

F+G TRAINING

17 January 1969

COLOSSUS 2

1. CREW NOTES AND CHECKLIST ITEMS

1.1 Nouns, verbs, and displays.

*1.1.1 Some nouns are not manually callable with valid data at any time, e.g., 1, 2, 3, 5, 6, 7, 10, 12, 15, 16, 24, 25, 26, 29, 30, 31, 34, 41, 72, 97 and 98.

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

\ * 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 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).

1.2 Selection of New Programs and Extended Verbs.

\ 1.2.1 V37 should not be called for 20 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: Any of the following: Perform V42 with zero torquing angles or any P5X program.

\ 1.2.2 In ENTRY (P62 - P67), V37's are inhibited after a response to "please perform separation" except a request to perform P00. To get another program up, 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. Any program which does not require DAP control may be selected from P00.

- D 1,2,3 C 1,2,2
- 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.
 - 1.2.4 V82 should never be selected in P11 within ± 5 seconds of LIFTOFF time.
 - 1.2.5 Since some extended verbs (notably V82, V83, and V85) use several JOB areas, a software restart may be generated if these verbs are selected in periods of high activity due to VAC or Core Set overflow. In this case the Program Alarm light will be lit and alarm code 1201 or 1202 will be stored. Extended verb activity will be lost and the verb must be reselected. Typical periods of high activity when this might occur are (1) V83 in P3X or P7X with P20 in the background, and (2) V82 in P4X with Lambert.
 - 1.2.6 Extended verbs are not restart protected and the extended verb activity is lost.

1.3 Navigation and W-Matrix.

- 1.3.1 V96 could leave the other state vector and the W-Matrix out of phase if requested during any permanent state vector updates, P00, P20, P22, P23, and P76, and Average G.

1.3.2 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 N.M.
- b) for orbital navigation - 8.5 N.M.
- c) for cislunar navigation - 275 N.M.

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1.3.3 During a marking sequence in P22, if only one mark is taken, it should not be identified as the "offset" landing site. If more than one mark is taken, any mark may be used (and identified) as the "offset" landing site mark.

↑ —

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

B 1.5.2

Depends on SV accuracy

1.3.5 The recycle on the V06N49 display in P23 does not work. Avoidance procedure: Do not recycle on V06N49 display in P23; always re-select the program.

NOW SPEC Remove as note

1.3.6 P23 does not operate properly at altitudes less than 425 N.M. above earth or moon when marking on the secondary body (i.e., if 400 N.M. above moon and marking on earth).

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1.4 Rendezvous and Targeting

1.4.1 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.

sphere problem

1.4.2 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.

✓ 1.4.3 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.

✓ 1.4.4 For pre-apogee, long transit time aborts, 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.

✓ 1.4.5 The assumption is made in the rendezvous targeting routines (i.e., not P30 or P31) that the resultant perigee altitude will be less than 9999.9 N.M. If it is greater, than this display (N58) will hold at 9999.9.

✓ 1.4.6 The \underline{v}_G or $\underline{\Delta}_v$ displays in control coordinates, N85 or N83, are based on reading the accelerometers every two seconds. The displays, however, are asynchronous one second monitors. The results is a possible 1/2 - 1-1/2 second delay between the application of ΔV and the visible result.

1.4.7 During rendezvous the orientation of the spacecraft about the track axis is unconstrained, when the rates are updated, approximately every eight seconds, the automatic tracking system does not demand a three-axis solution. This can result in drift around the track axis as follows: (1) for X-axis tracking at 1/2° deadband, the maximum drift would be 0.0625°/sec (or 180° in 47 min.). At 5° deadband, the maximum drift would be 0.5°/sec (or 180° in six min.), (2) for preferred axis tracking the maximum drift would be 0.0761°/sec (or 180° in 39 min and 0.61°/sec) (or 180° in 5 min.) for 1/2° and 5° deadbands, respectively.

