"G" NOTES CSM

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6-11-69

The numbering convention for the program notes is X.X.X, where:

A. First digit

1 = Crew notes and checklist items - These are notes being of particular interest to the crew.

2 = Ground notes - These are notes being of particular interest to mission operational and planning people.

3 = Restarts and priorities

B. Second digit

1 = Nouns, verbs, displays

2 = Selection of new programs and extended verbs

3 = Ground updates and pad loads

4 = Navigation and W-matrix

5 = Rendezvous and targeting

6 = Optics, IMU, and radars

7 = Guidance and control, boost, and entry

C. Last digit, order number

Define Sections

11

G
124
126
178

P 22 - 141

P 30 - 114

P 37 - C 35-1

P 20

V 82 - 129, 177
V 83 - 142, 155,
85

ENCLOSURE
V 96 G141

Section A

Program and procedure notes applicable to the G mission. from Colossus

1. Crew Notes and Checklist Items

1.1 Nouns, Verbs, and Displays

B 1.1.1

1.1.1 Some nouns are not manually callable with valid data at any time, e.g., 5, 6, 7, 12, 16, 24, 25, 26, 29, 30, 31, 35, 41, 72, 97, 98.

1.1.2 The following nouns can never be loaded via V24 or V25: 40, 44, 45, 50, 63, 80.

B 3.1.1

1.1.3 There are three priority displays in COLOSSUS which will ignore any response for two seconds:

V06N49 in R22
V05N09 in R52
V50N18 in R60 during P20

1.1.4 If P30 is used to estimate perilune during translunar coast ~~by loading zeros into N81, DO NOT PROCEED on N42, rather do V37EXXE. Avoidance procedure:~~ Load 0.2 ft/sec into R2 of N81. ~~Recognition: Arcsin alarm (code 1301).~~ Recovery procedure: Hit error reset, ~~then~~ do V37EXXE.

P30

Poo Doo or Bailout

just whole procedure in checklist

Section A

1.2 Selection of New Programs and Extended Verbs

1.2.1 V37 should not be called for 15 seconds after the NO ATT light goes off. If it is, the PIPA FAIL inhibit bit will not be reset and a PIPA FAIL will go undetected. Recovery procedure: Select P00. Then reset IMODES 30 bit 5 via V25N07E, 1320E, 20E, E.

1.2.2 During periods of high computer activity, e.g., P11, P4X with Lambert, or P20 with a targeting program, the selection of certain extended verbs (notably V82, V83, V85, V90) may result in program alarms 1201 or 1202 and extended verb activity is lost. Recovery procedure: Reselect extended verb.

1.2.3 If an extended verb has been selected during a mission program, with normal displays, the extended verb logic initially blanks the DSKY. Any response during the time the DSKY is blank would do one of the following things: a) respond to a normal mission program display underneath the extended verb; b) respond to the first display in the extended verb which could be initiated simultaneously with your response.

1.2.4 The following program sequences will cause problems:

a) P3X - P7X - P40 or P41
P3X - P17 - P40 or P41
P3X - P23 - P40 or P41

Problem: P3X computations are overwritten. Recovery procedure: Redo P3X and then P40 or P41.

b) 1. P40/P41 - P27 - P52
2. P27 - P40/P41 - P52

Problem: P27 and P40/P41 overwrite preferred computation. Recovery procedure: 1. Redo P40/P41 up to V50N18, then reselect P52. 2. Reload preferred REFSMMAT from ground.

1.2.5 V35 Restrictions: 1) In prelaunch do not use V35 during gyrocompassing; 2) After launch use V35 only in P00. Ten seconds should be allowed before the PIPA's are used; hit error reset to clear fail registers.

1.2.6 Depending upon intial gimbal angles, the VECPOINT routine may result in large computed rotations about the pointing vector when the pointing vector must be rotated through about 180° (an example of this would be in P40 or P41. If the +X axis were about 180° away from the thrust vector, the V50N18 may display a large change in outer gimbal angle.) Recovery procedure: If the computed attitude is acceptable then simply proceed with the maneuver. If it is not, then manually maneuver in pitch and have the solution recomputed after some 20-to-30 degrees by keying

Section A

PRO on V50N18 while not in CMC and AUTO.

1.2.7 Use V30 and V31 only in P00.

1.2.8 Any program can be terminated: 1) at any flashing display via V34E with the following exceptions: (a) P17/P77 only on the first and last display; (b) when P20 is running in the background of some other program, a V34E on a P20 display (R60 or N49 in R22) will terminate P20 only. Conversely, a V34E on a prethrust program will turn off that program only but not P20; (c) V34E on a V78E (P02 only) is ignored; (d) V34E on a program with an extended verb running will terminate the extended verb only; (e) V34E is ignored in P06. 2) At any flashing or non-flashing display via V37EXXE with the following restriction: only a V37E00E is allowed after separation (PROCEED on V50N25 - 00041 in P62).

