXXX.)

4              At T+80sec - ENTR
                T+80sec (X)R1___ (Y)R2 ___ (Z)R3 ___

5            Calculate XYZ Bias:
Take Last 3 Digits Of Displayed
Bias And Add 2 Zeroes

X _____

Y _____

Z _____

6            V06N01E, 1452E (Review X Bias) E
1454E (Review Y Bias) E
1456E (Review Z Bias)

7            V21N01E
F 21 01   LOAD 1452E(Calc X BIAS)E,E
1454E(Calc Y BIAS)E,E
1456E(Calc Z BIAS)E
Same Sign As In Measured Bias In Step4

### LGC CLOCK INITIALIZATION

1            V06N65
ON CSM MARK - ENTR
06 65    SAMPLED LGC TIME           (hr,min,.01sec)
RECORD
_____(hrs)

_____(min)

_____(sec)
COMPUTE CSM/LM $\Delta$T

2            V55E
F 21 24   LOAD $\Delta$T            (hr,min,.01sec)

## LANDING RADAR SELF TEST

1              CB(11) P~~GN~~S: LDG RDR - Close
                  X-POINTERS(Both)     - HI MULT
                  TEMP MON               - LDG RDR (50° - 70°F)
                  RATE/ERR MON          - LDG RDR/CMPTR
                  RNG/ALT MON           - ALT/ALT RATE
                  LDG ANT                - DES
                  MODE SEL               - LDG RDR

2              RADAR TEST - LDG(Alt And Alt Rt Tapes
                              Drive)
              TEST MONITOR - ALT XMTR (2.1 To 5.0)
                                    (3.4v)
                        - VEL XMTR (2.1 To 5.0)
                                    (3.3v)
              ALT/ALT RT MON - +7900 To +8100 ft/-478
                                To -482 fps

3              XPOINTER - UP, RT

4              V63E INITIATE RDR SELF TEST
      F 04 12      R1 00004 SPECIFY RDR
                  R2 00001 RNDZ RDR
                  V22E 2E   LDG RDR
                  PRO

5      F 16 66      SLANT RANGE, ANT POSITION          (ft)
                  R1 + 08277 To +08297 (+08287)
                  R2 + 00001
                  PRO

6      F 16 67      VX,VY,VZ
                  R1 -00494 ($\pm$2)
                  R2 +01861 ($\overline{+}$2)
                  R3 +01331 ($\overline{+}$2)
                  V34E (If Antenna Not Commanded
                        To HOVER, Go To 13)

7              LDG ANT - AUTO

8              V59E COMMAND ANT TO POS 2 (22 Sec)

LGC CLOCK INIT.;
LR, RR SELF TEST

Basic Date/ _____ October 6, 1969
Changed

LM-6

9     V63E INITIATE RDR SELF TEST
   F 04 12  R1 +00004 SPECIFY RDR
       R2 +00001 RNDZ RDR
       V22E 2E LDG RDR
       PRO

10  F 16 66  SLANT RANGE, ANT POSITION
       R1 +08277 To +08297
       R2 +00002

11     LDG ANT - DES (10 sec)
   F 16 66  R2 +00001 (PROG Lt-On, V05N09E,00522 RSET)

12     LDG ANT - AUTO
   F 16 66  R2 +00001
       V34E

13     RDR TEST - OFF
       CB(11) PGNS:  LDG RDR - Open

### RNDZ RDR SELF TEST

1     VERIFY: CSM RCS THRUSTER B3 - OFF
         : RADAR XPONDER - OFF
      RNDZ RDR ANT - Released
      X-POINTERS (Both)-HI MULT
      RATE/ERR MON (Both) - RNDZ RADAR
      ATTITUDE MON (Both) - PGNS
      RNG/ALT MON - RNG/RNG RATE
      SHFT/TRUN - +50°
      RR MODE - SLEW
      TEMP MONITOR - RNDZ (+10° To +145°)

2     CB(11) AC BUS A:  RNDZ RDR - Close
          : RNG/RNG RT/ALT/ALT RT-
           Close(Wait 30 sec)
      RR GYRO SEL - SEC
      CB(11) PGNS:  RNDZ RDR - Close
         (NO TRACK Lt-On)
      FLIGHT DISPLAYS:  RNG/RNG RT/ALT/ALT RT-
          Close

3          Slew Left To Mode I Region (18 sec)
         Slew Right, Down, Left, Up (FDAI Needles
             Right, Down, Left, Up)
         SLEW RATE - LO
         SHAFT/TRUN - $\pm 5°$
         Slew Right, Down, Left, Up (FDAI Needles
             Right, Down, Left, Up)

4          RR MODE - AUTO TRACK
         RADAR TEST-RNDZ RDR (Rng Rt Tape Drives To
         -500fps, X-Pointers and FDAI Needles Vary
         Between +5°. After 12 sec, Rng Tape Drives
         To 194, NO TRACK Lt - Out)

5          TEST MONITOR - AGC       (1.0 To 1.8) (1.5)
                    - XMTR PWR  (2.1 To 4.1) (3.7)
                    - SHAFT ERR (2.2 To 2.6@1/2cps)
                    - TRUN ERR  (2.2 To 2.5@1/2cps)
                    - AGC

6          Set NORRMON Flag
         V25 N07E
         101E, 10E, 1E
         RR MODE - LGC(NO TRACK Lt - On, Wait 10 sec)

7          V63E START RNDZ RDR SELF TEST
  F 04 12   R1 00004 SPECIFY RADAR
         R2 00001 RNDZ RADAR
         PRO
         NO TRACK Lt - Out After 12 sec

8   F 16 72   RR TRUN, SHAFT              (.01°)
         R1 Varying @1/2 cps
         R2 Varying @1/2 cps
         PRO

9   F 16 78   RNG, RNG RT, TFI    (.01nm,fps,min-sec)
         R1 +195.30 To +195.70 (TM Within+1.2 of R1)
         R2 -00480 To -00520 (TM=2 <R2)
         R3 00:00

10          V34E

11                     RADAR TEST - OFF (NO TRACK Lt - On,
                            X-Pntr-Center)

12                     V40N72E RRCDU ZERO (10 sec)

13                     SHFT/TRUN - $\pm 50°$
                         V41N72E
                           N73 R1 +04000
                                 R2 +04000
                           N12 R2  00002
                         V16N72E (Verify FDAI Needles Up & Right)
                         V44E

14                     SHFT/TRUN - $\pm 5°$
                         RR GYRO SEL - PRIM
                         V41N72E
                           N73 R1 -00400
                                 R2 -00400
                         N12 R2  00002
                         V16N72E (Verify FDAI Needles)
                         V44E

15                     V41N72E
                           N73 R1 +00000
                                 R2 +28300
                         N12 R2  00002
                         V16N72E

                     CB(11) PGNS:   RNDZ RDR - Open
                        AC BUS A:   RNDZ RDR - Open
                     V44E
                     Notify CSM To Enable Thruster B3

THRUSTER INHIBIT,
RR BIAS, E-MEM

## LGC THRUSTER INHIBIT

1            V25N07E
        (VERTICAL JET) 1257E
        (HORIZONTAL JET) 1260E
            XXXE (See Codes Below)

| | |
|---|---|
| A1U - 100E | B4U -   1E |
| B1D - 200E | A4D -   2E |
| A1F -   4E | B4F -   2E |
| B1L - 200E | A4R - 100E |
| B2U -  20E | A3U -   4E |
| A2D -  40E | B3D -  10E |
| A2A -  10E | B3A -   1E |
| B2L -  20E | A3R -  40E |

*            CAUTION            *
        *Affected Quad Valve Must*
        *Be Open Before Next Step*

2            1E

3            V48E
        PRO
        V34E

## RR BIAS INITIALIZATION

1            V21N01E
        1700E,E
        N15E,E
        E,E
        E,E
        V93E

## REVIEW DATA IN ERASABLE MEMORY

1            Perform During Any Flashing Display

2            V1 N1E OCTAL ADD E
    F 01 01    R3 OCTAL ADD, R1 (DATA)E

3   N15E (For Next Succeeding Address)
    ENTR (For Each Succeeding Address)

## TO CHANGE DATA IN ERASABLE MEMORY

1           V21 N01E ADD E
   F 21 01  R3 ADD
            Load New Data In R1 E

2   N15E For Next Succeeding Address
    Load New Data E
    ENTR And Load New Data For Each
       Succeeding Address E

## MONITOR OF INPUT/OUTPUT CHANNELS

1           V11N10E
   F 11 10  LOAD CHANNEL ADD E
            R1 Octal Contents Of Specified Channel

## LOAD OUTPUT CHANNELS

1           V21N10E
   F 21 10  LOAD CHANNEL ADD E
            R1 Load Octal Data E

## FLAG WORD SET/RESET

1           V25 N07E
   F 21 07  (Load FLAGWORD ADD) E

## RMAX - VMAX LOAD

V24 N01E
2004E ( RMAX )
77776E
77776E

2     F 22 07     (Load FLAGWORD BIT CODE)E

| BIT | CODE | SET | RESET |
|---|---|---|---|
| 1 | 1 | E= 1,3,5,7 | E= 0,2,4,6 |
| 2 | 2 | E= 2,3,6,7 | E= 0,1,4,5 |
| 3 | 4 | E= 4,5,6,7 | E= 0,1,2,3 |
| 4 | 10 | D= 1,3,5,7 | D= 0,2,4,6 |
| 5 | 20 | D= 2,3,6,7 | D= 0,1,4,5 |
| 6 | 40 | D= 4,5,6,7 | D= 0,1,2,3 |
| 7 | 100 | C= 1,3,5,7 | C= 0,2,4,6. |
| 8 | 200 | C= 2,3,6,7 | C= 0,1,4,5 |
| 9 | 400 | C= 4,5,6,7 | C= 0,1,2,3 |
| 10 | 1000 | B= 1,3,5,7 | B= 0,2,4,6 |
| 11 | 2000 | B= 2,3,6,7 | B= 0,1,4,5 |
| 12 | 4000 | B= 4,5,6,7 | B= 0,1,2,3 |
| 13 | 10000 | A= 1,3,5,7 | A= 0,2,4,6 |
| 14 | 20000 | A= 2,3,6,7 | A= 0,1,4,5 |
| 15 | 40000 | A= 4,5,6,7 | A= 0,1,2,3 |

3     F 23 07     (Load 1-SET/0-RESET) E

4

           To Verify Load:
           V1N1E, FLAGWORD ADD ENTR
01 01    R3 FLAGWORD ADD
           R1 FLAGWORD CONTENT (See Table Above)

### BINARY-TO-OCTAL CONVERSION

| | |
|---|---|
| 000-0 | 100-4 |
| 001-1 | 101-5 |
| 010-2 | 110-6 |
| 011-3 | 111-7 |

### OCTAL-TO-DECIMAL CONVERSION

| | | | | |
|---|---|---|---|---|
| 1-1 | 11-9 | 21-17 | 31-25 | 41-33 |
| 2-2 | 12-10 | 22-18 | 32-26 | 42-34 |
| 3-3 | 13-11 | 23-19 | 33-27 | 43-35 |
| 4-4 | 14-12 | 24-20 | 34-28 | 44-36 |
| 5-5 | 15-13 | 25-21 | 35-29 | 45-37 |
| 6-6 | 16-14 | 26-22 | 36-30 | 46-38 |
| 7-7 | 17-15 | 27-23 | 37-31 | 47-39 |
| 10-8 | 20-16 | 30-24 | 40-32 | 50-40 |

Basic Date _____ October 6, 1969
Changed __

| FLAG | ADD | CODE (BIT) | SET (1) RESET(0) | |
|------|-----|------------|------------------|---|
| P25 FLAG | 74 | 400 (9) | P25 Operating P25 Not Oper. | C=4,5,6,7 C=0,1,2,3 |
| IMU | 74 | 200 (8) | IMU In Use IMU Not In Use | C=2,3,6,7 C=0,1,4,5 |
| Rendezvous | 74 | 100 (7) | P20 Initiated P20 Terminated | C=1,3,5,7 C=0,2,4,6 |
| Lock On | 74 | 20 (5) | RR Lock-ON Desired RR Lock-ON Not Desired | D=2,3,6,7 D=0,1,4,5 |
| State Vector | 75 | 200 (8) | CSM S.V. Updated (V81) LM S.V. Updated (V80) | C=2,3,6,7 C=0,1,4,5 |
| Update | 75 | 100 (7) | S.V. Update by Marks Allowed S.V. Update by Marks Not Allowed | C=1,3,5,7 C=0,2,4,6 |
| Track | 75 | 20 (5) | Rndz Tracking Allowed Rndz Tracking Not Allowed | D=2,3,6,7 D=0,1,4,5 |

| | | | | |
|---|---|---|---|---|
| Manual Acquire | 76 | 10000 (13) | Enable man acq of CSM by RR / Enable auto acq of CSM by RR | A=1,3,5,7 / A=0,2,4,6 |
| LOS CM | 76 | 4000 (12) | LOS Being Computed (R21) / LOS Not Being Computed (R21) | B=4,5,6,7 / B=0,1,2,3 |
| External V | 76 | 200 (8) | Ext ΔV VG Computation / Lambert VG Computation | C=2,3,6,7 / C=0,1,4,5 |
| Final | 76 | 40 (6) | Final Pass Through Rndz Prog Comp / Interim Pass Through Rndz Prog Comp | D=4,5,6,7 / D=1,2,3,4 |
| Active Veh | 76 | 20 (5) | LM Active Veh / CSM Active Veh | D=2,3,6,7 / D=0,1,4,5 |
| Preferred Attitude | 76 | 10 (4) | Preferred Att Computed / Preferred Att Not Computed | D=1,3,5,7 / D=0,2,4,6 |
| REFSMMAT | 77 | 10000 (13) | REFSMMAT Good / REFSMMAT Not Good | A=1,3,5,7 / A=0,2,4,6 |
| No Throttle | 101 | 4000 (12) | Inhibit Full Throttle / Permit Full Throttle | B=4,5,6,7 / B=0,1,2,3 |

