

Attached are pages extracted from GSOP R-567, LUMINARY 1C, which have been updated to reflect LUMINARY 1D PCRs effected as of now.

This is a preliminary publication issued for information, evaluation, and comments. Formal publication of R-567, Program LUMINARY 1D is scheduled for April 1970.

The following PCRs were evaluated, and included in Sections 2, 3, 4, and 5 of GSOP as noted below:

	Section 2 Revision 8	Section 3 Revision 4	Section 4 Revision 8	Section 5 Revision 8
286 Format Change to Landing Site Update	*			
287 Removal of 526 Alarm in P22 and P20			**	**
821.2 Move AZO to Fixed Memory				**
872.2 Initiate TFI to P30s		NO CHANGES TO SECTION 3	**	
874.2 Change Decimal Load Technique			*	
892 Delete R29	*		*	*
896 LR Velocity Read Centered at PIPTIME			**	**
897 Delete PCR 775				*
898 LR Velocity Read	*		**	**
899 N38 in C/A, IS, and R/P Lists	*			
942 LR Update Cutoff			*	*
944 Read X-Pointer Input from CDU	*			
945 Descent Downlist	*			
970.2 Modify Gyro Torquing Routine				

* Reflected in this section of GSOP; preliminary change pages included.

** May impact this section, but changes not included since coding is as yet incomplete.

A blank space indicates that no change is required.

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1D

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APOLLO

GUIDANCE, NAVIGATION AND CONTROL

PRELIMINARY

R-567

Sections 2, 4, & 5

of GSOP

January 1970

MIT INSTRUMENTATION
LABORATORY
CAMBRIDGE 39, MASSACHUSETTS

PRELIMINARY

1D

SECTION 2 CHANGES

PRELIMINARY

Date: August 1969

REVISION INDEX COVER SHEET
GUIDANCE SYSTEM OPERATIONS PLAN

GSOP #R-567 Title: For Manned LM Earth Orbital and Lunar Missions
Using Program LUMINARY 1B (Rev. 116)

Section #2 Title: Data Links (Rev. 5)

This publication, a complete new revision (Rev. 5), incorporates revisions and additions as indicated below.

<u>PCR-LNY</u>	<u>Description of Change</u>
PCR 277	A fixed DUMPCNT.
PCR 279	Variable insertion computation with capability to abort at any time.
PCR 284	VGTIGs on C/A downlist.
PCR 802.2	Save alarm data after "error reset".
PCR 816	Modify R03 to permit astronaut setting of 1° deadband.
PCR 823	Delete P31 (Lambert aim point guidance program).
PCR 827	Add ZDOTD to Ascent/Descent downlist.
PCR 839	R12 and LR reposition routine improvements.
PCR 841	PGNCS derived vehicle attitude rates on FDAI error needles.
PCR 844	Deletion of P38/P78 and P39/P79.
LNY 89*	State vector integration in P00, P27.
LNY 90*	Response to V97 in P63.

* Anomaly.

Note: PCR 818 was completed with in Revision 5 but was inadvertently not so indicated in the list above.

R-567

Guidance System Operations Plan for Manned
LM Earth Orbital and Lunar Missions Using
Program LUMINARY 1C

Section 2 Data Links (Revision 7)

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tion routine is complete. A display of "27" in the program lights, along with a ground verification that BIT3 of FLAGWRD7 has been inverted and that the operator error light is "OFF", should indicate to the operator that the completion of P27 is temporarily being delayed.

After P27 is re-activated or if it initially finds that the integration routine is not in use, it will inhibit other routines from using State Vector data and complete the data verification requirements for the specific update Verb in use. (For each Verb, see appropriate verification section.)

2.1.1.2.1.1 Verb 70 Double Precision Time Verification

Program 27 verifies that the double precision octal time can be subtracted from the LGC clock without causing overflow. (For this operation two of the UPBUFF registers, UPBUFF+18D and 19D, are used as temporary buffers for TIME2 and TIME1.) If the double precision input time can be subtracted from the LGC clock without causing overflow, P27 proceeds to increment TEPHEM and decrement the LGC clock, the CSM State Vector time, and the LM State Vector time. Program 27 will then turn the uplink activity light "OFF", replace the downlink list code in DNLSTCOD with the code for the Coast and Align downlist, release the State Vector data for other routines, and reinstate the previous program.

If, on the other hand, an overflow would occur, P27 will leave the LGC clock intact and turn the operator error light "ON". It will then turn the uplink activity light "OFF", replace the downlink list code in DNLSTCOD with the code for the Coast and Align downlist, release the State Vector data, and reinstate the previous program.

2.1.1.2.2 Modify Some or All of the Update Data

If, during the verification time, some of the UPBUFF registers are found to be in error, the ground station may make corrections by either of the following methods:

- a. Individual parameters in UPBUFF+0 to UPBUFF+19D may be changed by sending a two digit octal identifier followed by the ENTER code. For example, if input word 2 (UPBUFF+1) required change, the ground station would transmit "02ENTER". This causes P27 to display the UPBUFF+1 address in R3 and flash V21N01, requesting a new octal data load from the ground. After transmission of the data and its ENTER code, P27 repeats the V21N02 flash to request data acceptance, modification or rejection (section 2.1.1.1.2). NOTE: If the octal identifier is ≤ 0 or $>$ COMPNUMB, P27 will continue the V21N02 flash and completely disregard the value just entered. It should also be noted that the contents of UP-COUNT is never changed during line-by-line correction.

If, however, COMPNUMB is valid, P27 will perform exactly as specified in the third paragraph of section 2.1.2.3.

2.1.4 LGC Octal Clock Increment

To initiate a double precision octal time increment, the ground station transmits "VERB73ENTER".

The loading procedure for this update is identical to the VERB70 update defined in section 2.1.1 except that 3 is placed in UPVERB instead of 0.

If the update data is acceptable, it is immediately used to increment the clock (i.e., positive double precision time is added to the clock). No delay is encountered if the orbital integration routine is in use since the registers that are used for the orbital integration routine are not modified.

2.1.5 Use of the Contiguous Block Update VERB

VERB 71, defined in section 2.1.2, can be used to perform the following updates:

1. LGC CSM/LM STATE VECTOR UPDATE
2. LGC DESIRED REFSMMAT UPDATE
3. LGC REFSMMAT UPDATE
4. LGC EXTERNAL DELTA V UPDATE
5. LGC LANDING SITE UPDATE

In defining each of these updates, it is assumed that the ground station has transmitted VERB71 ENTER and performed Program 27 verification as required prior to transmittal of the index value, ECADR and update parameters. It is also assumed that final verification of each update will be done as specified in section 2.1.2.3.

2.1.5.1 LGC CSM/LM STATE VECTOR UPDATE

This data consists of a single precision state vector identifier, three (3) double precision components of position, three (3) double precision components of velocity and a double precision time. The identifier (UPSVFLAG) indicates CSM or LM and whether coordinates are earth-centered or moon-centered as follows:

1 = CSM	}	earth-centered
-1 = LM		
2 = CSM	}	moon-centered
-2 = LM		

If a quantity other than 0, -0, 2 or -2 is loaded into UPSVFLAG, the data will also be interpreted as earth-centered. A 0 or -0 will update the UPSVFLAG erasable but the LGC will not perform a state vector update. In the other numeric cases a valid state vector update will be performed (earth-center).

The LGC CSM/LM STATE VECTOR UPDATE data must be sent in the following sequence:

<u>Octal Identifier</u>	<u>Data Value</u>	<u>Data Definition</u>
1	2 ₈	(index value) ENTER
2	(AAAA)*	(ECADR, UPSVFLAG) ENTER
3	XXXXX	(identifier) ENTER
4	XXXXX	(most sig. part of X position) ENTER
5	XXXXX	(least sig. part of X position) ENTER
6	XXXXX	(most sig. part of Y position) ENTER
7	XXXXX	(least sig. part of Y position) ENTER
10 ₈	XXXXX	(most sig. part of Z position) ENTER
11 ₈	XXXXX	(least sig. part of Z position) ENTER
12 ₈	XXXXX	(most sig. part of X velocity) ENTER
13 ₈	XXXXX	(least sig. part of X velocity) ENTER
14 ₈	XXXXX	(most sig. part of Y velocity) ENTER
15 ₈	XXXXX	(least sig. part of Y velocity) ENTER
16 ₈	XXXXX	(most sig. part of Z velocity) ENTER
17 ₈	XXXXX	(least sig. part of Z velocity) ENTER
20 ₈	XXXXX	(most sig. part of time from LGC clock zero) ENTER
21 ₈	XXXXX	(least sig. part of time from LGC clock zero) ENTER

2.1.5.2 LGC DESIRED REFSMMAT UPDATE

XSMO - XSMO + 17 is a 3 x 3 double precision matrix which represents the Reference to Stable Member Desired Transformation. Scaled 2⁻¹.

The LGC DESIRED REFSMMAT UPDATE must be sent in the following sequence:

<u>Octal Identifier</u>	<u>Data Value</u>	<u>Data Definition</u>
1	24 ₈	(index value) ENTER
2	(AAAA)*	(ECADR, XSMO) ENTER

* Refer to Paragraph 2.1.6 to obtain the absolute address (ECADR) for this UPDATE.

<u>Octal Identifier</u>	<u>Data Value</u>	<u>Data Definition</u>
3	XXXXX	(most sig. part of Row 1 Col. 1) ENTER
4	XXXXX	(least sig. part of Row 1 Col. 1) ENTER
5	XXXXX	(most sig. part of Row 1 Col. 2) ENTER
6	XXXXX	(least sig. part of Row 1 Col. 2) ENTER
7	XXXXX	(most sig. part of Row 1 Col. 3) ENTER
10 ₈	XXXXX	(least sig. part of Row 1 Col. 3) ENTER
11 ₈	XXXXX	(most sig. part of Row 2 Col. 1) ENTER
12 ₈	XXXXX	(least sig. part of Row 2 Col. 1) ENTER
13 ₈	XXXXX	(most sig. part of Row 2 Col. 2) ENTER
14 ₈	XXXXX	(least sig. part of Row 2 Col. 2) ENTER
15 ₈	XXXXX	(most sig. part of Row 2 Col. 3) ENTER
16 ₈	XXXXX	(least sig. part of Row 2 Col. 3) ENTER
17 ₈	XXXXX	(most sig. part of Row 3 Col. 1) ENTER
20 ₈	XXXXX	(least sig. part of Row 3 Col. 1) ENTER
21 ₈	XXXXX	(most sig. part of Row 3 Col. 2) ENTER
22 ₈	XXXXX	(least sig. part of Row 3 Col. 2) ENTER
23 ₈	XXXXX	(most sig. part of Row 3 Col. 3) ENTER
24 ₈	XXXXX	(least sig. part of Row 3 Col. 3) ENTER

2.1.5.3 LGC REFSMMAT UPDATE

REFSMMAT - REFSMMAT + 17D is a 3 x 3 double precision matrix used to convert from reference coordinates to stable member coordinates. The elements of the matrix are scaled, units/2¹.

The LGC REFSMMAT UPDATE must be sent in the following sequence:

<u>Octal Identifier</u>	<u>Data Value</u>	<u>Data Definition</u>
1	24 ₈	(index value) ENTER
2	(AAAA)*	(ECADR, REFSMMAT) ENTER
3	XXXXX	(most sig. part of Row 1 Col. 1) ENTER
4	XXXXX	(least sig. part of Row 1 Col. 1) ENTER
5	XXXXX	(most sig. part of Row 1 Col. 2) ENTER
6	XXXXX	(least sig. part of Row 1 Col. 2) ENTER
7	XXXXX	(most sig. part of Row 1 Col. 3) ENTER
10 ₈	XXXXX	(least sig. part of Row 1 Col. 3) ENTER
11 ₈	XXXXX	(most sig. part of Row 2 Col. 1) ENTER
12 ₈	XXXXX	(least sig. part of Row 2 Col. 1) ENTER
13 ₈	XXXXX	(most sig. part of Row 2 Col. 2) ENTER
14 ₈	XXXXX	(least sig. part of Row 2 Col. 2) ENTER
15 ₈	XXXXX	(most sig. part of Row 2 Col. 3) ENTER

* Refer to Paragraph 2.1.6 to obtain the absolute address (ECADR) for this UPDATE.

1D

<u>Octal Identifier</u>	<u>Data Value</u>	<u>Data Definition</u>
16 ₈	XXXXXX	(least sig. part of Row 2 Col. 3) ENTER
17 ₈	XXXXXX	(most sig. part of Row 3 Col. 1) ENTER
20 ₈	XXXXXX	(least sig. part of Row 3 Col. 1) ENTER
21 ₈	XXXXXX	(most sig. part of Row 3 Col. 2) ENTER
22 ₈	XXXXXX	(least sig. part of Row 3 Col. 2) ENTER
23 ₈	XXXXXX	(most sig. part of Row 3 Col. 3) ENTER
24 ₈	XXXXXX	(least sig. part of Row 3 Col. 3) ENTER

2.1.5.4 LGC EXTERNAL DELTA V UPDATE

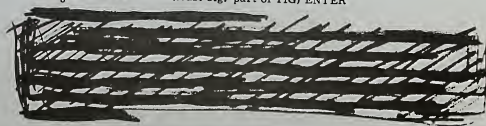
This data consists of three velocity components in local vertical coordinates and the time of ignition. The scale factors are as follows:

1. DELVSLV_{x,y,z} (meters/centisecond)/2⁷
2. TIG centiseconds/2²⁸

DELVSLV_{x,y,z} must be in a local vertical system at an origin which corresponds to the LM state (earth-centered or moon-centered) at TIG.