1.2.9 V82 may give erroneous results during translunar/trans-earth coast phases since its computations are based on two body conic equations.

Section A

1.3 Ground Updates and Pad Loads

None

Section A

1.4 Navigation and W-matrix

1.4.1 Taking marks on a landmark in the vicinity of the horizon and identifying the landmark as an unknown landmark, may cause either of the following to occur:

a) square root abort, termination of P22, and return to P00. Recovery procedure: Reselect P22.

b) overflow in the initialization of the landmark portion of the W-matrix, resulting in erroneous navigation calculations. Recognition of this effect is difficult. Recovery procedure (if recognized): Reject update on ΔRΔV display. Avoidance procedure: Do not use unknown landmark option of P22 for landmarks near the norizon. NOTE: It is recommended that all landmark sightings (known or unknown) be made such that the angle between the CSM-to-landmark LOS and the local vertical is less than 45 degrees.

1.4.2 The range and range rate displays (in R31 and R34) may degrade considerably at ranges below 0.3-0.5 NM depending on marking schedules and resultant AGC navigation accuracy.

1.4.3 If V56 (terminate P20) is keyed in during a computation in P34-P35, these computations will be restarted from the beginning.

Section A

1.5 Rendezvous and Targeting

1.5.1 To ensure processing of the last mark in P20, wait until the computer activity light goes on before proceeding. The light indicates the previous mark is being processed. If PROCEED is done too soon, one of the last two marks may be ignored.

1.5.2 P38 Stable Orbit program, operating in mode 1, only computes TFINAL on initial entry of the program. It is not recomputed on each recycle or proceed from V16N45. To have TFINAL recomputed, reselect P38.

1.5.3 P37 targeted maneuvers from earth parking orbit will yield transfer times on the order of two minutes for the portion of the premaneuver orbit from apogee to perigee (negative flight path angle), when using the $V_{-\gamma}$ target line built into the program. When the premaneuver orbit is highly circular with poorly defined apogee and perigee, the short transfer time will occur whenever the flight path angle is negative.

1.5.4 All uplinked or keyed in ΔV's and target vectors must be in the same sphere of influence as the AGC determined state at TIG and TIG-30.

1.5.5 V83 and V85 displays will be meaningless at altitudes greater than 425 NM for both earth and moon if these verbs are exercised during periods of precision state vector integration.

1.5.6 Provided that the time of ignition, TIG, is defined to occur outside the lunar sphere of influence, P37 will always produce a conic solution although no precision solution may be possible.

1.5.7 For pre-apogee, long transit time abort, the conic solutions in P37 may be grossly inaccurate yielding erroneous landing site coordinate displays. In addition, long integration period of perhaps 10 - 30 minutes may be experienced.

Section A

1.6 Optics and IMU

1.6.1 After a fresh start, or restart, or after turning optics power on, the optics must be taken out of zero and returned to perform an optics zero since it is not the position of the switch but the change to the zero position that triggers the zeroing program.

1.6.2 If the mode switch is in CMC and AUTO or HOLD mode during R55 (gyro torquing routine) or during V42, or during execution of the gyro pulse torquing option of P52/P54, the DAP will maneuver the vehicle to follow the platform as it moves.

Section A

1.7 Guidance and Control, Boost, and Entry

1.7.1 During the trimming of Lambert derived v_G, the v_G display may jump in earth environment, 0.1 - 0.2 ft/sec at transfer angles of 140°, 0.3 - 0.5 ft/sec at transfer angle of 60°, and 0.5 - 1 ft/sec at transfer angle of 30°. For moon environment these jump numbers are 0.02, 0.05, and 0.1, respectively. Recovery procedure: For transfer angles of 30° or less, trim to 0.1 ft/sec, for all transfer angles greater than 30° trim to zero.

1.7.2 During TVC control (in P40), astronaut use of the DSKY will mask possible V97 display (thrust fail display). Avoidance procedure: Do not allow extended verb, monitor or static displays to occupy DSKY for long periods of time during TVC.

1.7.3 Following a hybrid deorbit burn with long coast times, the time to 0.05g's, TFE, will be in error by up to four minutes, depending on how early after the deorbit maneuver P61 is called.

1.7.4 Because of the 0.01-second time granularity in the AGC, the calculation of small Lambert maneuvers may differ considerably from ground computations. The immediate effect, e.g., in P41, will be a different set of desired gimbal angles from those expected on the ground. The angular difference between the ground and AGC v_G's is a function of earth or moon environment, the magnitude of v_G, and the active vehicle transfer angle. For 1 ft/sec maneuvers, this angular "error" could vary from ~ 5° (at 140° transfer) to ~ 20° (at 60° transfer) to ~ 30° (at 30° transfer) for the earth. For the moon, these angles are ~ 1°, ~ 3°, and ~ 5°, respectively. For greater v_G the angular error is inversely proportional to the magnitude (approximately). Since the maximum error is 30°, the cross axis velocity introduced by performing the maneuver is $< \pi/6$ ft/sec.