PGNS-71

LM-6

Basic Date _____ October 6, 1969

Changed _____

| | | | | |
|---|---|---|---|---|
| 3 Axis | 101 | 40<br>(6) | Mnvr Specified By 3 Axis<br>Mnvr Specified By 1 Axis | D=4,5,6,7<br>D=0,1,2,3 |
| No RR Mon | 101 | 10<br>(4) | Bypass RR Gmbl Monitor<br>Perform RR Gmbl Monitor | D=1,3,5,7<br>D=0,2,4,6 |
| W Matrix | 101 | 1<br>(1) | W Matrix Valid For Flt Nav<br>W Matrix Not Valid For Flt Nav | E=1,3,5,7<br>E=0,2,4,6 |
| Attitude | 102 | 1<br>(1) | LM Att Stored In LGC<br>LM Att Not Stored In LGC | E=1,3,5,7<br>E=0,2,4,6 |
| Remode | 110 | 20000<br>(14) | LOS Within Other RR Ant Mode<br>RR Mode Set To 2 | A=2,3,6,7<br>A=0,1,4,5 |
| Antenna | 110 | 4000<br>(12) | RR Ant In Mode 2<br>RR Ant In Mode 1 | B=4,5,6,7<br>B=0,1,2,3 |
| Designate | 110 | 1000<br>(10) | Desired LOS Within Mode Lim<br>Desired LOS Not Within Mode Lim | B=1,3,5,7<br>B=0,2,4,6 |
| ACA Mode | 111 | 40000<br>(15) | Min Impulse Enabled (V76)<br>Rate Command Enabled(V77) | A=4,5,6,7<br>A=0,1,2,3 |

## NON FLAGS

| | | | | |
|---|---|---|---|---|
| Mark/Reject | 1307 | 10000 (13) | Use of Mark X or Y<br>Use of Mark Reject | A=1,3,5,7<br>A=0,2,4,6 |
| AOT Mark Y | 1307 | 2000 (11) | After Use of Mark Y<br>After Mark X & Y or<br>Mark Reject | B=2,3,6,7<br>B=0,1,4,5 |
| AOT Mark X | 1307 | 1000 (10) | After Use of Mark X<br>After Mark X & Y or<br>Mark Reject | B=1,3,5,7<br>B=0,2,4,6 |

LM-6

Basic Date _____ October 6, 1969
Changed _____

## CHANNEL LISTING

| CHANNEL | BIT | DSKY | FUNCTION |
|---|---|---|---|
| 5 OUTPUT | 1 | E=1,3,5,7 | JET 1 ON (B4U) |
|  | 2 | E=2,3,6,7 | JET 2 ON (A4D) |
|  | 3 | E=4,5,6,7 | JET 5 ON (A3U) |
|  | 4 | D=1,3,5,7 | JET 6 ON (B3D) |
|  | 5 | D=2,3,6,7 | JET 9 ON (B2U) |
|  | 6 | D=4,5,6,7 | JET 10 ON (A2D) |
|  | 7 | C=1,3,5,7 | JET 13 ON (A1U) |
|  | 8 | C=2,3,6,7 | JET 14 ON (B1D) |
| 6 OUTPUT | 1 | E=1,3,5,7 | JET 7 ON (B3A) |
|  | 2 | E=2,3,6,7 | JET 3 ON (B4F) |
|  | 3 | E=4,5,6,7 | JET 15 ON (A1F) |
|  | 4 | D=1,3,5,7 | JET 11 ON (A2A) |
|  | 5 | D=2,3,6,7 | JET 12 ON (B2L) |
|  | 6 | D=4,5,6,7 | JET 8 ON (A3R) |
|  | 7 | C=1,3,5,7 | JET 4 ON (A4R) |
|  | 8 | C=2,3,6,7 | JET 16 ON (B1L) |
| 11 OUTPUT | 1 | E=1,3,5,7 | ISS WARNING |
|  | 13 | A=1,3,5,7 | ENGINE ON |
|  | 14 | A=2,3,6,7 | ENGINE OFF |
| 12 OUTPUT | 1 | E=1,3,5,7 | ZERO RRCDU |
|  | 4 | D=1,3,5,7 | COARSE ALIGN ENABLE |
|  | 5 | D=2,3,6,7 | ZERO ICDU |
|  | 9 | C=4,5,6,7 | +PITCH GMBL TRIM CMD |
|  | 10 | B=1,3,5,7 | -PITCH GMBL TRIM CMD |
|  | 11 | B=2,3,6,7 | +ROLL GMBL TRIM CMD |
|  | 12 | B=4,5,6,7 | -ROLL GMBL TRIM CMD |
|  | 13 | A=1,3,5,7 | LR POS CMD |
|  | 14 | A=2,3,6,7 | RR AUTO TRACK ENABLE |
|  | 15 | A=4,5,6,7 | ISS TURN ON DELAY COMPLETE |
| 16 INPUT | 3 | E=4,5,6,7 | MARK X |
|  | 4 | D=1,3,5,7 | MARK Y |
|  | 5 | D=2,3,6,7 | MARK REJECT |
|  | 6 | D=4,5,6,7 | +RATE OF DESCENT |
|  | 7 | C=1,3,5,7 | -RATE OF DESCENT |

LM-6

| 30 | 1 | E=0,2,4,6 | ABORT |
|---|---|---|---|
| (INVERTED) | 2 | E=0,1,4,5 | STAGE VERIFY |
| INPUT | 3 | E=0,1,2,3 | ENG ARM |
| | 4 | D=0,2,4,6 | ABORT STAGE |
| | 5 | D=0,1,4,5 | AUTO THROTTLE |
| | 6 | D=0,1,2,3 | DISPLAY INERTIAL DATA |
| | 7 | C=0,2,4,6 | RR CDU FAIL |
| | 9 | C=0,1,2,3 | IMU OPERATE |
| | 10 | B=0,2,4,6 | G&N CONTROL OF S/C |
| | 11 | B=0,1,4,5 | IMU CAGE |
| | 12 | B=0,1,2,3 | ICDU FAIL |
| | 13 | A=0,2,4,6 | IMU FAIL |
| | 14 | A=0,1,4,5 | ISS TURN ON REQUEST |
| | 15 | A=0,1,2,3 | TEMP IN LIMITS |

| 31 | 1 | E=0,2,4,6 | +PITCH MIN IMPULSE/+EL LPD |
|---|---|---|---|
| (INVERTED) | 2 | E=0,1,4,5 | -PITCH MIN IMPULSE/-EL LPD |
| INPUT | 3 | E=0,1,2,3 | +YAW MIN IMPULSE |
| | 4 | D=0,2,4,6 | -YAW MIN IMPULSE |
| | 5 | D=0,1,4,5 | +ROLL MIN IMPULSE/+AZ LPD |
| | 6 | D=0,1,2,3 | -ROLL MIN IMPULSE/-AZ LPD |
| | 7 | C=0,2,4,6 | +X TRANSLATION |
| | 8 | C=0,1,4,5 | -X TRANSLATION |
| | 9 | C=0,1,2,3 | +Y TRANSLATION |
| | 10 | B=0,2,4,6 | -Y TRANSLATION |
| | 11 | B=0,1,4,5 | +Z TRANSLATION |
| | 12 | B=0,1,2,3 | -Z TRANSLATION |
| | 13 | A=0,2,4,6 | ATTITUDE HOLD |
| | 14 | A=0,1,4,5 | AUTO STAB |
| | 15 | A=0,1,2,3 | ACA OUT OF DETENT |

| 32 | 1 | E=0,2,4,6 | JETS 2,4 FAILED |
|---|---|---|---|
| (INVERTED) | 2 | E=0,1,4,5 | JETS 5,8 FAILED |
| | 3 | E=0,1,2,3 | JETS 1,3 FAILED |
| | 4 | D=0,2,4,6 | JETS 6,7 FAILED |
| | 5 | D=0,1,4,5 | JETS 14,16 FAILED |
| | 6 | D=0,1,2,3 | JETS 13,15 FAILED |
| | 7 | C=0,2,4,6 | JETS 9,12 FAILED |
| | 8 | C=0,1,4,5 | JETS 10,11 FAILED |
| | 9 | C=0,1,2,3 | GIMBAL NOT ENABLED |
| | 10 | B=0,2,4,6 | GIMBAL FAILED |
| | 14 | A=0,1,4,5 | PROCEED |

| 33 | 2 | E=0,1,4,5 | RR PWR ON/AUTO |
|---|---|---|---|
| (INVERTED) | 3 | E=0,1,2,3 | RR RNG SCALE LOW |
| | 4 | D=0,2,4,6 | RR DATA GOOD |
| | 5 | D=0,1,4,5 | LR DATA GOOD |
| | 6 | D=0,1,2,3 | LR POSITION 1 |
| | 7 | C=0,2,4,6 | LR POSITION 2 |
| | 8 | C=0,1,4,5 | LR VELOCITY DATA GOOD |
| | 9 | C=0,1,2,3 | LR RNG SCALE LOW |
| | 10 | B=0,2,4,6 | BLOCK UPLINK |
| | 11 | B=0,1,4,5 | UPLINK TOO FAST |
| | 12 | B=0,1,2,3 | DOWNLINK TOO FAST |
| | 13 | A=0,2,4,6 | PIPA FAIL |
| | 14 | A=0,1,4,5 | LGC WARNING |
| | 15 | A=0,1,2,3 | OSCILLATOR ALARM |

## LM OR CSM S.V. READOUT

1      V83E

2      After intergration: V05N01E

**CSM S.V.**               **LM S.V.**

2137E                       2167E

E,2142E                    E,2172E

E,2117E                    E,2104E

E,2122E                    E,2107E

E,2113E                    E,2113E

PRO                        PRO

Basic Date lovember 3, 1969 Changed

3      Transmit S.V. & Time Tag
           To CSM

## LM OR CSM S.V. LOADING

1      V37E00E
           V71E
           21E
           1501E
           (CSM S.V.) 00002E, Plus Xmited Pad
           (LM S.V.)  77775E, Plus Xmited Pad
           V33E

## AGS SELECTOR LOGIC LIST

| Address | Entry | |
|---|---|---|
| 400 | +00000 | Attitude Hold |
| | +10000 | Auto Guidance Steering |
| | +20000 | Z-Body Axis Steering |
| | +30000 | IMU Align |
| | +40000 | Lunar Align |
| | +50000 | Body Axis Align |
| | +60000 | Gyro and Accelerometer Calibration (302 sec, 32 sec) |
| | +70000 | Inflight Accelerometer Only Calibration (32 sec) |
| 407 | +00000 | Use Rotating External $\Delta V$ Reference Frame |
| | +10000 | Freeze External $\Delta V$ in Inertial Space And Allow $\Delta V$'s To Count |
| 410 | +00000 | Orbit Insertion Routine |
| | +10000 | CSI Routine |
| | +20000 | CDH Routine |
| | +30000 | TPI Search Routine |
| | +40000 | TPI Execute Routine |
| | +50000 | External $\Delta V$ |
| 411 | +00000 | DPS or RCS Engine Select |
| | +10000 | APS Engine Selection |
| 412 | +00000 | Reinitiate Test |
| | +10000 | Test Successful |
| | +30000 | Logic Test Fail |
| | +40000 | Memory Test Fail |
| | +70000 | Logic & Memory Test Fail |
| 413 | +00000 | Normal Position |
| | +10000 | Store Lunar Azimuth |
| 414 | +00000 | Navigation Initialization Complete (AUTO) |
| | +10000 | LM And CSM Navigation Initialization via PGNCS Downlinks |
| | +20000 | LM Navigation Initialization via DEDA |
| | +30000 | CSM Navigation Initialization via DEDA |

AGS LOGIC

| 415 | +00000 | Normal Position |
| | +10000 | Store Z-axis Direction Cosines & Rng/Rng Rt Data in RDR Filter |
| 416 | +10000 | For CSI Calculation Select CDH At 1/2 Orbital Period Following CSI |
| | +30000 | For CSI Calculation Select CDH At 3/2 Orbital Period Following CSI |
| 417 | +00000 | Normal Position |
| | +10000 | Initialize Radar Filter |
| 507 | +00000 | Z Body Points In Direction Of CSM When In Z-Body Axis Steering (400 set to +2) |
| | +10000 | Z Body Points To Thrust Direction When (400 set to +2) |
| 623 | +00000 | Z Body Parallel To CSM Orbit Plane When In Guidance Steering (400 set To +1) |
| | +10000 | Z Body Parallel To Plane Defined By WB When In Guidance Steering (400 set To +1) |