The LGC EXTERNAL DELTA V UPDATE data must be sent in the following sequence:

<u>Octal Identifier</u>	<u>Data Value</u>	<u>Data Definition</u>
1	12 ₈	(index value) ENTER
2	(AAAA)*	(ECADR, DELVSLV) ENTER
3	XXXXXX	(most sig. part of DELVSLV _x) ENTER
4	XXXXXX	(least sig. part of DELVSLV _x) ENTER
5	XXXXXX	(most sig. part of DELVSLV _y) ENTER
6	XXXXXX	(least sig. part of DELVSLV _y) ENTER
7	XXXXXX	(most sig. part of DELVSLV _z) ENTER
10 ₈	XXXXXX	(least sig. part of DELVSLV _z) ENTER
11 ₈	XXXXXX	(most sig. part of TIG) ENTER
12 ₈	XXXXXX	(least sig. part of TIG) ENTER



* Refer to Paragraph 2.1.6 to obtain the absolute address (ECADR) for this UPDATE.

PRELIMINARY

2.1.5.5

~~LGC LANDING SITE UPDATE~~

This data consists of the Landing Site Vector (X, Y, Z) in moon-fixed coordinates and the nominal time of landing referenced to the computer clock. The scale factors are as follows:

1. $RLS_{x,y,z}$ meters/ 2^{27}
2. TLAND centiseconds/ 2^{28}

The LGC LANDING SITE UPDATE may be sent in the following sequence:

Octal Identifier	Data Value	Data Definition
1	128	(index value) ENTER
2	(AAAA)*	(ECADR, RLS) ENTER
3	XXXXX	(most sig. part of RLS_x) ENTER
4	XXXXX	(least sig. part of RLS_x) ENTER
5	XXXXX	(most sig. part of RLS_y) ENTER
6	XXXXX	(least sig. part of RLS_y) ENTER
7	XXXXX	(most sig. part of RLS_z) ENTER
10 _B	XXXXX	(least sig. part of RLS_z) ENTER
11 _B	XXXXX	(most sig. part of TLAND) ENTER
12 _B	XXXXX	(least sig. part of TLAND) ENTER

* Refer to Paragraph 2.1.6 to obtain the absolute address (ECADR) for this UPDATE.

PRELIMINARY

2.1.6 Absolute Addresses for UPDATE Program

ABSOLUTE ADDRESSES FOR UPDATE PROGRAM

THIS SECTION PROVIDES ECADRS FOR SECTION 2 OF LUMINARY ^{1D} GSOP

ECADR	MNEMONIC
01501	ECADR UPSVFLAG
03606	ECADR XSMD
01733	ECADR REF5MMAT
03433	ECADR DELVSLV
02022	ECADR RLS
02023	ECADR RLS +1
02024	ECADR RLS +2
02025	ECADR RLS +3
02026	ECADR RLS +4
02027	ECADR RLS +5
02028 02030	ECADR TLAND
02029 02031	ECADR TLAND +1

PRELIMINARY

Word Number

Contents

39-44
(Cont'd)

Flagword

Bit

Meaning

0

3

FREEFLAG. Used as a temporary flag to control the internal logic of the following subroutines:

R54 - Used as a counter to control two passes through CHKSB which computes the star data check error. Set to 1 for first pass, set to 0 for second pass. Also used to indicate the response of the astronaut to the star data check display V06N05. Set to 1 if the astronaut performed PROCEED, V33E. Set to 0 if the astronaut performed RECYCLE, V32E.

R51 - Bit interrogated after R54 in P52. If bit is 1, gyro torquing (R55) is accomplished. If bit is 0, gyro torquing is bypassed and V50N25 R1 = 00014 is displayed.

P57 - GRAVITY VECTOR DETERMINATION routine is used to indicate astronaut response to error display. Bit is set to 0 if the astronaut performed PROCEED, and set to 1 if the astronaut performed RECYCLE.

P51 - Bit interrogated after R54. If bit is 1, the new REFSMMAT is computed and stored and the REFSMMAT flag is set. If bit is 0, P51 is started again and V50N25 R1 = 00015 is displayed.

LSPOS - Used as a counter to control two passes through POSITB. Bit is 0 for first pass, 1 for second pass.

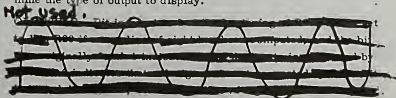
0

2

R10FLAG. Bit set to 1 during ascent (in P12, P70, and P71) to indicate that R10 only outputs data to altitude and altitude rate meters. Bit reset to 0 (initially and during descent) to indicate that R10 outputs data to the Forward and Lateral velocity cross-pointers, in addition to the altitude and altitude rate meters. Bit is checked in R10 (Landing Analog Displays) in order to determine the type of output to display.

0

1



1

15

NJETSFLG. Used for thrust determination in P41. Set in R03 (entered via V48) as follows: set to 1 if bit 11 of DAPDATR1 is 0, indicating that 2-jet X translation is specified; set to 0 if bit 11 of DAPDATR1 is 1, indicating 4-jet X translation.

Word Number39 - 44
(Cont'd)Contents

<u>Flagword</u>	<u>Bit</u>	<u>Meaning</u>
2	12	LOSCMFLG. A 1 means line-of-sight being computed during Radar Designate. A 0 means line-of-sight not being computed. Set to 0 when RR data good discrete (indicating lock-on) is received by the Radar Designate Routine. Set to 1 at the start of R21 RR Designate Routine. Set to 0 at the end of R21 when lock-on has been achieved. Set to 0 by V41N72 Designate, R24 Search Routine, and at the beginning of P20 or P22. Set to 1 by P20
2	11	STEERSW. Bit is set to 1 in SERVICER (P40 or P42) to indicate that cross-product steering computations are to be performed and the result loaded into communication cells with the DAP (if the MODE SELECT SWITCH is in AUTO). Bit is set to 0 when time-to-go (for a closed-loop guided burn, including predicted thrust decay) first drops below 4 seconds, or if bit 7 of FLAGWRD7 = 0 and the output of the accelerometers is below about 0, 12 m/sec (CSM-docked), 0, 36 m/sec (DPS), or 3, 08 m/sec (APS) (for the 2-second interval). Bit is set to 1 if the accelerometer output goes above these thresholds (if bit 7 FLAGWRD7 = 0). If bit is 0, only the required velocity is updated (no derivation of time-to-go or steering commands are performed). Bit is set to 1 in SERVICER (P12, P63 thru P66) but it is not looked at in P12, P66, and P70/P71. Set 0 in SERVICER in P12 and descent programs.
2	10	Not used.
2	9	IMPULSW. Bit set to 1 when a countdown to initiate engine (DPS or APS) cutoff is required (i. e. the value of time-to-go is known and is not to be updated further). The bit is set to 0 unconditionally at the start of S40, 13 (entered about 5 seconds before nominal ignition, and comprising the "short burn test and time-to-go predictor" routine), and is then set to 1 if it is concluded that the predicted burn duration is to be less than 6 seconds. (For DPS burns, a thrust level of approximately 10% is used.) The bit is set to 1 when time-to-go (for "long" burns) is less than 4 seconds; it is reset to 0 after being sensed (when the action to perform the engine cutoff has been initiated, so as to avoid double initiation).

Word NumberContents39-44
(Cont'd)

<u>Flagword</u>	<u>Bit</u>	<u>Meaning</u>
2	8	XDELVFLG. Set to 1 if an External Delta V burn is to be performed. Set to 0 if a Lambert burn is required. Set to 1 in P30 before N42 display. Set to 1 in P30 before N42 display. For P34, P35, P74, and P75 - set to 0 in subroutine S34/35.2. For P32/P72 and P33/P73 set to 1 in subroutine ADVANCE.
2	7	ETPIFLAG. A 1 means elevation angle supplied for P34, P74-compute TPI. A 0 means no elevation angle supplied for P34, P74-compute ELEV. Set to 0 initially in P34, P74. After ELEV has been input (V06N55), the bit is set to 1 if the ELEV input is non-zero.
2	6	FINALFLG. A 1 means last pass through rendezvous program computation. A 0 means interim pass through rendezvous program computation. Set to 0 by subroutine SELECTMU which is called at the start of P32 thru P35, and P72 thru P75 to perform initialization. Bit is set to 1 by P30. Set to 1 by subroutine VN1645 (which is called to perform calculations and display Noun 45 data) upon receipt of proceed to Noun 45 if FINALFLG not already set.
2	5	AVFLAG. Set to 1 if LM is active vehicle, set to 0 if CSM is active vehicle. Set to 1 in subroutine AVFLAGA which is called at the start of P32, P33, P34 and P35 to indicate that the LM is the active vehicle. Set to 1 in subroutine S40.9 and program P42. Set to 0 in subroutine AVFLAGP which is called at the start of P72, P73, P74 and P75.
2	4	PFRATFLG. Set to 1 if an IMU orientation matrix has been stored for the preferred IMU alignment option. Set to 1 in P40, P41, and P42 after computation of the "preferred IMU orientation" for engine ignition. Bit is reset to 0 in P52 after completion of coarse align and gyro torque coarse align, and at the end of re-align routine R51.
2	3	CALCMAN3. Set to 1 by the attitude maneuver routine (KALCMANU) to indicate that no gimbal lock avoidance (in going from the initial to final spacecraft attitude) is required. Since the checks for intermediate gimbal lock as well as the gimbal lock

1D

Word NumberContents39-44
(Cont'd)

<u>Flagword</u>	<u>Bit</u>	<u>Meaning</u>
2 (Cont'd)	3	avoidance feature have been removed, the bit should be 1 after the first maneuver computation and remain so (the final middle gimbal angle, THETAD+2 is checked and must be less than about 70° for the maneuver to be carried out).
2	2	CALCMAN2. A 1 means perform maneuver starting procedure (in KALCMANU). A 0 means bypass starting procedure. Set to 1 at the end of a large attitude calculation of maneuver parameters and reset after some computations concerning initial conditions for generation of the commands have been completed. Bit signifies that first iteration through the command generation equations is being performed; depending on phasing of the telemetry output with respect to the guidance computations, the 1 setting may or may not be observed on the downlink.
2	1	NODOFLAG. Set to 1 by R47, P76 P06, and P00 integration to inhibit selection of any new program except P00. Attempted selection of a new program other than P00 when the bit is 1 results in a program alarm (code 1520). Reset to 0 by P00, P76 and R47 when they are completed and by P06 when recovering from standby. Reset to 0 by POODOO routine.
3	15	POOHFLAG. Set to 1 in STATINT 1 as P00 integration is started to bypass backwards integration and perform check for 4 time-step criterion while P00 integration loop is going. Set to 0 in V37 logic.
3	14	GLOKFAIL. Set to 1 when CALCGA detects gimbal lock (alarm 401 occurs at the same time bit is set). Tested in IMU performance tests; if 1, PIPA test is done and GLOKFAIL is reset to 0. Also reset in R00.
3	13	REFSMFLG. Set to 1 if a meaningful REFSMMAT, reference to stable member matrix, is available, i.e. the alignment of the IMU is known in inertial (reference coordinate) space. Set to 1 after computation of REFSMMAT in the IMU orientation determination routine P51. Reset to 0 in the coarse align routine R50 and set to 1 on completion of R50 and on completion of gyro torque coarse align, after desired orientation is stored in REFSMMAT. Reset to 0 in gravity vector determination routine in P57. Reset to 0 in coarse align routine IMUCOARS. Set to 1 after desired orientation is stored in REFSMMAT after alignment is completed in P57.

STATINT

PRELIMINARY

Word NumberContents39-44
(Cont'd)

<u>Flagword</u>	<u>Bit</u>	<u>Meaning</u>
3	12	LUNAFLAG. Used in lat-long subroutine. A 1 means lunar lat-long. A 0 means earth lat-long. Set to 0 or 1 by routines that call lat-long subroutine.
3	11	Not used. [REDACTED]
3	10	VFLAG. Used in automatic star selection routine (R56) during IMU alignment program (P52). Set to 1 to indicate that a pair of stars are not in the AOT field-of-view. Set to 0 if pair of stars found. Initially set to 1 at beginning of R56 and is used temporarily for program control purposes.
3	9	Bit used for two distinct functions, hence assigned two separate mnemonics. R04FLAG. Set to 1 by Verb 63 entry to indicate R04 is running and set to 0 at the end of R04. Set to 0 by Verb 78 entry to indicate R77 is running, rather than R04, since the two routines use much of the same coding. Set to 0 in R00 (V37). Set to 0 in the beginning of P2/P22 in order that alarm 521 be sent if the radar cannot be read. Set to 1 by R65 before reading RR and set to 0 by R65 after reading RR. The bit is checked in the RADAREAD routine (which is used by R04 and P20/P22) if the radar cannot be read; if the bit is 1 (R04 is running), alarm 521 will not be sent.

~~[REDACTED]~~ that
~~[REDACTED]~~ setting
~~[REDACTED]~~
~~[REDACTED]~~ to

PRELIMINARY

Word NumberContents39-44
(Cont'd)FlagwordBitMeaning

9

13

P7071FLG. Set 1 near the beginning of P70 and P71 to indicate that the ascent guidance equations are operating in abort mode (i. e. explicit targeting) Pad-loaded 0. Tested as follows: near the beginning of Ascent Guidance Equations, if 1 compute needed ZDOTD; in middle of Ascent Guidance Equations, if 1 compute estimated pericyynthion radius (RP), in tipover segment of Ascent Guidance Equations.