1.7.5 If a roll jet fails "on" during SPS thrust, an appreciable roll excursion (≈ 30°) may occur. The PITCH-YAW dap will continue to function properly.

1.7.6 The Down Range Error display (N66) in P67 will be set to 9999.9 NM when the vehicle state "goes past" the target. That is, under these conditions this display will not exhibit negative down range error.

1.7.7 The TFF display in V82 may be incorrect if the return trajectory is hyperbolic. Recognition: Noun 73, R2>36339 ft/sec.

1.7.8 There is an extreme low probability of a CDU transient occuring during boost which will change the CDU readings by $11\frac{1}{4}$ degrees. This probability can further be reduced by not changing switches on the main panel.

Section A

2. Ground Rules

2.1 Nouns, Verbs, and Displays

2.1.1 See 1.1.2.

Section A

2.2 Selection of New Programs and Extended Verbs

2.2.1 See 1.2.1.

2.4 Navigation and W-matrix

2.4.1 The fixed ephemeris constants in COLOSSUS 2A are in error by small amounts. The following table shows maximum errors expected as a function of launch times between July 1, 1969, and July 1, 1970.

	July 1, 1969	July 1, 1970
ω_e error on earth surface	161 m	3760 m
$\dot{B}$ error on moon surface	0	22×10^{-8} m
Ω_{IO} error on moon surface	0.02 m	0.02 m
$\dot{\Omega}_{IO}$ error on moon surface	0	0.03 m
F_0 error on moon surface	4.1 m	4.1 m
$\dot{F}_0$ error on moon surface	0	8.2 m

Avoidance procedure: absorb errors in biasing lunar libration vector. See also anomaly report COM 11 Rev 1.

2.5 NONE

2.6 NONE

2.7 NONE

Section A

3. Restart Notes

3.1 Nouns, Verbs, and Displays

None

3.2 NONE

3.3 NONE

3.4 NONE

3.5 NONE

3.6 NONE

3.7 NONE

"G" NOTES
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R LARSON
6-11-69
B1

Section B

713-41836 247

Program and procedure notes applicable to the G mission.

1. Crew Notes and Checklist Items

1.1 Nouns, Verbs, and Displays

1.1.1 The nouns that can be called at any time with valid data are: 1, 2, 8, 9, 10, 20, 21, 27, 36, 46, 47, 48, 65, R1 of 45, and R2 of 66 and 72.

1.1.2 *Use of V30 or V31 (which uses N26 as transfer address) in programs that share N26 erasables may cause indeterminate transfer. (LNY-31) Avoidance: Use V30 or V31 only in P00. Recognition: Unexpected DSKY displays or activity. Recovery: Standard recovery (documented in crew checklist).

1.1.3 N42 values of h_a and h_p (in P30) will vary slightly from N44 values of h_a and h_p (in V82). N42 uses conic calculations which are slightly in error for near lunar orbits. The larger the ΔV used in P30, the greater the error in N42. Recognition: Difference in displays.

G
B 1 21
1 27
1 42
1 46
~~1 61~~
1 72
1 75
3 11
3 71

P 12
1.7.12

P 20
B 126

P 22
B 1210

P00
D 1.2.1

P 25
B 129
P 40 - 177
P 52 - 161
P 57
B 164, 165

P 63 - 178, 179
1.7.10, 1.7.13,
P 66 - 1.7.11
P 70 - 166,
R 03 - D1.7.1,
V 83 - B1.5.2

1.2 Selection of New Programs and Extended Verbs

A 124

1.2.1* The following program sequences may cause problems:
1) P3X-Pxx-P40, P41, or P42 - The P3X computations may be overwritten. Recovery: Repeat P3X and then P40, P41, or P42.

A121

1.2.2* If V37 is attempted within approximately 20 seconds of a fresh start or ISS turn on, a PIPA FAIL will go undetected. Recognition: None by the crew, ground support will see IMODES bit set. Recovery: Select P00. Then reset IMODES 30 bit 5 via V25N07E, 1320E, 20E, E.

A 122

1.2.3* During periods of high computer activity, the selection of certain extended verbs (notably V82, V83, V85, V90) may result in program alarms 1201 or 1202 and extended verb activity is lost. Recovery: Reselect extended verb.

A 123

1.2.4* If an extended verb has been selected during a mission program, with normal displays, the extended verb logic initially blanks the DSKY. Any response during the time the DSKY is blank would do one of the following things: a) respond to a normal mission program display underneath the extended verb; b) respond to the first display in the extended verb which could be initiated simultaneously with your response. In general, do not key a response (PRO, ENTER, V32E, V33E, V34E) to either a blank DSKY or a non-flashing display.

1.2.5 If RR is in Mode II, do not select a mission program via V37 after selecting P20 until the first R60 display in P20 (V50N18 priority display) (SDN-48). Recognition: RR may lock on in Mode II before the V50N18 if the +X axis is along the LOS. Recovery: Attitude maneuver (V50N18) will break lock, position +Z axis along LOS, and RR will be designated to Mode I.