## DEDA INPUT/OUTPUT LIST

### Address

| Address | Description | Units |
|---|---|---|
| 047 | Sine of Landing Azimuth Angle | Octal |
| 053 | Cosine of Landing Azimuth Angle | Octal |
| 223 | Attitude Update Input | 100 ft |
| 224 | Term In LM Desired Semi-major Axis $a_L$ (O.I.) | 100 ft |
| 225 | Lower Limit of $a_L$ (O.I.) | 100 ft |
| 226 | Upper Limit of $a_L$ (O.I.) | 100 ft |
| 231 | Radial Distance of Landing Site From Center of Moon | 100 ft |
| 232 | Orbit Insertion Altitude | 100 ft |
| 233 | Vertical Pitch Steering Altitude Threshold | 100 ft |
| 240 | X Position Comp (LM) | 100 ft |
| 241 | Y Position Comp (LM) | 100 ft |
| 242 | Z Position Comp (LM) | 100 ft |
| 244 | X Position Comp (CSM) | 100 ft |
| 245 | Y Position Comp (CSM) | 100 ft |
| 246 | Z Position Comp (CSM) | 100 ft |
| 254 | LM Ephemeris Data (Epoch Time) | 0.1 min |
| 260 | X Velocity Comp (LM) | .1 fps |
| 261 | Y Velocity Comp (LM) | .1 fps |
| 262 | Z Velocity Comp (LM) | .1 fps |
| 264 | X Velocity Comp (CSM) | .1 fps |
| 265 | Y Velocity Comp (CSM) | .1 fps |
| 266 | Z Velocity Comp (CSM) | .1 fps |
| 272 | CSM Ephemeris Data (Epoch Time) | 0.1 min |
| 274 | Initial Update Time For Radar Filter | .1 min |
| 275 | Desired Update Time For TIG TPI (For CSI Calc Only) | .1 min |
| 306 | Target Time Of Node Prior To Rendezvous | .01 min |
| 307 | Time From TPI To Rendezvous | .01 min |
| 310 | Targeted TFI TPI (For TPI Search Routine) | .01 min |
| 312 | TPI Rendezvous Offset Time (Stable Orbit Rendezvous) | .01 min |

| | | |
|---|---|---|
| 316 | Radar Range (R) | 0.1 nm |
| 373 | AGS TIG CSI, CDH, TPI, TPM | 0.1 min |
| 377 | AGS Computer Time (T) | 0.1 min |
| 404 | ΔVX (Use 470 For Readout) | Octal |
| 405 | ΔVY (Use 471 For Readout) | Octal |
| 406 | ΔVZ (Use 472 For Readout) | Octal |
| 450 | ΔVX (LV) (+Fwd) | .1fps |
| 451 | ΔVY (LV) (+Rt) | .1fps |
| 452 | ΔVZ (LV) (+Dn) | .1fps |
| 464 | Vertical Pitch Steering, Attitude Rate Threshold | .1fps |
| 465 | Target Radial Rate at Insertion (Lower Limit) | .1fps |
| 503 | Radar Range Rate (RDOT) Input | .1fps |
| 514 | Components of Unit Vector | Octal |
| 515 | Used to PROVIDE Yaw | |
| 516 | Steering Out of CSM Orbit Plane (400,+10000;623,+10000) | Octal |
| 534 | Scale Factor for X Accelerometer | Octal |
| 535 | Scale Factor for Y Accelerometer | Octal |
| 536 | Scale Factor for Z Accelerometer | Octal |
| 540 | X Accel Bias Comp Coeff | .001 ft/sec2 |
| 541 | Y Accel Bias Comp Coeff | .001 ft/sec2 |
| 542 | Z Accel Bias Comp Coeff | .001 ft/sec2 |
| 544 | X Gyro Bias Comp Coeff | .01°/hr |
| 545 | Y Gyro Bias Comp Coeff | .01°/hr |
| 546 | Z Gyro Bias Comp Coeff | .01°/hr |
| 547 | Lunar Align Azimuth Correction | Octal |
| 574 | Section Staging Flag(+ Not Staged) | Octal |
| 604 | Lunar Surface Flag(+ Not On Lunar Surface) | Octal |
| 605 | Desired cotangent of LOS at TPI (TAN LOS TPI) | Octal |
| 607 | HDOT Display Scale Factor | Octal |
| 613 | Central Angle Limit On TPI | Octal |
| 616 | Ullage Counter Value For Ullage Completion | 2 sec |

DEDA INPUT/OUTPUT CONSTANTS

Basic Date _____ October 6, 1969

Changed _____

## DEDA OUTPUT LIST

### Address

| Address | Description | Units |
|---|---|---|
| 211 | Present Out-of CSM Orbit Plane Position | 100 ft |
| 263 | Predicted Out-Of-Plane Velocity At TIG (CSI, CDH, TPI), Present Out of Plane O.I. | .1fps |
| 267 | ΔV To Be Gained (Except CDH) | .1fps |
| 270 | Present Vy Out-of-CSM Orbit Plane Velocity (Vyo) | .1fps |
| 277 | Angle Between Local Horizon & Z Body Axis (In Plane) | .01° |
| 303 | Predicted LOS At TIG TPI (TPI mode) | .01° |
| 303 | LM/CSM Phase Angle at TIG (CSI,CDH) Present O.I. | - |
| 310 | Time To Next Maneuver (CSI,CDH,TPI) | 0.01 min. |
| 311 | Time To Rndz (TPI) | 0.01 min. |
| 312 | Target Offset Time (TPI) | 0.01 min. |
| 313 | Time To Pericynthian | 0.01 min. |
| 314 | ΔH Along LM Radial At TIG (CSI,CDH) | .1 nm |
| 315 | Predicted Altitude Of LM Apogee | 0.1 nm |
| 317 | LM To CSM Range (R) | 0.1 nm |
| 337 | LM Altitude (h) | 0.1 nm |
| 340 | X Comp of LM Position | 100 ft |
| 341 | Y Comp of LM Position | 100 ft |
| 342 | Z Comp of LM Position | 100 ft |
| 344 | X Comp of CSM Position | 100 ft |
| 345 | Y Comp of CSM Position | 100 ft |
| 346 | Z Comp of CSM Position | 100 ft |
| 347 | Predicted Altitude At TIG (Except O.I.) | 100 ft |
| 357 | Time To Burnout | fps/16 |
| 360 | X Comp of LM Velocity | .1fps |
| 361 | Y Comp of LM Velocity | .1fps |
| 362 | Z Comp of LM Velocity | .1fps |
| 364 | X Comp of CSM Velocity | .1fps |
| 365 | Y Comp of CSM Velocity | .1fps |
| 366 | Z Comp of CSM Velocity | .1fps |
| 367 | LM Altitude Rate (H DOT) | .1fps |
| 371 | ΔV For CDH (Valid in CSI, Coast) | .1fps |
| 371 | ΔV Direct Trans + Braking (TPI) | .1fps |

| | | |
|---|---|---|
| 372 | CSI To CDH $\Delta T$ (CSI) | .1 min |
| 402 | $\Delta H$ In Coelliptic Orbit (CSI,CDH) | .1nm |
| 402 | Predicted Hp (TPI) | .1nm |
| 403 | LM Perigee Attitude (Hp) | .1nm |
| 423 | Desired Final HDOT (Except TPI) | .1fps |
| 427 | Present LM HOR Velocity | .1fps |
| 433 | LM Velocity | .1fps |
| 440 | Range Rate Between LM and CSM (R DOT) (-Closing) | .1fps |
| 470 | $\Delta VX$ Measured (LM) (+ Up) (Use 404 to zero) | .1fps |
| 471 | $\Delta VY$ Measured (LM) (+ Rt) (Use 405 to zero) | .1fps |
| 472 | $\Delta VZ$ Measured (LM) (+ Fwd) (Use 406 to zero) | .1fps |
| 477 | Predicted HDOT At CSI, CDH, or TPI Time | .1fps |
| 500 | $\Delta Vgx$ (LM) (+Up) | .1fps |
| 501 | $\Delta Vgy$ (LM) (+Rt) | .1fps |
| 502 | $\Delta Vgz$ (LM) (+Fwd) | .1fps |
| 612 | Staging Sequence Counter | Octal |
| 614 | Ullage Counter | 2 sec |

## DEDA ACCESSIBLE CONSTANTS LIST

## Address

| | | |
|---|---|---|
| 216 (2K3) | Value of LM Pericynthion If Overflow In Orbital Eccentricity | 100 ft |
| 227 (4K10) | Factor In LM Desired Semi-major Axis $\alpha L$ (Orbit Insertion) | 100 ft |
| 230 (2K19) | $\Delta P$ Limiter | 100 ft |
| 453 (2K20) | P Iterator Convergence Check (TPI) | N.A. |
| 454 (4K26) | VG Engine Cutoff Threshold | .1fps |
| 466 (5K26) | Vgx Pseudo Attitude Hold Threshold | .1fps |
| 473 (4K27) | Accumulated X-Velocity Bias | .1fps |
| 506 (4K12) | Acceleration Threshold for Radial Jerk Set (Orbit Insertion) | Octal |
| 523 (5K20) | Lower Limit Of Radial Jerk For Staged Vehicle (Orbit Insertion) | Octal |

| | | | |
|---|---|---|---|
| 526 (2K11) | Set Value Of Transfer Velocity (VT) (TPI) | | Octal |
| 527 (4K6) | Upper Limit Of Perdocted Radial Rate At Insertion (Orbit Insertion) | | Octal |
| 560 (5K14) | Upper Limit Of Radial Jerk (Orbit Insertion) | | Octal |
| 561 (5K16) | Upper Limit Of Out-Of-Plane Jerk (Orbit Insertion) | | Octal |
| 564 (5K18) | Lower Limit Of Radial Jerk For Unstaged Vehicle (Orbit Insertion) | | Octal |
| 566 (4K7) | Ascent Engine Pitch Cant Angle | | Octal |
| 601 (5K17) | Lower Limit Of Out-Of-Plane Jerk (Orbit Insertion) | | Octal |
| 602 (4K8) | Ascent Engine Roll Cant Angle | | Octal |
| 617 (1K30) | Gyro Calbrate Time | 1 Count(2sec) | |
| 621 (1K37) | Accelerometer Calibrate Time | 1 Count(2sec) | |
| 622 (4K23) | Attitude Hold At Abort Staging Threshold | 1 Count(40 millisec) | |
| 627 (1K27) | Lunar Align Constant | | Octal |
| 630 (1K28) | Lunar Align Constant | | Octal |
| 631 (1K29) | Lunar Align Constant | | Octal |
| 634 (1K35) | Navigation Sensed Velocity Threshold | | Octal |
| 636 (2K1) | Lunar Gravitational Constant | | Octal |
| 637 (2K2) | Reciprocal Of Lunar Gravitational Constant | | Octal |
| 657 (4K25) | Vgx Engine Cutoff Threshold | | Octal |
| 660 (4K34) | Lower Limit Of Thrust Acceleration | | Octal |
| 661 (4K35) | Increment Ullage Counter Threshold | | Octal |
| 666 (4K21) | Scale Factor For Attitude Error | | Octal |

## ORBIT INSERTION

1 MODE CONT: AGS - ATT HOLD
  GUID CONT - AGS
  EVENT TIMER - SET

2 616+0 ZERO ULLAGE COUNTER LIMIT
  232+(ORBIT INSERTION ALTITUDE)   (100ft)
  465+(ALTITUDE RATE AT INSERTION)  (.1fps)
  224+(Semi-Major Axis Targeting Term) (100ft)
  225+( a Lower)        (100ft)
  226+( a Upper)        (100ft)
  227+(4K10)         (100ft)
  410+0 ORBIT INSERTION ROUTINE

3 411+0 DES ENG OR RCS BURN
   +1 ASC ENG BURN

4 623+0 Z-AXIS PARALLEL TO CSM ORBIT PLANE
   +1 Z-AXIS PARALLEL TO SPECIFIED PLANE

5 If 623+1, Specify Plane
  514+(X Component of Unit Vector) (Octal)
  515+(Y Component of Unit Vector) (Octal)
  516+(Z Component of Unit Vector) (Octal)

6 400+1 GUIDANCE STEERING
  501R ΔVGY(LM)      (.1fps)
  502R ΔVGZ(LM)      (.1fps)
  500R ΔVGX(LM)      (.1fps)

7

| CONFIGURATION | DES | ASC | RCS |
|---|---|---|---|
| THR CONT | MAN | - | - |
| MAN THROT | CDR | - | - |
| BAL CPL | ON | ON | ON |
| ATT/TRANSL | 2 JET | 2 JET | 2 JET |
| TTCA (CDR) | THROT | JETS | JETS |
| DEADBAND | MIN | MIN | MIN |
| ABORT(STAGE)PB | RESET | RESET | RESET |
| ENG ARM | DES | ASC | OFF |
| MASTER ARM | ON(1st Burn Only) | ON(Un-staged) | OFF |

| | | |
|---|---|---|
| PRPLNT QTY MON | DES 1 | OFF | OFF |
| PRPLNT TEMP/PRESS MON | DES 1 | ASC | - |
| HELIUM MON | SUPCRIT PRESS | PRESS 2 | - |
| ENGINE STOP | - | - | PUSH |

8  -30   FOR DPS BURNS
CB(11) STAB/CONT:  DECA PWR - Close
CB(16) STAB/CONT:  DES ENG OVRD - Close
ENG  GMBL - ENABLE
FOR APS BURNS
CB(11) STAB/CONT:  AELD - Close
CB(16) STAB/CONT:  AELD - Close

9  -TBD  MODE CONT:  AGS - AUTO

10   00  ABORT (STAGE) - PUSH
IGNITION
When ΔV >50fps:  BAL CPL - OFF

11       When Burn Complete
ABORT (STAGE) PB - RESET
407+0
410+5
451+0
   (To Trim Out-of-Plane Comp)
        263R ΔVY        (.1fps)
        451 (ΔVY)(Same sign As 263)
407+1
NULL 501,502,500
   (Null 501 After 502 for Out-of-Plane Trim)

12       MASTER ARM        - OFF
ENG ARM           - OFF
BAL CPL           - ON
TTCA (CDR)        - JETS
DEADBAND          - MAX
PRPLNT QTY MON    - OFF
HELIUM MON        - OFF

13       616 + 00007

## CSI

| | |
|---|---|
| 1 | MODE CONT: AGS - ATT HOLD<br>GUID CONT - AGS |

2  Wait until TIG-136 min
   410 + 1 CSI Routine
   373 + (TIG CSI)                              (.1 min)
   275 + (TIG TPI)                              (.1 min)
   605 + (COTAN LOS TPI)                        (Octal)
   451 + OE
   416 + 1 CDH 1/2 Orbital Period After CSI
       + 3 CDH 3/2 Orbital Periods After CSI

3  477R HDOT CSI                                (.1fps)

4  310R TFI CSI                                 (.01 min)
   EVENT TIMER - SET

5  If Time Available
   372R ΔT CSI To CDH                           (.1min)
   303R LM/CSM Phase Angle                      (.01°)
   371R ΔV CDH                                  (.1fps)
   477R Predicted HDOT                          (.1fps)
   314R ΔH At TIG                               (.1nm)
   402R ΔH CDH                                  (.1nm)

6  410 + 5 EXT ΔV
   450R ΔVX CSI                                 (.1fps)
   263RΔVY  CSI                                 (.1fps)
   451 (ΔVY CSI) (Same sign as 263)             (.1fps)
   452R ΔVZ CSI                                 (.1fps)
   267R ΔVG CSI                                 (.1fps)

7  411 +0 DES ENG OR RCS BURN
       +1 ASC ENG BURN

8  623 +0 Z-Axis Parallel to CSM Orbit Plane
       +1 Z-Axis Parallel to Specified Plane

9    If 623 +1, Specify Plane
     514 + (X Component of Unit Vector) (Octal)
     515 + (Y Component of Unit Vector) (Octal)
     516 + (Z Component of Unit Vector) (Octal)

10   400 +1 GUIDANCE STEERING (Z Axis Mnvr, 400+2,
                                                507+1)

11   ATTITUDE CONTROL (3)-PULSE
     MODE CONT: AGS - AUTO
     Maneuver To Burn Attitude Then
     ATTITUDE CONTROL (3)-MODE CONT

