

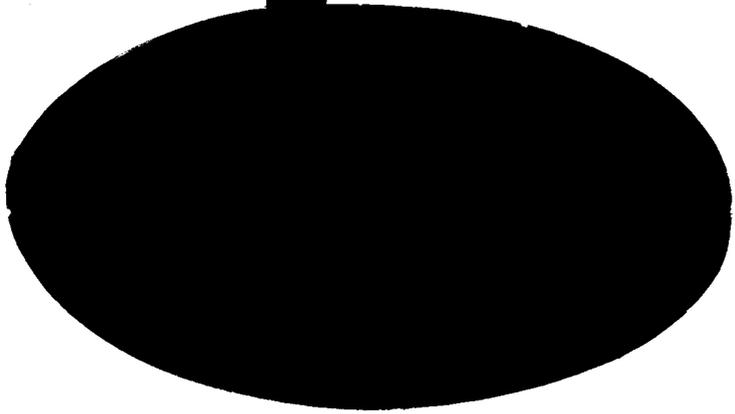
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

APOLLO

GUIDANCE, NAVIGATION AND CONTROL

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 MISSIONS USING PROGRAM SKYLARK 1. SECTION
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R-693

GUIDANCE SYSTEM OPERATIONS PLAN
FOR MANNED CM EARTH ORBITAL
MISSIONS USING PROGRAM SKYLARK I

SECTION 4 OPERATIONAL MODES
(REV. 01)

May 1972

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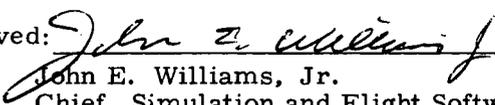
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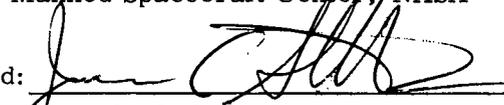
GUIDANCE SYSTEM OPERATIONS PLAN
FOR MANNED CM EARTH ORBITAL
MISSIONS USING PROGRAM
SKYLARK 1

SECTION 4 OPERATIONAL MODES
REVISION 01

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REVISION INDEX COVER SHEET
GUIDANCE SYSTEM OPERATIONS PLAN

GSOP No. R-693 Title: For Manned CM Earth Orbital
Missions Using Program
SKYLARK 1

Section No. 4 Title: Operational Modes

This section incorporates the following NASA/MSC approved changes to Colossus
3 (ART REV 72) and becomes the control document for SKYLARK I.

<u>PCR (PCN*)</u>		<u>PAGES/PROGRAMS AFFECTED</u>
003	Improved Short Burn Logic	P40, R00
004	Deletion of V94 (Cislunar Tracking)	VERBS
005	Deletion of V59 (Optics Cal. Mark)	VERBS, V59, p. 4-14, 4-18
006	Deletion of V52 (Offset Landing Site Mark)	VERBS
007	Deletion of V44 & 45 (Set and Reset of Surface Flag)	VERBS, P20, R31, R34, R61, V44, V45
008	Routine 57 Deletion (Optics Cal. Routine)	INDEX
009	Routine 33 Deletion	INDEX
010	Routine 05 Deletion (S-Band Antenna)	INDEX, VERBS, NOUNS, p. 4-11
011	Programs 72 thru 79 Deletion	INDEX, NOUNS, P20, P34, P35, P36, P38, P40, P41, R00, R07, R23, R31, p. 4-2
013	Deletion of Lunar Surface Alignment Option	P52, P54, OPT CODE
014	Program 39 Deletion	INDEX
015	Program 38 Deletion	INDEX
016	Program 37 Deletion	INDEX, OPT CODE, ALARMS, P20, P37 R22, p. 4-25

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PCR
(PCN*)

PAGES/PROGRAMS
AFFECTED

017	Program 23 Deletion	INDEX, NOUNS, CL CODES, P20, R22, R52, V67, V93
018	Program 22 Deletion	INDEX, NOUNS, P20, P51, R22, R52, R53, V67, V93
019	Program 24 Deletion	INDEX, NOUNS, P20, R52, R53
021	Program 32 Deletion	INDEX, NOUNS, P32, R07
025	Extended Range Capability	P20, P48, R22, R61
032	VHF Range Rate Computation & Display	INDEX, NOUNS, P20, P25, P48, R00, R08, R22, R27, p. 4-7
036	Compute ATM Star Tracker Gimbal Angles	INDEX, NOUNS, OPT CODE, ALARMS, P55, R00, R53
040	SKYLAB Digital Autopilot	INDEX, VERBS, NOUNS, P20, P40, P41, P52, P54, R00, R03, R04, R60, R62, V44, V45, V46, V59, V64
042	SKYLAB 4 Maneuver DKI Sequence	INDEX, P31, P32, P33
043	Moon Ephemeris Suppression in Skylab	P51, P52, P54, R56
400	Program 15 Deletion	INDEX, NOUNS, p. 4-4
405	Transform Optics Angles to Tracking Angles	INDEX, VERBS, R64, V64
410*	Delete Lunar Capability	INDEX, P20, P21, P29, P30, P51, P52, P54, P61, R30, R31, R34, R41, R56, R61, V46, p. 4-1
411*	Delete HAM Targeting Program	P31, R07
412*	Delete ECSTEER	P34, P35, P36, P38
413	ATM Orientation Determination Program (P50)	INDEX, NOUNS, OPT CODE, P50, R00, R53, R56
414	Docked Alignment Capability in P51	P20, P51, P53, R53, R56
415	Docked Alignment Capability in P52	NOUNS, P20, P52, P54, R53, R56
416	Add Gyro Trim to R50	P52, P54, R50

<u>PCR (PCN*)</u>		<u>PAGES/PROGRAMS AFFECTED</u>
420	Display Separation Angle in N05	NOUNS, R54
421	Allow Overwrite of N59 in P36	P36
422*	Initialize Rendezvous Navigation to Update the CSM State Vector	P20
423	Change Conic to Precision Integration in All Rendezvous Tar- getting Programs	P36
424	Improve Minkey Gyro Torquing Logic	P52
434	Correct α_{ATM} in P50	P50
435*	Do not Automatically take VHF in P20	R07
436*	Nominal Use of ATM Sources in P52 and P54	P52, P53, P54, R56
438*	Incorrect Star Tracker Angle in P55	P55
439 REV 1	VHF Range Rate Filter Enable/Disable by Extended Verb	VERBS, R22, V76, V77
442*	Modification to R22	R22
443	Improved R61 Tracking	R61
445*	Modification #3 to Skylark Memo #14	P33
448	Modification #4 to Skylark Memo #14	ALARMS, P31, P32
450*	Add Check for G&N Auto at Start of R67	R67
452	Precision Integration for V90	R36
454	Docked DAP Alarm Codes	ALARMS, R04
455*	Change to P35, P36 and R00 to fix Anomaly ART 07	P35, P36, R00

PCR
(PCN*)

PAGES/PROGRAMS
AFFECTED

456*	Zeroing HOLDFLAG	P20, R00, R60, R61, R67, V56
457*	Editorial Changes to GSOP No. R-577 Section 4 Rev. 16	INDEX, VERBS, ALARMS, P00, P03, P27, P29, P30, P40, P52, P62, R21, R23, R36, R40, R41, R52, R53, R61, R63, R67, V41N20, V42, V57, V86, p. 4-4, 4-8, 4-11, 4-14, 4-15, 4-18, 4-24, 4-25, OPT CODE

The following Skylark Memos have been referenced as source material for the indicated changes.

SLM #2	Operational Modes for SKYLARK Rendezvous Program	INDEX, NOUNS, P20, P31, P32, P33, P34, P35, P36, P37, P38, P47, R00, R07, R23, R31
SLM #8	Modification of VHF R Proposals	P25, P48
SLM #19	VHF R Displays; P48 Change; R22/R27 in P20	INDEX, NOUNS, P20, P25, P48, R08, R22, R27
SLM #20	GSOP Modifications for SKYLARK Complex Impulsive Burn Logic	P40

FOREWORD

SECTION 4

The Guidance System Operations Plan (GSOP) for Program SKYLARK 1 is published in five sections as separate volumes:

2. Data Links
3. Digital Autopilots
4. Operational Modes
5. Guidance Equations
7. Erasable Memory Programs

Since the information in Section 1 of the Colossus 2E GSOP is also applicable to the SKYLARK Program, Section 1 will not be re-published for SKYLARK. The reader is referred, therefore, to R577 Colossus 2E GSOP, Section 1, Revision 2, January 1970. Also, Section 6 will not be published for SKYLARK.

With this issue, Section 4 is revised from the previous issue of SKYLARK 1 (August, 1971), in order to reflect the NASA/MSC-approved changes listed on the "Revision Index Cover Sheet" at the beginning of this volume.

This volume is published as a control document governing operational modes for SKYLARK 1, including GNCS interfaces with the flight crew and MCC. Revisions constituting changes to the SKYLARK 1 Program require NASA approval.

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4. GNCS OPERATIONAL MODES

4.0 Introduction

Preparation of the GNCS for any mission involves the generation of computer programs, flight and ground crew procedures, and the provision of hardware to meet interface, accuracy, and instrumentation requirements. All of these mission-related items are specified in the Guidance System Operations Plan.

The guidance operational concept is designed to comprise a set of manually-initiated programs and functions which may be arranged by the flight crew to implement a large class of flight plans. This concept of operation will permit both a late flight-plan definition and a capability for real-time flight-plan changes.

The GNC System is designed to perform the CM guidance and navigation functions required in a self-contained mode within specified accuracy and maneuver propellant constraints. The System is also designed to accept navigation data from earth-based facilities whenever required to improve accuracy, to reduce maneuver propellant requirements, or to gain some other operational advantage.

4.1 AGC Program Control

To efficiently coordinate the design of the AGC* Programs, as well as define the astronaut and ground control procedures with respect to the GNC system, it is necessary to define the operating inter-relationships between the GNC system, other S/C systems, the astronauts and the ground.

In primary GNCS control modes the AGC can automatically compute required mission parameters and automatically command both GNCS and CSM subsystems. Complete automation of this control throughout a mission is neither feasible nor desirable. For primary as well as secondary GNCS control modes the astronauts and/or the ground must be capable of initiation or termination of AGC Programs. These procedures must be thoroughly defined to permit the design of the AGC Program logic for astronaut/ground participation.

4.1.1 AGC Program Initiation

4.1.1.1 AGC Programs

Due to the random time sequencing of many of the AGC tasks the design of Programs capable of being utilized at varied times and in varied circumstances offers the best method of accomplishing these tasks. These Programs must incorporate sufficient logic to clearly define the particular time and/or application for which they are to be used. They must also standardize astronaut/AGC communication procedures, ground/AGC communication procedures and GNCS and SCS Mode determination.

A logical arrangement of these Programs has been supplemented by simpler routines not requiring identification as Programs. The programs, and their associated routines are outlined in detail in Section 4.4.

When a single program is in process in the AGC, its program number is displayed in the Program lights on the DSKY. When more than one program is in process at the same time, the program which is making primary use of the DSKY will be displayed. There are three cases of dual program operation: programs with P20 in background, P27 with P00, P02 or P20 in background, and P03 with P02 in background.

The AGC is programmed to initiate a Program only in response to the initiation of a specific mission task and will continue the programmed sequence of computations and displays for the specific task until Program completion or termination.

Programs are generally initiated by manual keyboard entry (astronaut) or by AGC UPLINK command (ground). In certain cases Program initiation is automatically performed by the preceding Program. The diagrams of Section 4.4 show Program selection as it should occur normally.

* AGC is an acronym for Apollo Guidance Computer. In the CSM, this computer is officially designated as the CMC (CM Guidance Computer).

4.1.1.2 Special AGC Routines

In addition to the AGC Programs there are many routines and subroutines not specifically identified with a Program. The majority of these are automatically performed in a particular computation or control sequence and involve no notification to the "outside world" that they are in process. While they may occasionally be referred to in this document their large number requires that detailed descriptions be restricted to special AGC program documents.

Several special routines are described in detail herein because of one or more of the following characteristics:

- (a) The routine involves AGC communication with the astronaut.
- (b) The routine is of importance in understanding the Programs.
- (c) The routine involves significant sequences of AGC/Astronaut action but could be performed while certain programs are in process.

These routines include those automatically called by the AGC as well as those manually called. If the routine required AGC/astronaut communication, it will start with a particular display which acts as a key to the astronaut that the AGC has automatically entered the routine.

4.1.2 AGC Program Termination

Normally there are two ways by which an AGC Program in process is terminated:

1. At completion, the program in process will transfer control to (a) the Final Automatic Request Terminate Routine (R00), (b) a subsequent Program.
2. Via a terminate response by the astronaut to an AGC generated flashing display on the DSKY (usually results in transferring control to R00).

In addition to the above, the astronaut may terminate a particular AGC Program as follows:

1. Select a new Program to operate via the DSKY.
2. Select a routine via the DSKY which has been specifically designed to terminate a particular program or activity (e. g. state vector integration).
3. Select the FRESH START routine which essentially initializes the AGC.

4.2 AGC/Astronaut/Ground Communications

4.2.1 AGC/Ground Communications

The AGC/Ground Communications are via the AGC UPLINK and AGC DOWN-LINK and are described in detail in Section 2 of the GSOP.

4.2.2 AGC/Astronaut Communications

The display and keyboard logic in the AGC processes information exchanged between the AGC and the computer operator. This information is exchanged via the display and keyboard (DSKY).

The modes of operation are basically:

- (a) Display of internal data - This includes simple displays and periodically updated displays of data; and displays of requests for operator action required by the AGC.
- (b) Loading of external data - the process of inserting data into the AGC via the DSKY.
- (c) Program or Routine calling - Initiated by operator action via the DSKY.

The following paragraphs and Table 4-1 (page 4-18) provide a limited description of the DSKY, and the crew/DSKY operating procedures. They are included herein to facilitate understanding of the Program logic in Section 4.4 and do not comprise a complete instruction manual for the use of the DSKY. For detailed DSKY operating instructions refer to other MIT documents.

4.2.2.1 The DSKY (refer to Figure 4-1 page 4-19)

(a) UPLINK ACTY Light

1. is energized by the first character of a digital UPLINK message received by the AGC. If the light is not extinguished by the UPLINK transmission it should be extinguished by crew use of the RSET or KEY REL buttons when the UPLINK transmission is complete.
2. is energized during the Universal Tracking program (P20) when the tracking attitude routine (R61) detects that the 10^0 test has failed (see Section 3. for criteria), that HOLDFLAG is not positive non-zero, and that the V50N18 Flag is not set.

- (b) NO ATT Light - is energized when the AGC is in operate mode and there is no inertial reference; i. e. the ISS is caged or in the coarse align mode.
- (c) STBY Light - is energized when the AGC is in standby mode and deenergized when the AGC is in operate mode.
- (d) KEY REL Light
 - (1) Energized when:
 - (a) An internal display comes up while astronaut has the DSKY.
 - (b) An astronaut keystroke is made when an internal flashing display is currently on the DSKY. (Note three exceptions: PRO (proceed), RSET (reset) and ENTR (enter) if ENTR is a single button response.)
 - (c) The astronaut makes a keystroke on top of (his own) Monitor Verb display. This is the so-called "suspended monitor" case. (Monitor Verbs display data updated every one second.)
 - (2) De-energized when:
 - (a) Astronaut relinquishes DSKY by hitting KEY REL button.
 - (b) Astronaut terminates his current sequence normally, e. g.
 - i) with final ENTR of a load sequence.
 - ii) the ENTR of a response to a flashing display.
 - iii) the ENTR of an extended verb request.
 - (3) Some special DSKY cases that may not be universally appreciated are:
 - (a) The astronaut may select a non-Monitor Verb display on top of his own previously selected Monitor Verb. This will cause KEY REL light to flash (See 1 (c) above). Hitting the KEY REL button will bring back (unsuspend) the monitor and extinguish the light. However, if these sequences are selected on top of an internal display, the KEY REL light will not go out as the monitor is unsuspended. It requires one more KEY REL button operation to extinguish the light and bring back the internal display.
 - (b) Suppose the astronaut selects another verb-noun combination (e. g. a V16 monitor) on top of an internal flashing

display. That internal display can still be answered with a PRO or VERB 34 ENTR (terminate), which wipes everything from the DSKY till the next internal display. Therefore, an astronaut selected monitor should, as a rule, never be terminated with VERB 34 ENTR, because that may not be the desired response to the flashing display. The KEY REL button should be used instead.

- (e) TEMP Light - the AGC receives a signal from the IMU when the stable member temperature is in the range 126.3°F to 134.3°F . In the absence of this signal, the TEMP light on the DSKY is actuated.
- (f) GIMBAL LOCK Light - energized when the middle gimbal angle exceeds $+70^{\circ}$ from its zero position. When MGA exceeds $+85^{\circ}$ the ISS is down-moded to Coarse Align and the No Attitude lamp on the DSKY is actuated except during Average-G when the "config" window of DAPDATR1 indicates Saturn configuration.
- (g) PROG Light - The program alarm actuates the PROG light on the DSKY. A program alarm is generated under a variety of situations. For further information relative to program alarm see Sections 4.3.3 and 4.3.4.
- (h) TRACKER Light
 - 1. Failure within the optics CDUs generates a fail discrete (Optics CDU Fail) which is an input to the computer. The TRACKER light is energized by this error signal. The discrete will be set if any or all of the following conditions in either OCDU exist for approximately 2-10 seconds.
 - a. CDU fine error - in excess of 1.0V rms
 - b. READ COUNTER limit cycle - in excess of 160 cps
 - c. $\text{COS}(\theta - \phi)$ - below 2.0V
 - d. +14VDC supply - decrease to 50% of normal level
 - 2. In addition to the conditions described in (1.) the TRACKER light is energized when the VHF Range Read Routine (R08)

reads VHF Range data via the VHF DATA link but the DATA GOOD DISCRETE is missing. R08 is called by the rendezvous tracking data processing routine (R22) and the VHF range rate mark processing routine (R27).

3. It is de-energized if the DATA GOOD DISCRETE is present after reading VHF Range data and by keying in V88E.

It is also de-energized if the conditions described in (1.) and (2.) do not exist.

- (i) OPR ERR Light - is energized when the DSKY operator performs an improper sequence of key depressions. The light is de-energized by pressing the RSET button.
- (j) COMP ACTY Light - is energized when the AGC is occupied with an internal sequence. It is not an indicator of whether the operator may use the DSKY or whether the AGC is not capable of handling further computation.
- (k) RESTART Light - in the event of Restart during operate a latch is set in the AGC which maintains the RESTART light on the DSKY until the latch is manually reset by pressing the RSET button. For further detail see section 4.3.4.
- (l) Display Panel - consists of 24 electroluminescent sections arranged as in Fig. 4-1, page 4-19. Each section is capable of displaying any decimal character or remaining blank, except the 3 sign sections. These display a plus sign, a minus sign, or a blank. The numerical sections are grouped to form 3 data display registers, each of 5 numerical characters; and 3 control display registers, each of 2 numerical characters. The data display registers are referred to as R1, R2, R3. The control display registers are known as VERB, NOUN, and PROGRAM.

At maximum activity, the complete display panel may be updated in approximately 1/2 second.

- (m) Keyboard - contains the following buttons:

VERB - pushing the button indicates that the next two numerical characters keyed in are to be interpreted as the Verb Code.

NOUN - pushing the button indicates that the next two numerical characters keyed in are to be interpreted as the Noun Code.

+ and - sign keys used for sign convention and to identify decimal data.

0 - 9 -numerical keys.

CLR - used during a data loading sequence to clear or blank the data display register (R1, R2, R3) being used. It allows the operator to reload the data word.

PRO - this pushbutton performs two functions:

1. When the AGC is in a standby mode, pressing this button will put the AGC in the operate mode, turn off the STBY light (see (c)), update CMC time counter, and select Routine 00 in the AGC.
2. When the AGC is in the operate mode but Program 06 is not selected, pressing the button will provide the proceed function. Proceed directs the AGC to continue to the next programmed event. In response to an AGC request it further indicates crew compliance with the request. If the PRO button is pressed when the VERB lights contain verb 21, 22, or 23, the button is rejected and the OPR ERR light is energized.
- 2a. When the AGC is in the operate mode and Program 06 is selected, pressing the button will put the AGC in the standby mode and turn on the STBY light (see (c)).

KEY REL - releases the DSKY displays initiated by keyboard action so that the DSKY is available for displays generated by the AGC program.

ENTR - is used in three ways:

1. To direct the AGC to execute the Verb/Noun code now appearing on the Verb Noun lights.
2. To direct the AGC to accept a data word just loaded.
3. In response to a "please perform" request (see section 4.2.2.7).

RSET - turns off PROG light, RESTART light, and OPR ERR light; also clears R1 and R2 of the N09 registers containing the alarm code (FAILREG's).

4.2.2.2 Verbs and Nouns

The basic language of communication between the astronaut and the DSKY consists of Verb and Noun Codes. The Verb Code indicates what action is to be taken. The Noun Code indicates to what this action is applied.

Verb Noun codes may be originated either by manual operation or by the AGC Program in process.

The standard procedure for a manual keyboard operation consists of a sequence of 7 key depressions:

VERB V₁ V₂ NOUN N₁ N₂ ENTR

The VERB key depression blanks the Verb lights on the display panel and clears the Verb Code register within the computer. The next two numerical characters punched in are interpreted as the Verb Code. Each of these characters is displayed in the Verb lights on the display panel as it is punched in. The NOUN key operates similarly for the Noun lights and Noun Code register.

The depression of the ENTR key causes the performance of the Verb-Noun combination appearing in the lights at the time of depression. Thus it is not necessary to follow any order in punching in the Verb or Noun Code. They may be done in reverse order, or an old Verb or old Noun may be used without repunching it.

No action is ever taken in performing the Verb-Noun combination until ENTR is pressed. If an error is noticed in either the Verb Code or the Noun Code before the ENTR is pressed, correction is simple. Merely press the VERB or NOUN key and repunch the originally intended code, without necessarily changing the other. Only when the astronaut has verified that the desired Verb and Noun Codes are in the lights, should he press the ENTR key to execute the Verb-Noun combination.

A Noun Code can refer to a group of computer erasable registers, a group of counter registers, or may serve merely as a label. A label Noun refers to no particular computer registers, but conveys information by its Noun Code number only. The group of registers to which a Noun Code refers may be a group of 1, 2 or 3 members. These are generally referred to as 1, 2, or 3 component Nouns. The component is understood as a component member of the register group to which the Noun refers. The machine addresses for the registers to which a Noun refers are stored within the computer in Noun tables.

A single Noun Code refers to a group of 1, 2, or 3 component members. It is the Verb Code that determines which component member of the Noun group is operated on. Thus, for instance, there are 5 different Load Verbs. Verb 21 is 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 light 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 may be turned off by keying in: PRO, VERB 34 ENTR (terminate), VERB 32 ENTR (recycle), by internal program initiation of the Keyboard and Display System Program, (if the DSKY is not busy) or by a Fresh Start or Restart of the AGC.

Monitor action is suspended (but not ended) by the depression of any key, except RSET, KEY REL, and ENTR. This turns on the KEY REL 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 AGC Programs and routines.

As outlined in the Mission Programs (section 4.4) 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.
- c) Please Perform - to request an action from the astronaut.
(see section 4.2.2.7)
- d) Please Mark - to request the astronaut to push the "MARK" button for an optics sighting. (see section 4.2.2.8)

AGC initiated Verb/Noun combinations are either statically displayed or flashed. If static they identify data displayed only for astronaut information requiring no response from him. If the Verb/Noun is flashing, appropriate astronaut response is required as dictated by the Verb/Noun combination. In this case the AGC Program or Routine is interrupted until the astronaut responds appropriately, then the Verb/Noun flash is terminated and the Program or Routine is resumed. (In some cases, e.g. R31, and R34, the displays will be continuously updated until the flash is terminated).

An appropriate astronaut response to a flashing Verb/Noun should be a data load and ENTR, VERB 32 ENTR (recycle), PRO, or VERB 34 ENTR (terminate). The internal program response to any one of these astronaut responses varies according to the Verb/Noun flashing and the Program in process as described below and in Section 4.4.

4.2.2.3 Acceptance of Keys

The numerical keys, the CLR key, and the sign keys are rejected if struck after completion (final ENTR) of a data display or data load Verb. At such time, only the VERB, NOUN, ENTR, RSET, or KEY REL are accepted. Thus the data keys are accepted only after the control keys have instructed the program to accept them.

Similarly the plus (+) and minus (-) keys are accepted just before the first numerical character of R1, R2, R3 is punched in, and at no other time.

The 8 or 9 key is accepted only while defining a program number, a verb, a noun, or when loading a data word into R1, R2, or R3 which was preceded by a plus or minus sign. (If this is violated, the OPR ERR light is turned on.)

If more than two numerical characters are punched in while loading the Verb, Noun, or Program code in the noun register, or more than five numerical characters while loading a data word, the excess characters are not accepted.

4.2.2.4 Release of Keyboard and Display System

The Keyboard and Display System Program can be used by internal computer programs. However, any operator keyboard action (except RSET) makes the Keyboard and Display System Program busy to internal routines. The operator has control of the Keyboard and Display System until he wishes to release it. Thus he is assured that data he wishes to observe will not be replaced by internally initiated data displays. There are four cases in which the operator initiated normal displays will be replaced by internally initiated action. These are: in P40/P41 when the DSKY is blanked at T-35 seconds, in P20 when DSKY is blanked during return from R60 to R61 at end of maneuver, when P63 is initiated from P62, and at lift off when P11 is initiated. In general, it is recommended that the operator release the Keyboard and Display System for internal use when he has temporarily finished with it. This is done by pressing the KEY REL button.

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:

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

NOTE: Uncommon responses are defined in the program logic of Section 4.4.

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 AGC 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 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. Both decimal and 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 light 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.

If an attempt is made to key in more than 5 numerical characters in sequence, the sixth and subsequent characters are simply rejected. If the 8 or 9 key is punched during octal load (as identified by lack of a sign entry), it is rejected and the OPR ERR light is turned on.

In multi-component load situations, the appropriate single component Load Verbs are flashed one at a time. The computer always instructs the astronaut through a loading sequence. For example: the astronaut (or the internal program) initiates the sequence by selecting VERB 25, "load 3 components of:" (any 3-component noun will do). The Verb Code is changed to 21, "load first component of:" and the flash is turned on. VERB 21 continues to be flashed as the astronaut punches in the first word of data. When the ENTR is pressed, the Verb Code is changed to 22. Flashing continues while the astronaut punches the second data word. When ENTR is pressed, the Verb Code is changed to 23, "load third component," and again the flash continues while the third data word is punched in. When ENTR is pressed, the flash is turned off, and all three data words are placed in the locations specified by the Noun. Throughout the changing of the Verb Codes, the Noun Code is left unchanged.

The CLR button is used during data loading to remove errors in R1, R2, or R3. It allows the astronaut to begin loading the data word again. It does not clear the Program, Noun, or Verb lights. (The Noun lights are blanked by the NOUN key; the Verb lights, by the VERB key.) In the following discussions, the term Clearing Function will be used to mean blanking the data display register.

For single component Load Verbs, the CLR button depression performs the Clearing Function on whichever register is being loaded, provided that CLR is punched before data ENTR. Once ENTR is depressed, CLR does nothing. The only way to correct an error after the data ENTR for a single component Load Verb is to begin the Load Verb again.

For the 2- or 3-component Load Verbs, there is a retrograde sequencing feature of CLR. The first depression of the CLR button performs the Clearing Function on whichever register is being loaded. (CLR may be pressed after any character, before its ENTR.) Consecutive depressions of CLR perform the Clearing Function on the data display register preceding the current one, and also change the VERB light to indicate the register being acted upon until R1 is cleared. Any attempt to back up beyond R1 is simply ignored.

The retrograde sequencing of CLR operates only on data pertinent to the Load Verb which initiated the loading sequence. For example, if the initiating Load Verb was a load second component only, no backing-up action is possible.

4.2.2.7 Please Perform - Verb/Noun Flashing

This is always an internally initiated action, as astronaut response is always required to the "please perform" request; the Verb-Noun is always flashed, and the Program is interrupted. The "please perform" verb (50) is usually used with the "Checklist" noun (25) with an appropriate "checklist code" number in R1. The appropriate response is:

- (a) PRO to indicate an affirmative response to the request.
- (b) ENTR to indicate a negative response to the request.

4.2.2.8 Please Mark

The "please mark" verbs (51 and 53) are flashed when the AGC is prepared to accept optical sighting data upon the pushing of the "MARK" button and ENTER button, respectively. The logic associated with the "please mark" function is completely described in Section 4.4. Marking is also allowed during P20 option 0, 4 without the presence of a please mark verb.

4.2.2.9 Machine Address to be Specified

There is a class of Noun available to allow any machine address to be used. These are called "Machine Address to be Specified" Nouns. When the ENTR which causes the Verb-Noun combination to be executed senses a noun of this type, R3 is blanked and the flash is immediately turned on. The Verb Code is left unchanged. The astronaut should load the 5-octal-character complete machine address of interest. It is displayed in R3 as it is punched in. If an error is made in loading the address, the CLR may be used to remove it. Pressing ENTR causes the verb to be executed.

4.2.2.10 Program Selection

VERB 37 ENTR is used to select a Program. The ENTR causes the Noun display register to be blanked and the Verb Code to be flashed. The 2-character Program Code would then be loaded. For verification purposes, it is displayed as it is loaded in the Noun display register. The ENTR causes 1) the noun register to be blanked and the 37 remaining in the verb register to be non-flashing, 2) a request for the new Program to be entered, and 3) the new Program Code to be displayed (if allowed) in the Program display register.

4.2.2.11 Alarm Philosophy

The OPR ERR light is turned on when the astronaut performs some improper sequence of key depressions.

4.2.2.12 Illegal Verbs, Nouns and Combinations

The simplest alarm situation is an attempt to use an undefined (or spare) Verb Code or Noun Code. The OPR ERR light is turned on when the ENTR that attempts to execute the Verb/Noun combination is pressed. No further action is taken.

It is possible to choose a Verb that is defined and a Noun that is defined, but have the combination of Verb and Noun be illegal (for example, the "decimal display" Verb used with a Noun which is restricted to be "octal only"). The OPR ERR light is turned on at the ENTR that attempts to execute the Verb/Noun combination for display verbs and at the ENTR following the final data load for load verbs. No further action is taken.

Violation of the following principles causes the OPR ERR light to be turned on. No further action is taken.

- (a) An undefined (or spare) verb must not be used.
- (b) An undefined (or spare) noun must not be used.
- (c) In octal Display and Monitor Verbs and all Load verbs, the components number of the verb must not exceed the number of components in the noun. (Note, all "machine address to be specified" nouns are considered 3 component.)
- (d) The octal Display and Monitor Verbs must not be used with a "decimal only" noun.
- (e) The decimal Display and Monitor Verbs must not be used with an "octal only" noun.
- (f) The double precision decimal Display and Monitor Verbs (07, 17) must not be used with mixed nouns (codes 40-99).
- (g) No Load Verb (except V21, V22 and V23) may be used with a noun restricted to be "no load". All nouns having split MIN/SEC scale or 2 integers for any component are "no load" for the entire noun.
- (h) No input code other than those which are defined may be punched into the keyboard.

4.2.2.13 Illegal Data and Recycle

Many legal Verb/Noun combinations require the loading of additional data (either numerical or machine address). It is possible that the data supplied may itself be improper for the Noun selected. Examples are: (1) the numerical data exceeds the maximum value allowed by the scale factor associated with the Noun, and (2) decimal data is loaded into an "octal only" noun.

In general the offense is detected at the final ENTR of the loading sequence. The alarm is turned on and a recycle is performed back to the beginning of the loading sequence. The flash is left on, and the data display register associated with the first data word in the sequence is blanked again. It is necessary for the astronaut 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) Negative decimal data must not be loaded using the Y optics scale.
- (g) All 3 words must be loaded for the Hours, Minutes, Seconds scale.
- (h) 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.
- (i) Two numerical characters must be supplied for the Program Code under V37.

4.2.2.14 Operator Error and Key Rejection

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

- (a) 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.
- (b) Certain program controlled cases (see Section 4.4).
- (c) An attempt to call an extended verb on top of a priority display or an attempt to call an extended verb with displays on top of another extended verb with displays 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.
- (e) Neither V30E or V31E can be called if R1 of N26 is zero.

ASTRONAUT RESPONSE	DISPLAY OF INFORMATION		REQUEST FOR ASTRO ACTION		REQUEST FOR DATA LOAD	REQUEST FOR OPTICS MARK
	CMC Awaiting ASTRO Response V_N_Flashing	CMC Not Awaiting ASTRO Response V_N_Static	CMC Always Awaiting ASTRO Response	Request identified by V53	Request identified by V Loaded data appears in registers R1, R2, R3, At completion, key in "ENTER".	Request identified by V51 At completion of "MARK"s identify target (final entry is "ENTER")
Key in "ENTER"	No CMC Action	No CMC Action	CMC assumes ASTRO did not comply, terminates flashing Verb-Noun, and continues	CMC assumes ASTRO complied	V_N_Flashing CMC takes loaded data, terminated flashing Verb-Noun and continues	V51: No CMC Action
Key in "PRO"	CMC assumes displayed data is correct, terminates flashing Verb-Noun, and continues	No CMC Action	CMC assumes ASTRO complied, terminates flashing Verb-Noun, and continues	In R23 CMC assumes ASTRO has taken sufficient marks, In R56 response is not accepted	Varies with program in progress	See appropriate routine in Section 4.4
Key in "Terminate" (V34E)	Varies with program in progress	No CMC Action	Incorrect Response		Varies with program in process	Varies with program in process
Key in "Recycle" (V32E)	CMC returns to earlier point in sequence	No CMC Action	Incorrect Response		Incorrect response	V51: No CMC Action
Press MARK button	If there is no request for a mark at the time of key depression (P20 option 0, 4 not operating) the PROG Light is turned on. Marking is also allowed during P20 option 0 or 4 without the presence of a please mark verb. Pressing MARK will cause CMC to read 2 optics angles, 3 CDU angles and time and store for R22.					CMC reads 2 optics angles, 3 CDU angles, and time, terminates flashing Verb-Noun if a suitable number of marks have been made and continues

ASTRONAUT RESPONSE TO DSKY DISPLAYS
AND CMC RESULTANT ACTION

Table 4-1

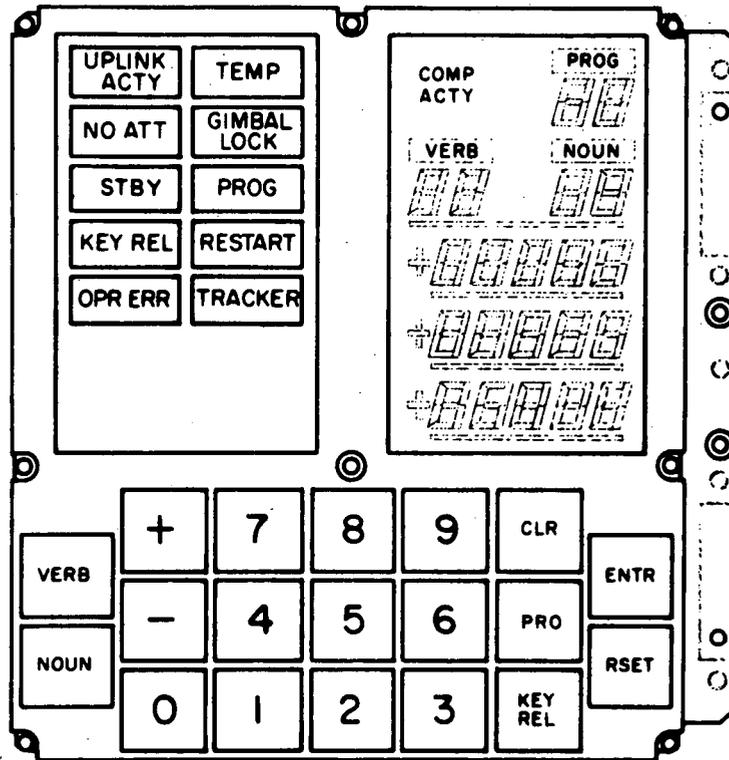


Fig. 4-1 Display and Control Panel

4.3 GNCS Failure Monitor

The GNCS performance and operational readiness are self-monitored and caution and warning information are displayed to the crew. Two warning (red) lamps are actuated by the GNCS on the Caution/Warning Panel: AGC Warning indicates computer failure; ISS warning indicates failure of the inertial subsystem. Also a GNCS Caution (amber) light is actuated to indicate non-critical problems in the system. Further detail regarding the caution items is displayed by means of the DSKY event lamps and the DSKY data registers (in the event of a program alarm).

4.3.1 AGC Warning

An AGC warning alarm is generated in the event of AGC power failure, scaler failure of either of two types, restart or counter failure during AGC operate, or in response to an alarm test program. A scaler fail or prime power fail result in an immediate alarm indication whereas the other inputs are buffered by a filter so as to prevent transient disturbances from causing a warning alarm. In this subsection the various inputs and conditions associated with AGC warning are defined.

- (a) SCAFAL - Occurs if scaler stage 17 (1.28-sec. period) fails to produce pulses. This provides a check on the timing for all logic alarms.
- (b) COUNTER FAIL - Occurs if counter increments happen too frequently or else fail to happen following an increment request. "Too frequently" means continuous counter requests and/or incrementing for from 0.625 to 1.875 ms.
- (c) SCADBL - Occurs if the 100 pps scaler stage operates at a pulse rate of 200 pps or more.
- (d) PARITY FAIL - Occurs if any accessed word in fixed or erasable memory whose address is octal 10 or greater contains an even number of "ones".
- (e) RUPT LOCK - Occurs if interrupt is either too long or too infrequent. The criterion for "too long" is phase dependent, varying in duration from 140 ms. to 300 ms. Likewise the criterion for "too infrequent" varies in absence from 140 ms to 300 ms.
- (f) TC TRAP - Occurs if too many consecutive TC or TCF instructions are run or TC or TCF instructions are too infrequent. The criterion for "too many" varies in duration from 5 ms to 15 ms. The criterion for "too infrequent" varies in absence from 5 ms to 15 ms.

(g) NIGHT WATCHMAN - Occurs if the computer should fail to access address octal 67 within a period whose duration varies from 0.64 sec. to 1.92 sec.

(h) V FAIL - Occurs if the AGC voltages (28, 14, 4) are out of limits. This signal produces STRT1 if it stays on for a period of between 157 and 470 μ sec. If the computer is in the STANDBY mode, an input to the AGC WARNING FILTER is generated simultaneously with STRT1. The following criteria apply for V FAIL:

4 V Supply > 4.4 V

14 V Supply > 16 V

4 V Supply < 3.65V

14 V Supply < 12.5V

28 V Supply < \sim 22.6V

(i) STANDBY - This is a signal which turns on RESTART and turns off the switchable +4 and +14 voltage, thus putting the AGC into a low power mode where only the scaler, timing signal, and a few auxiliary signals are operative. STANDBY is initiated by first setting the ENABLE STANDBY outbit (CH13 B11), and then pressing the PRO button on the DSKY for a time which varies from 0.64 sec. to 1.92 sec. at the end of which time the STANDBY light is turned on. (All AGC alarms are inhibited during the Standby mode with the exception of AGC WARNING, which can be caused by VOLTAGE FAIL or SCALER FAIL; and TEMPERATURE CAUTION, which can be caused by TEMP ALARM.) Normal operation is resumed by pressing the PRO Button on the DSKY again, time of depression same as above.

(j) RESTART - RESTART occurs at next time 12 following occurrence of any one or more of the following parameters: Rupt lock, TC Trap, Night Watchman, parity fail, and Standby as described above.

RESTART occurs immediately and forces time counter to 12 upon occurrence of OSCILLATOR FAIL. (See paragraph (1) below.)

RESTART causes the computer to transfer control to fixed memory address 4000₈ as soon as it disappears. It sets a flip-flop which lights the RESTART CAUTION lamp in the DSKY.

The flip-flop is reset either by the ALARM RESET hard-wired signal or by the CAUTION RESET outbit CH11 B10. ALARM TEST operates the lamp but not the flip-flop.

- (k) **WARNING FILTER** - This circuit is used to operate the AGC WARNING output following repeated or prolonged occurrences of any of certain parameters. All occurrences of these signals are stretched so that no more than one input to the filter is generated in each 160-millisecond period. Approximately six consecutive stretched pulses cause AGC WARNING to turn on for about 5 seconds. Non-consecutive stretched pulses may also cause AGC WARNING after an interval dependent on the frequency of the pulses. The output will not occur if input pulses occur at a frequency of less than 0.9 pps; and the output will remain on if pulses occur at a frequency of 0.6 pps or more. The threshold of the filter resumes its normal level with a time constant of many seconds after the filter has received inputs. An immediate reset of the AGC WARNING due to a WARNING FILTER output is therefore not possible.
- (1) **OSCILLATOR FAIL** - Occurs if the oscillator stops. Has nominal 250-millisecond delay to keep signal present after the oscillator starts. Also occurs when AGC is in STANDBY because of loss of power to front end of circuit. This results in a 250-millisecond delay in starting when AGC comes out of STANDBY into OPERATE and causes an immediate restart without waiting for time pulse 12.

4.3.2 ISS Warning

The ISS Warning signal is the logical "OR" of the following parameters, any one of which will cause an ISS Warning under the following conditions:

(a) **IMU Fail**

- (1) IG Servo Error - greater than 2.9 mr for 2 sec
- (2) MG Servo Error - greater than 2.9 mr for 2 sec
- (3) OG Servo Error - greater than 2.9 mr for 2 sec
- (4) 3200 cps supply - decrease to 50% of normal voltage level
- (5) 800 cps wheel supply - decrease to 50% of normal voltage level

These parameters are generated in the Inertial Subsystem. However, the "WARNING" signal itself is under AGC program control. It is ignored by the AGC program when the G&N system is in the Coarse Align Mode and during the 5-second interval following Coarse Align. During this mode the servo errors normally exceed the above criteria.

(b) **PIPA FAIL**

Pipa fail occurs if no pulses arrive from a PIPA during a 312.5-microsec period, or else if both plus and minus pulses occur, or if a "long

time" elapses without at least one plus pulse and at least one minus pulse arriving. By "long time" is meant a period between 1.28 sec. and 3.84 sec.

This FAIL signal is generated totally within the AGC and thus is completely under AGC program control. Its generation is enabled by the AGC only during AGC controlled translation or thrusting maneuvers.

- (c) ISS CDU FAIL (Monitored for each of 3 CDU's) Set if any or all of the following conditions exist for approximately 2-10 sec.
- (1) CDU fine error - in excess of 1.0 V rms
 - (2) CDU coarse error - in excess of 2.5 V rms
 - (3) READ COUNTER limit cycle - in excess of 160 cps
 - (4) $\text{Cos}(\theta - \phi)$ - below 2.0 V
 - (5) +14 VDC Supply - decrease to 50% of normal level

These parameters are generated in the Inertial Subsystem. However the response to the "FAIL" signal itself is under AGC program control. It is ignored by the AGC program for about 8 seconds after the CDU Zero Mode has been commanded. During this Mode the CDU errors normally exceed some of the above criteria.

4.3.3 GNCS Caution

The GNCS Caution lamp is actuated by the following undesirable and non-critical events:

- (a) CMC Restart during operation. In the event of Restart during operate a latch is set in the CMC which maintains the GNCS Caution alarm and the RESTART lamp on the DSKY until the latch is reset by the program or until the latch is manually reset by pressing the RSET button. For further detail see section 4.3.4.
- (b) Temperature out of Limits. The CMC receives a signal from the IMU when the stable member temperature is in the range 126.3°F to 134.3°F . In the absence of this signal, the Caution alarm and the TEMP lamp on the DSKY are actuated.
- (c) Gimbal Lock. When the CMC determines that the middle gimbal angle (MGA) of the IMU is greater than 70° , the Caution alarm and the Gimbal Lock lamp on the DSKY are actuated. When MGA exceeds 85° the ISS is downmoded to Coarse Align and the No Attitude lamp on the DSKY is actuated except during Average-G when the "config" window of DAPDATR1 indicates Saturn configuration.

- (d) Program Alarm. Under a variety of situations a program alarm is generated. One example is that of a PIPA fail when the vehicle is not in a thrusting mode. Under program control the CMC inhibits this program alarm for 10 sec. after system turn-on. The program alarm actuates the Caution alarm and the Program light on the DSKY. For further information see Section 4.3.4.

4.3.4 Restart and Program Alarms

Program Alarms

1. Alarm conditions are indicated by lighting the PROG ALARM light and storing the appropriate alarm code so that it may be examined by keying V05N09E. In some special cases V05N09 is automatically displayed. The light is turned off and R1, R2 of N09 are cleared by pressing the RSET button. For non-ABORT alarm conditions the normal program flow is not interrupted.

2. The ABORT type of alarm conditions preclude continuation of normal program flow; in these special cases recovery from the condition is accomplished by the software by means of a "software restart". These ABORT conditions are divided into two classes:

- a. "BAILOUT" alarms, designated by a five-digit alarm code with 3 as the first digit, e. g. 31201.

These alarms cause suspension of non-restartable program activity and continuation of only that program activity which is restartable. This type of alarm condition is generally due to temporary overloading of the system; the BAILOUT procedure will relieve the situation and allow continuation of the program.

- b. "POODOO" alarms, designated by a five-digit alarm code with 2 as the first digit, e. g., 21302.

These alarms are caused by conditions which are less likely to be correctable than the "BAILOUT" alarm conditions, e. g. inconsistencies in mathematical calculations. Software recovery procedures for POODOOS depend on program environment at the time:

- 1.) If AVERAGE G is active, the "BAILOUT" recovery procedure is followed. *
- 2.) If an extended verb is active, the "BAILOUT" recovery procedure is followed. *

* When a POODOO abort condition triggers a BAILOUT recovery procedure, the POODOO alarm code is retained.

3.) If neither of the above applies, current program flow is terminated and a flashing V37 is displayed, requesting astronaut selection of a new program.

3. Exit from a continuous "BAILOUT" loop can be accomplished by simultaneous depression of the RSET and MARK REJECT buttons, as in the case of a hardware restart loop. Exit from either a hardware or a software restart loop by means of the above will cause reinitialization of the software by a Fresh Start.

Restarts

Hardware restarts will light the Restart lamp on the DSKY.

4.3.5 Restart Protection

With the exception of P06, the pulse torquing option of P52 and P54 (following ENTR on V50N25, R1 = 00013 until V50N25, R1 = 00014), and in P52 following PRO on V50N25 R1 = 00020 until termination of P52, all programs are restart protected. All routines which are called by a program are restart protected. Restart logic is designed such that significant information is not lost due to a restart. Extended verb routines and manually called displays are not restart protected.

4.3.6 Channel 31, 33 Fail Bit Protection

A new erasable C31FLWRD has been defined which is examined by the AGC to determine if the channel representations of the CMC MODE SWITCH, SC CONTROL SWITCH, OPTICS MODE SWITCH, or OPTICS ZERO SWITCH are to be used or if back-up indications are to be used. The erasable is of the form AxxDx_g.

If A = 0 or 4, the CMC MODE SWITCH and SC CONTROL SWITCH indications are assumed valid. Other values of A cause the AGC to use a back-up indication as shown in Table I.

If D = 0 or 4, the OPTICS MODE SWITCH and OPTICS ZERO SWITCH indications are assumed valid. Other values of D cause the AGC to use a back-up indication as shown in Table II.

C31FLWRD is padloaded as 0xx0x. If the astronaut desires to bypass the channel representation, he should load C31FLWRD via V21 N01 to the values shown in Tables I and II.

Table I

A value	Meaning
1	G&N control FREE
2	G&N control ATT. HOLD
3	G&N control AUTO
5	SCS control FREE
6	SCS control ATT. HOLD
7	SCS control AUTO

Table II

D value	Meaning
1	OPTICS Mode CMC
2	OPTICS Mode ZERO
3	OPTICS Mode MANUAL
5	OPTICS Mode CMC
6	OPTICS Mode ZERO
7	OPTICS Mode MANUAL

4.4 AGC Logic/Ground/Crew Interface Diagrams Description

These diagrams outline the detailed logic of the inter-relationship between the AGC/Crew/Ground. For ease of correction and reproduction the diagrams have been incorporated in a computer memory and are presented as a computer printout.

The diagrams contain the following:

1) Program Control - Indication of sequence interruptions and the following display notation:

- a) PRIO (Priority) - denotes a priority display
- b) HOLD - denotes that the verb-noun and data will continue to be displayed until the astronaut takes DSKY action.
- c) TEMP HOLD (Temporary HOLD) - denotes that the duration of the display on the DSKY (non-flashing) is controlled by the AGC.
- d) POSS HOLD (Possible HOLD) - denotes that the display is a possible path taken by the AGC.
- e) MON (Monitor) - denotes that the displayed data is automatically updated and displayed by the AGC.
- f) SNAP - denotes that the displayed data is not automatically updated (monitored) by the AGC.

2) AGC
 3) Ground
 4) Crew

} The sequence logic and interface relationships of the AGC logic, ground operations and crew activities.

5) A line count is provided on the far right hand side of the page.

6) The AGC Program (or Routine) number and the PROGRAM assembly specification are printed on the lower right hand corner of each page e. g. P40/SKYLARK.

11	EARTH ORBIT INSERTION MONITOR
12	-----*
13	-----*
14	-----*
15	-----*
16	-----*
17	-----*
18	-----*
19	-----*
20	UNIVERSAL TRACKING
21	GROUND TRACK DETERMINATION
22	-----*
23	-----*
24	-----*
25	CONTINGENCY VHF RANGE RATE
26	-----*
27	CMC UPDATE
28	-----*
29	TIME OF LONGITUDE
30	EXTERNAL DELTA V
31	NC1 TARGETING
32	NC2 TARGETING
33	NCC TARGETING
34	NSR TARGETING
35	TPI TARGETING
36	TPM TARGETING
37	RENDEZVOUS FINAL PHASE
38	PLANE CHANGE TARGETING

	39	-----*
THRUST-	40	SPS
ING	41	RCS
	42	-----*
	43	-----*
	44	-----*
	45	-----*
	46	-----*
	47	THRUST MONITOR
	48	RENDEZVOUS THRUST MONITOR
	49	-----*
ALIGN-	50	ATM ORIENTATION DETERMINATION
MENT	51	IMU ORIENTATION DETERMINATION
	52	IMU REALIGN
	53	BACKUP IMU ORIENTATION DETERMINATION
	54	BACKUP IMU REALIGN
	55	ATM STAR TRACKER GIMBAL ANGLE
	56	-----*
	57	-----*
	58	-----*
	59	-----*
ENTRY	60	-----*
	61	ENTRY - PREPARATION
	62	ENTRY - CM/SM SEPARATION AND PRE-ENTRY MANEUVER
	63	ENTRY-INITIALIZATION
	64	ENTRY - POST 0.05G
	65	ENTRY - UP CONTROL

66 ENTRY - BALLISTIC
67 ENTRY - FINAL PHASE
68 -----*
69 -----*
70 PCST
THRUSTING
71 -----*
72 -----*
73 -----*
74 -----*
75 -----*
76 -----*
77 CSM VELOCITY VECTOR UPDATE
78 -----*
79 -----*

ROUTINE ROUTINE TITLE
00 FINAL AUTOMATIC REQUEST TERMINATE
01 ERASABLE AND CHANNEL MODIFICATION
02 IMU STATUS CHECK
03 CSM DAP DATA LOAD
04 DOCKED DAP DATA LOAD
05 -----*
06 -----*
07 MINKEY CONTROLLER
08 VHF RANGE READ
09 -----*

10	-----*
11	-----*
12	-----*
13	-----*
14	-----*
15	-----*
16	-----*
17	-----*
18	-----*
19	-----*
20	-----*
21	RENDEZVOUS TRACKING SIGHTING MARK
22	RENDEZVOUS TRACKING DATA PROCESSING
23	RENDEZVOUS BACKUP SIGHTING MARK
24	-----*
25	-----*
26	-----*
27	VHF RANGE RATE MARK PROCESSING
28	-----*
29	-----*
30	ORBITAL PARAMETERS DISPLAY
31	RENDEZVOUS PARAMETER DISPLAY NO. 1
32	-----*
33	-----*
34	RENDEZVOUS PARAMETER DISPLAY NO. 2
35	-----*
36	RENDEZVOUS OUT-CF-PLANE DISPLAY
37	-----*
38	-----*

39	-----*
40	SPS THRUST FAIL
41	STATE VECTOR INTEGRATION (MID TO AVE)
42	-----*
43	-----*
44	-----*
45	-----*
46	-----*
47	-----*
48	-----*
49	-----*
50	COARSE ALIGN
51	-----*
52	AUTOMATIC OPTICS POSITIONING
53	SIGHTING MARK
54	SIGHTING DATA DISPLAY
55	GYRO TORQUING
56	ALTERNATE LOS SIGHTING MARK
57	-----*
58	-----*
59	-----*
60	ATTITUDE MANEUVER
61	TRACKING ATTITUDE
62	CREW-DEFINED MANEUVER
63	RENDEZVOUS FINAL ATTITUDE
64	OPTICS ANGLES TRANSFORM
65	-----*
66	-----*

	ROTATION
67	-----*
68	-----*
69	-----*
70	-----*
71	-----*
72	-----*
73	-----*
74	-----*
75	-----*
76	-----*
77	-----*
78	-----*
79	-----*

* THIS PROGRAM OR ROUTINE DOES NOT EXIST FOR ASSEMBLY SKYLARK

** THIS PROGRAM IS DOCUMENTED IN SECTION 1 OF R577

CHANGE CONTROL NOTES

REV 00 PCR 008,009,010,011,014,015,016,017,018,019,021,032,036,040,042,400,405,413, PCN 410,457, SL MEMO #2,#19

.....
MONITOR DSKY:
OBSERVE DISPLAY OF
PROGRAM 00

#20

IS QUIT FLAG SET?
.N .Y

RFSET
QUIT
FLAG

#30

SET
NODDFLAG
TO INHIBIT
NEW
PROGRAM
SELECTION.
ASTRO-
NAUT
ACTION

#40

EXTRAPOLATE PERMAN-
ENT STATE VECTORS
FORWARD TO PRESENT
TIME AS DEFINED
IN SECTION 5

#50

RESET NJDDFLAG TO
PERMIT NEW PROGRAM
SELECTION.