1.2.6 Do not select P20 in the update mode prior to completion of P65, P66 or P67. The W-matrix initialization will destroy the E-memory descent targets.

A 127

1.2.7* Depending upon initial gimbal angles, the VECPOINT routine may result in large desired rotations about the pointing vector when the pointing vector must be rotated through about 180° (an example of this would be in P40, P41, or P42). If the +X axis were about 180° away from the desired thrust vector, the V50N18 may display a large change in yaw desired. Recovery: If the computed attitude is desired then simply proceed with the maneuver. If it is not, then manually maneuver in pitch and have the solution recomputed after some 20-to-30 degrees by keying PRO on V50N18.

1.2.8 If P20 is exited by means of V56E and no other program is running concurrently, the major mode display on the DSKY goes blank and V37 flashes requesting a new program. The integration in P20 is completed but there is no further integration performed until a new program is selected. (LNY-51) Avoidance: Answer the flashing V37 as soon as practical. NOT AN ANOMALY

1.2.9 Indeterminate program behavior may occur if R04 or R77 (V63 or V78, respectively) is run simultaneously with P25. (LNY-66) Avoidance: Do not enter V63 or V78 with P25 running.

1.2.10 In P22 Lunar Surface Navigation, the RR pre-designate routine stores into an erasable used by orbital integration (precision integration only) and could cause bad results from extended verb routines such as R31. The P22 results are not affected. (LNY-71) Avoidance: Do not select such extended verbs while the pre-designate in P22 is running.

-P25 put in checklist

-P22 check among for "such" and checklist to see if this is a problem

1.3 Ground Updates and Pad Loads

None

1.4 Navigation and W-matrix

1.4.1 A V96E can cause the W-matrix to be out of phase with the state vectors if it is performed ~~1) during P20 mark processing, but only if the CSM state is being updated (V81); or 2)~~ during AVETOMID, i.e., after responding to the FLV37 when leaving a program where Average-G was on and before the program lights change. Recovery: ~~For 1) none needed; 2)~~ V93E.

1.4.2 If a V37EXXE is used when the radar is being read during P20 or the self-test routines (R04 or R77), a 520 alarm may occur. The mark that was taken is not used. Recovery: ERROR RESET and continue.

1.4.3 If V56E or V34E on a P20 display is keyed to terminate P20 during a computation in P32, P33, P34 or P35, these computations will be restarted from the beginning.

1.4.4 An infinite loop in coasting integration can occur under the conditions of the extrapolation of faulty state vectors. Recognition: Excessive time to update state vector verified by keying V16N36E (small oscillating time steps). Recovery: V96E to stop integration loop. State vector update may be required.

1.4.5 P20 rendezvous navigation provides a priority display (V06N49) of ΔR and ΔV when the state vector update exceeds the pad-loaded erasable values RMAX and VMAX. Currently there are two problems: 1) If the display is desired before every incorporation, any negative value must be set into RMAX, not zeroes; 2) ΔR is computed as zero if ΔR < 256 meters for earth or < 64 meters for moon; ΔV is computed as zero if ΔV < 0.006 meters/second for earth or < 0.0015 meters/second for moon. Avoidance procedure: If it is desired to observe V06N49 for each mark then RMAX should be loaded as any negative number. Recovery procedure: None.

1.4.6 An incorrect state vector update may occur, if there is a restart (hardware or software) during the trunnion or shaft incorporations of P20 or P22. (LNY-61) Recognition: Noun 49 display occurs when it shouldn't (this may or may not happen). Avoidance: 1) none for a restart. 2) Do not select another program via V37 while P20 is incorporating a mark. Recovery: If the N49 occurs, key in recycle to reject the mark.

1.5 Rendezvous and Targeting

1.5.1 The scaling of computations in P32 may cause CDH TIG to be in error by 18 seconds (E < .000488)(LNY-29).

1.5.2 Range rate display in V83 may degrade considerably at ranges less than 0.3 to 0.5 NM depending on navigation accuracy.

1.5.3 Lambert computations should not be used within three degrees of a target vector.

1.5.4 The $\underline{V}g$ or $\underline{\Delta}v$ displays in body axes, N83 or N85, are based on reading the accelerometers every two seconds. The displays, however, are asynchronous one-second monitors. The result is a $\frac{1}{2}$ - $1\frac{1}{2}$ delay between application of ΔV and the visible result.

1.6 Optics, IMU, and Radars

1.6.1 In all P5X's the permissible values of R1 of N70 and/or N71 are 0-508 for the star code. Anything else will cause indeterminate program transfer. Recovery: Confer with ground to determine possible erasable memory damage (ground uplink may be required).

1.6.2 If the attitude control mode switch is in AUTO or ATT HOLD mode during R55 (gyro pulse torquing in P52) or during V42E, the DAP will maneuver the vehicle to follow the platform as it moves.