9

12

FLPC. Bit is set to 1 in Ascent Guidance Equations when Time-to-go is less than 10 seconds. A 1 indicates that the pitch rate parameter is nulled, thereby releasing altitude control. Bit is assumed to be 0 in padload. A 0 indicates that the pitch rate parameter is a function of altitude and altitude rate. Bit is tested in guidance parameter computations.

9

11

FLPI. Bit is set to 1 in P12 initialization (pre-launch computation) to use Ascent Guidance Equations as a subroutine. A 1 indicates that program sequence will return to P12. Bit is reset to 0 immediately upon return from Ascent Guidance Equations. A 0 indicates that normal Ascent Guidance operation will be continued (call FINDCDUW). Bit is tested in Ascent Guidance Equations before call to FINDCDUW.

9

10

FLRCS. Bit is set to 1 when an engine cuts off while guidance is under control of Ascent Guidance Equations. A 1 indicates that the thrust-magnitude filter will be bypassed, and that the Ascent Guidance Equations will only be used to generate \underline{V}_{GB} . Bit is assumed to be 0 in padload. Bit is reset to 0 in P70, P71 initialization. A 0 indicates that the thrust-magnitude filter will be used (if ΔV is large enough), and that the normal mode of the guidance equations will be used. Bit is tested at the beginning of thrust-magnitude filter, and early in Ascent Guidance Equations.

9

9

LETABORT. Bit is set to 1 in P63 after ignition, permitting the calling of the abort programs P70 and P71. Bit is reset to 0 during P68, prohibiting any subsequent call to P70 or P71. Bit is also reset to 0 after a TERMINATE or PROCEED response to the V16N85 display following injection, and at the beginning of P71. Bit is tested at the beginning of P70, P71.

9

8

FLAP. This bit is examined by P71 in order to determine if it has been preceded by the P70 abort program. If P71 finds it set the abort will proceed using target initialization set up by P70. If P71 finds it reset then either P70 did not precede P71 or else the P70 target initialization had not been completed by the time P71 was selected. In this case, P71 performs the target initialization itself. P70 sets the bit to 1 when all target initialization is complete. P71 also sets the bit to 1 if it is required to do its own initialization but this has no real function.

1D

PRELIMINARY

VFAILFLG. Velocity fail test. Set 1 when corresponding radar reading has failed the LR data responsibility test. Bit is reset 0 when the corresponding radar reading has passed the responsibility test.

Word Number		Contents
39-44 (Cont'd)		
Flagword	Bit	Meaning
11	15	LRBYPASS. Bit is reset to 0 by P63 to permit R12 operation. R09, the "R10, R11, R12 service monitor", checks LRBYPASS and when it is 0, R12 is entered. When the bit is set to 1, R09 bypasses R12. This bit is set to 1 by R00 (V37) or by an abort (R11), insuring that R12 will be off when either P12, P70, or P71 is called.
11	14	[REDACTED]
11	13	[REDACTED]
11	12	VXINH. If the Z velocity component fails to pass the data reasonability test, the bit is set to 1 and the X velocity component is not updated with landing radar data. If the next velocity sample to pass the reasonability test is not an X component, the bit is reset to 0 and the data is accepted; X component data will be rejected, and then the bit will be reset to 0. This process prevents updating with questionable data caused by cross lobe lock-on on the X component.
11	11	PSTHIGAT. Bit is initially reset to 0. Bit is set to 1 when the criteria for repositioning the landing radar antenna are first met, and indicates that the antenna should be either repositioning or in position 2. Bit remains set for the duration of the landing.
11	10	NOLRREAD. Bit is set to 1 when PSTHIGAT is set to 1, to prevent reading the landing radar while the antenna is repositioning. Bit is reset to 0 after the antenna achieves position 2 and allows further readings. If the antenna does not achieve position 2, and the astronaut chooses to proceed without R12 (i. e. V34E response to flashing V05N09 alarm 00523), bit will remain set to 1 and therefore inhibit landing radar reading.
11	9	XORFLG. Bit is set to 1 when the LM estimated altitude first falls below 30K feet. At this point, R12 inhibits X axis override in the digital autopilot. Bit remains set to 1 for the duration of the landing. Its purpose is to prevent R12 from inhibiting X axis override in P65.

HFAILFLG. Altitude fail test. Set 1 when corresponding radar reading has failed the LR data responsibility test. Bit is reset 0 when the corresponding radar reading has passed the responsibility test.

<u>Word Number</u>		<u>Contents</u>
39-44 (Cont'd)		
<u>Flagword</u>	<u>Bit</u>	<u>Meaning</u>
11	8	LRINH. This bit is controlled by the astronaut. Bit is initially reset to 0 and therefore the landing radar data is read and tested but not incorporated into the state vector. Bit may be set to 1 via extended verb 57 to permit landing radar data incorporation into the state vector. Bit is reset to 0 via extended verb 58 to inhibit landing radar data incorporation. Bit may be reset to 0 after it has been set to 1 in V57.
11	7	VELDATA. Bit is set to 1 by the landing radar velocity read routine after a valid reading has been made. A 1 indicates that a landing radar velocity reading has been made and that the data is available. Bit is reset to 0 by R12 after the data is used. Bit has a limited value on the downlink because it is set and reset at least once during a two second interval; and, due to the fact that the downlink reads this bit at the same point during each pass, it may read exactly the same (either always set or always reset) on each pass.
11	6	LPOS2FLG. Set 1 in SETPOS2 to inform that position 2 transformation is being used. Reset 0 in fresh start and V37 logic. Also set 0 for abort or abort stage.
11	5	Not used. Bit is set to 1 when the 1st interval velocity estimate is less than 516 feet per second. When the bit is set to 1, it permits the data to be read and the data is available. When the data is available, the bit is set to 1. When the data is not available, the bit is reset to 0. When the data is available, the bit is set to 1. When the data is not available, the bit is reset to 0.
11	4	RNGEDATA. Bit is set to 1 by the landing radar altitude read routine after a valid reading has been made. A 1 indicates that a landing radar altitude reading has been made and that the data is available. Bit is reset to 0 by R12 after the data is used. Bit has a limited value on the downlink because it is set and reset at least once during a two second interval; and, due to the fact that the downlink reads this bit at the same point during each pass, it may read exactly the same (either always set or always reset) on each pass.

Word Number

62b, 63

Contents

FAILREG's, a set of three single-precision cells used to retain alarm pattern code information. They are all reset to 0 by a fresh start. FAILREG and FAILREG+1 are also reset to 0 by use of the "ERROR RESET" keycode. FAILREG contains the first alarm code received after the "ERROR RESET", FAILREG+1 contains the second, and FAILREG+2 will always contain the most recent alarm code. Octal quantities.

64a

RADMODES. A flagword associated with radar modes. A fresh start sets bits 7 and 2 to 1, sets bit 6 to the value of bit 6 of channel 33, and sets all other bits to 0.

Bit

Meaning

- 15 Continuous Designate. A 1 means that commands are issued by the LGC to the Rendezvous Radar without checking to see if lock-on is achieved. A 0 indicates that the LGC checks for lock-on when designating the antenna. Set to 1 by selection of the continuous designate option of Verb 41, RR Coarse Align, and RR Automatic Search Routine (R24). Set 0 by Verb 56 (Terminate Tracking), Verb 37 selection of P00, Verb 44 (Terminate RR Coarse Align), by answering the display (V16 N80) of R24, and by RR Monitor Routine (R25) if the RR mode changes from LGC to manual or off, i.e., if the RR auto mode discrete (Bit 2 of channel 33) changes from 0 to 1. Also set 0 at the start of P20, P22, and P12.
- 14 Remode. A 1 means that a change in the antenna mode has been requested or is in progress. A 0 indicates that no remode is requested. Set to 1 when the Radar Designate Routines (R21, R24, Verb 41) determine that a designate may be performed after a remode has been done, and by R21 when on the lunar surface (in P22). Set to 0 by the remode subroutine at the end of remodeling and by Verb 56 or a Verb 37 request for another program and by R25 when the RR auto-mode discrete changes from 0 to 1. ~~XXXXXXXXXXXXXXXXXXXX~~
- 13 RR CDU Zero. A 1 means that the RR CDUs are being zeroed. A 0 means that they are not being zeroed. A 1 inhibits an RR CDU fall from lighting the tracker fall light. Set to 1 by R25 when the RR auto-mode discrete changes from off/manual to on, and by Verb 40 with Noun 72. Set to 0 by the RR zero subroutine at the end of the CDU zero, by Verb 56 or a Verb 37 request for another program and by a change in the RR auto-mode discrete from 0 to 1.

PRELIMINARY

Word Number64a
(Cont'd)BitContentsMeaning

- 12 RR Antenna Mode. A zero means the antenna is in Mode I, a 1 indicates Mode II. The bit is set to the appropriate value by the RR turn-on sequence in R25 after an RR CDU zero, by the remode subroutine at the conclusion of a remode, and by a Verb 37 request for a new program.
- 11 Monitor Reposition. A 1 means that an RR reposition is taking place. A 0 means that no reposition is taking place. A 1 inhibits further checking of the antenna gimbal limits by R25. When a designate is possible and about to begin, a 1 in this bit delays the designate until the reposition is completed. If this bit is set to 1 during a designate operation, the designate is terminated with an error return (503 alarm). Set to 1 by the RR Monitor Routine (R25) when it detects the antenna gimbal angles outside the limits for the present mode. Set to 0 by the Reposition Routine at the end of the reposition, by Verb 56 or a Verb 37 request for another program and by R25 when the RR auto-mode discrete changes from on to off/manual. [REDACTED]
- 10 Designate. A 1 means that an RR designate has been requested or is in progress. A 0 indicates that a designate has not been requested nor is one in progress. Set to 1 at the start of a designate by R21, R24 or Verb 41. Set to 0 by Verb 44, by R21 when the designate is completed, by R24 when the V16 N80 display is answered, and by Verb 56. [REDACTED] Also set 0 at the start of P20, P22 and P12.
- 9 Landing Radar Altitude Scale. A 1 means that the landing radar altitude reading is on the high scale. A 0 means low scale. Set to the value in channel 33 bit 9 by R04 and R77 and each time the LR altitude is read.

<u>Word Number</u>	<u>Contents</u>
64b	DAPBOOLS. A flagword associated with the DAP. A fresh start sets DAPBOOLS to 21322 _g .

<u>Bit</u>	<u>Name</u>	<u>1 Meaning</u>	<u>0 Meaning</u>
15	PULSES	Minimum impulse command mode.	Not in minimum impulse command mode.
14	USEQRJTS	Gimbal unusable. Use jets only.	Gimbal may be used.
13	CSMDOCKD	CSM-DOCKED (Use backup DAP)	CSM not docked.
12	OURRCBIT	Still in rate command.	Not in rate command.
11	ACC4OR2X	4-Jet X-Axis translation requested.	2-Jet X-Axis translation requested.
10	AORBTRAN	B-System for X-translation.	A-System for X-translation.
9	LPDPHASE (XOVINHIB)	In LPD Phase (X-Axis over-ride locked out).	Not in LPD Phase.
8	DRIFTBIT	Assume zero offset. Drifting Flight.	Offset acceleration likely (DPS, APS).
7	RHCSCALE	Normal RHC scaling requested.	Fine RHC scaling requested.
6	ULLAGER	Internal Ullage request.	No internal ullage request.
5-4	DBSL2FLG DBSELECT	These bits used together to indicate astronaut-chosen deadband (5°, 1° or 0.3°).	
3	ACCSOKAY	Computed accelerations probably correct.	Computed accelerations probably incorrect.
2-1	AUTRATE2 [REDACTED] AUTRATE1	These bits are used together to indicate astronaut-chosen KALCMANU maneuver rates.	

Word NumberContents

- 64b (Cont'd) Bits 13, 11, 10, 7, 5, 4, 2, and 1 are changed only in R03. Bit 15 is set by V76 and P68. It is reset by V77, P63, P70, P71, R40 and at ignition of all burn programs (including P12, P40, P41, and P42). Bit 12 is under internal DAP control. Bit 3 is set by 1/ACCS, cleared by fresh start and restart.
- 65a POSTORKU. Running sum of positive torque commands about control axis U (RCS on-time multiplied by the number of jets used). POSTORKU will, in time, overflow and subsequently increase once more from zero (overflow does not go into sign bit). The scaling is such as to preclude more than one overflow per downlink cycle (2 sec) thus making the change from one reading to the next unambiguous. Calculated every 0.1 sec when DAP is running. Scaled jetseconds/32 (1 jetsecond is defined as 1 jet firing for 1 second).
- 65b NEGORKU. Running sum (always positive) of negative torque about control axis U. Calculated every 0.1 second when DAP is running. Scaled jetseconds/32.
- 66a POSTORKV. Running sum of positive torque about control axis V. Calculated every 0.1 second when DAP is running. Scaled jetseconds/32.
- 66b NEGORKV. Running sum (always positive) of negative torque about control axis V. Calculated every 0.1 second when DAP is running. Scaled jetseconds/32.
- 67 Spare. The first half of each spare contains 00000₈. The second half is ARUPT (the contents of the accumulator when the telemetry interrupt was recognized).
- 68 CDH TIME. The time of ignition of the CDH maneuver. Used in CDHMVR subroutine. Calculated each iteration of CSI/A subroutine in P32/P72. Input to P33/P73. Scaled centiseconds/2²⁸, referenced to computer clock.
- 69-71 DELTA VELOCITY (X, Y, Z) at CDH. In reference coordinates. Used to calculate ΔV_{CDH} in local vertical coordinates. Calculated each iteration of CDHMVR subroutine (once in P33/P73, possibly numerous times in P32/P72). Also calculated after the local vertical velocity is displayed in P33/P73 (regardless of whether or not overwrite occurs). Earth-centered if CMOONFLG is zero, moon-centered if CMOONFLG is one. Scaled (meters/centisecond)/2⁷.