#60

F

R3-BLANK

XSM LAUNCH AZIMUTH
MEASURED CLOCKWISE
FROM TRUE NORTH IN
DEGREES TO NEAREST
.01 DEGREES

MONITOR DSKY:
OBSERVE VERB-NUON
FLASH TO REQUEST
PROCEED AND DISPLAY
OF XSM LAUNCH
AZIMUTH

AM I SATISFIED
WITH XSM LAUNCH
AZIMUTH?

.Y .N

WAIT FOR KEYBOARD
ENTRY

KEY IN V2IE AND
LOAD NEW LAUNCH
AZIMUTH

TERMINATE FLASH
UPON RECEIPT OF PRO-
CEED OR NEW DATA

KEY IN PROCEED

.P .NEW
.R .DATA
.O .
.C .
.E .
.E STORE
.D NEW
DATA

SET TIMER

#90

#100

#110

#120

#130

PASTE VJ5N30 AND
THEN V06N41 (DO NOT
OVERWRITE R3)

#80

HCLD .
.....
SNAP .

FLASH VERB-NOUN TO
REQUEST PROCEED AND
DISPLAY STORED
TARGET 1 AZIMUTH AND
ELEVATION:
V06 N41
R1-TARG AZ
R2-TARG ELEV
R3-TARG IDENT

TARG AZ-TARGET
AZIMUTH-ANGLE CLOCK-
WISE FROM TRUE NORTH
TO THE TARGET. IN
DEGREES TO NEAREST
.01 DEGREE

TARG ELEV-TARGET
ELEVATION-ANGLE FROM
THE LOCAL HORIZONTAL
(OF NAV BASE) TO THE
TARGET. IN DEGREES
TO NEAREST .001
DEGREE

TARG IDENT-TARGET
IDENTIFIER-IDENTIFI-
ES AZIMUTH AND
ELEVATION FOR TARGET
1 OR 2

.....

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PROCEED AND DISPLAY
OF TARGET 1 AZIMUTH
AND ELEVATION

#90

.....

AM I SATISFIED WITH
THE AZIMUTH AND
ELEVATION OF TARGET
1?

#100

.Y .V

#110

B

ELEVATION:

V06 N41
R1-TARG AZ
R2-TARG ELEV
R3-TARG IDENT

TARG AZ-TARGET
AZIMUTH-ANGLE CLOCK-
WISE FROM TRUE NORTH
TO THE TARGET. IN
DEGREES TO NEAREST
.01 DEGREE

TARG ELEV-TARGET
ELEVATION-ANGLE FROM
THE LOCAL HORIZONTAL
(OF NAV BASE) TO THE
TARGET. IN DEGREES
TO NEAREST .001
DEGREE

TARG IDENT-TARGET
IDENTIFIER-IDENTIFI-
ES AZIMUTH AND
ELEVATION FOR TARGET
1 OR 2

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

P. .NEW
R. .DATA
O. .
C. .
E. .
E. STORE NEW
D. DATA

COMPUTE LOS TO
TARGET NUMBER ONE

OF TARGET 2 AZIMUTH
AND ELEVATION

AM I SATISFIED WITH
THE AZIMUTH AND
ELEVATION OF TARGET
2?

.Y .N

KEY IN PROCEED

KEY IN V21E,V22E,
OR V24E AND LOAD NEW
DATA

#180

#190

#200

#210

#220

AND DRIVE OPTICS,
IF ALLOWED.

#230

HOLD
.....
.....
.....
.....
.....

FLASH VERB TO
REQUEST PLEASE MARK
V51N BLANK
R1-BLANK
R2-BLANK
R3-BLANK

(NOTE: YOU'N AND R1
WILL NOT BE BLANK IF
ENTERED FROM MARK
REJ. AFTER V50N25,
R1 = 00J16 DISPLAY)

MONITOR DSKY:
OBSERVE VERB
FLASH TO REQUEST
PLEASE MARK

#240

#250

SELECT CMC OPTICS
MODE, OBSERVE SXT
DRIVE (OPTIONAL).

#260

SELECT MANUAL OPTICS
MODE

#270

WHEN SIGHTING ON
TARGET 1 IS SATIS-
FACTORY PRESS MARK
BUTTON

WAIT FOR MARK
TERMINATE FLASH UPON
RECEIPT OF MARK

#330

#340

#350

#360

#370

DATA

COMPUTE LOS TO
TARGET NUMBER
TWO AND DRIVE
OPTICS IF
ALLOWED.

HOLD

FLASH VERB TO
REQUEST PLEASE MARK
V51N BLANK
R1-BLANK
R2-BLANK
R3-BLANK

(NOTE: NOUN AND R1
WILL NOT BE BLANK IF
ENTERED FROM MARK
REJ. AFTER V50N25,
R1 = 00016 DISPLAY)

MONITOR DSKY:
OBSERVE VERB
FLASH TO REQUEST
PLEASE MARK

SELECT CMC OPTICS
MODE. OBSERVE SXT
DRIVE (OPTIONAL)

SELECT MANUAL OPTICS
MODE

#430

#440

#450

#460

#470

ERASE LAST
SET OF MARK
DATA

CALCULATE SM MIS-
ALIGNMENT

FLASH VERB-NOUN TO
REQUEST PROCEED AND
DISPLAY DELTA GYRO
ANGLE:
V06 N93
R1-DELTA GYRO
ANGLE X
R2-DELTA GYRO
ANGLE Y
R3-DELTA GYRO
ANGLE Z

DELTA GYRO ANGLE--
ALIGNMENT ERROR IN
DEGREES TO NEAREST
.001 DEGREE

MOVITOR DSKY:
OBSERVE FLASHING
VERB-NOUN AND
DISPLAY MISALIGNMENT
ANGLES

037

61
P03/SKYLARK

TORQUE Z GYRO PER
ERROR

#580

TERMINATE P03 AND
REDISPLAY P02.
CONTINUE GYRO
COMPASSING.

#590

EXIT P03

CHANGE CONTROL NOTES

REV 00 PCN 457

P03/SKYLARK

MONITOR DSKY:
OBSERVE DISPLAY
OF PROGRAM 06

#20

.....
.....

SET NODOFLAG

RESET REFSMAT,
DRIFT AND TRACK FLAGS

RESET RENDEZVOUS AND
IMUSE FLAGS

RESET UTFLAG

STORE CMC CLOCK TIME

#40

#50

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASHING TO REQUEST
PLEASE PUT CMC IN
STANDBY:

FLASH VERB-NOUN TO
REQUEST PLEASE PUT
CMC IN STANDBY:
V5J N25
R1-00062
R2-BLANK
R3-BLANK

HOLD
SNAP

#60

.....
EXIT P06

.....
EXIT P06

#130

NOTE: WHEN IT IS DESIRED TO BRING THE CMC FROM STANDBY TO OPERATE THE FOLLOWING PROCEDURES APPLY.

#140

.....
KEY IN PROCEED (STANDBY) BUTTON AND HOLD ON

#150

.....
OBSERVE STANDBY LIGHT TO GO OFF

#160

.....
RELEASE PROCEED (STANDBY) BUTTON

#170

.....
UPDATE CMC TIME COUNTER

SEND EFFECTIVE TIME
OF LIFTOFF ON
DOWNLINK

VERIFY AUTOMATIC
START OF DIGITAL
EVENT TIMER

#20

ZERO CMC CLOCK

UPDATE TEPHEM TO
TIME OF LIFTOFF

#30

CALL AVERAGE
G INTEGRATION
WITH DELTA V
INTEGRATION

#40

SET NODDP01
FLAG

#50

SWITCH TO POWE-
RED FLIGHT DOWN-
LIST

TERMINATE 3 YRO-
COMPASSING

#60

#70

COMPUTE INITIAL
STATE VECTOR

COMPUTE REFSMMAT

SET REFSMMAT FLAG

STORE LIFTOFF
ATTITUDE

WAIT 0.5 SEC BEFORE
STARTING ATTITUDE
ERROR COMPUTATION

CALL ROUTINE TO
LOAD ICDU DACS WITH
PITCH, ROLL, AND YAW
ATTITUDE ERRORS DE-
RIVED FROM PRESENT
ATTITUDE AND STORED
LIFTOFF ATTITUDE
UNTIL PRESENT TIME
EQUALS TEL (STORED
IN ERASABLE MEMORY)
AT WHICH TIME THE

MONITOR:
(A) FDAI ATTITUDE
ERROR NEEDLES AS
INDICATION OF
GMC COMPUTATIONS
OF INSERTION.

NOTE: DURING A
NOMINAL LAUNCH
AND AFTER SEPAR-
ATION OF THE LET

#100

#110

VIA R00

.
.
.
...

EXIT P11

#170

.
.
.
.
.
...

EXIT P11

CHANGE CONTROL NOTES

UNIVERSAL TRACKING PROGRAM (P20)

REV 01 03/20/72

PURPOSE:

(1) TO CONTROL CSM ATTITUDE/OPTICS OR ATTITUDE RATES DEPENDING ON WHICH OF THE FIVE OPTIONS IS SELECTED. THEY ARE AS FOLLOWS:

- OPTION 0 - POINT SPECIFIED SPACECRAFT VECTOR ALONG LOS TO OMS WITHOUT CONSTRAINING ROTATION ABOUT VECTOR (VECPNT). THIS OPTION IS USED TO ACQUIRE THE OMS IN THE SXT FIELD.
- OPTION 1 - POINT SPECIFIED SPACECRAFT VECTOR AT SPECIFIED HEAVENLY BODY WITHOUT CONSTRAINING ROTATION ABOUT VECTOR (VECPNT). THIS OPTION DOES NOT EMPLOY OPTICS DRIVE.
- OPTION 2 - PERFORM ROTATION ABOUT SPECIFIED SPACECRAFT VECTOR AT SPECIFIED RATE AND BEGINNING AT SPECIFIED TIME. THIS OPTION IS NORMALLY USED TO EFFECT PTC. THIS OPTION DOES NOT EMPLOY OPTICS DRIVE.
- OPTION 4 - POINT SPECIFIED SPACECRAFT VECTOR ALONG LOS TO OMS, ALSO CONSTRAINING ROTATION ABOUT VECTOR (3-AXIS). THIS OPTION IS USED TO ACQUIRE THE OMS IN THE SXT FIELD AND IS AUTOMATICALLY ENABLED BY THE MINKEY CONTROLLER.
- OPTION 5 - POINT SPECIFIED SPACECRAFT VECTOR AT SPECIFIED HEAVENLY BODY, ALSO CONSTRAINING ROTATION ABOUT VECTOR (3-AXIS). THIS OPTION DOES NOT EMPLOY OPTICS DRIVE.

(2) TO UPDATE EITHER THE OMS OR CSM STATE VECTOR (AS SPECIFIED BY THE ASTRONAUT BY DSKY ENTRY) ON THE BASIS OF OPTICAL TRACKING DATA AND/OR VHF RANGE DATA (OPTIONS 0 AND 4 ONLY). TO UPDATE THE CSM AND OMS STATE VECTORS EVERY FOUR TIME STEPS (OPTIONS 1,2 AND 5 ONLY)

ASSUMPTIONS: (1) THE IMU MUST BE ON AND ALIGNED IN ORDER TO PERFORM THIS PROGRAM.

(2) THE GNCS IS IN CONTROL OF THE VEHICLE IN THE AUTO MODE IN THE NOMINAL CASE. IF THE ASTRONAUT TAKES OVER CONTROL OF THE VEHICLE WITH RHC THE CSM WILL REMAIN AT THE ATTITUDE IT IS DRIVEN TO. REGARDLESS OF MODE SELECTION THE GNCS WILL CALCULATE THE DESIRED TRACKING ATTITUDE.

(3) ROUTINE R03 (R04 FOR CSM-OMS DOCKED) HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM, IN ORDER FOR THE GNCS TO PERFORM THE AUTOMATIC ATTITUDE MANEUVERS THE ASTRONAUT SHOULD KEY IN V46E (V45E FOR CSM-OMS DOCKED) AT SOME TIME PRIOR TO THE FIRST MANEUVER.

(4) THE OMS OPTICAL BEACON IS VISIBLE TO THE CSM. (OPTIONS 0 OR 4).

(5) THE OPERATION OF THE PROGRAM INCLUDES THE FOLLOWING FLAGS:

RENDEZVOUS FLAG-- CONTROLS THE PERMANENT TERMINATION OF THE TOTAL RENDEZVOUS NAVIGATION PROCESS, OPTION 0,4. THESE OPTIONS WILL ONLY RUN OR RESUME RUNNING WHEN THIS FLAG IS SET. SET BY P20 SELECTION OF OPTION 0 OR 4. RESET BY P20 SELECTION OF OPTION 1,2 OR 5. SELECTION OF CMC IDLING PROGRAM(P00), CMC POWER DOWN PROGRAM(P06), CONTINGENCY VHF RANGE RATE PROGRAM(P25), RENDEZVOUS THRUST MONITOR PROGRAM(P48), OR BY V56E, P0000 OR V34E FROM R60 OR R22. THE KEYING IN OF V56E WILL IMMEDIATELY TERMINATE P20 UNLESS A NAVIGATION MEASUREMENT IS BEING PROCESSED IN WHICH CASE IT WILL HOLD UNTIL COMPLETION OF THE INCORPORATION AND THEN TERMINATE P20.

TRACK FLAG-- CONTROLS THE TEMPORARY TERMINATION OF THE TRACKING PROCESS. RESET OF THIS FLAG INTERRUPTS THE AUTOMATIC ATTITUDE MANEUVER/OPTICS POINTING PROCESS, AS WELL AS THE STATE VECTOR UPDATE PROCESS. THE SET OF THIS FLAG ENABLES ALL THESE PROCESSES. SET BY P20,21,29,30,31,32,33,34,35,36,37 AND 38. SET BY P52, P54 SELECTION IF OPTION 2 OF P20 IS RUNNING. RESET BY ANY V37EXE, P0000 AND V56E.

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+ +
+01
+
+489
+ +

SNAPFLAG - INHIBITS R22 MARK PROCESSING DURING CDU-SNAPSHOT AT TIME TD IN R27. SET BY R27 20 SEC. BEFORE TD. RESET IN R27 AFTER TC AND ALSO BY ANY V37EXXE.

UPDATE FLAG- CONTROLS THE TEMPORARY TERMINATION OF THE STATE VECTOR UPDATE PROCESS ONLY. SET BY P20 (OPTION 0 OR 4), 30,31,32,33,34,35,36,37,38 SELECTION. RESET BY ANY V37EXXE, V56E, AND IT IS ALSO RESET AND SET DURING THE PRETHRUST COMPUTATIONS TO PROTECT ERASABLE MEMORY.

STICK FLAG - RESET BY EXECUTION OF A PROGRAM CHANGE VIA R00 AND BY V58E. SET BY TAKING RHC OUT OF DETENT WHEN THE SC CONTROL SWITCH IS CMC AND WHEN THE THC IS NOT CLCKWISE. CDU RATE DRIVE IS NOT PERFORMED IF THE STICK FLAG IS SET. SET BY RCS DAP WHEN MIDDLE GIMBAL ANGLE IS GREATER THAN + OR - 75 DEGREES DURING AN AUTOMATIC MANEUVER.

STATE VECTOR FLAG - DEFINES WHICH STATE VECTOR WILL BE UPDATED BY SIGHTING MARKS AND VHF RANGING. SET TO CSM BY P20 TURN ON AND V81E. SET TO OWS BY V80E.

VHF RANGE FLAG - SET BY V87E, RESET BY V88E. ALLOWS AUTOMATIC VHF RANGE DATA TO BE USED BY THE RENDEZVOUS TRACKING DATA PROCESSING ROUTINE (R22).

AZIMFLAG- SET BY SELECTION OF MINKEY AND P20 (OPTIONS 4 OR 5) TO CONSTRAIN ATTITUDE ABOUT POINTING VECTOR. RESET BY SELECTION OF P20 (OPTIONS 1,2, OR 5).

V50N18 FLAG - SET BY V37EXXE (EXCEPT XX=00) AND BY V58E; RESET BY R61.

UTFLAG- CONTROLS THE PERMANENT TERMINATION OF THE UNIVERSAL TRACKING PROGRAM P20, OPTIONS 1,2,5. THESE OPTIONS WILL ONLY RUN OR RESUME RUNNING WHEN THIS FLAG IS SET. SET BY SELECTION OF P20 OPTIONS 1,2, OR 5. RESET BY SELECTION OF P20 OPTIONS 0 OR 4 AND BY SELECTION OF CMC IDLING PROGRAM (P00), CMC POWER DOWN PROGRAM (P06), BY V56E, P00D00, IMU TURNOFF, OR V34E FROM R60.

R27FLAG- SET BY V76E AND RESET BY V77E AND AT P20 SELECTION. ALLOWS R22 TO CALL THE VHF RANGE-RATE MARK PROCESSING ROUTINE (R27).

R67FLAG- INDICATES THAT R67 (ROTATION ROUTINE) IS ACTIVE. SET WHEN R67 IS INITIATED OR RESTARTED. RESET IN R67 IF TRACKFLG IS RESET, BY V56E, AND BY SELECTION OF V37EXXE.

(6) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY AND BY MINKEY. IT MAY BE TERMINATED BY THE SELECTION OF THE CMC IDLING PROGRAM (P00), CMC POWER DOWN PROGRAM (P06), V34E FROM R60 OR R22, OR BY V56E. P00 SELECTION WILL TERMINATE P20 AND ANY OTHER PROGRAM IN PROCESS AND ESTABLISH P00. ALL OTHER PROGRAMS SELECTED WILL CHANGE THE PROGRAM NUMBER DISPLAYED ON THE DSKY BUT WILL NOT TERMINATE P20. THIS PROGRAM IS DESIGNED TO OPERATE AUTOMATICALLY AND SIMULTANEOUSLY WITH ANOTHER PROGRAM WITHOUT REQUIRING USE OF THE DSKY UNLESS NON-NOMINAL CIRCUMSTANCES REQUIRE CMC COMMUNICATION WITH THE ASTRONAUT. IF V56E IS KEYED INTO THE DSKY AND P20 IS THE ONLY PROGRAM RUNNING, ROUTINE R00 WILL BE INITIATED.

(7) W-MATRIX INITIALIZATION FOR RENDEZVOUS MAY BE ENABLED IN ANY OF THE FOLLOWING WAYS:

- (A) KEYING IN OF VERB 93E
- (B) COMPUTER FRESH START (KEYING IN OF VERB 36E)
- (C) STATE VECTOR UPDATE FROM THE GROUND
- (D) DURING MINKEY BY AUTOMATIC W-MATRIX INITIALIZATION.

(8) THERE IS A RENDEZVOUS OPTICS MARK COUNTER USED IN THE CMC TO COUNT THE NUMBER OF OPTICS MARKS USED TO CHANGE EITHER STATE VECTOR AND THERE IS A RENDEZVOUS VHF RANGING MARK COUNTER USED IN THE CMC TO COUNT THE NUMBER OF VHF RANGING MARKS USED TO CHANGE EITHER STATE VECTOR.

THESE COUNTERS ARE ZEROED BY SEVERAL DISTINCT EVENTS, THEY ARE:

(A) INITIALIZATION OF THE W-MATRIX FOR RENDEZVOUS (FOR ANY REASON, SEE ASSUMPTION 7).

(B) KEYING V36E (REQUEST FOR FRESH START)

(9) SUMMARY OF EXTENDED VERBS ASSOCIATED WITH THE PROGRAM:

- V54E - DO R23 - ALLOWS BACKUP MARKING ON THE OWS.
- V56E - RESET THE RENDEZVOUS FLAG, RESET UTFLAG. CAUSES TERMINATION OF P20.
- V57E - ALLOWS CREW TO CHANGE SETTING OF FULL TRACK FLAG.
- V58E - RESET STICK FLAG, SET V50N18 FLAG - ALLOW AUTO MANEUVERS
- V67E - W-MATRIX RSS ERROR DISPLAY
- V76E - ENABLE R27 (DURING P20 OPTION 0,4)
- V77E - DISABLE R27 (DURING P20 OPTION 0,4)
- V80E - SET STATE VECTJR FLAG TO OWS. DATA WILL UPDATE OWS STATE VECTOR
- V81E - SET STATE VECTOR FLAG TO CSM. DATA WILL UPDATE CSM STATE VECTOR
- V87E - SET VHF RANGE FLAG - ALLOWS R22 TO ACCEPT RANGE DATA.
- V88E - RESET VHF RANGE FLAG - STOPS ACCEPTANCE OF RANGE DATA BY R22.
- V93E - RESET REVDWFLG - CAUSE INITIALIZATION OF W-MATRIX FOR RENDEZVOUS AT NEXT DATA INCORPORATION

(10) PROGRAMS ALLOWING P20 TO RJN IN BACKGROUND (SET TRACKFLG):

PROGRAM NUMBER:	COMPATIBLE OPTIONS:				
	0	1	2	4	5
P21*	X	X	X	X	X
P27		X	X		X
P29*	X	X	X	X	X
P30	X	X	X	X	X
P31-P38	X				X
P52				X	
P54				X	

* TRACKING ONLY (NO NAVIGATION).

(11) ANY PROPORTIONAL SET OF COMPONENTS MAY BE LOADED IN N88, HOWEVER, UNIT VECTORS ARE RECOMMENDED.

(12) INFORMATION FROM THE VHF RANGE RATE MARK PROCESSING ROUTINE (R27) IS AVAILABLE IN OPTIONS 0 AND 4 IF R27 HAS BEEN ENABLED IN P20 BY V76E.

THE NOUNS ASSOCIATED WITH R27 ARE:

- N72 - TIME OF 327 OPTIMIZATION (TD)
- N76 - R1 - RANGE - VHF RANGE TO OWS IN NAUT. MI. TO .01 NM
- R2 - RANGE-RATE - RANGE-RATE BETWEEN CSM, OWS CALCULATED BY VHF RANGE-RATE FILTER IN FPS TO NEAREST .1 FPS. NEGATIVE SIGN INDICATES CLOSING
- R3 - TFO TIME FROM NUM TO OPTIMIZATION TIME (N72) IN MIN AND SEC TO NEAREST SEC. THE VALUE IS +59B59 IF VJ OPTIMIZATION WAS REQUESTED.

N76 CONTAINS EITHER CURRENT OR CONVERGING VALUES OF RANGE-RATE AS SHOWN IN TABLE BELOW

++
+01
+
+
+
+
+
+

#70

RESET R27FLAG

SET STATE VECTOR
FLAG TO THE CSM

SET V50N18 FLAG

SET TRACK FLAG

#90

SET ASSUMED OPTION
IN R2 = 0.

#100

IS AUTOSEQ FLAG
SET?

.NO .YES
. .
. .

SET ASSUMED
GAMMA, RHD,

#110

: 056

AND OMICRON
 TO PREFER-
 RED VALUES
 GAMMA=0.00
 DEG
 RHO=-35.00
 DEG
 OMICRON=
 00.00 DEG

#120

GO TO
 #B#
 BELOW

#130

POSS
 HOLD
 SNAP

FLASH VERB-NOUN TO
 REQUEST RESPONSE AND
 DISPLAY OPTION CODE
 FOR ASSUMED TRACKING
 MODE:

V04ND6
 R1 - 00024
 R2 - 0000X
 R3 - BLANK

R1 IS OPTION CODE
 FOR ASSUMED TRACKING
 MODE.

R2 IS ASSUMED
 OPTION:

0 = RENDEZVOUS
 (VECPPOINT)
 1 = TARGET POINT-
 ING (VEC-
 POINT)
 2 = ROTATION
 4 = RENDEZVOUS

MONITOR DSKY:
 OBSERVE VERB-NOUN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 OF OPTION CODE FOR
 ASSUMED TRACKING
 MODE.

#140

IS THIS THE CORRECT
 OPTION CODE?

.Y .N

#150

#160

(3AXIS)
5 = TARGET POINT-
ING (3AXIS)

WAIT FOR KEYBOARD
ENTRY

KEY IN
PROCEED

#170

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW JATA.

KEY IN V22E AND
LOAD THE CORRE-
CT OPTION CODE.

.P
.DATA
.R
.O
.C
.E
STORE NEW
DATA

#180

IS THIS OPTION
0 OR 4?

.YES
.NO

#190

SET ASSUMED GAMMA,
RHO, AND OMICRON
TO PREFERRED VALUES:
GAMMA = 0
RHO = -J5 DEG
OMICRON = 0

#200

POSS
HOLD
SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY DESIRED
SPACECRAFT VECTOR

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY

#210

ANGLES AND Y-AXIS
CONSTRAINT.

V36N78
R1 - GAMMA
R2 - RHO
R3 - MICRON

ALL ANGLES IN DE-
GREES TO NEAREST
.01 DEGREE.
REFER TO SECT. 5 OF
THIS DOCUMENT FOR
DEFINITION OF
PARAMETERS

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

.NEW
.DATA
.P
.R
.O
.C
STORE NEW
DATA
.E
.D

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY POSITION
PAGE AND DEADBRAND.

IF DESIRED SPACE-
CRAFT VECTOR ANGLES
AND Y-AXIS
CONSTRAINT.

AM I SATISFIED WITH
THESE VALUES?

KEY IN
PROCEED

KEY IN V25E
AND LOAD THE
CORRECT VALUES.

PCSS
+OLD
SNAP

MONITOR DSKY:
RESERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY

#220

#230

#240

#250

#260

#270

#280

#290

#300

#310

UF ROTATION RATE
AND DEADBAND.

AM I SATISFIED
WITH THESE VALUES?

KEY IN
PROCEED

KEY IN V21E, V22E,
OR V24E AND LOAD THE
CORRECT VALUES.

V06N79
R1 - RATE
R2 - DEADBAND
R3 - BLANK

R1 - SPACECRAFT RATE
IN DEG/SEC TO THE
NEAREST .0001 DEG/
SEC. R1 IS BLANK
EXCEPT FOR OPTION 2

R2 - SPACECRAFT
DEADBAND IN DEGREES
TO THE NEAREST .01
DEGREE.

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.P
.R
.D
.C
.E
STORE NEW
DATA

IS OPTION = 4 OR 5?

#370

#380

#390

#400

#410

#420

RESET RENDEZVOUS
FLAG

IS OPTION = 2?

.N .Y
.(1 JR .
.5)
.....
GO TO
"C"
BELOW

++
+01
POSS
HOLD
SNAP
++
+460
++

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY CELESTIAL
BODY CODE.

VOIN70
R1 - 000E
R2 - BLANK
R3 -- BLANK

R1-DE-DESIRED CELES-
TIAL BODY CODE

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
CATA.

.NEW .P
.
.
.

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF CELESTIAL BODY
CODE.

IS THIS THE CORRECT
CODE?

.Y .N
.
.
.
.
.

KEY IN
PROCEED

KEY IN V21E AND
LOAD THE CORRECT
CODE.

.
.
.

"0"
REFL

#470

PCSS
HOLD
SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY PLANET
POSITION VECTOR.

V06N08
R1 - X PL
R2 - Y PL
R3 - Z PL

X PL - THE X COMPO-
NENT OF THE UNIT
POSITION VECTOR OF
THE PLANET AT GET.
IN REFERENCE COORDI-
NATES TO THE FIFTH
PLACE (.XXXXX).

Y PL - SAME AS X PL
FOR Y COMPONENT.

Z PL - SAME AS X PL
FOR Z COMPONENT.

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

NEW
DATA
P
R
O
C
E
E
D

STORE NEW
DATA

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF PLANET POSITION
VECTOR.

ARE THE POSITION
VECTOR COMPONENTS
CORRECT?

.Y .N

KEY IN
PROCEED

KEY IN V25E AND
LOAD CORRECT
POSITION VECTOR
COMPONENTS.

#480

#490

#500

#510

#520

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

.P
.R
.D
.C
.E
STORE NEW
DATA

KEY IN V25E AND LOAD
THE CORRECT VALUE.

#590

STORE TIME IN
R67TIME

#600

"D"

#610

IS UTFLAG SET?

.NO .YES

#620

EXTRAPOLATE PERMA-
NENT STATE VECTORS

#630

#730

#740

#750

#760

#770

++
+01
+
+489
++

GO TO
NEXT
BELOW

COMMAND ZERO
VEHICLE RATE

IS HOLDFLAG
NEGATIVE?

.Y N.

SET HOLDFLAG
ZERO

SET DAP REFER-
ENCE TO DESIRED
DAP CDUS

CLEAR RESTORE DAP
R2IMARK DEADBAND
FLAG

RESET R67-
FLAG

#830

#840

#850

#860

#870

IS TRACK FLAG SET?

.Y .N

COMMAND ZERO
VEHICLE RATE

IS HOLDFLAG
NEGATIVE?

.Y N

SET HOLDFLAG
ZERO

SET DAP REFER-
ENCE TO DESIRED
DAP COUS

RESET R67FLAG

++
+01
+
+489
++

CHANGE CONTROL NOTES

REV 00 PCR 0J7,011,016,017,018,019,025,032,040,414,415, PCN 410,422,456, SKYLARK MEMO #2, #19
REV 01 PCR 459,460, PCN 489



#30

SET CMC ASSUMED
OPTION TO 00001.

#40

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY OPTION CODE
FOR ASSUMED VEHICLE
(OMS OR CSM)
V04 V06
R1 0J002
R2 0000X
R3 BLANK

#50

R1 IS THE OPTION
CODE FOR ASSUMED
VEHICLE.
R2 IS THE CMC
ASSUMED OPTION:
00001 - THIS
VEHICLE
00002 - OTHER
VEHICLE

#60

WAIT FOR KEYBOARD
ENTRY

#70

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

.P .NEW
.R .DATA
.O .
.C .-----
.E STORE
. .
. .
. .

#80

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF OPTION CODE FOR
ASSUMED VEHICLE
(OMS OR CSM).

IS THE ASSUMED
OPTION CORRECT?

.Y .N
. .
. .
. .
. .
. .
. .
. .

KEY IN
PROCEED

KEY IN VZ2E
AND LOAD THE
DESIRED OPTION
INTO R2

#90

#100

#110

#120

#130

NEW
DATA

ZERO T LAT LONG
DISPLAY REGIS-
TERS. R1, R2,
AND R3 WILL
INITIALLY READ
C0000

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY T LAT LONG:
V06 V34
R1-T LAT LONG-HRS
R2-T LAT LONG-MIN
R3-T LAT LONG-SECS

T LAT LONG - TIME
(GET) AT WHICH LAT
AND LONG OF VEHICLE
POSITION IS DESIRED
IN HRS, MINS,SECS
TO NEAREST .01 SEC.

HOLD
SNAP

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF T LAT LONG.

DO I WISH TO HAVE
THE CMC COMPUTE
PARAMETERS FOR THE
PRESENT TIME?

.N .Y

AM I SATISFIED
WITH THE DIS-

#140

#150

#160

#170

#180

PLAYED TIME?

.N
.Y

ARE ALL
THREE RE-
GISTERS
EQUAL TO
ZERO?

.Y .N

KEY IN
PROCEED

KEY IN V25E AND L3AD
NEW DATA.

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF NEW DATA
OR PROCEED

.P
.NEW
.DATA
.R
.O
.C
STORE
.E
NEW
DATA
.D

IS T LAT LONG ZERO?

.N
.Y

CHANGE T LAT LONG
TO PRESENT TIME

LONG-LONGITUDE OF
VEHICLE. + IS EAST.
IN DEGREES TO NEAR-
EST .01 DEGREE.
ALT-ALTITUDE OF
VEHICLE ABOVE THE
LAUNCH PAD RADIUS.
IN NAUTICAL MILES TO
NEAREST .1 NM.

#240

#250

DO I WISH TO OBTAIN
NEW PARAMETERS FOR
A TIME 10 MIN.
FROM NOW OR ANY TIME
OTHER THAN THAT
WHICH APPLIES TO
PRESENT DISPLAY?

#260

.N .Y

WAIT FOR KEYBOARD
ENTRY

WHEN FINISHED
WITH DISPLAY
KEY IN
PROCEED

#270

TERMINATE FLASH UPON
RECEIPT OF RECYCLE
OR PROCEED

WHEN FINISHED
WITH DISPLAY KEY
IN RECYCLE
V32E

#280

.P
.R
.O
.C
.Y

REV 01 03/20/72

CONTINGENCY VHF RANGE RATE PROGRAM (P25)

- PURPOSE: (1) TO DISPLAY TO THE ASTRONAUT RANGE AND RANGE RATE FROM A SOURCE INDEPENDENT OF THE VEHICLE STATE VECTORS.
 ++
 +01 (2) TO ALLOW THE ASTRONAUT TO SELECT A SEQUENCE OF TIMES FOR WHICH THE RANGE RATE WILL BE OPTIMIZED.
 +
 ASSUMPTIONS: (1) THE VHF MUST BE OPERATING.
 +
 + (2) IF THE ASTRONAUT LOADS N72 WITH A TIME IN THE FUTURE, OPTIMIZATIONS WILL OCCUR AUTOMATICALLY EVERY 4 MINUTES,
 + BEGINNING WITH THAT TIME (N72) SELECTED BY THE ASTRONAUT.
 ++459
 ++ (3) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG
CONT

CREW

GROUND

CMC

.CREW PROG
.SELECTION

Preceding page blank

DO R00 TO START
CONTINGENCY VHF
RANGE RATE PROGRAM
DISPLAY PROGRAM 25

KEY IN CONTINGENCY
VHF RANGE RATE
PROGRAM (P25)
V37E 25E

MONITOR DSKY:
OBSERVE DISPLAY OF
PROGRAM 25

RESET RENDEZVOUS
FLAG

PRECEDING PAGE BLANK NOT FILMED

#10

#20

#30

AND SEC TO NEAREST
SEC. THE VALUE IS
+59859 IF NO
OPTIMIZATION WAS
REQUESTED.

#180

++
+01

DO I WANT TO ALTER
THE PRESENT OPTI-
MIZATION SEQUENCE?

.NO
.YES

#190

WAIT FOR KEYBOARD
ENTRY

WHEN FINISHED
WITH DISPLAY
KEY IN PROCEED.

#200

TERMINATE FLASH UPON
RECEIPT OF RECYCLE
OR PROCEED

NOTE: NEXT
DISPLAY NOT
VALID UNTIL
TFO = +00802

.R
.P
.E
.R
.C
.D
.Y
.C
.E
.L
.E
.D

WHEN FINISHED
WITH DISPLAY KEY
IN RECYCLE V32E

#210

+489
++

FLASH VERB-NOUN TO
REQUEST RESPONSE. AND
DISPLAY RENDEZVOUS
PARAMETERS:

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY

#220

HOLD
MON


```

N72 TIME IS HERE
INCREMENTED BY 4
MIN, IFJ NOW COUNTS
DOWN FROM -32B25 TO
NEXT OPT TIME.

```

#280

++459

```

DO I WANT TO ALTER
THE PRESENT OPTIMI-
ZATION SEQUENCE?

```

#290

```

.NO
.YES

```

```

WAIT FOR KEYBOARD
ENTRY

```

#300

```

TERMINATE FLASH UPON
RECEIPT OF RECYCLE
OR PROCEED

```

```

.P
.R
.O
.C
.Y
.C
.E
.L
.E
.D

```

#310

```

WHEN FINISHED
WITH DISPLAY KEY
IN RECYCLE V32E

```

DO ROUTINE R00

DO ROUTINE R00

#320

FCR DOWMLINK TRANS-
MISSION

DISPLAY PROGRAM 27

IS THIS A TIME IN-
CREMENT UPDATE
(V70 OR V73)?

.N .Y
"B"
FROM
BELOW
SET COMPNUMB
EQUAL TO 2

FLASH VERB/NOUN TO
REQUEST LOAD OF
INDEX IN MACHINE
ADDRESS SPECIFIED IN
R3 AND DISPLAY:
V21 N01
R1-BLANK
R2-BLANK
R3-AAAAA

AAAA-MEMORY LOCA-
TION IN WHICH THE
INDEX VALUE WILL BE
LOADED. THE INDEX
VALUE REPRESENTS THE
TOTAL NUMBER OF
NUMERIC VALUES TO BE
LOADED, INCLUDING
THE INDEX VALUE IT-

POSS
HOLD
SNAP

MONITOR DSKY:
OBSERVE DISPLAY
OF PROGRAM 27

GO TO
"A"
BELOW

#120

#130

#140

#150

SELF MINIMUM INDEX
IS 3; MAXIMUM IS 20.

#160

WAIT FOR KEYBOARD
ENTRY

TRANSMIT
TERMINATE
V34E

#170

GO TO "A"
BELOW

#180

TRANSMIT
INDEX
VALUE

TERMINATE FLASH UPON
RECEIPT OF TERMINATE
OR INDEX

#190

- .I
- .N
- .D
- .E
- .X
- .A
- .T
- .E
- .
- .
- ...

#200

GO TO "A"
BELOW

DISPLAY
INDEX

THE TRANSMITTED
WORDS WILL BE
CORRECTED.

DO I WISH TO
TERMINATE?

WAIT FOR KEYBOARD
ENTRY

.Y .N

#360

DO I WISH
TO COR-
RECT ANY
DATA?

.Y .N

#370

TRANSMIT
TERMIN-
ATE V34E

#380

GO TO
"A"
BELOW

TRANSMIT
OCTAL
IDENTIF-
IER

#390

TRANSMIT
PROCEED
V33E

#400

#560

GO TO "A"
BELOW

#570

INCREMENT TEPHEM
AND DECREMENT
STATE VECTOR
TIME TAGS AND
CMC CLOCK

#580

GO TO "A" BELOW

#590

ARE ALL LOADED ADD-
RESSES LEGAL?
NOTE 1 - FOR V72
COMPNUMB MUST BE
AN ODD NUMBER
NOTE 2 - FOR V71 ALL
ADDRESSES MUST BE
IN THE SAME E-BANK.

.N
.Y

MONITOR DSKY:
OBSERVE OPERA-
TOR ERROR LITE

#610

GO TO "A"
BELOW

TRANSFER DATA TO
SPECIFIED BLOCK
(V71) OR SPECIFIED
ADDRESSES (V72)

WAS THIS A STATE
VECTOR UPDATE?

.N .Y

"A"
FROM
ABOVE

ZERO
CHANNEL
77

"A"
FROM
ABOVE

"A"
FROM
ABOVE

TURN OFF UPLINK ACTY...
LITE

MONITOR DOWN-
LINK:
OBSERVE UPLINK
ACTY LITE
OUT, REVERSION
TO ORIGINAL
DOWNLINK LIST,
TERMINATION OF
P27, AND RE-
TURN TO P00,
P02, OR P20.

TERMINATE P27 AND GO
TO PROGRAM WHICH WAS

MONITOR DSKY:
SUCCESSFUL UPDATE IS
INDICATED BY UPLINK
ACTY LITE OUT,
OPERATOR ERROR LITE
OUT, AND RETURN TO
P00, P02, OR P20.

#620

#630

#640

#650

109

135
P27/SKYLARK

#660

INTERRUPTED (P00,
P02, OR P20)

.
.
.
...

EXIT P27

CHANGE CONTROL NOTES

REV 00 PCN 457
REV 01 PCN 489

#30

#40

#50

#60

#70

SET TRACK FLAG

SET CMC ASSUMED
OPTION TO 00001.

HOLD
SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY OPTION CODE
FOR ASSUMED VEHICLE
(OMS OR CSM)
V04 N06
R1 00002
R2 0000X
R3 BLANK

R1 IS THE OPTION
CODE FOR ASSUMED
VEHICLE.

R2 IS THE CMC
ASSUMED OPTION:
00001 - THIS
VEHICLE
00002 - OTHER
VEHICLE

"A"

MONITOR DSKV:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF OPTION CODE FOR
ASSUMED VEHICLE
(OMS OR CSM)

IS THE ASSUMED
OPTION CORRECT?

.Y .N

R1-BASE TIME-HRS
 R2-BASE TIME-MINS
 R3-BASE TIME-SECS
 BASE TIME- TIME FROM
 WHICH THE NEXT
 CROSSING OF DESIRED
 LONGITUDE IS
 COMPUTED.
 IN HRS, MINS, SECS
 TO NEAREST .01 SEC.

OF BASE TIME

#130

#140

DO I WISH TO HAVE
 THE CMC COMPUTE
 PARAMETERS FOR THE
 PRESENT TIME?

.N .Y

#150

AM I SATISFIED
 WITH THE DIS-
 PLAYED TIME?

.N .Y

#160

ARE ALL
 THREE RE-
 GISTERS
 EQUAL TO
 ZERO?

.Y .N

#170

WAIT FOR KEYBOARD
 ENTRY

KEY IN
PROCEED

TERMINATE FLASH UPON
RECEIPT OF NEW DATA
OR PROCEED

.NEW .P
.DATA .R
.O .C
STORE .E
NEW .E
DATA .D

IS BASE TIME ZERO?

.N .Y

CHANGE BASE TIME
TO PRESENT TIME

HOLD
SNAP
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY LONGITUDE:
V06 N43
R1 - BLANK

KEY IN V25E AND LOAD
NEW DATA.

.
.
.

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF DESIRED LONGI-

#180

#190

#200

#210

#220

R2 - LONG
R3 - BLANK

LONG - DESIRED LONG-
ITUDE OF VEHICLE.
+ IS EAST. IN
DEGREES TO NEAREST
.01 DEGREE.

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF NEW DATA
OR PROCEED

.NEW .P
.DATA .R
. .O
STORE .C
NEW DATA .E
. .E
. .D

COMPUTE TIME TO NEXT
CROSSING OF DESIRED

TUDE

AM I SATISFIED WITH
THE DISPLAYED
LONGITUDE?

.Y .N

KEY IN
PROCEED

KEY IN V22E AND
LOAD NEW DATA.

#230

#240

#250

#260

#270

LONGITUDE AFTER BASE TIME.

.
. .
. .

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY T LAT LONG: V06 N34 R1-T LAT LONG-HRS R2-T LAT LONG-MINS R3-T LAT LONG-SECS

T LAT LONG- TIME OF LONGITUDE CROSSING. IN HRS, MINS, SECS TO NEAREST .01 SEC.

.
. .
. .

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF RECYCLE OR PROCEED

.P
.R
.E
.D
.C
.Y
.C
.E
.L
.D

MONITOR DSKY: OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF T LAT LONG.

.
.

DO I WISH TO OBTAIN NEW PARAMETERS USING THE ORIGINAL BASE TIME AND A NEW DESIRED LONGITUDE?

.N
.Y
. .
. .

WHEN FINISHED WITH DISPLAY, KEY IN PROCEED

WHEN FINISHED WITH DISPLAY, KEY IN RECYCLE V32E

#280

#290

#300

#310

 BASED ON THE STORED
 TARGET PARAMETERS
 COMPUTE NECESSARY
 DEPENDENT VARIABLES
 FOR EVALUATION OF THE
 THRUSTING MANEUVER
 INCLUDING PERIGEE
 ALTITUDE, APOGEE
 ALTITUDE AND DELTA V
 REQUIRED (SEE SECTION
 5.3 OF R693).

#180

HCLD
 SNAP

 FLASH VERB-NOUN TO
 REQUEST RESPONSE AND
 DISPLAY CALCULATED
 THRUSTING PARAMETERS:
 V06 N#2
 R1-APO ALT
 R2-PER ALT
 R3-DELTA V

#190

 APO ALT - ALTITUDE
 OF APOGEE ABOVE THE
 LAUNCH PAD RADIUS
 IN NAUTICAL MILES TO
 THE NEAREST .1 NM.
 PER ALT - ALTITUDE
 OF PERIGEE ABOVE THE
 LAUNCH PAD RADIUS
 IN NAUTICAL MILES
 TO THE NEAREST
 .1 NM.

#200

 DELTA V - MAGNITUDE
 OF IMPULSIVE DELTA V
 VECTOR AT TIG. IN FPS
 TO NEAREST .1 FPS
 NOTE: IF APO ALT OR
 PER ALT EXCEEDS
 SCALE, THE DISPLAY
 WILL BE 9999.9 NM

#210

 MONITOR DSKY:
 OBSERVE VERB-NOUN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 OF CALCULATED
 THRUSTING PARAMETERS

 IS A GROUND STATION
 AVAILABLE FOR CON-
 FIRMATION OF THESE
 PARAMETERS?

#220

#230

MONITOR CMC
 DOWNLINK TELE--
 METRY OF APO
 ALT, PER ALT
 AND DELTA V RE-
 QUIRED. COORDI-
 NATE EVALUATION
 OF CMC COMPUTED
 PARAMETERS WITH
 ASTRONAJT

 COORDINATE
 EVALUATION OF
 THE CMC COMPU-
 TED PARAMETERS
 WITH THE
 GROUND

#240

 SELECT ONE OF THE
 FOLLOWING FIVE
 ALTERNATIVES:

#250

(1) IF THE CALCULATED DATA IS SATISFACTORY, PERFORM THE THRUSTING MANEUVER USING THE CMC CALCULATED PARAMETERS WITHOUT GROUND CONFIRMATION.

#260

(2) IF THE CALCULATED DATA IS NOT SATISFACTORY ADJUST THE CALCULATED PARAMETERS BY RESELECTING P30 AS NECESSARY AND CHANGING THE LOADED AIM PARAMETERS UNTIL CMC COMPUTED PARAMETERS ARE SATISFACTORY. THEN PERFORM THE THRUSTING MANEUVER.
 (3) REMAIN AT

#270

THIS POINT IN THE
 CMC PROGRAM UNTIL
 GROUND COORDINA-
 TION IS AVAIL-
 ABLE.
 (4) SELECT A NEW
 PROGRAM AS DE-
 SIRED UNTIL
 GROUND CO-ORDINA-
 TION IS AVAILABLE
 THEN RESELECT
 P30. LEAVE AIM
 PARAMETERS
 UNCHANGED ETC.
 (5) SELECT A NEW
 PROGRAM AS DE-
 SIRED AND PERFORM
 THRUSTING MANEU-
 VER USING BACKUP
 PROCEDURE.

#290

 2.1.
 4.
 5.

#300

ARE THESE
 PARAMETERS
 SATISFACTORY
 FOR USE BY THE
 CMC FOR THE
 THRUSTING
 MANEUVER?

N Y.
 .
 .
 .
 .
 .

#310

 SELECT ONE OF
 THE FOLLOWING
 FOUR ALTERNA-
 TIVES:

#320

#330

#340

#350

#360

(1) ADJUST THE
CALCULATED PARA-
METERS BY RESEL-
ECTING P30 AS
NECESSARY AND
CHANGING THE
LOADED AIM PARA-
METERS UNTIL CMC
COMPUTED PARA-
METERS ARE
SATISFACTORY.
(2) OBTAIN NEW
AIM PARAMETERS
FROM THE GROUND
BY VOICE LINK,
RESELECT P30,
KEY IN NEW DATA,
ETC.
(3) SELECT THE
CMC UPDATE
PROGRAM (P27).
LOAD NEW AIM
PARAMETERS FROM
THE GROUND VIA
THE CMC UPLINK,
OR BY CREW
DSKY INPUT.
OBSERVE NEW AIM
PARAMETERS, ETC.
(4) TERMINATE
P30 BY SELECT-
ING A NEW PRO-
GRAM AS DESIRED
AND PERFORM THR-
USTING MANEUVER
USING BACKUP
PROCEDURES.

- 1.
- 2.
- 3.
- 4.

WAIT FOR KEYBOARD
ENTRY.

KEY IN PROGRAM
SELECTION AS
DESIRED
V37E--E

.....

SIGNIFICANT DIGITS
IS THE VHF RANGING
MARK COUNTER AND
THE TWO LEAST SIGNI-
FICANT DIGITS IS THE
OPTICS MARK COUNTER.

#470

NOTE: THE OPTICS
MARK COUNTER DOES
NOT DISTINGUISH BE-
TWEEN BACKUP AND
PRIMARY MARKS.

#480

TFI - TIME FROM
TIG. IN MIN AND SEC
TO NEAREST SEC.
MAXIMUM READING IS
59859. (- BEFORE
+ AFTER TIG.)

MGA-MIDDLE GIMBAL
ANGLE AT TIG IF
+X CSM AXIS IS
ALIGNED WITH INITIAL
THRUST DIRECTION.
SIGN IS ALWAYS +
EXCEPT WHEN THE IMU
IS NOT ALIGNED THE
VALUE IS -00002. IN
DEGREES TO NEAREST
.01 DEGREE

#490

.....

WAIT FOR KEYBOARD
ENTRY

..... KEY IN PROCEED

#500

TERMINATE FLASH UPON
RECEIPT OF PROCEED

#510

.PRO

.....

NCL TARGETING PROGRAM (P31)

REV 01 03/20/72

PURPOSE:

- (1) TO CALCULATE THE PARAMETERS ASSOCIATED WITH THE NCL MANEUVER FOR DELTA V BURNS.
- (2) TO CALCULATE THESE PARAMETERS BASED UPON MANEUVER DATA APPROVED AND KEYED INTO THE CMC BY THE ASTRONAUT.
- (3) TO DISPLAY TO THE ASTRONAUT AND THE GROUND DEPENDENT VARIABLES ASSOCIATED WITH THE NCL MANEUVER FOR APPROVAL BY THE ASTRONAUT/GROUND.
- (4) TO STORE THE NCL TARGET PARAMETERS FOR USE BY THE DESIRED THRUSTING PROGRAM.

ASSUMPTIONS:

- (1) AT A SELECTED TPI TIME, THE LINE OF SIGHT BETWEEN THE CSM AND THE OWS IS SELECTED TO BE A PRESCRIBED ANGLE (E) FROM THE HORIZONTAL PLANE DEFINED AT THE ACTIVE POSITION.
- (2) THE NCL, NC2, VCC MANEUVERS ARE CONSTRAINED TO BE HORIZONTAL MANEUVERS.
- (3) THE NSR MANEUVER IS CONSTRAINED TO RESULT IN COELLIPTIC ORBITS FOLLOWING THE MANEUVER.
- (4) THE FOLLOWING TIME CONSTRAINTS APPLY:
 - A) THE TPI TIME AND THE TIME BETWEEN THE NCC AND NSR MANEUVERS ARE SPECIFIED (DSKY INPUT AND PAD-LOAD RESPECTIVELY).
 - B) THE TIMES BETWEEN THE NCL AND NC2 MANEUVERS AND THE NC2 AND VCC MANEUVERS ARE INDIRECTLY SPECIFIED BY SPECIFYING THE NUMBER OF 1/2 REVOLUTIONS INVOLVED IN THE TRANSFERS BETWEEN THE MANEUVERS (DSKY INPUT AND PAD-LOAD RESPECTIVELY).
- (5) THE ALTITUDES BETWEEN THE OWS ORBIT AND THE CSM AT BOTH NCC AND NSR TIME ARE SPECIFIED (DSKY INPUT).
- (6) CMC COMPUTED VARIABLES MAY BE STORED FOR LATER VERIFICATION BY THE GROUND. THESE STORAGE CAPABILITIES ARE NORMALLY LIMITED ONLY TO THE PARAMETERS FOR ONE THRUSTING MANEUVER AT A TIME EXCEPT FOR CONCENTRIC FLIGHT PLAN MANEUVER SEQUENCES.
- (7) IF P20 IS IN OPERATION WHILE THE PROGRAM IS OPERATING THE ASTROVAJT MAY HOLD AT ANY FLASHING DISPLAY AND TAKE OPTICS MARKS AND/OR HE MAY ALLOW VHF RANGING MARKS TO ACCUMULATE. (HOWEVER, IF THE UPDATE FLAG IS NOT SET THE MARKS WILL NOT BE INCORPORATED OR ACCUMULATED) SEE P20 FOR DETAILED DESCRIPTION.
- (8) THERE IS NO REQUIREMENT FOR ISS OPERATION TO PERFORM THIS PROGRAM.
- (9) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY OR INTERNALLY BY THE MINKEY CONTROLLER (R07).

++
+01
+
+
+
+489
++

PROG

CMC

GROUND

CREW

CONT

•AUTOMATIC
•PROGRAM
•SELECTION

•CREW
•PROGRAM
•SELECTION

DO R00 TO START
NCL TARGETING
PROGRAM (P31)

KEY IN NCL TARGET-
ING PROGRAM (P31)
V37E31E

#10

DISPLAY P31

MONITOR DSKY:
OBSERVE DISPLAY
OF P31

#20

•
•
• *START*
•
•
•
•
•
•

SET UPDATE FLAG

#30

SET TRACK FLAG

#40

RESET PCFLAG

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

-PRO
-NEW
-DATA

STORE DATA

#110

HOLD
SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STORED HALF-
REVS, DELTA H(NCC),
AND DELTA H(NSR)
V06 V57

R1 - HALFREVS
R2 - DELTA H(NCC)
R3 - DELTA H(NSR)

#120

HALFREVS - NUMBER OF
1/2 REVS BETWEEN NC1
AND NC2

#130

DELTA H(NCC) - THE
ALTITUDE BETWEEN THE
ACTIVE AND PASSIVE
VEHICLE ORBITS AT
TIG(NCC). SIGN IS +
WHEN THE ACTIVE
VEHICLE IS BELOW THE
PASSIVE VEHICLE. IN
NAUTICAL MILES TO
NEAREST 0.1 NM.

#140

DELTA H(NSR) - THE
ALTITUDE BETWEEN THE
ACTIVE AND PASSIVE

#150

KEY IN V25E
AND LOAD DE-
SIRED VALUE

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF STORED HALFREVS,
DELTA H(NCC) AND
DELTA H(NSR)

AM I SATISFIED WITH
THESE VALUES?

.Y .N

RECORD THESE
VALUES

VEHICLE ORBITS AT
 TIG(NSR). SIGN IS +
 WHEN THE ACTIVE
 VEHICLE IS BELOW THE
 PASSIVE VEHICLE. IN
 NAUTICAL MILES TO
 NEAREST 0.1 NM.

#160

WAIT FOR KEYBOARD
 ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON
 RECEIPT OF PROCEED
 OR NEW DATA

#170

.PRO
 .NEW
 .DATA

KEY IN V25E
 AND LOAD DE-
 Sired VALUES

STORE DATA

#180

HOLD
 SNAP

FLASH VERB-NOUN TO
 REQUEST RESPONSE AND
 DISPLAY STORED
 TIG(TPI):
 V06 N37
 R1-TIG(TPI)-HRS
 R2-TIG(TPI)-MINS
 R3-TIG(TPI)-SECS

#190

MONITOR DSKY:
 OBSERVE VERB-NOUN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 OF STORED TIG(TPI)

"B"
BELOW

#250

BASED ON THE STORED
TARGET PARAMETERS,
COMPUTE AND STORE
THE FOLLOWING

PARAMETERS:

- TIG(NC2) IN N28
- TIG(NCC) IN N11
- TIG(NSR) IN N13
- DELTA V(LV) FOR NC1
IN N81
- DELTA V(NC2) IN R1
N84
- DELTA H(NC2) IN R2
N84
- DELTA V(NCC) IN R3
N84
- DELTA V(LV) FOR NSR
IN N82

#260

+ +
+ 01
+
+
+
+
+ 489
+ +

#270

ESTABLISH ALARM IF:
(A) FAILURE IN THE
PHASE MATCH
ITERATION.
(ALARM CODE
00600).