1.6.3 It is possible to enter a program (V40N72, V41N72, V60, V63, V78) which uses the RR or LR while R12 is reading the LR. (LNY-58) Recognition: Program alarm 1210 (two programs using device at the same time) and the verb is lost. Avoidance: Do not enter any of the listed verbs while Average-G is on during the landing. Recovery: Self recovery.

1.6.4 In P57 a bad alignment will result in the following cases: Option 2; If the star code is for Sun, Earth ~~or Moon~~ for both sightings. If first body sighted is a star and the second body is the Sun, Earth ~~or Moon~~. Option 3; If the star code is for the Sun, Earth ~~or Moon~~. (LNY-74) Avoidance: Option 2; If sighting on Star and Sun or Earth, specify Sun or Earth first. Option 3; Use Planet code (00) and key in Sun or Earth vectors.

1.6.5 In P57, if gyro torquing is attempted (proceed on V06N93) while IMU compensation routines are torquing the gyros, a 1210 alarm will occur (LNY-68). Recognition: 1210 alarm and a restart after the PROCEED on V06N93 in P57. Recovery: Repeat P57.

1.6.6 The powered flight RR designate routine (R29) will not continue tracking during a switch from P70 to P71 but instead will again designate and then begin to track.

1.7 Guidance and Control, Boost and Entry

1.7.1 Do not select P40 or P42 if VG < ΔV_m (i.e., ullage DELTA V should not exceed the total velocity-to-be-gained). The engine will be turned on for 0.01 second; may cause engine freeze-up and may be dangerous to crew safety. Recognition: R2 of N40 is less than 45000/weight prior to TIG-30. Recovery: Confer with ground.

1.7.2 In order to avoid excitation of the CSM-docked bending mode and possible damage to the docking tunnel, +X translation exceeding 10 seconds with jet 10 should be avoided and small steady ACA deflections with fine stick scaling (4°/sec) should be used in the ATT HOLD mode. Recognition: Perceiving a surprising increase in RCS jet activity and seeing a sinusoidal motion on the rate needles and the FDAI error needles (between 2 and 4 cps).

1.7.3 The rate command/attitude hold mode during powered flight performance with the CSM docked spacecraft configuration should be avoided. Recognition: Poor control in manual rate command mode during docked DPS burns. Recovery: Return to ATT HOLD mode by returning the rotational hand controller to center detent position or switch to the automatic mode.

1.7.4 During P40 and P42 when V99 or V97 is flashing, V06 may occasionally appear for one flash. There is no recovery procedure required.

1.7.5 A CALCMANU maneuver rate in excess of 0.5°/sec should not be used in the CSM-docked configuration.

1.7.6 If P70 is run to fuel depletion and the astronaut responds with an ENTER to the flashing V97N63, he will see a flashing V99N63. Then if the astronaut keys ENTER to this display, the autopilot deadband will be restored to whatever value was last specified in R03; i.e., either .3 degrees or 5 degrees rather than the nominal 1 degree. (LNY-62) Avoidance: If a flashing V97N63 occurs during P70 and it is desired to observe a display of the residuals simply key in V16N85E to display the residuals. Then take action to select P71 or enter the trimming mode.

1.7.7 If a flashing V97N40 (engine fail) occurs during the trimming phase of a P40 burn, then an attempt to relight the DPS by keying an ENTER to the flashing V97N40 and a PROCEED to the flashing V99N40 may cause the engine to throttle up within a few seconds of the new ignition. (LNY-63) Avoidance: If a flashing V97N40 appears during the trimming phase of P40, place the throttle control switch in MANUAL, ENTER to the flashing V97N40 and PROCEED to the flashing V99N40. Then after sufficient trimming time, return the throttle control switch to the AUTO position.

1.7.8 If a restart (hardware or software) occurs during the trimming phase of P63, the LGC will fail to throttle the DPS to FTP and the landing guidance equations will not be put into operation. (LNY-64) Recovery: Manually force the throttle to FTP at nominal FTP time (or earlier) and then key in V21N01E 01252E 02462E. Then wait a few seconds and reduce manual throttle to 10%.

1.7.9 If the LGC does not receive indication of the LR antenna's having reached position 2 (hover) after the LGC command to reposition, priority alarm 523 is displayed. It is intended that the crew be able to terminate R12 on this display by keying V32E and continue the landing, since the state vector should have been satisfactorily updated by this time. But, the V32E instead of terminating R12 simply puts R12 in the no update mode. Furthermore, there is another check in R12 for the LR position 2 discrete. If the position 2 discrete is not present, R12 turns on the program alarm light and stores alarm code 511. 511 is not a priority alarm but it does turn on the program alarm light every 2 seconds (LNY-72). Recognition: Program alarm light after V32E response to 523 priority alarm. Recovery: Set FLAGWORD 11 to 40000 by V21N01E 00107E 40000E.