<u>Word Number</u>	<u>Contents</u>
90a	POSTORKP. Running sum of positive torque about control axis P. Calculated every 0.1 second when DAP is running. Scaled jetseconds/32.
90b	NEGTOOKP. Running sum (always positive) of negative torque about control axis P. Calculated every 0.1 second when DAP is running. Scaled jetseconds/32.
91a	CHANNEL 11. Output channel. Bits are used to control engine on/off and for display parameter quantities. Set A by a fresh 20000₈ start. A restart zeroes all output channels by hardware means. The program associated with restart or processing of a V37 program change preserves the value of bits 14, 13 and 1 and sets remaining bits to 0. A restart then sets bit 13 to 1 if ENGONFLG (bit 7 of flagword 5) is 1 and sets bit 14 to 1 if ENGONFLG is 0.

<u>Bit</u>	<u>Meaning</u>
15	Not used.
14-13	Engine on-off. A 1 in bit 14 and a 0 in bit 13 turns off the descent (ascent) engine. A 0 in bit 14 and a 1 in bit 13 turns on the descent (ascent) engine. All other combinations are ignored.
12-11	Not used.
10	Caution Reset signal (for display system lights). A 1 indicates an Error Reset Key code (uplink or DSKY) has been received.
9	Used in hybrid simulation only.
8	Not used.
7	Operator Error Light. Set to 0 when an Error Reset Key code (uplink or DSKY) is received. Set to 1 if various procedures (mainly DSKY, such as illegal noun/verb combinations) are not performed properly.
6	Flash verb and noun lights. Set 1 to indicate that an operator action is required.

Word Number	Contents		Comments
	First Register	Second Register	
69.	VECTOR 1X	VECTOR 1X	associated with STAR ID1 stable member coord.
70.	VECTOR 1Y	VECTOR 1Y	
71.	VECTOR 1Z	VECTOR 1Z	
72.	VECTOR 2X	VECTOR 2X	associated with Star ID2 stable member coordinates.
73.	VECTOR 2Y	VECTOR 2Y	
74.	VECTOR 2Z	VECTOR 2Z	
75.	LR VEL X	LR VEL Y	
76.	LR VEL Z TET	LR VEL Z TET	Raw data
77.	RR SHAFT CDU	Actual PIPA X	Raw data
78.	Actual PIPA Y	Actual PIPA Z	
79.	RR Trunnion Error Counter	RR Shaft Error Counter	
80.	LM MASS	CSM MASS	
81.	IMODES 30	IMODES 33	
82.	TIG		
83.	Actual Body Rate X (OMEGAP)	Actual Body Rate Y (OMEGAQ)	Body Axes
84.	Actual Body Rate Z (OMEGAR)	Garbage	
85.	CDU XD	CDU YD	Internal CDUs desired
86.	CDU ZD	Garbage	
87.	Actual CDU X	Actual CDU Y	
88.	Actual CDU Z	RR TRUNNION CDU	
89.	Moment Offset Q	Moment Offset R	
90.	POSTORK P	NEGTORK P	
91.	Channel 11	Channel 12	
92.	Channel 13	Channel 14	
93.	Channel 30	Channel 31	
94.	Channel 32	Channel 33	
95.	DSPTAB + 0	DSPTAB + 1	
96.	DSPTAB + 2	DSPTAB + 3	
97.	DSPTAB + 4	DSPTAB + 5	
98.	DSPTAB + 6	DSPTAB + 7	
99.	DSPTAB + 8D	DSPTAB + 9D	
100.	DSPTAB + 10D	DSPTAB + 11D	

Word NumberContents

- 65-67 OGC, IGC, MGC. The X, Y, and Z gyro torquing angles computed in CALCGTA in P52, P57; counted down as gyros are torqued. During coarse align in CALCGA in P52, P57 the desired gimbal angles. Scaled degrees/360.
- 68 STAR IDs. 68a contains the star I.D. for the sighting vector in words 69-71. 68b contains the star I.D. for the sighting vector in words 72-74. Set during PICAPAR and after astronaut changes star number. These I.D.s will be the LGC catalogue number (Refer to Control Data section of this GSOP) multiplied by six. Scaled 2^{-14} .
- 69-71 STAR SIGHTING VECTOR 1(STARSAV1). During P52, P51 and Technique 2 of P57 STARSAV1 contains the 1st optics sighting vector. During Technique 0 of P57 it contains the Y spacecraft axis and the gravity vector during techniques 1 and 3. In stable member coordinates. Scaled 2^{-1} .
- 72-74 STAR SIGHTING VECTOR 2(STARSAV2). During P52, P51 and Techniques 2 and 3 of P57 STARSAV2 contains the 2nd optics sighting vector and contains the 1st sighting vector temporarily during sighting on the 2nd body. During P57 techniques 0 and 1, STARSAV2 contains the Z spacecraft axis. In stable member coordinates. Scaled 2^{-1} .
- 75 Repeat of word 25 of this list.
- 77a ACTUAL RR SHAFT CDU. RR shaft angle CDU counter. Defines RR antenna position (along with trunnion angle). Updated from RR CDUs as shaft angle changes. This register is an unsigned 15-bit fraction. The quantity is scaled degrees/360.
- 77b, 78 ACTUAL PIPAS (X, Y, Z). Velocity increments along the IMU Stable Member X, Y, and Z axes. Data is valid commencing at approximately 15 seconds after ISS Turn-on. Automatic increments when ISS is on. Zeroed every 2 seconds during powered flight. Zeroed after coarse alignment in P51, P52, and P57. Zeroed by NBDONLY (after reading) if SURFFLAG is set 1. In stable member coordinates. Scaled (centimeters/second)/ 2^{14} .
- 79 Repeat of word 29 of this list.
- 80-94 Same as words 80-94 on Orbital Maneuvers List.
- 95-100 Same as words 45-50 on Orbital Maneuvers List.
- 76 TET. Time of state vector being integrated or time to which last state vector was integrated. It is stepped by half-time-step increments, plus or minus, whenever integration is being done. Scaled, centi-seconds/ 2^{28} .

Word Number	Contents		Comments
	First Register	Second Register	
64.	RADMODES	DAPBOOLS	
65.	POSTORK U	NEGORK U	
66.	POSTORK V	NEGORK V	
67.	Spare	Spare	
68.	CDH Time	CDH Time	
69.	CDH Delta V_x	CDH Delta V_x	} DELVEET 2 Reference Coordinates
70.	CDH Delta V_y	CDH Delta V_y	
71.	CDH Delta V_z	CDH Delta V_z	
72.	TPI Time	TPI Time	
73.	TPI Delta V_x	TPI Delta V_x	} DELVEET 3 Reference Coordinates
74.	TPI Delta V_y	TPI Delta V_y	
75.	TPI Delta V_z	TPI Delta V_z	
76.	Elevation Angle	Elevation Angle	
77.	RR SHAFT CDU	Actual PIPA X	
78.	Actual PIPA Y	Actual PIPA Z	
79.	RR Trunnion Error Counter	RR Shaft Error Counter	
80.	LM Mass	CSM Mass	
81.	IMODES 30	IMODES 33	
82.	TIG	TIG	
83.	Actual Body Rate X (OMEGAP)	Actual Body Rate Y (OMEGAQ)	} Body Axes
84.	Actual Body Rate Z (OMEGAR)	Garbage	
85.	CDU XD	CDU YD	} Internal CDUs Desired
86.	CDU ZD	Garbage	
87.	Actual CDU X	Actual CDU Y	
88.	Actual CDU Z	RR TRUNNION CDU	
89.	Moment Offset Q	Moment Offset R	
90.	POSTORK P	NEGORK P	
91.	Channel 11	Channel 12	
92.	Channel 13	Channel 14	
93.	Channel 30	Channel 31	
94.	Channel 32	Channel 33	
95.	SPARE TET	SPARE TET	
96.	Central Angle	Central Angle	
97.	CDH APSIS	Garbage	
98.	CDH DELTA Altitude	CDH DELTA Altitude	
99.	TPF ΔV Magnitude	TPF ΔV Magnitude (DELV TPF)	
100.	Spare	Spare	

IV Descent/Ascent

Word Number	Contents		Comments
	First Register	Second Register	
1.	L. D. (77773 ₈)	Sync (77340 ₈)	
2.	[REDACTED] Spare	[REDACTED] Spare	
3.	[REDACTED] Spare	[REDACTED] Spare	
4.	[REDACTED] Spare	[REDACTED] Spare	[REDACTED]
5.	[REDACTED] Spare	[REDACTED] Spare	[REDACTED]
6.	[REDACTED] Spare	[REDACTED] Spare	[REDACTED]
7.	L R RANGE TIME	L R RANGE TIME	
8.	LR RANGE	L R RANGE	
9.	[REDACTED] LR VEL	[REDACTED] LR VEL ₂	[REDACTED]
10.	CDU Y (vehicle)	CDU Z (vehicle)	[REDACTED]
11.	CDU X (vehicle)	VELOCITY	[REDACTED]
12.	Lateral Vel.	Forward Vel.	[REDACTED]
13.	[REDACTED] Spare	[REDACTED] Spare	[REDACTED]
14.	Time of Event	Time of Event	
15.	Desired Thrust Axis Orientation X	Desired Thrust Axis Orientation X	} stable member coordinates
16.	Desired Thrust Axis Orientation Y	Desired Thrust Axis Orientation Y	
17.	Desired Thrust Axis Orientation Z	Desired Thrust Axis Orientation Z	
18.	VG VEC X	VG VEC X	} velocity-to-be-gained in stable member coordinates
19.	VG VEC Y	VG VEC Y	
20.	VG VEC Z	VG VEC Z	
21.	TTF/8	TTF/8	
22.	DELTA H	DELTA H	
23.	Landing Site Vector X comp.	Landing Site Vector X comp.	} moon fixed coordinates
24.	Landing Site Vector Y comp.	Landing Site Vector Y comp.	
25.	Landing Site Vector Z comp.	Landing Site Vector Z comp.	
26.	ZDOTD	ZDOTD	
27.	Delta Beta	Delta Beta	
28.	Delta Theta	Delta Theta	
29.	RR Trunnion Error Counter	RR Shaft Error Counter	
30.	REDO Counter	Final Desired CDU X (THETAD)	
31.	Final Desired CDU Y (THETAD+1)	Final Desired CDU Z (THETAD+2)	
32. *	RSBBQ	RSBBQ + 1	

PRELIMINARY

IV DESCENT/ASCENT LIST

Word Number

Contents

PCR 892, 898

1a I.D. word for this list. Will contain 77773₈.

1b Sync bits. Will contain 77340₈.

2-6 *Spares. See page 2-70 for definition.*

PCR 892

VSELECT. Indicates LR velocity (X, Y, or Z) which has been read. Changes after a different velocity component has been read. An integer. 2 indicates X, 1 indicates Y, 0 indicates Z.

LR VELOCITY. Velocity along one of the antenna axes (as indicated by VSELECT). Each is the sum of five readings. A different component is read every 2 seconds during LR velocity updates. Scaled (ft/sec)/(K x 2²⁸) where K = -0.6440 for X, K = 1.212 for Y, and K = 0.8668 for Z. Divide by 5 for average of readings.

7 LR RANGE TIME. Time of CDUs for LR Range Reading when R12 running. Scaled centi-seconds/2²⁸, referenced to computer clock.

8 LR RANGE (d.p.). Landing radar slant range. Scaled ft/(1.079 x 2²⁸). Always low scale. Calculated every 2 seconds during altitude updates.

10, 11a

CDUY, CDUZ, CDUX. The Y, Z, and X CDUs for LR Range Reading for R12 at LR Range Time. 15-bit fractions scaled degrees/360.

11b

12

LATVEL(12a)FORVEL(12b). Lateral and forward velocity. The orthogonal components of the horizontal velocity of the vehicle with respect to the moon, which are essentially parallel and perpendicular to the X-Z plane of the vehicle (for small pitch and roll angle displacements). It is scaled, (ft/sec)/(0.5571 x 2¹⁴) and is computed and displayed four times per second.

13

14

Spares. See page 2-70 for definition.

Same as word 14 on Orbital Maneuvers List.