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part in CM

1.4.8 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 $\Delta R < 256$ meters for earth or < 64 meters for moon; ΔV is computed as zero if $\Delta V < 0.006$ 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.

1.4.9 During P30 (external ΔV) the apocenter and pericenter altitude of the trajectory resulting from the addition of the uplinked ΔV to the state vector existing at ignition time is displayed. For relatively short burns this display is accurate. For the LOI1 burn of the C-prime mission the burn time is 240 seconds, burning for a 170×60 N.M. ellipse. The P30 display will show a pericenter of approximately 970 N.M. (70 N.M. below the lunar surface). This characteristic is inherent to the external ΔV method of targeting for a burn. It should be pointed out that this display is predictable given the spacecraft's state and the ΔV input to P30.

✓ 1.4.10 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.

✓ 1.4.11 P37 targeted maneuvers from earth parking orbit will yield transfer times on the order of 2 minutes for the portion of the pre-maneuver orbit from apogee to perigee (negative flight path angle), where using the $V-\gamma$ target line built into the program. When the pre-maneuver 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 Optics and IMU

1.5.1 Optics CDU fail during TVC sets the tracker light which will stay on even if fail is removed. Recovery: Ignore light.

1.5.2 During auto optics, the computation lag between sampling the IMU CDU's and driving the optics causes the optics to lag behind the target. The amount of offset is proportional to the S/C angular rate. At the usual rate of $4^{\circ}/\text{min}$. the maximum offset would be 0.133 deg. This will not cause an error during manual tracking and marking.

1.5.3 After a fresh start, or RESTART, or after turning OPTICS power on, 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.

1.5.4 If the S/C CONTROL switch is in CMC and the CMC MODE switch is in AUTO or HOLD during R55 (gyro torquing routine), the DAP will maneuver the vehicle to follow the platform as it moves. Go to FREE during gyro torquing.

1.6 Powered Flight, Boost, and Entry.

1.6.1 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 settles down in four to five seconds.

1.6.2 If a roll jet fails "on" during SPS thrust, an appreciable roll excursion ($\approx 300^{\circ}$) may occur. The PITCH-YAW DAP will continue to function properly.

1.6.3 Once the stroke test is started, it can be stopped by V69E which causes a hardware restart and this is acceptable at this time.

1.6.4 ^{C-172} The engine gimbal trim angles (astronaut input to N48) should not exceed 9° .

1.6.5 ^{A 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 of 140° , 0.3 - 0.5 ft/sec at transfer of 60° , and 0.5 - 1 ft/sec at transfer of 30° . For moon environment these jump numbers are 0.02, 0.05, and 0.1, respectively.

1.6.6 The display of range to go (N64) in P63 is bypassed in the first computer cycle (2 sec).

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

1.6.8 ^{A 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 $\sim 5^{\circ}$ (at 140° transfer) to $\sim 20^{\circ}$ (at 60° transfer) to $\sim 30^{\circ}$ (at 30° transfer) for the earth. For the moon, these angles are $\sim 1^{\circ}$, $\sim 3^{\circ}$, and $\sim 5^{\circ}$, 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 less than 1/2 ft/sec.

1.6.9 The velocity, altitude rate, and altitude display (N62) is available in P47, as well as P11, by V16N62. The indicated altitude will be correct in earth environment only. In lunar environment the altitude reading can still be useful to the astronaut by simply adding 2500 N.M. to the displayed value.

- A 1.7.2

1.6.10 During TVC control, failure of the low thrust criterion will cause a flashing V97N40 display. This display, however, is a normal display and cannot "interrupt" and replace an astronaut initiated display; e.g., an extended verb or a monitor or any astronaut key stroke. The result is that the astronaut should not exercise, for extended periods, monitors or extended verb displays while in TVC control. Of course, he can tell if the engine has shut down but the purpose of the flashing V97 is to indicate that the AGC "thinks" the engine is off and has terminated steering (including the cutoff computation) and gone into attitude hold.