1.7.10 If the response to V06N61 (P63) is V32E, control will be passed to the engine fail routine as if there had been an ENTER response to a flashing V97NXX. The display will change to flashing V99N61 asking for engine ignition enable and Average-G will not be turned on. (LNY-73) Avoidance: Do not recycle on the V06N61 display in P63.

1.7.11 P66 (ROD program) is selected automatically by the LGC when the attitude control switch has been placed in ATTITUDE HOLD and the ROD switch has input a net change in descent rate over the last sampling cycle. Once P66 is selected the attitude control switch should not be returned to the AUTO position. Program control will remain in P66 but the quadratic guidance equations will be restarted causing use of unnecessary computer time. Avoidance: Do not return attitude control switch to AUTO after selection of P66.

1.7.12 Do not use V90E (request R36 the rendezvous out-of-plane display) during P12. R36 uses the permanent state (which during ascent would be the $\bar{R}$ and $\bar{V}$ on the lunar surface) and since that state was not an orbital state an acceleration overflow in integration will occur causing a 430 P00D00 alarm.

1.7.13 In P63, grossly bad initial conditions or targets can cause the landing ignition algorithm to terminate abnormally, i.e., instead of the V06N61 flashing display after the ignition algorithm, a static V06N63 will appear. Recovery: State vector update and/or target update and then re-select P63.

2. Ground Notes

2.1 Nouns, Verbs, and Displays

2.1.1 See 1.1.2

2.2 Selection of New Programs and Extended Verbs

2.2.1 See 1.2.1

2.2.2 See 1.2.2

2.2.3 See 1.2.8

2.3 Ground Updates and Pad Loads

None

2.4 Navigation and W-Matrix

2.4.1 See 1.4.1

2.4.2 See 1.4.4

2.4.3 See 1.4.5

2.4.4 See 1.4.6

2.4.5 The fixed ephemeris constants in LUMINARY 1A are in error by small amounts. The following table shows maximum errors expected as a function of launch times between July 1, 1969, and July 1, 1970 (LNY-55).

	July 1, 1969	July 1, 1970
ω_e error on earth surface	161 m.	3760 m.
$\dot{B}$ error on moon surface	0	22 x 10^{-8} m.
Ω_{IO} error on moon surface	0.02 m.	0.02 m.
Ω_{IO} error on moon surface	0	0.03 m.
F_O error on moon surface	4.1 m.	4.1 m.
$\dot{F}_O$ error on moon surface	0	8.2 m.

Avoidance: Absorb errors in biasing lunar libration vector.

2.5 Rendezvous and Targeting

2.5.1 See 1.5.3

2.6 Optics, IMU, and Radars

None

2.7 Guidance and Control, Boost, and Entry

2.7.1 See 1.7.1

2.7.2 See 1.7.13

3. Restarts and Priorities

3.1 Nouns, Verbs, and Displays

3.1.1 There are seven priority displays in LUMINARY which ignore any response for two seconds:

V06N49 in R22
V50N18 in P20 or P25
V05N09 in P20 (Alarm codes 501, 503, 514, 525, 526, 527)
V06N05 in P20 + P22
V16N80 in P20
V05N09 in P22 (Alarm codes 501, 503, 514, 525, 526, 527, 530)
V05N09 in R12 (Alarm code 523)

3.1.2 No astronaut initiated verb/noun is restart protected. Recovery: Reselect verb/noun.

3.2 Selection of New Programs and Extended Verbs

3.2.1 Restart will terminate extended verbs. Recovery: Reselect extended verb.

3.3 Ground Updates and Pad Loads

None

3.4 Navigation and W-matrix

None

3.5 Rendezvous and Targeting

None

3.6 Optics, IMU, and Radars

3.6.1 If P20 is in progress, a hardware restart will remove TRACK ENABLE and force the program back to the beginning of the designate and attitude maneuver. Recovery: Self recovery.

3.7 Guidance and Control, Boost, and Entry

3.7.1 Restarts will terminate automatic attitude maneuvers. Recognition: Restart light or program alarm (software restart) light on with V50N18 flashing. Recovery: PRO to V50N18 that returns to DSKY after restart.

Section C

Program notes applicable to <u>all</u> COLOSSUS releases.

1. Crew Notes and Checklist Items

1.1 Nouns, Verbs, and Displays

D 111

1.1.1 When loading decimal data into the AGC, the ENTER sometimes changes the last digit of the loaded value since PINBALL roundoff in decimal/octal/decimal conversion occurs when data is keyed in (decimal to octal) and entered and redisplayed (octal to decimal).

Section C

1.2 Selection of New Programs and Extended Verbs

1.2.1 In ENTRY (P62-P67), V37's are inhibited after a response to "please perform separation" except a request to perform P00. To call another program, P00 must be entered first, then the desired program called. Care should be taken, however, that P62 be reselected before entering the atmosphere, since AVEG is terminated by going to P00. Of course after separation, GNCS DAP control can only be established by initialization of the entry DAP in P62.