(B) FAILURE IN EITHER
THE NC2 OR NCC
HEIGHT MANEUVER
ITERATIONS
(ALARM CODE
00601).

#280

(C) FAILURE IN THE
OUTER (PHASE)
LOOP ITERATION
(ALARM CODE
00602).

#290

(D) FAILURE IN THE
QRDTPI ITERATION
(ALARM CODE

006031.

NO ALARM
ALARM

#300

IS THIS ALARM
00602?

Y

IS FINAL FLAG
SET?

N Y

SET UPDATE
FLAG

#320

POSS
HOLD
SNAP

"A"
.
.
.
....

FLASH VERB-NOUN
TO REQUEST
RESPONSE AND
DISPLAY ALARM
CODE:

V05 N09
R1-
R2-
R3-

THE EXPECTED
ALARM CODES AT
THIS TIME ARE
00500, 00601,
00602, AND

MONITOR DSKY:
DOES ALARM CODE
INDICATE COMPUTA-
TIONAL DIFFICULTY?

Y N

DO I WISH
TO CONTINUE?

Y N

#340

F

00603.

WAIT FOR KEY-
BCARD ENTRY

KEY IN
PROCEED

TERMINATE FLASH
UPON RECEIPT OF
RECYCLE OR
PROCEED

.PRD .V3ZE

IS THIS
ALARM RETURN
00602? TO
"START"

Y .N

.600
.601
.603

IS FINAL FLAG SET?

Y N.

SET
N81=0

KEY IN RECYCLE
V3ZE
RETURN TO
START OF
PROGRAM AND
ADJUST INPUT
PARAMETERS.

RETURN
TO
"START"

IS THIS
ALARM
00602?

N. .Y

600.
601.
603.

#350

#360

#370

#380

#390

#400

#410

#420

#430

#440

SET UPDATE FLAG

+01
HOLD

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY CALCULATED
DELTA V(NC2), DELTA
H(NC2), DELTA V(NCC):
V06 N84
R1-DELTA V(NC2)
R2-DELTA H(NC2)
R3-DELTA V(NCC)

DELTA V(NC2) -
VELOCITY TO BE
GAINED IN NC2
MANEUVER. IN FPS TO
NEAREST 0.1 FPS.

DELTA H(NC2) - THE
ALTITUDE BETWEEN THE
ACTIVE AND PASSIVE
VEHICLE ORBITS AT
TIG(NC2). SIGN IS +
WHEN THE ACTIVE
VEHICLE IS BELOW THE
PASSIVE VEHICLE. IN
NAUTICAL MILES TO
NEAREST 0.1 NN.

DELTA V(NCC) -
VELOCITY TO BE
GAINED IN NCC
MANEUVER. IN FPS TO
NEAREST 0.1 FPS.

+489

WAIT FOR KEYBOARD
ENTRY

MONITOR DSKY:
OBSERVE VERB-
NOUN FLASH TO
REQUEST RES-
PONSE AND DIS-
PLAY OF CALCU-
LATED DELTA
V(NC2), DELTA
H(NC2), DELTA
V(NCC).

RECORD
THESE VALUES

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED

.PRO

#450

HOLD .
.....
SNAP .

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY CALCULATED
COMPONENTS OF DELTA
V(ILV) FOR NCI:

- V06 V81
- R1-DELTA VX(ILV)
- R2-DELTA VY(ILV)
- R3-DELTA VZ(ILV)

DELTA VX(ILV) - COM-
PONENT OF IMPULSIVE
DELTA V AT TIG(NCI)
ALONG (RXV)XR- IN
FPS TO NEAREST .1
FPS.

DELTA VY(ILV) - COM-
PONENT OF IMPULSIVE
DELTA V AT TIG(NCI)
ALONG VXR. IN FPS TO
NEAREST .1 FPS.

DELTA VZ(ILV) - COM-
PONENT OF IMPULSIVE
DELTA V AT TIG(NCI)
ALONG -R. IN FPS TO

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF DELTA V(ILV) FOR
NCI

NOTE: N81 VALUES
WILL BE ZERO IF PRO
WAS KEYED AFTER
ALARM 600,601 OR 603

#460

#470

AM I SATISFIED WITH
THESE VALUES?

.Y .N

RECORD THESE
VALUES

#480

#490

#500

#510

#520

#530

#540

NEAREST .1 FPS.

WHERE R IS CSM GEO-
CENTRIC RADIUS
VECTOR AND V IS CSM
INERTIAL VELOCITY
VECTOR AT TIG(NCI)

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

KEY IN V25E
AND LOAD DE-
STRED VALUES

.PRO
.NEW
.DATA

STORE DATA

SET EXTERNAL DELTA V
FLAG

"B"

IS FINAL FLAG SET?

.N
.Y

V16 N45
R1-MARK COUNTERS
R2-TFI
R3-MGA

MARK COUNTERS - THE NUMBER OF MARKS PROCESSED BY THE RENDEZVOUS TRACKING DATA PROCESSING ROUTINE (R22) SINCE THE LAST W-MATRIX REINITIALIZATION (REFER TO ASSUMPTION (8) OF P20). THE REGISTER WILL DISPLAY XXBX WHERE THE TWO MOST SIGNIFICANT DIGITS COMPRISE THE VHF RANGING MARK COUNTER AND THE TWO LEAST SIGNIFICANT DIGITS COMPRISE THE OPTICS MARK COUNTER. (NOTE: THE OPTICS MARK COUNTER DOES NOT DISTINGUISH BETWEEN BACKUP AND PRIMARY MARKS.)

TFI-TIME FROM TIG(NCI). IN MIN AND SEC TO NEAREST SEC. MAX READING IS 59859 SIGN IS - BEFORE, + AFTER TIG(NCI).

MGA-MIDDLE GIMBAL ANGLE AT TIG(NCI) IF CSM +X AXIS IS ALIGNED WITH INITIAL THRUST DIRECTION. IN DEGREES TO THE NEAREST .01 DEGREE. SIGN IS ALWAYS + EXCEPT:

(A) WHEN DISPLAYED

TFI AND MGA

.
.

#600

#610

#620

WAS THIS THE LAST PASS THROUGH THE PROGRAM?

.Y
.N
.
DO I WISH TO TERMINATE THE

#630

AT ANY TIME
OTHER THAN THE
LAST PASS
THROUGH THE
PROGRAM THE
VALUE IS
-J0001.

#640

(B) ON THE LAST
PASS WHEN THE
IMU IS NOT
ALIGNED THE
VALUE IS
-J0002.

#650

MARK PROCESS
AND DO THE
FINAL PASS
THROUGH THE
PROGRAM?

.....Y.....N

WAIT FOR KEYBOARD
ENTRY

#660

.....KEY IN
.....PROCEED

.....KEY IN
.....PROCEED

#670

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

.....PROCEED.....RECYCLE

.....RESET UPDATE
.....FLAG

#680

.....KEY IN RECYCLE
.....V32E

.....GO TO
....."A"
.....ABOVE

CHANGE W-MATRIX
REINITIALIZA-
TION VALUES TO
2000 F, 2 FPS

#740

DC ROUTINE R00

#750

DD ROUTINE R00

EXIT P31

EXIT P31

#760

CHANGE CONTROL NOTES

REV 00 PCR 042,448, PCN 411, SL MEMJ #2
REV 01 PCN 489

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NC2 TARGETING PROGRAM (P32)

REV 01 03/20/72

PURPOSE:

- (1) TO CALCULATE PARAMETERS ASSOCIATED WITH THE NC2 MANEUVER FOR DE-TA V BURNS.
- (2) TO CALCULATE THESE PARAMETERS BASED UPON MANEUVER DATA APPROVED AND KEYED INTO THE CMC BY THE ASTRONAUT.
- (3) TO DISPLAY TO THE ASTRONAUT AND THE GROUND DEPENDENT VARIABLES ASSOCIATED WITH THE NC2 MANEUVER FOR APPROVAL BY THE ASTRONAUT/GROUND.
- (4) TO STORE THE NC2 TARGET PARAMETERS FOR USE BY THE DESIRED THRUSTING PROGRAM.

ASSUMPTIONS:

- (1) AT A SELECTED TPI TIME, THE LINE OF SIGHT BETWEEN THE CSM AND THE OMS IS SELECTED TO BE A PRESCRIBED ANGLE (E) FROM THE HORIZONTAL PLANE DEFINED AT THE ACTIVE POSITION.
- (2) THE NC2 AND NCC MANEUVERS ARE CONSTRAINED TO BE HORIZONTAL MANEUVERS.
- (3) THE NSR MANEUVER IS CONSTRAINED TO RESULT IN COELLIPTIC ORBITS FOLLOWING THE MANEUVER.
- (4) THE FOLLOWING TIME CONSTRAINTS APPLY:
 - A) THE TPI TIME AND THE TIME BETWEEN THE NCC AND NSR MANEUVERS ARE SPECIFIED (DSKY INPUT AND PAD-LOAD RESPECTIVELY).
 - B) THE TIME BETWEEN THE NC2 AND NCC MANEUVERS IS INDIRECTLY SPECIFIED BY SPECIFYING THE NUMBER OF REVOLUTIONS INVOLVED IN THE TRANSFER BETWEEN THE MANEUVERS (PAD-LOAD).
- (5) THE ALTITUDE BETWEEN THE OMS ORBIT AND THE CSM AT NSR IS SPECIFIED (DSKY INPUT).
- (6) CMC COMPUTED VARIABLES MAY BE STORED FOR LATER VERIFICATION BY THE GROUND. THESE STORAGE CAPABILITIES ARE NORMALLY LIMITED ONLY TO THE PARAMETERS FOR ONE THRUSTING MANEUVER AT A TIME EXCEPT FOR CONCENTRIC FLIGHT PLAN MANEUVER SEQUENCES.
- (7) IF P20 IS IN OPERATION WHILE THE PROGRAM IS OPERATING THE ASTROVAJT MAY HOLD AT ANY FLASHING DISPLAY AND TAKE OPTICS MARKS AND/OR HE MAY ALLOW VPF RANGING MARKS TO ACCUMULATE. (HOWEVER, IF THE UPDATE FLAG IS NOT SET THE MARKS WILL NOT BE INCORPORATED OR ACCUMULATED) SEE P20 FOR DETAILED DESCRIPTION.
- (8) THERE IS NO REQUIREMENT FOR ISS OPERATION TO PERFORM THIS PROGRAM.
- (9) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY OR INTERNALLY BY THE MINKEY CONTROLLER (R07).

++
+01
+
+489
++

PRGG CMC GROUND CREW

Preceding page blank

CONT

•AUTOMATIC
•PROGRAM
•SELECTION
.
.
.....
.....
.....

•CREW
•PROGRAM
•SELECTION
.
.
.....
.....

DC R00 TO START
NC2 TARGETING
PROGRAM (P32)
DISPLAY P32

KEY IN NC2 TARGET-
ING PROGRAM (P32)
V37E 32E

#10

#20

MONITOR DSKY:
OBSERVE DISPLAY OF
P32

#30

"START"
.
.
.....
.....

SET UPDATE FLAG

#40

SET TRACK FLAG

#50

RESET PCFLAG

#60

SET NC12FLG

"START"

#70

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STORED TIG
(NC2):
V06 N28
R1-TIG(NC2)-HRS
R2-TIG(NC2)-MINS
R3-TIG(NC2)-SECS

TIG(NC2) - TIME OF
NC2 IGNITION (GET)
IN HRS, MINS, SECS,
TO NEAREST .01 SEC

#80

AM I SATISFIED WITH
THIS VALUE?

.Y .N

#90

RECORD THIS
VALUE

#100

WAIT FOR KEYBOARD ENTRY
.....
KEY IN PROCEED

#110

TERMINATE FLASH UPON RECEIPT OF PROCEED, OR NEW DATA.
.....
KEY IN V25E AND LOAD DESIRED VALUE.

#120

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY STORED DELTA H(NCC) AND DELTA H(NSR)
.....
MONITOR DSKY: OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF STORED DELTA H(NCC) AND DELTA H(NSR)

#130

DELTA H(NCC)-THE ALTITUDE BETWEEN THE ACTIVE AND PASSIVE VEHICLE ORBITS AT
.....
AM I SATISFIED WITH THESE VALUES?

#140

DELTA H(NCC)-THE ALTITUDE BETWEEN THE ACTIVE AND PASSIVE VEHICLE ORBITS AT
.....
AM I SATISFIED WITH THESE VALUES?

TIG(INCC). SIGN IS +
 WHEN THE ACTIVE
 VEHICLE IS BELOW THE
 PASSIVE VEHICLE. IN
 NAUTICAL MILES TO
 NEAREST 0.1 NM

#150

DELTA H(NSR)-THE
 ALTITUDE BETWEEN THE
 ACTIVE AND PASSIVE
 VEHICLE ORBITS AT
 TIG(NSR). SIGN IS +
 WHEN THE ACTIVE
 VEHICLE IS BELOW THE
 PASSIVE VEHICLE. IN
 NAUTICAL MILES TO
 NEAREST 0.1 NM

#160

 RECORD THESE
 VALUES

 WAIT FOR KEYBOARD
 ENTRY

#170

 KEY IN PROCEED

 TERMINATE FLASH UPON
 RECEIPT OF PROCEED,
 OR NEW DATA.

- .P .NEW
- .R .DATA
- .O .
- .C .
- .E .
- .D .

#180

 LOAD THE DESIRED
 VALUES

 STORE DATA

#190

HOLD .
.....
SNAP .
.....
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STORED TIG
(TPI):
V06 N37
R1-TIG(TPI)-HRS
R2-TIG(TPI)-MINS
R3-TIG(TPI)-SECS

#200

TIG(TPI) - TIME OF
TPI IGNITION (GET).
IN HRS, MINS, SECS,
TO NEAREST .01 SEC

#210

RECORD THIS
VALUE

#220

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
OR NEW DATA.

#230

.P .NEW
.R .DATA
.O .
.C .
.E .
.D .
STORE DATA

#240

GO TO
"8"
BELOW

#250

#260

#270

#280

#290

.
. .
. .
. .
. .
. .
. .
. .

RESET FINAL
FLAG

.
. .
. .
.
. "A"
.
GO TO
"B"
BELOW

BASED ON THE STO-
RED TARGET PARA-
METERS, COMPUTE
AND STORE THE
FOLLOWING PARA-
METERS:
TIG(NCC) IN N11
TIG(NSR) IN N13
DELTA V(LV) FOR
NC2 IN N81
DELTA V(NCC)
IN R1 OF N84
DELTA V(NSR) RSS
IN R3 OF N84
DELTA V(LV) FOR
NSR IN N82
ESTABLISH ALARM
IF:

(A) FAILURE IN
THE PHASE MATCH
ITERATION.
(ALARM CODE
00600)

(B) FAILURE IN
NCC HEIGHT MAN-
EUVER ITERATION

++
+01
+
++489
++

#390

RETURN
TO
"START"

#400

RETURN
TO
"START"

#410

IS THIS
ALARM
00602?

N. .Y
.600.
.601.
.603.

#420

SET N81=0

#430

IS FINAL FLAG SET?
.Y
.N

SET UPDATE FLAG

#440

MONITOR DSKY:
 OBSERVE VERB-
 NOUN FLASH TO RE-
 QUEST RESPONSE
 AND DISPLAY OF
 DELTA V(NCC),
 DELTA H(NCC), AND
 DELTA V(NSR).

#450

#460

#470

#480

FLASH VERB-NOUN
 TO REQUEST RES-
 PONSE AND DISPLAY
 DELTA V(NCC),
 DELTA H(NCC), AND
 DELTA V(NSR):

V06 NB4
 R1-DELTA V(NCC)
 R2-DELTA H(NCC)
 R3-DELTA V(NSR)

DELTA V(NCC) -
 REQUIRED IMPUL-
 SIVE DELTA V TO
 ACCOMPLISH NCC
 MANEUVER AT
 TIG(NCC). IN FPS
 TO NEAREST 0.1
 FPS

DELTA H(NCC) - THE
 ALTITUDE BETWEEN
 THE ACTIVE AND
 PASSIVE VEHICLE
 ORBITS AT TIG
 (NCC). SIGN IS +
 WHEN THE ACTIVE
 VEHICLE IS BELOW
 THE PASSIVE VEHI-
 CLE. IN NAUTICAL
 MILES TO NEAREST
 0.1 NM.

DELTA V(NSR) -
 RSS OF THE REQU-
 IRED IMPULSIVE
 DELTA V TO
 ACCOMPLISH THE
 NSR MANEUVER AT
 TIG(NSR). IN FPS
 TO NEAREST 0.1
 FPS.

NOTE: TIG(NSR)

HOLD
 SNAP

#01

#489

IS AVAILABLE BY
KEYING IN V06N13.

#490

RECORD THESE
VALUES

#500

WAIT FOR KEYBOARD
ENTRY

#510

TERMINATE FLASH
UPON RECEIPT OF
PROCEED

KEY IN PROCEED

- .P
- .R
- .O
- .C
- .E
- .E
- .D

#520

#530

FLASH VERB-NOUN
TO REQUEST RES-
PONSE AND DISPLAY
CALCULATED COM-

MONITOR DSKY:
OBSERVE VERB-
NOUN FLASH TO RE-
QUEST RESPONSE

HOLD
SNAP

COMPONENTS OF DELTA
 V(LV) FOR NC2:
 V06 N81
 R1-DELTA VX(LV)
 R2-DELTA VY(LV)
 R3-DELTA VZ(LV)

DELTA VX(LV) -
 COMPONENT OF IM-
 PULSIVE DELTA V
 AT TIG(NC2) ALONG
 (RXV)XR. IN FPS
 TO NEAREST .1
 FPS.

DELTA VY(LV) -
 COMPONENT OF IM-
 PULSIVE DELTA V
 AT TIG(NC2) ALONG
 VXR. IN FPS TO
 NEAREST .1 FPS.

DELTA VZ(LV) -
 COMPONENT OF IM-
 PULSIVE DELTA V
 AT TIG(NC2) ALONG
 -R. IN FPS TO
 NEAREST .1 FPS

WHERE R IS CSM
 GEOCENTRIC RADIUS
 VECTOR AND V IS
 CSM INERTIAL VEL-
 OCITY VECTOR AT
 TIG(NC2).

WAIT FOR KEYBOARD
 ENTRY

AND DISPLAY OF DELTA
 V(LV) FOR
 NC2
 NOTE: N81 VALUES
 WILL BE ZERO IF
 PRD WAS KEYED
 AFTER ALARM 600,
 601 OR 603.

AM I SATISFIED
 WITH THESE
 VALUES?
 (NOTE: CREW HAS
 THE OPTION AT
 THIS TIME TO RE-
 DEFINE THE DELTA
 V(LV) FOR NC2
 COMPONENTS FOR
 THE SUBSEQUENT
 THRUSTING
 MANEUVER.)

.Y .N

KEY IN VZ5E
 AND LOAD DE-
 Sired DELTA V
 VALUES

#540

#550

#560

#570

#580

#780

FLAG

.
.
.
.
.
GO TO
"A"
ABOVE

#790

IS FINAL FLAG SET?

.Y
.
N.
.
.

#800

SET FINAL FLAG

.
.
.
RESET UPDATE
FLAG

.
.
.
.

#810

GO TO
"A"
ABOVE

#820

SET MANEUFL G

.
.
.
IS THIS MINKEY?
(IS AUTOSEQ FLAG

SET?

.Y .N

#830

CHANGE 4-MATRIX
REINITIALIZATION
VALUES TO 2000
F, 2 FPS.

#840

DO ROUTINE R00

DO ROUTINE R00

EXIT P32

EXIT P32

#850

CHANGE CONTROL NOTES

REV 00 PCR 021,042,448, SL MEMO #2
REV 01 PCN 489

NCC TARGETING PROGRAM (P33)

REV 01 03/20/72

PURPOSE:

- (1) TO CALCULATE PARAMETERS ASSOCIATED WITH THE NCC MANEUVER FOR LAMBERT STEERING DELTA V BURNS.
- (2) TO CALCULATE THESE PARAMETERS BASED UPON MANEUVER DATA APPROVED AND KEYED INTO THE DSKY BY THE ASTRONAUT.
- (3) TO DISPLAY TO THE ASTRONAUT AND THE GROUND DEPENDENT VARIABLES ASSOCIATED WITH THE NCC MANEUVER FOR APPROVAL BY THE ASTRONAUT/GROUND.
- (4) TO STORE THE NCC TARGET PARAMETERS FOR USE BY THE DESIRED THRUSTING PROGRAM.

ASSUMPTIONS:

(1) THIS PROGRAM IS BASED UPON PREVIOUS COMPLETION OF THE NC2 TARGETING PROGRAM (P32).

(A) AT A SELECTED TPI TIME (NOW IN STORAGE) THE LINE OF SIGHT BETWEEN THE CSM AND THE OWS WAS SELECTED TO BE A PRESCRIBED ANGLE (E) (NOW IN STORAGE) FROM HORIZONTAL PLANE DEFINED AT THE ACTIVE VEHICLE POSITION.

(3) THE NCC AND NSR MANEUVERS WERE ASSUMED TO BE PARALLEL TO THE PLANE OF THE OWS ORBIT. HOWEVER, THE N81 DISPLAY IS MODIFIED TO ESTABLISH AN ANTINODE AT NSR.

(2) CMC COMPUTED VARIABLES MAY BE STORED FOR LATER VERIFICATION BY THE GROUND.

(3) IF P20 IS IN OPERATION WHILE THIS PROGRAM IS OPERATING THE ASTRONAUT MAY HOLD AT ANY FLASHING DISPLAY AND TAKE OPTICS MARKS AND/OR HE MAY ALLOW VHF RANGING MARKS TO ACCUMULATE. (HOWEVER, IF THE JDATE FLAG IS NOT SET THE MARKS WILL NOT BE INCORPORATED OR ACCUMULATED) SEE P20 FOR DETAILED DESCRIPTION.

(4) THERE IS NO REQUIREMENT FOR ISS OPERATION TO PERFORM THIS PROGRAM.

(5) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY OR INTERNALLY BY THE MINKEY CONTROLLER (ROT).

PROG
CONT

PRECEDING PAGE BLANK NOT FILMED

CMC	GROUND	CREW
.AUTOMATIC		.CREW
.PROGRAM		.PROGRAM
.SELECTION		.SELECTION
.		.
.		.
.		.

DO ROO TO START NCC TARGETING PROGRAM (P33) DISPLAY P33	.....	KEY IN NCC TARGETING PROGRAM (P33) V37E 3JE
.	.	.
.	.	.
.	.	.
.	.	.

Preceding page blank

#20

#30

#40

#50

#60

.....
MONITOR DSKY:
OBSERVE DISPLAY OF
P33

.....
"START"
.....

.....
SET TRACK FLAG
.....

.....
SET UPDATE FLAG
.....

.....
RESET PCFLAG
.....

"START"
.....

.....
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STORED TIG
(NCC):
V06 N11

.....
MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF STORED TIG

HOLD .
.....
SNAP .

R1-TIG(NCC)-HRS
R2-TIG(NCC)-MIN
R3-TIG(NCC)-SECS

TIG(NCC) - TIME OF
NCC IGNITION (GET).
IN HRS, MINS, SECS
TC NEAREST .01 SEC.

(NCC).

AM I SATISFIED WITH
THIS VALUE?

.Y .N

RECORD THIS
VALUE

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.P .NEW
.R .DATA
.D .
.C .
.E .
.E STORE DATA
.D .

HOLD .
.....
SNAP .
.....
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY COMPUTED
TIG(NSR):

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY

#70

#80

#90

#100

#110

V06 N13
R1-TIG(NSR)-HRS
R2-TIG(NSR)-MINS
R3-TIG(NSR)-SECS

TIG(NSR)-TIME OF NSR
IGNITION (GET). IN
HRS, MINS, SECS TO
NEAREST .01 SEC.

#120

OF STORED TIG(NSR).

AM I SATISFIED WITH
THIS VALUE?

.Y .N

RECORD THIS
VALUE

#130

WAIT FOR KEYBOARD
ENTRY

#140

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.PROCEED .NEW
.DATA

STORE DATA

KEY IN V25E
AND LOAD DE--
SIRE VALUE

#150

HOLD .
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STORED
TIG(TPI):

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY

#160

#170

V06 NJ7
 R1-TIG(TPI)-HRS
 R2-TIG(TPI)-MINS
 R3-TIG(TPI)-SECS

TIG(TPI)-TIME OF TPI
 IGNITION (GET). IN
 HRS, MINS, SECS, TO
 NEAREST .01 SEC.

OF STORED TIG(TPI)

AM I SATISFIED WITH
 THIS VALUE?

.YES .NO

RECORD THIS
 VALUE

#180

WAIT FOR KEYBOARD
 ENTRY

KEY IN PROCEED

#200

TERMINATE FLASH UPON
 RECEIPT OF PROCEED
 OR NEW DATA

.PROCEED .NEW
 .DATA

STORE DATA

KEY IN V25E
 AND LOAD THE
 DESIRED VALUE

#210

RESET FINAL
 FLAG

#220

#20

#30

#40

#50

#60

MONITOR DSKY:
OBSERVE DISPLAY OF
P34

"START"

SET TRACK FLAG

SET UPDATE FLAG

RESET PCFLAG

"START"

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF STORED TIG

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STORED TIG
(NSR):
V06 V13

HOLD
SNAP

R1-TIG(NSR)-HRS
R2-TIG(NSR)-MIN
R3-TIG(NSR)-SECS

TIG(NSR) - TIME OF
NSR IGNITION (GET).
IN HRS, MINS, SECS
TO NEAREST .01 SEC.

#70

.Y .N

RECORD THIS
VALUE

#80

KEY IN PROCEED

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

#90

KEY IN V25E
AND LOAD
DESIRED VALUE

.P .NEW
.R .DATA
.0 .
.C .
.E .
.E .STORE DATA
.D .

#100

GO TO
"B"
BELOW

RESET FINAL
FLAG

#110

GO TO
"B"
BELOW

"A"
.
.
.
...

#120

SET EXTERNAL
DELTA V FLAG

#130

BASED ON THE STO-
RED TARGET PARA-
METERS, COMPUTE
THE PARAMETERS
ASSOCIATED WITH
NSR, AS DES-
CRIBED IN SECTION
5.4 OF R693.
ESTABLISH ALARM
IF NO SOLUTION
CAN BE REACHED

#140

.N
.O
.A
.L
.R
.M
.A
.L
.A
.R
.M

#150

"A"
.
.
.
...

FLASH VERB-
NOUN TO RE-
QUEST RESPON-
SE AND DIS-

MONITOR DSKY:
DOES ALARM
CODE DISPLAY IN-
DICATE COMPUTATI-

#160

POSS
HOLD
SNAP

PLAY ALARM
CODE:
V05N09
R1-
R2-
R3-

THE EXPECTED
ALARM AT THIS
TIME IS 00611

WAIT FOR KEY-
BOARD ENTRY

ONAL DIFFICULTY?

.N Y.

DO I WISH TO
READJUST TIG?

.Y .N

KEY IN RE-
CYCLE
V32E

RETURN
TO
START

DO I WISH TO
ATTEMPT TO
DEFINE NSR
MANEUVER
ANYWAY, RE-
ALIZING THAT
DELTA H
(NSR), DELTA
T(TPI-NSR) AND
DELTA
T(TPI-NOMTPI)
ARE NOT

#170

#180

#190

#200

#210

TIG(TPI) AS DE-
FINED IN N37
AFTER PRO TO N13.
COMPUTED IN
HRS, MINS, AND
SECS OF WHICH
ONLY THE MINS AND
SECS ARE DIS-
PLAYED.

#320

NOTE 1: TIG(TPI)
IS AVAILABLE BY
KEYING IN V06N37

NOTE 2: R2 IS
COMPUTED MODULO
ONE HOUR IF IT IS
POSITIVE. IF IT
IS NEGATIVE IT IS
LIMITED INSTEAD.
R3 IS ALWAYS
MODULO ONE HOUR.

#330

RECORD THESE
VALUES

#340

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH
UPON RECEIPT OF
PROCEED

#350

FLASH VERB-NOUN
TO REQUEST RES-
PONSE AND DISPLAY
CALCULATED COM-

#360

HOLD .
.....
SNAP .

MONITOR DSKY-
OBSERVE VERR-
NOUN FLASH TO
REQUEST RE-

#370

SPONSE AND DIS-
PLAY OF DELTA
V(LV) FOR NSR.
R2 OF N81 WILL
CONTAIN -Y DOT
CM FROM N90

#380

AM I SATISFIED
WITH THESE
VALUES?
(NOTE: CREW HAS
THE OPTION AT
THIS TIME TO
REDEFINE THE
DELTA V(LV)
THE SUBSEQUENT
THRUSTING MAN-
EUVER.)

#390

.Y .N

#400

KEY IN V25E
AND LOAD DE-
SIRE DELTA
V VALUES

#410

COMPONENTS OF DELTA
V(LV) FOR NSR:
V06 N81
R1-DELTA VX(LV)
R2-DELTA VY(LV)
R3-DELTA VZ(LV)

DELTA VX(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(NSR)
ALONG (RX)XR.
IN FPS TO NEAR-
EST .1 FPS

DELTA VY(LV) -
COMPONENT OF
IMPULSIVE DELTA
V AT TIG(NSR)
ALONG VXR. IN
FPS TO NEAREST
.1 FPS

DELTA VZ(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIG(NSR)
ALONG -R.
WHERE R IS CSM
GEOCENTRIC RADIUS
VECTOR AND V IS
CSM INERTIAL VEL-
OCITY VECTOR AT
TIG(NSR). IN FPS
TO NEAREST .1 FPS

WAIT FOR KEYBOARD
ENTRY

+01

+489

#420

#430

#440

#450

#460

RECORD THESE
VALUES

KEY IN PROCEED

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA.

P NEW
R DATA
O
C STORE DATA
E
D

IS FINAL FLAG SET?

N
Y

SET
MGA
DIS-
PLAY
IN R.3
(BELOW)
= 00001.

PASS WHEN THE IMU
IS NOT ALIGNED
THE VALUE IS
-0002. IN DEGREES
TO NEAREST .01
DEGREE

#560

WAIT FOR KEYBOARD
ENTRY

#570

KEY IN
PROCEED.

KEY IN
PROCEED

#580

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

KEY IN RECYCLE
V32E

.P
.R
.E
.C
.Y
.C
.E
.L
.E
.D

#590

RESET UPDATE
FLAG

GO TO
"A"
ABOVE

#600

GO TO

PRECEDING PAGE BLANK NOT FILMED

REV 01 03/20/72

TPI TARGETING PROGRAM (PJ5)

PURPOSE:

- + +
- + 01
- + +
- + 489
- + +

(1) TO CALCULATE THE REQUIRED DELTA V AND OTHER INITIAL CONDITIONS REQUIRED BY THE CMC FOR EXECUTION OF THE TRANSFER PHASE INITIATION MANEUVER, GIVEN:

- (A) TIME OF IGNITION TIG (TPI) OR THE ELEVATION ANGLE (E) OF THE CSM/DMS LOS AT TIG(TPI)
- (B) CENTRAL ANGLE OF TRANSFER (CENTANG) OF 130 DEGREES FROM TIG(TPI) TO INTERCEPT TIME (TIG(TPFF)).

(2) TO CALCULATE TIG (TPI) GIVEN E OR E GIVEN TIG (TPI).

(3) TO DISPLAY TO THE ASTRONAUT AND THE GROUND CERTAIN DEPENDENT VARIABLES ASSOCIATED WITH THE MANEUVER FOR APPROVAL BY THE ASTRONAUT/GROUND.

(4) TO STORE THE TPI TARGET PARAMETERS FOR USE BY THE DESIRED THRUSTING PROGRAM.

ASSUMPTIONS:

(1) THE PROGRAM MUST BE DONE OVER A TRACKING STATION FOR REAL TIME GROUND PARTICIPATION IN AGC DATA INPUT AND OUTPUT. AGC COMPUTED VARIABLES MAY BE STORED FOR LATER VERIFICATION BY THE GROUND. THESE STORAGE CAPABILITIES ARE LIMITED ONLY TO THE PARAMETERS FOR ONE THRUSTING MANEUVER AT A TIME.

(2) IF P20 IS IN OPERATION WHILE THIS PROGRAM IS OPERATING THE ASTRONAUT MAY HOLD AT ANY FLASHING DISPLAY AND TAKE OPTICS MARKS AND/OR HE MAY ALLOW VHF RANGING MARKS TO ACCUMULATE. (HOWEVER, IF THE UPDATE FLAG IS NOT SET THE MARKS WOULD NOT BE INCORPORATED OR ACCUMULATED).
SEE P20 FOR DETAILED DESCRIPTION.

(3) ONCE THE PARAMETERS REQUIRED FOR COMPUTATION OF THE MANEUVER HAVE BEEN COMPLETELY SPECIFIED, THE VALUE OF THE ACTIVE VEHICLE CENTRAL ANGLE OF TRANSFER IS COMPUTED AND STORED. THIS NUMBER WILL BE AVAILABLE FOR DISPLAY TO THE ASTRONAUT THROUGH THE USE OF V06N52.

THE ASTRONAUT WOULD CALL THIS DISPLAY TO VERIFY THAT THE CENTRAL ANGLE OF TRANSFER OF THE ACTIVE VEHICLE IS NOT WITHIN 170 TO 190 DEGREES. IF THE ANGLE IS WITHIN THIS ZONE THE ASTRONAUT SHOULD REASSESS THE INPJT TARGETING PARAMETERS BASED UPON DELTA V AND EXPECTED MANEUVER TIME.

(4) WHEN DETERMINING THE INITIAL POSITION AND VELOCITY OF THE TARGET AT INTERCEPT TIME, EITHER CONIC OR PRECISION INTEGRATION MAY BE USED.

(5) THE OPERATION OF THE PROGRAM UTILIZES THE FOLLOWING FLAGS:

FINAL FLAG - SELECTS FINAL PROGRAM DISPLAYS AFTER CREW HAS SELECTED THE FINAL MANEUVER COMPUTATION CYCLE.

EXTERNAL DELTA V FLAG - RESET BY THIS PROGRAM WHICH DESIGNATES THAT LAMBERT STEERING IS REQUIRED FOR EXECUTION OF THIS MANEUVER BY THE THRUSTING PROGRAM SELECTED AFTER COMPLETION OF THIS PROGRAM.

(6) THERE IS NO REQUIREMENT FOR ISS OPERATION TO PERFORM THIS PROGRAM.

(7) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY OR INTERNALLY BY THE MINKFY CONTROLLER (ROT).

(8) THE DELTA V IN LOS COORDINATES (N59) IS AVAILABLE AT FL V16 N45 AFTER EACH COMPUTATION CYCLE.

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CONT

• AUTOMATIC
• PROGRAM
• SELECTION
.
.
.....
.

• CREW PROG.
• SELECTION
.
.
.....
.

DC R00 TO START TPI
TARGETING PROGRAM
(P35) DISPLAY PRO-
GRAM P35

KEY IV TPI TARGETING
PROGRAM (P35)

#10

MUNITOR DSKY:
OBSERVE DISPLAY OF
PROGRAM 35

#20

"START"
.
.
.....
.

#30

INITIALIZE NN=0

#40

SET TRACK FLAG
(SEE P2J)

SET UPDATE FLAG
(SEE P2J)

#50

++
+01
+
+464
++

RESET TP1MFLG

#60

"START"

RESET PCFLAG

#70

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY TIG(TPI):
V06N37
R1-TI; (TPI)-HRS
R2-TI; (TPI)-MIN
R3-TI; (TPI)-SEC

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF TIG (TPI).

TIG(TPI)-TIME OF TPI
IGNITION (GET).
IN HRS, MIN, SEC
TO NEAREST .01 SEC.

#80

AM I SATISFIED WITH
THIS VALUE?
(NOTE: THIS PROGRAM
ALWAYS REQUIRES AN
INITIAL VALUE OF
TIG(TPI) WHICH IS
WITHIN 30 MINUTES
OF THE ACTUAL VALJE
EVEN IF TIG (TPI) IS
TO BE CALCULATED
FROM A SPECIFIED E.)

#90

.Y N.

#100

RECORD THIS
VALUE.

.....

INTEGRATION TO
DETERMINE THE
INITIAL POSITION
AND VELOCITY OF
THE TARGET AT
INTERCEPT TIME.
WHEN NN=NON 0 USE
THE INDICATED NUMBER
OF OFFSETS.

.....

E-ELEVATION ANGLE
BETWEEN THE CSM/DWS
LOS AND THE CSM
LOCAL HORIZONTAL AT
TIG(TPI) REFERENCED
TO THE DIRECTION OF
FLIGHT (SEE SECTION
5.4 OF R693
FOR DETAILED DESCRI-
PTION). FROM 0 TO
360 IN DEGREES TO
NEAREST .01 DEGREE.

.....

WAIT FOR KEYBOARD
ENTRY

.....

MAKE THE TARGET-
ING CALCULA-
TIONS USING CO-
NIC INTEGRATION,
R1 SHOULD BE SET
TO +00000 BEFORE
PROCEEDING ON
THIS DISPLAY;
OTHERWISE IT
SHOULD BE SET
TO +00002.

.....

IF I WISH TO
HAVE THE CMC
CALCULATE E, R2
SHOULD BE SET
TO +00000 BEFORE
PROCEEDING ON
THIS DISPLAY;
OTHERWISE R2
SHOULD CONTAIN
THE E THAT I
WISH TO USE.

.....

E IS A
PAD-LOADED
ERASABLE.

.....

AM I SATISFIED WITH
THESE VALUES?

.....

.Y .N

.....

< KEY IN V21E THRU
V24E (AS THE CASE
MAY BE) AND LOAD

#160

#170

#180

#190

#200

.
. .
. .
. .
. .
. .

RESET FINAL FLAG

.
. .
. .
. .
. .

GO TO
"B"
BELOW

"A"
. .
. .
. .
. .

IS COMP E FLAG
SET?

.Y N.
. .
. .
. .
. .

COMPUTE E FOR
SPECIFIED
TIGITPI

PCSS
+OLD .
.....
SNAP .

FLASH VERB-
NOUN TO RE-
QUEST RESPONSE
AND DISPLAY
CALCULATED E:
V06 N55
R1-NN
R2-E
R3-BLANK

(NOTE: FOR DE-

"A"
. .
. .
. .
. .

DID I SPECIFY E
TO BE +00000?

.Y N.
. .
. .
. .
. .

MONITOR DSKY:
OBSERVE
VERB-NOUN
FLASH TO RE-
QUEST RESPON-
SE AND DIS-
PLAY OF CAL-
CULATED E.

.
.....
.

#260

#270

#280

#290

#300

#310

#320

#330

#340

FINITION SEE
ABOVE).

RECORD THIS
VALUE

WAIT FOR KEY-
BOARD ENTRY

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED

.P
.R
.O
.C
.E
.E
.D

COMPUTE TIG
(TPI) FOR THE
SPECIFIED E.
ESTABLISH
ALARM IF NO
SOLUTION CAN
BE REACHED

.N
.O
.A
.L
.A
.R
.M

KEY IN PRO-
CEED.

PCSS
HOLD
.....
SNAP

A
R
M
FLASH VERB-
NOUN TO
REQUEST RE-
SPONSE AND
DISPLAY
ALARM CODE:
V05N09
R1-
R2-
R3-
EXPECTED
ALARM CODE
AT THIS
TIME IS
0J611

MONITOR DSKY:
DOES ALARM
CODE DISPLAY
INDICATE THAT
NO SOLUTION
CAN BE
REACHED?

.Y N

WAIT FOR
KEYBOARD
ENTRY
TERMINATE
FLASH UPON
RECEIPT OF
PROCEED

RETURN TO
START OF
PROGRAM
AND ADJUST
INPUT PARA-
METERS.
KEY IN
PROCEED.

.PRO
.
.
.
GO TO
"START"
ABOVE

.
.
.
GO TO
"START"
ABOVE

PCSS
HOLD
.....
SNAP

FLASH VERB-
NOUN TO RE-
QUEST RESPONSE
AND DISPLAY
CALCULATED

MONITOR DSKY:
OBSERVE
VERB-NOUN
FLASH TO RE-
QUEST RE-

#350

#360

#370

#380

#390

TIG(TPI):
V06N37
R1-TIG(TPI)
-MRS
R2-TIG(TPI)
-MINS
R3-TIG(TPI)
-SECS.

(NOTE: FOR DE-
FINITION SEE
ABOVE).

#400

#410

#420

#430

#440

SPONSE AND
DISPLAY OF
CALCULATED
TIG(TPI).
(NOTE: IF
THIS IS THE
LAST PASS IN
MINKEY, TPI
TIG MAY BE
CHANGED AND
THE E=0
OPTION WILL
BE EXECUTED.)

RECORD THIS
VALUE

KEY IN
PROCEED

IS THIS FINAL
PASS IN
MINKEY?

WAIT FOR KEY-
BOARD ENTRY

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED.

*PRO

IS THIS MINKEY?
(IS AUTOSEQ
FLAG SET?)

IS FINAL FLAG
SET?

++
*01

#500

#510

#520

#530

METERS ASSOC-
 IATED WITH
 TPI AND TPF
 AS DESCRIBED
 IN SECTION
 5.4 OF R693.

 USING PRECI-
 SION INTEGRA-
 TION AND NN
 OFFSETS COM-
 PUTE THE PARA-
 METERS ASSOC-
 IATED WITH
 TPI AND TPF
 AS DESCRIBED
 IN SECTION
 5.4 OF
 R693.

 RESET EXTERNAL
 DELTA V FLAG

 FLASH VERB-NOUN
 TO REQUEST RE-
 SPONSE AND DIS-
 PLAY CALCULATED
 DELTA V(TPI),
 DELTA V(TPF), AND

POSS
 HOLD

 SNAP

 MONITOR DSKY:
 OBSERVE VERB-
 NOUN FLASH TO
 REQUEST RESPONSE
 AND DISPLAY OF
 CALCULATED DELTA

.....

#540

DELTA T(TPI-NOM-
TPI):
V06N58
R1-DELTA V(TPI)
R2-DELTA V(TPF)
R3-DELTA T(TPI-
NOMTPI)

#550

DELTA V(TPI)-RE-
QUIRED IMPULSIVE
DELTA V TO ACCOM-
PLISH TPI MANEU-
VER AT TIG(TPI).
IN FPS TO NEAREST
.1 FPS.

#560

DELTA V(TPF)-RE-
QUIRED IMPULSIVE
DELTA V TO ACCOM-
PLISH TPF MANEU-
VER AT TIME OF
INTERCEPT. IN FPS
TO NEAREST .1 FPS.

#570

DELTA T(TPI-
NOMTPI) -
TIG(TPI) AS DE-
FINED BY THIS
PROGRAM MINUS
TIG(TPI) AS
INPUT IN N37.
COMPUTED IN HRS,
MINS, SECS OF
WHICH ONLY MINS,
SECS (MODULO ONE
HOUR) ARE
DISPLAYED.

#580

RECORD THESE
VALUES

KEY IN PROCEED

++
+01
+
+
+
+
+489
++

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH

COMPONENTS OF
 DELTA V(LV)
 FJR TPI:
 V06N81
 R1-DELTA
 VX(LV)
 R2-DELTA
 VY(LV)
 R3-DELTA
 VZ(LV)

PONSE AND
 DISPLAY OF
 DELTA V(LV)
 FOR TPI

#640

DELTA VX(LV) -
 COMPONENT OF
 IMPULSIVE
 DELTA V AT
 TIG(TPI) ALONG
 (XV)XP. IN
 FPS TO NEAREST
 .1 FPS.

AM I SATIS-
 FIED WITH
 THESE VALUES?
 (NOTE: CREW
 HAS THE OP-
 TION AT THIS
 TIME TO RE-
 DEFINE THE
 DELTA V(LV)
 COMPONENTS
 FOR THE SUB-
 SEQUENT THRU-
 STING MANEU-
 VER. THIS
 CAPABILITY
 WILL NORMALLY
 BE EXERCISED
 TO CORRECT
 OUT OF PLANE-
 NESS BY FIRST
 SELECTING THE
 RENDEZVOUS
 OUT-OF-PLANE
 DISPLAY ROU-
 TINE (R36)
 (V90E), AND
 THEN MODIFY-
 ING DELTA
 VY(LV).)

#650

DELTA VY(LV) -
 COMPONENT OF
 IMPULSIVE
 DELTA V AT
 TIG(TPI) ALONG
 VXR. IN FPS TO
 NEAREST .1 FPS

#660

DELTA VZ(LV) -
 COMPONENT OF
 IMPULSIVE
 DELTA V AT
 TIG(TPI) ALONG
 -Z. IN FPS TO
 NEAREST .1 FPS

#670

WHERE R IS THE
 CSM GEODCENTRIC
 RADIUS VECTOR
 AND V IS THE
 CSM INERTIAL
 VELOCITY
 VECTOR AT
 TIG(TPI).

#680

.Y N.

+489
++

#690

#700

#710

#720

#730

WAIT FOR KEY-
BOARD ENTRY

KEY IN V25E
AND LOAD
THE DESIRED
VALUES.

RECORD THESE
VALUES

TERMINATE
FLASH UPON RE-
CEIPT OF PRO-
CEED OR NEW
DATA

KEY IN
PROCEED

.P .NEW
.R .DATA
.O .
.C .
.E STORE DATA
.E .
.D .

WAS NEW DATA
LOADED?

.N .Y

#880

.....
KEY IN
PROCEED
.....

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

.P
.R
.E
.C
.Y
.C
.L
.E
.D

RESET UPDATE
FLAG

GO TO
"A"
ABOVE

IS FINAL FLAG SET?

.Y
N.

SET FINAL FLAG

.....
KEY IN RECYCLE
V32E
.....

GO TO
"A"
ABOVE

#890

#900

#910

#920

225

253
P35/SKYLARK

.

RESET UPDATE
FLAG

.
GO TO
"A"
ABOVE

SET MANEUFLG

.

IS THIS MINKEY?
(IS AUTOSEQ FLAG
SET?)

.Y .N

CHANGE "M"-MATRIX
RINITIALIZATION
VALUES TO 2000 F.
2FPS

DC ROUTINE R00

.
EXIT P35

DU ROUTINE R00

.
EXIT P35

#930

#940

#950

#960

#970

CHANGE CONTROL NOTES

REV 00 PCR J11, PCN 412,455, SKYLARK MEMO #2
REV 01 PCR 464, PCN 489

C

#20

MONITOR DSKY:
OBSERVE DISPLAY OF
PRJGRAM 36

#30

.....
GO TO
"B"
BELOW

#40

SET TRACK FLAG (SEE
P20)

#50

SET UPDATE FLAG
(SEE P20)

#60

RESET PCFLAG

.....
GO TO "A"

#310

#320

#330

#340

#350

SET MGA DISPLAY
IN R3(BELOW)=
-00001.

IS REFSMMAT FLAG
SET?

.Y N.

COMPUTE IMU
MIDDLE GIMBAL
ANGLE AT TIG
(TPM) FOR THE
PRESENT IMU
ORIENTATION
WITH THE CSM
+X AXIS ALIG-
NED WITH THE
INITIAL
THRUST VECTOR

SET MGA DIS-
PLAY IN R3
(BELOW) =
-00002.

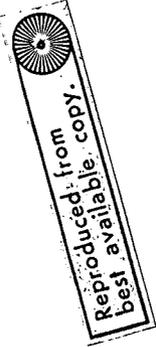
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY OF MARK CTRS
TFI AND MGA:

HOLD
MCN

"B"

...

MONITOR DSKY:
UPSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY



SIVE DELTA V AT TIG
FOR PC ALONG
(RXV)XR. IN FPS TO
NEAREST .1 FPS.

DELTA VY(LV) -
COMPONENT OF IMPUL-
SIVE DELTA V AT TIG
FOR PC ALONG VXR.
IN FPS TO NEAREST
.1 FPS.

DELTA VZ(LV) -
COMPONENT OF IMPUL-
SIVE DELTA V AT
TIG FOR PC ALONG -R.
IN FPS TO NEAREST
.1 FPS.

WHERE R IS CSM GEO-
CENTRIC RADIUS VEC-
TOR AND V IS CSM
INERTIAL VELOCITY
AT TIG FOR PC

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH JPN
RECEIPT OF PROCEED
OR NEW DATA.

.PROCEED .NEW
.DATA

STORE NFW
DATA

AM I SATISFIED WITH
THESE VALUES?

.Y

RECORD THESE
VALJES

KEY IN PROCEED

KEY IN V22E AND

LOAD DESIRED

DELTA V VALUE.

NOTE: OVERWRITING

R1, R2, R3 WITH 0

DURING MINKEY

SEQUENCE WILL

CAUSE ENTRANCE

INTO P52 FOLLOW-

ING P38 TO BE

BYPASSED

IF N91 = 0, J, 0

EITHER VIA THE

#270

#280

#290

#300

#310

#320

#330

#340

#350

#360

```

DSKY OR MINKEY
SEQUENCE A 01301
ALARM
(ARC SINE - ARC
COSINE ARGUMENT
TOO LARGE) MAY
RESULT.

```

```

IS FINAL FLAG SET?

```

```

.N
.Y

```

```

SET MGA DISPLAY
IN R3 (BELOW) =
-00001

```

```

IS REFSMAT
FLAG SET?

```

```

.Y
.N

```

```

COMPUTE IMU
MIDDLE GIM-
BAL ANGLE
AT TIG(PC)
FOR THE
PRESENT
IMU ORIE-
TATION WITH
THE CSM +X
AXIS ALIGNED
WITH THE
INITIAL
THRUST
VECTOR

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```

SET MGA
DISPLAY

```


+ AFTER TIG(PC).

MGA-MIDDLE GIMBAL
ANGLE AT TIG(PC) IF
C.SM +X AXIS IS
ALIGNED WITH INITIAL
THRUST DIRECTION.
IN DEGREES TO NEAR-
EST .01 DEGREE.
SIGN IS ALWAYS +
EXCEPT:

(A) WHEN DISPLAYED
AT ANY TIME OTHER
THAN THE LAST PASS
THROUGH THE PROGRAM
THE VALUE IS -00001.

(B) ON THE LAST PASS
WHEN THE IMU IS NOT
ALIGNED THE VALUE IS
-00002.

#420

#430

#440

#450

#460

.....
KEY IN PROCEED
.....

.....
KEY IN PROCEED
.....

.....
KEY IN RECYCLE
V32E
.....

.....
GO TO
.....

.....
WAIT FOR KEYBOARD
ENTRY
.....

.....
TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE
.....

.....
PROCEED RECYCLE
.....

.....
GO TO
.....

"A"
ABOVE

#470

#480

#490

#500

#510

"A"
ABOVE

IS FINAL FLAG SET?

.Y .N

SET FINAL
FLAG

GO TO
"A"
ABOVE

IS THIS MINKEY?
(IS AUTOSEQ FLAG
SET?)

.Y .N

CHANGE W-MATRIX
REINITIALI-
ZATION VALJES
TO 2000 F,
2 FPS.

DO ROUTINE R00

DO ROUTINE R00

SPS PROGRAM (P40)

REV 01 03/20/72

PURPOSE:

(1) TO COMPUTE A PREFERRED IMU ORIENTATION AND A PREFERRED VEHICLE ATTITUDE FOR A SPS THRUSTING MANEUVER.

(2) TO CALCULATE AND DISPLAY THE GIMBAL ANGLES WHICH WOULD RESULT WITH THE PRESENT IMU ORIENTATION IF THE VEHICLE WERE MANEUVERED TO THE PREFERRED VEHICLE ATTITUDE FOR A SPS THRUSTING MANEUVER. THE CREW IS THEREBY GIVEN AN OPPORTUNITY TO PERFORM THE MANEUVER WITH:

(A) THE PRESENT IMU ORIENTATION, IF THE MIDDLE GIMBAL ANGLE IS NOT GREATER THAN 45 DEGREES, AND THE IMU HAS BEEN ALIGNED WITHIN THE LAST 3 HRS.

(B) A NEW ORIENTATION ACHIEVED BY SELECTION OF P52.

(3) TO DO THE VEHICLE MANEUVER TO THE THRUSTING ATTITUDE.

(4) TO CONTROL THE GNCS DURING COUNTDOWN, IGNITION, THRUSTING, AND THRUST TERMINATION OF A GNCS CONTROLLED SPS MANEUVER.

ASSUMPTIONS:

(1) THE TARGET PARAMETERS HAVE BEEN CALCULATED AND STORED IN THE CMC BY PRIOR EXECUTION OF A PRE-THRUSTING PROGRAM.

(2) THE REQUIRED STEERING EQUATIONS ARE IDENTIFIED BY THE PRIOR PRE-THRUST PROGRAM, WHICH EITHER SET OR RESET THE EXTERNAL DELTA V STEERING FLAG. FOR EXTERNAL DELTA V STEERING, VG IS CALCULATED ONCE FOR THE SPECIFIED TIME OF IGNITION. THEREAFTER BOTH DURING THRUSTING AND UNTIL THE CREW NOTIFIES THE CMC TRIM THRUSTING HAS BEEN COMPLETED THE CMC UPDATES VG ONLY AS A RESULT OF COMPENSATED ACCELEROMETER IMPJTS.

FOR LAMBERT STEERING VG IS CALCULATED AND UPDATED SIMILARLY, HOWEVER IT IS ALSO UPDATED PERIODICALLY BY LAMBERT SOLUTIONS TO CORRECT FOR CHANGES IN THE CSM STATE VECTOR.

(3) IT IS NORMALLY REQUIRED THAT THE ISS BE ON FOR 15 MINUTES PRIOR TO A THRUSTING MANEUVER.

(4) THE TTE CLOCK IS SET TO COUNT TO ZERO AT TIG.

(5) ENGINE IGNITION MAY BE SLIPPED BEYOND THE ESTABLISHED TIG IF DESIRED BY THE CREW OR IF INTEGRATION CAN NOT BE COMPLETED ON TIME.