PCR 944

PCR 892

Word NumberContents

- 15-17 DESIRED THRUST AXIS ORIENTATION. Defines the desired thrust axis orientation (X, Y, Z) in stable member coordinates. Input command for FINDCDUW. Calculated once every 2 seconds during powered flight. The magnitude of the vector is variable.
- 18-20 VG VEC (X, Y, Z). A stable member vector that indicates current velocity error. Scaled (meters/centisecond)/2⁷. Calculated every 2 sec. during P12 (after ignition), P70 and P71. Good for ascent and aborts, not good for descent.
- 21 TTF/8. Landing guidance time to go, negative in sign. The computed time to achievement of the target conditions currently being aimed for. Used in the guidance equations and as a basis for guidance phase switching. Calculated once every 2 seconds during P63 (after full throttle), and P64. Scaled centiseconds/2¹⁷. In P65 TTF/8 will continue to be modified, but for no functional reason. Approximately 2 seconds will be added to TTF/8 every pass through P65.
- 22 DELTAH. LR Altitude minus LGC altitude. Scaled meters/2²⁴. Calculated every 2 seconds during altitude updates.
- 23-25 LANDING SITE VECTOR(X, Y, Z). Landing site in moon-fixed coordinates. "LAND" is initialized from this vector (RLS) at the start of P63. HLS is recomputed after landing by P68 and is computed by P57 if the landing site determination option is selected. Otherwise except perhaps by uplink, it does not change. Scaled meters/2²⁷.
- 26 ZDOTD. The desired down-range velocity at injection. Garbage until P12 selection or until P70 or P71 selection. In P12 it is a constant (Loaded by astronaut via DSKY). In P70/P71 it is recomputed every 2 seconds. Scaled (meters/centisecond)/2⁷.
- 27-29 Same as words 27-29 on Rendezvous and Prethrust List.
- 30-66 Same as words 30-66 on Orbital Maneuvers List.
- 67-72 LM STATE VECTOR in GUIDANCE COORDINATES. Words 67-69 contain the position vector (X, Y, Z) scaled meters/2²⁴. Words 70-72 contain the velocity vector (X, Y, Z) scaled (meters/centisecond)/2¹⁰. Calculated once every 2 sec. during P63 (after full throttle), P64 and P65. Not good during ascent and aborts. ~~See word 67-69 on LM STATE VECTOR~~
- 73-75 POSITION OF LANDING SITE (LAND). Position vector (X, Y, Z) of current landing site in stable member coordinates. Updated for lunar rotation once every 2 seconds during P63 (after full throttle), P64 and P65. May be changed by astronaut redesignation during P64, and also by selection of N69. Scaled meters/2²⁴.

ID

PRELIMINARY

V. Lunar Surface Align

Word Number	Contents		Comments
	First Register	Second Register	
1.	I. D. (77772 ₈)	Sync (77340 ₈)	
2.	CSM State Vector (Rx)	CSM State Vector (Rx)	Reference Coordinates
3.	CSM State Vector (Ry)	CSM State Vector (Ry)	
4.	CSM State Vector (Rz)	CSM State Vector (Rz)	
5.	CSM State Vector (Vx)	CSM State Vector (Vx)	
6.	CSM State Vector (Vy)	CSM State Vector (Vy)	
7.	CSM State Vector (Vz)	CSM State Vector (Vz)	
8.	CSM State Vector Time	CSM State Vector Time	
9.	RR RANGE (RAW)	RR RANGE RATE (RAW)	at Mark Time
10.	CDU Y (Vehicle)	CDU Z (Vehicle)	
11.	CDU X (Vehicle)	Number of Marks	
12.	RR TRUNNION CDU	RR SHAFT CDU	
13.	MARKTIME	MARKTIME	
14.	TALIGN	TALIGN	
15.	REFSMMAT (R ₁ C ₁)	REFSMMAT (R ₁ C ₁) ^T	
16.	REFSMMAT (R ₁ C ₂)	REFSMMAT (R ₁ C ₂)	
17.	REFSMMAT (R ₁ C ₃)	REFSMMAT (R ₁ C ₃)	REFSMMAT
18.	REFSMMAT (R ₂ C ₁)	REFSMMAT (R ₂ C ₁)	3 x 3
19.	REFSMMAT (R ₂ C ₂)	REFSMMAT (R ₂ C ₂)	Matrix
20.	REFSMMAT (R ₂ C ₃)	REFSMMAT (R ₂ C ₃)	R = row, C = Column
21.	Y NAV Base Vector (1st comp)	Y NAV Base Vector (1st comp)	
22.	Y NAV Base Vector (2nd comp)	Y NAV Base Vector (2nd comp)	with respect to lunar - fixed coordinate system
23.	Y NAV Base Vector (3rd comp)	Y NAV Base Vector (3rd comp)	
24.	Z NAV Base Vector (1st comp)	Z NAV Base Vector (1st comp)	
25.	Z NAV Base Vector (2nd comp)	Z NAV Base Vector (2nd comp)	
26.	Z NAV Base Vector (3rd comp)	Z NAV Base Vector (3rd comp)	
27.	DELTA BETA	DELTA BETA	
28.	DELTA BETA TET	DELTA BETA TET	
29.	RR Trunnion Error Counter	RR Shaft Error Counter	
30.	REDO COUNTER	Final Desired CDUX (THETAD)	
31.	Final Desired CDU Y (THETAD+1)	Final Desired CDU Z (THETAD+2)	
32.	* RSBBQ	RSBBQ +1	
33.	Actual Body Rate X (OMEGAR)	Actual body rate Y (OMEGAQ)	} body axes
34.	Actual body rate Z (OMEGAR)	GARBAGE	
35.	CDUXD	CDUYD	} Internal CDUs Desired
36.	CDUZD	Garbage	
37.	Actual CDUX	Actual CDUY	
38.	Actual CDUZ	RR TRUNNION CDU	
39.	Flagword 0	Flagword 1	

V LUNAR SURFACE ALIGN LIST

<u>Word Number</u>	<u>Contents</u>
1a	I. D. word for this list. Will contain 77772 _g .
1b	Sync bits. Will contain 77340 _g .
2-8	Same as words 2-8 on Orbital Maneuvers List.
9-13	Same as words 9-13 on Rendezvous and Prethrust List.
14	TALIGN. Time to which a landing site or LM state vector is referenced for the landing site and nominal IMU alignment orientations during P52 and P57. Scaled centiseconds/2 ²⁸ , referenced to computer clock.
15-20	Same as words 15-20 on Orbital Maneuvers List.
21-23	Y NAV BASE VECTOR (X, Y, Z). Orientation of Y component of navigation base with respect to lunar-fixed coordinate system. Computed initially by P68. Computed with each P57 alignment if REFSMFLG (Bit 13 of flagword 3) is set 1. Unit vector. Scaled 2 ⁻¹ .
24-26	Z NAV BASE VECTOR (X, Y, Z). Orientation of Z component of navigation base with respect to lunar-fixed coordinate system. Computed initially by P68. Computed with each P57 alignment if REFSMFLG (Bit 13 of flagword 3) is set 1. Unit vector. Scaled 2 ⁻¹ .
27	Same as word 27 on Rendezvous and Prethrust List.
30-64	Same as words 30-64 on Orbital Maneuvers List.
65-74	Same as words 65-74 on Coast and Align List.
75-77	GRAVITY VECTOR. Defines direction of gravity with respect to body axes. Initially computed by P68. Recomputed with each technique 1 & 3 alignment in P57. Unit vector. Scaled 2 ⁻¹ .
78	Same as word 9 on Coast and Align List.
79	Same as word 79 on Coast and Align List.
80-98	Same as words 80-98 on Orbital Maneuvers List.
99-100	Spares. See page 2-70 for definition.
28	Same as word 76 on Coast and Align List.
29	Same as word 29 on Rendezvous and Prethrust List.

ORBITAL MANEUVERS LIST - Mnemonics

1D

For each word the mnemonic of the first register is given. The second register is always the register adjacent to the first.

1 I.D. and Sync	36 CDUZD	70 DELVEET2 +2
2 R-OTHER	37 CDUX	71 DELVEET2 +4
3 R-OTHER +2	(2nd reg is CDUY)	72 TTPI
4 R-OTHER +4	38 CDUZ	73 DELVEET3
5 V-OTHER	(2nd reg is CDUT)	74 DELVEET3 +2
6 V-OTHER +2	39 STATE	75 DELVEET3 +4
7 V-OTHER +4	40 STATE +2	76 DNRRANGE
8 T-OTHER	41 STATE +4	(2nd reg is DNRRDOT)
9 DELLT4	42 STATE +6	77 DNLRVELX
10 RTARG	43 STATE +8	(2nd reg is DNLRVELY)
11 RTARG +2	44 STATE +10D	78 DNLRVELZ
12 RTARG +4	45 DSPTAB	(2nd reg is DNLRALT)
13 ELEV	46 DSPTAB +2	79 DIFFALT
14 TEVENT	47 DSPTAB +4	80 LEMMASS
15 REFSMMAT	48 DSPTAB +6	(2nd reg is CSMMASS)
16 REFSMMAT +2	49 DSPTAB +8	81 IMODES30
17 REFSMMAT +4	50 DSPTAB +10D	(2nd reg is IMODES33)
18 REFSMMAT +6	51 TIME2	82 TIG
19 REFSMMAT +8	52 RN	83 OMEGAP
20 REFSMMAT +10D	53 RN +2	(2nd reg is OMEGAQ)
21 TCSI	54 RN +4	84 OMEGAR
22 DELVEET1	55 VN	85 CDUXD
23 DELVEET1 +2	56 VN +2	(2nd reg is CDUYD)
24 DELVEET1 +4	57 VN +4	86 CDUZD
25 VGTIG	58 PIPTIME	87 CDUX
26 VGTIG +2	59 OMEGAPD	(2nd reg is CDUY)
27 VGTIG +4	(2nd reg is OMEGAQD)	88 CDUZ
28 DNLRVELZ	60 OMEGARD	(2nd reg is CDUT)
(2nd reg is DNLRALT)	61 CADRFLSH	89 ALPHAQ
29 TPASS4	62 CADRFLSH +2	(2nd reg is ALPHAR)
30 REDOCTR	(2nd reg is FAILREG)	90 POSTORKP
(2nd reg is THETAD)	63 FAILREG +1	(2nd reg is NEGOTKP)
31 THETAD +1	64 RADMODES	91 Channels 11, 12
(2nd reg is THETAD +2)	(2nd reg is DAPBOOLS)	92 Channels 13, 14
32 RSBBQ	65 POSTORKU	93 Channels 30, 31
(2nd reg is RSBBQ +1)	(2nd reg is NEGORKU)	94 Channels 32, 33
33 OMEGAP	66 POSTORKV	95 PIPTIME1
(2nd reg is OMEGAQ)	(2nd reg is NEGORKV)	96 DELV
34 OMEGAR	67 SPARE	97 DELV +2
35 CDUXD	68 TCDH	98 DELV +4
(2nd reg is CDUYD)	69 DELVEET2	99 SPARE
		100 TGO

1D

COAST AND ALIGN LIST - Mnemonics

For each word the mnemonic of the first register is given. The second register is always the register adjacent to the first.

1	I.D. and Sync	35	CDUXD	71	STARSAV1 +4
2	R-OTHER		(2nd reg is CDUYD)	72	STARSAV2
3	R-OTHER +2	36	CDUZD	73	STARSAV2 +2
4	R-OTHER +4	37	CDUX	74	STARSAV2 +4
5	V-OTHER		(2nd reg is CDUY)	75	DNLRVELX
6	V-OTHER +2	38	CDUZ		(2nd reg is DNLRVELY)
7	V-OTHER +4		(2nd reg is CDUT)	76	OMEGAQD TET
8	T-OTHER	39	STATE		(2nd reg is STATE)
9	AGSK	40	STATE +2	77	CDUS
10	TALIGN	41	STATE +4		(2nd reg is PIPAX)
11	POSTORKU	42	STATE +6	78	PIPAY
	(2nd reg is NEGORKU)	43	STATE +8		(2nd reg is PIPAZ)
12	POSTORKV	44	STATE +10D	79	LASTXCMD
	(2nd reg is NEGORKV)	45	DSPTAB		(2nd reg is LASTXCMD)
13	DNRRANGE	46	DSPTAB +2	80	LEMMASS
	(2nd reg is DNRRDOT)	47	DSPTAB +4		(2nd reg is CSMMASS)
14	TEVENT	48	DSPTAB +6	81	IMODES30
		49	DSPTAB +8		(2nd reg is IMODES33)
15	REFSMMAT	50	DSPTAB +10D	82	TIG
16	REFSMMAT +2	51	TIME2	83	OMEGAP
17	REFSMMAT +4	52	RN		(2nd reg is OMEGAQ)
18	REFSMMAT +6	53	RN +2	84	OMEGAR
19	REFSMMAT +8	54	RN +4	85	CDUXD
20	REFSMMAT +10D	55	VN		(2nd reg is CDUYD)
21	AOTCODE	56	VN +2	86	CDUZD
22	RLS	57	VN +4	87	CDUX
23	RLS +2	58	PIPTIME		(2nd reg is CDUY)
24	RLS +4	59	OMEGAPD	88	CDUZ
25	DNLRVELX		(2nd reg is OMEGAQD)		(2nd reg is CDUT)
	(2nd reg is DNLRVELY)	60	OMEGARD	89	ALPHAQ
26	DNLRVELZ		(2nd reg is OMEGAR)		(2nd reg is ALPHAR)
	(2nd reg is DNLRALZ)	61	CADRFLSH	90	POSTORKP NEGOTK NEGOTKP
27	VTIG	62	CADRFLSH +2		(2nd reg is POSTORKP)
28	VTIG +2		(2nd reg is FAILREG)	91	Channels 11, 12
29	VTIG +4	63	FAILREG +1	92	Channels 13, 14
		64	RADMODES	93	Channels 30, 31
			(2nd reg is DAPBOOLS)	94	Channels 32, 33
30	REDOCTR	65	OGC	95	DSPTAB
	(2nd reg is THETAD)	66	IGC	96	DSPTAB +2
31	THETAD +1	67	MGC	97	DSPTAB +4
	(2nd reg is THETAD +2)	68	BESTI	98	DSPTAB +6
32	RSBBQ		(2nd reg is BESTJ)	99	DSPTAB +8
	(2nd reg is RSBBQ +1)	69	STARSAV1	100	DSPTAB +10D
33	OMEGAP	70	STARSAV1 +2		
	(2nd reg is OMEGAQ)				
34	OMEGAR				

PRELIMINARY

RENDEZVOUS AND PRETHRUST LIST - Mnemonics

1D

For each word the mnemonic of the first register is given. The second register is always the register adjacent to the first.