12   407 +0

13   501R ΔVGY (LM)                              (.1fps)
     502R ΔVGZ (LM)                              (.1fps)
     500R ΔVGX (LM)                              (.1fps)

14

| CONFIGURATION | DES | ASC | RCS |
|---|---|---|---|
| THR CONT | MAN | - | - |
| MAN THROT | CDR | - | - |
| BAL CPL | ON | ON | ON |
| ATT/TRANSL | 2 JET | 2 JET | 2 JET |
| TTCA(CDR) | THROT (MIN THRUST) | JETS | JETS |
| DEADBAND | MIN | MIN | MIN |
| ABORT(STAGE) | PUSH | PUSH | - |
| ENG ARM | DES | ASC | OFF |
| MASTER ARM | ON(1st Burn Only) | ON(Un-Staged Only) | OFF |
| PRPLNT QTY MON | DES 1 | OFF | OFF |
| PRPLNT TEMP/PRESS MON | DES 1 | ASC | - |
| HELIUM MON | SUPCRIT PRESS | PRESS 2 | - |
| ENGINE STOP | - | - | PUSH |

15  -30   FOR DPS BURNS
          CB(11) STAB/CONT: DECA PWR-Close
          CB(16) STAB/CONT: DES ENG OVRD-Close
          ENG GMBL - ENABLE
          FOR APS BURNS
          CB(11) STAB/CONT: AELD-Close
          CB(16) STAB/CONT: AELD-Close

    -15   407 +1 (For RCS Burn Not +X LM)
          (X-Axis) 500R
          (Z-Axis) 502R

16  - :14 Start Ullage

17    :00 Ignition
          (RCS Burn) When ΔVG <15fps,
             MODE CONTROL (AGS)-ATT HOLD

18        When Burn Complete:
          ABORT (STAGE) Reset
          NULL 501,502,500

19        410 +2 CDH Routine

20        MASTER ARM - OFF
          ENG ARM - OFF
          BAL CPL - ON
          TTCA(CDR) - JETS
          DEADBAND - MAX
          PRPLNT QTY MON - OFF
          HELIUM MON - OFF

__CDH__

| 1 | MODE CONT: AGS - ATT HOLD |
| | GUID CONT - AGS |

2   410 +2 CDH ROUTINE
    373R TIG CDH (Adjust AGS TIG CDH
      As Desired For New Solution)                    (.1 min)

3   310R TFI CDH                                       (.01 min)
    EVENT TIMER - SET

4   If Time Available Check The Following:
    402R ΔH CDH                                        (.1nm)
    423R HDOT CDH (Final)                              (.1fps)
    477R HDOT CDH                                      (.1fps)

5   410 +5 EXT ΔV
    450R ΔVX CDH                                       (.1fps)
    263R ΔVY CDH                                       (.1fps)
    451 (ΔVY CDH) (Same Sign As 263)                   (.1fps)
    452R ΔVZ CDH                                       (.1fps)
    267R ΔVG CDH                                       (.1fps)

6   411 +0 DES ENG OR RCS BURN
        +1 ASC BURN

7   623 +0 Z-axis Parallel To CSM Orbit Plane
        +1 Z-axis Parallel To Specified Plane

8   If 623 +1, Specify Plane
    514 +(X Component of Unit Vector)
    515 +(Y Component of Unit Vector)
    516 +(Z Component of Unit Vector)

9      400 +1 GUIDANCE STEERING (Z-Axis,400+2,507+1)

10     ATTITUDE CONTROL (3)-PULSE
        MODE CONT: AGS - AUTO
        Maneuver To Burn Attitude Then
        ATTITUDE CONTROL (3) - MODE CONT

11     407 +0

12     501R ΔVGY (LM)                              (.1fps)
        502R ΔVGZ (LM)                              (.1fps)
        500R ΔVGX (LM)                              (.1fps)

13

| CONFIGURATION | DES | ASC | RCS |
|---|---|---|---|
| THR CONT | MAN | - | - |
| MAN THROT | CDR | - | - |
| BAL CPL | ON | ON | ON |
| ATT/TRANSL | 2 JET | 2 JET | 2 JET |
| TTCA(CDR) | THROT (MIN THRUST) | JETS | JETS |
| DEADBAND | MIN | MIN | MIN |
| ABORT(STAGE) | PUSH | PUSH | - |
| ENG ARM | DES | ACS | - |
| MASTER ARM | ON(1st Burn Only) | ON(Un- Staged Only) | OFF |
| PRPLNT QTY MON | DES 1 | OFF | OFF |
| PRPLNT TEMP/PRESS MON | DES 1 | ASC | - |
| HELIUM MON | SUPCRIT PRESS | PRESS 2 | - |
| ENGINE STOP | - | - | PUSH |

14　-30　For DPS Burns
　　　　CB(11) STAB/CONT: DECA PWR-Close
　　　　CB(16) STAB/CONT: DES ENG OVRD-Close
　　　　ENG GMBL-ENBL
　　　　For APS Burns
　　　　CB(11) STAB/CONT: AELD-Close
　　　　CB(16) STAB/CONT: AELD-Close

　　-15　407 +1 (For RCS BURN Not Along +X)
　　　　(X-Axis) 500R
　　　　(Z-Axis) 502R

15　- :14 Start Ullage

16　00　IGNITION
　　　　(RCS Burn) When ΔVG <15fps,
　　　　　MODE CONTROL(AGS)-ATT HOLD

17　　　When Burn Complete
　　　　ABORT(STAGE) - Release
　　　　NULL 501, 502, 500　　　　　　　　　　　(fps)

18　　　MASTER ARM　　　　　　　　　　-OFF
　　　　ENG ARM　　　　　　　　　　　-OFF
　　　　BAL CPL　　　　　　　　　　　-ON
　　　　TTCA (CDR)　　　　　　　　　-JETS
　　　　DEADBAND　　　　　　　　　　-MAX
　　　　PRPLNT QTY MON　　　　　　　-OFF
　　　　HELIUM MON　　　　　　　　　-OFF

## TPI

1  MODE CONT: AGS - ATT HOLD
   GUID CONT: AGS

2  410 +3 TPI SEARCH
   307 +(ΔT RND TRANS)                          (.01 min)
   306 +0 NODE AT TPF                           (.01 min)
   310 +(TARGET TFI TPI)                        (.01 min)

3  303R LOS ANGLE TPI                           (.01°)
   410 +4 TPI EXECUTE (When 303 is 26.6° (Below),
                              28.3° (Above)

      (TO RETARGET 410 +3 And
       310 (Target TFI TPI) Then
       410 +4 (When 303 Reads Desired Value)

4  310R TFI TPI                                 (.01 min)
   EVENT TIMER - SET
   371R ΔVG to RNDZ                             (.1fps)
      (If +06000 Retarget)

5  If Time Available:
   303 LOS ANGLE TPI                            (.01°)
   373R TIG TPI                                 (.1 min)
   311R Time To Rendezvous                      (.01min)
   306R Target Time of Node                     (.01min)
   312R Target Offset Time                      (.01min)
   307R Desired Transfer Time                   (.01min)
   373R TIG TPI                                 (.1min)
   402R Hp TPI                                  (.1nm)

6  411 +0 DES ENG OR RCS
       +1 ASC ENG

7  410 +5
   267R ΔVG TPI

8    623 +0 Z-Axis Parallel To CSM Orbit Plane
        +1 Z-Axis Parallel To Specified Plane

9    If 623 +1, Specify Plane
     514 +(X-Component of Unit Vector)
     515 +(Y-Component of Unit Vector)
     516 +(Z-Component of Unit Vector)

10   400 +1 GUIDANCE STEERING (Z Axis, 400+2,507+1)

11   ATTITUDE CONTROL (3) - PULSE
     MODE CONT: AGS - AUTO
     Maneuver To Burn Attitude Then
     ATTITUDE CONTROL (3) - MODE CONT

12   407 +0

13   501R   VGY (LM)                                    (.1fps)
     502R   VGZ (LM)                                    (.1fps)
     500R   VGX (LM)                                    (.1fps)

14

| CONFIGURATION | DES | ASC | RCS |
|---|---|---|---|
| THR CONT | MAN | - | - |
| MAN THROT | CDR | - | - |
| BAL CPL | ON | ON | ON |
| ATT/TRANS | 2 JET | 2 JET | 2 JET |
| TTCA (CDR) | THROT | JETS | JETS |
| DEADBAND | MIN | MIN | MIN |
| ABORT PB | PUSH | PUSH | - |
| ENG ARM | DES | ASC | OFF |
| MASTER ARM | ON(1st Burn Only) | ON(Un-Staged Only) | OFF |
| PRPLNT QTY MON | DES 1 | OFF | - |
| PRPLNT TEMP/PRESS MON | DES 1 | ASC | - |
| HELIUM MON | SUPCRIT PRESS | PRESS 2 | - |
| ENGINE STOP | - | - | DEPRESS |

15  -30  For DPS Burns
         CB(11) STAB/CONT: DECA PWR-Close
         CB(16) STAB/CONT: DES ENG OVRD-Close
         ENG GMBL-ENBL
         For APS Burns
         CB(11) STAB/CONT: AELD-CLOSE
         CB(16) STAB/CONT: AELD-CLOSE

    -15  407 +1  (For RCS BURN Not In +X)
         (X-Axis) 500R
         (Z-Axis) 502R

16  -06  Start Ullage

17  00   IGNITION
         (RCS Burn)When ΔVG <15fps,
            MODE CONTROL (AGS)-ATT HOLD

18       When Burn Complete
         ABORT(STAGE)PB - Release
         NULL 501, 502, 500                                    (fps)

19       410 +4 TPI EXECUTE

20       MASTER ARM                      -OFF
         ENG ARM                         -OFF
         BAL CPL                         -ON
         TTCA (CDR)                      -JETS
         DEADBAND                        -MAX
         PRPLNT QTY MON                  -OFF
         HELIUM MON                      -OFF

Basic Date ____ October 6, 1969
Changed ____

LM-6

TPM

### Retargeting (Same Rndz Time)

| | | |
|---|---|---|
| 1 | 410 +3 TPI SEARCH | |
| | 307 +(ΔT RNDZ TRANS) | |
| |     (+02800 For 1st MCC) | |
| |     (+01300 For 2nd MCC) | |
| | 310 ΔT To TPM | (.01min) |
| | 410 +4 TPI EXECUTE | |
| | | |
| 2 | If Time Available: | |
| | 311R ΔT RDZ | (.01 min) |
| | 277R THETA | (.01°) |
| | | |
| 3 | 410 +5 | |
| | 407 +0 Ref Frame | (.1fps) |
| | 267R VG MDC | |
| | 407 +1 Freeze Ext ΔV | |
| | | |
| 4 | Null 501, 502, 500 | |

## EXTERNAL ΔV

1        MODE CONT: AGS - ATT HOLD
           GUID CONT: AGS

2        410 +5 EXTERNAL ΔV
           450 + ΔVX (LV)          (.1fps)
           451 + ΔVY (LV)          (.1fps)
           452 + ΔVZ (LV)          (.1fps)

3        267R Total ΔV
           EVENT TIMER - SET

4        411 +0 DES ENG OR RCS
              +1 ASC ENG

5        400 +1 GUIDANCE STEERING (Z-Axis,400+2,507+1)

6        ATTITUDE CONTROL (3) - PULSE
           MODE CONT: AGS - AUTO
           Maneuver To Burn Attitude Then
           ATTITUDE CONTROL (3) - MODE CONT

7        407 +0

8        501R ΔVGY (LM)          (.1fps)
           502R ΔVGZ (LM)          (.1fps)
           500R ΔVGX (LM)          (.1fps)

9

| CONFIGURATION | DES | ASC | RCS |
|---|---|---|---|
| THR CONT | MAN | - | - |
| MAN THROT | CDR | - | - |
| BAL CPL | ON | ON | ON |
| ATT/TRANS | 2 JET | 2 JET | 2 JET |
| TTCA(CDR) | THROT | JETS | JETS |
| DEADBAND | MIN | MIN | MIN |
| ABORT(STAGE) | PUSH | PUSH | - |

| | | | |
|---|---|---|---|
| ENG ARM | DES | ASC | OFF |
| MASTER ARM | ON(1st Burn Only) | ON(Un- Staged Only) | OFF |
| PRPLNT QTY MON | DES 1 | OFF | - |
| PRPLNT TEMP/PRESS MON | DES 1 | ASC | - |
| HELIUM MON | SUPCRIT PRESS | PRESS 2 | - |
| ENGINE STOP | - | - | DEPRESS |

10  -30  For DPS Burns
CB(11) STAB/CONT: DECA PWR-Close
CB(16) STAB/CONT: DES ENG OVRD-Close
ENG GMBL-ENBL
For APS Burns
CB(11) STAB/CONT: AELD-Close
CB(16) STAB/CONT: AELD-Close

-15  407 +1 (For RCS Burn Not Along +X)

11  -:06  Start Ullage

12  00  IGNITION
(RCS Burn) When ΔVG <15fps,
   MODE CONTROL (AGS) - ATT HOLD

13  When Burn Complete
ABORT(STAGE) - Release
NULL 501, 502, 500                                    (.1fps)

14  MASTER ARM          -OFF
ENG ARM               -OFF
BAL CPL               -ON
TTCA(CDR)             -JETS
DEADBAND              -MAX
PRPLNT QTY MON        -OFF
HELIUM MON            -OFF

## AGS MANUAL THRUST

1        GUID CONT                      -AGS
                   MODE CONT: AGS          -ATT HOLD
                   ATT CONT RPY            -MODE CONT
                   DEADBAND                -MIN
                   TTCA/TRANSL             -ENABLE
                   TTCA(CDR)              -JETS

2        MNVR Vehicle To Desired Attitude (Align One
            Of The Spacecraft Body Axes In The Desired
            Thrust Direction)

3        400 +0
            MODE CONT: AGS - AUTO
            404 +0
            405 +0
            406 +0

4        Monitor $\Delta$V Along Thrust Axis
            X - 470R                            (.1fps)
            Y - 471R                            (.1fps)
            Z - 472R                            (.1fps)

5        Thrust Residuals

6        Trim Residuals

            X - 470R                            (.1fps)
              Null (TTCA Up/Dn)
              (If Thrust Axis Acquire Desired $\Delta$V)