(6) THE SPS THRUSTING PROGRAM DOES NOT MONITOR THE SC CONTROL DISCRETE (CHANNEL 31 BIT 15) DURING THRUSTING. THIS MEANS THAT THE CMC WILL CONTINUE TO GENERATE ENGINE ACTUATOR COMMANDS, SPS ENGINE ON DISCRETE, AND FDAI ATTITUDE ERROR NEEDLE COMMANDS UNTIL THE CMC SOLUTION INDICATES ENGINE OFF AT WHICH TIME THESE COMMANDS AND THE ENGINE ON DISCRETE ARE TERMINATED. HOWEVER, THIS PROGRAM IS NOT WRITTEN TO TAKE INTO ACCOUNT THE SITUATION WHERE CONTROL MAY BE TAKEN AWAY FROM THE GNCS AND THEN GIVEN BACK, AND IT IS NOT RECOMMENDED. IN EVENT CONTROL IS TAKEN AWAY FROM THE GNCS, THE CMC WILL ONLY BE RESPONSIBLE FOR COMPUTATION OF POSITION AND VELOCITY.

(7) ROUTINE R03 HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM. IN ORDER FOR THE GNCS TO PERFORM THE ATTITUDE MANEUVER AND CONTROL THE THRUSTING MANEUVER THE ASTRONAUT MUST KEY IN V46E AT SOME TIME PRIOR TO THE ATTITUDE MANEUVER.

(8) P40 SHOULD NOT BE PERFORMED IN THE CSM-DWS DOCKED CONFIGURATION.

(9) THE VALUE OF DELTA V REQUIRED WILL BE STORED IN THE LOCAL VERTICAL COORDINATE SYSTEM AND IS AVAILABLE DURING THIS PROGRAM UNTIL AVERAGE G TURN ON BY KEYING IN V06N81.

(10) THE ORBITAL PARAMETERS DISPLAY ROUTINE (R30) MAY BE CALLED DURING THIS PROGRAM BY KEYING IN V82E.

(11) THE CMC ISSUES AN SIV-B CUTOFF COMMAND (CHANNEL 12 BIT 14) FOR POSSIBLE BACK-JP USE. THIS SIGNAL IS RECOGNIZED BY SATURN ONLY IF THE LAUNCH VEHICLE GUIDANCE SWITCH IS SET TO CMC.
 (12) THE ASTRONAUT MAY REQUEST A TFI DISPLAY (AVAILABLE UNTIL ENTRY INTO TVC DAP) BY KEYING IN EITHER V16N40 FOR MINS-SECS (R1), OR V16N35 FOR HRS (R1), MINS (R2), AND SECS (R3).
 (13) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY OR INTERNALLY BY THE MINKEY CONTROLLER (R07).

++
+01
+
+489
++

PROG CONT	CMC	GROUND	CREW	
	•AUTOMATIC •PROGRAM •SELECTION		•CREW PROG. •SELECTION	#10
	----- DO R00 TO START SPS PROGRAM (P40) DISPLAY PROGRAM 40	..... . .....	----- KEY IN SPS PROGRAM (P40) V37E 40E	
	----- SET SBFLAG -----	..... . .....	----- MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 40 -----	#20
	----- SET SBFLAG -----	..... . .....		#30

IS EXTERNAL DELTA V
FLAG SET?

.N

.Y

SET CSTEER = 1
IN STEER LAW

SET CSTEER=0
IN STEER LAW

DO IMU STATUS CHECK
ROUTINE (R02)

COMPUTE INITIAL
THRUST DIRECTION AND
INITIAL VALUE OF VG
VECTOR AND STORE IN
N81 (VG LOCAL VERT-
ICAL)

#40

#50

#60

#70

#80

DO IMU STATUS CHECK
ROUTINE (R02)

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. .
. .
. .
. .
. .

FROM INITIAL THRUST
DIRECTION AND ENGINE
BELL TRIM ANGLES
COMPUTE PREFERRED
IMU ORIENTATION:

#90

X = UNIT (X)
-SM -CSM
Y = UNIT (X X R)
-SM -CSM
Z = UNIT (X X Y)
-SM -SM

#100

WHERE:
X = THE CSM X AXIS
-CSM AT IGNITION
(AT THE PREFERRED VE-
HICLE ATTITUDE)

#110

R = THE CSM POS-
ITION RADIUS
VECTOR AT TIG.

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. .
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STORE DESIRED ATTITUDE SPECIFICATION
(TRIMMED ENGINE BELL CENTER LINE IN DIRECTION OF INITIAL THRUST) FOR USE BY ATTITUDE MANEUVER ROUTINE (R60). THE FINAL ATTITUDE WILL

#120

#560

IS SBFLAG SET?

.Y N.

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#570

#580

#590

#600

SHUT OFF SHUT OFF
RCS DAP RCS DAP

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R2-VG SHOULD BE
DECREASING

R3-DELTA VM
SHOULD INCREASE

2. FDAI-ATT. ERROR
SHOULD BE LESS THAN
OR EQUAL TO --DEGREE
ATT RATES SHOULD BE
LESS THAN OR EQUAL
TO --- DEGREE/SEC.

#710

3. SPS CHAMBER
PRESSURE (PC)
SHOULD BE NORMAL

#720

Y. .N
.
.
.
.

MONITOR DSKY:
AS TFC AND VG GO
TO ZERO THRUST
SHOULD CUTOFF.

.N
.L
.O
.A
.R
.T
.M
.E
.A
.L

#730

GO TO
BACKUP
PROCEDURES

#740

#750

 CMC TERMINATES EN-
 GINE ON COMMAND WHEN
 INDICATED BY CROSS
 PRODUCT STEERING,
 COMPLEX IMPULSIVE
 BURN ROUTINE (AS
 DESCRIBED IN SECTION
 5.3) OR IMPULSIVE
 THRUST TIMER (SET UP
 AT IGNITION AS
 DEFINED IN SECTION
 5.3 OF R693)

#770

 WAIT ABOUT 2.5
 SECONDS

#780

 SET WIDE DEADBAND
 IN RCS DAP

#790

 TURN OFF TVC
 DAP AND DIS-
 ABLE TVC IN-
 TERFACE

270

#850

HOLD .
.....
MON :

FLASH VERB-NOUN TO
REQUEST PROCEED.
V16 N40
R1 - TFC
R2 - VG
R3 - DELTA VM

.....
MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PROCEED AND DISPLAY
OF TFC, VG AND DELTA
VM.

#860

WAIT FOR KEYBOARD
ENTRY

#870

.....
.....

KEY IN PROCEED

#880

TERMINATE FLASH UPON
RECEIPT OF PROCEED.

.P
.R
.O
.C
.E
.E
.D
.....

#890

#940

.....
KEY IN PROCEED

.....

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED

.P
.R
.O
.C
.E
.E
.D

#950

TRANSMIT ORBITAL.....RECEIVE ORBITAL DATA
DATA TO CREW . FROM GROUND

DO ROUTINE R00

.....

DO ROUTINE R00

#970

.....
EXIT

.....
EXIT

#980

CHANGE CONTROL NOTES

REV 00 PCR 003,011,040, PCN 457, SKYLARK MEMO #20
REV 01 PCN 489



RCS PROGRAM (P41)

REV 01 03/20/72

PURPOSE:

- (1) TO COMPUTE A PREFERRED IMU ORIENTATION AND A PREFERRED VEHICLE ATTITUDE FOR AN RCS THRUSTING MANEUVER.
- (2) TO CALCULATE THE GIMBAL ANGLES WHICH WOULD RESULT WITH THE PRESENT IMU ORIENTATION IF THE VEHICLE X-AXIS WERE ALIGNED TO THE THRUST VECTOR. THE CREW IS THEREBY GIVEN AN OPPORTUNITY TO PERFORM THE MANEUVER WITH:

(A) THE PRESENT IMU ORIENTATION (NOT RECOMMENDED IF MIDDLE GIMBAL ANGLE IS GREATER THAN 45 DEGREES), IF THE IMU HAS NOT BEEN ALIGNED WITHIN THE LAST 3 HRS, REALIGNMENT IS DESIRABLE.

(B) A NEW ORIENTATION ACHIEVED BY SELECTION OF P52.

- (3) TO DO THE VEHICLE MANEUVER TO THE THRUSTING ATTITUDE.
- (4) TO PROVIDE SUITABLE DISPLAYS FOR MANUAL EXECUTION OF THE THRUSTING MANEUVER.

ASSUMPTIONS:

- (1) THE TARGET PARAMETERS HAVE BEEN CALCULATED AND STORED IN THE CMC BY PRIOR EXECUTION OF A PRE-THRUSTING PROGRAM.
- (2) THE REQUIRED STEERING EQUATIONS ARE IDENTIFIED BY THE PRIOR PRETHRUST PROGRAM, WHICH EITHER SET OR RESET THE EXTERNAL DELTA V STEERING FLAG. FOR EXTERNAL DELTA V STEERING, VG IS CALCULATED ONCE FOR THE SPECIFIED TIME OF IGNITION. THEREAFTER BOTH DURING THRUSTING AND UNTIL THE CREW NOTIFIES THE CMC TRIM THRUSTING HAS BEEN COMPLETED, THE CMC UPDATES VG ONLY AS A RESULT OF COMPENSATED ACCELEROMETER INPUTS.
FOR LAMBERT STEERING VG IS CALCULATED AND UPDATED SIMILARLY, HOWEVER IT IS ALSO UPDATED PERIODICALLY BY LAMBERT SOLUTIONS TO CORRECT FOR CHANGES IN THE CSM STATE VECTOR.
- (3) IT IS NORMALLY REQUIRED THAT THE ISS BE ON FOR 15 MINUTES PRIOR TO A THRUSTING MANEUVER.
- (4) THE TTE CLOCK IS SET TO COUNT TO ZERO AT TIG.
- (5) TRANSLATION INITIATION MAY BE SLIPPED BEYOND THE ESTABLISHED TIG IF DESIRED BY THE CREW OR IF INTEGRATION CAN NOT BE COMPLETED ON TIME.
- (6) ROUTINE R03 (R04 IF CSM-DWS DOCKED) HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM. IN ORDER FOR THE GNGCS TO PERFORM THE ATTITUDE MANEUVER AND MAINTAIN ATTITUDE CONTROL THE ASTRONAUT MUST KEY IN V46E (V45E IF CSM-DWS DOCKED) AT SOME TIME PRIOR TO THE ATTITUDE MANEUVER.
- (7) THE VALUE OF DELTA V REQUIRED AT TIG IN LOCAL VERTICAL COORDINATES IS STORED IN NDOUN 81 AND MAY BE CALLED UNTIL AVERAGE G IS TURNED ON BY KEYING IN V06N31E.
- (8) THE ORBITAL PARAMETERS DISPLAY ROUTINE (R30) MAY BE CALLED DURING THIS PROGRAM BY KEYING IN V82E.
- (9) THE ASTRONAUT MAY REQUEST A TFI DISPLAY BY KEYING IN EITHER V16N40 FOR MINS-SECS (R1), OR V16N35 FOR HRS (R1), MINS (R2), AND SECS (R3).
- (10) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY OR INTERNALLY BY MINKEY CONTROLLER (R07).

PRG

CMC

GROUND

CREW

NOUN 81 (VG LOCAL
VERTICAL)

#50

.
.
.
.

COMPUTE PREFERRED
IMU ORIENTATION:

X = UNIT (T)
-SM -

#60

Y = UNIT (X X R)
-SM -

Z = UNIT (X X Y)
-SM -SM -SM

WHERE:
T = INITIAL THRUST
- VECTOR

#70

R = THE CSM POSITION
- RADIUS VECTOR AT
TIG

#80

.
.
.
.

STORE DESIRED ATTITUDE SPECIFICATION
FOR USE BY ATTITUDE
MANEUVER ROUTINE
(R60). THE FINAL
ATTITUDE WILL BE
COMPUTED DURING R60
AND WILL POINT THE
+X TRANSLATION AXIS
IN THE INITIAL
THRUST DIRECTION.

#90

HOWEVER, IN ORDER TO
CONSERVE RCS FUEL
AND NOT CONSTRAIN
THE NONCRITICAL ROLL
ATTITUDE, WINGS MAY
NOT BE LEVEL IN THE
COMPUTED FINAL
ATTITUDE.

#100

.
. .

SFT PREFERRED
ORIENTATION FLAG

.
. .

#110

IS DOCKED DAP
RUNNING?

.N .Y
. .
. .

. SET DOCKED
. DEADBAND INTO
. DOCKED DAP

#120

.
. .
. .
. .
. .
. .
. .
. .
. .
. .

#130

SET MINIMUM
DEADBAND IN RCS DAP

.
. .
. .
. .
. .
. .
. .
. .
. .
. .

RESET 3AXISFLG

#140

.
. .
. .
. .
. .
. .
. .
. .
. .
. .

#200

COMPLETION OF ROUTINE 41.

WAIT UNTIL TFI =
- 35 SEC

BLANK DISPLAY OF
VERB-NOJN AND R1,
R2, R3 AT TFI =-35
SEC.

WAIT UNTIL TFI =
-30 SEC

RESET PREFERRED
ORIENTATION FLAG

CALL AVERAGE G
INTEGRATION AND
VG UPDATE (IN-
STANTANEOUS VG
VECTOR).

#210

MONITOR DSKY:
OBSERVE THAT DISPLAY
GOES BLANK AT TFI =
- 35 SEC.

#220

#230

#240

.

DISPLAY V16N85 NON-
FLASHING AND DISPLAY
THE VALUES OF VG IN
CONTROL AXIS COMPUT-
ED FOR THE PRESENT
TIME (NOT TIG) UP-
DATED EVERY TWO
SECONDS.

.

MONITOR DSKY:
OBSERVE DISPLAY OF
VG IN CONTROL AXIS
AT TFI = 30 SEC.
THE AVERAGE G
ROUTINE IS TURNED
ON. OBSERVE COM-
PUTER ACTIVITY LIGHT
BLINKS ON EVERY 2
SECONDS DURING
AVERAGE G.

#250

.

WAIT UNTIL
TFI= ZERO

#260

.

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY:
V16N85
R1-VGX(CONT)
R2-VGY(CONT)
R3-VGZ(CONT)
VGX(CONT), VGY(CONT)
VGZ(CONT) - COMPON-
ENTS OF THE VG
VECTOR RESOLVED
ALONG PRESENT CSM
X, Y, AND Z CONTROL
AXES RESPECTIVELY.
THE VG VECTOR WILL
BE UPDATED BY THE
STEERING LOOPS DUR-
ING EACH COMPUTATION
CYCLE. IN FPS TO

HOLD .
MON .
+ +
+01 +
+ +
+ +
+ +
+489 +
+ +

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH (INDICATING
CMC COMPUTED TIG) TO
REQUEST RESPONSE AND
DISPLAY OF VG COMP-
ONENTS AT TFI = 0

.

#280

#290

REV 01 03/20/72

THRUST MONITOR PROGRAM (P47)

PURPOSE:

- (1) TO MONITOR VEHICLE ACCELERATION DURING A NON GNCS CONTROLLED THRUSTING MANEUVER.
- (2) TO DISPLAY THE DELTA V APPLIED TO THE VEHICLE BY THIS THRUSTING MANEUVER.

ASSUMPTIONS:

- (1) IT IS NORMALLY REQUIRED THAT THE ISS BE ON FOR 15 MINUTES PRIOR TO A THRUSTING MANEUVER.
- (2) THE RESPONSIBILITY OF AVOIDING GIMBAL LOCK DURING EXECUTION OF THIS PROGRAM IS UPON THE ASTRONAUT.
- (3) THIS PROGRAM IS NORMALLY USED DURING RENDEZVOUS FINAL PHASE. IF THE CREW DESIRED TO DO ANY FINAL PHASE THRUSTING MANEUVERS AUTOMATICALLY UNDER GNCS CONTROL THEY MUST BE ACCOMPLISHED VIA SELECTION OF THE TPI TARGETING PROGRAM (P35) AND THEN THE SPS THRUSTING PROGRAM (P40) OR THE RCS THRUSTING PROGRAM (P41).
- (4) RANGE, RANGE RATE, AND THETA MAY BE DISPLAYED DURING THIS PROGRAM BY CALLING THE RENDEZVOUS PARAMETER DISPLAY NO 1 ROUTINE (R31) WITH V83E.
- (5) RANGE, RANGE RATE, AND PHI MAY BE DISPLAYED DURING THIS PROGRAM BY CALLING THE RENDEZVOUS PARAMETER DISPLAY NO 2 ROUTINE (R34) WITH V85E.
- (6) VI, HDOT, AND H MAY BE CALLED BY KEYING IN V16N62E.
- (7) THE ORBITAL PARAMETERS DISPLAY ROUTINE MAY BE CALLED DURING THIS PROGRAM BY KEYING IN V82E.
- (8) THIS PROGRAM SHOULD BE TURNED ON JUST PRIOR TO THE PLANNED THRUSTING MANEUVER AND TERMINATED AS SOON AS POSSIBLE FOLLOWING THE MANEUVER IN ORDER TO KEEP IMU COMPENSATION AND AVERAGE G COMPUTATION ERRORS AT A MINIMUM.
- (9) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG
CONT

CMC GROJND CREW
 .CREW
 .
 .PROGRAM
 .SELECTION
 .
 ...
 .

DO NOT TO START
 THRUST MONITOR
 PROGRAM (P47).
 DISPLAY P47.

KEY IN THRUST
 MONITOR PROGRAM
 (P47)
 V37E47E

#10

DELTA VX (CONT)-COM-
 PONENT OF INTEGRATED
 ACCELERATION ALONG
 CSM CONTROL +X AXIS.
 IN FPS TO NEAREST
 .1 FPS.

DELTA VY (CONT)-COM-
 PONENT OF INTEGRATED
 ACCELERATION ALONG
 CSM CONTROL +Y AXIS.
 IN FPS TO NEAREST
 .1 FPS.

DELTA VZ (CONT)-COM-
 PONENT OF INTEGRATED
 ACCELERATION ALONG
 CSM CONTROL +Z AXIS.
 IN FPS TO NEAREST .1
 FPS.

NOTE1: R1,R2, AND R3
 WILL READ 0000 IN-
 ITIALLY AND WILL RE-
 MAIN SC (EXCEPT FOR
 ACCELEROMETER BIASES)
 UNTIL A THRUSTING
 MANEUVER IS STARTED.
 THEY WILL BE UPDATED
 EVERY 2 SEC.

NOTE2: IN THE EVENT
 THIS PROGRAM IS USED
 TO MONITOR MANEUVERS
 WITH A DELTA V
 GREATER THAN 9999.9
 FPS THIS DISPLAY
 WILL ONLY LOSE THE
 HIGH ORDER DIGIT. IT
 WILL OTHERWISE READ
 CORRECTLY.

 PERFORM THRUSTING
 MANEUVER AS DESIRED
 MONITOR FDI1 BALL
 TO AVOID GIMBAL
 LOCK

#70

#80

#90

#100

#110

#120

WAIT FOR KEYBOARD
ENTRY

SHALL I ZERO
THE DISPLAY IN
ORDER TO MONI-
TOR ANOTHER
BURN?

#130

.N .Y

.....
*
.....

KEY
IN
RE-
CYCLE
V32E

#140

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

KEY IN PROCEED

#150

.RECYCLE .PROCEED

REINITIAL-
IZE ACCEL-

EROMETER
INTEGRA-
TION

#160

DO ROUTINE R00

DO ROUTINE R00

#170

EXIT P47

EXIT P47

CHANGE CONTROL NOTES

REV 00 SKYLARK MEMO #2
REV 01 PCN 489

#10

KEY IN RENDEZVOUS
THRUST MONITOR
PROGRAM (P48).
V37E48E

#20

MONITOR DSKY:
OBSERVE DISPLAY
OF PROGRAM 48.

#30

NOTE: THE TIME OF
OPTIMIZATION MAY BE
CHANGED IN P48 ONLY
BY KEYING V25N72E
AND LOADING THE
DESIRED TIME

#40

#50

DO IMU STATUS
CHECK ROUTINE
(R02)

DO R00 TO START REN-
DEZVOUS THRUST MONI-
TOR PROGRAM (P48).
DISPLAY P48.

MONITOR DSKY:
OBSERVE DISPLAY
OF PROGRAM 48.

RESET RENDEZVOUS
FLAG

INITIALIZE THE
OPTIMIZATION TIME
(NOUN 72) TO ZERO IN
ORDER TO ESTABLISH
THE CURRENT OPTION
FOR RANGE, RANGE
RATE.

DO IMU STATUS
CHECK ROUTINE
(R02)

#210

#220

#230

#240

#250

HOLD

MON

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY RENDEZVOUS
PARAMETERS:
V16 N77
R1 - RANGE
R2 - RANGE RATE
R3 - THETA
RANGE - VHF RANGE
TO SKYLAB IN NAUTI-
CAL MILES TO
NEAREST .01 NM.

RANGE RATE - RANGE
RATE BETWEEN CSM AND
SKYLAB CALCULATED
(AND OPTIMIZED TO
N72 TIME IF IN
OPTIMIZATION OPTION)
BY VHF RANGE RATE
FILTER. IN FPS TO
NEAREST .1 FPS
NEGATIVE SIGN INDI-
CATES CLOSING.

THETA - ANGLE BE-
TWEEN CSM +X AXIS
AND THE LOCAL
HORIZONTAL PLANE.
FROM 0 TO 360 DEG-
REES. IN DEGREES TO
NEAREST .01 DEGREE.
NOTE: IF R27
OPT = 0, RANGE,

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF RANGE, RANGE
RATE, AND THETA.
NOTE: RANGE RATE
OPTIMIZATION IS DIS-
CUSSED IN GSOP
SECTION 5, R27.

PERFORM +X OR -X
TRANSLATION ONLY
WHEN COAS IS BORE-
SIGHTED; PERFORM
Y OR Z TRANSLATION
AS DESIRED

#310

#320

#330

#340

KEY IN V25N72E
AND LOAD
DESIRED N72
TIME.

WHEN FINISHED
WITH DISPLAY KEY
IN RECYCLE V32E

MONITOR DSKY:
OBSERVE FLASHING
VERB-NOUN TO REQUEST
RESPONSE AND DISPLAY
OF EACH COMPONENT OF
DELTA V(CONT).

TERMINATE FLASH UPON
RECEIPT OF RECYCLE
OR PROCEED

.P
.R
.E
.C
.O
.Y
.C
.E
.L
.E
.D

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY DELTA V
(CONT):

V16N83
R1-DELTA VX(CONT)
R2-DELTA VY(CONT)
R3-DELTA VZ(CONT)

DELTA VX(CONT)-COM-
PONENT JF INTEGRATED
ACCELERATION ALONG
CSM CONTROL +X AXIS.
IN FPS TO NEAREST
.1 FPS.

DELTA VY(CONT)-COM-
PONENT OF INTEGRATED

HOLD
MON

+489
++

#400

MONITOR R27
DATA BY
ASTRONAUT
CALL IF
DESIRED.

#410

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

RECYCLE . PROCEED

#420

DO ROUTINE R00

DO ROUTINE R00

#430

EXIT
P48

EXIT
P48

CHANGE CONTROL NOTES

REV 00 PCR 025,032, SKYLARK MEMDS #3,19
REV 01 PCR 459, PCN 489

ATM ORIENTATION DETERMINATION PROGRAM (P50) REV 01 03/20/72

PURPOSE:

(1) TO COMPUTE AND STORE THE ORIENTATION OF THE APOLLO TELESCOPE MOUNT SENSOR COORDINATE SYSTEM WITH RESPECT TO THE NAVIGATION BASE COORDINATE SYSTEM.

(2) TO COMPUTE AND DISPLAY THE DOCKING ANGLES CORRESPONDING TO THIS ORIENTATION.

ASSUMPTIONS:

(1) THE CSM MUST BE DOCKED TO THE ORBITAL ASSEMBLY.
 (2) THE +Z AXIS OF THE ATM SENSOR COORDINATE SYSTEM POINTS IN THE SAME DIRECTION AS THE SUN SENSOR. THE -Y AXIS OF THE ATM SENSOR COORDINATE SYSTEM POINTS IN THE SAME DIRECTION AS THE STAR TRACKER WHEN STAR TRACKER GIMBAL ANGLES ARE ZERO.

(3) THREE OPTIONS ARE AVAILABLE:

- (A) OPTION 1 - ATM SUN SENSOR AND IMU ORIENTATION ARE USED TO DETERMINE ATM SENSOR ORIENTATION
 - (B) OPTION 2 - ATM SUN SENSOR, ATM STAR TRACKER, AND IMU ORIENTATION ARE USED TO DETERMINE ATM SENSOR ORIENTATION
 - (C) OPTION 3 - INDEPENDENT SOURCE IS USED TO DETERMINE ATM ORIENTATION
- (4) ATM MUST BE IN SOLAR INERTIAL ATTITUDE FOR OPTIONS 1 AND 2.
- (5) ASTRONAUT MUST RECORD STAR TRACKER GIMBAL ANGLES AT TIME OF MARK IN OPTION 2. THESE ARE USED AS INPUT (NI4) LATER IN PROGRAM.
- (6) IMU MUST BE ON AND ALIGNED FOR OPTIONS 1 AND 2.
- (7) STAR TRACKER MUST BE LOCKED ON TO CELESTIAL BODY FOR OPTION 2.
- (8) THE ASTRONAUT IDENTIFIES THE CELESTIAL BODY ACQUIRED BY THE STAR TRACKER. SUN AND EARTH ARE NOT VALID CELESTIAL BODIES FOR THE STAR TRACKER.
- (9) ANY PROPORTIONAL SET OF COMPONENTS MAY BE LOADED INTO N88. HOWEVER, UNIT VECTORS ARE RECOMMENDED.
- (10) THE ASTRONAUT HAS THE OPTION TO UPDATE OR NOT UPDATE THE CURRENTLY STORED ATM SENSOR ORIENTATION. OPTION 3 MAY BE USED TO DISPLAY CURRENT ATM SENSOR ORIENTATION.
- (11) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG

CMC

GROUND

CREW

COAT

•CREW
•PROG
•SELECTION
.
.
....
.

#10

KEY IN ATM ORIENTA-
TION DETERMINATION
PROGRAM (P50).
V37E50E

#20

MONITOR DSKY:
OBSERVE DISPLAY
OF PROGRAM 50

#30

MONITOR DSKY:
OBSERVE VERB-NOJN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF OPTION CODE FOR
ASSUMED ORIENTATION
DETERMINATION
TECHNIQUE.

#40

DC ROO TO START ATM
ORIENTATION DETERMI-
NATION PROGRAM (P50).
DISPLAY PROGRAM 50.

SET CMC ASSUMED
OPTION CODE IN R2
(BELOW) TO 00001

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY OPTION CODE
FOR ASSJMED ORIENTA-
TION DETERMINATION
TECHNIQUE:
V04 '06
R1 - 00012
R2 - 0000X
R3 - BLANK

R1 - IS THE OPTION
CODE FOR ASSUMED
ORIENTATION DETERMI-
NATION TECHNIQUE
R2 - IS THE ASSUMED

HOLD .
.....
SNAP .

#100

SET P50.1FLG

IS ATM SUN SENSOR
AND ATM STAR
TRACKER OPTION
(00002) STORED?

.Y .N
.(00002) .(00003)

USE OLD ATM Y
AND Z AXES AS
NEW Y AND Z
AXES

GO TO
"A"
BELOW

WAS CODE 00003
SELECTED?

.Y .N

GO TO
"A"
BELOW

#110

#120

DO IMU STATUS CHECK
ROUTINE (R02).

DO IMU STATUS CHECK
ROUTINE (R02).

#130

SFT CELESTIAL BODY
CODE = 46 (OCTAL)

++
+01
+
+489
++

#140

DO SIGHTING MARK
ROUTINE (R53).

DO SIGHTING MARK
ROUTINE (R53).

#150

CALCULATE LOS VECTOR
TO SUN AT MARK TIME
IN BASIC REFERENCE
COORDINATES.

#160

WAS CELESTIAL BODY
CODE 00 SELECTED?

#170

IS THE CELESTIAL
BODY CODE 46 OR 47?
(IT IS ASSUMED THAT
THE ASTRONAUT WILL
NEVER SELECT CODES
46 OR 47 FOR STAR
TRACKER)

#180

OBTAIN STAR VEC-
TOR FROM STORED
EPHEMERIS

#190

CALCULATE CELES-
TIAL BODY VECTOR
FOR THE BODY
DEFINED BY THE
STAR CODE

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA.

.P .NEW
.R .DATA
.O .
.C .
.E .
.E STORE NEW
.D DATA

TRANSFORM VECTOR
FROM BASIC REFERENCE
COORDINATES TO NAV
BASE COJRDINATES AND
STORE AS TRACKER LOS

TRANSFER SUN VECTOR
FROM BASIC REFERENCE
COORDINATES TO NAV
BASE COORDINATES AND
STORE AS NEW Z AXIS
OF ATM

IS STORED ORIENTA-
TION DETERMINATION
TECHNIQUE CODE
00001?
(P50.IFLG SET?)

.Y N.
(.00002).

KEY IN V25E AND
LOAD CORRECT
POSITION VECTOR
COMPONENTS

#250

#260

#270

#280

#290

+489

#300

CALCULATE NEW
Y AXIS OF ATM
USING NEW Z
AXIS AND OLD
Y AXIS

CALCULATE NEW Y
AXIS OF ATM
USING NEW Z
AXIS, STAR
TRACKER MARK
DATA, AND LOS
VECTOR TO CELE-
STIAL BODY

#320

"A"

USING NEW Y AND Z AXES,
CALCULATE DOCKING ANGLES
DESCRIBING ATM COORDI-
NATE SYSTEM WITH RESPECT
TO NAV BASE COORDINATE
SYSTEM

#330

"A"

HOLD . FLASH VERB--NOUN TO
..... REQUEST RESPONSE AND
SNAP . DISPLAY DOCKING
 ANGLES:

#340

MONITOR DSKY:
OBSERVE VERB--NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY

V06 N23
 R1 - ALPHA ATM
 R2 - BETA ATM
 R3 - GAMMA ATM

R1 - ALPHA ATM
 R2 - BETA ATM
 R3 - GAMMA ATM
 ARE THE DOCKING
 ANGLES WHICH SPECIFY
 THE ATM AXES ORIENT-
 TATION WITH RESPECT
 TO THE NAV BASE.
 EACH IN DEGREES TO
 THE NEAREST .01 DEG.
 (SEE SECTION 5.6 OF
 R693).

WAIT FOR KEYBOARD
 ENTRY

OF DOCKING ANGLES

AM I SATISFIED
 WITH DOCKING
 ANGLE?

.Y .N

KEY IN V25E
 AND LOAD NEW
 ANGLES

DO I WISH TO
 UPDATE ATM AXES?

.Y .N

#350

#360

#370

#380

#390

IMU ORIENTATION DETERMINATION PROGRAM (P51) REV 01 03/20/72

PURPOSE: (1) TO DETERMINE THE INERTIAL ORIENTATION OF THE IMU USING SIGHTINGS ON TWO CELESTIAL BODIES USING THE SCANNING TELESCOPE, THE SEXTANT, THE ATM SUN SENSOR, OR THE ATM STAR TRACKER.

ASSUMPTIONS: (1) THE IMU MAY BE:

(A) CFF (STANDBY)

(B) ON, AND ALIGNED OR NOT ALIGNED SINCE TURN ON.

IF (A) IS TRUE, THE IMU MUST BE TURNED ON BEFORE THIS PROGRAM CAN BE PERFORMED.

IF (B) IS TRUE THIS PROGRAM CAN BE COMPLETED.

(2) THERE ARE NO RESTRAINTS UPON THE CSM ATTITUDE CONTROL MODES IN THIS PROGRAM.

(3) TIME AND RCS FUEL MAY BE SAVED, AND SUBSEQUENT IMU ALIGNMENT DECISIONS GREATLY SIMPLIFIED IF THIS PROGRAM IS PERFORMED IN SUCH A WAY AS TO LEAVE THE IMU INERTIALLY STABILIZED AT AN ORIENTATION AS CLOSE AS POSSIBLE TO THE OPTIMUM ORIENTATION REQUIRED BY FUTURE CMC PROGRAMS.

(4) IF ATM SUN SENSOR IS USED AS SOURCE OF SIGHTING DATA, CSM MUST BE DOCKED TO ORBITAL ASSEMBLY, ATM MUST BE IN SOLAR INERTIAL ATTITUDE, AND ATM ORIENTATION WITH RESPECT TO NAV BASE MUST BE KNOWN.

(5) IF ATM STAR TRACKER IS USED AS SOURCE OF SIGHTING DATA, CSM MUST BE DOCKED TO ORBITAL ASSEMBLY, AND ATM ORIENTATION WITH RESPECT TO NAV BASE MUST BE KNOWN.

(6) ANY PROPORTIONAL SET OF COMPONENTS MAY BE LOADED INTO N88. HOWEVER, UNIT VECTORS ARE RECOMMENDED.

(7) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY USKY ENTRY.

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PROG
CONT

CMC GROUND CREW
•CHEW PROG
•SELECTION
•
•
•

DO NOT TO START IMU
ORIENTATION DETERMI-
NATION PROGRAM (P51)
DISPLAY PROGRAM 51
KEY IN IMU
ORIENTATION DETERMI-
NATION PROGRAM (P51)
V37E 51E

MONITOR DSKY:
OBSERVE DISPLAY OF
PROGRAM 51

#20

IS THE ISS ON?

.Y
.N

TURN ON PROGRAM
ALARM LIGHT AND
STORE ALARM
CODE 00210.

MONITOR DSKY:
DOES PROGRAM ALARM
LIGHT COME ON AND
DOES V37 FLASH INDI-
CATING THAT THE IMU
IS NOT ON?

.Y .N

TURN ON THE IMU
AND RESELECT P51
VIA R00.

#40

DO ROUTINE R00

DO ROUTINE R00

#50

EXIT

EXIT

"C"

"C"

#60

#120

WITH THE ROTATION CONTROL
ORIENT THE CSM UNTIL 2 CELESTIAL BODIES ARE VISIBLE IN THE SCT

MONITOR FCAI BALL IS GIMBAL LOCK IMPENDING?

#130

SHALL I COARSE ALIGN IMU TO 0.0,0 GIMBAL ANGLES?

#140

WAIT FOR KEYBOARD ENTRY

KEY IN ENTER

#150

TERMINATE FLASH UPON RECEIPT OF PROCEED OR ENTER

KEY IN PROCEED

.P
.R
.E
.N

#160

POSS
TEMP
HOLD
SNAP

.
C
E
E
D

DISPLAY ON DSKY:

V4 I N22
R1-00000
R2-00000
R3-00000

WHERE R1, R2,
AND R3 REPRESENT

CDU/ISS ANGLES
TO BE COARSE
ALIGNED TO (OG,
IG, MG, RESPEC-
TIVELY).

RESET REFSMAT
FLAG

COMMAND ISS TO
COARSE ALIGN
MODE

TURN ON "NO ATT"
LIGHT

COARSE ALIGN ISS

TERMINATE COARSE
ALIGN MADE IN

MONITOR DSKY:
OBSERVE DISPLAY
OF COARSE ALIGN
VERB AND ICDO
ANGLES (ALL
00000) FOR COARSE
ALIGNMENT

#170

#180

#190

#200

#210

OBSERVE "NO ATT"
LIGHT ON

477

.N Y.

OBTAIN STAR
VECTOR FROM
STORED
EPHEMERIS

CALCULATE CEL-
ESTIAL BODY
VECTOR FOR THE
BODY DEFINED
BY THE STAR
CODE.

PCSS
HOLD .
.....
SNAP .

FLASH VERB-
NUJN TO RE-
QUEST RESPONSE
AND DISPLAY
PLANET POSI-
TION VECTOR;
V06N88
R1-X PL
R2-Y PL
R3-Z PL
X PL - THE X
CJYMPONENT OF
UNIT POSITION
VECTOR OF THE
PLANET AT GET.
IN REFERENCE
CJORDINATES.
TJ THE FIFTH
PLACE

.....
MONITOR DSKY:
OBSERVE VERB-NUJN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF PLANET POSITION
VECTOR.

ARE THE POSITION
VECTOR COMPONENTS
CORRECT?

.Y .N

#270

#280

#290

#300

#310

Reproduced from
Best available copy.

(.XXXXX).

Y PL - SAME AS
X PL FOR Y
CJMPJVENT.

Z PL - SAME AS
X PL FOR Z
CJMPJVENT.

.

WAIT FOR KEY-
BOARD ENTRY

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED OR NEW
DATA.

.P .NEW
.R .DATA
.O .
.C .

.E .STORE NEW
.D .DATA

CALCULATE CELESTIAL
RCOY #1 VECTOR
W.R.T. IMU

KEY IN
PROCEED

KEY IN V25E AND
LOAD CORRECT
POSITION VECTOR
COMPONENTS

#320

#330

#340

#350

#360

#410

#420

#430

#440

#450

PCSS
HOLD
SNAP

FLASH VERB-
NJUN TO RE-
QUEST RESPONSE
AND DISPLAY
PLANET POSI-
TION VECTOR;
V06N88
R1-X PL
R2-Y PL
R3-Z PL

X PL - THE X
COMPONENT OF
UNIT POSITION
VECTOR OF THE
PLANET AT GET.
IN REFERENCE
COORDINATES.
TO THE FIFTH
PLACE
(.XXXXX).

Y PL - SAME AS
X PL FOR Y
COMPONENT.

Z PL - SAME AS
X PL FOR Z
COMPONENT.

WAIT FOR KEY-
BOARD ENTRY

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED OR NEW

MONITOR DSKY:
OBSERVE VERB-NOJN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF PLANET POSITION
VECTOR.

ARE THE POSITION
VECTOR COMPONENTS
CORRECT?

.Y .N

KEY IN
PROCEED

KEY IN V25E AND
LOAD CORRECT
POSITION VECTOR

CELESTIAL COORDIN-
ATES AS DEFINED BY
CELESTIAL BODIES #1
AND #2. STORE AS
PRESENT PLATFORM
ORIENTATION (REFS-
MMAT)

#510

SET REFSMMAT FLAG

#520

DO ROUTINE R00

DO ROUTINE R00

EXIT P51

EXIT P51

#530

CHANGE CONTROL NOTES

REV 00 PCN 410, PCR 018,043,414
REV 01 PCN 489

IMU REALIGN PROGRAM (P52)

REV 01 03/20/72

PURPOSE:

(1) TO ALIGN THE IMU FROM A "KNOWN" (SEE ASSUMPTION 4) ORIENTATION TO ONE OF THREE ORIENTATIONS SELECTED BY THE ASTRONAUT USING SIGHTINGS ON TWO CELESTIAL BODIES WITH THE SCANNING TELESCOPE, THE SIXTANT, THE ATM SUN SENSOR, OR THE ATM STAR TRACKER.

(A) PREFERRED ORIENTATION

AN OPTIMUM ORIENTATION FOR A PREVIOUSLY CALCULATED MANEUVER. THIS ORIENTATION MUST BE JPLINKED OR CALCULATED AND STORED BY A PREVIOUSLY SELECTED PROGRAM.

(B) NOMINAL ORIENTATION

X = UNIT(Y X Z)
-SM -SM -SM

Y = UNIT(V X R)
-SM -

Z = UNIT(-R)
-SM -

WHERE:

R = THE GECENTRIC RADIUS VECTOR AT TIME T (ALIGN)
- SELECTED BY THE ASTRONAUT

V = THE INERTIAL VELOCITY VECTOR AT TIME T (ALIGN) SELECTED BY THE ASTRONAUT.

(C) REFSMMAT

SEE ASSUMPTION (4)

(2) TO ALIGN THE IMU TO A PRE-DETERMINED ORIENTATION SUITABLE FOR A PLANE-CHANGE MANEUVER AND TO REALIGN THE IMU AFTER THE MANEUVER TO THE PRE-PLANE CHANGE ORIENTATION.

X = UNIT(X COS45 + Y SIN45) BEFORE THE MANEUVER (AFTER MANEUVER IF COS(CDUY).VGY < 0)
-SM -SMO -SMO LV

X = UNIT(X COS45 - Y SIN45) AFTER THE MANEUVER (BEFORE MANEUVER IF COS(CDUY).VGY < 0)
-SM -SMO -SMO LV

Y = UNIT(Z X X)
-SM -SM -SM

Z = Z
-SM -SMO

WHERE: SUBSCRIPT '0' REFERS TO THE ORIENTATION EXISTING BEFORE THE ALIGNMENT.

ASSUMPTIONS: (1) THE CONFIGURATION MAY BE SIVB/CSM, SKYLAB/CSM, OR CSM. THE PRESENT CONFIGURATION SHOULD HAVE BEEN ENTERED INTO

THE CMC BY COMPLETION OF EITHER ROUTINE R03 OR R04 AND EITHER V45 OR V46 (DEPENDING ON CONFIGURATION).

(2) IF THE S/C CONTROL SWITCH IS IN CMC AND THE MODE SWITCH IS IN ATTITUDE HOLD OR AJTD DURING THE GYRO TORQUING ROUTINE (R55) OR THE GYRO TORQUING OPTION (ENTER ON V50N25, R1=13 OR PRO ON V50N25, R1=20) OR THE GYRO TRIM PORTION OF COARSE ALIGN ROUTINE (R50), THE DAP WILL MANEUVER THE VEHICLE TO FOLLOW THE PLATFORM.

(3) THIS PROGRAM MAKES NO PROVISION FOR AN ATTITUDE MANEUVER TO RETURN THE VEHICLE TO A SPECIFIC ATTITUDE. SUCH A MANEUVER IF DESIRED MUST BE DONE MANUALLY. AN OPTION IS PROVIDED HOWEVER TO POINT THE SKY AT ASTRONAUT OR CMC SELECTED STARS EITHER MANUALLY BY CREW INPUT OR AUTOMATICALLY UNDER CMC CONTROL.

(4) THE ISS IS ON AND HAS BEEN ALIGNED TO A KNOWN ORIENTATION WHICH IS STORED IN THE CMC (REFSMAT). THE PRESENT IMU ORIENTATION DIFFERS FROM THAT TO WHICH IT WAS LAST ALIGNED ONLY DUE TO GYRO DRIFT (I.E., NEITHER GIMBAL LOCK NOR IMU POWER INTERRUPTION HAS OCCURRED SINCE THE LAST ALIGNMENT).

(5) IF ATM SUN SENSOR IS USED AS SOURCE OF SIGHTING DATA, CSM MUST BE DOCKED TO ORBITAL ASSEMBLY, ATM MUST BE IN SOLAR INERTIAL ATTITUDE, AND ATM ORIENTATION WITH RESPECT TO NAV BASE MUST BE KNOWN.

(6) IF ATM STAR TRACKER IS USED AS SOURCE OF SIGHTING DATA, CSM MUST BE DOCKED TO ORBITAL ASSEMBLY, AND ATM ORIENTATION WITH RESPECT TO NAV BASE MUST BE KNOWN.

(7) ANY PROPORTIONAL SET OF COMPONENTS MAY BE LOADED IN N88. HOWEVER, UNIT VECTORS ARE RECOMMENDED.

(8) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY FOR PURPOSE 1 AND BY MINKEY CONTROLLER (R07) FOR PURPOSE 2.

PROG
CONT

	CMC	GROUND	CREW	
	.AUTOMATIC		.CREW PROG	
	.PROGRAM		.SELECTION	
	.SELECTION		.	
	
	.		.	
	-----		-----	
DO R00 TO START IMU	.		KEY IN IMU REALIGN	
REALIGN PROGRAM (P52)		PROGRAM (P52)	
DISPLAY PROGRAM 52	.		V37E 52E	

	.		.	
	.		.	
	.		.	
	.		.	
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	.		.	
	-----		-----	
	.		MONITOR DSKY:	
		OBSERVE DISPLAY OF	
	.		PROGRAM 52	
	-----		-----	
	.		.	
	.		.	
	.		.	
	.		.	
	.		.	
	.		.	

#10

#20

DO IMU STATUS CHECK
ROUTINE (R02)

DO IMU STATUS CHECK
ROUTINE (R02)

#30

IS AUTOSEQ FLAG SET?

IS THIS MINKEY?

IS UTFLAG SET
AND IS P20
OPTION=2?

#40

SET TRACK
FLAG

#50

COMPUTE PLANE
CHANGE ORIENTA-
TION FOR GIMBAL
ANGLE COMPUTATION
(NOTE: AT THIS
TIME ANY PREFERRED
ORIENTATION
STORED IN THE
CMC IS LOST).

#60

SET PREFERRED
ORIENTATION FLAG

#70

VU+ NJ6
R1-00J01
R2-0000X
R3-BLANK

R1 IS THE OPTION
CODE FOR ASSUMED
IMU ORIENTATION
SELECTION

R2 IS THE CMC
ASSUMED OPTION:
0001-PREFERRED
0002-NOMINAL
0003-REFSMAT

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

P . NEW
R . CODE
D .
C .
F .
E . STORE CODE
D .

IS STORED ORIENTA-
TION CODE 0001?

.N .Y
. .
. .
. .
. .
. .
. .

ORIENTATION
SELECTION

. .
. .
. .
. .
. .
. .
. .
. .
. .
. .

IS THIS THE IMU ORI-
ENTATION I DESIRE?

.Y .N
. .
. .
. .
. .

KEY IN PROCEED

. .
. .
. .
. .
. .
. .
. .
. .
. .
. .

KEY IN V22E
AND LOAD THE
DESIRED ORIEN-
TATION CODE IN
R2

. .
. .
. .
. .
. .
. .
. .
. .

WAS PREFERRED ORIEN-
TATION SELECTED?

.N .Y
. .
. .
. .
. .
. .
. .
. .

#130

#140

#150

#160

#170

#230

R1- T(ALIGN)-HRS
R2- T(ALIGN)-MINS
R3- T(ALIGN)-SECS

OF T(ALIGN).

T(ALIGN)- TIME (GET)
AT WHICH VEHICLE
POSITION AND VELO-
CITY VECTORS ARE SE-
LECTED TO DEFINE IMU
AND CSM NOMINAL ORI-
ENTATION. IN HRS,
MINS AND SECS TO
NFAREST .01 SEC.

T(ALIGN) WILL APPEAR
HERE AS 00000,
00000, 00000, WHICH
IF ACCEPTED WILL
INDICATE THAT THE
NOMINAL ORIENTATION
WILL BE DEFINED FOR
A T(ALIGN) AUTOMATI-
CALLY SELECTED AS
THE PRESENT TIME

#240

#250

DO I WISH TO ALIGN
THE IMU TO AN ORIEN-
TATION DEFINED BY
THE T(ALIGN) PRE-
SENTLY DISPLAYED?

.Y .N

WAIT FOR KEYBOARD
ENTRY

#260

KEY IN
PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.P .NEW
.R .DATA
.O .
.C .
.E .STORE
.E .NEW
.D .

#270

KEY IN V25E
AND LOAD
THE DESIRED
T(ALIGN) IN
R1, R2, AND
R3.

#280

#290

#300

#310

#320

DATA

IS T(ALIGN) DEFINED
TO BE= 0?

.Y .N

DEFINE T(ALIGN)
= T PRESENT.

FIND CSM
STATE AT T(A-
LIGN) USING
PRECISION
INTEGRATION
MODE

COMPUTE NOMINAL
ORIENTATION FOR
THE PREVIOUSLY
DEFINED
T(ALIGN). SEL-
T THIS ORIE-
N TATION FOR
GIMBAL ANGLES
COMPUTATION.
(NOTE: AT THIS

#380

AFTER PROPOSED CSM/
IMU ALIGNMENT

R1-OG ROLL
R2-IG PITCH
R3-MG YAW

ALL GIMBAL ANGLES IN
DEGREES TO NEAREST
.01 DEGREE

IS MIDDLE GIMBAL
ANGLE SATISFACTORY?

.Y .N

. .

BY SUITABLE MODE
SELECTION ENSURE
THAT VEHICLE IS
AS INERTIALLY
STABLE AS
POSSIBLE TO EN-
SURE ACCURACY OF
IMJ COARSE
ALIGNMENT.

WAIT FOR KEYBOARD
ENTRY

#400

#410

DO I WISH TO
MANEUVER VEHICLE
TO AN ATTITUDE
WHICH WILL PRO-
VIDE A MORE
SUITABLE MGA?

.N .Y

. .

MANEUVER VEH-
ICLE WITH

#420

#530

#540

#550

#560

#570

GO TO
"D"
BELOW

KEY IN ENTER
NOTE: AFTER
PC MANEUVER
ENTER RES-
PONSE WILL
RESULT IN
402 ALARM
AND CONTINUE
FL V50 N25

GO TO
"D"
BELOW

IS THIS 1ST PLANE
CHANGE ALIGNMENT?
(IS THE PCFLAG SET?)

.N .Y

DO ROUTINE R00

DO ROUTINE R00

EXIT P52

EXIT P52

LIGHT PLO-
GRAM ALARM
AND STORE
ALARM CJDE
402

B

#580

++
+01
POSS
HOLD
.....
SNAP
+
+489
++

FLASH VERB-NOUN TO
REQUEST PLEASE PER-
FORM NORMAL OR GYRO
TORQUE COARSE ALIGN:
V50N25
R1-00J13
R2-BLANK
R3-BLANK

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
NORMAL OR GYRO TOR-
QUE COARSE ALIGN

#590

#600

THE NORMAL METHOD
OF ACHIEVING IMU
REALIGNMENT IS TO
ACCEPT THIS REQUEST
BY KEYING IN PROCEED
WHICH WILL CAUSE THE
CMC TO COARSE ALIGN
AND GYRO TRIM THE
STABLE MEMBER TO THE
GIMBAL ANGLES COM-
PUTED FOR THE
NEW ORIENTATION AND
THEN TO PROCEED
THROUGH OPTICAL
SIGHTINGS AND PULSE
TORQUING TO ACHIEVE
FINAL ALIGNMENT.
AN ALTERNATE METHOD
OF ACHIEVING IMU
REALIGNMENT IS TO
KEY IN ENTER WHICH
WILL CAUSE THE CMC
TO COMPUTE THE NUM-
BER OF TORQUING
PULSES REQUIRED BY
EACH IRIG (X,Y,Z)
IN ORDER TO ACHIEVE

#610

#620

+ +
 +01
 +
 +
 +
 POSS
 HOLD
 SNAP
 +489
 + +

FLASH VERB-NOUN TO
 REQUEST PLEASE PER-
 FORM CELESTIAL BODY
 ACQUISITION
 V50 V25
 R1-00015
 R2-BLANK
 R3-BLANK

MONITOR DSKY:
 OBSERVE VERB-NOUN
 FLASH TO REQUEST
 PLEASE PERFORM
 CELESTIAL BODY
 ACQUISITION:
 NOTE: THE CMC WILL
 ATTEMPT TO SELECT
 TWO CELESTIAL BODIES
 SUITABLE FOR SIGHT-
 ING BY USE OF THE
 OPTICS. IF THE
 OPTICS ARE NOT BEING
 USED THE ROUTINE MAY
 HAVE NO VALUE.

#770

#780

#790

#800

#810

DO I WISH ASSISTANCE
 FROM THE CMC IN
 SELECTING TWO STARS
 SUITABLE FOR
 ALIGNMENT?

WAIT FOR KEYBOARD
 ENTRY

KEY IN ENTER

MANEUVER VEHICLE UN-
 TIL SUITABLE STARS

MAY BE ACQUIRED.
 MONITOR FDAI BALL
 TO AVOID GIMBAL
 LOCK. (NOTE: ASTRO-
 NAUT MAY USE OPTICS
 TO ASSIST ATTITUDE
 CHOICE OR MAY MANEJ-
 VER AT RANDOM.)

#820

KEY IN PROCEED

#830

TERMINATE FLASH UPON
 RECEIPT OF ENTER OR
 PROCEED

ENTER PROCEED

DO STAR SELECTION
 ROUTINE (REFER TO
 SECTION 5.6 OF R693)

TWO
 STARS
 AVAILABLE NOT
 AVAILABLE

#840

MONITOR DSKY:
 DOES ALARM
 CODE DISPLAY
 INDICATE THAT TWO
 STARS ARE NOT AVAIL-
 ABLE IN THE SXT
 FIELD OF VIEW?

Y N

#860

SHALL I BYPASS
 STAR SELECTION

FLASH VERB-NOUN
 TO REQUEST RES-
 PONSE AND DIS-
 PLAY ALARM CODE:

V05N09
 R1-
 R2-
 R3-

EXPECTED ALARM
 CODE AT THIS
 TIME IS 405

PCSS
 HOLD
 SNAP

#870

ROUTINE AND
SELECT MY OWN
CELESTIAL
BODY?

.Y .N
. .
. .

MANEUVER
VEHICLE UN-
TIL A SUIT-
ABLE CELES-
TIAL BODY
IS ACQUIRED

#880

KEY IN PRO-
CEED

#890

WAIT FOR KEY-
BOARD ENTRY

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR RE-
CYCLE.

.P .R
.R .E
.D .C
.C .Y
.E .C
.E .L
.D .E
. .
. .

KEY IN RE-
CYCLE
V32E

#900

#910

IS BODY CODE = 00?

.N .Y

#1010

#1020

#1030

#1040

#1050

IS THE CELESTIAL BODY CODE NEGATIVE?

.Y .N

TURN ON OPERATOR ERROR LIGHT

IS THE CELESTIAL BODY CODE >47 (OCTAL)?

.Y .N

IS C=1 (ATM SUN SENSOR)?

.Y .N

IS DE=46 (SUN)?

.N .Y

TURN ON OPERATOR ERROR

#1060

#1070

#1080

#1090

#1100

LIGHT

IS CELESTIAL BODY
CODE 00?

.N .Y

IS THE CELESTIAL
BODY CODE 46 OR
47?

.N .Y

OBTAIN STAR
VECTOR FROM
STORED
EPHEMERIS

CALCULATE CEL-
ESTIAL BODY
VECTOR FOR THE
BODY DEFINED
BY THE CELEST-
IAL BODY CODE.

POSS
HOLD
SNAP

FLASH VERB-NOUN
TO REQUEST RE-
SPONSE AND DIS-
PLAY PLANET

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY

POSITION VECTOR:
 V05N88
 R1-X PL
 R2-Y PL
 R3-Z PL

#1110

X PL - THE X COMPONENT OF UNIT POSITION VECTOR OF THE PLANET AT GET. IN REFERENCE COORDINATES. TO THE FIFTH PLACE (.XXXXX).

#1120

Y PL - SAME AS X PL FOR Y COMPONENT.

#1130

Z PL - SAME AS X PL FOR Z COMPONENT.

WAIT FOR KEY-BOARD ENTRY

#1140

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

#1150

P NEW DATA
 R O
 C
 E STORE NEW DATA

OF PLANET POSITION VECTOR.