1	I.D. and Sync	35	CDUXD	70	DELVEET2 +2
2	R-OTHER		(2nd reg is CDUYD)	71	DELVEET2 +4
3	R-OTHER +2	36	CDUZD	72	TTPI
4	R-OTHER +4	37	CDUX	73	DELVEET3
5	V-OTHER		(2nd reg is CDUY)	74	DELVEET3 +2
6	V-OTHER +2	38	CDUZ	75	DELVEET3 +4
7	V-OTHER +4		(2nd reg is CDUT)	76	ELEV
8	T-OTHER	39	STATE	77	CDUS
9	RANGRDOT	40	STATE +2		(2nd reg is PIPAX)
	(2nd reg is RANGRDOT +1)	41	STATE +4	78	PIPAY
10	AIG	42	STATE +6		(2nd reg is PIPAZ)
	(2nd reg is AMG)	43	STATE +8	79	LASTYCMD
11	AOG	44	STATE +10D		(2nd reg is LASTXCMD)
	(2nd reg is TRMKCNT)	45	DSPTAB	80	LEMMASS
12	TANGNB	46	DSPTAB +2		(2nd reg is CSMMASS)
	(2nd reg is TANGNB +1)	47	DSPTAB +4	81	IMODES30
13	MKTIME	48	DSPTAB +6		(2nd reg is IMODES33)
14	DELLT4	49	DSPTAB +8	82	TIG
15	RTARG	50	DSPTAB +10D	83	OMEGAP
		51	TIME2		(2nd reg is OMEGAQ)
16	RTARG +2	52	RN	84	OMEGAR
17	RTARG +4	53	RN +2	85	CDUXD
18	DELVSLV	54	RN +4		(2nd reg is CDUYD)
19	DELVSLV +2	55	VN	86	CDUZD
20	DELVSLV +4	56	VN +2	87	CDUX
21	TCSI	57	VN +4		(2nd reg is CDUY)
22	DELVEET1	58	PIPTIME	88	CDUZ
23	DELVEET1 +2	59	OMEGAPD		(2nd reg is CDUT)
24	DELVEET1 +4		(2nd reg is OMEGAQD)	89	ALPHAQ
25	SPARE	60	OMEGARD		(2nd reg is ALPHAR)
26	TPASS4	61	CADRFSLH	90	POSTORKP
27	X789	62	CADRFSLH +2		(2nd reg is NEGOTK)
28	X789 +2		(2nd reg is FAILREG)	91	Channels 11, 12
29	LASTYCMD	63	FAILREG +1	92	Channels 13, 14
	(2nd reg is LASTXCMD)	64	RADMODES	93	Channels 30, 31
30	REDOCTR		(2nd reg is DAPBOOLS)	94	Channels 32, 33
	(2nd reg is THETAD)	65	POSTORKU	95	STET
31	THETAD +1		(2nd reg is NEGORKU)	96	CENTANG
	(2nd reg is THETAD +2)	66	POSTORKV	97	NN
32	RSBBQ		(2nd reg is NEGORKV)	98	DIFFALT
	(2nd reg is RSBBQ +1)	67	SPARE	99	DELVTFF
33	OMEGAP	68	TCDH	100	SPARE
	(2nd reg is OMEGAQ)	69	DELVEET2		
34	OMEGAR				

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PRELIMINARY

DESCENT/ASCENT LIST - Mnemonics

For each word the mnemonic of the first register is given. The second register is always the register adjacent to the first.

1	I.D. and Sync	34	OMEGAR	68	RGU +2
2	██████████ Spare	35	CDUXD	69	RGU +4
	██████████		(2nd reg is CDUYD)	70	VGU
3	██████████ Spare	36	CDUZD	71	VGU +2
4	██████████ Spare	37	CDUX	72	VGU +4
5	██████████ Spare		(2nd reg is CDUY)	73	LAND
6	██████████ Spare	38	CDUZ	74	LAND +2
7	MKTIME		(2nd reg is CDUT)	75	LAND +4
8	HMEAS	39	STATE	76	AT
9	██████████ VMEAS	40	STATE +2	77	TLAND
	██████████	41	STATE +4	78	FC
10	AIG	42	STATE +6	79	LASTYCMD
	(2nd reg is AMG)	43	STATE +8		(2nd reg is LASTXCMD)
11	AOG	44	STATE +10D	80	LEMMASS
	(2nd reg is VSELECT)	45	DSPTAB		(2nd reg is CSMMASS)
12	██████████	46	DSPTAB +2	81	IMODES30
	(2nd reg is LATVEL FORVEL)	47	DSPTAB +4		(2nd reg is 1MODES33)
13	██████████ Spare	48	DSPTAB +6	82	TIG
14	TEVENT	49	DSPTAB +8	83	OMEGAP
15	UNFC/2	50	DSPTAB +10D		(2nd reg is OMEGAQ)
16	UNFC/2 +2	51	TIME2	84	OMEGAR
17	UNFC/2 +4	52	RN	85	CDUXD
18	VGVECT	53	RN +2		(2nd reg is CDUYD)
19	VGVECT +2	54	RN +4	86	CDUZD
20	VGVECT +4	55	VN	87	CDUX
21	TTF/8	56	VN +2		(2nd reg is CDUY)
22	DELTAH	57	VN +4	88	CDUZ
23	RLS	58	PIPTIME		(2nd reg is CDUT)
24	RLS +2	59	OMEGAPD	89	ALPHAQ
25	RLS +4		(2nd reg is OMEGAQD)		(2nd reg is ALPHAR)
26	ZDOTD	60	OMEGAR	90	POSTORKP
27	X789	61	CADRFLSH		(2nd reg is NEGTOTKP)
28	X789 +2	62	CADRFLSH +2	91	Channels 11, 12
29	LASTYCMD		(2nd reg is FAILREG)	92	Channels 13, 14
	(2nd reg is LASTXCMD)	63	FAILREG +1	93	Channels 30, 31
30	REDOCTR	64	RADMODES	94	Channels 32, 33
	(2nd reg is THETAD)		(2nd reg is DAPBOOLS)	95	PIPTIME1
31	THETAD +1	65	POSTORKU	96	DELV
	(2nd reg is THETAD +2)		(2nd reg is NEGORKU)	97	DELV +2
32	RSBBQ	66	POSTORKV	98	DELV +4
	(2nd reg is RSBBQ +1)		(2nd reg is NEGORKV)	99	PSEUDO55
33	OMEGAP	67	RGU	100	TTOGO
	(2nd reg is OMEGAQ)				

PRELIMINARY

LUNAR SURFACE ALIGN LIST - Mnemonics

1D

For each word the mnemonic of the first register is given. The second register is always the register adjacent to the first.

1	I.D. and Sync	34	OMEGAR	69	STARSAV1
2	R-OTHER	35	CDUXD	70	STARSAV1 +2
3	R-OTHER +2		(2nd reg is CDUYD)	71	STARSAV1 +4
4	R-OTHER +4	36	CDUZD	72	STARSAV2
5	V-OTHER	37	CDUX	73	STARSAV2 +2
6	V-OTHER +2		(2nd reg is CDUY)	74	STARSAV2 +4
7	V-OTHER +4	38	CDUZ	75	GSAV
8	T-OTHER		(2nd reg is CDUT)	76	GSAV +2
9	RANGRDOT	39	STATE	77	GSAV +4
	(2nd reg is RANGRDOT +1)	40	STATE +2	78	AGSK
10	AIG	41	STATE +4	79	LASTYCMD
	(2nd reg is AMG)	42	STATE +6		(2nd reg is LASTXCMD)
11	AOG	43	STATE +8	80	LEMMASS
	(2nd reg is TRKMKCNT)	44	STATE +10D		(2nd reg is CSMMASS)
12	TANGNB	45	DSPTAB	81	IMODES30
	(2nd reg is TANGNB +1)	46	DSPTAB +2		(2nd reg is IMODES33)
13	MKTIME	47	DSPTAB +4	82	TIG
14	TALIGN	48	DSPTAB +6	83	OMEGAP
15	REFSMMAT	49	DSPTAB +8		(2nd reg is OMEGA'Q)
16	REFSMMAT +2	50	DSPTAB +10D	84	OMEGAR
17	REFSMMAT +4	51	TIME2	85	CDUXD
18	REFSMMAT +6	52	RN		(2nd reg is CDUYD)
19	REFSMMAT +8	53	RN +2	86	CDUZD
20	REFSMMAT +10D	54	RN +4	87	CDUX
21	YNBSAV	55	VN		(2nd reg is CDUY)
22	YNBSAV +2	56	VN +2	88	CDUZ
23	YNBSAV +4	57	VN +4		(2nd reg is CDUT)
24	ZNBSAV	58	PIPTIME	89	ALPHAQ
25	ZNBSAV +2	59	OMEGAPD		(2nd reg is ALPHAR)
26	ZNBSAV +4		(2nd reg is OMEGAQD)	90	POSTORKP
27	X789	60	OMEGAR		(2nd reg is NEGOTKQ)
	XXXXXXXXXX TET	61	CADRFLSH	91	Channels 11, 12
29	LASTYCMD	62	CADRFLSH +2	92	Channels 13, 14
	(2nd reg is LASTXCMD)		(2nd reg is FAILREG)	93	Channels 30, 31
30	REDOCTR	63	FAILREG +1	94	Channels 32, 33
	(2nd reg is THETAD)	64	RADMODES	95	PIPTIME1
31	THETAD +1		(2nd reg is DAPBOOLS)	96	DELV
	(2nd reg is THETAD +2)	65	OGC	97	DELV +2
32	RSBBQ	66	IGC	98	DELV +4
	(2nd reg is RSBBQ +1)	67	MGC	99	SPARE
33	OMEGAP	68	BESTI	100	SPARE
	(2nd reg is OMEGAQ)		(2nd reg is BESTJ)		

PRELIMINARY

AGS INITIALIZATION/UPDATE LIST - Mnemonics

For each word the mnemonic of the first register is given. The second register is always the register adjacent to the first.

1	I.D. and Sync	35	CDUXD	68	SPARE
2	AGSBUFF		(2nd reg is CDUYD)	69	AGSK
3	AGSBUFF +2	36	CDUZD	70	UPBUFF
4	AGSBUFF +4	37	CDUX	71	UPBUFF +2
5	AGSBUFF +12D		(2nd reg is CDUY)	72	UPBUFF +4
6	AGSBUFF +1	38	CDUZ	73	UPBUFF +6
7	AGSBUFF +3		(2nd reg is CDUT)	74	UPBUFF +8
8	AGSBUFF +5	39	STATE	75	UPBUFF +10D
9	AGSBUFF +13D	40	STATE +2	76	UPFUBB +12D
10	AGSBUFF +6	41	STATE +4	77	UPBUFF +14D
11	AGSBUFF +8	42	STATE +6	78	UPBUFF +16D
12	AGSBUFF +10D	43	STATE +8	79	UPBUFF +18D
13	AGSBUFF +12D	44	STATE +10D	80	LEMMASS
14	AGSBUFF +7	45	DSPTAB		(2nd reg is CSMMASS)
15	AGSBUFF +9	46	DSPTAB +2	81	IMODES30
16	AGSBUFF +11D	47	DSPTAB +4		(2nd reg is IMODES33)
17	AGSBUFF +13D	48	DSPTAB +6	82	SPARE
18	COMPNUMB	49	DSPTAB +8	83	OMEGAP
	(2nd reg is UPOLDMOD)	50	DSPTAB +10D		(2nd reg is OMEGAQ)
19	UPVERB	51	TIME2	84	OMEGAR
	(2nd reg is UPCOUNT)	52	RN	85	CDUXD
20	UPBUFF	53	RN +2		(2nd reg is CDUYD)
21	UPBUFF +2	54	RN +4	86	CDUZD
22	UPBUFF +4	55	VN	87	CDUX
23	UPBUFF +6	56	VN +2		(2nd reg is CDUY)
24	UPBUFF +8	57	VN +4	88	CDUZ
25	UPBUFF +10D	58	PIPTIME		(2nd reg is CDUT)
26	UPBUFF +12D	59	OMEGAPD	89	ALPHAQ
27	UPBUFF +14D		(2nd reg is OMEGAQD)		(2nd reg is ALPHAR)
28	UPBUFF +16D	60	OMEGARD	90	POSTORKP
29	UPBUFF +18D	61	CADRFLSH		NEGTOTKP
30	REDOCTR	62	CADRFLSH +2	91	Channels 11, 12
	(2nd reg is THETAD)		(2nd reg is FAILREG)	92	Channels 13, 14
31	THETAD +1	63	FAILREG +1	93	Channels 30, 31
	(2nd reg is THETAD +2)	64	RADMODES	94	Channels 32, 33
32	RSBBQ		(2nd reg is DAPBOOLS)	95	DSPTAB
	(2nd reg is RSBBQ +1)	65	POSTORKU	96	DSPTAB +2
33	OMEGAP		(2nd reg is NEGORKU)	97	DSPTAB +4
	(2nd reg is OMEGAQ)	66	POSTORKV	98	DSPTAB +6
34	OMEGAR		(2nd reg is NEGORKV)	99	DSPTAB +8
		67	SPARE	100	DSPTAB +10D

PRELIMINARY

SECTION 4 CHANGES

PRELIMINARY

required for loading the first component of whatever Noun is used therewith; Verb 22 loads the second component of the Noun; Verb 23, the third component; Verb 24, the first and second components of the Noun; and Verb 25 loads all three components of the Noun. A similar component format is used in the Display and Monitor Verbs.