            Z - 472R                            (.1fps)
              Null (TTCA In/Out)
              (If Thrust Axis Acquire Desired $\Delta$V)

## AGS ACTIVATION & SELF TEST

1          AGS STATUS - STBY
              (AGS Warn Lt - On)
           CB(11) AC BUS B: AGS-Close
           CB(16) STAB/CONT: AEA-Close
              (AGS Warn Lt - Off)
           AGS STATUS - OPERATE
              (AGS Warn Lt - On)
           O2/H2O QTY MON - CWEA RESET
              (AGS Warn Lt - Off)

2          000 +888888 (OPR ERR Lt - On)

3          123 -45679

4          412  +0 To Reinitiate Test
           412R +1 SELF TEST SATISFACTORY
                 +3 LOGIC TEST FAILURE
                 +4 MEMORY TEST FAILURE
                 +7 LOGIC AND MEMORY TEST FAILURE

5          574 +0 DESCENT STAGE FLAG (+NOT STAGED)

6          604 +0 LUNAR SURFACE FLAG (+NOT ON
                        LUNAR SURFACE)

7          612R +0 STAGING SEQ COUNTER

AGS ACT, SELF-
TEST, CALIBRATION

LM-6

NASA — MSC

AGS ACT, SELF
TEST, CALIBRATION

## AGS CALIBRATION

1       Verify AGS In Standby/Operate For 25 min

2       Read And Record
        540R X ACCEL BIAS       _____(.001 ft/sec2)
        541R Y       _____(.001 ft/sec2)
        542R Z       _____(.001 ft/sec2)
        544R X GYRO DRIFT COEFF   _____(.01°/hr)
        545R Y       _____(.01°/hr)
        546R Z       _____(.01°/hr)

3       V16N20E
16 20  ICDU Angles 0,I,M
        CSM MNVR Until LM Angles: 292.5°
                                  338.0°
                                  337.0°

       Rates <.075°/sec
       Disable CSM & LM Thrusters
       V40N20E

4       400 +6 CALIBRATE GYRO & ACCEL
       Read And Record
       540R X ACCEL BIAS       _____(.001 ft/sec2)
       541R Y       _____(.001 ft/sec2)
       542R Z       _____(.001 ft/sec2)
       Values Should Not Change From Step 2
         By More Than (.039)  ft/sec2 (.008nom)

5       400R +0 GYRO & ACCEL CALIBRATE COMPLETE (302 Sec)
       Read And Record
       544R X GYRO DRIFT COEFF   _____(.01°/hr)
       545R Y       _____(.01°/hr)
       546R Z       _____(.01°/hr)
       Values Should agree with Step 2 Values
         Within 2.0°/hr (Nominal 0.9)

Basic Date   October 6, 1969
Changed   October 24, 1969

LM-6

## AGS RR MANUAL ACQUISITION AND UPDATE

| 1 | GUID CONT | -AGS |
|---|---|---|
| | RNG/ALT MON | -RNG/RNG RT |
| | RATE/ERR MON | -LDR RDR/CMPTR |
| | ATT MON | -AGS |
| | SHFT/TRUN | -+5° |
| | RR MODE | -SLEW |
| | ATT CONT (3) | -PULSE |
| | MODE CONT: AGS | -AUTO |
| | DB | -MIN |

2      400 +2 ACQUISITION STEERING
       507 +0 Z Body Boresight

3      Manually Null FDAI

4      RATE/ERR MON-RNDZ RADAR

5      Slew Null FDAI, Then Search For Strongest
          Signal And Check For Side Lobe

6      RR MODE - AUTO TRACK

7      417 +1 INITIALIZE RADAR FILTER

8      415 +1 STORE Z AXIS COSINES
       ENTR (When FDAI's Centered)

9      316 +(RADAR RANGE)                              (.1nm)
             (Must Be Entered Within 30 sec)
       Wait 16 sec Before Step 10

10     415 +1 Store Z Axis cosines

11     503 ± (RADAR RANGE RATE)                        (.1fps)
             (Must Be Entered Within 30 sec)
             (Wait 16sec Before Next 415 Entry)

12     Repeat Steps 8 thru 11

13     Repeat Procedure For A Minimum of 6
          Range Data Points Approximately
       4 min Apart (9 Points if Pre CSI)

LM-6

## AGS ORDEAL INITIALIZATION

1       POWER - ON
        FDAI 1 and/or 2 - ORB RATE
        EARTH LUNAR - LUNAR

2       315R Ha LM                                          (.1nm)
        403R Hp LM

3       ALT SET - Set To Ave of HA & HP

4       Verify LM Pointed +Z In Direction Of
           Orbit Travel

5       277R THETA (0-360P)                                 (.01°)

6       MODE - HOLD/FAST
        SLEW - Set To Theta
        MODE - OPR/SLOW

AGS MAN ACQ,
ORDEAL INIT

LM-6

## AGS MANUAL STATE VECTOR UPDATE

| | | |
|---|---|---|
| 1 | RECORD LM DATA AND TIME | |
| 2 | 240 +(LM X Position) | (100 ft) |
| 3 | 241 +(LM Y Position) | (100 ft) |
| 4 | 242 +(LM Z Position) | (100 ft) |
| 5 | 260 +(LM X Velocity) | (.1fps) |
| 6 | 261 +(LM Y Velocity) | (.1fps) |
| 7 | 262 +(LM Z Velocity) | (.1fps) |
| 8 | 254 +(LM Epoch Time) | (.1 min) |
| 9 | 414 +20000E Update State Vector | |
| 10 | 414R (+00000=Update Complete) | |
| 11 | RECORD CSM DATA AND TIME | |
| 12 | 244 +(CSM X Position) | (100 ft) |
| 13 | 245 +(CSM Y Position) | (100 ft) |
| 14 | 246 +(CSM Z Position) | (100 ft) |
| 15 | 264 +(CSM X Velocity) | (.1fps) |
| 16 | 265 +(CSM Y Velocity) | (.1fps) |
| 17 | 266 +(CSM Z Velocity) | (.1fps) |
| 18 | 272 +(CSM Epoch Time) | (.1 min) |
| 19 | 414 +30000E Update State Vector | |
| 20 | 414R (+00000=Update Complete) | |

Basic Date _____ October 6, 1969
Changed _____

LM-6

AGS MAN S.V.;
BACK-UP ALIGN

## BACK-UP RNDZ ALIGNMENT

1    Fly to 0° Roll, Z-Axis Toward CSM

2    400 +5

3    400 +0 DO NOT ENTER

4    When Wings Level (HORIZ REF) And Z-Axis
     Toward CSM Key ENTER And Note GET _____.

5    Coordinate with CSM To Adjust Ordeal
     (PITCH LM = 180° + PITCH CM)

6    Transmit GET of Align to MSFN

## BACK-UP STAR ALIGNMENT

1    MODE CONT: AGS - ATT HOLD

2    MNVR To Place Star Set In AOT (FWD DETENT)

3    Position Prime Star In Center of Reticle

4    DEADBAND - MIN

5    Rotate Reticle To Place Either +X,+Y Line
     on Star #2

6    400 +5E
     400 +0E

7    RECORD & Report To MSFN Star Set, ID Line
     AOT Counter
                    _____ (Star #1)
                    _____ (Star #2)
                    _____ (ID Line)
                    _____ (AOT Counter)

8    MNVR To FDAI Angles From MSFN

9    At New Attitude
     400 +5E
     400 +0E

AGS MAN S.V.;
BACK-UP ALIGN

LM-6

| | | V | | | | | V | | | | | V | | | PURP | |
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| INDEX | | | | | INDEX | | | | | INDEX | | | | | 1173 | 01 |
| | | | | | | | | | | | | | | | | 02 |
| | | | | | | | | | | | | | | | | 03 |
| | | | | | | | | | | | | | | | | 04 |
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| X | X | X | X | | | X | X | X | X | | | | | | | MIN |
| X | X | | | • | | X | X | | | • | | | | | NAV CHECK | SEC |
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Basic Date ____ October 6, 1969

Changed ____ ____

LM-6

## P27 UPDATE (LM)

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| INDEX | | | | | INDEX | | | | | INDEX | | | | 1173 | 01 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | 02 |
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| X | X | | | | X | X | | | | | | | | NAV CHECK SEC |
| | 0 | | | | | 0 | | | | | | | | N43 | LAT |
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Basic Date ___October 6, 1969___

Changed _____

LM-6

## P27 UPDATE (LM)

Basic Date __October 6, 1969__
Changed _____

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| | ⋮ | | ⋮ | | | | ⋮ | | ⋮ | | | | ⋮ | | ⋮ | GET |
| INDEX | | | | | INDEX | | | | | INDEX | | | | 1173 | 01 |
| | | | | | | | | | | | | | | | 02 |
| | | | | | | | | | | | | | | | 03 |
| | | | | | | | | | | | | | | | 04 |
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| | | | | | | | | | | | | | | | 23 |
| | | | | | | | | | | | | | | 1216 | 24 |
| X | X | X | | | | X | X | X | | | | | | N34 | HR |
| X | X | X | X | | | X | X | X | X | | | | | | MIN |
| X | X | | | | | X | X | | | | | | | NAV CHECK | SEC |
| | 0 | | | ⋮ | | | 0 | | | ⋮ | | | | N43 | LAT |
| | | | | ⋮ | | | | | | ⋮ | | | | | LONG |
| + | 0 | | | | ⋮ | + | 0 | | | | ⋮ | | | | ALT |
| INDEX | | | | | INDEX | | | | | INDEX | | | | | |

# P27 UPDATE (LM)

| | V | | | | V | | | | V | | | PURP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | :: | :: | | | :: | :: | | | :: | :: | | GET |
| INDEX | | | | INDEX | | | | INDEX | | | | 1173  01 |
| | | | | | | | | | | | | 02 |
| | | | | | | | | | | | | 03 |
| | | | | | | | | | | | | 04 |
| | | | | | | | | | | | | 05 |
| | | | | | | | | | | | | 06 |
| | | | | | | | | | | | | 07 |
| | | | | | | | | | | | | 10 |
| | | | | | | | | | | | | 11 |
| | | | | | | | | | | | | 12 |
| | | | | | | | | | | | | 13 |
| | | | | | | | | | | | | 14 |
| | | | | | | | | | | | | 15 |
| | | | | | | | | | | | | 16 |
| | | | | | | | | | | | | 17 |
| | | | | | | | | | | | | 20 |
| | | | | | | | | | | | | 1213  21 |
| | | | | | | | | | | | | 22 |
| | | | | | | | | | | | | 23 |
| | | | | | | | | | | | | 1216  24 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | | | | X | X | X | | | | N34 | HR |
| X | X | X | X | | | X | X | X | X | | | | MIN |
| X | X | | | | | X | X | | | | | NAV CHECK | SEC |
| | 0 | | | | | | 0 | | | | | N43 | LAT |
| | | | | | | | | | | | | | LONG |
| + | 0 | | | | | + | 0 | | | | | | ALT |

Basic Date ____ October 6, 1969 ____
Changed ____

LM-b

# P 30 LM MANEUVER

P30 UPDATE (LM)

| | | + | 0 | 0 | | | | + | 0 | 0 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE | | | | | | | | | | | | | |
| HR | N33 | + | 0 | 0 | | | | + | 0 | 0 | | | |
| MIN | TIG | + | 0 | 0 | 0 | | | + | 0 | 0 | 0 | | |
| SEC | | + | 0 | | | • | | + | 0 | | | • | |
| ΔVX | N81 | | | | | | • | | | | | | • |
| ΔVY | LOCAL | | | | | | • | | | | | | • |
| ΔVZ | VERT | | | | | | • | | | | | | • |
| HA | N42 | + | | | | | • | + | | | | | • |
| HP | | | | | | | • | | | | | | • |
| ΔVR | | + | | | | | • | + | | | | | • |
| BT | | X | X | X | | • | • | X | X | X | | • | • |
| R | FDAI | X | X | X | | | | X | X | X | | | |
| P | INER | X | X | X | | | | X | X | X | | | |
| ΔVX AGS | N86 | | | | | | • | | | | | | • |
| ΔVY AGS | | | | | | • | | | | | | | • |
| ΔVZ AGS | | | | | | | | | | | | | • |
| BSS | | X | X | X | | | | X | X | X | | | |
| SPA | | X | X | | | | • | X | X | | | | • |
| SXP | | X | X | X | | | • | X | X | X | | | • |

REMARKS:

**P30 LM MANEUVER**

<table>
<tr><td rowspan="2">P30 UPDATE (LM)</td></tr>
</table>

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE | | | | | | | | | | | | | |
| HR · · · · · · N33 | + | 0 | 0 | | | | | + | 0 | 0 | | | |
| MIN · TIG | + | 0 | 0 | 0 | | | | + | 0 | 0 | 0 | | |
| SEC | + | 0 | | | | • | | + | 0 | | | • | |
| ΔVX · · · · · · N81 | | | | | | • | | | | | | • | |
| ΔVY · · · LOCAL | | | | | | • | | | | | | • | |
| ΔVZ · · · · VERT | | | | | | • | | | | | | • | |
| HA · · · · · · N42 | + | | | | | • | | + | | | | • | |
| HP | | | | | | • | | | | | | • | |
| ΔVR | + | | | | | • | | + | | | | • | |
| BT | X | X | X | | • | | | X | X | X | | • | |
| R · · · · · · FDAI | X | X | X | | | | | X | X | X | | | |
| P · · · · · · INER | X | X | X | | | | | X | X | X | | | |
| ΔVX · AGS · N86 | | | | | | • | | | | | | • | |
| ΔVY · AGS | | | | | | • | | | | | | • | |
| ΔVZ · AGS | | | | | | • | | | | | | • | |
| BSS | X | X | X | | | | | X | X | X | | | |
| SPA | X | X | | | | • | | X | X | | | | • |
| SXP | X | X | X | | | • | | X | X | X | | | • |

REMARKS:

Basic Date  October 6, 1969
Changed

LM-

# P 30 LM MANEUVER

| PURPOSE | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HR            N33 | + | 0 | 0 | | | | | + | 0 | 0 | | | |
| MIN    TIG | + | 0 | 0 | 0 | | | | + | 0 | 0 | 0 | | |
| SEC | + | 0 | | | | • | | + | 0 | | | | • |
| ΔVX           N81 | | | | | | • | | | | | | | • |
| ΔVY        LOCAL | | | | | | • | | | | | | | • |
| ΔVZ         VERT | | | | | | • | | | | | | | • |
| HA            N42 | + | | | | | • | | + | | | | | • |
| HP | | | | | | • | | | | | | | • |
| ΔVR | + | | | | | • | | + | | | | | • |
| BT | X | X | X | | ⦂ | | | X | X | X | | ⦂ | |
| R            FDAI | X | X | X | | | | | X | X | X | | | |
| P            INER | X | X | X | | | | | X | X | X | | | |
| ΔVX   AGS   N86 | | | | | | • | | | | | | | • |
| ΔVY   AGS | | | | | | • | | | | | | | • |
| ΔVZ   AGS | | | | | | • | | | | | | | • |
| BSS | X | X | X | | | | | X | X | X | | | |
| SPA | X | X | | | | • | | X | X | | | | • |
| SXP | X | X | X | | | • | | X | X | X | | | • |

REMARKS:

# P 30 LM MANEUVER

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PURPOSE | | | | | | | | | | | | | | |
| HR · · · · · · · N33 | + | 0 | 0 | | | | | + | 0 | 0 | | | | |
| MIN · · TIG | + | 0 | 0 | 0 | | | | + | 0 | 0 | 0 | | | |
| SEC | + | 0 | | | • | | | + | 0 | | | • | | |
| ΔVX · · · · · N81 | | | | | | • | | | | | | | • | |
| ΔVY · · · · LOCAL | | | | | | • | | | | | | | • | |
| ΔVZ · · · · VERT | | | | | | • | | | | | | | • | |
| HA · · · · · · N42 | + | | | | | • | | + | | | | | • | |
| HP | | | | | | • | | | | | | | • | |
| ΔVR | + | | | | | • | | + | | | | | • | |
| BT | X | X | X | | • | | | X | X | X | | • | | |
| R · · · · · · FDAI | X | X | X | | | | | X | X | X | | | | |
| P · · · · · · INER | X | X | X | | | | | X | X | X | | | | |
| ΔVX · AGS · N86 | | | | | | • | | | | | | | • | |
| ΔVY · AGS | | | | | | • | | | | | | | • | |
| ΔVZ · AGS | | | | | | • | | | | | | | • | |
| BSS | X | X | X | | | | | X | X | X | | | | |
| SPA | X | X | | | | • | | X | X | | | | • | |
| SXP | X | X | X | | | • | | X | X | X | | | • | |

REMARKS:

Basic Date _____ October 6, 1969

Changed _____

LM-6

## AGS STATE VECTOR UPDATE

| | | | | | | | | | | | | PURP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 240 | |
| | | | | | | | | | | | | 241 | |
| | | | | | | | | | | | | 242 | |
| | | | | | | | | | | | | 260 | |
| | | | | | | | | | | | | 261 | |
| | | | | | | | | | | | | 262 | |
| + | | | | | | + | | | | | | 254 | |
| | | | | | | | | | | | | 244 | |
| | | | | | | | | | | | | 245 | |
| | | | | | | | | | | | | 246 | |
| | | | | | | | | | | | | 264 | |
| | | | | | | | | | | | | 265 | |
| | | | | | | | | | | | | 266 | |
| + | | | | | | + | | | | | | 272 | |

**REMARKS:**

# AGS STATE VECTOR UPDATE

| | | | | | | | | | | | | PURP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 240 | |
| | | | | | | | | | | | | 241 | |
| | | | | | | | | | | | | 242 | |
| | | | | | | | | | | | | 260 | |
| | | | | | | | | | | | | 261 | |
| | | | | | | | | | | | | 262 | |
| + | | | | | + | | | | | | | 254 | |
| | | | | | | | | | | | | 244 | |
| | | | | | | | | | | | | 245 | |
| | | | | | | | | | | | | 246 | |
| | | | | | | | | | | | | 264 | |
| | | | | | | | | | | | | 265 | |
| | | | | | | | | | | | | 266 | |
| + | | | | | + | | | | | | | 272 | |

**REMARKS:**

**AGS STATE VECTOR**

Basic Date ___ October 6, 1969 ___

Changed ___

LM-6

# AGS STATE VECTOR UPDATE

|  |  |  |  |  |  |  |  |  |  |  |  | PURP |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  |  | 240 |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 241 |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 242 |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 260 |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 261 |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 262 |  |
| + |  |  |  |  |  | + |  |  |  |  |  | 254 |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 244 |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 245 |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 246 |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 264 |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 265 |  |
|  |  |  |  |  |  |  |  |  |  |  |  | 266 |  |
| + |  |  |  |  |  | + |  |  |  |  |  | 272 |  |

REMARKS:

# AGS STATE VECTOR UPDATE

| | | | | | | | | | | | | PURP | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | 240 | |
| | | | | | | | | | | | | 241 | |
| | | | | | | | | | | | | 242 | |
| | | | | | | | | | | | | 260 | |
| | | | | | | | | | | | | 261 | |
| | | | | | | | | | | | | 262 | |
| + | | | | | + | | | | | | | 254 | |
| | | | | | | | | | | | | 244 | |
| | | | | | | | | | | | | 245 | |
| | | | | | | | | | | | | 246 | |
| | | | | | | | | | | | | 264 | |
| | | | | | | | | | | | | 265 | |
| | | | | | | | | | | | | 266 | |
| + | | | | | + | | | | | | | 272 | |

**REMARKS:**

# AGS STATE VECTOR UPDATE

|  |  |  |  |  |  |  |  |  |  |  |  | PURP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  |  | 240 |
|  |  |  |  |  |  |  |  |  |  |  |  | 241 |
|  |  |  |  |  |  |  |  |  |  |  |  | 242 |
|  |  |  |  |  |  |  |  |  |  |  |  | 260 |
|  |  |  |  |  |  |  |  |  |  |  |  | 261 |
|  |  |  |  |  |  |  |  |  |  |  |  | 262 |
| + |  |  |  |  |  | + |  |  |  |  |  | 254 |
|  |  |  |  |  |  |  |  |  |  |  |  | 244 |
|  |  |  |  |  |  |  |  |  |  |  |  | 245 |
|  |  |  |  |  |  |  |  |  |  |  |  | 246 |
|  |  |  |  |  |  |  |  |  |  |  |  | 264 |
|  |  |  |  |  |  |  |  |  |  |  |  | 265 |
|  |  |  |  |  |  |  |  |  |  |  |  | 266 |
| + |  |  |  |  |  | + |  |  |  |  |  | 272 |

**REMARKS:**

Basic Date _____ October 6, 1969

Changed _____

**VENUS HALF-UNIT VECTORS**

| GMT M:D:H | GET Hr | X vector | Y vector | Z vector | GMT M:D:H | GET Hr | X vector | Y vector | Z vector |
|---|---|---|---|---|---|---|---|---|---|
| 11:14:16 | 0 | -.40935 | -.26799 | -.10306 | 11:20:02 | 130 | -.37271 | -.31002 | -.12241 |
| 11:14:21 | 5 | -.40804 | -.26969 | -.10383 | 11:20:07 | 135 | -.37120 | -.31154 | -.12312 |
| 11:15:02 | 10 | -.40672 | -.27138 | -.10461 | 11:20:12 | 140 | -.36968 | -.31307 | -.12383 |
| 11:15:07 | 15 | -.40539 | -.27306 | -.10538 | 11:20:17 | 145 | -.36816 | -.31458 | -.12453 |
| 11:15:12 | 20 | -.40406 | -.27474 | -.10614 | 11:20:22 | 150 | -.36662 | -.31609 | -.12524 |
| 11:15:17 | 25 | -.40271 | -.27641 | -.10691 | 11:21:03 | 155 | -.36508 | -.31759 | -.12594 |
| 11:15:22 | 30 | -.40136 | -.27807 | -.10767 | 11:21:08 | 160 | -.36353 | -.31909 | -.12664 |
| 11:16:03 | 35 | -.40000 | -.27973 | -.10843 | 11:21:13 | 165 | -.36197 | -.32058 | -.12733 |
| 11:16:08 | 40 | -.39864 | -.28138 | -.10919 | 11:21:18 | 170 | -.36041 | -.32206 | -.12803 |
| 11:16:13 | 45 | -.39726 | -.28303 | -.10994 | 11:21:23 | 175 | -.35884 | -.32353 | -.12872 |
| 11:16:18 | 50 | -.39588 | -.28467 | -.11069 | 11:22:04 | 180 | -.35726 | -.32500 | -.12941 |
| 11:16:23 | 55 | -.39449 | -.28630 | -.11144 | 11:22:09 | 185 | -.35568 | -.32646 | -.13009 |
| 11:17:04 | 60 | -.39309 | -.28793 | -.11219 | 11:22:14 | 190 | -.35408 | -.32792 | -.13078 |
| 11:17:09 | 65 | -.39168 | -.28955 | -.11294 | 11:22:19 | 195 | -.35248 | -.32937 | -.13146 |
| 11:17:14 | 70 | -.39027 | -.29116 | -.11368 | 11:23:00 | 200 | -.35087 | -.33081 | -.13214 |
| 11:17:19 | 75 | -.38885 | -.29277 | -.11442 | 11:23:05 | 205 | -.34926 | -.33224 | -.13281 |
| 11:18:00 | 80 | -.38742 | -.29437 | -.11516 | 11:23:10 | 210 | -.34764 | -.33367 | -.13349 |
| 11:18:05 | 85 | -.38598 | -.29596 | -.11589 | [a]11:23:15 | 215 | -.34601 | -.33509 | -.13416 |
| 11:18:10 | 90 | -.38454 | -.29755 | -.11663 | [a]11:23:20 | 220 | -.34437 | -.33651 | -.13483 |
| 11:18:15 | 95 | -.38309 | -.29913 | -.11736 | [a]11:24:01 | 225 | -.34273 | -.33792 | -.13550 |
| 11:18:20 | 100 | -.38163 | -.30071 | -.11809 | [a]11:24:06 | 230 | -.34107 | -.33932 | -.13616 |
| 11:19:01 | 105 | -.38016 | -.30227 | -.11881 | [a]11:24:11 | 235 | -.33942 | -.34071 | -.13682 |
| 11:19:06 | 110 | -.37869 | -.30384 | -.11954 | [a]11:24:16 | 240 | -.33775 | -.34210 | -.13748 |
| 11:19:11 | 115 | -.37720 | -.30539 | -.12026 | [a]11:24:21 | 245 | -.33608 | -.34348 | -.13814 |
| 11:19:16 | 120 | -.37571 | -.30694 | -.12098 | [a]11:25:02 | 250 | -.33440 | -.34485 | -.13879 |
| 11:19:21 | 125 | -.37422 | -.30848 | -.12169 | | | | | |

[a]Planet is within 15 degrees of the sun

# PLANET VECTORS
## NOV 14

### MARS HALF-UNIT VECTORS

| GMT M:D:H | GET Hr | X vector | Y vector | Z vector |
|---|---|---|---|---|
| 11:14:16 | 0 | .30172 | -.35950 | -.17244 |
| 11:15:02 | 10 | .30387 | -.35803 | -.17172 |
| 11:15:12 | 20 | .30601 | -.35655 | -.17100 |
| 11:15:22 | 30 | .30814 | -.35506 | -.17027 |
| 11:16:08 | 40 | .31026 | -.35356 | -.16953 |
| 11:16:18 | 50 | .31237 | -.35205 | -.16879 |
| 11:17:04 | 60 | .31448 | -.35053 | -.16805 |
| 11:17:14 | 70 | .31657 | -.34900 | -.16730 |
| 11:18:00 | 80 | .31866 | -.34746 | -.16655 |
| 11:18:10 | 90 | .32073 | -.34591 | -.16579 |
| 11:18:20 | 100 | .32280 | -.34435 | -.16503 |
| 11:19:06 | 110 | .32485 | -.34278 | -.16427 |
| 11:19:16 | 120 | .32689 | -.34120 | -.16350 |
| 11:20:02 | 130 | .32892 | -.33961 | -.16273 |
| 11:20:12 | 140 | .33094 | -.33802 | -.16195 |
| 11:20:22 | 150 | .33295 | -.33641 | -.16118 |
| 11:21:08 | 160 | .33495 | -.33480 | -.16039 |
| 11:21:18 | 170 | .33693 | -.33318 | -.15961 |
| 11:22:04 | 180 | .33891 | -.33155 | -.15882 |
| 11:22:14 | 190 | .34087 | -.32991 | -.15803 |
| 11:23:00 | 200 | .34282 | -.32827 | -.15724 |
| 11:23:10 | 210 | .34476 | -.32662 | -.15644 |
| 11:23:20 | 220 | .34668 | -.32496 | -.15564 |
| 11:24:06 | 230 | .34860 | -.32329 | -.15484 |
| 11:24:16 | 240 | .35050 | -.32161 | -.15403 |
| 11:25:02 | 250 | .35239 | -.31993 | -.15322 |

### JUPITER HALF-UNIT VECTORS

| GMT M:D:H | GET Hr | X vector | Y vector | Z vector |
|---|---|---|---|---|
| 11:14:16 | 0 | -.45655 | -.19071 | -.07210 |
| 11:15:12 | 20 | -.45595 | -.19195 | -.07263 |
| 11:16:08 | 40 | -.45534 | -.19318 | -.07315 |
| 11:17:04 | 60 | -.45474 | -.19440 | -.07367 |
| 11:18:00 | 80 | -.45414 | -.19562 | -.07418 |
| 11:18:20 | 100 | -.45353 | -.19682 | -.07469 |
| 11:19:16 | 120 | -.45292 | -.19802 | -.07520 |
| 11:20:12 | 140 | -.45232 | -.19921 | -.07570 |
| 11:21:08 | 160 | -.45171 | -.20039 | -.07620 |
| 11:22:04 | 180 | -.45110 | -.20157 | -.07670 |
| 11:23:00 | 200 | -.45049 | -.20274 | -.07720 |
| 11:23:20 | 220 | -.44988 | -.20391 | -.07769 |
| 11:24:16 | 240 | -.44927 | -.20507 | -.07818 |