ARE THE POSITION VECTOR COMPONENTS CORRECT?

.Y .N

KEY IN PROCEED

KEY IN V25E AND LOAD CORRECT POSITION VECTOR COMPONENTS

#1160

IS C=0 (CSM OPTICS)?

.Y .N

WAS CSM OPTICS
SELECTED?

.Y .N

DO SIGHTING
MARK ROUTINE
(R53)

DO SIGHTING
MARK ROUTINE
(R53)

DO AUTO OPTICS
POSITIONING ROUTINE
R52 (INCLUDES SIGHT-
ING MARK ROUTINE
(R53))

DO AUTO OPTICS
POSITIONING ROUTINE
R52 (INCLUDES
SIGHTING MARK
ROUTINE (R53))

IS CELESTIAL BODY
CODE 00?

IS THE TARGET A STAR
OR THE EARTH OR SUN?

IS THE CELESTIAL
BODY CODE 46 OR
47?

IS THE TARGET A STAR
OR THE EARTH OR SUN?

#1170

#1180

#1190

#1200

#1260

#1270

#1280

#1290

#1300

Y PL - SAME AS
X PL FOR Y
COMPONENT.
Z PL - SAME AS
X PL FOR Z
COMPONENT.

WAIT FOR KEY-
BOARD ENTRY

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED OR NEW
DATA.

.P .NEW
.R .DATA
.O .
.C .
.E .STORE NEW
.D .DATA

HAVE TWO CELEST-
IAL BODIES BEEN
MARKED?

.N .Y

KEY IN
PROCEED

KEY IN V25E AND
LOAD CORRECT
POSITION VECTOR
COMPONENTS

HAVE I MARKED TWO
CELESTIAL BODIES?

.Y .N

#1360

IS THIS A MINKEY
PLANE-CHANGE
ALIGNMENT?
.N .Y

#1370

DO ROUTINE
R00

#1380

EXIT P52

#1390

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM FINE
ALIGN.

#1400

DO I WANT TO REDO
THE CELESTIAL BODY

IS THIS A MINKEY
PLANE-CHANGE
ALIGNMENT?
{AUTOSEQ FLAG
SET?}
.N .Y

RESET PCFLAG

DO ROUTINE
R00

EXIT P52

FLASH VERB-NOUN TO
REQUEST PLEASE PER-
FORM FINE ALIGN:
V50 N25
R1-00014
R2-BLANK
R3-BLANK

489

HOLD .
.....
SNAP .

BACKUP IMU ORIENTATION DETERMINATION PROGRAM (P53)

REV 01 03/20/72

PURPOSE:

(1) TO DETERMINE THE INERTIAL ORIENTATION OF THE IMU USING A BACKUP OPTICAL DEVICE, THE ATM SUN SENSOR, OR THE ATM STAR TRACKER.

ASSUMPTIONS: (1) THE IMU MAY BE:

(A) OFF (STANDBY)

(B) ON, AND ALIGNED OR NOT ALIGNED SINCE TURN ON.

IF (A) IS TRUE, THE IMU MUST BE TURNED ON BEFORE THIS PROGRAM CAN BE PERFORMED.
IF (B) IS TRUE THIS PROGRAM CAN BE COMPLETED.

(2) THIS PROGRAM AND ITS ROUTINES HAVE THE SAME DISPLAY SEQUENCE AS P31 EXCEPT THAT R56 IS CALLED IN PLACE OF R53.

(3) THE CSM ATTITUDE CONTROL MODE SELECTED IS AT THE OPTION OF THE CREW.

(4) TIME AND RCS FUEL MAY BE SAVED, AND SUBSEQUENT IMU ALIGNMENT DECISIONS GREATLY SIMPLIFIED IF THIS PROGRAM IS PERFORMED IN SUCH A WAY AS TO LEAVE THE IMU INERTIALLY STABILIZED AT AN ORIENTATION AS CLOSE AS POSSIBLE TO THE OPTIMUM ORIENTATION REQUIRED BY FUTURE CMC PROGRAMS.

(5) IF ATM SUN SENSOR IS USED AS SOURCE OF SIGHTING DATA, CSM MUST BE DOCKED TO ORBITAL ASSEMBLY, ATM MUST BE IN SOLAR INERTIAL ATTITUDE, AND ATM ORIENTATION WITH RESPECT TO NAV BASE MUST BE KNOWN.

(6) IF ATM STAR TRACKER IS USED AS SOURCE OF SIGHTING DATA, CSM MUST BE DOCKED TO ORBITAL ASSEMBLY, AND ATM ORIENTATION WITH RESPECT TO NAV BASE MUST BE KNOWN.

(7) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY OSKY ENTRY.

PROG
CONT

CMC	GROUND	CREW
		.CREW PROG
		.SELECTION
		...
		...
		...

```

-----
DC R00 TO START
BACKUP IMU ORIENTA-
TION DETERMINATION PROGRAM (P53)
DISPLAY PROGRAM 53
-----
KEY IN BACKUP IMU
ORIENTATION DETERMI-
NATION PROGRAM (P53)
V37E 53E
-----

```


#160

#170

#180

#190

#200

#210

POSS
TEMP
HOLD
.....
SNAP

.C
.E
.R
.E
.D

DISPLAY ON DSKY:
V41 N22
R1-00000
R2-00000
R3-00000

WHERE R1, R2,
AND R3 REPRESENT
CDU/ISS ANGLES
TO BE COARSE
ALIGNED TO (DG,
IG, MG, RESPEC-
TIVELY).

RESET REFSMAT
FLAG

COMMAND ISS TO
COARSE ALIGN
MODE

TURN ON "NO ATT"
LIGHT

COARSE ALIGN ISS

TERMINATE COARSE
ALIGN MODE IN

MONITOR DSKY:
OBSERVE DISPLAY
OF COARSE ALIGN
VERB AND ICDU
ANGLES (ALL
00000) FOR COARSE
ALIGNMENT

OBSERVE "NO ATT"
LIGHT ON

#220

ISS. RESUME ATTI-
TUDE HOLD OF
VEHICLE.

TURN OFF "NO
ATT" LIGHT

WAIT FOR "NO ATT"
LIGHT OFF

#230

++
+01
+
+
+489
++

DO ALTERNATE LOS
SIGHTING MARK
ROUTINE (R56) FOR
CELESTIAL BODY #1

DO ALTERNATE LOS
SIGHTING MARK
ROUTINE (R56) FOR
CELESTIAL BODY #1

#240

CALCULATE CELESTIAL
BODY #1 VECTOR W.R.T
IMU

#250

DO ALTERNATE LOS
SIGHTING MARK ROU-
TINE (R56) FOR
CELESTIAL BODY #2

DO ALTERNATE LOS
SIGHTING MARK ROU-
TINE (R56) FOR
CELESTIAL BODY #2

#260

REV 01 03/20/72

BACKUP IMU REALIGN PROGRAM (P54)

PURPOSE:

(1) TO ALIGN THE IMU FROM A "KNOWN" (SEE ASSUMPTION 4) ORIENTATION TO ONE OF THREE ORIENTATIONS SELECTED BY THE ASTRONAUT USING SIGHTINGS ON TWO CELESTIAL BODIES WITH A BACKUP OPTICAL DEVICE, THE ATM SUN SENSOR, OR THE ATM STAR TRACKER.

(A) PREFERRED ORIENTATION

AN OPTIMUM ORIENTATION FOR A PREVIOUSLY CALCULATED MANEUVER. THIS ORIENTATION MUST BE CALCULATED AND STORED BY A PREVIOUSLY SELECTED PROGRAM.

(B) NOMINAL ORIENTATION

X = UNIT(Y X Z)
-SM -SM -SM

Y = UNIT(V X R)
-SM - -

Z = UNIT(-R)
-SM -

WHERE:

R = THE GEOCENTRIC RADIUS VECTOR AT TIME T (ALIGN) SELECTED BY THE ASTRONAUT

V = THE INERTIAL VELOCITY VECTOR AT TIME T (ALIGN) SELECTED BY THE ASTRONAUT.

(C) REFSMAT
SEE ASSUMPTION (4)

ASSUMPTIONS:

- (1) THE DOCKED CONFIGURATION MAY BE SIVB/CSM, SKYLAB/CSM, OR CSM. THE PRESENT CONFIGURATION SHOULD HAVE BEEN ENTERED INTO THE CMC BY COMPLETION OF EITHER ROUTINE R03 OR R04 AND EITHER V45 OR V46 (DEPENDING ON CONFIGURATION).
- (2) IF THE S/C CONTROL SWITCH IS IN CMC AND THE MODE SWITCH IS IN ATTITUDE HOLD OR AUTO DURING THE GYRO TORQUING ROUTINE (R55) OR THE GYRO TORQUING OPTION (CENTER ON V50M25, RL=13), OR THE GYRO TRIM PORTION OF CBASE ALIGN ROUTINE (R50), THE GAP WILL MANEUVER THE VEHICLE TO FOLLOW THE PLATFORM.
- (3) THIS PROGRAM MAKES NO PROVISION FOR AN ATTITUDE MANEUVER TO RETURN THE VEHICLE TO A SPECIFIC ATTITUDE. SUCH A MANEUVER, IF DESIRED, MUST BE DONE MANUALLY.
- (4) THE ISS IS ON AND HAS BEEN ALIGNED TO A KNOWN ORIENTATION WHICH IS STORED IN THE CMC (REFSMAT). THE PRESENT IMU ORIENTATION DIFFERS FROM THAT TO WHICH IT WAS LAST ALIGNED ONLY DUE TO GYRO DRIFT (I.E. NEITHER GIMBAL LOCK NOR IMU POWER INTERRUPTION HAS OCCURRED SINCE THE LAST ALIGNMENT).
- (5) IF ATM SUN SENSOR IS USED AS SOURCE OF SIGHTING DATA, CSM MUST BE DOCKED TO ORBITAL ASSEMBLY, ATM MUST BE IN SOLAR INERTIAL ATTITUDE, AND ATM ORIENTATION WITH RESPECT TO NAV BASE MUST BE KNOWN.
- (6) IF ATM STAR TRACKER IS USED AS SOURCE OF SIGHTING DATA, CSM MUST BE DOCKED TO ORBITAL ASSEMBLY, AND ATM ORIENTA-

#90

#100

#110

#120

#130

SELECTION

R2 IS THE CMC
ASSUMED OPTION:
0001-PREFERRED
0002-NJMINAL
0003-REFSYNAT

IS THIS THE IMU ORI-
ENTATION I DESIRE?

.Y .N

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.P .NEW
.R .CODE
.D .
.C .
.E .
.E .STORE CODE
.D .

KEY IN V22E
AND LOAD THE
DESIRED ORIEN-
TATION CODE IN
R2

IS STORED ORIENTA-
TION CODE 0001?

.N .Y

WAS PREFERRED ORIEN-
TATION SELECTED?

.N .Y

SELECT PRE-
FERRED IMU

GO TO

T(ALIGN) - TIME
(GET) AT WHICH
VEHICLE POSITION AND
VELOCITY VECTORS
ARE SELECTED TO DE-
FINE IMU AND CSM
NOMINAL ORIENTATION.
IN HRS, MINS, AND
SECS TO NEAREST .01
SEC.

#190

T(ALIGN) WILL APPEAR
HERE AS 00000, 00000
00000, WHICH IF AC-
CEPTED WILL INDICATE
THAT THE NOMINAL
ORIENTATION WILL BE
DEFINED FOR A
T(ALIGN) AUTOMATI-
CALLY SELECTED AS
THE PRESENT TIME

#200

DO I WISH TO ALIGN
THE IMU TO AN ORIE-
NTATION DEFINED BY
THE T(ALIGN) PRE-
SENTLY DISPLAYED?

#210

.Y .N

WAIT FOR KEYBOARD
ENTRY

#220

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.P .NEW
.R .DATA
.D .
.C .
.E .
.E STORE
.D NEW
DATA

#230

KEY IN V25E AND
LOAD THE DESIRED
T(ALIGN) IN R1,
R2, AND R3.

DEGREES TO NEAREST
.01 DEGREE

IS MIDDLE GIMBAL
ANGLE SATISFACTORY?

.Y .N

. .

BY SUITABLE MODE
SELECTION ENSURE
THAT VEHICLE IS
AS INERTIALLY
STABLE AS
POSSIBLE TO EN-
SURE ACCURACY OF
IMU COARSE
ALIGNMENT.

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

DO I WISH TO
MANEUVER VEHICLE
TO AN ATTITUDE
WHICH WILL PRO-
VIDE A MORE
SUITABLE MGA?

.N .Y

MANEUVER VEH-
ICLE WITH
ROTATION
CONTROLLER

UPDATE THE
DISPLAY OF
RESULTING
GIMBAL ANGLES
KEY IN RECY-

#340

#350

#360

#370

#380

REALIGNMENT IS TO
 ACCEPT THIS REQUEST
 BY KEYING IN PROCEED
 WHICH WILL CAUSE THE
 CMC TO COARSE ALIGN
 AND GYRO TRIM THE
 STABLE MEMBER TO
 THE GIMBAL ANGLES
 COMPUTED FOR THE
 NEW ORIENTATION AND
 THEN TO PROCEED
 THROUGH OPTICAL
 SIGHTINGS AND PULSE
 TORQUING TO ACHIEVE
 FINAL ALIGNMENT.
 AN ALTERNATE METHOD
 OF ACHIEVING IMU
 REALIGNMENT IS TO
 KEY IN ENTER WHICH
 WILL CAUSE THE CMC
 TO COMPUTE THE NUM-
 BER OF TORQUING
 PULSES REQUIRED BY
 EACH IRIG (X,Y,Z)
 IN ORDER TO ACHIEVE
 PRECISE ALIGNMENT,
 AND ISSUE THESE
 PULSES. THIS ALTER-
 NATE METHOD INTRO-
 DUCES A PREDICTABLE
 ERROR INTO THE CMC'S
 KNOWLEDGE OF THE
 STABLE MEMBER ORIE-
 NTATION AND TAKES A
 PREDICTABLE PERIOD
 OF TIME FOR COMPLE-
 TION.
 AN APPROXIMATION OF
 THIS ERROR AND THE
 TIME TO TORQUE CAN
 BE MADE BY CALCULA-
 TING THE SUM OF THE
 GIMBAL ANGLE CHAN-
 GES, MULTIPLYING BY
 2 FOR TIME TC TORQUE
 IN SECONDS, AND MUL-
 TIPLYING BY .002 FOR
 ERROR IN DEGREES.

#440

#450

#460

#470

#480

.....

 WAIT FOR KEYBOARD
 ENTRY

SHALL I REALIGN IN
THE NORMAL WAY?

.Y .N

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR ENTER

.P .ENTER
.R .
.O .
.C .
.E .
.E .
.D .
. .
. .
. .

COMPUTE TORQUING
ANGLES REQUIRED
TO ACHIEVE NEW
ORIENTATION.

RESET REFSMAT
FLAG

PULSE IRIG'S
THROUGH TORQUING
ANGLES AND DIS-
PLAY PRESENT ICDU
ANGLES UNTIL

MONITOR DSKY:
OBSERVE VERB-NDUN
DISPLAY OF PRE-
SENT GIMBAL
ANGLES UNTIL COM-

#490

#500

#510

#520

#530

PLETION OF PULSE
 TORQUING
 NOTE 1: IT IS NOT
 NECESSARY TO
 MAINTAIN A FIXED
 INERTIAL ORIENTA-
 TION OF SPACE-
 CRAFT DURING
 PULSE TORQUING.
 NOTE 2: IF IT
 APPEARS THAT THE
 IMU WILL BE PULSE
 TORQUED INTO
 GIMBAL LOCK THE
 ASTRONAUT SHOULD
 MANEUVER THE
 VEHICLE TO AVOID
 THAT CONDITION.

#540

#550

#560

#570

COMPLETION.
 V1-N20
 R1-OG ROLL
 R2-IG PITCH
 R3-MG YAW
 ALL GIMBAL ANGLES
 IN DEGREES TO
 NEAREST .01
 DEGREES.

STORE THE DESIRED
 IMU ORIENTATION
 IN REFSMAT
 AND SET REFSMAT
 FLAG

SELECT FINAL DESIRED
 IMU ORIENTATION FROM
 STORAGE FOR USE BY
 THE COARSE ALIGN
 ROUTINE (R50)

TFMP
 HOLD
 MON

GO TO
 "C"
 BELOW

GO TO
 "C"
 BELOW

SECTION 5.6 OF
R693).

- TWO
- STARS
- AVAILABLE NOT
- AVAILABLE

POSS
HOLD
SNAP

FLASH VERB-NOUN
TO REQUEST RES-
PONSE AND DIS-
PLAY ALARM CODE:
V05N09

- R1-
- R2-
- R3-

EXPECTED ALARM
CODE AT THIS
TIME IS 405

WAIT FOR KEY-
BOARD ENTRY

MONITOR DSKY:
DOES ALARM
CODE DISPLAY
INDICATE THAT TWO
STARS ARE NOT AVAIL-
ABLE IN THE SXT
FIELD OF VIEW?

- Y
- N

SHALL I BYPASS
STAR SELECTION
ROUTINE AND
SELECT MY OWN
CELESTIAL
BODY?

- Y
- N

MANEUVER
VEHICLE UN-
TIL A SUIT-
ABLE CEL-
ESTIAL BODY
IS ACQUIRED

KEY IN PRO-
CEED

#680

#690

#700

#710

#720

#780

#790

#800

#810

#820

SOURCE CODE AND
CELESTIAL BODY CODE

CODE
VJINTO
R1-00CDE
R2-BLANK
R3-BLANK

R1-C=SOURCE OF SIGHTING DATA
0-BACKUP OPTICAL DEVICE
1-ATM SUN SENSOR
2-ATM STAR TRACKER

DE=CELESTIAL BODY
CJDE

NOTE: N70 DISPLAYS RESULTS OF SUCCESSFUL STAR SELECTION ROUTINE OTHERWISE CONTAINS RESIDUAL DATA.

IS CODE SATISFACTORY?

WAIT FOR KEYBOARD ENTRY

IT IS NOT NECESSARY TO CHANGE CODE AT THIS TIME SINCE THIS DISPLAY IS FOR INFORMATION ONLY. HOWEVER, IF IT IS CHANGED NOW IT WILL NOT HAVE TO BE CHANGED FOLLOWING THE SIGHTING.
NOTE: THE CEL-

#880

TURN ON
OPERATOR
ERROR LIGHT.

#890

IS CELESTIAL BODY
CODE >47 (OCTAL)?

IS C=1
(ATM SUN SENSOR)?

#900

IS DE=46
(SUN)?

#910

TURN ON
OPERATOR
ERROR LIGHT.

#920

#930

#940

#950

#960

#970

IS CELESTIAL BODY
CODE 00?

.N .Y

IS CELESTIAL BODY
CODE 00?

.N .Y

IS THE CELESTIAL
BODY CODE 46 OR
47?

.N .Y

OBTAIN STAR
VECTOR FROM
STORED
EPHEMERIS

CALCULATE CEL-
ESTIAL BODY
VECTOR FOR THE
BODY DEFINED
BY THE CELES-
TIAL BODY CODE

POSS
HOLD
SNAP

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF PLANET POSITION
VECTOR.

FLASH VERB-NOUN
TO REQUEST RE-
SPONSE AND DIS-
PLAY PLANET
POSITION
VECTOR:
V06N88
R1-X PL
R2-Y PL

R3-Z PL

X PL - THE X
COMPONENT OF
UNIT POSI-
TION VECTOR OF
THE PLANET AT
GET. IN REFER-
ENCE COORDINA-
TES. TO THE
FIFTH PLACE
(.XXXXX).

Y PL - SAME AS
X PL FOR Y
COMPONENT.

Z PL - SAME AS
X PL FOR Z
COMPONENT.

WAIT FOR KEY-
BOARD ENTRY

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED OR NEW
DATA.

.P .NEW
.R .DATA
.O .
.C .
.E .
.E STORE NEW
.D DATA

DO ALTERNATE LOS
SIGHTING MARK
ROUTINE (R55).

ARE THE POSITION
VECTOR COMPONENTS
CORRECT?

.Y .N

KEY IN
PROCEED

KEY IN V25E AND
LOAD CORRECT
POSITION VECTOR
COMPONENTS

DO ALTERNATE LOS
SIGHTING MARK
ROUTINE (R56).

#980

#990

#1000

#1010

#1020

#20

MONITOR DSKY:
OBSERVE DISPLAY
OF PROGRAM 55

#30

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF OPTION CODE FOR
ASSUMED INPUTS TO
PROGRAM

#40

R1 IS THE OPTION
CODE FOR ASSUMED
INPUTS TO PROGRAM

R2 IS THE INPUT CODE:
00001 - CELESTIAL
BODY AND
IMU ORI-
ENTATION

00002 - CELESTIAL
BODY, OP-
TICS MARK,
AND ATM
SOLAR-IN-
ERTIAL
ATTITUDE

#50

#60

IS THIS THE SET OF
INPUTS THAT I DE-
SIRE?

.Y
.N

WAIT FOR KEYBOARD
ENTRY.

KEY IN PROCEED

#70

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

KEY IN V22E AND
LOAD THE DESIR-
ED SENSOR CODE
IN R2

#80

P. NEW
R. CODE
G.
C.
E.
F.
D. STORE NEW
CODE

#90

WAS CODE 00001
SELECTED?

IS CELESTIAL BODY-
IMU ORIENTATION
OPTION (00001)
STORED?

WAS CODE 00001
SELECTED?

#100

DO SIGHTING MARK
ROUTINE (R53)

DO SIGHTING MARK
ROUTINE (R53)

#110

CALCULATE LOS VECTOR
TO SUN IN BASIC

#120

#130

#140

#150

#160

#170

REFERENCE COORDI-
NATES AT MARK TIME.

IS CELESTIAL BODY
CODE 00?

.N
.Y

IS THE CELESTIAL
BODY CODE 46 OR 47?

.N
.Y

OBTAIN STAR VEC-
TOR FROM STORED
EPHEMERIS

CALCULATE CELES-
TIAL BODY VECTOR
FOR THE BODY
DEFINED BY THE
STAR CODE

FLASH VERB-NOUN
TO REQUEST RE-
SPONSE AND DISPLAY

WAS CELESTIAL BODY
CODE 00 SELECTED?

.Y
.N

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST

++
+01

POSS
HOLD

SIMP

PLANET POSITION
 VECTOR;
 V06N88
 R1-X PL
 R2-Y PL
 R3-Z PL

X PL - THE X
 COMPONENT OF UNIT
 POSITION VECTOR
 OF THE PLANET AT
 GET. IN REFERENCE
 COORDINATES. TO
 THE FIFTH PLACE
 (.XXXXX).

Y PL - SAME AS
 X PL FOR Y
 COMPONENT.

Z PL - SAME AS
 X PL FOR Z
 COMPONENT.

WAIT FOR KEYBOARD
 ENTRY

TERMINATE FLASH
 UPON RECEIPT OF
 PROCEED OR NEW
 DATA.

P NEW
 .DATA
 R .
 O .
 C .
 E STORE NEW
 .D DATA

RESPONSE AND DIS-
 PLAY OF PLANET
 POSITION VECTOR.

ARE THE POSITION
 VECTOR COMPONENTS
 CORRECT?

.Y .N

KEY IN
 PROCEED

KEY IN V25E AND
 LOAD CORRECT
 POSITION VECTOR
 COMPONENTS

#180

#190

#200

#210

#220

#230

DO IMU STATUS
CHECK ROUTINE
(R02)

CALCULATE BASIC REFERENCE TO
ATM COORDINATE TRANSFORMATION
MATRIX USING SUN VECTOR AND
MARK DATA FROM CELESTIAL BODY
SIGHTED WITH SXT OR SCT IN R53.

SET P55.1FLG

#240

#250

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY CELESTIAL
BODY CODE:
V01N70
R1 - 000DE
R2 - BLANK
R3 - BLANK
R1-DE-CELESTIAL
BODY CODE

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF CELESTIAL BODY
CODE

#260

DO I WISH TO SIGHT
ON THIS CELESTIAL
BODY WITH STAR
TRACKER?

#270

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.P
.R
.D
.C
.E
STORE NEW
DATA

KEY IN V21E
AND CHANGE
CELESTIAL BODY
CODE

#280

IS CELESTIAL
BODY CODE
NEGATIVE?

.Y .N

#290

TURN ON
OPERATOR ERROR
LIGHT

#300

IS CELESTIAL
BODY CODE >47
(OCTAL)?

.Y .N

#310

TURN ON
OPERATOR ERROR
LIGHT

#320

B

#330

IS CELESTIAL BODY
CODE 00 (PLANET)?

WAS CODE 00000
SELECTED?

.N .Y

IS CELESTIAL BODY
CODE 46 OR 47?
(IT IS ASSUMED
THAT THE ASTRO-
NAUT WILL NEVER
SELECT CODES 46
OR 47 FOR STAR
TRACKER)

.N .Y

-(STAR)

OBTAIN STAR
VECTOR FROM
STORED
EPHEMERIS

CALCULATE
VECTOR TO
DESIGNATED
CELESTIAL BODY

POSS
HOLD
SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE
AND DISPLAY PLANET
POSITION VECTOR:

MONITOR DSKY:
OBSERVE VERB-NOJN
FLASH TO REQUEST
RESPONSE AND DISPLAY

#340

#350

#360

#370

V06 N88
R1 - X PL
R2 - Y PL
R3 - Z PL

OF PLANET POSITION
VECTOR

#380

X PL-THE X COMPO-
NENT OF THE UNIT
POSITION VECTOR OF
THE PLANET AT GET
IV BASIC REFERENCE
COORDINATES. TO
THE FIFTH PLACE
(.XXXXX)

Y PL-SAME AS X PL
FOR Y COMPONENT

ARE THE POSITION
VECTOR COMPONENTS
CORRECT?

#400

.Y .N

.Y .N

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

#410

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA

KEY IN V25E AND
LOAD CORRECT
POSITION VECTOR
COMPONENTS

#420

.P .NEW
.R .DATA
.D .
.C .
.E STORE NEW
.D DATA

#480

```

.....
MONITOR DSKY:
OBSERVE PROGRAM
ALARM LIGHT ON IF
STAR TRACKER GIMBAL
ANGLES NOT WITHIN
PERMISSIBLE RANGE.
KEY V05N09E TO
VERIFY ALARM CODE
00107.

```

#490

```

.....
MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF STAR TRACKER
GIMBAL ANGLES, PSI
AND PSI

```

#500

```

.....
ARE STAR TRACKER
GIMBAL ANGLES SATIS-
FACTORY?

```

#520

#530

```

+ +
+01
TURN ON PRO-
GRAM ALARM
LIGHT AND
STORE ALARM
CODE 00107

```

+489

```

.....
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STAR TRACKER
GIMBAL ANGLES:
V06 N14
R1-AZIMUTH (PSI )
R2-ELEVATION (PSI )
R3-BLANK

```

```

.....
AZIMUTH-OUTER GIMBAL
ANGLE OF THE ATM
STAR TRACKER. IN ARC
MINUTES TO THE NEAR-
EST ARC MINUTE.

```

```

.....
ELEVATION-INNER GIM-
BAL ANGLE OF THE ATM
STAR TRACKER. IN ARC
MINUTES TO THE NEAR-
EST ARC MINUTE.

```

```

.....
WAIT FOR KEYBOARD
ENTRY
KEY IN
RECYCLE,
V32E

```


CHANGE CONTROL NOTES

REV 00 PCR 036, PCN 438
REV 01 PCR 460, PCN 499

REV 00 05/19/71

ENTRY-PREPARATION PROGRAM (P61)

PURPOSE: (1) TO START NAVIGATION, CHECK IMU ALIGNMENT, AND PROVIDE ENTRY MONITOR SYSTEM INITIALIZATION DATA.

ASSUMPTIONS: (1) THE PROGRAM IS ENTERED WITH ADEQUATE FREE FALL TIME TO COMPLETE THE PREPARATIONS FROM A WORST CASE STARTING ATTITUDE.

(2) THE ISS IS ON AND PRECISELY ALIGNED TO A SATISFACTORY ORIENTATION.

(3) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG
CONT

CMC

GROUND

CREW

- CREW PROG
- SELECTION
-
-
-

 DO R00 TO START
 ENTRY-PREPARATION
 PROGRAM (P61)
 DISPLAY PROGRAM 61

 KEY IN ENTRY-PREPAR-
 ATION PROGRAM
 (P61)
 V37E 61E

#10

 MONITOR DSKY:
 OBSERVE DISPLAY OF
 PROGRAM 61

#20

 DO IMU STATUS CHECK
 ROUTINE (R02)

 DO IMU STATUS CHECK
 ROUTINE (R02)

POSS
TEMP
HOLD
SNAP

COMMAND PROGRAM
ALARM AND
DISPLAY
VO5 N09
R1-
R2-
R3-

EXPECTED ALARM
CODE AT THIS
TIME IS 01426

WAIT 10 SEC

HOLD
SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STORED DATA
VO5 N61
R1-IMPACT LAT
R2-IMPACT LONG
R3-HEADS UP/DOWN

IMPACT LAT - LATI-
TUDE OF DESIRED
IMPACT POINT. IN
DEGREES TO NEAREST
.01 DEG. + IS NORTH
IMPACT LONG - LONG-
TUDE OF DESIRED
IMPACT POINT. IN
DEGREES TO NEAREST
.01 DEG. + IS EAST

OBSERVE PROGRAM
ALARM LIGHT CN DSKY
AND DISPLAY OF ERROR
CODE (IMU UNSATIS-
FACTORY)

#90

#100

#110

#120

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF S/C ENTRY DATA.

#130

HEADS UP/DOWN -
DEFINES ENTRY ROLL
ATTITUDE
+0001 FOR HEADS UP/
LIFT DOWN
-0001 FOR HEADS DOWN
/LIFT UP

#140

AM I SATISFIED WITH
THESE VALUES?

.Y .N
. .
. .

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

#150

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW DATA

P. .NEW
R. .DATA
O. .
C. .
E. .
D. .
STORE DATA

KEY IN
V25E
AND LOAD
DESIRED
PARAMETERS

#160

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY:
V06 N60
R1 - G MAX
R2 - VPRED
R3 - GAMMA EI
G MAX - MAX PREDICTED

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF G MAX, VPRED AND
GAMMA EI

HOLD .
SNAP .

G FOR FREE FALL AND
 ENTRY AT NOMINAL
 BANK ANGLE (L/D =
 .13) IN GS TO
 NEAREST .01 G.

#180

VPRED- PREDICTED
 INERTIAL VELOCITY
 AT 400,000 FT
 ALTITUDE ABOVE
 THE FISCHER
 ELLIPSOID.
 IN FPS TO NEAREST
 FPS.

#190

GAMMA EI - FLIGHT
 PATH ANGLE. ANGLE
 BETWEEN INERTIAL
 VELOCITY AND THE
 LOCAL HORIZONTAL
 AT THE ENTRY INTER-
 FACE ALTITUDE AT
 400,000 FT ALTI-
 TUDE ABOVE THE
 FISCHER ELLIPSOID.
 IN DEGREES TO
 NEAREST .01 DEG.

#200

MINUS INDICATES
 FLIGHT PATH IS BELOW
 THE HORIZONTAL PLANE.

#210

RECORD DATA IF
 NECESSARY

#220

#230

KEY IN PROCEED

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED

.PRO

#240

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF EMS INITIALIZA-
TION PARAMETERS

FLASH VERB-NOUN
TO REQUEST RESPONSE
AND DISPLAY:
V16 N63
R1 - RTJGO
R2 - VIO
R3 - TFE

#250

AM I SATISFIED WITH
THE VALUE FOR TFE?

RTOGO - RANGE TO GO
FROM A PRELOADED
ALTITUDE (SEE NOTE)
ABOVE THE FISCHER
ELLIPSOID TO THE
SPLASH POINT. IN
NAUTICAL MILES TO
NEAREST .1 NM.

#260

RECORD DATA FOR
EMS INITIAL-
IZATION

VIO - PREDICTED
INERTIAL VELOCITY
AT A PRELOADED AL-
TITUDE (SEE NOTE)
ABOVE THE FISCHER
ELLIPSOID IN FPS TO
NEAREST FPS.

#270

TFE - TIME FROM NOW
TO A PRELOADED ALT-
ITUDE (SEE NOTE)
ABOVE THE FISCHER
ELLIPSOID IN MIN

.....
EXIT P61

#330

SWITCH TO ENTRY
DOWNLIST

.....
EXIT P61

CHANGE CONTROL NOTES

REV 00 PCN 410

ENTRY - CM/SM SEPARATION AND PRE-ENTRY MANEUVER PROGRAM (P62) REV 00 05/19/71

PURPOSE: (1) TO NOTIFY CREW WHEN THE JNCS IS PREPARED FOR CM/SM SEPARATION.

(2) TO ORIENT THE CM TO THE CORRECT ATTITUDE FOR ATMOSPHERIC ENTRY.

ASSUMPTIONS: (1) THE PROGRAM IS ENTERED WITH ADEQUATE FREE FALL TIME TO ACCOMPLISH CM/SM SEPARATION AND TO COMPLETE THE MANEUVER FROM A WORST CASE STARTING ATTITUDE.

(2) THE IMU IS SATISFACTORILY ALIGNED FOR ENTRY.

(3) THE PROGRAM IS AUTOMATICALLY SELECTED BY THE ENTRY-PREPARATION PROGRAM (P61) OR IT MAY BE SELECTED MANUALLY.

(4) IN ADDITION TO THE AUTOMATIC DISPLAYS, THE ASTRONAUT MAY MONITOR NS3(RTOGO,VIO,TFE) BY KEYING IN VI6N63E.

PROG CONT

CMC .CMC PROG .SELECTION

GROUND

CREW .CREW PROG .SELECTION

DO R00 (CREW PROG SELECTION ONLY - NO R00 FOR ENTRANCE FROM P61) TO START ENTRY-CM/SM SEPARATION AND PRE-ENTRY MANEUVER PROGRAM (P62). DISPLAY PROGRAM 62

.

KEY IN ENTRY-CM/SM SEPARATION AND PRE-ENTRY MANEUVER PROGRAM (P62) V37E 62E

#10

MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 62

MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 62

#20

DO IMU STATUS CHECK
ROUTINE R02.

DO IMU STATUS CHECK
ROUTINE R02.

#30

HAS THIS PROGRAM
BEEN ENTERED AUTO-
MATICALLY FROM P61?

.Y N.

DO STATE VECTOR
INTEGRATION
(MID TO AVE)
ROUTINE (R41).

DO STATE VECTOR
INTEGRATION
(MID TO AVE) ROUTINE
(R41).
OBSERVE THAT THE
COMPUTER ACTIVITY
LIGHT IS ON UNTIL
THE COMPLETION OF
ROUTINE 41.

#50

CALL THE AVERAGE
G ROUTINE

IS UNIT (V X R)

WITHIN 30 DEG OF
+Y ?
--SM

.Y .N
IS UNIT (V X R)

#60

#70

CALCULATIONS AND
LEAVE IN STANDRY
STATE.

.
. .

CALCULATE THE RE-
QUIRED GIMBAL ANGLES
TO GIVE CORRECT
ANGLE OF ATTACK OF
THE CM INTO THE AT-
MOSPHERE AT THIS
TIME AND CONTINUE
CALCULATION EVERY
TWO SECONDS UNTIL
COMPLETION OF THIS
PROGRAM. THESE GIM-
BAL ANGLES ARE
STORED IN NOUN 22.

. .

HOLD . FLASH VERB-NOUN
.....TO REQUEST PLEASE
SNAP . PERFORM CM/SM SEPAR-
ATION:
V50 N25
R1 - 00041
R2 - BLANK
R3 - BLANK

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM CM/SM
SEPARATION

CM/SM . CM/SM
NOT . SEPAR-
SEPA . ATED
RATED .
.
.

PRIOR TO
COMMANDING
CM/SM SEPAR-
ATION THE
GNC AUTO-
PILOT SHOULD
BE SWITCHED
TO FREE MODE

#130

#140

#150

#160

#170

TO PREVENT
RCS ACTIVITY
IMMEDIATELY
AFTER SEPA-
RATION

#180

MOVE CM/SM
SEP SWITCH TO
UP ON CREW
SAFETY PANEL

#190

WHEN SATISFIED THAT
CM/SM SEPARATION
HAS SATISFACTORILY
OCCURRED WAIT -- SEC
FOR ADEQUATE SEPARA-
TION DISTANCE AND
KEY IN PROCEED.

#200

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH UPON
RECEIPT OF PROCEED.

- P
- R
- O
- C
- E
- E
- D

TURN OFF CSM
RCS JAP

#210

PARAMETERS

P. NEW
 R. DATA
 O. .
 C. .
 E. STORE DATA
 D. .

#280

ESTABLISH ATTITUDE
 COMMANDS FOR ENTRY
 DAP NECESSARY TO
 GIVE CORRECT ANGLE
 OF ATTACK INTO ATMOSPHERE:

ROLL COMMAND -
 BASED ON PREVIOUS
 DEFINITION OF HEADS
 UP/DOWN
 ALPHA COMMAND -
 TRIM ANGLE OF ATTACK
 (TRIM ALPHA)
 BETA COMMAND - ZERO
 FOR LIFT DOWN

THIS ATTITUDE WILL
 BE OBTAINED AFTER A
 SIMPLE PITCH DOWN
 MANEUVER FROM THE
 SEPARATION ATTITUDE.
 FOR LIFT UP AN ADDITIONAL
 180 DEGREES
 OF ROLL IS REQUIRED.

#290

#300

#310

TURN ON ENTRY DAP

#320

#330

#340

#350

#360

#370

IS THE ANGLE ALPHA
ALREADY WITHIN 45
DEGREES?
.Y .N
. .
.....

TEMP HOLD MON
.....
DISPLAY ON DSKY DE-
SIRED FINAL GIMBAL
ANGLES:
V06 N22
R1- JG ROLL
R2- IG PITCH
R3- NG YAW
.....
IN DEGREES TO
NEAREST .01 DEG.

WAIT UNTIL CM
ANGLE OF ATTACK
(ALPHA) IS WITH-
IN 45 DEGREES
AND THEN WAIT
AN ADDITIONAL
21 SECONDS.

TERMINATE PROGRAM
62 AND GO TO ENTRY-
INITIALIZATION
PROGRAM (P 63)

MONITOR DSKY:
OBSERVE DISPLAY
OF FINAL GIMBAL
ANGLES.

MONITOR DSKY:
OBSERVE TERMINATION
OF P 62 AND DISPLAY
OF P 63

PRECEDING PAGE BLANK NOT FILMED

#10

REV 00 05/19/71

ENTRY-INITIALIZATION PROGRAM (P63)

PURPOSE:

- (1) TO INITIALIZE THE ENTRY EQUATIONS.
- (2) TO CONTINUE TO HOLD THE CM TO THE CORRECT ATTITUDE WITH RESPECT TO THE ATMOSPHERE FOR THE ONSET OF ENTRY DECELERATION.
- (3) TO ESTABLISH ENTRY DSKY DISPLAYS.
- (4) TO SENSE .05G AND DISPLAY THIS EVENT TO THE CREW BY SELECTING THE ENTRY-POST 0.05G PROGRAM (P64).

ASSUMPTIONS:

- (1) THE PROGRAM IS AUTOMATICALLY SELECTED BY THE ENTRY-CM/SM SEPARATION AND PRE-ENTRY MANEUVER PROGRAM (P62).
- (2) IN ADDITION TO N64(G,VI,R TO GO) THE ASTRONAUT MAY MONITOR THE FOLLOWING NOUNS BY KEYING IN VI6NXXE:
 - N63 (RT060, V10, TFE)
 - N68 (BETA, VI, HDOT)
 - N74 (BETA, VI, G)

PROG
CONT

Preceding page blank

CMC GROUND CREW

.CMC PROG
.SELECTION

START ENTRY -
INITIALIZATION
PROGRAM (63)
DISPLAY PROGRAM 63

.....
MONITOR DSKY:
OBSERVE DISPLAY OF
PROGRAM 63

PERFORM ENTRY
INITIALIZATION

G-ACCELERATION IN G
TO NEAREST .01G

VI-INERTIAL VELOCITY
IN FPS TO NEAREST
FPS

R TO GO - RANGE TO
GO TO THE DESIRED
SPLASH POINT
ASSUMING SPLASH
POINT LOCATED AT
CALCULATED IMPACT
TIME. IN NAUTICAL
MILES TO NEAREST
.1 NM. NEGATIVE AND
COUNTING DOWN WHEN
APPROACHING TARGET,
POSITIVE AND COUNT-
ING UP WHEN LEAVING
TARGET.

.....

WAIT FOR .05G
INDICATION

.....

ENTRY LOGIC DETECTS
.05G

.....

CHANGE ENTRY DAP
FROM ATTITUDE HOLD

MONITOR GNCS CONTROL
OF PRE - .05G CM
ATTITUDE:

(1) DSKY:

R1-G-INCREASING

R2-VI-NOMINAL

R3-R TO GO
NEGATIVE AND
COUNTING DOWN
WHEN APPROACHING
TARGET, POSITIVE
AND COUNTING UP
WHEN LEAVING
TARGET.

(2) FDAI:

ATTITUDE RATES
LESS THAN--DEG./
SEC.

ATTITUDE ERRORS
LESS THAN --DEG.

#80

#90

#100

#110

IN ALPHA AND BETA TO
RATE DAMPING IN
PITCH AND YAW, ROLL
UNCHANGED.

#120

.....

TERMINATE P63 AND GO
TO ENTRY-POST 0.05G
PROGRAM (P64)

.....

MONITOR DSKY:
OBSERVE TERMINATION
OF P63 AND DISPLAY
OF P64

#130

.....

.Y .N

.....

EXIT P63

#140

.....

HAS 0.05 G OCCURRED
YET ACCORDING TO
EMS?

.Y .N

.....

#150

GO TO BACKUP
PROCEDURES

.....

HAS .05G OCCURRED
YET ACCORDING TO
SEAT OF PANTS?

.Y .N

#160

.....

GO TO BACKUP
PROCEDURES

#170

.....

EXIT P63

425

477
P63/SKYLARK

CHANGE CONTROL NOTES

P63/SKYLARK

ENTRY - POST 0.05 G PROGRAM (P64) REV 00 05/19/71

PURPOSE:

- (1) TO START ENTRY GUIDANCE AT .05G SELECTING ROLL ATTITUDE, CONSTANT DRAG LEVEL, AND DRAG THRESHOLD, KA, WHICH ARE KEYPED TO THE .05G POINT.
- (2) SELECT FINAL PHASE (P67) WHEN 0.2G OCCURS IF V WAS <27000 FPS AT 0.05G.
- (3) ITERATE FOR UPCTRCL SOLUTION (P65) IF V >27000 FPS AND IF ALTITJDE RATE AND DRAG LEVEL CONDITIONS ARE SATISFIED
- (4) SELECT FINAL PHASE (P67) IF NC UPCTRCL SOLUTION EXISTS WITH VL >18000 FPS.
- (5) TO ESTABLISH THE 0.05 G MODE IN SCS.
- (6) TO CONTINUE ENTRY DSKY DISPLAYS.

ASSUMPTIONS: (1) THE PROGRAM IS AUTOMATICALLY SELECTED BY THE ENTRY INITIALIZATION PROGRAM (P 53).

- (2) IN ADDITION TO N74 (BETA, VI, G) THE ASTRONAUT MAY MONITOR THE FOLLOWING NOUNS BY KEYING IN VL6NXXE:
N64 (G, VI, R TO GO)
N68 (BETA, VI, HDOT)

PROG
CONT

CMC GROUND CREW

.CMC PROG.
.SELECTION

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START ENTRY-POST
0.05 G PROGRAM
(P 64)

DISPLAY PROGRAM 64

MONITOR DSKY:
OBSERVE DISPLAY OF
PROGRAM 64

#10

#20

TEMP
HOLD
.....
MCN

DISPLAY ON DSKY:
V06 N74
R1-BETA
R2-VI
R3-G

BETA-COMMANDED BANK
ANGLE. IN DEGREES
TO NEAREST .01
DEGREE

VI - INERTIAL
VELOCITY. IN FPS TO
NEAREST FPS

G-ACCELERATION IN G
TO NEAREST .01G.

SET 0.05 G ENTRY
SWITCH ON SCS
CONTROL PANEL TO ON

MONITOR G+N CONTROL
OF ENTRY:
(A) FDOI:
ATT ERRORS LESS
THAN --DEG

ATT RATES LESS
THAN --DEG/SEC
BALL INDICATES
LIFT VECTOR
DIRECTION COR-
RELATION WITH
BETA

(B) DSKY:
R1-BETA VARIES
TO LIMIT G AND
CONTROL LIFT
VECTOR

R2 - VI
DECREASING
R3-G- INCREASING

COMMAND CM ATTITUDE
IN ACCORDANCE WITH
CMC ENTRY LOGIC

#30

#40

#50

#60

#70

#80

#90

.....

EXIT P64

.....

```

-----
TERMINATE P64 AND GO
TO ENTRY-UP CONTROL
PROGRAM (P65)
IF V EQUAL TO OR
GREATER THAN 27000
FPS AND CONSTANT
DRAG CONTROL HAS
BROUGHT RANGE PRE-
DICTION TO WITHIN
25 NM OF DESIRED
RANGE. IF V < 27000
FPS AT .05G, THEN
WHEN .2G IS REACHED
THE DSKY WILL DIS-
PLAY P67
-----

```

.....

EXIT P64

CHANGE CONTROL NOTES

REV 00 05/19/71

ENTRY - UP CONTROL PROGRAM (P65)
NOTE: P65 HAS NOT BEEN TESTED AND IS
THEREFORE NOT OPERATIONAL FOR SKYLARK.

PURPOSE:

- (1) TO EXECUTE ENTRY - JP CONTROL GUIDANCE WHICH STEERS THE CM TO A CONTROLLED EXIT (SKIP OUT) CONDITION.
- (2) TO ESTABLISH ENTRY - UP CONTROL DISPLAYS WHICH ARE USED IN CONJUNCTION WITH THE EMS TO DETERMINE FOR THE ASTRO-NAUT IF THE BACKUP PROCEDURES SHOULD BE IMPLEMENTED.
- (3) TO SENSE EXIT (DRAG ACCELERATION LESS THAN Q7 FPS) AND THEREUPON TO SELECT THE ENTRY - BALLISTIC PROGRAM (P66).
- (4) WHERE RDOT IS NEGATIVE AND THE V IS SUFFICIENTLY LOW (V-VL-C18 VE3), PROGRAM WILL EXIT DIRECTLY TO P67 (FINAL PHASE).

ASSUMPTIONS: (1) THIS PROGRAM IS AUTOMATICALLY SELECTED BY THE ENTRY - PJST 0.053 PROGRAM (P64) WHEN CONSTANT DRAG CONTROL HAS BROUGHT RANGE PREDICTION TO WITHIN 25 N.M. OF THE DESIRED RANGE. IT IS SKIPPED IN EARTH ORBIT MISSIONS.

(2) IN ADDITION TO N74 (BETA, VI, G) THE ASTRONAUT MAY MONITOR THE FOLLOWING NOUNS BY KEYING IN VI6NXXE:
N64 (G, VI, R TO GO)
N68 (BETA, VI, HDOT)

(3) MANUAL RESPONSE TO N69 IS NOT NECESSARY TO TERMINATE P65. SELECTION OF EITHER P66 OR P67 BY ENTRY GUIDANCE PROVIDES AUTOMATIC TERMINATION.

PROG
CONT

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CMC GROUND CREW

.CMC PROG
.SELECTION

START ENTRY - UP
CONTROL PROGRAM (65)

MONITOR DSKY:
OBSERVE DISPLAY OF
PROGRAM 65

DISPLAY PROGRAM 65

#10

#20

#70

TEMP
HOLD

MON

DISPLAY ON DSKY:

V06 N74

R1 - BETA

R2 - VI

R3 - G

BETA - COMMANDED
BANK ANGLE. IN
DEGREES TO NEAREST
0.01 DEGREE

VI - INERTIAL VELO-
CITY. IN FPS TO
NEAREST FPS

G-ACCELERATION IN G
TO NEAREST .01G

MONITOR G&N CONTROL
OF ENTRY:

(A) FDAI:

ATT ERRORS LESS
THAN -- DEG
ATT RATE LESS
THAN -- DEG/SEC.

m

#80

#90

(B) DSKY:

R1 - BETA VARIES
TO LIMIT G AND
CONTROL LIFT
VECTOR

R2-VI DECREASING

R3-G-DECREASING
(G MAY INCREASE
INITIALLY IF IT
IS NECESSARY TO
FLY DOWN TO THE
BEGINNING OF THE
REFERENCE
TRAJECTORY.)

#100

#110

COMMAND CM ATTITUDE
IN ACCORDANCE WITH
CMC ENTRY LOGIC

435

487
P65/SKYLARK

CHANGE CONTROL NOTES

P65/SKYLARK

#20

 ESTABLISH ATTITUDE
 COMMANDS FOR ENTRY
 DAP NECESSARY TO
 GIVE CORRECT ANGLE
 OF ATTACK INTO THE
 ATMOSPHERE:
 ROLL COMMAND-
 MAINTAIN LAST
 COMPUTED VALUE
 FROM ENTRY
 GUIDANCE UNLESS
 ACCELERATION GOES
 BELOW .05 G IN
 WHICH CASE MAIN-
 TAIN ZERO DEGREES
 UNTIL TERMINATION
 OF P66.
 ALPHA COMMAND-
 TRIM ANGLE OF
 ATTACK (TRIM
 ALPHA)
 BETA COMMAND-
 ZERO.

#30

#40

#50

 CALCULATE FINAL
 GIMBAL ANGLES RE-
 QUIRED BASED ON PRE-
 SENT STATE VECTOR.
 REPEAT CALCULATION
 EVERY TWO SECONDS
 UNTIL TERMINATION OF
 P66.

#60

TEMP
 HOLD .
 MON .

 DISPLAY ON DSKY:
 THE DESIRED GIMBAL
 ANGLES TO WHICH THE
 ENTRY DAP WILL ORI-
 ENT THE CM

..... MONITOR GNCS CONTROL
 OF ENTRY:

V06 V22
 R1-0G ROLL
 R2-1G PITCH
 R3-MG YAW

ALL COMMANDED GIMBAL
 ANGLES IN DEGREES TO
 NEAREST 0.01 DEGREE.

F0A1: ATTITUDE
 ERROR NEEDLES -
 DIFFERENCE BETW-
 EEN THE TOTAL DE-
 Sired ATTITUDE
 AND THE ACTUAL
 ATTITUDE (FLY TO
 POLARITY).

#70

.....

 COMMAND CM ATTITUDE
 IN ACCORDANCE WITH
 CM ENTRY - BALLIS-
 TIC PHASE LOGIC

#90

 ROLL ANGLE IS HELD
 AT LAST COMPUTED
 VALUE FROM ENTRY
 GUIDANCE UNLESS
 ACCELERATION GOES
 BELOW 0.05G IN WHICH
 CASE ZERO DEGREES IS
 HELD UNTIL TERMINA-
 TION OF P66.
 PITCH AND YAW
 ATTITUDE IS DETER-
 MINED BY THE VEHICLE
 POSITION AND VELO-
 CITY W.R.T. THE
 ATMOSPHERE. THIS
 ATTITUDE IS ZERO
 SIDESLIP AND ANGLE
 OF ATTACK NEAR THE
 TRIM VALUE.

#100

NOTE: THREE AXIS DAP
 CONTROL WAS REGAINED
 WHEN LESS THAN 0.05
 G WAS SENSED AND

BALL: ACTUAL GIMBAL
 ANGLES READ ON BALL
 SHOULD AGREE WITH
 COMMANDED GIMBAL
 ANGLES READ ON DSKY.

.....

#110

WILL BE RELINQUISHED
WHEN 0.5 G IS AGAIN
SENSED.

.
.
.

#120

TERMINATE P66 AND GO
TO ENTRY-FINAL PHASE
PROGRAM (P67) WHEN
DRAG ACCELERATION
RUILDS JP 2
TO Q7F + 0.5 FPS

.
.
.
...

#130

MONITOR DSKY:
OBSERVE TERMINATION
OF P66 AND DISPLAY
OF P67

.....
.
.

EXIT P66

EXIT P66

CHANGE CONTROL NOTES

TEMP

HOLD .

.....

MCN .

DISPLAY ON DSKY:

V06 V66

R1-BETA

R2-X RNG ERR

R3-Dwn RNG ERR

.....

MONITOR G+N CONTROL
OF ENTRY:

.....

(A)FDAI:

ATT ERRORS LESS

THAN --DEG

ATT RATES LESS

THAN --DEG/SEC.

#30

BETA-COMMANDED
BANK ANGLE. IN
DEGREES TO NEAREST
.01 DEGREE.

X RNG ERR - CMC
SOLUTION FOR CROSS
RANGE ERROR. POS-
ITIVE IF TARGET ON
THE SOUTH SIDE OF
TRAJECTORY PLANE.
NEGATIVE IF ON THE
NORTH SIDE OF
TRAJECTORY PLANE.
IN NAUTICAL
MILES TO THE NEAR-
EST .1 NM.

#40

BALL INDICATES
LIFT VECTOR
DIRECTION COR-
RELATION WITH
BETA

(B) DSKY:
R1-BETA VARIES
TO LIMIT G AND
CONTROL LIFT
VECTOR.

#50

DWN RNG ERR - CMC
SOLUTION FOR DOWN
RANGE ERROR (DEC-
REASING) POSITIVE
FOR OVERSHOOT,
NEGATIVE FOR UN-
DERSHOOT. IN NAUT-
ICAL MILES TO
NEAREST .1 NM.
(PRDANGLE--THETA)

NOTE: THE DWN RNG
ERR DISPLAY WILL
BE 9999.9 NM ONCE
THE TARGET HAS
BEEN OVERSHOT.

#60

R3- DWN RNG ERR
- DECREASING

#70

COMMAND CM ATTITUDE
IN ACCORDANCE WITH
CMC ENTRY LOGIC

WAIT UNTIL CM
VELOCITY WRT EARTH =
1000 FPS

#80

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY:
V16 N67
R1-R TO GO
R2-LAT
R3- LONG

#90

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST RE-
SPONSE AND DISPLAY
PRESENT POSITION AND
RANGE TO GO

R TO GO-RANGE TO GO
TO TARGET. IN NAUTI-
CAL MILES TO NEAREST
.1 NM. NEGATIVE AND
DECREASING WHEN AP-
PROACHING TARGET,
POSITIVE AND IN-
CREASING WHEN LEAV-
ING TARGET.
LAT - LATITUDE OF
PRESENT POSITION. IN
DEGREES TO NEAREST
.01 DEG.
(+ IS NORTH)

#100

LONG - LONGITUDE OF
PRESENT POSITION. IN
DEGREES TO NEAREST
.01 DEG.
(+ IS EAST)

#110

HOLD CONSTANT ATTI-
TUDE MANUALLY (FULL
LIFT UP OR DOWN, DE-
PENDING ON R TO GO)
UNTIL CHUTE DEPLOY-
MENT.