1.2.2 When a new program selection is made via V37, the key release light will remain on during R00 and will not go off until the new program is started. No further keyboard activity should be attempted until the key release light goes off and the new mode lights are displayed.

1.2.3 Extended verbs are not restart protected. If the restart light goes on during an extended verb, the verb should be reselected.

1.2.4 In extended verb V67, N99 correct values to be loaded in R3 (the option code) are 1, 2, and 3. All other values except 0 are treated as 3.

1.2.5 In R03 (V48) the permissible values for R1 of N46 are:

vehicle config	A	0, 1, 2, 3 and 6
+X Quad AC	B	0 and 1
+X Quad BD	C	0 and 1
Deadband code	D	0 and 1
Maneuver rate	E	0, 1, 2 and 3

For R2 of N46, permissible values are:

Quad AC or BD roll code	A	0 and 1
Quad A code	B	0 and 1
Quad B code	C	0 and 1
Quad C code	D	0 and 1
Quad D code	E	0 and 1

If wrong values are loaded into R1, they will give results in r03 as follows:

A	4 is treated as 0. 5 is treated as 1. 7 is treated as 3.
B - D	All odds are treated as 1. All evens are treated as 0.
E	4, 5, 6, 7 are treated as 0, 1, 2, and 3, respectively.

Section C

All wrong odd values in R2 are treated as 1. All wrong even values are treated as 0.

Section 3

1.4 Navigation and W-matrix

1.4.1 V96E may cause significant loss of W-matrix correlation in two cases: 1) The keying of V96E after a V37EXXE from a program using AVERAGE-G and before the XX appears in the mode lights (AVETOMID); 2) The keying of V96E during a permanent state vector integration in P20 during mark processing. In all other cases the use of V96E will cause no ill effects providing the next program selection in P00. Recovery ~~procedure: If V96E is keyed in during the two cases described, key~~ V93E at some time prior to the next navigation mark or VHF range input. See also 3.1.1 section A.

1.4.2 The W-matrix should not be initialized to magnitudes greater than 325 ft/sec and the following limits in position:

a) for rendezvous navigation - 8.5 NM
b) for orbital navigation - 8.5 NM
c) for cislunar navigation - 275 NM

Section 3

9

1.5.7 The assumption is made in the rendezvous targeting routines (i.e., not P30 or P31) that the resultant perigee altitude will be less than 9999.7 NM. If it is greater, then this display (N58) will ~~become meaningless~~. Hold at 9999.9

1.5.8 In P37 the correct values to be loaded into R2 for N06 are 1 and 2. Any other value will be treated as a 1.

Section C

1.6 Optics and IMU

1.6.1 In P52 and P54 the permissible values for R2 of N06 are 1, 2, 3, and 4. Illegal values,

1, 5, 11, 15 . . . . . are treated as 1.
2, 6, 12, 16 . . . . . are treated as 2.
3, 7, 13, 17 . . . . . are treated as 3.
0, 4, 10, 14 . . . . . are treated as 4.

1.6.2 In P52 and P54, loads of angles greater than 90 degrees into R1 and R2 of N89 cause erroneous results as follows:

R1 (Lat): 90 + X input yields 90 - X output, but longitude is rotated 180°.

R2 (Long): 90 + X input yields -(180 - X) output.
-(90 + X) input yields +(180 - X) output.

Section C

1.7 Guidance and Control, Boost, and Entry

D 1.7.2

1.7.1 TGO display is discontinuous immediately after ignition. TGO is computed from the ratio of velocity to be gained over ΔV, where ΔV is the velocity change over the last time period. At ignition ΔV will increase until it becomes fairly constant. Until this time, the ratio will behave erratically. The computation will settle in four-to-five seconds.

D 1.7.1

1.7.2 The engine gimbal trim angles (astronaut input to N48) should not exceed 9°. WHAT HAPPENS?

B 1.7.4

1.7.3 During P40 when V99 is flashing and during P40/R41 when V97 is flashing, V06 occasionally appears for one flash. This happens because V97 and V99 are paste verbs. There is no recovery procedure required.

correct

1.7.4 In P61 and P62, the permissible values for R3 of N61 (headsup/headsdown) are +1 and -1. 0 is treated as -1, i.e., roll angle of 0. All positive values are treated as +1 (180° roll angle). All negative values will give a + roll angle of the value decremented by 1. These angles are scaled in revolutions (360/16384 degrees per bit).

Section C

2. Ground Notes

2.1 Nouns, Verbs, and Displays

-D 211

2.1.1 The program will ignore any attempt to load Channel 7 via the DSKY. It will not even alarm. Channel 7 is the superbank indicator and is under exclusive program control.

2.1.2 See 1.1.1.

Section C

2.2 Selection of New Programs and Extended Verbs

2.2.1 See 1.2.2.

Section C

2.3 Ground Updates and Pad Loads

2.3.1 Any P27 update will destroy the preferred orientation matrix (e.g., that calculated by P40, P41), except an update of the matrix itself. Therefore, if a preferred alignment is to be part of an update, it should be the last quantity in the sequence.