When the decimal Display Verb is employed, all the component members of the Noun being used are scaled as appropriate, converted to decimal, and displayed in the data display registers.

Decimal data is identified by a + or - sign preceding the numerical characters. If decimal is used for loading data of any component members of a multi-component Load Verb, it must be used for all components of the Verb. Thus no mixture of decimal and octal data is permitted for different components of the same Load Verb. (If this is violated, the OPR ERR alarm is turned on.)

There is a class of verbs called Monitor Verbs which display data every one second. Once a Monitor Verb is executed, the data on the display panel continues to be updated until the Monitor is turned off.

The Monitor is turned off by: PRO, VERB 34 ENTR (terminate), and internal program initiation of the Keyboard and Display System Program, (if the DSKY is not busy) or by a Fresh Start of the LGC, or by a re-cycle verb, or a Restart.

Monitor action is suspended (but not ended) by the depression of any key, except RSET. This turns on the KEY RLSE light immediately. Monitor action continues after the Keyboard and Display System is released. Thus it is possible to suspend a monitor while the astronaut loads some data (or requests another display) and to return to the original monitor when his intervention is concluded.

After any use of the DSKY, the numerical characters (verb, noun and data words) remain visible until the next use of the DSKY. If a particular use of the DSKY involves fewer than 3 data words, the data display registers (R1, R2, R3) not used remain unchanged unless blanked by deliberate program action.

The DSKY procedures above were described for manual operation; however, the principles described remain the same for DSKY operation by the LGC Programs and Routines.

As outlined in the Mission Programs (sec. 4.4.9) the majority of DSKY operations are of the following categories:

- a) Display - to display data to the operator. Display Verbs present data computed by the mission program.
- b) Load - to request a data load as described in detail below.

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If an internal program attempts to use the Keyboard and Display System, but finds that the astronaut has used it and not yet released it, the KEY REL light is turned on. When the astronaut finds it convenient, he should strike the KEY REL button to allow the internal program to use the keyboard and display panel.

4.2.2.5 Display - Verb/Noun Flashing

This is an internally initiated action. The appropriate astronaut response to a flashing display Verb/Noun combination is:

- Correct the data (see Section 4.2.2.6 below). Perform the appropriate Load Verb sequence. Upon the final ENTR, the program proceeds normally.
- VERB 32 ENTR (recycle). This causes the program to return to a previous location.
- PRO. This indicates acceptance of the displayed data, and a desire for the internal sequence to continue normally.
- VERB 34 ENTR (terminate). The astronaut wishes to terminate the operation.

NOTE: Uncommon responses are defined in the program logic of Section 4.4.9.

4.2.2.6 Load - Verb/Noun Flashing

Whenever any data is to be loaded the Verb/Noun flashes. The flash occurs whether the data load is initiated by the LGC or by the astronaut. The appropriate data display register (R1, R2, or R3) is blanked in anticipation of the data load. Data is loaded in 5-character words and is displayed character-by-character in one of the 5-position data display registers as it is keyed in.

Numerical data is considered decimal if the [redacted] data word is preceded by a plus or minus sign; if no sign is supplied it is considered octal. The plus and minus keys are accepted only when they precede the first numerical character of the data word; they are ignored at any other time. [redacted]

[redacted] Octal data may be loaded with high order zeros suppressed. If decimal is used for any component of a multi-component Load Verb, it must be used for all components of that Verb. No mixing of octal and decimal data is permitted for different components of the same Load Verb. (If this principle is violated, the OPR ERR alarm is turned on.)

The ENTR key must be pressed after each data word. This tells the program that the numerical word punched in is complete. The flash is turned off after the last ENTR of a loading sequence.

As data is loaded, it is temporarily stored in buffers. It is not placed into its final destination, as specified by the Noun Code, until the final ENTR of the load sequence.

Both decimal and

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only to supply the data again; he need not attempt to re-execute the Verb/Noun combination. (Note, if decimal data is supplied for the address of a "machine address to be specified" noun, the alarm and recycle are performed at the ENTR immediately following the address keyed in.)

Violation of the following principles causes the OPR ERR light to be turned on, and a recycle to be performed:

- (a) The address keyed in for a "machine address to be specified" noun must be octal.
- (b) In multicomponent load verbs, no mixing of octal and decimal data is permitted. All the data words loaded for a given noun must either be all octal or all decimal.
- (c) Octal data must not be loaded into a "decimal only" noun.
- (d) Decimal data must not be loaded into an "octal only" noun.
- (e) Decimal data loaded must not numerically exceed the maximum permitted by the scale factor associated with the appropriate component of the noun.
- (f) All 3 words must loaded for the Hours, Minutes, Seconds scale.
- (g) When loading with the Hours, Minutes, Seconds scale, the minutes must not exceed 59; the seconds must not exceed 59.99; and the total magnitude must not exceed 745 hours, 39 minutes, 14.55 seconds.
- (h) Two numerical characters must be supplied for the Program Code under V37.

three

4.2.2.13 Operator Error and Key Rejection

There are three situations which cause the OPR ERR light to be turned on and the offending key depression to be simply rejected. These are:

(a) An attempt to ENTR a decimal data word having fewer than 5 numerical characters. The ENTR is simply rejected. The flash is lit on and the Verb Code is not advanced. Thus it is possible to supply the remaining characters and to press the ENTR again for the same data word. Or the CLR key may be used if the operator wished to begin loading the offending data word a new.

- (b) An 8 or 9 is punched while loading a word which was not preceded by a plus or minus sign. The 8 or 9 is simply rejected. The remaining characters may then be supplied or the offending word removed and its loading begun again.

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- (b) Certain program controlled cases (see Section 4.4.9).
- (g) An attempt to call one extended verb on top of another without allowing proper termination of the first.
- (d) The PRO button may not be pressed when the VERB lights contain verb 21, 22 or 23.

PCR 892 - "Delete R29"

The Routine "Powered Flight RR Designate Routine (R29)" has been deleted from the LUMINARY 1D Program. All references to this Routine have also been deleted. Those areas affected are as follows:

INDEX (Sections 4. 4. 1 and 4. 4. 10)
FLAG LIST (See attached)
P12
P63
R00
R04
R12 (See attached)
R20
R29 (Deleted)
R41
R77
V36
V40N72
V41N72
V59

4856,
4857,4858,
4859

DID FLAG	INERTIAL DATA AVAILABLE	REQUESTED CR IN PROGRESS	R10	R10	R10
DRIFT FLAG	GYRO LCP-PENSATION	PERFORM DATA DISPLAY INITIALIZATION	T30UPT	R05,R 30,R 31,R 76,V 85	P51,P52,P57,R00,R50
EXTENDED VERB FLAG	EXTENDED VERB IN PROGRESS	NO EXTENDED VERB PROGRESS		R76	P27,R03,R04,R05, P30,R31,R36,R47, R62,R63,V41,V42, V43,V55,V67,V85, V91,V92
EXTERNAL DELTA V FLAG	EXTERNAL DELTA V W COMP	LAMBERT VG COMP	TVC COMPUTATIONS	P30,P32,P33,P72,P73	P34,P35,P74,P75
FINAL FLAG	EDIT LAST PASS THROUGH REMS. CLMP.	INTERIM PASS THROUGH REMS. CLMP	P32,P33,P34,P35,P72, P73,P76,P75	P30,P32,P33,P34,P35, P72,P73,P74,P75	P32,P33,P34, P35,P72,P73, P74,P75
FIRST PASS FLAG	FIRST PASS CF R26	SUCCESSING PASS OF R26	R26	R26	R26
GIMBAL LOCK FLAG	GIMBAL LOCK	NOT GIMBAL LOCK			R00
H FLASH FLAG	FLASH LR ALTITUDE FAIL LAMP	DC ACT FLASH LR ALTITUDE FAIL LAMP	R09	R12	R00,R12
HIGATE FLAG	AFTER HIGATE	BEFORE HIGATE	R12	R12	R00
IDLE FLAG	EDIT NO DV MONITOR	CONNECT DV MONITOR	R40		P12,P40,P42,P7C,P71, R00,R40, FRESH START (VYEE)
IGNITION FLAG	TIG HAS ARRIVED	TIG HAS NOT ARRIVED			P12,P40,P41,P42, P63,R40
IMPULSE FLAG	MINIMUM IMPULSE BURR (C/C SET)	STEERING BURR (C/C NOT SET)	P12,P40,P42,P63,R40	P12,P40,P41,P42,P63, R40	P12,P40,P41,P42, P63,R40
IMUSE FLAG	IMU IN USE	IMU NOT IN USE	R47		P40,P42
INERTIAL DATA DISCRETE FLAG	AK CIGUS IN USE FOR INERTIAL DATA DISPLAY	RF CIGUS NOT IN USE FOR INERTIAL DATA DISPLAY	R10		P06,R00,R56
INITIAL ALIGN FLAG	INITIAL PASS	SECOND PASS OF P57	P57		K10
LANDING ANALOG DISPLAYS	LANDING ANALOG	LANDING ANALOG	R10	P12,P63	P57 P68,R00

PRELIMINARY

FLAG	DISPLAYS NOT ENABLED	015PLAYS NOT ENABLED			
LOCK-ON FLAG	EDIT RADAR LOCK-UN DESIRED	RACAR LOCK-CN NOT DESIRED	V41N72	R21, V41N72	R21, R26, W41N72
LOG2H	892 LCS BEING COMPUTED	LCS NOT BEING COMPUTED	R21	R21	P20, P22, R21, R24, V41N72
LPDSE FLAG	LSE LR POSITION, 2 TRANSFORMATION	USE LR POSITION, 1 TRANSFORMATION	R12	R12	ROD
LR BYPASS FLAG	EDIT BYPASS LR UPDATES	DC NOT BYPASS LR UPDATES	R04, R12, R20, R71, V59, V4DN72, W41N72	P68, P70, P71, ROD, FRESH START (V36E1)	P63
LR PERMIT FLAG	942 LR UPDATES PERMITTED BY ASTRONAUT	LR UPDATES NOT PERMITTED BY ASTRONAUT	R12	V57	ROD, V57, V59, R12
LR POSITION DATA FAIL FLAG	LR ALTITUDE DATA FAIL	NO LR ALTITUDE DATA FAIL	R12	R20	R20
LR POSITION FLAG	LR POSITION #1 DESIRED	LR POSITION #1 DESIRED	R20	R04, R12, R77, V60	R04, R77
LR VELOCITY DATA FAIL FLAG	LR VELOCITY DATA FAIL	NO LR VELOCITY DATA FAIL	R12	R20	R20
MANUAL ACQUIRE FLAG	MANUAL ACQUIRE BY REND. RADAR	AUTO ACQUIRE BY REND. RADAR	P20, P22	P20	P20, P22
MARK IN PROGRESS FLAG	MARK IN PROGRESS INHIBITED	NO MARK IN PROGRESS	R53, R76	R53	R53
MARK IMPLT INHIBIT FLAG	MARK PROCESSING INHIBITED	MARK PROCESSING ALLOWED	R57	R53	R53
MARK PAIR FLAG	PAIR COMPLETE, NEXT MARK STARTS NEW PAIR	PAIR IN PROCESS, MARKS NOW WILL BE REJECTED	R57	P57	R53, R57
MARK REJECT FLAG	MARK MADE AND WILL BE CLEARED BY REJECT	BOTH MARKS WILL BE CLEARED BY REJECT	R57	R57	R53, R57
MID 1 FLAG	EDIT INTEGRATE STATE TO TCECL	INTEGRATE STATE TC PRESENT TIME	R41	R41	R53, R57
MUMFLAG	SERVICE# CALLS MUMNG	SERVICE# CALLS CALC RWG	R25	P12, P63	ROD
NEEDLE FLAG	TOTAL ATTITUDE ENGRJ DISPLAYED	A/P FOLLOWING ENGRJ DISPLAYED	DAP	R60, V62	V61, FRESH START (V36E1)
NEED2PLG	EDIT VEHICLE ATTITUDE RATES DISPLAYED	VEHICLE ATTITUDE RATES NOT DISPLAYED	DAP	V60	R60, V61, V62, FRESH START (V36E1)

PRELIMINARY

FLAG/LUMINARY

ID

NEW TARGET FLAG	ASTRONAUT DID NOT CYBERMATE DELAY	P 34, P 35, P 74, P 75	P 34, P 35, P 74, P 75	
NO S11 FLAG	DC NCT TEST LR ANTENNA POSITION AFTER F-GATE IN R12	R12	R12	FRESH START (V36E)
NC OD VERE 37 FLAG	863 V37 NOT ALLOWED EDIT	R00	P06, P76, R47	P06, P76, R00, R47
NC MARKS ALLCALL FLAG	MARKS NOT ALLOWED (ATTENDED VERB ACTIVE)	R53, R76	R76	P27, R03, R04, R05, R30, R31, R36, R67, R62, R63, V41, V42, R31, V55, V67, V85, V91, V92
NO LR REAC FLAG	LR REPUIS- TICKING	R12	R12	R00, R12
NG RR MONITOR FLAG	EDIT BYPASS RR MONITOR	R25	R23, R26, W4, N72	P20, P22, R21, R23, V44, FRESH START (V36E)
NO THROTTLE FLAG	INHIBIT FULL THROTTLE	P40	[REDACTED]	P40, P63
NO UPDATE FLAG	NEITHER VEHICLE MAY BE UPDATED	R22	R95	V80, V81
OLDES FLAG	R29 GYRO CND LOOP REQUESTED	R29	R29	R29
PREFERRED-ATTITUDE- COMPUTEC FLAG	PREFERRED ATTI- TUDE COMPUTED	P92	P40, P41, P42	P52
PRIORITY DISPLAY AWAITING KEY RELEASE FLAG	ASTRONAUT USING KEYBOARD WHEN PRIORITY DISPLAY INITIATED	R76	OSKY O1SPLAY PROGRAM	OSKY O1SPLAY PROGRAM
PRIORITY DISPLAY FLAG	P20 PRIORITY DISPLAY	R76	R61, R65	R61, R65
PRIORITY IDLE FLAG	PRIORITY DISPLAY NOT INITIATING NAUT RESPONSE	R76	OSKY O1SPLAY PROGRAM	OSKY O1SPLAY PROGRAM
PULSES FLAG	EDIT MINIMUM IMPULSE COMMAND PCEE	OAP	P69, P76	P12, P40, P41, P42, P63, P70, P71, R40, V77