#120

MONITOR ALTIMETER
AND STANDBY TO BACK-

UP MESC FOR CHUTE
DEPLOYMENT

.
.
.

WHEN CM IS ON THE
CHUTES SWITCH THE SC
CONT SWITCH FROM CMC
TO SCS TO PREVENT
UNDESIRE JET
FIRINGS. LEAVE P67
OPERATING AS LONG
AS POSSIBLE SO THAT
AVERAGE G DATA
WILL CONTINUE. THIS
IS HIGHLY DESIRABLE
FOR PURPOSES OF
POST-FLIGHT
ANALYSIS.
KEY IN PROCEED

#130

#140

TERMINATE FLASH UPON
RECEIPT OF PROCEED

.PRO
.
.

TURN OFF ENTRY DAP

.
.

#150

DO ROUTINE R00

.
.
.

DO ROUTINE R00

.
.
.

#160

EXIT P67

EXIT P67

CHANGE CONTROL NOTES

REV 01 03/20/72

CSM VELOCITY VECTOR UPDATE PROGRAM (P77)

PURPOSE: (1) TO PROVIDE A MEANS OF NOTIFYING THE CMC THAT THE CM HAS CHANGED (OR WILL CHANGE) ITS ORBITAL PARAMETERS BY THE EXECUTION OF A THRUSTING MANEUVER WHEN AVERAGE G IS NOT RUNNING.

(2) TO PROVIDE TO THE CMC THE DELTA V APPLIED TO THE CM TO ENABLE AN UPDATING OF THE CM STATE VECTOR.

ASSUMPTIONS: (1) THE CSM CREW HAS THE DELTA V TO BE APPLIED BY THE CM IN LOCAL VERTICAL AXES AT A SPECIFIED TIG.

(2) R03 SHOULD BE PERFORMED AFTER P77 TO UPDATE CSM HEIGHT.

(3) THE CONTENTS OF N81 IS THE SAME AS THE PREVIOUS VALUE OF N81 AT ENTRANCE TO P77.

(4) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG
CONT

CREW

GROUND

CMC

.CREW
.PROGRAM
.SELECTION
...

++
+01
+
+
+
+489
++

DO R00 TO START CSM
VELOCITY VECTOR UP-
DATE PROGRAM (P77)
DISPLAY P77

#10

KEY IN CSM VELOCITY
VECTOR UPDATE
PROGRAM (P77)
V37ET7E

MONITOR DSKY:
OBSERVE DISPLAY
OF PROGRAM 77

#20

CORRECT ONES
EXECUTED OR TO BE
EXECUTED?

.Y .N
.
.

#130

KEY IN
PROCEED

.....
.
.....

KEY IN V25E
AND LOAD THE
CORRECT DELTA V.

.....
.
.....

#140

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

. PROCEED . NEW
 . DATA

. STORE DATA

.....
.
.....

#150

SET NODOFLAG

.....
.
.....

#160

UPDATE CM STATE
VECTOR TO REFLECT
THE DELTA V ADDED.
DELTA V HAS BEEN
TRANSFORMED FROM
LOCAL VERTICAL INTO
BASIC REFERENCE
COORDINATES.

.....
.
.....

#170

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REV 01 03/20/72

FINAL AUTOMATIC REQUEST TERMINATE ROUTINE (R00)

PURPOSE:

++
+01
ASSUMPTIONS:
++
+489
++

- (1) TO PROVIDE A STANDARD EXIT FOR PROGRAMS, AND AN OPTION TO SELECT ANY PROGRAM DESIRED.
- (2) TO PROVIDE A GENERAL DESCRIPTION OF THE COMPUTER ACTIVITY FOLLOWING ANY PROGRAM SELECTION.
- (1) THE CALLING PROGRAM HAS SUCCESSFULLY COMPLETED ALL ITS FUNCTIONS OR THE OPERATOR HAS PREMATURELY TERMINATED THE PROGRAM OR A P0000 TYPE ABORT (WITHOUT AVERAGE G ACTIVE AND WITH NO EXTENDED VEP3 ACTIVE) HAS OCCURRED.
- (A) IF A PROGRAM HAS COMPLETED ALL ITS FUNCTIONS AND MINKEY IS RUNNING (AUTOSEQ SET) CONTROL WILL GO TO THE NEXT POINT IN THE MINKEY CONTROLLER (R07) INSTEAD OF FLASHING V37.
- (B) PREMATURE TERMINATION OF AN OPERATION WILL TURN OFF MINKEY (RESET AUTOSEQ).

- (2) THE COMPUTER CHECKS ON THE UNIVERSAL TRACKING PROCESS FOLLOWING ANY V37EXXE IN THE FOLLOWING WAYS:

- (A) IF P20 IS THE NEW PROGRAM KEYED IN AND IS NOT PRESENTLY RUNNING AND WAS NOT RUNNING IN THE BACKGROUND IT WILL BE STARTED AS A NEW PROGRAM.
- (B) IF P20 IS THE NEW PROGRAM KEYED IN AND P20 IS PRESENTLY RUNNING (I.E. 20 DISPLAYED IN THE PROG LIGHTS) IT WILL BE STARTED AS A NEW PROGRAM (I.E. RE-INITIALIZED).
- (C) IF P20 IS THE NEW PROGRAM KEYED IN AND IS NOT PRESENTLY THE ONLY PROGRAM RUNNING (I.E. A PROGRAM OTHER THAN P20 IS DISPLAYED IN THE PROG LIGHTS) AND P20 IS RUNNING IN THE BACKGROUND THE P20 LIGHTS WILL BE CHANGED TO 20 AND P20 WILL START AT P20 RESTART POINT WITH THE FLAGS SET TO ALLOW TRACKING. IN ADDITION R22 WILL START AT THE R22 RESTART POINT FOR OPTIONS 0,4 AND ALLOW STATE VECTOR UPDATES; P00 TYPE INTEGRATION WILL START IN THE REMAINING OPTIONS.
- (D) IF P00 IS SELECTED, THE RENDEZVOUS FLAG AND UFLAG ARE RESET (SHJT OFF P20) AND P00 IS STARTED.
- (E) IF A PROGRAM OTHER THAN P20 AND P00 IS KEYED IN, THE NEW PROGRAM WILL BE STARTED AND THE PROG LIGHTS WILL DISPLAY THE NEW PROGRAM. THE COMPUTER WILL THEN ATTEMPT TO RESTART P20 AND WILL BE SUCCESSFUL IF P20 WAS RUNNING IN THE BACKGROUND AND THE NEW PROGRAM WILL ALLOW TRACKING.
- (F) IF NEW PROGRAM SELECTED IS P31-P38 AND P20, OPTION 0 OR 4, IS NOT RUNNING, ANY OTHER P20 OPTION WILL BE TERMINATED AND P20 OPTION 0 WILL BE STARTED WITH NOMINAL TRACKING VALUES. NO P20 DISPLAYS WILL APPEAR. IF THE IMJ IS NOT ALIGNED (REFSMAT FLAG SET) P20 WILL NOT BE STARTED.
- (3) IF THE IMU IS ALIGNED AND THE NEW PROGRAM SELECTED IS P31-P38, FL V50 N25 R1=17 WILL BE DISPLAYED TO REQUEST CREW TO AUTHORIZE MINKEY SEQUENCE. THIS FLASHING DISPLAY MARKS THE TRANSITION FROM R00 TO MINKEY CONTROLLER (R07).

++
+01
++
++
++
+489
++

PROG CMC GROUND CREW

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STOP ACCEPTING VHF
RANGE DATA
(RESET VHERFLAG)

#200

INVALIDATE MARK
BUFFER

#210

IS MAJOR MODE
SELECTED GREATER
THAN 79?

.NO .YES
. .
. .

TURN ON OPERATOR
ERROR

#220

EXIT

#230

IS THE IMU ALIGNED
(REFSMAT FLAG SET)?

.NO .YES
. .
. .

IS MAJOR MODE
P31-P38?

#240

.NO .YES
. .
. .

GO TO

IS THE ENGINE ON?

.Y .N

TERMINATE THE
ENGINE ON
COMMAND.

TURN OFF TVC
DAP

TURN OFF ALL
RCS TRANSLATION
AND ROTATION

WAIT ABOUT 3
SECONDS

TURN ON RCS DAP

WRITE ZEROS
INTO NEW PROG-
RAM SELECTION

RESELECT V37

EXIT

#360

#370

#380

#390

#400

B

SO THAT REGARD--
LESS OF THE
SELECTED PROG--
RAM, R0J WILL
SELECT P00.

#410

IS NEW PROGRAM P00?

.Y
.N

IS N000FLAG SET TO
INHIBIT SELECTION
OF A NEW PROGRAM
OTHER THAN P00?

.N .Y

TURN ON PRO--
GRAM ALARM
LIGHT AND
STORE ALARM
CODE 1520

.

EXIT

DOES THE NEW
PROGRAM EXIST?

.Y .N

MONITOR DSKY:
DOES PROGRAM ALARM
LIGHT COME ON, INDI-
CATING THAT NEW
PROGRAM SELECTION IS
NOT PERMITTED AT
THIS TIME?

.N .Y

RESET ALARM
LIGHT AND
WAIT FOR COM-

#440

#450

#510

IS DOCKED DAP
RUNNING?

.ND .YES

SET DOCKED
DEADBAND INTO
DOCKED DAP

#520

#530

IS MAX DB FLAG SET?

.N .Y

SET MAX
DEAD-
BAND IN
RCS DAP

#540

SET MIN DEAD-
BAND IN RCS DAP

#550

COMMAND ZERO RATE
IN THE RCS DAP (TO

STOP RATE DRIVE
FROM P2J

#560

IS HOLDFLAG
NEGATIVE?

.Y N.

SET HOLDFLAG
ZERO

#570

SET DAP REFERENCE
TO DESIRED DAP
CDUS

#580

RESET TARGIFLG

#590

RESET SUBFLAG,
P55.IFLG, P50.IFLG

#600

#610

#620

#630

#640

#650

464

RESET TRACK FLAG,
R27UP1, R27UP2,
T0FLAG, P25FLAG,
P48FLAG, SNAPFLAG,
CYCLFLAG

RESET UPDATFLG

RESET R67FLAG

RESET EXTRANGE FLAG

RESET STICK FLAG

TURN OFF UPLINK ACTY
LIGHT

RESET R21MARK

.....

IS NEW PROGRAM P00?

.N .Y
. .
. .

RESET NJDOFLAG

. .
. .
. .

RESET RENDEZVOUS
FLAG.

. .
. .
. .

RESET UTFLAG

. .
. .
. .

IS NEW PROGRAM P20?

.N .Y
. .
. .

IS THE CURRENT
PROGRAM P20?

.Y .Y
. .
. .
. .

IS UTFLAG SET?

.YES .NO
. .
. .

#660

#670

#680

#690

#700

#710

IS RENDEZVOUS
FLAG SET?

.Y .N

#720

ESTABLISH
POO TYPE
INTEGRA-
TION

IS DOCKED
DAP RUNNING?

.N .Y

#730

SET
DOCKED
DEADBAND
INTO
DOCKED
DAP

#740

IS MAXDBFLG
SET?

.NO .YES

#750

SET SET
MIN MAX

DEAD- DEAD-
 BAND BAND
 IN IN
 RCS RCS
 DAP DAP

#760

SET UPDATE FLAG

#770

COMMAND
 ZERO
 VEHICLE
 RATE

#780

SET TRACK FLAG

IS HOLDFLAG
 NEGATIVE?

#790

.Y N

SET HOLDFLAG
 ZERO

#800

SET DAP REFERENCE
 TO DESIRED DAP

#810

#820

#830

#840

#850

CDUS

DISPLAY NEW PROGRAM

RELEASE DISPLAY
SYSTEM

GO TO RESTART POINT
IN P20 (AND R22 IF
APPROPRIATE)

EXIT

DISPLAY NEW
PROGRAM AND
GO TO PROGRAM
SELECTED.

RELEASE DISPLAY
SYSTEM.

MONITOR DSKY:
OBSERVE DISPLAY OF
NEW PROGRAM.

GO TO
PROGRAM
SELECTED

PRECEDING PAGE BLANK NOT FILMED

ERASABLE AND CHANNEL MODIFICATION ROUTINE (R01) REV 00 05/19/71

- PURPOSE: (1) TO PROVIDE MANUAL CAPABILITY OF CHANGING FLAGWORD BITS OR CHANNEL BITS.
- ASSUMPTIONS: (1) THIS PROCEDURE CAN BE PERFORMED AT ANY TIME.
 (2) THIS PROCEDURE IS NOT RESTRICTED TO FLAGWORDS OR CHANNELS BUT CAN MODIFY ANY LEGITIMATE ERASABLE LOCATION > 30.
 (3) THIS PROCEDURE CANNOT BE USED TO MODIFY CHANNEL 77.

- DESCRIPTION: (1) NOUN 07 MUST BE LOADED BY V25NOTE.
 (2) NOUN 07 IS A THREE COMPONENT OCTAL NOUN WITH THE FOLLOWING DEFINITION:
- R1 = AN ADDRESS SPECIFYING EITHER THE ECADR OF AN ERASABLE LOCATION OR THE NUMBER OF A CHANNEL:
 IF R1>30, THE ADDRESS IS ASSUMED TO BE AN ECADR;
 IF R1<30, THE ADDRESS IS ASSUMED TO BE A CHANNEL NUMBER.
 - AS IN ALL ATTEMPTS TO MODIFY CHANNEL 7, THE REQUEST IS IGNORED IF R1=7.
 - R2 = UP TO FIVE OCTAL DIGITS SPECIFYING BITS IN THE WORD TO BE SET (E.G.: 200 IS BIT 8).
 - R3 = POSITIVE NON-ZERO INDICATES A "1" IS TO BE SET INTO BIT POSITIONS SPECIFIED IN R2. ZERO, NEGATIVE, OR BLANK INDICATES A "0".

- (3) AS AN EXAMPLE, SETTING OF BITS 1, 3 AND 13 TO "1" IN FLAGWORD 8 REQUIRES THE FOLLOWING SEQUENCE:
- ```
V25NOTE
104E
10005E
1E
```

RESETTING THE SAME BITS TO "0" REQUIRES THE SEQUENCE:

```
V25NOTE
104E
10005E
OE
```

- (4) SETTING OF BIT 10 OF CHANNEL 12 TO "1" REQUIRES THE FOLLOWING SEQUENCE:
- ```
V25NOTE
12E
1000E
1E
```

RESETTING THE SAME BIT TO "0" REQUIRES THE SEQUENCE:

```
V25NOTE
12E
1000E
OE
```

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CHANGE CONTROL NOTES

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REV 00 05/19/71

CSM DAP DATA LOAD ROUTINE (R03)

PURPOSE:

(1) TO LOAD AND VERIFY CMC DIGITAL AUTOPILOT (DAP) DATA FOR CSM.

(2) TO PROVIDE THE CREW A MEANS FOR SELECTING APPROPRIATE COAST AUTOPILOTS. AFTER COMPLETION OF THIS ROUTINE, WHICH IDENTIFIES THE VEHICLE CONFIGURATION, THE USE OF VERB 46 ENTER (ACTIVATE CSM DAP) WILL CAUSE THE APPROPRIATE DAP TO BECOME ACTIVE. V45 IS NECESSARY TO START NEW DAP MODE: 1) WHEN SWITCHING FROM IDLE MODE TO SATURN OR RCS, 2) WHEN SWITCHING FROM SATURN TO RCS, 3) WHEN SWITCHING FROM SATURN OR RCS TO IDLE MODE.

ASSUMPTIONS:

(1) THE MOMENTS OF INERTIA AND OTHER PERTINENT PARAMETERS ARE STORED IN THE CMC AS A FUNCTION OF THE KEYED IN WEIGHTS.

(2) THE VALUE FOR WEIGHT IS REDUCED LINEARLY AS A FUNCTION OF SPS MANEUVER TIME DURING SPS THRUSTING PROGRAM (P40) MANEUVERS ONLY. ALL THRUSTING MANEUVERS THAT ARE PERFORMED WITHOUT USING P40 COULD CAUSE THE CMC'S KNOWLEDGE OF WEIGHT TO BE COMPROMISED.

(3) THIS ROUTINE IS SELECTED BY THE ASTROVAULT BY DSKY ENTRY.

(4) THIS ROUTINE IS NOT AVAILABLE IF UNDER THRUST VECTOR CONTROL.

PROG
CONT

CMC GROUND CREW

- .CREW
- .ROUTINE
- .SELECTION
- .
- ...
- .

START CSM DAP DATA
LOAD ROUTINE (R03)

KEY IN V48E

IS TVC DAP ON?

.N .Y

IS ANOTHER EX-
TENDED VERB, A

Preceding page blank

#10

#20

#30

#40

#50

#60

MARKING DISPLAY,
OR A PRIORITY
DISPLAY ACTIVE?

.N
.Y

TURN ON OPERATOR
ERROR LIGHT.

.....
EXIT

40LD .
.....
SNAP .

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY DAP CONFIG-

URATION DATA:
V04 N46
R1-ABCDE
R2-ABCDE
R3-BLANK

R1 DATA CODE:
A-VEHICLE CONFIG.

CODE:
0-NO DAP
1-CSM

3-S1VB
B-QUAD AC FOR
X TRANS CODE:
0-DON'T USE
QUAD

1-JSE QUAD
C-QUAD 80 FOR
X TRANS CODE:
0-DON'T USE

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF DAP CONFIGURATION
DATA

AM I SATISFIED WITH
THE STORED DAP CON-
FIGURATION DATA?

.Y .N

#70

#80

#90

#100

#110

#120

QUAD
 1-JSE QUAD
 0-DEADBAND CODE:
 0-0.5 DEG
 1-5.0 DEG
 E (LSB)-MANEUVER
 RATE CODE:
 0-0.05 DEG/SEC
 1-0.2 DEG/SEC
 2-0.5 DEG/SEC
 3-2.0 DEG/SEC
 NOTE: IF BOTH B+C
 DISPLAY ZERO
 THIS MEANS 1-1

R2 DATA CODE:
 A-QUAD AC OR BD
 ROLL CODE
 0-USE BD
 1-JSE AC
 B-QUAD A CODE
 0-DON'T USE
 QUAD
 1-USE QUAD
 C-QUAD B CODE
 0-DON'T USE
 QUAD
 1-USE QUAD
 D-QUAD C CODE
 0-DON'T USE
 QUAD
 1-USE QUAD
 E-QUAD D CODE
 0-DON'T USE
 QUAD
 1-USE QUAD

WAIT FOR KEYBOARD
 ENTRY

TERMINATE FLASH UPON
 RECEIPT OF PROCEED
 OR NEW DATA
 .PROCEED .NEW DATA

KEY IN PRO-
 CEED

KEY IN V21E,
 V22E, OR V24E AND
 LOAD DESIRED DATA
 CODES IN R1, R2

HOLD .
.....
SNAP .

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY CSM WEIGHT:
V06 V47
R1-CSM WEIGHT
R2-XXXX
R3-BLANK

CSM WEIGHT-WEIGHT OF
THE CSM IN POUNDS TO
THE NEAREST POUND.

NOTE: R2 (LM WEIGHT)
NOT APPLICABLE TO
SKYLARK

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF CSM WEIGHT

IS THE CSM
WEIGHT
CORRECT?

.Y .N

KEY IN PROCEED

KEY IN V21E
AND LOAD
CORRECT DATA

#180

#190

#200

#210

#220

#230

#240

#250

#260

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

- .P .NEW
- .R .DATA
- .O .
- .C .
- .E .
- .D .

IS THE VEHICLE CON-
FIGURATION CODE
EQUAL TO 0 OR 3?

- .Y .N

COMPUTE MASS
PROPERTIES

IS VEHICLE CONFIGUR-
ATION CODE EQUAL TO
2 OR 6?

- .N .Y

PITCH TRIM AND YAW
TRIM-SPS ENGINE BELL
TRIM ANGLES AT
IGNITION DATA
TAKEN IN DEGREES
TO NEAREST .01
DEGREE.

#320

DO THESE VALUES
AGREE WITH MY CARRY
ON DATA?

Y. . N

WAIT FOR KEYBOARD
ENTRY

#330

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

P. . NEW
R. . DATA
O. .
C. .
E. .
E. .
D. .

#340

LOAD DESIRED
DATA

. .
. .
. .
. .

EXIT
R03

#350

EXIT R03

CHANGE CONTROL NOTES

REV 00 PCR 040

#30

#40

#50

#60

#70

LIGHT

EXIT R04

FLASH VERB-NOUN TO
 REQUEST RESPONSE AND
 DISPLAY DAP CONFIGU-
 RATION DATA:
 V05 N87
 R1 - ABCDE
 R2 - 00CDE
 R3 - 00CDE

R1: A - AC/BD ROLL
 CONTROL SPECI-
 FICATION
 0 - BD
 1 - AC
 PREFERRED
 PREFERRED

B - QUADS AC
 FOR X TRAN-
 SLATION
 0-DON'T USE
 1-USE

C - QUADS BD
 FOR X TRAN-
 SLATION
 0-DON'T USE
 1-USE

D - PITCH CON-
 TROL
 0-USE TOR-
 QUE COU-

MONITOR DSKY:
 OBSERVE VERB-NOUN
 FLASH TO REQUEST
 RESPONSE AND DISPLAY
 OF DAP CONFIGURATION
 DATA

AM I SATISFIED WITH
 DAP CONFIGURATION
 DATA?

.Y

.N

#80

#90

#100

#110

#120

PLE CON-
TROL
1-USE Z
FORCE
CONTROL

E - YAW CONTROL
0-USE TOR-
QUE COU-
PLE CON-
TROL
1-USE Y
FORCE
CONTROL

R2: CHANNEL 5 JET
INHIBIT

TO INHIBIT JETS,
SELECT CORRE-
SPNDING OCTAL
VALUES FROM
FOLLOWING TABLE
AND LOAD THEIR
SUM (CODE) IN R2.

JET	BIT #	VALUE
C3(1)	1	00001
C4(4)	2	00002
A3(3)	3	00004
A4(2)	4	00010
D3(5)	5	00020
D4(8)	6	00040
B3(7)	7	00100
B4(6)	8	00200

CH5 FAIL
OCTAL
VALUE

R3: CHANNEL 6 JET
INHIBIT

TO INHIBIT JETS,
SELECT CORRE-
SPNDING OCTAL

VALUES FROM
FOLLOWING TABLE
AND LOAD THEIR
SUM (CODE) IN R3.

CH6 FAIL	
JET BIT #	OCTAL VALUE
B1(9)	1 00001
B2(12)	2 00002
D1(11)	3 00004
D2(10)	4 00010
A1(13)	5 00020
A2(16)	6 00040
C1(15)	7 00100
C2(14)	8 00200

#130

#140

#150

#160

#170

WAIT FOR KEYBOARD
ENTRY

KEY IN
PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

- .P .NEW
- .R .DATA
- .D .
- .C .
- .E .
- .E STORE
- .D DATA

LOAD DESIRED
DATA

RESET 500**FLG AND
501**FLG

#180

HOLD
SNAP
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY DAP RATE AND
DEADBAND

V06 N89
R1 - DAP RATE
R2 - DAP DEADBAND
R3 - BLANK

R1-DOCKED DAP RATE
IN DEG/SEC TO
NEAREST .0001
DEG/SEC
R2-DOCKED DAP DEAD-
BAND IN DEGREES
TO THE NEAREST
.01 DEG.

#190

WAIT FOR KEYBOARD
ENTRY

#200

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.P .NEW
.R .DATA

#210

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF DAP RATE AND
DEADBAND

AM I SATISFIED WITH
THIS DAP DATA?

.Y .N

KEY IN
PROCEED

LOAD DESIRED
DATA

MINKEY CONTROLLER ROUTINE (R07)

REV 00 05/19/71

PURPOSE:

- (1) TO PERFORM AUTOMATIC SEQUENCING OF RENDEZVOUS PROGRAMS.
- (2) TO ESTABLISH UNIVERSAL TRACKING PROGRAM (P20) OPTION 4, WITH PRESET VALUES FOR P20 DISPLAYS. THESE DISPLAYS MAY BE ALTERED BY DSKY ENTRY.

ASSUMPTIONS:

- (1) ROUTINE R03 HAS BEEN PERFORMEC PRIOR TO SELECTION OF THIS PROGRAM. IN ORDER FOR THE GNCS TO ESTABLISH P20 THE ASTRONAUT SHOULD KEY IN V46E AT SOME TIME PRIOR TO SELECTION OF A RENDEZVOUS TARGETING PROGRAM.
- (2) THE INITIALIZATION VALUES FOR THE W-MATRIX (WRENDPOS AND WRENDVEL) MUST BE LOADED PRIOR TO SELECTION OF A RENDEZVOUS TARGETING PROGRAM.
- (3) SOME TARGETING PROGRAMS REQUIRE THAT INPUTS TO PREVIOUS TARGETING PROGRAMS HAVE BEEN MADE.
- (4) THIS ROUTINE IS INITIATED BY ASTRONAUT SELECTION OF A RENDEZVOUS TARGETING PROGRAM (V37E 3XE).
- (5) PROGRAMS SELECTED BY R07 ENTER R00 AT "B".

PROG
CONT

CMC

GROUND

CREW

- .P31
- .NCI INI-
- .TIATION
- .POINT
- .FROM R00
- .
- .
- ...
- .

HOLD
SNAP

FLASH VERB-NOUN TO
REQUEST PLEASE PER-
FORM MINKEY SEQUENCE:
V50 N25
R1-00J17
R2-BLANK
R3-BLANK

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
MINKEY SEQUENCE

WAIT FOR KEYBOARD
ENTRY

DO I WISH TO PERFORM
THE RENDEZVOUS USING
THE MINKEY SEQUENCE?

.NO .YES

#10

#20

#230

ROO -----
FLAG -----
.
.
.
.....

EXIT R07

#240

WAS P20 STARTED
WITH HEADS
ORIENTATION
SPECIFIED
(AZIMFLAG SET)?

.NO
.YES
.
.
.....

#250

SET AZIMFLAG
.
.
.....

#260

IS HEADS UP DESIRED
(HDSUPFLAG SET)?

.YES
.NO
.
.
.....

#270

SET OMICRON=0
DEGREES
(R3 OF N78)

SET OMICRON=180
DEGREES
.
.
.....

(R3 OF N78)

#280

IS W-MATRIX VALID
FOR RENDEZVOUS
NAVIGATION
(RENDWFLG SET)?

#290

.NO
.YES

SET FLAGS FOR
AUTO W-MATRIX
REINITIALIZA-
TION (MANEUFLG,
PTV93FL3)

#300

RESET PCFLAG

#310

START MINKEY
(SET AUTOSEQ
FLAG)

#320

#470

SET OMICRON=0
DEGREES
(R3 OF V78)

SET OMICRON=180
DEGREES
(R3 OF N78)

#480

IS W-MATRIX VALID
FOR RENDEZVOUS
NAVIGATION
(RENDFLG SET)?

#490

•NO
•YES

SET FLAG'S FOR
AUTO W-MATRIX
REINITIALIZA-
TION (MANEUFLG,
PIV93FLG)

#500

RESET PCFLAG

#510

#520

START MINKEY
(SET AUTOSEQ
FLAG)

#530

.....
"D"
.....

#540

CALL THE NCC TARGET-
ING PROGRAM (P33)

#550

.....
IS THE MAGNITUDE OF
DELTA V (RSS OF NBI)
GREATER THAN OR
EQUAL TO 10 FPS?

*YES *NO
* *
* *

CALL THE SPS
THRUSTING
PROGRAM
(P40)

#560

CALL THE RCS
THRUSTING

PROGRAM
(P41)

#570

GO TO THE NSR
INITIALIZATION
POINT IN THIS
ROUTINE
"E" BELOW

#580

.P34
.NSR TARGET-
.ING INITI-
.ALIZATION
.POINT FROM
.ROO

#590

HOLD .
.....
SNAP .
.....
FLASH VERB-NOUN TO
REQUEST PLEASE PER-
FORM MINKEY SEQUENCE
V50 M25
R1-00J17
R2-BLANK
R3-BLANK

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
MINKEY SEQUENCE

#600

DO I WISH TO PERFORM
THE RENDEZVOUS USING
THE MINKEY SEQUENCE?

#610

..NO ..YES

WAIT FOR KEYBOARD
ENTRY
.....
KEY IN ENTER

TERMINATE FLASH UPON
RECEIPT OF ENTER,
PROCEED OR TERMINATE
.....
KEY IN PROCEED

#620

.V34E
P .E
R .N
O .T
C .E
RESET .R
AUTOSEQ .E
FLAG .D
.....
RESET
AUTOSEQ
FLAG

#630

DO ROU-
TINE
R00
.....

#640

EXIT R07
.....

WAS P20 STARTED
WITH HEADS
ORIENTATION
SPECIFIED
(AZIMFLAG SET)?
.....
.NO .YES
. .
.....

#650

SET AZIMFLAG
.....

#660

PROGRAM
(P41)

#770

GO TO THE TPI
TARGETING
INITIALIZATION
POINT IN THIS
ROUTINE
"F" BELOW

#780

.P35
.TPI TARGET-
.ING INITIA-
.LIZATION
.POINT FROM
.R00

#790

HOLD
SNAP

FLASH VERB-NOUN TO
REQUEST PLEASE PER-
FORM MINKEY SEQUENCE
V50 V25
R1-00017
R2-BLANK
R3-BLANK

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
MINKEY SEQUENCE

#800

DO I WISH TO PERFORM
THE RENDEZVOUS USING

#810

THE MINKEY SEQUENCE?

.NO
.YES

#820

WAIT FOR KEYBOARD
ENTRY
.....
KEY IN ENTER

TERMINATE FLASH UPON
RECEIPT OF ENTER,
PROCEED OR TERMINATE
.....
KEY IN PROCEED

#830

.V34E .P .E
. .R .N
. .O .T
RESET .C .E
AUTOSEQ .E .R
FLAG .D
RESET
AUTOSEQ
FLAG

#840

DO ROU-
TIME
R00

#850

EXIT R07
.....

#860

WAS P20 STARTED
WITH HEADS
ORIENTATION
SPECIFIED
(AZIMFLAG SET)?

.NO
.YES

REINITIALIZATION (MANEUF LG, PTV93FLG)

#920

RESET PCFLAG

START MINKEY (SET AUTOSEQ FLAG)

#930

"FR"

#940

CALL THE TPI TARGETING PROGRAM (P35)

#950

IS THE MAGNITUDE OF DELTA V (RSS OF N81) GREATER THAN OR EQUAL TO 10 FPS?

.YES

.NO

#960

R1 - 00017
R2 - BLANK
R3 - BLANK

MINKEY SEQUENCE

#1260

DO I WISH TO PERFORM
THE RENDEZVOUS USING
THE MINKEY SEQUENCE?

#1270

.NO .YES

WAIT FOR KEYBOARD
ENTRY

KEY IN ENTER

TERMINATE FLASH UPON
RECEIPT OF ENTER,
PROCEED OR TERMINATE

KEY IN PROCEED

#1280

.V34E .P .E
.R .N .N
.O .T .T
.C .E .E
RESET .E .R
AUTOSEQ .E .
FLAG .D .

#1290

RESET
AUTOSEQ
FLAG

DO RUU-
TINE
R00

#1300

EXIT R07
GO TO
"H"
BELOW

#1310

WAS P20 STARTED WITH
HEADS ORIENTATION
SPECIFIED (AZIMFLAG
SET)?

.NO .YES
.
.

SET AZIMFLAG

.
.
.

IS HEADS UP DE-
SIGNED (HDSUPFLG
SET)?

.YES .NO
.
.

SET
OMICRON=0
DEGREES
(R3 OF N78)

.
.
.
.

SET
OMICRON=180
DEGREES
(R3 OF N78)

.
.
.
.
.
.

IS W-MATRIX VALID FOR
RENDEZVOUS NAVIGATION

.
.
.
.
.

#1320

#1330

#1340

#1350

IS HEADS UP DESIRED
(HDSUPFLG SET)?

.YES .NO

SET OMEGACRON=0
DEGREES
(R3 OF N78)

SET OMEGACRON=180
DEGREES
(R3 OF N78)

IS W-MATRIX VALID
FOR RENDEZVOUS
NAVIGATION
(RENDFLG SET)?

.NO .YES

SET FLAGS FOR
AUTO W-MATRIX
REINITIALIZA-
TION (MANEUF LG,
PTV93FLG)

RESET PCFLAG

#1510

#1520

#1530

#1540

#1550

523

585
R07/SKYLARK

START MINKEY
(SET AUTOSEQ
FLAG)

#1560

CALL PLANE CHANGE
TARGETING PROGRAM
(P38)

#1570

IS MAGNITUDE OF
DELTA V (RSS OF N81)
EQUAL TO ZERO?

#1580

.YES .NO

#1590

PERFORM R03

DO THE IMU
REALIGNMENT
PROGRAM
(P52)

#1600

R07/SKYLARK

CHANGE CONTROL NOTES

REV 00 PCR 011,021, PCN 411,435, SL MEMO #2

VHF RANGE READ ROUTINE (R08)

REV 00 05/19/71

PURPOSE:

(1) TO READ RANGE FROM VHF DATA LINK AND RECORD TIME OF THE READING.

ASSUMPTIONS:

- (1) THE VHF IS ON.
- (2) THIS ROUTINE IS SELECTED BY R22 FOR VHF NAVIGATION MEASUREMENTS WHEN ENABLED BY V87E (DISABLED BY V88E). THIS ROUTINE IS SELECTED BY R22 VIA R27 FOR RANGE RATE FILTER MEASUREMENT WHEN ENABLED BY V76E (DISABLED BY V77E). THIS ROUTINE IS SELECTED BY P25 AND P48 VIA R27 FOR RANGE RATE FILTER MEASUREMENT.
- (3) WHEN CALLED BY R22, THE VHF MEASURED RANGE IS EXTENDED BEYOND 327.67 N.M. IF INDICATED BY THE RANGE COMPUTED IN R61 USING THE ON-BOARD STATE VECTOR ESTIMATES.

PROG
CONT

CMC

GROUND

CREW

.CMC ROUTINE
.SELECTION

.
.
...

START VHF RANGE READ
ROUTINE (R08)

.

RESET BITS 1-4 OF
CHANNEL 13

.

SYNCHRONIZE SETTING
OF RADAR ACTIVITY

#10

#20

BIT WITH CHANNEL 4
(LOSCALAR) TO PRE-
VENT SPLIT RADAR
PULSE

#30

.
.
.

SET BITS 1 AND 4 OF
CHANNEL 13 TO "1" TO
REQUEST RANGE READ-
OUT FROM VHF DATA
LINK

#40

.
.
.

READ PRESENT TIME

.
.
.

RESET VHF RESTART
FLAG

#50

.
.
.

WAIT FOR READ TO BE
COMPLETED
NOTE: RADARUPT WILL
SIGNAL END OF READ

#60

.R
.A
.D
.A
.R
.U
.P
.T
. .
. .

IS VHF RESTART FLAG
SET?

#70

.N Y.
. .
. .
. .
. .
. .
. .
. .
. .

#130

TO CALLER'S
ERROR RETURN

CONVERT RAW DATA
FROM N.M. TO METERS

#140

IS EXCHANGE SET?
(IS THERE A STATE
VECTOR RANGE ESTI-
MATE FROM R61
AVAILABLE?)

Y. N

#150

IS DIFFERENCE
BETWEEN R61
COMPUTED RANGE
AND VHF RANGE
GREATER THAN
300 N.M.?

Y. N

#160

ADD 327.68
N.M. TO VHF
RANGE

#170

.....
EXIT R08
TO CALLER'S
GOOD RETURN

531

595
R08/SKYLARK

CHANGE CONTROL NOTES

REV 00 PCR 032, SL MEMO #19

9

RENDEZVOUS TRACKING SIGHTING MARK ROUTINE (R21)

REF 00 05/19/71

PURPOSE: (1) TO PERFORM SIGHTING MARKS IN CONJUNCTION WITH THE UNIVERSAL TRACKING PROGRAM (P20), OPTIONS 0,4.

ASSUMPTIONS: (1) SIGHTINGS ARE MADE ON THE OMS USING THE SXT.

(2) WHEN THE CMC ACCEPTS A MARK IT RECORDS AND STORES 5 ANGLES (3 L/DUS AND 2 O/DUS) AND THE TIME OF MARK IN POSITION #1. IF A MARK IS REJECTED (BY PRESSING MARK REJECT BUTTON) THE MARK DATA IN POSITION #1 IS ERASED IF ANY. OTHERWISE A FLAG IS SET FOR R22 REJECTION BEFORE INCORP.

THE RENDEZVOUS TRACKING DATA PROCESSING ROUTINE (R22) ATTEMPTS TO PROCESS THE MARK DATA (IF ANY) IN POSITION #1 ONCE EVERY 4 SECONDS. IF DATA IS IN POSITION #1, IT IS MOVED TO POSITION #2 FOR PROCESSING BY (R22). IF NO DATA IS IN POSITION #1, R22 INTERROGATES POSITION #1 AFTER 4 SECONDS.

IF MARKS ARE MADE AT A GREATER FREQUENCY THAN R22 PROCESSES THEM THE OVERFLOW FROM POSITION #1 IS LOST.

(3) THE TRACKING ATTITUDE ROUTINE (R61) WILL AUTOMATICALLY HOLD RENDEZVOUS REFERENCE VECTOR AIMED AT THE OMS, IF THE SC CONTROL SWITCH IS PLACED AT CMC, IF THE AUTOMODE IS SELECTED AND IF THE PREFERRED ATTITUDE IS SPECIFIED IN N78. IF THE FREE MODE IS SELECTED THE ASTRONAUT MAY HOLD THE OMS IN THE FIELD OF VIEW USING THE MINIMJM IMPULSE CONTROLLER OR ROTATIONAL HAND CONTROLLER. IF THE ATTITUDE HOLD MODE IS SELECTED THE ASTRONAUT MAY HOLD THE OMS IN THE FIELD OF VIEW USING THE ROTATIONAL HAND CONTROLLER.

(4) THIS ROUTINE IS AUTOMATICALLY SELECTED BY A SXT MARK OR MARK REJECT DURING P20, OPTIONS 0,4.

PROG
CONT

CMC GROUND CREW

START RENDEZVOUS
TRACKING SIGHTING
MARK ROUTINE (R21)

SELECT MANUAL OPTICS
MODE

#10

WAIT FOR MARK, MARK
REJECT

WHEN OMS IS AT
CENTER OF RETICLE
PRESS MARK BUTTON

Preceding page blank

#20

WAS SIGHTING SATIS-
FACTORY?

.N .Y

. MARK REJECT.

PRESS MARK
REJECT BUTTON
WITHIN 7 SEC
AFTER MARK

#30

TERMINATE WAIT UPON
RECEIPT OF MARK,
MARK REJECT

.M
.A
.R
.K
.R
.E
.J
.E
.C
.T
. .

. . . .
EXIT R21

#40

ERASE
MARK DATA
IN POSI-
TION #1
(IF ANY)
OR SET
REJCTFLG
TO REJECT
MARK BE-
ING PRO-
CESSED BY
R22 (IF
ANY).

#50

#60

535

599
R21/SKYLARK

#70

#80

#90

.....
EXIT
R21

.....
EXIT R21

STORE NEW
MARK DATA
IN POSITION #1 AND
TAG AS PRIMARY
MARK DATA FOR
USE BY R22.

.....
EXIT
R21

REV 00 PCN 457

R21/SKYLARK

#10

START RENDEZVOUS
TRACKING DATA PROC--
ESSING ROUTINE (R22)

#20

SET VHF TIME TO
PRESENT TIME

#30

WAIT 4 SECONDS

#40

IS RENDEZVOUS FLAG
SET?

#50

IS REFSMAT FLAG
SET?

#300

DELTA V-MAGNITUDE
OF THE DIFFERENCE
BETWEEN THE VELOCITY
VECTOR BEFORE AND
AFTER INCORPORATION
OF THIS MARK DATA.
IN FPS TO THE NEAR-
EST .1 FPS.

SOURCE CODE-DEFINES
SOURCE OF DATA:
1 = OPTICS MARKS
2 = VHF RANGING

WAIT 2 SECONDS

WAIT FOR KEYBOARD
ENTRY

#310

IS THE SOURCE CODE
IN R3 = 1?

.Y .N

VERIFY THAT
MARKING WAS DONE
ON THE OMS AND
DISCUSS OUT OF
TOLERANCE CON-
DITION WITH THE
GROUND, IF
POSSIBLE.

VERIFY (TO BE
DEFINED) AND
DISCUSS OUT OF
TOLERANCE CON-
DITION WITH THE
GROUND, IF
POSSIBLE.

SHALL I INCORPORATE
THIS UPDATE?

.Y .N

KEY
V34E

KEY IN RE-
CYCLE V32E

#340

#350


```

.
.
.
MARK CCJNTER
-----
.
.
.
GO TO
"E"
ABOVE

```

#460

#470

"A"

#480

```

....
.
-----
WAIT 4 SECONDS
-----
.
.

```

#490

```

-----
IS RENDEZVOUS FLAG
SET?

```

.Y. .N

```

-----
IS REFSMAT
FLAG SET?

```

.Y .N

#500

#510

EXIT EXIT
R22 R22

IS TRACK
FLAG SFT?

Y. .N

#520

EXIT
R22

IS R60 OPERATING?

Y. .N

#530

IS R27FLAG
SET?

.Y .N

DO VHF RANGE
RATE MARK
PROCESSING
ROUTINE R27

IS SWAPFLAG
SET?

.N .Y

#550

#610

#620

#630

#640

#650

550

"D"
ABOVE

CALL VHF RANGE READ
ROUTINE (R08)

IS THIS CALLER'S
ERROR RETURN?

.N .Y

IS UPDATE FLAG
SET?

.Y .N

IS R60
OPERATING?

N. Y.

STORE TIME OF
MARK IN VHFTIME

GO TO

++
+01
+
+489
++

551

615
R22/SKYLARK

"B"
ABOVE

SET SOURCE CODE TO 2

#660

STORE TIME OF MARK
IN VHFTIME

#670

GO TO
"C"
ABOVE

CHANGE CONTROL NOTES

REV 00 PCR 016,017,018,025,032,439, PCN 442, SKYLARK MEMO #19
REV 01 PCN 489

#130

.....
KEY IN V24E
AND LOAD
ANGLES.
.....

#140

.....
KEY IN
PROCEED
.....

.....
TERMINATE FLASH
UPON RECEIPT OF NEW
DATA OR PROCEED
.....

.....
NEW
DATA
.....

.....
STORE
NEW DATA
.....

#150

.....
.....
.....

.....
FLASH VERB-NOUN TO
REQUEST PLEASE PER-
FORM ALTERNATE LOS
SIGHTING MARK AND
DISPLAY MARK CTRS,
TFI, AND MGA:
V53N45
R1-MARK CTRS
R2-TFI
R3-MGA
.....

HOLD
MON

#160

.....
MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM AL-
TERNATE LOS SIGHTING
MARK, AND DISPLAY OF
MARK CTRS, TFI,
AND MGA.
.....

#170

MARK CTRs- THE NUM-
BER OF MARKS PROCES-
SED BY THE RENDEZ-
VOUS TRACKING DATA
PROCESSING ROUTINE
(R22) SINCE LAST
W-MATRIX REIN-
ITIALIZATION (REFER
TO ASSUMPTION (8)
OF P20). THE REGIS-
TER WILL DISPLAY
XXBXX WHERE THE TWO
MOST SIGNIFICANT
DIGITS ARE THE VHF
RANGING MARK COUNTER
AND THE TWO LEAST
SIGNIFICANT DIGITS
ARE THE OPTICS MARK
COUNTER.

NOTE: THE OPTICS
MARK COUNTER DOES
NOT DISTINGUISH
BETWEEN BACKUP AND
PRIMARY MARKS.

TFI- TIME FROM TIG.
IN MIN AND SEC
TO NEAREST SEC.
MAXIMUM READING IS
59859. (-BEFORE, +
AFTER TIG)

MGA- MIDDLE GIMBAL
ANGLE AT TIG IF +X
CSM AXIS IS ALIGNED
WITH INITIAL THRUST
DIRECTION.
SIGN IS ALWAYS +
EXCEPT:
(A) WHEN DISPLAY-
ED AT ANY TIME
OTHER THAN THE
LAST PASS THROUGH
P31-P36, P38, THE
VALUE IS -00001

#180

#190

#200

#210

(B) DURING P30,
OR ON THE LAST
PASS OF P31-P36,
P38 WHEN THE IMU
IS NOT ALIGNED
THE VALUE IS
-00002. IN DEG-
GRES TO THE NEAR-
EST .01 DEGREES.

+ +
+ 01
+ +
+ +
+ +
+ +
+ +
+ +
+ +
+ 489
+ +

NOTE: R2 AND R3
CONTENTS VALID
ONLY IF SELECT
R23 AT V16N45
DISPLAY IN
P31-P36, P38.

WAIT FOR KEYBOARD
ENTRY

USING THE ROTATIONAL
HAND CONTROLLER PO-
SITION THE SPACE-
CRAFT SO THAT THE
OMS IS PRECISELY
ALONG THE LOS
CHOSEN.

KEY IN ENTER

WAS SIGHTING SATIS-
FACTORY?

.N .Y
.
.
.
.

KEY IN V86E
WITHIN 7
SECONDS

#220

#230

#240

#250

#260

#270

VHF RANGE RATE MARK PROCESSING ROUTINE (R27) REV 01 03/20/72

PURPOSE:

- (1) TO PROCESS VHF RANGING DATA TO UPDATE THE CURRENT RANGE STATE VECTOR (RANGE,RANGE RATE).
 - (2) TO PROCESS VHF RANGING DATA TO OBTAIN AN OPTIMUM ESTIMATE OF THE RANGE STATE VECTOR (RANGE,RANGE RATE) FOR A TIME TD SPECIFIED IN NOUN 72.
 - (3) TO CALCULATE THE RENDEZVOUS PARAMETERS PHI OR THETA, DEPENDING ON THE CALLING PROGRAM.
 - (4) TO INCREMENT OPTIMIZATION BY 4 MIN.
- ASSUMPTIONS:
- (1) THIS ROUTINE IS AUTOMATICALLY SELECTED BY EITHER P25 OR P48.
 - (2) THIS ROUTINE IS SELECTED BY R22 PROVIDED THE ASTRONAUT HAS SET R27FLAG BY KEYING V76E AND KEYING PRO ON THE FLASHING V06N72 DISPLAY. R27 WILL CONTINUE WITHIN R22 UNTIL R27FLAG IS RESET BY KEYING V77E OR BY START OF P20 (SEE P20 INITIALIZATION LOGIC).
 - (3) THE RANGE RATE FILTER WILL BE REINITIALIZED BY THE PERFORMANCE OF ANY V37EXXE OR BY KEYING V76E AND P20.
 - (4) RANGE AND RANGE RATE ARE CALCULATED ON THE BASIS OF VHF RANGING DATA ONLY AND DO NOT REQUIRE EITHER VALID STATE VECTORS OR, EXCEPT FOR P48, THAT THE ISS BE ON.
 - (5) THE CALCULATION OF THE RENDEZVOUS PARAMETERS PHI (COMPUTED FOR R22) AND THETA (FOR P48) REQUIRES BOTH VALID STATE VECTORS AND THAT THE ISS BE ON AND ALIGNED TO A "KNOWN" ORIENTATION. IN THE CASE OF PHI, THE ISS MUST BE ON AND OPERATIONAL AND INTEGRATION MUST NOT BE IN PROGRESS.
 - (6) THE RANGE RATE FILTER REQUIRES APPROXIMATELY 190 SEC TO CONVERGE TO THE DESIRED ACCURACY.
 - (7) IF THE ASTRONAUT LOADS N72 WITH A TIME IN THE FUTURE, OPTIMIZATIONS WILL OCCUR AUTOMATICALLY EVERY 4 MINUTES, BEGINNING WITH THAT TIME (N72) SELECTED BY THE ASTRONAUT.

++
 +01
 ++
 +459
 ++
 +
 +
 +
 +
 +
 +
 +
 +
 +
 +
 +489
 ++
 ++
 +01
 +468
 ++
 ++
 ++
 +01
 +459
 ++
 ++

PROG
CONT

CMC GROUND CREW

.CMC
 .ROUTINE
 .SELECTION
 .
 .
 .
 .
 .
 .

 DO R08:
 OBTAIN R1 AND T1

IS R27UP2 FLAG SET?

.Y
.N

#120

IS R27JP1 FLAG SET?

.Y
.N

STORE 1ST MARK

#130

SET R27UP1 FLAG

#140

EXIT R27

INITIALIZE R27
(SEE SEC. 5)

#150

RESET FIXFLAG

SET R27UP2 FLAG

#160

#220

#230

#240

#250

#260

RESET N77FLAG

IS THE PRESENT TIME
WITHIN 20 SEC OF TD?

SET SNAPFLAG

STORE THE CODE
-00001 INTO R3
OF N77.

WAIT UNTIL YD=0

SNAP CDU'S AND
COMPJTE PHI
FOR TD

BEGIN MONITORING TFO
IN NOUN 76. INSURE
THAT OMS IS AT
CENTER OF SXT RETI-
CLE AT TFO = -00800.

OBSERVE PHI(TD)
APPEAR IN N77 AT
APPROX TFO = +00802.

++
+01
+
+
+
+
+
+
+
+459
++

STORE FINAL
OPTIMIZED
R, R DOT
(RANGE, RATE)
INTO N77.

OBSERVE OPTIMIZED
VALUES OF RANGE,
RANGE RATE IN N77
BEFORE TFO = +01B35.
NOTE: OPTIMIZED
VALUES ARE REPLACED
BY CURRENT VALUES
AFTER TFO = +01B35.

SET N77FLAG

RESET
FIXFLAG

EXTRAPOLATE
THE RANGE
STATE VEC-
TOR AHEAD
TO THE
CURRENT
TIME TM.

SET TDFLAG

#270

#280

#290

#300

ORBITAL PARAMETERS DISPLAY ROUTINE (R30) REV 01 03/20/72

PURPOSE:

(1) TO PROVIDE THE ASTRONAUT PERTINENT ORBITAL PARAMETERS COMPUTED BY THE CMC TO SUPPLEMENT ORBITAL INFORMATION PROVIDED HIM BY THE GROUND.

ASSUMPTIONS:

(1) THE COMPUTATIONS MADE DURING THIS ROUTINE ARE UPDATED ABOUT EVERY TWO SECONDS ONLY IF THE AVERAGE 3 ROUTINE IS ON WHEN THIS ROUTINE IS CALLED.

(2) THE VALUE OF TFF OR TPER WILL BE MADE TO COUNT DOWN IF THE AVERAGE 6 ROUTINE IS NOT ON WHEN THIS ROUTINE IS CALLED.

(3) IF AVERAGE 6 ROUTINE IS OFF, THE ASTRONAUT MAY KEY IN THE PREDICTED GET TIME OF PERIGEE IN ORDER TO CAUSE THE CMC TO DO PRECISION INTEGRATION TO THAT TIME AND THEN MAKE A CONIC CALCULATION.

(4) IF TFF IS NOT COMPUTABLE BECAUSE TRAJECTORY DOES NOT INTERSECT THE INTERFACE ALTITUDE (E.G. ON THE PAD), THE CMC WILL SET TFF EQUAL TO -59859. ALSO, IF PER ALT IS GREATER THAN THE INTERFACE ALTITUDE OF 300,000 FT CMC WILL COMPUTE TPER; OTHERWISE TPER=0. TPER IS STORED IN N32 AND THE ASTRONAUT MAY CALL IT BY KEYING IN N32E.
 TPER: TIME FROM NOW TO PERIGEE ALTITUDE IN HRS, MIN, AND SEC. FOR SIGN CONVENTION, SEE ASSUMPTION 5.

(5) SIGN CONVENTION FOR TFF AND TPER: DSKY DISPLAY IS NEGATIVE (DECREASING) AS INTERFACE ALTITUDE IS APPROACHED. BETWEEN INTERFACE ALTITUDE AND PERIGEE ALTITUDE, DISPLAY IS POSITIVE (INCREASING). WHEN PERIGEE IS PASSED, R30 CONTINUES TO DISPLAY POSITIVE INCREASING TIME EXCEPT DURING AVERAGE-3 OR ON V32 RESPONSE TO V16N44. NEGATIVE (DECREASING) TIME WILL BE DISPLAYED FOR ELLIPSES IN THESE CASES.

(6) IF THIS ROUTINE IS CALLED WHILE THE EARTH ORBIT INSERTION MONITOR PROGRAM (PI11) IS ON OR WHEN IN CMC IDLING PROGRAM (P000), THE CMC WILL DISPLAY SPLERROR IN N50 BY KEYING IN N50E. IF THE APOGEE IS ABOVE 300,000 FT ALTITUDE AND THE PERIGEE IS BELOW 300,000 FT ALTITUDE ABOVE THE LAUNCH PAD, SPLERROR WILL BE DISPLAYED AS THE DISTANCE BETWEEN THE PREDICTED AND THE DESIRED ABORT TARGET. IF THESE CONDITIONS ARE NOT SATISFIED, SPLERROR WILL BE DISPLAYED AS THE DISTANCE BETWEEN THE PRESENT POSITION VECTOR AND THE DESIRED ABORT TARGET.

(7) REFER TO THE NOUN LIST IN THE BACK OF THIS DOCUMENT FOR DEFINITION OF THE CONTENTS OF NOUNS 32 AND 50.

(8) THIS ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG
CONT

CMC	GROUND	CREW
.....
		•CREW
		•ROUTINE
		•SELECTION
		•
		•
		•
		•
		•
		•
		•

START ORBITAL PARAMETERS DISPLAY ROUTINE (R30) KEY IN V82E

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R1-00002
R2-0000X
R3-BLANK

R1 IS THE OPTION
CODE FOR ASSUMED
VEHICLE.

R2 IS THE CMC ASSUM-
ED OPTION:
00001-THIS VEHICLE
00002-OTHER VEHICLE

ASSUMED VEHICLE (OMS
OR CSM)

#70

#80

IS THE VEHICLE
(OMS OR CSM) AS-
SUMPTION CORRECT?