### SATURN HALF-UNIT VECTORS

| GMT M:D:H | GET Hr | X vector | Y vector | Z vector |
|---|---|---|---|---|
| 11:14:16 | 0 | .41333 | .26061 | .08988 |
| 11:16:18 | 50 | .41406 | .26558 | .08948 |
| 11:18:20 | 100 | .41480 | .26459 | .08910 |
| 11:20:22 | 150 | .41549 | .26363 | .08874 |
| 11:23:00 | 200 | .41616 | .26269 | .08840 |
| 11:25:02 | 250 | .41680 | .26179 | .08806 |

Basic Date __ ober 6, 1969
Changed __NOVEMBER 3, 1969

| VENUS HALF-UNIT VECTORS | | | |
|---|---|---|---|
| g.e.t., hr | X vector | Y vector | Z vector |
| 108.5 | -.37881 | -.30370 | -.11945 |
| 110.5 | -.37822 | -.30432 | -.11974 |
| 112.5 | -.37763 | -.30494 | -.12003 |
| 114.5 | -.37704 | -.30556 | -.12031 |
| 116.5 | -.37645 | -.30618 | -.12060 |
| 118.5 | -.37585 | -.30679 | -.12088 |
| 120.5 | -.37526 | -.30741 | -.12117 |
| 122.5 | -.37467 | -.30802 | -.12145 |
| 124.5 | -.37407 | -.30863 | -.12173 |
| 126.5 | -.37347 | -.30924 | -.12202 |
| 128.5 | -.37287 | -.30985 | -.12230 |
| 130.5 | -.37227 | -.31046 | -.12258 |
| 132.5 | -.37167 | -.31107 | -.12286 |
| 134.5 | -.37107 | -.31167 | -.12315 |
| 136.5 | -.37047 | -.31228 | -.12343 |
| 138.5 | -.36986 | -.31288 | -.12371 |
| 140.5 | -.36926 | -.31349 | -.12399 |
| 142.5 | -.36865 | -.31409 | -.12427 |
| 144.5 | -.36804 | -.31469 | -.12455 |

| JUPITER HALF-UNIT VECTORS | | | |
|---|---|---|---|
| GMT LO ___:___:___ | | | |
| g.e.t., hr | X vector | Y vector | Z vector |
| 108.5 | -.45323 | -.19739 | -.07493 |
| 120.5 | -.45288 | -.19810 | -.07523 |
| 132.5 | -.45252 | -.19881 | -.07552 |
| 144.5 | -.45216 | -.19951 | -.07582 |

# EARTH HALF-UNIT VECTORS

| g.e.t., hr | X vector | Y vector | Z vector | g.e.t., hr | X vector | Y vector | Z vector | g.e.t., hr | X vector | Y vector | Z vector |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 110.00 | -.49993 | .00176 | -.00856 | 121.00 | -.49676 | -.04550 | -.03409 | 132.00 | -.48792 | -.09192 | -.05905 |
| 110.50 | -.49991 | -.00041 | -.00973 | 121.50 | -.49648 | -.04764 | -.03524 | 132.50 | -.48739 | -.09400 | -.06016 |
| 111.00 | -.49988 | -.00256 | -.01089 | 122.00 | -.49619 | -.04977 | -.03638 | 133.00 | -.48685 | -.09608 | -.06128 |
| 111.50 | -.49984 | -.00472 | -.01206 | 122.50 | -.49589 | -.05189 | -.03753 | 133.50 | -.48629 | -.09816 | -.06239 |
| 112.00 | -.49978 | -.00688 | -.01323 | 123.00 | -.49557 | -.05402 | -.03868 | 134.00 | -.48572 | -.10023 | -.06350 |
| 112.50 | -.49972 | -.00903 | -.01439 | 123.50 | -.49525 | -.05615 | -.03982 | 134.50 | -.48515 | -.10230 | -.06461 |
| 113.00 | -.49964 | -.01119 | -.01556 | 124.00 | -.49491 | -.05827 | -.04096 | 135.00 | -.48456 | -.10437 | -.06572 |
| 113.50 | -.49955 | -.01334 | -.01672 | 124.50 | -.49456 | -.06039 | -.04210 | 135.50 | -.48396 | -.10643 | -.06683 |
| 114.00 | -.49944 | -.01549 | -.01789 | 125.00 | -.49420 | -.06251 | -.04324 | 136.00 | -.48334 | -.10849 | -.06793 |
| 114.50 | -.49933 | -.01765 | -.01905 | 125.50 | -.49382 | -.06462 | -.04438 | 136.50 | -.48272 | -.11055 | -.06903 |
| 115.00 | -.49920 | -.01980 | -.02021 | 126.00 | -.49344 | -.06674 | -.04552 | 137.00 | -.48209 | -.11261 | -.07013 |
| 115.50 | -.49907 | -.02195 | -.02138 | 126.50 | -.49304 | -.06885 | -.04666 | 137.50 | -.48144 | -.11466 | -.07123 |
| 116.00 | -.49892 | -.02409 | -.02254 | 127.00 | -.49263 | -.07096 | -.04779 | 138.00 | -.48079 | -.11670 | -.07232 |
| 116.50 | -.49875 | -.02624 | -.02370 | 127.50 | -.49221 | -.07307 | -.04892 | 138.50 | -.48012 | -.11875 | -.07342 |
| 117.00 | -.49858 | -.02839 | -.02485 | 128.00 | -.49178 | -.07517 | -.05005 | 139.00 | -.47944 | -.12079 | -.07451 |
| 117.50 | -.49839 | -.03053 | -.02601 | 128.50 | -.49134 | -.07728 | -.05118 | 139.50 | -.47875 | -.12283 | -.07560 |
| 118.00 | -.49820 | -.03268 | -.02717 | 129.00 | -.49089 | -.07938 | -.05231 | 140.00 | -.47805 | -.12486 | -.07669 |
| 118.50 | -.49799 | -.03482 | -.02832 | 129.50 | -.49042 | -.08147 | -.05344 | 140.50 | -.47734 | -.12689 | -.07777 |
| 119.00 | -.49777 | -.03696 | -.02948 | 130.00 | -.48994 | -.08357 | -.05456 | 141.00 | -.47662 | -.12892 | -.07885 |
| 119.50 | -.49753 | -.03910 | -.03063 | 130.50 | -.48946 | -.08566 | -.05569 | 141.50 | -.47589 | -.13094 | -.07994 |
| 120.00 | -.49729 | -.04123 | -.03179 | 131.00 | -.48896 | -.08775 | -.05681 | 142.00 | -.47515 | -.13296 | -.08101 |
| 120.50 | -.49703 | -.04337 | -.03294 | 131.50 | -.48845 | -.08984 | -.05793 | 142.50 | -.47439 | -.13498 | -.08209 |
|  |  |  |  |  |  |  |  | 143.00 | -.47363 | -.13699 | -.08316 |

Basic Date ___ October 6, 1969

Changed _ NOVEMBER 3, 1969

**Basic Date** October 6, 1969
**Changed** NOVEMBER 3, 1969

VENUS HALF-UNIT VECTORS

| GMT M:D:H | GET Hr | X vector | Y vector | Z vector |
|---|---|---|---|---|
| 11:16:19 | 0 | -.39659 | -.28400 | -.11045 |
| 11:17:00 | 5 | -.39420 | -.28703 | -.11140 |
| 11:17:05 | 10 | -.39240 | -.28826 | -.11234 |
| 11:17:10 | 15 | -.39133 | -.28984 | -.11309 |
| 11:17:15 | 20 | -.38994 | -.29143 | -.11383 |
| 11:17:20 | 25 | -.38856 | -.29310 | -.11457 |
| 11:18:01 | 30 | -.38713 | -.29470 | -.11531 |
| 11:18:06 | 35 | -.38569 | -.29629 | -.11604 |
| 11:18:11 | 40 | -.38424 | -.29787 | -.11678 |
| 11:18:16 | 45 | -.38279 | -.29945 | -.11751 |
| 11:18:21 | 50 | -.38133 | -.30103 | -.11824 |
| 11:19:02 | 55 | -.37986 | -.30259 | -.11897 |
| 11:19:07 | 60 | -.37838 | -.30415 | -.11968 |
| 11:19:12 | 65 | -.37690 | -.30571 | -.12040 |
| 11:19:17 | 70 | -.37541 | -.30725 | -.12112 |
| 11:19:22 | 75 | -.37391 | -.30880 | -.12184 |
| 11:20:03 | 80 | -.37240 | -.31033 | -.12255 |
| 11:20:08 | 85 | -.37089 | -.31186 | -.12326 |
| 11:20:13 | 90 | -.36937 | -.31338 | -.12397 |
| 11:20:18 | 95 | -.36784 | -.31489 | -.12468 |
| 11:20:23 | 100 | -.36631 | -.31640 | -.12538 |
| 11:21:04 | 105 | -.36477 | -.31790 | -.12608 |
| 11:21:09 | 110 | -.36321 | -.31939 | -.12678 |
| 11:21:14 | 115 | -.36166 | -.32088 | -.12747 |
| 11:21:19 | 120 | -.36009 | -.32236 | -.12817 |
| 11:22:00 | 125 | -.35852 | -.32383 | -.12886 |

| GMT M:D:H | GET Hr | X vector | Y vector | Z vector |
|---|---|---|---|---|
| 11:22:05 | 130 | -.35694 | -.32530 | -.12955 |
| 11:22:10 | 135 | -.35535 | -.32676 | -.13023 |
| 11:22:15 | 140 | -.35375 | -.32822 | -.13092 |
| 11:22:20 | 145 | -.35215 | -.32966 | -.13160 |
| 11:23:01 | 150 | -.35054 | -.33110 | -.13228 |
| 11:23:06 | 155 | -.34893 | -.33254 | -.13296 |
| 11:23:11 | 160 | -.34730 | -.33397 | -.13363 |
| *11:23:16 | 165 | -.34567 | -.33539 | -.13430 |
| *11:23:21 | 170 | -.34403 | -.33680 | -.13497 |
| *11:24:02 | 175 | -.34239 | -.33820 | -.13563 |
| *11:24:07 | 180 | -.34074 | -.33960 | -.13630 |
| *11:24:12 | 185 | -.33907 | -.34100 | -.13696 |
| *11:24:17 | 190 | -.33741 | -.34238 | -.13762 |
| *11:24:22 | 195 | -.33573 | -.34376 | -.13827 |
| *11:25:03 | 200 | -.33405 | -.34513 | -.13892 |
| *11:25:08 | 205 | -.33236 | -.34650 | -.13957 |
| *11:25:13 | 210 | -.33067 | -.34786 | -.14022 |
| *11:25:18 | 215 | -.32896 | -.34921 | -.14087 |
| *11:25:23 | 220 | -.32725 | -.35055 | -.14151 |
| *11:26:04 | 225 | -.32553 | -.35189 | -.14215 |
| *11:26:09 | 230 | -.32381 | -.35322 | -.14279 |
| *11:26:14 | 235 | -.32208 | -.35455 | -.14342 |
| *11:26:19 | 240 | -.32034 | -.35586 | -.14406 |
| *11:27:00 | 245 | -.31859 | -.35717 | -.14469 |
| *11:27:05 | 250 | -.31684 | -.35848 | -.14531 |

*Planet is within 1° degrees of the sun.

# PLANET VECTORS
## NOV 16

### MARS HALF-UNIT VECTORS

| GMT M:D:H | GET Hr | X vector | Y vector | Z vector |
|---|---|---|---|---|
| 11:16:19 | 0 | .31259 | -.35190 | -.16872 |
| 11:17:05 | 10 | .31469 | -.35037 | -.16797 |
| 11:17:15 | 20 | .31679 | -.34884 | -.16722 |
| 11:18:01 | 30 | .31887 | -.34730 | -.16647 |
| 11:18:11 | 40 | .32095 | -.34575 | -.16571 |
| 11:18:21 | 50 | .32301 | -.34419 | -.16495 |
| 11:19:07 | 60 | .32506 | -.34262 | -.16419 |
| 11:19:17 | 70 | .32710 | -.34104 | -.16342 |
| 11:20:03 | 80 | .32913 | -.33945 | -.16265 |
| 11:20:13 | 90 | .33115 | -.33785 | -.16187 |
| 11:20:23 | 100 | .33316 | -.33625 | -.16110 |
| 11:21:09 | 110 | .33515 | -.33463 | -.16031 |
| 11:21:19 | 120 | .33714 | -.33301 | -.15953 |
| 11:22:05 | 130 | .33911 | -.33138 | -.15874 |
| 11:22:15 | 140 | .34107 | -.32975 | -.15795 |
| 11:23:01 | 150 | .34302 | -.32810 | -.15715 |
| 11:23:11 | 160 | .34495 | -.32645 | -.15636 |
| 11:23:21 | 170 | .34688 | -.32479 | -.15556 |
| 11:24:07 | 180 | .34879 | -.32312 | -.15475 |
| 11:24:17 | 190 | .35069 | -.32144 | -.15395 |
| 11:25:03 | 200 | .35258 | -.31975 | -.15314 |
| 11:25:13 | 210 | .35446 | -.31806 | -.15232 |
| 11:25:23 | 220 | .35633 | -.31636 | -.15151 |
| 11:26:09 | 230 | .35818 | -.31465 | -.15069 |
| 11:26:19 | 240 | .36003 | -.31293 | -.14987 |
| 11:27:05 | 250 | .36186 | -.31121 | -.14904 |

### JUPITER HALF-UNIT VECTORS

| GMT M:D:H | GET Hr | X vector | Y vector | Z vector |
|---|---|---|---|---|
| 11:16:19 | 0 | -.45501 | -.19385 | -.07343 |
| 11:17:15 | 20 | -.45441 | -.19507 | -.07395 |
| 11:18:11 | 40 | -.45380 | -.19628 | -.07446 |
| 11:19:07 | 60 | -.45320 | -.19748 | -.07497 |
| 11:20:03 | 80 | -.45259 | -.19868 | -.07548 |
| 11:20:23 | 100 | -.45198 | -.19986 | -.07598 |
| 11:21:19 | 120 | -.45138 | -.20104 | -.07648 |
| 11:22:15 | 140 | -.45077 | -.20222 | -.07697 |
| 11:23:11 | 160 | -.45015 | -.20339 | -.07747 |
| 11:24:07 | 180 | -.44954 | -.20455 | -.07796 |
| 11:25:03 | 200 | -.44893 | -.20571 | -.07845 |
| 11:25:23 | 220 | -.44831 | -.20686 | -.07894 |
| 11:26:19 | 240 | -.44769 | -.20801 | -.07943 |