PRELIMINARY

P25 FLAG	P25 BLANKING	P25 NOT RUNNING	P25, R00, R56		
QUIT FLAG	STOP INTERGRATICA	CONTINUE INTERGRATICA	PCC	V96	P00
RANGE DATA FLAG	LR ALTITUDE MEASUREMENT MADE	NO LR ALTITUDE MEASUREMENT MADE	R12	R12	R03, R12
RANGE SCALE FLAG	SCALE CHANGE DURING RR/LR PEAC	NO SCALE CHANGE DURING RR/LR READ	R12, R22	R20	R12, R22
RCS FLAG	EDIT RCS INJECTION MODE	MAIN ENGINE MODE	P12	P12, P76, P71	P70, P71
READ VELOCITY FLAG	READ LR VELOCITY DATA	OC NOT READ LR VELOCITY DATA	R12	R12	R00
REDESIGNATION FLAG	LANDING SITE REDESIGNATION ALLIGNED	LANDING SITE REDESIGNATION FRIBITEC	P04	P04	P63, P64
REFSWAT FLAG	REFSWAT GOOD	REFSWAT BAD	P3C, P32, P33, P34, P35, P57, R02, R47	P51, P52, P57	P06, P51, P52, P57, R50, W41N20
REMOVE FLAG	CHANGE IN ANTENNA MODE REQUESTED	NO CHANGE IN ANTENNA MODE REQUESTED	R24, R25 W41N2	R21, R25 W41N2	R21, R25 W41N2, FRESH START (V36E)
RENOUVOUS FLAG	EDIT P20 OR P22 RUNNING	MELTHER P20 NOR P22 RUNNING	P20, P22, R00, R22, R25, W41N2, R65, R77, R59, W40N25, V41N2	P20, P22, NAVIGATION COMPUTATIONS	P06, P12, P63, R00, R56
RENO W FLAG	W MATRIX VAL ID	W MATRIX INVALID	NAVIGATION COMPUTATIONS	R25	P12, W67, V93
REPOSITION FLAG	REPOSITION IN PROGRESS	NO REPOSITION IN PROGRESS	R2C, R21, R25 W40N25, V41N2	P70, P71	R25 W41N2, FRESH START (V36E)
ROTATION FLAG	FORCE VEHICLE ORIENTATION IN PREPEREC EXPECTICN	OC NOT FORCE VEHICLE ORIENTATION	R21	R25, V40N27	P70, P71, FRESH START (V36E)
RR ANTENNA MODE FLAG	RR IN MODE #2	RR IN MODE #1		R25, V40N27	R25, V40N27
RR AUTO MODE FLAG	RR NOT IN AUTO MODE	RR IN AUTO MODE	V40N27	R25, FRESH START (V36E)	R25

DESCENT STATE VECTOR UPDATE ROUTINE (R12)

05
REV. 05/68

PURPOSE

- (1) TO OBTAIN VEHICLE RANGE AND VELOCITY DATA RELATIVE TO THE LUNAR SURFACE FROM THE LR.
- (2) TO INCORPORATE THE LR RANGE AND VELOCITY DATA INTO THE LP STATE VECTOR.
- (3) TO NOTIFY THE CREW OF ABNORMALITIES IN THE PROCESS OF LGC INTERROGATION OF THE LR.
- (4) TO COMPARE THE LP TC POSITION #2, AND ISSUE AN ALARM IF THAT COMMAND IS NOT SUCCESSFUL.

05
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ASSUMPTIONS:

- (1) THE NECESSARY PARAMETERS (AS DESCRIBED IN SECTION 5.3.4 OF R567) FOR CONVERSION OF THE LR DATA TO STATE VECTOR UPDATES ARE STORED IN THE LGC.
- (2) THE FORMAT OF THE LR DATA AND THE TECHNIQUE OF ITS TRANSFER TO THE LGC ARE AS DESCRIBED IN SECTION 5.3.4 OF R567.
- (3) THE LR PERMIT FLAG WAS RESET PRIOR TO THE START OF THIS ROUTINE BY ROO. UNTIL THIS FLAG IS SET BY A MANUAL DSKY ENTRY (SEE (4) BELOW), NO LR DATA WILL BE INCORPORATED INTO THE LM STATE VECTOR.
- (4) THERE ARE 2 EXTENDED VERBS AVAILABLE TO THE CREW TO ALLOW MANUAL CONTROL OF THE USE OF LR DATA FOR STATE VECTOR UPDATING. THEY ARE:
 - V57E SETS (OR RESETS) THE LR PERMIT FLAG, ENABLING USE OF GOOD LR DATA.
 - V58E RESETS THE LR PERMIT FLAG, PREVENTING USE OF ALL LR DATA.

(5) THE LR, R, M, AND S COUNTERS WERE ZEROED BY P63. THE LR BYPASS FLAG WAS SET BY ROO AND RESET BY P63. THE FOLLOWING FLAGS WERE INITIATED, NO LR READ, R12 X-AXIS OVERRIDE, LR PERMIT, VELOCITY DATA READ VELOCITY, RANGE DATA, LPSR, V FLAS, AND H FLAS.

(6) THIS ROUTINE IS CALLED EVERY 2 SECONDS BY SERVICER (AVERAGE G), BUT ONLY OURLING P12, P63, P64, P65, P66, P70 OR P71. HOWEVER THE ROUTINE IS IMMEDIATELY BYPASSED IF THE LR BYPASS FLAG IS SET. THIS FLAG IS ALWAYS SET BY ROO, P70 AND P71. IT IS RESET BY P63.

PROG
CONT

LGC

CREW

PRELIMINARY

- LGC
- ROUTE
- SELECTICN
-
-
-

START DESCENT STATE
VECTR LPOATE
ROUTINE (R12)

.....

IS LR BYPASS FLAG
SET?



50
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IS THE R12 X-AXIS
OFFERICE FLAG SET?

.....

IS ALTITUDE LESS
THAN 30,000 FT

.....

#10

#20

#30

#40

#50

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INLW?

+Y

N

SET THE R12
X-AXIS OVER-
RIDE FLAG

SET X-AXIS
OVERRIDE IN-
HIBIT FLAG

IS THE NO LK REAG
FLAG SET?

+N

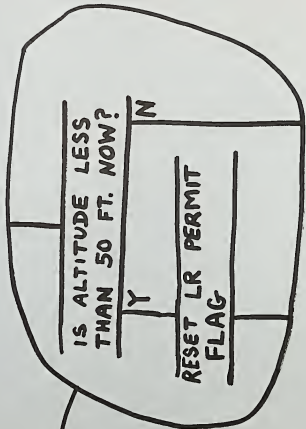
Y

IS THE NC 911
FLAG SET?

Y

N

GC TC GC TC
NC NC
EELW BELW



1D

SECTION 5 CHANGES

PRELIMINARY

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5. 6. 7	Additional Rendezvous Displays	5. 6- 64
5. 6. 7. 1	Range, Range Rate, Theta Display	5. 6- 64
5. 6. 7. 2	Final Attitude Display	5. 6- 65
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R-52	Auto Optics Positioning Routine	5.6.2.1.2	5.6-3

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III Powered Landing Maneuver and Post Landing PhaseA) Nominal

- P-63 Landing Braking Phase
- P-64 Landing Approach Phase
- P-65 Automatic Landing Phase Guidance

(or)

- P-66 Rate of Descent Landing Guidance

- P-68 Landing Confirmation Program
- P-57 Lunar Surface Alignment Program
- R-47 AGS Initialization Routine

B) Abort to Orbit1. Aborts During Powered Landing Maneuver

- P-70 DPS Abort Guidance Program
- P-71 APS Abort Guidance Program

2. Aborts from the Lunar Surface (Anytime Launch Case)

- P-27 LGC Update Program (CSM State vector update)
- P-57 Lunar Surface Alignment (Fast Alignment Mode)

- P-12 Powered Ascent Guidance Program

~~R-29 Powered Flight RR Designate Routine~~

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5.1-17

Revised
 Added

LUMINARY

GSOP #567

PCR # 285
845

Rev. 7

Date 11/69

V LM Powered Ascent PhaseA) Nominal

P - 12 Powered Ascent Guidance

~~R - 29 Powered Flight RR Designate Routine~~B) Aborts

None

PCR
892VI Rendezvous PhaseA) Nominal

P - 20 Rendezvous Navigation Program

P - 32 CSI Pre-Thrust Program

P - 33 CDH Pre-Thrust Program

P - 34 TPI Pre-Thrust Program

P - 35 TPM Pre-Thrust Program

P - 41	}	RCS or APS Thrust Programs
P - 42		

R - 47 AGS Initialization Routine

P - 47 Thrust Monitor Program (Manual Terminal
Rendezvous Maneuvers)

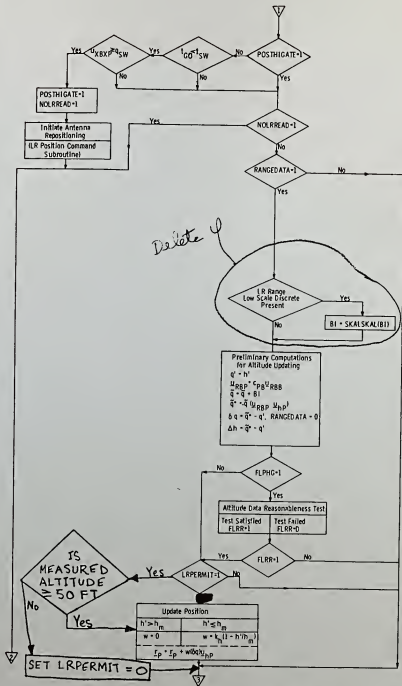


Fig. 3.4.3-1 State-Vector-Update Routine

(Page 2 of 4)

5.3-60

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At this time, the LR-Updating Permit flag (LRPERMIT) is checked. If this flag has been set to unity by the astronaut, the altitude updating-procedure is begun. Otherwise, it is bypassed. *If the measured altitude ≤ 50 ft, it is seen in Fig. 3.4.3-1 that the LRPERMIT flag is set to zero and the updating of position and velocity is bypassed (See Fig. 3.4.3-1).*

The difference between the altitude measurement at the measurement time (q^*) and its extrapolated estimate (q') is used to update the LM position vector at the PIPA-output processing time. As can be seen in Fig. 3.4.3-1, the weighted measurement difference is used to update the position component of the state vector (r_p) along the direction estimated for the altitude measurement (u_{hP}). The altitude-measurement weighting function (w), as can be seen, is stored as a linear function of the estimated LM altitude (h'). The coefficients h_m and k_h will be stored in erasable memory.

A check is next made to see if the Velocity Measurement flag (VELDATA) is set at unity. This flag is set at unity in the LR Velocity-Data Read Subroutine (Section 5.3.4.4.) after Velocity Data-Good discretes are observed on three consecutive computation cycles through the subroutine. As soon as the test indicates that no Velocity Data-Good discrete is present, then the measurement flag (VELDATA) is reset to zero. If VELDATA is unity, then the preliminary computations for velocity updating are begun; if the flag is zero, the entire velocity updating process is by-passed.

The preliminary computations for velocity updating involve first the selection of the coefficient (c) to be used in the linear weighting function for the velocity component of interest. This depends on the particular component used on the current cycle, which is identified by the velocity-component flag (FLV) from the LR Velocity-Data Read Subroutine (Section 5.3.4.4.). The numerical values for the coefficients k_{VX} , k_{VY} , and k_{VZ} , will be stored in erasable memory. Next, the unit vector for the velocity component being processed (u_{AB}) is selected. The unit vectors for the different velocity components as shown in Fig. 3.4.3-1, are referred to as u_{XAB} , u_{YAB} , and u_{ZAB} . (See Fig. 3.4.4-5.)

An estimate of vehicle velocity at the measurement time (v_u') is next obtained. Because of the fact that the velocity measurements are not taken at the normal PIPA-processing times, it is necessary to read the PIPA-output data also at the measurement time (t_u) and store the data for use on the next computation cycle through the State-Vector Update Routine. The velocity-measurement estimate (v_u'), as indicated in Fig. 3.4.3-1, is obtained by adding the velocity change measured by the PIPA-output data from the preceding updating time ($\Delta \tilde{v}_{uP}$) to the preceding-cycle updated velocity (v_{n-1}). The effect of the lunar gravitational acceleration is included in the computation of v_u' by using the previous-cycle value (g_{n-1}) over the interval from the preceding updating time (t_{n-1}) to the measurement time (t_u).

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Delete Section 5.6.18 Powered Flight
RR Designate Routine (pp. 5.6-98 to
5.6-105).

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