.Y .N

WAIT FOR KEYBOARD
ENTRY

KEY IN PRO-
CEED

#90

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

.P .NEW
.R .CODE
.D .DATA
.C .
.E .
.D .
STORE CODE
DATA

#100

KEY IN
VZ2E
AND L2AD
THE
DESIRED
VEHICLE
(OMS OR
CSM)
CODE IN-
TO R2.

#110

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA

PROCEED NEW
DATA

STORE NEW
DATA

IS NOUN 16
ZERO?

YES. NO

SET TDECI
TO PRE-
SENT TIME

SET TDECI
TO TIME IN
NOUN 16

EXTRAPOLATE SELECTED
VEHICLE STATE VECTOR
TO TIME IN TDECI

KEY IN V25E AND L3AD
NEW DATA.

#180

#190

#200

#210

#220

USING PRECISION
EQUATIONS

#230

COMPUTE APD ALT, PER
ALT, AND TFF. (SEE
ASSUMPTION 4.)

#240

IS PER ALT GREATER
THAN 300,000 FT?

.N .Y

SET TPER COMPUTE
EQUAL TO TPER.
ZERO.

#250

IS AVE G ROUTINE ON?

.Y .N

#260

TFF-TIME OF FREE
 FALL FROM NOW TO
 AN INTERFACE AL-
 TITUDE OF 300,000
 FT. FJR SIGN CON-
 VENTION, SEE
 ASSUMPTION 5.
 ALTITUDE DEFINED
 ABOVE THE LAUNCH
 PAD RADIUS.
 IN MIN, SEC TO
 NEAREST SEC. MAX
 READING IS -59859.
 NOTE: WHEN THE
 TRAJECTORY DOES
 NOT INTERSECT THE
 INTERFACE ALT-
 ITUDE (E.G. ON
 THE PAD), THE TFF
 DISPLAY WILL READ
 -59859.
 NOTE: IF PER ALT OR
 APD ALT EXCEEDS
 SCALE THE DISPLAY
 WILL BE 9999.9 NM.

WAIT FOR KEYBOARD
 ENTRY

CULATIONS RE-
 PEATED? (SEE
 ASSUMPTION 1)

.Y .N

KEY IN
 RECYCLE
 V32E
 NOTE:
 THE
 KEYING
 OF RE-
 CYCLE
 DURING
 AVE G
 WILL
 HAVE NO
 EFFECT.

#320

#330

#340

#350

#360

++
 +01
 +
 +
 +
 +
 +
 +
 +489
 ++

#40

#50

#60

#70

#80

EXIT

IS AVERAGE G RUNNING?

N Y

SFT T = PRESENT TIME

EXTRAPOLATE OWS AND CSM STATE VECTORS TO T USING COASTING INTEGRATION ROUTINE

SET T = AVERAGE G TIME.

B

OF RENDEZVOUS
PARAMETERS.
(NOTE: THESE PARA-
METERS WILL BE
UPDATED ABOUT EVERY
TWO SECONDS.)

#140

#150

#160

#170

V16 N54
 R1-RANGE
 R2-RANGE RATE
 R3-THETA
 RANGE-CALCULATED
 RANGE TO DWS. IN
 NAUTICAL MILES TO
 NEAREST .01 NM.
 RANGE RATE--
 CALCULATED RANGE
 RATE BETWEEN CSM AND
 DWS. NEGATIVE SIGN
 INDICATES CLOSING
 IN FPS TO NEAREST
 .1 FPS
 THETA-ANGLE BETWEEN
 CSM +X AXIS AND THE
 LOCAL HORIZONTAL
 PLANE AT THE PRESENT
 TIME. FROM 0 TO 360
 DEGREES. IN DEGREES
 TO NEAREST .01
 DEGREE

++
+01
+489
++

IS AVERAGE G
RUNNING?

.N .Y

SET TF = AVERAGE
G TIME

REV 01 03/20/72

RENDEZVOUS PARAMETER DISPLAY NO 2 ROUTINE (R34)

PURPOSE: (1) TO DISPLAY AT ASTRONAUT REQUEST CMC CALCULATED RENDEZVOJS PARAMETERS (RANGE, RANGE RATE, PHI)

ASSUMPTIONS: (1) RANGE AND RANGE RATE ARE CALCULATED BY THE CMC ON THE BASIS OF THE STORED OWS AND CSM STATE VECTORS AND DO NOT REQUIRE THAT THE ISS BE ON. THE ISS MUST BE ON AND ALIGNED TO A "KNOWN" ORIENTATION AND THE OPTICAL SUBSYSTEM MUST BE ON AND OPERATIONAL, IF A CORRECT DISPLAY OF PHI IS DESIRED. THE RANGE/RANGE RATE/PHI DISPLAY IS NOT INHIBITED HOWEVER IF THE IMU IS NOT ON AND ALIGNED OR THE OPTICS IS OFF.

(2) THE ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PRDG
CONT

CMC

GROUND

CREW
•CREW
•ROUTINE
•SELECTION
•
•
•

START
RENDEZVOUS PARAMETER
DISPLAY NO 2 ROUTINE
(R34)

KEY IN V85E

.....

#10

.....

#20

IS ANOTHER EXTENDED
VERB, A MARKING DIS-

#30

#140

#150

#160

#170

CALCULATE RANGE,
RANGE RATE AND
PHI

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY RENDEZVOUS
PARAMETERS:
V16 N53
R1-RANGE
R2-RANGE RATE
R3-PHI

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF RENDEZVOUS
PARAMETERS.
(NOTE: THESE PARA-
METERS WILL BE
UPDATED ABOUT EVERY
TWO SECONDS.)

RANGE RATE-
CALCULATED RANGE
RATE BETWEEN CSM AND
OMS. NEGATIVE SIGN
INDICATES CLOSING
IN FPS TO NEAREST
.1 FPS
PHI-ANGLE BETWEEN
OPTICS STAR LINE OF
SIGHT AND THE LOCAL
HORIZONTAL PLANE AT
THE PRESENT TIME.
ANGLE IS ALWAYS
POSITIVE.
FROM 0 TO 360

HOLD *
MON *
*+
*+01
*+
*+489
+

DEGREES IN DEGREES
TO NEAREST .01
DEGREE

.
.
.
.
.....

IS AVERAGE G
RUNNING?

.N .Y

.
.
.
.....

SET TF=AVERAGE
G TIME

.
.
.
.

EXTRAPOLATE OMS
STATE VECTOR TO TF
FROM T USING COAS-
TING INTEGRATION
ROUTINE

.
.
.
.
.....

WAIT FOR KEYBOARD
ENTRY

.

#180

#190

#200

#210

#220

RENDEZVOUS OUT-OF-PLANE DISPLAY ROUTINE (R36)

REV 00 05/19/71

- PURPOSE: (1) TO DISPLAY AT ASTRONAUT REQUEST CMC CALCULATED RENDEZVOUS OUT-OF-PLANE PARAMETERS (Y CM, Y DOT CM, Y DOT OWS).
- ASSUMPTIONS: (1) THESE PARAMETERS ARE CALCULATED BY THE CMC ON THE BASIS OF THE STORED OWS AND CSM STATE VECTORS AND DO NOT REQUIRE THAT THE ISS BE JN.
- (2) THE ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG
CONT

CMC	GROUND	CREW
-----	--------	------

- .CREW
- .ROUTINE
- .SELECTION

START THE RENDEZVOUS
OUT-OF-PLANE DISPLAY
ROUTINE (R36)

..... KEY IN V90E

#10

IS ANOTHER EXTENDED
VERB, A MARKING DIS-
PLAY, OR A PRIORITY
DISPLAY ACTIVE?

#20

.N Y.
.
.
.

TURN ON
OPERATOR
ERROR LIGHT

#30

#80

AM I SATISFIED
WITH THE DIS-
PLAYED TIME?

.N .Y

#90

ARE ALL
THREE
REGISTERS
EQUAL TO
ZERO?

.Y .N

#100

KEY IN
PROCEED

#110

KEY IN V25E AND LOAD
NEW DATA (ALL ZEROS
FOR PRESENT TIME).

#120

IS T(EVENT) ZERO?

.N .Y

#130

EXTRAPOLATE CSM
AND OMS VECTORS

#140

#150

#160

#170

TO THE PRESENT
TIME USING
PRECISION
INTEGRATION

EXTRAPOLATE CSM
AND OWS STATE
VECTORS TO THE
TIME DEFINED BY
T(EVENT) USING
PRECISION
INTEGRATION

CALCULATE OUT-OF-
PLANE PARAMETERS:
Y CM
Y DOT CM
Y DOT OWS

FLASH VERB NOUN TO
REQUEST RESPONSE AND
DISPLAY RENDEZVOUS
OUT-OF-PLANE PARA-
METERS:
V06 V96
R1 Y CM
R2 Y DOT CM
R3 Y DOT OWS

Y CM-(NOTE: FOR
DEFINITION OF
PARAMETERS REFER
TO SECTION
5.6 OF THIS
DOCUMENT.) IN
NAUTICAL MILES TO

HOLD
SNAP

MONITOR DSKY:
OBSERVE VERB NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF RENDEZVOUS OUT-
OF-PLANE PARAMETERS

DO I WISH TO RECEIVE
ANOTHER DATA POINT

THE NEAREST .01
NM.

Y DOT CM-RATE OF
CHANGE OF Y CM
(+ IS INCREASING
AND - IS DE-
CREASING) IN FPS
TO THE NEAREST
.1 FPS.

Y DOT OMS-RATE OF
CHANGE OF Y OMS
(+ IS INCREASING
AND - IS DE-
CREASING) IN FPS
TO THE NEAREST
.1 FPS.

WAIT FOR KEYBOARD
ENTRY:

FOR A DIFFERENT
TIME?

.N .Y

KEY IN RECYCLE
V32E

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

.P
.R
.E
.C
.Y
.C
.L
.E
.D
.....
EXIT
R36

KEY IN PROCEED

#180

#190

#200

#210

#220

#230

TURN OFF
TVC DAP

.
. .
. . .
. . . .
.

SET NARROW
DEADBAND
IN RCS DAP

.
. .
. . .

SET SBFLAG

.
. .
. . .

++
+01
+
+489
++

#240

DRIVE SPS ENGINE
BELL TO TRIM PO-
SITION.
NOTE: THE TRIM
POSITION IS THAT
LAST DEFINED BY
THE C.G. TRACKING
COMPUTATION.

#250

.
. .
. . .

TURN ON RCS
DAP IN .6
SEC

.
. .
. . .
GO TO
"A"

#260

607

679
R40/SKYLARK

IN P40

#270

CHANGE CONTROL NOTES

REV 00 PCN 457
REV 01 PCN 489

D

REV 00 05/19/71

STATE VECTOR INTEGRATION (MID TO AVE) ROUTINE (R41)

- PURPOSE:
- (1) TO INTEGRATE THE STATE VECTOR OF THIS VEHICLE TO THE TIME AT WHICH THE AVERAGE S ROUTINE WILL BE TURNED ON BY THE CALLING PROGRAM.
 - (2) TO DEFINE A NEW TIG FOR PROGRAMS 40 OR 41 IN THE EVENT THE STATE VECTOR CAN NOT BE INTEGRATED TO THE TIME DEFINED BY PROGRAMS 40 OR 41 AND TO LIGHT THE ALARM LIGHT TO INFORM THE CREW THAT TIG HAS BEEN SLIPPED.
- ASSUMPTIONS:
- (1) THERE IS A SIGNIFICANT AMOUNT OF TIME REQUIRED BY THE CMC TO TURN ON THE AVERAGE S ROUTINE. THIS TIME IS APPROXIMATELY 2 SECONDS PER TIME STEP IN EARTH ORBIT WHERE TIME STEP IS EQUAL TO APPROXIMATELY 243 SECONDS.
 - (2) THE ROUTINE IS ONLY AUTOMATICALLY SELECTED.

PROG
CONT

CMC GROUND CREW

CMC ROUTINE
SELECTION

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PRECEDING PAGE BLANK NOT FILMED

IS CALLING PROGRAM
P40 OR P41?

.Y .N

SET MIDIFLAG

RESET MIDIFLAG

#10

#20

COARSE ALIGN ROUTINE (R53) REV 00 05/19/71

PURPOSE: (1) TO COARSE ALIGN AND GYRO TRIM THE IMJ TO A DESIRED INERTIAL ORIENTATION.

ASSUMPTIONS: (1) THE DESIRED IMU INERTIAL ORIENTATION HAS BEEN SPECIFIED BY THE CALLING PROGRAM.
 (2) THE ROUTINE IS AUTOMATICALLY SELECTED BY THE IMU REALIGN PROGRAM (P52) AND BY THE BACKUP IMU REALIGN PROGRAM (P54).

PROG CONT	CMC	GROUND	CREW	
	.CMC .ROUTINE .SELECTION . . .			#10
	START COARSE ALIGN ROUTINE (R50)			
	. . .			#20
	READ PRESENT IMU ORIENTATION W.R.T. THE VEHICLE. (GIMBAL ANGLES)			
	. . .			#30
	SELECT PRESENT IMU INERTIAL ORIENTATION FROM STORAGE			
	. . .			
	CALCULATE THE INERTIAL ORIENTA-			

REV 00 05/19/71

AUTOMATIC OPTICS POSITIONING ROUTINE (R52)

PURPOSE:

- (1) TO POINT THE STAR LJS OF THE OPTICS AT A STAR DEFINED BY THE PROGRAM OR BY DSKY INPUT (ASTRONAUT).
- (2) TO POINT THE STAR LJS OF THE OPTICS AT THE OMS DURING RENDEZVOUS TRACKING OPERATIONS.
- (3) TO DO THE TRACKING ATTITUDE ROUTINE (R61) APPROXIMATELY EVERY 2 SECONDS DURING RENDEZVOUS TRACKING OPERATIONS.

ASSUMPTIONS:

- (1) THE ROUTINE IS AUTOMATICALLY SELECTED BY IMU REALIGN PROGRAM (P52) OR BY THE UNIVERSAL TRACKING PROGRAM (P2J).
- (2) THIS ROUTINE IS SELF PERPETUATING AND IS TERMINATED BY THE SIGHTING MARK ROUTINE (R53) FOR STARS AND BY RESETTING THE TRACK FLAG FOR OMS.

PROG
CONT

Preceding page blank

CREW

GROUND

CMC

.CMC ROUTINE
.SELECTION

START AUTOMATIC
OPTICS POSITIONING
ROUTINE (R52)

RESET SIGHTING MARK
FLAG

PRECEDING PAGE BLANK NOT FILMED

#10

#20

IS THE TARGET FLAG SET?

THE LOGIC FROM THIS POINT TO "B" BELOW IS FOR THE OMS TARGET CASE ONLY.

#30

.YES .NO

#40

RESET
TERM-
INATE
FLAG

GO TO
"B"
BELOW

#50

"A"

DO THE TRACKING ATTITUDE ROUTINE (R61).

#60

IS TRACK FLAG SET? (SEE P20)

#70

.Y .N
.
.
.
EXIT

R52

IS UPDATE FLAG SET?

.N .Y

#80

WAIT ABOUT 1.3
SECONDS

#90

EXTRAPOLATE CSM AND
OMS STATE VECTORS TO
THE PRESENT TIME
+2.4 SECONDS USING
CONIC EQUATIONS

#100

READ PRESENT VEHICLE
ATTITUDE FROM THE
ICDU'S

#110

COMPUTE TARGET VEC-
TOR FROM CSM TO OMS

#120

CALCULATE THE REQUI-
RED OPTICS ANGLES
TO POINT THE STAR
LINE OF SIGHT AT
THE OWS.

#130

CHECK OPTICS MODE
DISCRETE. IS THE
OSS IN THE
CMC MODE?

#140

IS A TRUNNION
ANGLE GREATER
THAN APPROX 50
DEG. REQUIRED TO
POINT THE STAR
LINE OF SIGHT AT
THE OWS ?

#150

DRIVE DRIVE
SHAFT SHAFT
AND CDU
TRUNNION AND
CDU'S DRIVE
TRUN-
NION
TO

#160

#170

621

695
R52/SKYLARK

APPROX
50
DEG-
REES

WAIT 0.5 SEC

GO TO
"A"
ABOVE

#180

#190

#200

#210

"B"

THE LOGIC FROM
THIS POINT ON IS FOR

#320

#330

#340

#350

#360

DESIGNATED STAR.

CALCULATE THE RE-
QUIRED OPTICS ANGLES
TO POINT THE STAR
LOS OF THE OPTICS
ALONG THE TARGET
VECTOR.

IS A TRUNNION ANGLE
REQUIRED TO POINT
THE STAR LOS OF THE
OPTICS AT THE TARGET
GREATER THAN 90 DEG?

.N .Y

PCSS
PRIO
HOLD
.....
SNAP

FLASH VERB-NOUN
TO REQUEST RESP-
ONSE AND DISPLAY
ALARM CODE:
V05N09
R1-
R2-
R3-

EXPECTED ALARM
CODE AT THIS
TIME IS 404

WAIT 2 SECONDS

MONITOR DSKY:
DOES ALARM CODE
DISPLAY INDICATE
THAT THE TARGET IS
NOT WITHIN THE
HEMISPHERE OF
OPTICS VISIBILITY?

.Y N.

FOR STAR SIGHTINGS
THERE ARE TWO
OPTIONS:

(A) MANUALLY MA-
NEUVER VEHICLE
UNTIL OPTICS CAN
ACQUIRE THE DES-
IRED TARGET.

#370

(B) TERMINATION
OF THE PROGRAM AND
ROUTINE.

A
B

MANUALLY
MANEUVER VEHICLE UNTIL IT
IS ESTIMATED
THAT OPTICS
CAN ACQUIRE
THE TARGET.
MONITOR FDAI
TO AVOID
GIMBAL LOCK.

#380

WAIT FOR KEY-
BOARD ENTRY.

KEY IN
PROCEED

#390

TERMINATE FLASH
UPON RECEIPT OF
PROCEED, OR
TERMINATE.

KEY IN TERMINATE.
V34E

#400

P
R
O
C
E
E
D
T
O
R
M
I
N
A
T
E

#410

GO TO

#420

#430

#440

#450

#460

"B"
ABOVE

N
A
T
E
E
D

WAIT .5 SEC

GO TO
"B"
ABOVE

DO ROUTINE
R00

DU ROUTINE
R00

EXIT R52
AND CALLING
PROGRAM

EXIT R52
AND CALLING
PROGRAM

IS SIGHTING
MARK FLAG SET?

.Y .N

MONITOR DSKY:
OBSERVE DISPLAY
OF DESIRED OPTICS
ANGLES. NOTE: THIS
DISPLAY WILL NOT
APPEAR IF R53 HAS
ALREADY BEEN CALLED

DISPLAY ON DSKY:
VJ6N9Z
R1-SHAFT
R2-TRUNNION
R3-BLANK
SHAFT-DESIRED

POSS
MON

BY SWITCHING OPTICS
MODE SWITCH TO
MANUAL.

SHAFT ANGLE IN
DEGREES TO NEAR-
EST .01 DEGREE.
TRUNNION-DESIRED
TRUNNION ANGLE
IN DEGREES TO
NEAREST .001
DEGREE.

#470

CHECK OPTICS MODE
DISCRETE. IS THE
LOSS IN CMC MODE?

#480

Y N

IS THE TRUN-
NION ANGLE
REQUIRED TO
POINT THE STAR
LOS OF THE
OPTICS AT THE
TARGET GREATER
THAN APPROX 50
DEGREES?

#490

Y N

DRIVE DRIVE
SHAFT SHAFT
AND CDU
TRUN- AND
NION DRIVE
CDU'S TRUN-
NION
TO
APPROX
50

#500

START SIGHTING MARK
ROUTINE (R 53)

#10

SET SIGHTING
MARK FLAG

#20

FLASH VERB
TO REQUEST PLEASE
MARK:
V51 N BLANK
R1-BLANK
R2-BLANK
R3-BLANK

#30

(NOTE: NOUN AND
R1 WILL NOT BE
BLANK IF ENTERED
FROM MARK REJ.
AFTER V50N25, R1
= 00016 DISPLAY)

#40

IS THIS AN OPTICS
SIGHTING?

#50

++ #01
+
+
+
+
+
+
+
+
+
+ #489
++

WAIT FOR KEYBOARD
ENTRY

#60

SELECT MANUAL
OPTICS MODE

WHEN CONDITIONS ARE
SATISFACTORY FOR
MARKING WITH DE-
VICES) TO BE USED,
PRESS MARK BUTTON.
RECORD STAR TRACKER
GIMBAL ANGLES IF
STAR TRACKER BEING
USED.

#70

TERMINATE FLASH OF
V51 UPON RECEIPT OF
MARK

MARK M.
REJECT A.
R.
K.

#80

IS MARK FLAG
SET?
(IS MARK REJECT
PERMITTED AT
THIS TIME?)

#90

TURN ON
PROG ALARM

#100

LIGHT AND
STORE
ALARM CODE
COLLO

GO TO
"A"
ABOVE

RESET MARK FLAG

GO TO
"A"
ABOVE

SET MARK
FLAG

STORE FIVE ANGLES
AND TIME.

#110

#120

#130

#140

#150

ATM SUN SEV-
SCH (C = 1)?

.N .Y

IS CELES-
TIAL BODY
CODE = SUN
(DE = 46)?

.Y .N

TURN ON OPERA-
TOR ERROR LIGHT

IS CALLING
PROGRAM P50?

.N .Y

IS SOURCE OF
SIGHTING
DATA ATM
STAR TRACKER
(C = 2)?

.N .Y

SET TER-
MINATE
FLAG (FJR
USE BY
R52).

#350

#360

#370

#380

#390

IS THIS P50?

.N .Y

IS THIS ATM
STAR TRACKER
DATA?

.N .Y

EXIT
R53

#400

#410

#420

#430

#440

#450

```

HOLD .
.....
SNAP .
.....
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STAR TRACKER
GIMBAL ANGLES:
V06 N14
R1-AZIMUTH (PSI ) 3
R2-ELEVATION (PSI ) 1
R3-BLANK
AZIMUTH-OUTER GIMBAL
ANGLE OF THE ATM
STAR TRACKER. IN ARC
MINUTES TO THE NEAR-
EST ARC MINUTE.
ELEVATION-INNER GIM-
BAL ANGLE OF THE ATM
STAR TRACKER. IN ARC
MINUTES TO THE NEAR-
EST ARC MINUTE.
.....
WAIT FOR KEYBOARD
ENTRY
.....
TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA
.....
PROCEED .NEW
      .DATA
.....
STORE NEW
DATA
.....
MONITOR DSKY:
OBSERVE VERB-NOJN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF STAR TRACKER
GIMBAL ANGLES, PSI 3
AND PSI 1
.....
ARE THESE THE
CORRECT STAR TRACKER
ANGLES?
.....
Y .N
.....
KEY IN PROCEED
.....
KEY IN V24E
AND LOAD NEW
STAR TRACKER
ANGLES
.....

```


REV 00 05/19/71

SIGHTING DATA DISPLAY ROUTINE (R54)

PURPOSE:

(1) TO TEST THE ACCURACY OF A PAIR OF CELESTIAL BODY SIGHTINGS.

ASSUMPTIONS:

(1) THE ROUTINE IS NORMALLY AUTOMATICALLY SELECTED BY THE IMU ORIENTATION DETERMINATION PROGRAM (P51), BY THE IMU REALIGN PROGRAM (P52), BY THE BACKUP IMU ORIENTATION DETERMINATION PROGRAM (P53), OR BY THE BACKUP IMU REALIGN PROGRAM (P54).

PROG
CONT

CMC

GROUND

CREM

- CMC
- ROUTINE
- SELECTION
- • •
- • •

 START SIGHTING DATA
 DISPLAY ROUTINE
 (R54).

#10

 CALCULATE ANGLE BE-
 TWEEN TWO CELESTIAL
 BODIES USING STORED
 EPHEMERIS DATA
 (ACTUAL)

#20

 CALCULATE ANGLE BE-
 TWEEN TWO CELESTIAL
 BODIES USING CELES-
 TIAL BODY VECTORS
 DERIVED FROM MARK
 ANGLES (INDICATED)

#30

• • • • •

PRECEDING PAGE BLANK NOT FILMED

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FROM R54
CONTINUE
AS DEFINED
IN CALLING
PROGRAM/
ROUTINE

#90

TERMINATE FLASH UPON .
RECEIPT OF PROCEED
OR RECYCLE ----- KEY IN RECYCLE
V32E

.P
.R
.O
.C
.Y
.C
.E
.D
. .
. .
. .
....
.R
.E
.C
.Y
.C
.L
.E
. .
. .
. .
....

#100

EXIT "B"
FROM R54
CONTINUE AS
DEFINED IN THE
CALLING PRO-
GRAM/ROUTINE

EXIT "A"
FROM R54
CONTINUE IN
CALLING PRO-
GRAM/ROUTINE
EXIT "B"
FROM R54
CONTINUE AS
DEFINED IN THE
CALLING PRO-
GRAM/ROUTINE

#110

CHANGE CONTROL NOTES

REV 00 PCR +20

#220

#230

#240

#250

#260

00 - PLANET (ANY
 PLANET)
 01/45 - STAR (FROM
 CELESTIAL BODY
 CODE LIST)
 46 - SUN
 47 - EARTH

WAIT FOR KEYBOARD
 ENTRY

KEY IN
 PROCEED

TERMINATE FLASH UPON
 RECEIPT OF PROCEED
 OR NEW DATA.

.P .NEW
 .R .DATA
 .O
 .C
 .E
 .E
 .D

STORE
 IS THE CEL- NEW
 ESTIAL BODY DATA
 CODE NEG-
 ATIVE?

.N .Y

IS THE
 CELEST-

KEY IN V21E AND
 LOAD DESIRED
 CODE.

655

731
R56/SKYLARK

IAL BODY
CODE >47
{OCTAL)?

.N .Y

#270

IS
SOUR-
CE
OF
SIGH-
TING
DATA
ATM
SUN
SFN-
SOR
(C=1)?

#280

.N .Y

#290

IS
CELE-
STIAL
BODY
CODE
= SUN
(DE =
46)?

#300

.Y .N

TURN ON OPERATOR
ERROR LIGHT

#310

#320

IS THIS ATM STAR
TRACKER DATA?
N Y

IS SOURCE OF SIGHT-
ING DATA ATM STAR
TRACKER (C = 2)?
N Y

#330

MONITOR DSKY:
OBSERVE VERB-NOJN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF STAR TRACKER
GIMBAL ANGLES, PSI
AND PSI
1 3

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STAR TRACKER
GIMBAL ANGLES:
V06 N14
R1-AZIMUTH (PSI)
R2-ELEVATION (PSI)
R3-BLANK
1 3

#350

ARE THESE THE
CORRECT STAR TRACKER
ANGLES?
Y

AZIMUTH-OUTER GIMBAL
ANGLE OF THE ATM
STAR TRACKER. IN ARC
MINUTES TO THE NEAR-
EST ARC MINUTE.
ELEVATION-INNER GIM-
BAL ANGLE OF THE ATM
STAR TRACKER. IN ARC
MINUTES TO THE NEAR-
EST ARC MINUTE.

#360

#420

#430

#440

#450

STORED
EPHEMERIS

CALCULATE CEL-
ESTIAL BODY
VECTOR FOR THE
BODY DEFINED
BY THE STAR
CODE.

POSS
HOLD
.....
SNAP

FLASH VERB-
NOUN TO RE-
QUEST RESPONSE
AND DISPLAY
PLANET POSI-
TION VECTOR;
V06N88
R1-X PL
R2-Y PL
R3-Z PL

X PL - THE X
COMPONENT OF
UNIT POSITION
VECTOR OF THE
PLANET AT GET
IN REFERENCE
COORDINATES.
TO THE FIFTH
PLACE
(.XXXXX).

Y PL - SAME AS
X PL FOR Y
COMPONENT.

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF PLANET POSITION
VECTOR.

ARE THE POSITION
VECTOR COMPONENTS
CORRECT?

.Y
.....
.N

659

735
R56/SKYLARK

Z PL - SAME AS
X PL FOR Z
COMPONENT.

#460

WAIT FOR KEY-
BOARD ENTRY

KEY IN
PROCEED

#470

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED OR NEW
DATA.

KEY IN V25E AND
LOAD CORRECT
POSITION VECTOR
COMPONENTS

#480

.P .NEW
.R .DATA
.D .
.C .
.E .
.E .LOAD DATA
.D .

#490

EXIT
R56

EXIT
R56

#500

CHANGE CONTROL NOTES

REV 00 PCR 0+3,413,414,415, PCN 410,436
REV 01 PCN 489

REV 01 03/20/72

ATTITUDE MANEUVER ROUTINE (R6C)

(1) TO MANEUVER THE CWS/CSM OR CSM ALONE TO AN ATTITUDE SPECIFIED BY THE PROGRAM IN PROGRESS.

(1) THE FINAL ATTITUDE DESIRED, DEFINED AS FOLLOWS, HAS BEEN STORED BY THE CALLING PROGRAM: (A) A SPECIFIC BODY FIXED VECTOR AND A DIRECTION IN SPACE TO WHICH THIS VECTOR IS TO BE ALIGNED (THE 3AXISFLG IS RESET).

(B) A THREE AXIS (ORTHOGONAL) INERTIAL ORIENTATION TO WHICH THE THREE BODY AXES ARE TO BE ALIGNED (THE 3AXISFLG IS SET).

(2) THE MANEUVER MAY BE PERFORMED AUTOMATICALLY BY THE GNCS OR PERFORMED MANUALLY WITH AN OPTIONAL FINAL AUTOMATIC GNCS CONTROLLED TRIM MANEUVER. THIS OPTIONAL TRIM MANEUVER SHOULD BE CONSIDERED ESSENTIAL FOR MANEUVERS TO SPS THRUSTING ATTITUDES.

(3) THE DAP DATA LOAD ROUTINE (R03 OR R04) HAS BEEN PERFORMED PRIOR TO THIS ROUTINE.

(4) THE ROUTINE IS AUTOMATICALLY SELECTED BY THE PROGRAM OR ROUTINE REQUIRING THE ATTITUDE MANEUVER.

(5) IF THIS ROUTINE WAS SELECTED BY THE TRACKING ATTITUDE ROUTINE (R61) THE V06N18 AND THE V06N18 IN THIS ROUTINE ARE PRIORITY DISPLAYS. THE V06N18 DISPLAY WILL REMAIN UP A MINIMUM OF 2 SECONDS. RESPONSE AFTER 2 SECONDS WILL CAUSE THE PROGRAM TO CONTINUE AS DESCRIBED.

(6) DURING ANY AUTOMATIC MANEUVER, A MIDDLE GIMBAL ANGLE GREATER THAN OR EQUAL TO 75 DEG (MAGNITJDE) CAUSES THE RCS DAP TO TERMINATE THE MANEUVER AND MAINTAIN ATTITUDE HOLD (SET STIKFLAS AND ZERO HOLDFLAG).

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CREW

GROUND

CMC

- .CMC
- .ROUTINE
- .SELECTION
- .
- .
- ...
- .

#10

START ATTITUDE
MANEUVER ROUTINE
(R60)

OBTAIN DESIRED
ATTITUDE SPECIFICA-

PROG
CONT

TIGN FRJM THE CALL-
ING PROGRAM

.
. .
. .

IS 3AXISFLG SET?

.N .Y
. .
. .

CALCULATE FINAL
VEHICLE ATTITUDE
TO POINT SPECIFIC
BODY FIXED VECTOR
IN DESIRED DIR-
ECTION (VECPPOINT
ROUTINE) IN SUCH
A WAY AS TO LEAVE
UNCONSTRAINED THE
VEHICLE ATTITUDE
ABOUT THE BODY
FIXED VECTOR.

.

SELECT GIMBAL
ANGLES CORRES-
PONDING TO
PREFERRED
VEHICLE ATTI-
TJDE AND PRES-
ENT IMU ORIEN-
TATION

.

HOLD.
.....
SNAP

FLASH VERB-NOUN TO
REQUEST PLEASE
PERFORM AUTO
MANEUVER:

.

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM AUTO

.

#20

#30

#40

#50

#60

V50 V18
 R1-CG ROLL
 R2-IG PITCH
 R3-MG YAW

OG - FINAL DESIRED
 OUTER GIMBAL ANGLE
 IN DEGREES TO
 NEAREST .01 DEGREES.

IG - FINAL DESIRED
 INNER GIMBAL ANGLE
 IN DEGREES TO
 NEAREST .01 DEGREES

MG - FINAL DESIRED
 MIDDLE GIMBAL ANGLE
 IN DEGREES TO
 NEAREST .01 DEGREES.

MANEUVER AND DISPLAY
 OF DESIRED GIMBAL
 ANGLES.

U J I WISH TO CONTIN-
 UE IN THIS PROGRAM?

.N .Y

KEY IN
 TERMINATE
 V34E

WAIT FOR KEYBOARD
 ENTRY

REVIEW THE PRESENTLY
 DISPLAYED GIMBAL
 ANGLES AND THE
 PRESENT ATTITUDE. AM
 I WITHIN THE PRESENT
 RCS DAP DEADBAND
 LIMITS IN EACH AXIS?

.N .Y

DO I WISH
 TO FURTHER
 ADJUST THE
 VEHICLE
 ATTITUDE
 ABOUT THE
 DESIRED
 VECTOR?

#70

#80

#90

#100

#110

#120

(NOT POS-
SIBLE FOR
ALL CASES.
SEE ASSUMP-
TION 1)

.N .Y

TERMINATE FLASH UPON
RECEIPT OF ENTER,
PROCEED, OR TERMINATE

.P .T
.R .E .N
.O .R .T
.C .M .E
.E .I .R
.E .N .
.D .A .
. .T .E
. .

IS MAJOR
MODE 00?

.N .Y

WAS THIS
ROUTINE EXIT
CALLED BY R60
P20?

.N .Y

DO ROU-
TINE R00

.N .Y

KEY IN ENTER

. .
. .
. .
. .
EXIT
R60

SHALL I HAVE THE
GNCS PERFORM THE
MANEUVER AUTO-
MATICALLY?

.Y .N

#130

#140

#150

#160

#170

DO P20 TERMINATION PROCESS (V56 LOGIC).

EXIT R60
EXIT R60

IS 3AXISFLG SET?

.N
.Y

CALCULATE FINAL VEHICLE ATTITUDE TO POINT SPECIFIC BODY FIXED VECTOR IN DESIRED DIRECTION (VECPPOINT ROUTINE) IN SUCH A WAY AS TO LEAVE UNCONSTRAINED THE VEHICLE ATTITUDE ABOUT THE BODY FIXED VECTOR.
NOTE: GNC'S CAPABILITY TO PERFORM MANEUVER AUTOMATICALLY WILL BE COMPROMISED

SELECT CMC CONTROL AND SELECT THE AUTO MODE.

SHALL I HAVE THE GNC'S RECOMPUTE THE DESIRED ATTITUDE WITHOUT PERFORMING THE AUTOMATIC MANEUVER? (NOT POSSIBLE FOR ALL CASES. SEE ASSUMPTION 1)

.Y .N

EITHER SELECT SCS CONTROL

#180

#190

#200

#210

MISED IF THE
ATTITUDE IS
CHANGED BY MANUAL
INPUTS AFTER THIS
TIME

OR PLACE
MODE SWITCH
NOT IN AUTO.

KEY IN
PROCEED

SELECT GIMBAL
ANGLES CORRES-
PONDING TO
PREFERRED
VEHICLE ATTI-
TJDE AND PRES-
ENT IMU ORIEN-
TATION

PERFORM
ATTITUDE
MANEUVER
MANUALLY
USING
RHC AND
BY REFE-
RENCE TO
THE OUT
THE WIV-
DOW VIEW
AND/OR
THE FDAI
BALL AND
ATTITUDE
ERROR
NEEDLES.

#220

#230

#240

#250

#260

DO MANEUVER
CALCULATION
(KALCMANU) AND
ICDU DRIVE
ROUTINE TO
ACHIEVE FINAL
GIMBAL ANGLES.
THE MANEUVER
RATE WILL BE
THAT LAST DE-
FINED TO THE
CMC BY DSKY
ENTRY. THIS
PROCESS WILL
INCLUDE A MON-
ITOR OF THE
RHC INPTS TO
THE CMC. ANY
INPUT FROM THE
RHC WILL BE
INTERPRETED AS
A MANUAL OVER-
RIDE AND WILL
CAUSE IMMEDI-
ATE TERMINA-
TION OF THIS
MANEUVER CAL-
CULATION AND
ICDU DRIVE
ROUTINE.

MONITOR ATTITUDE
MANEUVER BY
REFERENCE TO FDAI
BALL AND ATTI-
TUDE ERROR
NEEDLES TO AVOID
GIMBAL LOCK.

SHALL I OVERRIDE
THE GNCS AND
COMPLETE THE MAN-
EUVER MANUALLY?

WAIT FOR
AUTOMATIC
COMPLETION.

IS THIS A
P20 MANEU-
VER DURING
MINKEY?

COMMAND ZERO VEHICLE
RATE

IS HOLDFLAG
NEGATIVE?

#320

#330

#340

#350

#360

++
+01
+
+
+
+489
++



CHANGE CONTROL NOTES

REV 00 PCR 040, PCN 456
REV 01 PCN 489

.
. .
. . .
. . . .
.

SAVE DAP REFERENCE
ANGLES FOR LATER USE

.
. .
. . .
. . . .
.

"D"
FROM
BELOW

#80

EXTRAPOLATE CSM
STATE VECTOR TO
DESIRED TIME
USING CONIC
EQUATIONS

#90

.
. .
. . .

IS UTFLAG SET?

#100

.N .Y
. .
. . .

EXTRAPOLATE OWS
STATE VECTOR TO
DESIRED TIME
USING CONIC
EQUATIONS

#110

.
. .
. . .

IS AZIM- IS AZIM-
FLAG FLAG

```

SET?      SET?
-----
.N .Y .N
. . .
. . .
. . .
. . .
. GO TO GO TO
  "B" "C"
. BELOW BELOW
.
.
.
-----
CALCULATE THE
DESIRED TRACKING
ATTITUDE FROM
CSM TO OMS.
VECTOR ALIGNED
WITH LOS FROM
CSM TO OMS.)
THIS ATTITUDE
WILL BE COMPUTED
(VEGPOINT) TO
POINT THE DE-
SIRED UNIT VEC-
TOR AT THE OMS
BUT WILL NOT
CONSTRAIN THE
NONCRITICAL
ORIENTATION
ABOUT THAT
VECTOR.
-----
.
.
.
. CALCULATE THE
. DESIRED TRACKING
. ATTITUDE FROM CSM
. TO CELESTIAL BODY.
. (DESIRED UNIT
. VECTOR ALIGNED
. WITH LOS FROM CSM
. TO CELESTIAL
.
.
.

```

#120

#130

#140

#150

#160

#220

#230

#240

#250

676

 • CALCULATE DESIRED
 • TRACKING ATTITUDE
 • FROM CSM TO CELES-
 • TIAL BODY (DESIRED
 • UNIT VECTOR ALIG-
 • NED WITH LOS FROM
 • CSM TO CELESTIAL
 • BODY). THIS ATTI-
 • TUDE WILL BE COM-
 • PUTED TO POINT THE
 • DESIRED UNIT VEC-
 • TOR AT THE CELES-
 • TIAL BODY AND WILL
 • CONSTRAIN THE ORI-
 • ENTATION ABOUT
 • THAT VECTOR.

•
 •
 •

 COMPUTE REQUIRED
 GIMBAL ANGLES AT THE
 DESIRED TRACKING
 ATTITUDE IF THE
 PRESENT IMJ ORIENTA-
 TION IS HELD AND
 STORED IN NOUN 18.
 OPTIONS 4 OR 5 WILL
 GIVE 401 ALARM IF
 DESIRED ANGLES YIELD
 GIMBAL LOCK.

•
 •
 •
 •
 •

 STORE ATTITUDE SPE-
 CIFICATION FOR

DESIRED TRACKING
ATTITUDE FOR USE BY
THE ATTITUDE MANEU-
VER ROUTINE (R60).

#260

.
. .
. . .
. . . .

SET EXTRANGE (RANGE
ESTIMATE AVAILABLE
FROM STATE VECTORS)

#270

.
. .

IS P27 IN MODE
LIGHTS?

#280

.N .Y
. .
. . .

TURN OFF UPLINK
ACTY LIGHT

#290

.
.
.
.

IS HOLDFLAG EQUAL TO
A POSITIVE, NON-ZERO
NUMBER?

#300

.N .Y
. . .
. . .

RESET V50N18
FLAG

.
.
.
.
.
.
.
.
.

#310

#320

GO TO
"A"
BELOW

IS OPTION 3 OR 1?

.YES .NO

#330

COMPARE DESIRED
LOS DIRECTION
WITH DIRECTION
OF S/C VECTOR TO
BE POINTED
(ASSUMING CSM IS
AT DAP REFERENCE
ATTITUDE SAVED
ABOVE)

#340

COMPARE DESIRED
CDUS WITH SAVED
DAP REFERENCE
ANGLES

#350

IS ANGLE CHANGE(S)
GREATER THAN 10
DEGREES?

.N .Y

678

#410

"A"

SET R61
COUNTER EQUAL
TO 3.

EXIT

IS THE PRIORITY
DISPLAY IN ROU-
TINE 22 USING
THE DSKY?

.Y .N

SET R61 COU-
NTER EQUAL
TO -1.

EXIT

IS AZIMFLAG SET?

.Y .N

#420

#430

#440

#450

#460

#560

INPUT THE FOLLOWING QUANTITIES TO THE RCS DAP:

(1) DESIRED BODY ATTITUDE (CURRENT DEAD-BAND CENTER)

(2) DESIRED BODY RATE (IN CONTROL AXIS COMPONENTS).

(3) AMOUNTS BY WHICH THE CDU-DESIRED REGISTERS SHOULD BE INCREMENTED AT 0.1 SECOND INTERVALS.

SET R61 COUNTER EQUAL TJ 3.

EXIT R61

#590

CHANGE CONTROL NOTES

REV 00 PCR 007,025,443, PCN 410,456,457
REV 01 PCN 489

#30

IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

N. Y.

TURN ON OPERATOR ERROR LIGHT

EXIT R63

MONITOR DSKY: DOES OPERATOR ERROR LIGHT COME ON, INDICATING THAT THIS ROUTINE CAN NOT BE SELECTED AT THIS TIME?

.Y .N

IN ORDER TO TURN THIS ROUTINE ON SELECT CMC IDLING PROGRAM (POO) BY KEYING V37E00E AND RESELECT THIS ROUTINE

#60

DO IMU STATUS CHECK ROUTINE (R02)

DO IMU STATUS CHECK ROUTINE (R02)

#70

#130

#140

#150

#160

#170

.....

STORE
DATA

EXTRAPOLATE OMS AND
CSM STATE VECTORS
FORWARD TO THE
PRESENT TIME +1 MIN
USING CONIC EQUATIONS

CALCULATE THE
DESIRED TRACKING
ATTITUDE FROM CSM
TO OMS. (DESIRED
UNIT VECTOR ALIGNED
WITH LOS FROM CSM TO
OMS). THIS ATTITUDE
WILL BE COMPUTED
(VECPPOINT) TO POINT
THE DESIRED AXIS
AT THE OMS BUT WILL
NOT CONSTRAIN THE
NON-CRITICAL ORIENT-
ATION ABOUT THAT
VECTOR.

CRAFT TO THE
DESIRED ATTITUDE?

.Y .N
.

#230

DO I WISH TO
UPDATE THIS
DISPLAY?

.Y .N
.

#240

KEY IN
RECYCLE
V32E

.

#250

TO TERMINATE
THIS ROUTINE
KEY IN
V34E

.

#260

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
RECYCLE OR TERMINATE

.R .T
.E .E
.C .R
.Y .M
.C .I
.L .N
.E .A
.D .T
.....
.E .E
.....
EXIT

#270

EXIT
R63

695

773
R63/SKYLARK

R63

RESET 3AXISFLG

DO ATTITUDE MANEUVER
ROUTINE (R60)

.....
EXIT
R63

.....
DO ATTITUDE MANEUVER
ROUTINE (R60)

.....
EXIT
R63

#280

#290

CHANGE CONTROL NOTES

REV 00 PCN 457

R63/SKYLARK

ROTATION ROUTINE (R67)

REV 01 03/20/72

PURPOSE: (1) TO COMPUTE THE DAP COMMANDS FOR THE CSM WHICH ENABLES ROTATION OF THE CSM ABOUT THE SPECIFIED AXIS.
(2) TO PERFORM THE ROTATION MANEUVER.

ASSUMPTIONS: (1) THE ROUTINE IS CALLED BY THE UNIVERSAL TRACKING PROGRAM (P20), FOR OPTION 2.

PROG CMC GROUND CREW

.CMC
.ROUTINE
.SELECTION
.

START ROTATION
ROUTINE (R67)

#10

SET R67FLAG

#20

IS S/C CONTROL CMC?

.Y .N

IS THE AUTO MODE
SELECTED?

.Y .N

#30

#140

IS HOLDFLAG
NEGATIVE?

.Y N.

SET HOLDFLAG
ZERO

#150

SET DAP REFERENCE TO DE-
SIRE DAP
CDJS

#160

SET R61 COUNTER
=2048

#170

SET R67FLAG

#180

RESTORE DAP
DEADBAND

EXIT

#240

LOAD ACTUAL CDUS
INTJ DAP DESIRED
CDUS

#250

COMMAND ZERO
VEHICLE RATE

#260

IS HOLDFLAG
NEGATIVE?
.Y N.

#270

SET HOLDFLAG
ZERJ

#280

SET DAP REFER-
ENCE TO DESI-
RED DAP CDUS

WAIT ONE
SECOND

++
+01
+
+489
++

REV 01 03/20/72

TEST DSKY LIGHTS VERB 35

++

+01

PURPOSE:

+

+

+

+

+

+

+

+

+

+

+

+

+

+

++489

++

(1) TO CHECK THAT ALL THE DSKY LIGHTS ARE WORKING PROPERLY.

ASSUMPTIONS: (1) THE STATUS OF THE DSKY LIGHTS MAY BE CHECKED ONLY WHILE IN P00.

PROG
CONT

CYC

GROUND

CREW

.CREW
.SELECTION

START CREW INITIATED
TEST OF DSKY LIGHTS

KEY IN V35E

IS THE PRESENT
PROGRAM P00?

.Y
.N

TURN ON
OPERATOR
ERROR LIGHT

. . .
. . .
EXIT

PRECEDING PAGE BLANK NOT FILMED

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#10

#20

#30

RECJEST FRESH START VERB 35 REV 01 03/20/72

- PURPOSE: (1) TO INITIATE A COMPUTER FRESH START
- ASSUMPTIONS: (1) FRESH START IS CREW INITIATED BY DSKY ENTRY.
- (2) IF A FRESH START INTERRUPTS STATE VECTOR INTEGRATION, THE STATE VECTOR MAY BE INVALIDATED.
- (3) THIS PROCESS MAY BE SELECTED AT ANY TIME.

PRG
CONT

CMC

GROUND

CREW

CREW
SELECTION

++
+01
+
+
+489
++

 START CREW INITIATED KEY IN V36E
 FRESH START

 ZERO OUTBIT CHANNELS
 5 (RCS PITCH AND
 YAW) AND 6 (RCS
 RCLL)

 ZERO CHANNEL 77

#10

#20

#30

SET TIME 3 = 3777
TIME 4 = 3775
TIME 5 = 3774

#40

TERMINATE WAITLISTED
TASKS

#50

CLEAR ALL EXECUTIVE
REGISTER SETS

#60

INDICATE NO ACTIVE
JOBS

#70

MAKE ALL VAC AREAS
AVAILABLE

++
+01
+
+489
++

BLANK DSKY REGISTERS
(PROGRAM, VERB,
NOUN, R1, R2, R3.)

OBSERVE DSKY
REGISTERS BLANK

#80

B

#30

#40

#50

#60

TURN ON
OPERATOR
ERROR LIGHT

EXIT

FLASH VERB-NOUN TO
REQUEST LOAD OF
DESIRED CDU ANGLES.
V2IN22
R1-OG ROLL
R2-IG PITCH
R3-MG YAW

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH REQUESTING
LOAD OF CDU ANGLES

ALL REGISTERS
INITIALLY BLANK

HOLD .
.....
.

.....

#70

ALL ANGLES IN DE-
GREES TO NEAREST .01
DEGREE

SHALL I LOAD CDU
ANGLES?

.Y .N

#80

WAIT FOR KEYBOARD
ENTRY

LOAD DESIRED
ANGLES

#90

TERMINATE FLASH UPON
RECEIPT OF DATA OR
V33E

KEY IN
V33E

.DATA .V
. .3
. .3
. .E
. .
. .
. .
. .
. .

#100

DISPLAY COARSE ALIGN
VERB V41

MONITOR DSKY:
OBSERVE DISPLAY OF
COARSE ALIGN VERB

#110

IS MUDE SWITCHING OR
GYRO TORQUING IN
PROGRESS?

N .Y

TURN ON OPERA-
TOR ERROR LIGHT

#120

VEHICLE.
(GIMBAL ANGLES)

.

ARE THE GIMBALS
WITHIN 2 DEGREES OF
THE DESIRED ANGLES?

.Y .N

.

TURN ON PROGRAM
ALARM AND STORE
ALARM CODE
(00211)

.

.

...

EXIT

.

.

...

EXIT

#180

#190

0200

0210

#220

MONITOR DSKY:
DOES PROGRAM ALARM
INDICATE THAT THE
IMU GIMBALS DID NOT
DRIVE TO WITHIN 2
DEGREES OF THE DE-
SIRED ANGLES?

.N .Y

.

.

...

EXIT

.

.

CHECK STATUS OF CW
PANEL. IS AN ISS
MALFUNCTION
INDICATED?

.Y .N

.

.

...

EXIT

.

DO I DESIRE TO
RESELECT THE

#30

EXIT

IS ANOTHER EXTENDED
VERB, A MARKING DIS-
PLAY, OR A PRIORITY
DISPLAY ACTIVE?

#40

.N

.Y

TURN ON OPER-
ATOR ERROR
LIGHT

#50

EXIT

#60

IS OPTICS MODE
CMC?

.Y

.N

TURN ON OPER-
ATOR ERROR
LIGHT

#70

TURN ON PROGRAM
ALARM AND STORE
ALARM CODE
(00115)

#80

MONITOR PROGRAM
ALARM LIGHT: IF THE
PROGRAM ALARM LIGHT
COMES ON AT THIS
TIME, THE ASTRONAUT
SHOULD KEY V05N09E
TO CHECK THE ALARM
CODE:

00115-SET OPTICS
MODE SW-CMC
RSET
00117-OPTICS NOT
AVAILABLE.
THE PROCESS

REV 01 03/20/72

PULSE TORQUE GYROS EXTENDED VERB 42

PURPOSE: (1) TO FINE ALIGN THE STABLE MEMBER BY TORQUING THE GYROS.

(2) TO TERMINATE THE COARSE ALIGN MODE AND ENTER THE INERTIAL MODE.

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

(2) THE PROCESS MAY BE SELECTED ONLY WHEN NO OTHER EXTENDED VERB IS ACTIVE.

(3) THE PROCESS IS INTENDED PRIMARILY FOR USE ON THE GROUND.

PROG
CONT

CMC

GROUND

CREW

DO I DESIRE TO LOAD
A DELTA GYRO ANGLE
GREATER THAN +99.999
DEGREES? -

.Y .N
.
.

#10

THE ASTRONAUT
MUST LOAD THE
THREE DOUBLE PRE-
CISION OGC
REGISTERS:

<KEY V21N02E
02757E
XXXXXE
N15E
XXXXXEE
YYYYYEE
YYYYYEE
ZZZZZEE
ZZZZZE

BIT 14 OF THE
HIGH ORDER RE-

#20

IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

.N .Y

TURN ON OPERATOR ERROR LIGHT

EXIT

FLASH VERB-NOUN TO REQUEST LOAD OF DELTA GYRO ANGLES V21N93
R1-DELTA GYRO X
R2-DELTA GYRO Y
R3-DELTA GYRO Z

ALL REGISTERS INITIALLY BLANK

DELTA GYRO ANGLES - THE ANGLES THROUGH WHICH EACH GYRO MUST BE TORQUED TO COM-

MONITOR DSKY: OBSERVE VERB-NOUN FLASH REQUESTING LOAD OF DELTA GYRO ANGLES

DID I LOAD THE GYRO TORQUING REGISTERS

#80

#90

#100

#110

#120

.....
EXIT

CHANGE CONTROL NOTES

REV 00 PCN 457
REV 01 PCN 489

SET ERROR COUNTER
ENABLE

.
. .
. . .

#130

WAIT 20 MILLISECONDS

.
. .

#140

LOAD ISS ERROR
COUNTERS

.
. .
. . .
EXIT

#150

. . .
EXIT

CHANGE CONTROL NOTES

741

831

REQUEST DOCKED DAP DATA -DAD ROUTINE (R04)
EXTENDED VERB 44

REV 00 05/19/71

NOTE: THIS EXTENDED VERB IS USED TO CALL ROUTINE
R04. SEE R04 FOR SPECIFICATION LOGIC FLOW FOR
LOADING DAP DATA.

CHANGE CONTROL NOTES

REV 00 PCR 007,040

REV 00 05/19/71

ACTIVATE DOCKED DAP EXTENDED VERB 45

PURPOSE: (1) TO ACTIVATE DOCKED RCS DAP.
ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

PROG CONT	CMC	GRJUND	CREW
			.CREW
			.SELECTION
			.
			...
			.

			START CREW INITIATED
			ACTIVATION OF DOCKED
			RCS DAP
		 KEY IN V45E
			.
			.
			...
			EXIT

			IS THIS P40?
			.N
			.
			.

			TURN ON
			OPERATOR
			ERROR LIGHT

			.
			.
			...
			EXIT

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#10

#20

#30

#40

DISABLE S IVB
TAKEOVER

.
.
.

ESTABLISH DOCKED RCS
DAP

.
.
.
.

EXIT

#50

CHANGE CONTROL NOTES

REV 00 PCR 007,040

REV 00 05/19/71

ACTIVATE CSM DAP EXTENDED VERB 46

PURPOSE: (1) TO ACTIVATE THE CSM DAP.