### SATURN HALF-UNIT VECTORS

| GMT M:D:H | GET Hr | X vector | Y vector | Z vector |
|---|---|---|---|---|
| 11:16:19 | 0 | .41410 | .26556 | .08948 |
| 11:18:21 | 50 | .41482 | .26457 | .08910 |
| 11:20:23 | 100 | .41551 | .26361 | .08874 |
| 11:23:01 | 150 | .41617 | .26267 | .08839 |
| 11:25:03 | 200 | .41681 | .26177 | .08805 |
| 11:27:05 | 250 | .41743 | .26088 | .08773 |

Basic Date October 6, 1969
Changed NOVEMBER 3, 1969

## VENUS HALF-UNIT VECTORS

| g.e.t., hr | X vector | Y vector | Z vector |
|---|---|---|---|
| 108.0 | -.36437 | -.31828 | -.12622 |
| 110.0 | -.36376 | -.31887 | -.12650 |
| 112.0 | -.36314 | -.31946 | -.12677 |
| 114.0 | -.36252 | -.32005 | -.12705 |
| 116.0 | -.36191 | -.32064 | -.12733 |
| 118.0 | -.36128 | -.32123 | -.12760 |
| 120.0 | -.36066 | -.32182 | -.12788 |
| 122.0 | -.36004 | -.32241 | -.12815 |
| 124.0 | -.35942 | -.32300 | -.12842 |
| 126.0 | -.35879 | -.32358 | -.12870 |
| 128.0 | -.35817 | -.32416 | -.12897 |
| 130.0 | -.35754 | -.32475 | -.12925 |
| 132.0 | -.35691 | -.32533 | -.12952 |
| 134.0 | -.35628 | -.32591 | -.12979 |
| 136.0 | -.35565 | -.32649 | -.13006 |
| 138.0 | -.35   | -.32707 | -.13033 |
| 140.0 | ..354   | -.32765 | -.13061 |
| 142.0 | ..     | -.32822 | -.13088 |
| 144.0 | -.     | -.32880 | -.13115 |

## JUPITER HALF-UNIT VECTORS

GMT LO ___:___:___

| g.e.t., hr | X vector | Y vector | Z vector |
|---|---|---|---|
| 108.0 | -.45180 | -.20021 | -.07612 |
| 120.0 | -.45144 | -.20091 | -.07641 |
| 132.0 | -.45108 | -.20161 | -.07670 |
| 144.0 | -.45072 | -.20230 | -.07700 |

EARTH HALF-UNIT VECTORS

| g.e.t., hr | X vector | Y vector | Z vector | g.e.t., hr | X vector | Y vector | Z vector | g.e.t., hr | X vector | Y vector | Z vector |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 108.0 | -.44449 | -.19770 | -.11556 | 119.0 | -.41822 | -.23757 | -.13662 | 130.0 | -.38762 | -.27460 | -.15605 |
| 108.5 | -.44339 | -.19956 | -.11655 | 119.5 | -.41692 | -.23932 | -.13754 | 130.5 | -.38614 | -.27621 | -.15689 |
| 109.0 | -.44229 | -.20143 | -.11754 | 120.0 | -.41561 | -.24106 | -.13845 | 131.0 | -.38464 | -.27781 | -.15773 |
| 109.5 | -.44117 | -.20329 | -.11852 | 120.5 | -.41429 | -.24279 | -.13937 | 131.5 | -.38314 | -.27941 | -.15856 |
| 110.0 | -.44005 | -.20514 | -.11950 | 121.0 | -.41296 | -.24452 | -.14028 | 132.0 | -.38163 | -.28100 | -.15939 |
| 110.5 | -.43892 | -.20699 | -.12048 | 121.5 | -.41163 | -.24625 | -.14118 | 132.5 | -.38011 | -.28258 | -.16022 |
| 111.0 | -.43777 | -.20883 | -.12145 | 122.0 | -.41028 | -.24797 | -.14209 | 133.0 | -.37859 | -.28416 | -.16104 |
| 111.5 | -.43662 | -.21067 | -.12243 | 122.5 | -.40893 | -.24968 | -.14298 | 133.5 | -.37705 | -.28573 | -.16186 |
| 112.0 | -.43546 | -.21250 | -.12339 | 123.0 | -.40757 | -.25138 | -.14388 | 134.0 | -.37551 | -.28729 | -.16267 |
| 112.5 | -.43429 | -.21433 | -.12436 | 123.5 | -.40620 | -.25308 | -.14477 | 134.5 | -.37396 | -.28885 | -.16348 |
| 113.0 | -.43311 | -.21615 | -.12532 | 124.0 | -.40482 | -.25478 | -.14566 | 135.0 | -.37240 | -.29040 | -.16429 |
| 113.5 | -.43192 | -.21796 | -.12628 | 124.5 | -.40343 | -.25646 | -.14655 | 135.5 | -.37084 | -.29194 | -.16509 |
| 114.0 | -.43072 | -.21977 | -.12724 | 125.0 | -.40204 | -.25814 | -.14743 | 136.0 | -.36927 | -.29348 | -.16589 |
| 114.5 | -.42951 | -.22158 | -.12819 | 125.5 | -.40063 | -.25982 | -.14831 | 136.5 | -.36769 | -.29501 | -.16669 |
| 115.0 | -.42829 | -.22338 | -.12914 | 126.0 | -.39922 | -.26149 | -.14918 | 137.0 | -.36610 | -.29653 | -.16748 |
| 115.5 | -.42706 | -.22517 | -.13008 | 126.5 | -.39780 | -.26315 | -.15005 | 137.5 | -.36451 | -.29804 | -.16827 |
| 116.0 | -.42583 | -.22696 | -.13103 | 127.0 | -.39637 | -.26480 | -.15092 | 138.0 | -.36290 | -.29955 | -.16905 |
| 116.5 | -.42458 | -.22874 | -.13197 | 127.5 | -.39493 | -.26645 | -.15178 | 138.5 | -.36129 | -.30105 | -.16983 |
| 117.0 | -.42333 | -.23052 | -.13290 | 128.0 | -.39349 | -.26810 | -.15264 | 139.0 | -.35968 | -.30255 | -.17061 |
| 117.5 | -.42206 | -.23229 | -.13384 | 128.5 | -.39203 | -.26973 | -.15350 | 139.5 | -.35805 | -.30403 | -.17138 |
| 118.0 | -.42079 | -.23406 | -.13477 | 129.0 | -.39057 | -.27136 | -.15435 | 140.0 | -.35642 | -.30551 | -.17215 |
| 118.5 | -.41951 | -.23582 | -.13569 | 129.5 | -.38910 | -.27298 | -.15520 | 140.5 | -.35478 | -.30698 | -.17291 |
| | | | | | | | | 141.0 | -.35314 | -.30845 | -.17367 |

**Basic Date** _ ober 6, 1969
**Changed** NOVEMBER 3, 1969

# Basic Date November 10, 1969
*Change November 11, 1969*

## STAR HALF-UNIT VECTORS

| Star number (octal) | X | Y | Z |
|---|---|---|---|
| 46 HAMAL | .39204 | .23901 | .19794 |
| 47 | .29402 | .32311 | -.24320 |
| 50 POLLUX | -.19246 | .39464 | .23551 |
| 51 | -.13002 | .11414 | -.46462 |
| 52 | -.22786 | .05905 | .44112 |
| 53 | -.32441 | -.05469 | -.37414 |
| 54 REGULUS | -.18904 | -.15521 | -.43609 |
| 55 DENEBOLA | .01396 | .49564 | .06442 |
| 56 | -.21408 | -.12572 | -.43401 |
| 57 BELLATRIX | .07877 | .49868 | .05507 |
| 60 | .06784 | .43377 | .23922 |
| 61 | .05509 | .49464 | -.01064 |
| 62 | .04520 | .49764 | -.01708 |
| 63 | -.04431 | .47362 | -.15401 |
| 64 | -.07498 | .47369 | .14139 |
| 65 | -.10854 | .42363 | -.24187 |
| 66 | -.12945 | .42856 | -.22168 |
| 67 CASTOR | -.16693 | .39001 | .26463 |
| 70 | -.14766 | .20720 | -.43043 |
| 71 | -.18991 | .21871 | -.40755 |
| 72 | -.27046 | -.23969 | -.41908 |
| 73 | -.24850 | -.25051 | -.43093 |
| 74 | -.27137 | -.06354 | .41511 |
| 75 | -.04936 | -.39581 | -.20149 |
| 76 | -.03957 | -.36365 | -.34988 |
| 77 | .03986 | -.41062 | -.28249 |
| 100 | .25750 | .00450 | .42051 |
| 101 | .36464 | .03084 | -.33754 |
| 102 | .38943 | .11414 | .25008 |
| 103 | .31910 | .18810 | .33577 |
| 104 | .06424 | .49585 | .00279 |
| 105 | .02937 | .49201 | -.06467 |
| 106 | .06413 | .35384 | .35322 |
| 107 | -.15441 | .40404 | -.24426 |
| 110 | -.19540 | .32997 | -.32084 |
| 111 | -.26488 | .24941 | -.34298 |
| 112 | -.19372 | .16767 | -.42925 |
| 113 | -.20627 | .27130 | .41715 |
| 114 | -.20777 | -.19107 | .48998 |
| 115 | -.09958 | -.39167 | .48129 |
| 116 | -.00554 | -.31126 | .39126 |

| Star number (octal) | X | Y | Z |
|---|---|---|---|
| 117 | .22075 | -.31191 | .22244 |
| 120 | .28932 | -.16193 | -.36631 |
| 121 | .32063 | -.11530 | -.36593 |
| 122 | .27293 | .04465 | .41433 |
| 123 | -.29470 | .00954 | .40380 |
| 124 | -.23342 | -.39848 | -.16165 |
| 125 | -.12736 | -.39323 | -.28133 |
| 126 | .48730 | .02467 | .12055 |
| 127 | -.33317 | -.38704 | -.31477 |
| 130 | .23289 | .38921 | .43336 |
| 131 | .41214 | .22140 | .17443 |
| 132 | .25259 | .38052 | .20348 |
| 133 | .22482 | .36063 | .26345 |
| 134 | .19772 | .32457 | .32089 |
| 135 | .11712 | .40904 | .37320 |
| 136 | .11547 | .48443 | -.04465 |
| 137 | .06716 | .46262 | -.17741 |
| 140 | .05923 | .47225 | -.15320 |
| 141 | .05637 | .49412 | -.05164 |
| 142 | .04906 | .46341 | .18021 |
| 143 | .03868 | .41227 | -.28024 |
| 144 | .00404 | .39418 | .30238 |
| 145 | -.06763 | .31023 | -.38625 |
| 146 | -.13007 | .37730 | -.30121 |
| 147 | -.23871 | .38853 | -.20510 |
| 150 | -.22129 | .18374 | -.40899 |
| 151 | -.42438 | .20149 | .17096 |
| 152 | -.30920 | .10425 | -.37865 |
| 153 | -.45775 | .09622 | .17664 |
| 154 | -.45476 | -.06555 | -.19722 |
| 155 | -.17729 | -.02759 | -.46670 |
| 156 | -.49223 | -.08710 | -.01122 |
| 157 | -.38035 | -.09241 | .31112 |
| 160 | -.47351 | -.12839 | .06643 |
| 161 | -.37808 | -.13456 | -.29780 |
| 162 | -.27183 | -.12344 | -.40094 |
| 163 | -.41732 | -.22483 | .15005 |
| 164 | -.30980 | -.23959 | .31084 |
| 165 | -.29108 | -.23070 | -.33474 |
| 166 | -.26002 | -.21803 | -.36722 |
| 167 | -.33604 | -.29128 | .22855 |
| 170 | -.35561 | -.32363 | -.13713 |

| Star number (octal) | | | |
|---|---|---|---|
| 171 | -.26236 | -.25469 | -.34109 |
| 172 | -.32474 | -.37156 | -.08057 |
| 173 | -.22537 | -.30218 | -.32847 |
| 174 | -.27996 | -.41034 | .05477 |
| 175 | -.22966 | -.38619 | -.21941 |
| 176 | -.22874 | -.41134 | -.16875 |
| 177 | -.09718 | -.21720 | .43975 |
| 200 | -.17997 | -.42840 | .16369 |
| 201 | -.16155 | -.41017 | -.23593 |
| 202 | -.17717 | -.45858 | -.05118 |
| 203 | -.14530 | -.40004 | .26241 |
| 204 | -.10694 | -.46934 | -.13521 |
| 205 | -.04576 | -.27045 | -.41708 |
| 206 | -.05413 | -.39414 | -.30281 |
| 207 | -.04275 | -.31052 | -.38720 |
| 210 | -.04022 | -.30295 | .36573 |
| 211 | -.03913 | -.49687 | .03951 |
| 212 | .03605 | -.43220 | -.24781 |
| 213 | .05134 | -.44850 | -.21478 |
| 214 | .11344 | -.41823 | -.24043 |
| 215 | .15488 | -.31743 | .35390 |
| 216 | .21709 | -.44103 | .05145 |
| 217 | .27376 | -.31718 | .27856 |
| 220 | .17572 | -.15026 | .44334 |
| 221 | .39955 | -.26559 | -.14003 |
| 222 | .22212 | -.10774 | -.43479 |
| 223 | .42788 | -.11003 | .23412 |
| 224 | .46814 | -.11832 | .12077 |
| 225 | .20630 | .11651 | -.44630 |
| 226 | .41167 | .28248 | -.02715 |
| 227 | .26013 | .27462 | .32658 |
| 230 | -.21684 | .16562 | -.41887 |
| 231 | -.20482 | .07265 | -.45030 |
| 232 | -.31753 | -.00942 | -.38612 |
| 233 | -.11849 | -.19051 | -.44684 |
| 234 | .13389 | -.46670 | .11942 |
| 235 | .13637 | -.44619 | -.17078 |
| 236 | -.22905 | -.44537 | -.03155 |

Basic Date November 10, 1969
Changed _____