2.3.2 Downrupts may be lost at infrequent intervals during high level computer activity.

2.3.3 The lunar-solar ephemeris pad loaded data is only good for 2^{26} cs (approximately 14.5 days). If the flight lasts longer, new data must be loaded.

Section C

2.4 Navigation and W-matrix

2.4.1 See 1.4.1.

2.4.2 See 1.4.2.

2.5 NONE

2.6 NONE

2.7 NONE

Section C

3. Restart Notes

3.1

3.2 Selection of New Programs and Extended Verbs

3.2.1 See 1.2.3.

3.3 NONE

3.4 NONE

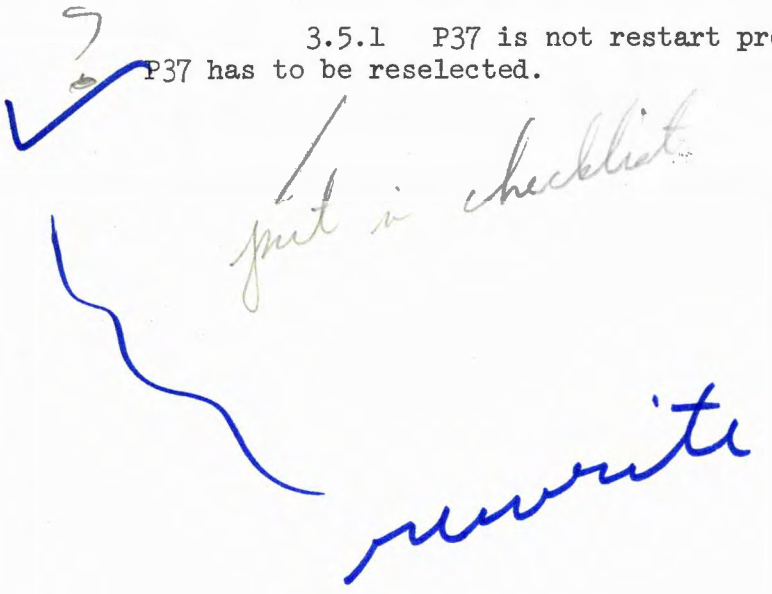
Section C

3.5 Rendezvous and Targeting

3.5.1 P37 is not restart protected. If a restart occurs, P37 has to be reselected.

- P37

put in checklist



Section C

3.6 Optics and IMU

3.6.1 See 1.6.1.

Section C

3.7 Guidance and Control, Boost, and Entry

None

Section D

Program notes applicable to all LUMINARY releases.

1. Crew notes and Checklist Items

1.1 Nouns, Verbs, and Displays

1.1.1 When loading decimal data into the LGC, the ENTER sometimes changes the last digit of the loaded value since PINBALL roundoff in decimal/octal/decimal conversions occur when data is keyed in (decimal to octal) and entered and redisplayed (octal to decimal).

1.1.2 V35 should only be used in P00. Always use ERROR RESET to clear FAILREGS following the PROG light off when V35 is used.

1.2 Selection of New Programs and Extended Verbs

1.2.1 Do not select V92 during P00. Recognition: 1) 07 appears in program light; 2) the DAP is turned off for 10 seconds; 3) the W-matrix will be zero or overwritten; 4) flashing V06N41. Recovery: Select P00 via V37E00E, key V93.

1.2.2 Any program can be terminated: 1) via V34E at any flashing display, or 2) via V37EXXE at any flashing or non-flashing display.

1.2.3 When a new program selection is made via V37, the key release light will remain on during R00 and will not go off until the new program is started. No further keyboard activity should be attempted until the key release light goes off and the new mode lights are displayed.

1.3 Ground Updates and Pad Loads

None

1.4 Navigation and W-matrix

None

1.5 Rendezvous and Targeting

None

1.6 Optics, IMU, and Radars

None

1.7 Guidance and Control, Boost, and Entry

1.7.1 Do not load a zero or negative number in R1 or R2 of N48 (DPS pitch or Roll trim) (SDN-124). Recognition: 1204 alarm with V37 flash. Recovery: Recall present program and R03.

1.7.2 The TGO display in N40 is discontinuous immediately after ignition. The ΔV measured becomes fairly constant and the computation settles out in four-to-five seconds.

2. Ground Notes

2.1 Nouns, Verbs, and Displays

2.1.1 The program will ignore any attempt to load channel 7 via the DSKY. It will not even alarm. Channel 7 is the superbank indicator and is under exclusive program control.

2.2 Selection of New Programs and Extended Verbs

None

2.3 Ground Updates and Pad Loads

None

2.4 Navigation and W-matrix

None

2.5 Rendezvous and Targeting

None

2.6 Optics, IMU, and Radars

None

2.7 Guidance and Control, Boost, and Entry

None

3. Restarts and Priorities

3.1 Nouns, Verbs, and Displays

None