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

PROG CONT	CMC	GROUND	CREW
			.CREW
			.SELECTION
			.
			.
			...
			.
			.
			..... KEY IN V46E
			.
			.
			...
			.
			EXIT

010

```

-----
START CREW INITIATED
ACTIVATION OF CSM
DAP
-----

```

IS TVC DAP ON?

.N .Y

.

.

IS VEHICLE CON-

FIGURATION 2 OR

6?

.

.

.Y .V

.

.

.

TURN ON

OPERATOR

ERROR

.

.

.

.

.

.

.

.

.

.

.

.

.

.

.

.

.

.

020

030

CONTROL	(TO OWS)
STICK	RCS DAP
•	•
•	•
•	•
•••	•••
•	•
EXIT	EXIT

#90

CHANGE CONTROL NOTES

REV 00 PCR 040; PCN 410

SET OWS STATE VECTOR INTO CSM STATE VECTOR
 EXTENDED VERB 47
 REV 00 05/19/71

PURPOSE: (1) TO TRANSFER THE OWS STATE VECTOR INFORMATION TO THE CSM STATE VECTOR.

ASSUMPTIONS: (1) THIS TRANSFER OF THE STATE VECTOR INFORMATION MAY BE ACCOMPLISHED AT ANY TIME EXCEPT WHEN AVERAGE-3 IS ON.
 (2) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

PROG CONT	C4C	GRJUND	CREW	#10	#20	#30
			.CREW .SELECTION			
	START CREW INITIATED STATE VECTOR TRANS- FER. (OWS TO CW)	KEY IN V47E			
			
	IS INTEGRATION IN PROCESS?		EXIT			
	.Y					
					
	COMPLETE INTEGRATION					
					
					
					

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#40

#50

TRANSFER OTHER
VEHICLE STATE VECTOR
TO THIS VEHICLE
STATE VECTOR.

.
. .
. . .
EXIT

CHANGE CONTROL NOTES

REQUEST CSM DAP DATA LOAD (R03)
EXTENDED VERB 48 REV 00 05/19/71

NOTE: THIS EXTENDED VERB IS USED TO CALL ROUTINE
R03. SEE R03 FOR SPECIFICATION LOGIC FLOW
FOR LOADING DAP DATA.

CHANGE CONTROL NOTES

REV 00 05/19/71

START CREW-DEFINED MANEUVER (R62)
EXTENDED VERB 49

NOTE: THIS EXTENDED VERB IS USED TO CALL ROUTINE
R62. SEE R62 FOR THE SPECIFICATION LOGIC FLOW
FOR A CREW DEFINED MANEUVER.

CHANGE CONTROL NOTES

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PLEASE PERFORM EXTENDED VERB 50

REF 00 05/19/71

PURPOSE: (1) TO INTERRUPT A PROGRAM OR ROUTINE TO ALLOW THE ASTRONAUT TO MANUALLY ACCEPT OR REJECT THE INFORMATION DISPLAYED ON THE DSKY.

ASSUMPTIONS: (1) PRESSING PROCEED ON DSKY INDICATES REQUESTED ACTION HAS BEEN PERFORMED.

(2) EXECUTION OF ENTER INDICATES THE REQUESTED ACTION IS NOT DESIRED.

(3) THIS VERB ALWAYS APPEARS FLASHING ON THE DSKY.

(4) THIS VERB IS INTERNALLY INITIATED BY THE PROGRAM AND SHOULD NOT BE SELECTED BY THE CREW.

NOTE: THIS VERB IS COMPLETELY DESCRIBED IN SECTION 4.2

CHANGE CONTROL NOTES

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REV 00 05/19/71

PLEASE MARK EXTENDED VERB 51

- PURPOSE: (1) TO ALLOW THE ASTRONAUT TO OBTAIN OPTICAL SIGHTING DATA BY USE OF THE SXT, SCT, AND THE MARK BUTTON.
- ASSUMPTIONS: (1) OPTICS IS ON AND OPERATIONAL.
- (2) THIS VERB IS USED IN P03 AND R53. REFER TO THOSE PURPOSES AND ASSUMPTIONS FOR ADDITIONAL RESTRICTIONS.
- (3) THIS VERB IS INTERNALLY INITIATED BY THE PROGRAM AND SHOULD NOT BE SELECTED BY THE CREW.

NOTE: THIS VERB IS COMPLETELY DESCRIBED IN SECTION 4.2

CHANGE CONTROL NOTES

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REV 00 05/19/71

PLEASE MARK ALTERNATE LOS EXTENDED VERB 53

PURPOSE: (1) TO ALLOW THE ASTRONAJT TO OBTAIN OPTICAL SIGHTING DATA BY USE OF ANY DESIGNATED ALTERNATE LINE OF SIGHT.

ASSUMPTIONS: (1) THIS VERB IS USED IN R23 AND R56 ONLY. REFER TO THE PURPOSES AND ASSUMPTIONS OF THESE ROUTINES FOR ADDITIONAL RESTRICTIONS.

(2) THIS VERB IS INTERNALLY GENERATED BY THE PROGRAM AND SHOULD NOT BE SELECTED BY THE CREW.

NOTE: THIS VERB IS COMPLETELY DESCRIBED IN SECTION 4.2

CHANGE CONTROL NOTES

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REV 00 05/19/71

START RENDEZVOUS BACKUP SIGHTING MARK (R23)
EXTENDED VERB 54

NOTE: THIS EXTENDED VERB IS USED TO CALL ROUTINE
R23. SEE R23 FOR THE SPECIFICATION LOGIC FLOW
FOR RENDEZVOUS BACKUP SIGHTING MARK PROCESS.

CHANGE CONTROL NOTES

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#40

EXIT

#50

#60

#70

#80

.....
EXIT

.....
EXIT

RESET AJTOSEQ FLAG

RESET R21MARK FLAG

RESET UPDATE FLAG

IS TRACK FLAG SET?

.Y .N

RESET RENDEZVOUS
FLAG AND UTFLAG

.....
EXIT

RESET TRACK FLAG,
IMUSE, RENDEZVOUS

REV 00 05/19/71

RESET STICK FLAG AND SET V50N18
FLAG EXTENDED VERB 58

- PURPOSE: (1) RESET THE STICK FLAG (SEE P20 AND R61)
 - (2) SET THE V50N18 FLAG (SEE P20 AND R61)
- ASSUMPTIONS: (1) PROCESS IS CREW INITIATED BY DSKY ENTRY

PROG
CONT

CREW

GROUND

CMC

.CREW
.SELECTION

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```

START CREW INITIATED ..... KEY IN V58E
STICK FLAG RESET .....
PROCESS .....

RESET STICK FLAG .....

SET V50N18 FLAG .....
.....
EXIT

```

#10

#20

#30

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CHANGE CONTROL NOTES

873
V60/SKYLARK

#30

CHANGE CONTROL NOTES

V50/SKYLARK

780

REV 01 03/20/72

SELECT MODE 1 (DISPLAY DAP ATTITUDE ERROR)
EXTENDED VFRB 61

++
+01
+489

PURPOSE: (1) TO DISPLAY ON THE FDI ERROR NEEDLES THE DIFFERENCE BETWEEN THE CURRENT CDU ANGLES AND THE DAP COMMANDED ANGLES.

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.
(2) THIS PROCESS MAY BE SELECTED AT ANY TIME.

PROG CMC GROUND CREW

CREW
SELECTION

START CREW INITIATED KEY IN V61E
MODE 1 ERROR DISPLAY .

#10

RESET NEEDL FLG

#20

EXIT

CHANGE CONTROL NOTES

REV 01 PCN 489

CHANGE CONTROL NOTES

REV 01 PCN 489

784

V62/SKYLARK

884
V62/SKYLARK

CHANGE CONTROL NOTES

REV 01 PCN 483

786

V63/SKYLARK

V63/SKYLARK

REQJEST OPTICS ANGLES TRANSFORM ROUTINE (R64)
EXTENDED VERB 64

REV 00 05/19/71

NOTE: THIS EXTENDED VERB IS USED TO CALL ROUTINE
R64. SEE R64 FOR THE SPECIFICATION LOGIC FLOW.

CHANGE CONTROL NOTES

REV 00 PCR 040, 405

REV 00 05/19/71

START OPTICAL VERIFICATION OF GYRO COMPASSING
(P03) EXTENDED VERB 65

NOTE: THIS EXTENDED VERB IS USED TO CALL PROGRAM
P03. SEE PROGRAM P33 FOR THE SPECIFICATION
LOGIC FLOW FOR STARTING THE OPTICAL
VERIFICATION OF GYRO COMPASSING.

CHANGE CONTROL NOTES

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SET CSM STATE VECTOR INTO OWS STATE VECTOR
 EXTENDED VERB 66 REV 00 05/19/71

- PURPOSE: (1) TO TRANSFER THE CSM STATE VECTOR INFORMATION TO THE OWS STATE VECTOR.
- ASSUMPTIONS: (1) THE TRANSFER OF THE STATE VECTOR INFORMATION MAY BE ACCOMPLISHED AT ANY TIME EXCEPT IF AVERAGE-G ROUTINE WAS IN PROCESS.
- (2) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

PROG CONT	CMC	GROUND	CREW	
			.CREW .SELECTION	
			.	
			...	
			.	
			...	
			.	
			...	
			EXIT	
				#10
				#20
				#30

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#40

#50

TRANSFER THIS VEHIC-
LE STATE VECTOR TO
OTHER VEHICLE STATE
VECTOR

.
. .
. . .
EXIT

CHANGE CONTROL NOTES

REQUEST W-MATRIX RSS ERRJR DISPLAY EXTENDED VERB 67 REV 01 03/20/72

PURPOSE: (1) TO PROVIDE A MEANS OF DISPLAYING W-MATRIX INFORMATION AND LOADING NEW VALUES FOR REINITIALIZING THE W-MATRIX IF DESIRED.

ASSUMPTIONS: (1) NO OTHER EXTENDED VERBS ARE ACTIVE.

(2) THIS PROCESS IS CREW SELECTED BY DSKY ENTRY.

PROG
CONT

++
+01
+
+489
++

CMC GROUND CREW

.CREW
.SELECTION
.
.
.
.

START W-MATRIX RSS
ERROR DISPLAY
PROCESS

KEY IN V67E

#10

IS ANOTHER EXTENDED
VERB, A MARKING DIS-
PLAY, OR A PRIORITY
DISPLAY ACTIVE?

.N .Y

TURN ON OPERATOR
ERROR LIGHT

#20

#30

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#130

#140

STORE INITIAL-
IZATION PARA-
METERS FOR REND-
EZVOUS NAVI-
GATION

.
. .
. . .
. . . .
EXIT

CHANGE CONTROL NOTES

REV 00 PCR 017,018
REV 01 PCN 489

REV 01 03/20/72

RESTART EXTENDED VERB 69

PURPOSE: (1) TO CAUSE A COMPUTER RESTART.

ASSUMPTIONS: (1) THE RESTART IS CREW INITIATED BY DSKY ENTRY.

(2) V69E DOES NOT DIRECTLY SELECT RESTART PROCESSING. IT CAUSES A SITUATION WHICH SATISFIES ONE OF THE CONDITIONS FOR AN AUTOMATIC RESTART, I.E. TOO MANY CONSECUTIVE TC INSTRUCTIONS.

(3) THIS PROCESS MAY BE SELECTED AT ANY TIME.

PROG
CONT

C4C

GROUND

CREW

CREW
SELECTION

.
. .
. . . .
.

START CREW INITIATED KEY IN V69E
COMPUTER RESTART

#10

++
+01
+
+
+
+489
++

BRANCH (TC) TO SELF

.
.
.
.

#20

NOTE: THE LOGIC FROM
THIS POINT IS NOT

#30

MODE REGISTER.

#230

ZERO OUTBIT
CHANNELS: 11
(*A" RELAYS); 12
(GNC) (BITS 6 AND
4 SET TO 1 IF
NECESSARY); 13
(AGC); AND
14 (ISS)

#240

INITIALIZE DOWN-
LINK WITH P00
DOWNLIST

#250

CLEAR PHASE TABLE

#260

INITIALIZE IMU
(INHIBIT IMU FAIL
FOR APPROXIMATELY
7.90 SECONDS)

#270

TERMINATE OPTICS
COARSE ALIGN

#280

++
+01
+
+
+489
++

TURN OFF DSKY DIS-
CRETE LIGHTS EXCEPT
PROG, GIMBAL LOCK
AND NO ATT.

.....
OBSERVE DSKY
LIGHTS OFF EXCEPT
PROG, GIMBAL LOCK
AND NO ATT

#340

IS NO ATT LIGHT ON?
.N
.Y

RETURN ISS TO
COARSE ALIGN

#350

IS ENGONFLG SET?
.N
.Y

#360

TURN ENGINE ON
(BIT 13 CHANNEL
11)

TEST PHASE TABLE.
IS IT CORRECT?
.N
.Y

#370

TURN ON PROG
ALARM AND

805

913
V69/SKYLARK

STORE ALARM
CODE 1107

#380

WERE ANY PHASES
ACTIVE?

#390

.Y .N
. .
. .

JO ROUTINE
. R00

#400

DISPLAY PROGRAM
NUMBER

#410

EXIT EXIT

CHANGE CONTROL NOTES

REV 01 PCN 489

REV 00 05/19/71

UPDATE LIFTOFF TIME (P27) EXTENDED VER3 70

NOTE: THIS EXTENDED VER3 IS USED BY UPDATE PROGRAM
P27 ONLY. SEE P27 FOR THE SPECIFICATION LOGIC
FLOW FOR UPDATING THE LIFTOFF TIME.

CHANGE CONTROL NOTES

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UNIVERSAL UPDATE - BLOCK ADR (P27)
EXTENDED VERB 71
REV 00 05/19/71

NOTE: THIS EXTENDED VERB IS USED BY UPDATE PROGRAM
P27 ONLY. SEE P27 FOR THE SPECIFICATION LOGIC
FLOW FOR A BLOCK ADDRESS UNIVERSAL UPDATE.

CHANGE CONTROL NOTES

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REV 00 05/19/71

UNIVERSAL UPDATE - SINGLE ADDRESS (P27)
EXTENDED VERB 72

NOTE: THIS EXTENDED VERB IS USED WITH UPDATE
PROGRAM P27 ONLY. SEE P27 FOR THE SPECIFI-
CATION LOGIC FLOW FOR A SINGLE
ADDRESS UNIVERSAL UPDATE.

CHANGE CONTROL NOTES

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REV 00 05/19/71

UPDATE CMC TIME (OCTAL) (P27)
EXTENDED VERB 73

NOTE: THIS EXTENDED VERB IS USED BY THE UPDATE
PROGRAM P27 ONLY. SEE P27 FOR THE SPECIFI-
CATION LOGIC FLOW FOR THE OCTAL UPDATE OF
CMC TIME.

CHANGE CONTROL NOTES

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INITIALIZE ERASABLE DUMP VIA DOWNLINK
EXTENDED VERB 74

REV 00 05/19/71

PURPOSE:

(1) TO DUMP ALL EIGHT BANKS OF ERASABLE MEMORY VIA DOWNLINK.

ASSUMPTIONS:

- (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.
- (2) THE DUMP OF EACH BANK IS PRECEDED BY AN ID WORD, SYNC BITS, ECADR AND TIME.
- (3) THE E BANKS ARE DUMPED IN ORDER, STARTING WITH E BANK ZERO.
- (4) DUMPING OF ALL EIGHT BANKS IS REPEATED ONCE (TWO COMPLETE DUMPS) TO FACILITATE SUCCESSFUL GROUND RECORDING.
- (5) THE TIME REQUIRED FOR 2 COMPLETE DUMPS IS 41.6 SECONDS (100 WORDS PER SEC BIT RATE).

PROG
CONT

CREW

GROUND

CMC

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CREW
SELECTION

.
. . .
...

KEY IN V74E

START CREW INITIATED
DOWNLINK ERASABLE
DUMP

.
. . .
EXIT

TERMINATE CURRENT
DOWNLIST

.
. . .
...

#10

#20

#30

SET E BANK COUNTER,
WORD COUNTER, AND
DUMP COUNTER=0

#40

INITIALIZE E BANK
DUMP. DUMP ID, SYNCH
BITS, ECADR AND
TIMEL.

#50

DUMP E BANK

#60

INCREMENT E BANK
COUNTER AND SET WORD
COUNTER=0.

#70

ARE ALL 8 BANKS
DUMPED (E BANK
COUNTER = 8)?

.N .Y

INCREMENT DUMP COU-
NTER AND SET E BANK

REV 00 05/19/71

SET LIFTOFF FLAG EXTENDED VERB 75

PURPOSE: (1) SET LIFTOFF BACKUP FLAG.

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

PROG
CONT

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CMC	GROUND	CREW
START CREW INITIATED		.CREW
SET LIFTOFF FLAG		.SELECTION
PROCESS		.
		...
		.
	
		KEY IN V75E
		.
		...
		EXIT
SET LIFTOFF BACKUP FLAG		
		.
		...
		EXIT

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#10

#20

#30

CHANGE CONTROL NOTES

ENABLE RANGE RATE MARK PROCESSING ROUTINE (R27) EXTENDED VERB 76 REV 01 03/20/72

- PURPOSE:
- + (1) TO ENABLE THE RANGE RATE MARK PROCESSING ROUTINE R27 TO BE CALLED FROM R22.
 - + (2) TO ALLOW THE ASTRONAUT TO SELECT A SEQUENCE OF TIMES FOR WHICH THE RANGE RATE WILL BE OPTIMIZED.
 - + (3) TO PROVIDE A MEANS OF REINITIALIZING THE RANGE RATE FILTER.
- ASSUMPTIONS:
- + (1) THE RANGE RATE FILTER WILL REQUIRE APPROXIMATELY 120 SECONDS TO CONVERGE TO THE DESIRED ACCURACY.
 - + (2) IF THE ASTRONAUT LOADS N72 WITH A TIME IN THE FUTURE, OPTIMIZATIONS WILL OCCUR AUTOMATICALLY EVERY 4 MINUTES, BEGINNING WITH THAT TIME (V72) SELECTED BY THE ASTRONAUT.
 - + (3) THIS PROCESS MAY BE CREW SELECTED BY DSKY ENTRY AT ANY TIME PRIOR TO FIRST USE OF R27 DURING P20. IT IS NOT NECESSARY TO SELECT V76E AGAIN DURING THE RENDEZVOUS UNLESS R27 HAS BEEN DISABLED VIA V77E.

PROG
CONT

CMC GROUND CREW

CREW
SELECTION

#10

```

-----
START CREW INITIATED ..... KEY IN V76E
EXTENDED VERB 76 .....
PROCESS
-----

```

```

-----
IS ANOTHER EXTENDED
VERB A MARKING DIS-
PLAY, OR A PRIORITY
-----

```

#20

DISPLAY ACTIVE?
Y. .N
. .
. .

TURN ON OPERATOR
ERROR LIGHT
. .
. .
...

EXIT

#30

HOLD . FLASH VERB-NOUN TO
..... REQUEST RESPONSE AND
SNAP . DISPLAY TIME OF
OPTIMIZATION:
V06 N72
R1 - R27 OPT-HRS
R2 - R27 OPT-MIN
R3 - R27 OPT-SEC

#40

R27 OPT -
TIME FOR WHICH RANGE
RATE WILL BE OPTI-
MIZED TO NEAREST
.01 SEC.
(ZEROS INDICATE NO
OPTIMIZATION DESIRED)

#50

WAIT FOR KEYBOARD
ENTRY

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF TIME OF OPTIMI-
ZATION.

AM I SATISFIED WITH
THE DISPLAYED TIME?
Y. .N
. .
. .
...

#60

KEY IN PROCEED

EXIT

#70

REV 00 05/19/71

DISABLE VHF RANGE RATE MARK PROCESSING ROUTINE (R27) EXTENDED VERB 77

- PURPOSE: (1) TO TERMINATE OPERATION OF THE RANGE RATE MARK PROCESSING ROUTINE R27 IN R22.
- ASSUMPTIONS: (1) R27 MAY ONLY BE CALLED AGAIN FROM R22 VIA V76E, WHICH WILL REINITIALIZE R27.
- (2) THIS PROCESS MAY BE CREW SELECTED BY DSKY ENTRY AT ANY TIME.

PROG
CONT

CMC GROUND CREW

CREW
SELECTION

.
. .
. . .
. . . .

START CREW INITIATED KEY IN V77E
 EXTENDED VERB 77
 PROCESS

.
. .
. . .
. . . .

EXIT

RESET R27FLAG

.
. .
. . .
. . . .
EXIT

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CHANGE CONTROL NOTES

REV 00 PCR 439

#10

#20

CHANGE GYRO COMPASS LAUNCH AZIMUTH
EXTENDED VERB 78
REV 00 05/19/71

- PURPOSE: (1) TO PROVIDE THE PROPER STABLE MEMBER ORIENTATION FOR LAUNCH.
- ASSUMPTIONS: (1) THE PROCESS HAS THE CAPABILITY TO CHANGE THE LAUNCH AZIMUTH OF THE STABLE MEMBER WHILE GYRO COMPASSING (P02)
- (2) PROCESS IS CREW SELECTED BY DSKY ENTRY.
- (3) THE PROCESS MAY BE SELECTED ONLY DURING GYRO COMPASSING PROGRAM (P02).

PROG
CONT

CMC GROUND CREW

.CREW
.SELECTION
.
.
.
.
.
.

START CHANGE GYRO
COMPASS LAUNCH
AZIMUTH PROCESS

..... KEY IN V78E

IS THE CURRENT PROGRAM P02?

.Y .N

TURN ON OPERATOR
ERRJR LIGHT

MONITOR DSKY:
DOES OPERATOR ERROR
LIGHT COME ON INDICATING
THAT THIS ROUTINE CAN NOT BE

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#10

#20

REV 00 05/19/71

UPDATE OMS STATE VECTOR EXTENDED VERB 80

PURPOSE: (1) TO CAUSE THE REVDEZVJUS DATA PROCESSING RESULTS TO UPDATE THE OMS STATE VECTOR.
ASSUMPTION: (1) PROCESS IS CREW SELECTED BY DSKY ENTRY.

PROG
CONT

CMC

GROUND

CREW

.CREW
.SELECTION
.
.
.
.

START CREW INITIATED
OMS STATE VECTOR UP-
DATE PROCESS

KEY IN V80E

.
.
.
.
.

.
.
.
.
.
EXIT

RESET VEHICLE UPDATE
FLAG

.
.
.
.
EXIT

#10

#20

#30

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CHANGE CONTROL NOTES

REV 00 05/19/71

UPDATE CSM STATE VECTOR EXTENDED VER3 81

PURPOSE: (1) TO CAUSE THE RENDEZVOUS DATA PROCESSING RESULTS TO UPDATE THE CSM STATE VECTOR.

ASSUMPTION: (1) PROCESS IS CREW SELECTED BY DSKY ENTRY.

PROG
CONT

CHC GROUND CREW

.CREW
.SELECTION
.
.
.
.

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START CREW INITIATED KEY IN V81E
CSM STATE VECTOR
UPDATE PROCESS

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SET VEHICLE UPDATE
FLAG

.
.
.
.
EXIT

EXIT

#10

#20

#30

CHANGE CONTROL NOTES

REV 00 05/19/71

REQUEST ORBITAL PARAMETERS DISPLAY (R30)
EXTENDED VERB 82

NOTE: THIS EXTENDED VER3 CALLS ROUTINE 30. SEE
R30 FOR THE SPECIFICATION LOGIC FLOW FOR
REQUESTING ORBITAL PARAMETERS DISPLAY.

CHANGE CONTROL NOTES

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REV 00 05/19/71

REQUEST RENDEZVOUS PARAMETER
DISPLAY #1 (R31) EXTENDED VERB 83

NOTE: THIS EXTENDED VER3 CALLS ROUTINE 31. SEE
R31 FOR THE SPECIFICATION LOGIC FLOW FOR
REQUESTING RENDEZVOUS PARAMETER DISPLAY #1

CHANGE CONTROL NOTES

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REV 00 05/19/71

REQUEST RENDEZVOUS PARAMETER
DISPLAY #2 (R34) EXTENDED VERB 85

NOTE: THIS EXTENDED VERB CALLS ROUTINE 34. SEE
R34 FOR THE SPECIFICATION LOGIC FLJW FOR
REQUESTING RENDEZVOUS PARAMETER DISPLAY #2.

CHANGE CONTROL NOTES

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REV 00 05/19/71

REJECT RENDEZVOUS BACKUP SIGHTING
MARK EXTENDED VERB 86

PURPOSE: (1) IN THE EVENT OF AN UNSATISFACTORY SIGHTING MARK TAKEN DURING THE RENDEZVOUS BACKUP SIGHTING MARK ROUTINE (R23),
V86E MAY BE USED TO ERASE THE MARK DATA (IF ANY) IN POSITION 1.

ASSUMPTIONS: (1) PROCESS IS CREW SELECTED BY DSKY ENTRY.

PROG
CONT

C4C

GRJND

CREW

.CREW
.SELECTION
.
.
...
.

```

-----
START CREW INITIATED ..... KEY IN V86E
REJECT OF RENDEZVOUS .
BACKUP SIGHTING
MARK PRJCESS.
.
.
.
.
-----
ERASE MARK DATA
( IF ANY) IN POSITION
#1 OR SET REJCTFLG
TO REJECT MARK BEING
PROCESSED BY R22
( IF ANY)
.
.
.
-----
RECYCLE TO PERFORM
ALTERNATE LOS

```

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#10

#20

#30

SIGHTING MARK

.
.
.
...
.
EXIT

#40

CHANGE CONTROL NOTES

REV 00 PCN 457

REV 00 05/19/71

SET VHF RANGE FLAG EXTENDED VERB 87

PURPOSE: (1) TO SET THE VHF RANGE FLAG
ASSUMPTION: (1) PROCESS IS CREW SELECTED BY DSKY ENTRY

PROG
CONT

CMC

GROUND

CREW

.CREW
.SELECTION
.
...
.

INITIATE SET VHF
RANGE FLAG PROCESS

.
.
.
.
.
.

KEY IN V87E

.
.
.
...
.
EXIT

SET VHF
RANGE FLAG

.
.
...
.
EXIT

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#10

#20

#30

CHANGE CONTROL NOTES

CHANGE CONTROL NOTES

START RENDEZVOUS FINAL ATTITUDE (R63)
EXTENDED VERB 89 REV 00 05/19/71

NOTE: THIS EXTENDED VER3 CALLS ROUTINE 63. SEE
R63 FOR THE SPECIFICATION LOGIC FLOW TO START
RENDEZVOUS FINAL ATTITUDE MANEUVER.

CHANGE CONTROL NOTES

REQUEST RENDEZVOUS OUT-OF-PLANE DISPLAY (R36)
EXTENDED VERB 90
REV 00 05/19/71

NOTE: THIS EXTENDED VERB CALLS ROUTINE 36. SEE
R36 FOR THE SPECIFICATION LOGIC FLOW OF THE
REQUEST FOR RENDEZVOUS OUT-OF-PLANE DISPLAY.

CHANGE CONTROL NOTES

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REQUEST BANKSUM DISPLAY
EXTENDED VERB 91

REV 01 03/20/72

PURPOSE: (1) DISPLAY THE SUM OF EACH BANK FOR COMPARISON.

ASSUMPTIONS: (1) PJO IS OPERATING.

(2) NO OTHER EXTENDED VERB IS ACTIVE.

(3) PROCESS IS CREW SELECTED BY DSKY ENTRY

PROG
CONT

CMC GROJND CREW

.CREW
.SELECTION
. . .
. . .

START CREW INITIATED .
BANKSUM DISPLAY KEY IN V91E

#10

IS PROGRAM P00
OPERATING?

.Y .N
. . .
. . .

IS ANOTHER
EXTENDED
VERB, A
MARKING
DISPLAY,

#20

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++
+01
+
+
+489
++

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#30

OR A PRIOR-
RITY DIS-
PLAY
ACTIVE?

.N .Y

TURN ON OPERA-
TOR ERROR LIGHT

#40

#50

INITIALIZE ROUTINE
TO DISPLAY BANK SUMS

.....
FLASH V-N TO REQUEST
DISPLAY OF BANK SUM
V05 V01
R1 BANK SUM
R2 BANK #
R3 BUGGER WORD
HOLD
SNAP

#60

MONITOR DSKY:
OBSERVE V-N FLASH TO
REQUEST DISPLAY OF
BANK SUMS

#70

IS THIS THE BANK I
DESIRE TO READ?

.N .Y

IS THE BANK SUM
THE NUMBER I EX-

#20

SET V96UNFLG

GC TO IDLING PROGRAM
(POO) VIA ROUTINE
ROO

#30

.....
GO TO "A"
IN ROO

#40

CHANGE CONTROL NOTES

REV 01 PCN 489

THRUST FAIL DISPLAY EXTENDED VERB 97

REV 00 05/19/71

NOTE: EXTENDED VERB 97 IS USED IN THE SPS THRUST FAIL ROJTIVE R40. SEE R40 FOR THE SPECIFICATION LOGIC FLOW FOR DISPLAY OF THRUST FAIL.

THIS VERB IS INTERNALLY INITIATED BY THE PROGRAM AND SHOULD NOT BE SELECTED BY THE CREW.

CHANGE CONTROL NOTES

REV 00 05/19/71

ENABLE ENGINE IGNITION EXTENDED
VERB 99

NOTE: EXTENDED VERB 99 IS USED IN THE SPS PROGRAM P40. SEE
P40 FOR THE SPECIFICATION LOGIC FLOW TO ENABLE ENGINE IGNITION.

THIS VERB IS INTERNALLY INITIATED BY THE PROGRAM AND SHOULD
NOT BE SELECTED BY THE CREW.

CHANGE CONTROL NOTES

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REV 01 03/20/72

PCR/PCN

4.5 THIS LIST REPRESENTS THE VERBS USED IN PROGRAM SKYLARK

4.5.1 REGULAR VERBS

- 00 NOT IN USE
- 01 DISPLAY OCTAL COMP 1 IN R1
- 02 DISPLAY OCTAL COMP 2 IN R1
- 03 DISPLAY OCTAL COMP 3 IN R1
- 04 DISPLAY OCTAL COMP 1,2 IN R1,R2
- 05 DISPLAY OCTAL COMP 1,2,3 IN R1,R2,R3
- 06 DISPLAY DECIMAL IN R1 OR R1,R2 OR R1,R2,R3
- 07 DISPLAY DP DECIMAL IN R1,R2
- 08 SPARE
- 09 SPARE
- 10 SPARE
- 11 MONITOR OCTAL COMP 1 IN R1
- 12 MONITOR OCTAL COMP 2 IN R1
- 13 MONITOR OCTAL COMP 3 IN R1
- 14 MONITOR OCTAL COMP 1,2 IN R1,R2
- 15 MONITOR OCTAL COMP 1,2,3 IN R1,R2,R3
- 16 MONITOR DECIMAL IN R1 OR R1,R2 OR R1,R2,R3
- 17 MONITOR DP DECIMAL IN R1,R2
- 18 SPARE
- 19 SPARE
- 20 SPARE
- 21 LOAD COMPONENT 1 INTO R1
- 22 LOAD COMPONENT 2 INTO R2
- 23 LOAD COMPONENT 3 INTO R3

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- 24 LOAD COMPONENT 1,2 INTO R1,R2
- 25 LCAD COMPONENT 1,2,3 INTO R1,R2,R3
- 26 SPARE
- 27 DISPLAY FIXED MEMORY

- 28 SPARE
- 29 SPARE
- 30 REQUEST EXECUTIVE
- 31 REQUEST WAITLIST
- 32 RECYCLE
- 33 PROCEED
- 34 TERMINATE
- 35 TEST DSKY LIGHTS
- 36 REQUEST FRESH START
- 37 CHANGE PROGRAM
- 38 SPARE
- 39 SPARE

- 4.5.2 EXTENDED VERBS

- 40 ZERO IMU CDU
- 41 COARSE ALIGN CDU (W N20,N91)
- 42 PULSE TORQUE GYRO
- 43 LOAD FDAI ATT ERROR NEEDLES (TEST ONLY)
- 44 REQUEST DOCKED DAP DATA LOAD (R04)
- 45 ACTIVATE DOCKED DAP
- 46 ACTIVATE CSM DAP
- 47 SET OMS STATE VECTOR INTO CSM STATE VECTOR
- 48 REQUEST CSM DAP DATA LOAD (R03)
- 49 START C Ψ -DEFINED MANEUVER (R62)

50 PLEASE PERFORM
51 PLEASE MARK
52 SPARE
53 PLEASE MARK ALTERNATE LOS
54 START RENDEZVOUS BACKUP SIGHTING MARK (R23)
55 INCREMENT CMC TIME (DECIMAL)
56 TERMINATE TRACKING
57 SPECIFY SETTING OF FULL TRACK FLAG
58 RESET STICK FLAG AND SET V50N18 FLA3
59 ENABLE ALL JETS (DOCKED)
60 SET ATTITUDE ERROR REFERENCE TO PRESENT ATTITUDE
61 SELECT MODE 1 (DISPLAY DAP ATTITUDE ERROR)
62 SELECT MODE 2 (DISPLAY TOTAL ATTITUDE ERROR (N22-N20))
63 SELECT MODE 3 (DISPLAY TOTAL ASTRONAUT ATTITUDE ERROR (N17-N20))
64 REQUEST OPTICS ANGLES TRANSFORM (R64)
65 START OPTICAL VERIFICATION OF GYRO COMPASSING (P03)
66 SET CSM STATE VECTOR INTO OMS STATE VECTOR
67 REQUEST W-MATRIX RSS ERROR DISPLAY
68 SPARE
69 RESTART
70 UPDATE LIFTOFF TIME (P27)
71 UNIVERSAL UPDATE-BLOCK ADR (P27)
72 UNIVERSAL UPDATE-SINGLE ADR (P27)
73 UPDATE CMC TIME (OCTAL) (P27)
74 INITIALIZE ERASABLE DUMP VIA DOWNLINK
75 SET LIFTOFF FLAG
76 ENABLE RANGE RATE MARK PROCESSING (R27)
77 DISABLE RANGE RATE MARK PROCESSING (R27)

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- 78 CHANGE GYRO COMPASS LAUNCH AZIMUTH
- 79 SPARE
- 80 UPDATE OMS STATE VECTOR
- 81 UPDATE CSM STATE VECTOR
- 82 REQUEST ORBITAL PARAMETERS DISPLAY (R30)
- 83 REQUEST RENDEZVOUS PARAMETER DISPLAY #1 (R31)
- 84 SPARE
- 85 REQUEST RENDEZVOJS PARAMETER DISPLAY #2 (R34)
- 86 REJECT RENDEZVOUS BACKUP SIGHTING MARK
- 87 SET VHF RANGE FLAG
- 88 RESET VHF RANGE FLAG
- 89 START RENDEZVOUS FINAL ATTITUDE (R63)
- 90 REQUEST RENDEZVOUS OUT-OF-PLANE DISPLAY (R36)
- 91 REQUEST BANKSUM DISPLAY
- 92 SPARE
- 93 ENABLE M-MATRIX INITIALIZATION
- 94 SPARE
- 95 SPARE
- 96 TERMINATE INTEGRATION AND GO TO P00
- 97 THRUST FAIL DISPLAY
- 98 SPARE
- 99 ENABLE ENGINE IGNITION

CHANGE CONTROL NOTES

REV 00 PCR 004,005,006,007,010,040,405,439, PCN 457
REV 01 PCN 489

REV 01 03/20/72 PCR/PCN

489

4.6 THIS LIST REPRESENTS THE NOUNS USED IN PROGRAM SKYLARK.

NOUNS SPECIFIED AS NOT BEING LOADABLE ARE MARKED (NL).

00 NOT IN USE

01 SPECIFY ADDRESS (FRAC)

.XXXXX FRAC
.XXXXX FRAC
.XXXXX FRAC

02 SPECIFY ADDRESS (WHOLE)

XXXXX. INTEG
XXXXX. INTEG
XXXXX. INTEG

03 SPECIFY ADDRESS (DEGREE)

XXX.XX DEG
XXX.XX DEG
XXX.XX DEG

04 ATTITUDE ERROR (NL)

R XXX.XX DEG
P XXX.XX DEG
Y XXX.XX DEG

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05 ANGULAR ERROR/DIFFERENCE SIGHTING ANGLE

XXX.XX DEG
XXX.XX DEG

06 OPTION CODE

OCT
OCT

07 CHANNEL/FLAGWORD/ERASABLE OPERATOR

OCT
OCT
OCT

08 ALARM DATA

OCT
OCT
OCT

09 ALARM CODES

OCT
OCT
OCT

10 CHANNEL TO BE SPECIFIED

OCT

11 TIG (NCC)

00XXX. HRS
000XX. MIN
0XX.XX SEC

12 OPTION CODE

OCT
OCT

13 TIG (NSR)

00XXX. HRS

14	STAR TRACKER AZIMUTH ELEVATION	JJXX. MIN OXX.XX SEC
15	INCREMENT ADDRESS	XXXX. ARC MIN XXXX. ARC MIN OCT
16	TIME OF EVENT (USED BY EXT VERB ON_Y)	JJXX. HRS JJXX. MIN OXX.XX SEC
17	ASTRONAUT TOTAL ATTITUDE (USED IN MODE 3 NEEDLES (V63))	R XXX.XX DEG P XXX.XX DEG Y XXX.XX DEG
18	BALL ANGLES AUTO MANEUVER	R XXX.XX DEG P XXX.XX DEG Y XXX.XX DEG
19	STAR TRACKER AZIMUTH	OCT OCT
20	PRESENT ICDU ANGLES	R XXX.XX DEG P XXX.XX DEG Y XXX.XX DEG
21	PIPAS	X XXXX. PULSES Y XXXX. PULSES Z XXXX. PULSES
22	NEW ICDU ANGLES	R XXX.XX DEG P XXX.XX DEG Y XXX.XX DEG
23	NAV BASE TO ATM DOCKING ANGLES	ALPHA BETA GAMMA XXX.XX DEG XXX.XX DEG XXX.XX DEG
24	DELTA TIME FOR CMC CLOCK	00XX. HRS 00XX. MIN 0XX.XX SEC
25	CHECKLIST (USED WITH V50)	XXXX.
26	PRIO/DELAY,ADRES,BBCDN	OCT OCT OCT
27	SELF TEST ON/JFF SWITCH	XXXX.
28	TIG (NC2)	0JXX. HRS 00XX. MIN JXX.XX SEC
29	XSM LAUNCH AZ	XXX.XX DEG

483

30 TARGET CODE
 (GYROCOMPASSING
 VERIFICATION)
 XXXXX.
 XXXXX.
 XXXXX.

31 TIME OF LAST #--MATRIX REINITIALIZATION
 00XXX. HRS
 000XX. MIN
 0XX.XX SEC

32 TIME FROM PERIGEE
 00XXX. HRS
 000XX. MIN
 0XX.XX SEC

33 TIG
 00XXX. HRS
 000XX. MIN
 0XX.XX SEC

34 TIME OF EVENT
 00XXX. HRS
 000XX. MIN
 0XX.XX SEC

35 TIME FROM EVENT
 00XXX. HRS
 000XX. MIN
 0XX.XX SEC

36 TIME OF CMC CLOCK
 00XXX. HRS
 000XX. MIN
 0XX.XX SEC

37 TIG (TPI)
 00XXX. HRS
 000XX. MIN
 0XX.XX SEC

38 TIME OF STATE VECTOR
 00XXX. HRS
 000XX. MIN
 0XX.XX SEC

39 TIG OF LAST MANEUVER
 00XXX. HRS
 000XX. MIN
 0XX.XX SEC

40 TFI/TFC (NL)
 VG
 DELTA V (ACCUMULATED)
 XXBXX M-S
 XXXX.X FPS
 XXXX.X FPS

41 TARGET AZIMUTH
 TARGET ELEVATION
 TARGET IDENTIFIER (OCTAL PASTE FROM N30)
 XXX.XX DEG
 XX.XXX DEG
 000X

42 APO ALT
 PER ALT
 DELTA V (REQUIRED)
 XXXX.X NM
 XXXX.X NM
 XXXX.X FPS

43 LATITUDE (+ NORTH)
 LONGITUDE (+ EAST)
 ALTITUDE
 XXX.XX DEG
 XXX.XX DEG
 XXXX.X NM

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XXXX.X NM
XXXX.X NM
XXBX M-S

(NL)

44 APO ALT
PER ALT
TFF

489

XXBXX
XXBXX M-S
XXX.XX DEG
/0000X.

(NL)

45 MARKS (VHF-OPTICS)
TFI (NEXT BURN)
MGA/CODE

OCT
OCT

46 DAP CONFIG

XXXXX. LBS
XXXXX. LBS

47 THIS VEHICLE WEIGHT
OTHER VEHICLE WEIGHT

XXX.XX DEG
XXX.XX DEG

48 GIMBAL PITCH TRIM
GIMBAL YAW TRIM

XXX.XX NM
XXXXX.X FPS
0000X.

49 DELTA R
DELTA V
SOURCE CODE

XXXXX.X NM
XXXXX.X NM
XXBX M-S

(NL)

50 SPLERROR
PERIGEE
TFF

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51 SPARE

52 CENTRAL ANGLE OF ACTIVE VEHICLE

XXX.XX DEG

53 RANGE
RANGE RATE
PHI

XXX.XX NM
XXXXX.X FPS
XXX.XX DEG

54 RANGE
RANGE RATE
THETA

XXX.XX NM
XXXXX.X FPS
XXX.XX DEG

55 NN
ELEVATION ANGLE (E)

XXXXX.
XXX.XX DEG

56 VEHICLE RATE (NL)

R X.XXXX DEG/SEC
P X.XXXX DEG/SEC
Y X.XXXX DEG/SEC

489

57 HALFREVS
DELTA H (INCC)
DELTA H (NSR)

XXXXX.
XXXXX.X NM
XXXXX.X NM

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58 DELTA V (TPI)
DELTA V (TPF)
DELTA T (TPI-VDMTP)

XXXXX.X FPS
XXXXX.X FPS
XXBX M-S

489

59 DELTA V LOS 1
DELTA V LOS 2
DELTA V LOS 3

XXXXX.X FPS
XXXXX.X FPS
XXXXX.X FPS

50	G MAX VPRED GAMMA EI (+ UP)	XXX.XX G XXXXX. FPS XXX.XX DEG	
61	IMPACT LATITUDE IMPACT LONGITUDE HEADS UP/DOWN (+ UP)	XXX.XX DEG XXX.XX DEG +/- 00001.	489
62	VI , INERTIAL VEL MAG HDOT , ALT RATE H , ALT ABOVE PAD RADIUS	XXXXX. FPS XXXXX. FPS XXXXX.X NM	
63	RTOGO , RNG FRJM E.I. TO SPLASH (NL) VIO , PREDICTED INERT VEL AT E.I. TFE , TIME FRJM FROM E.I.	XXXX.X NM XXXXX. FPS XXBXX M-S	489
64	G, DRAG ACCELERATION VI , INERTIAL VELOCITY R TO GO (+ OVSHT)	XXX.XX G XXXXX. FPS XXXXX.X NM	
65	SAMPLED CMC TIME (FETCHED IN INTERRUPT)	0000X. HRS 0000X. MIN 0XX.XX SEC	
66	BETA, CMD BANK ANGLE CROSS RANGE ERROR (+ TGT RT) DCWN RANGE ERROR (+ OVSHT)	XXX.XX DEG XXXXX.X NM XXXXX.X NM	
67	R TO GO (+ OVSHT) LAT ,PRESENT POSITION (+ NORTH) LONG ,PRESENT POSITION (+ EAST)	XXXXX.X NM XXX.XX DEG XXX.XX DEG	
68	BETA, CMD BANK ANGLE VI , INERTIAL VELOCITY HDOT ,ALT RATE	XXX.XX DEG XXXXX. FPS XXXXX. FPS	
69	BETA DL VL	XXX.XX DEG XXX.XX G XXXXX. FPS	
70	SIGHTING SOURCE - CELESTIAL BODY CCDE (BEFORE MARK)	OCT	
71	SIGHTING SOURCE - CELESTIAL BODY CCDE (AFTER MARK)	OCT	
72	TIME OF R27 OPTIMIZATION	0000X. HRS 0000X. MIN 0XX.XX SEC	
73	ALTITUDE VELOCITY FLIGHT PATH ANGLE	XXXXXB. NM XXXXX. FPS XXX.XX DEG	
74	BETA, CMD BANK ANGLE VI , INERTIAL VELOCITY	XXX.XX DEG XXXXX. FPS	

75	G + DRAG ACCELERATION DELTA H (NSR) (NL) DELTA T (TPI-YSR) DELTA T (TPI-NOMTPI)	XXX.XX G XXX.X NM XXBXX MIN/SEC XXBXX MIN-SEC	489
76	R27 RANGE (NL) R27 RANGE RATE TIME FROM R27 OPTIM	XXX.XX NM XXX.X FPS XXBXX M-S	489
77	R27 RANGE R27 RANGE RATE R27 THETA/PHI/CODE	XXX.XX NM XXX.X FPS XXX.XX DEG /-00001	489
78	GAMMA RHO CMICRON	XXX.XX DEG XXX.XX DEG XXX.XX DEG	
79	RATE (+ INCREASING CDU) DEADBAND	X.XXX DEG/SEC XXX.XX DEG	489
80	TPI/TFC (NL) VG DELTA V (ACCUMULATED)	XXBXX M-S XXXXX. FPS XXXXX. FPS	
81	DELTA VX (LV) DELTA VY (LV) DELTA VZ (LV)	XXX.X FPS XXX.X FPS XXX.X FPS	
82	DELTA VX (LV) FOR NSR DELTA VY (LV) FOR NSR DELTA VZ (LV) FOR NSR	XXX.X FPS XXX.X FPS XXX.X FPS	
83	DELTA VX (CONT) DELTA VY (CONT) DELTA VZ (CONT)	XXX.X FPS XXX.X FPS XXX.X FPS	
84	DELTA V (NEXT MANEUVER) DELTA H (NEXT MANEUVER) DELTA V (THIRD MANEUVER)	XXX.X FPS XXX.X NM XXX.X FPS	489
85	VGX (CONT) VGY (CONT) VGZ (CONT)	XXX.X FPS XXX.X FPS XXX.X FPS	
86	DELTA VX (LV) DELTA VY (LV) DELTA VZ (LV)	XXX.X FPS XXX.X FPS XXX.X FPS	
87	DCCKED DAP FLAG SPECIFICATION CHANNEL 5 JETS INHIBITED CHANNEL 6 JETS INHIBITED	OCT OCT OCT	
88	PLANET UNIT POSITION VECTOR X Y	.XXXXX .XXXXX	

Z .XXXX

89 DOCKED DAP RATE X.XXXX DEG/SEC
DOCKED GAP DEADBAND XXX.XX DEG

90 REND OUT-OF-PLANE PARAMETERS (P3X) Y CM XXX.XX NM
Y DOT CM XXXX.X FPS
Y DOT OMS XXXX.X FPS

91 PRESENT OCDU ANGLES - SHAFT XXX.XX DEG
- TRUN XX.XXX DEG

92 NEW OCDU ANGLES - SHAFT XXX.XX DEG
- TRUN XX.XXX DEG

93 DELTA GYRO ANGLES X XX.XXX DEG
Y XX.XXX DEG
Z XX.XXX DEG

94 ALTERNATE LOS - SHAFT XXX.XX DEG
- TRUN XX.XXX DEG

95 TIG (NC1) 00XXX. HRS
000XX. MIN
0XX.XX SEC

96 REND OUT-OF-PLANE PARAMETERS Y CM XXX.XX NM
(BY V90E) Y DOT CM XXXX.X FPS
Y DOT OMS XXXX.X FPS

97 SYSTEM TEST INPUTS XXXXX.
XXXXX.
XXXXX.

98 SYSTEM TEST RESULTS AND INPUTS XXXXX.
.XXXXX
XXXXX.

99 RSS VALUE OF POSITION ERROR XXXXX. FT
RSS VALUE OF VELOCITY ERROR XXXX.X FPS
OPTION CODE XXXXX.

CHANGE CONTROL NOTES

REV 00 PCR 010,011,017,018,019,021,032,036,040,400,413,415,420, SLM #2,19
REV 01 PCN 489

4.7 THIS LIST REPRESENTS THE CHECKLIST REFERENCE CODES USED WITH V50N25 FOR PRJ33AM SKYLARK.
REV 00 05/19/71

PCR/PCN

RI CODE ACTION TO BE EFFECTED

00013 PERFORM COARSE ALIGNMENT

00014 PERFORM FINE ALIGNMENT

00015 PERFORM CELESTIAL BODY ACQUISITION

00016 TERMINATE MARK SEQUENCE

00017 PERFORM MINKEY RENDEZVOUS

00020 PERFORM PULSE-TORQUING FOR PLANE CHANGE

00041 SWITCH CM/SM SEPARATION TO UP

00062 KEY CMC TO STANDBY

00204 PERFORM SPS GIMBAL TRIM

SWITCH-DENOTES CHANGE POSITION OF A CONSOLE SWITCH

PERFORM-DENOTES START OR END OF A TASK

KEY IN-DENOTES KEY IN JF DATA THRU THE DSKY

CHANGE CONTROL NOTES

REV 00 PCR 017

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4.8 THIS LIST REPRESENTS THE OPTION CODES USED WITH V04N06 AND V04N12 FOR PROGRAM SKYLARK. REV 00 05/19/71

THE SPECIFIED OPTION CODES WILL BE DISPLAYED IN R1 IN CONJUNCTION WITH FL V04N06 OR FL V04N12 TO REQUEST THE ASTRONAUT TO LOAD INTO R2 THE OPTION HE DESIRES.

PCR/PCN

R1	OPTION	PURPOSE	INPUT FOR R2
	00001	SPECIFY IMU ORIENTATION	1= PREF 2= NOMINAL 3=REFSMAT
	00002	SPECIFY VEHICLE	1=THIS VEHICLE 2=OTHER VEHICLE
	00004	SPECIFY STATE OF TRACKING=FULTKFLG	0=RESET (FULL) 1=SET (PARTIAL)
	00012	SPECIFY P50 OPTION	1=ATM SUN SENSOR 2=ATM SJN SENSOR AND ATM STAR TRACKER 3=ATM ANGLES FROM INDEPENDENT SOURCE
	00013	SPECIFY P55 OPTION	1=CELESTIAL BODY AND IMU ORIENTATION 2=CELESTIAL BODY, OPTICS MARK, AND ATM SOLAR-INERTIAL ATTITUDE
	00024	SPECIFY ASSUMED TRACKING MODE	0=RENDEZVOUS (VECPPOINT) 1=TARGET POINTING (VECPPOINT) 2=ROTATION 4=RENDEZVOUS (3AXIS) 5=TARGET POINTING (3AXIS)

CHANGE CONTROL NOTES

REV 00 PCR 013,016,036,413, PCN 457

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4.9 THIS LIST REPRESENTS THE ALARM CODES USED WITH V05N09 FOR PROGRAM SKYLARK. REV 01 03/20/72

RL	CODE	PURPOSE	SET BY	PCR/PCN
	00107	STAR TRACKER ANGLES OUT OF LIMITS	P55	
	00110	NO MARK SINCE LAST MARK REJECT	SXTMARK	
	00113	NO INBITS	SXTMARK	
	00114	MARK MADE BUT NOT DESIRED	SXTMARK	
	00115	OPTICS TORQUE REQUEST WITH SWITCH NOT AT CMC	EXT VERB OPTICS CDU	
	00116	OPTICS SWITCH ALTERED BEFORE 15 SEC ZERO TIME ELAPSED	T4RUPT	
	00117	OPTICS TORQUE REQUEST WITH OPTICS NOT AVAILABLE (OPTIND=-0)	EXT VERB OPTICS CDU	
	00120	OPTICS TORQUE REQUEST WITH OPTICS NOT ZEROED	T4RUPT	
	00121	CDU'S NOT GOOD AT TIME OF MARK	SXTMARK	
	00205	BAD PIPA READING	SERVICER	
	00206	ZERO ENCODE NOT ALLOWED WITH COARSE ALIGN + GIMBAL LOCK	IMU MODE SWITCH IMU 2	
	00207	ISS TURNON REQUEST NOT PRESENT FOR 90 SEC	T4RUPT	
	00210	IMU NOT OPERATING	IMU MODE SWITCH, IMU 2, R02, P51, P53	
	00211	COARSE ALIGN ERROR-DRIVE >2 DEGREES	IMU MODE SWITCH-1	
	00212	PIPA FAIL BUT PIPA IS NOT BEING USED	IMU MODE SWITCH, T4RUPT	
	00213	IMU NOT OPERATING WITH TJRN-ON REQUEST	T4RUPT	
	00214	PROGRAM USING IMU WHEN TURNED OFF	T4RUPT	
	00217	BAD RETURN FROM STALL ROUTINES	P51, P52, P53, P54	
	00220	IMU NOT ALIGNED (BAD REFSHMT)	R02	
	00401	DESIRED GIMBAL ANGLES YIELD GIMBAL LOCK	INF ALIGN, IMU2, R61	
	00402	ENTER RESPONSE NOT ALLOWED	P52	

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00404	TARGET OUT OF VIEW (TRUN. ANGLE > 90 DEG)	R52
00405	TWO STARS NOT AVAILABLE	P52,P54
00406	RENJ NAVIGATION NOT OPERATING	R23
00421	W-MATRIX OVER FLOW	INTEGRV
00500	NOT ENOUGH JETS FOR SOME PITCH OR YAW ROTATION	DOCKED DAP
00501	NOT ENOUGH JETS FOR SOME ROLL ROTATION	DOCKED DAP
00600	FAILURE IN PHASE MATCH ITERATION	P31,P32
00601	FAILURE IN HEIGHT MANEJVER ITERATION	P31,P32
00602	FAILURE IN OUTER LOOP ITERATION	P31,P32
00603	FAILURE IN QDTP1 ITERATION	P31,P32,P33
00611	NO TIG FOR GIVEN ELEV ANGLE	P34,P35
00777	PIPA FAIL CAUSED THE ISS WARNING	T4RUPT
01102	CMC SELF TEST ERROR	SELF CHECK
01105	DOWNLINK TOO FAST	T4RUPT
01106	UPLINK TOO FAST	T4RUPT
01107	PHASE TABLE FAILURE. ASSJME ERASABLE MEMORY IS DESTROYED	RESTART
01301	ARCSIN-ARCCOS INPUT ANGLE TOO LARGE	INTERPRETER
01407	VG INCREASING	S40.8
01426	IMU UNSATISFACTORY	P61,P62
01427	IMU REVERSED	P61, P62
01520	V37 REQUEST NOT PERMITTED AT THIS TIME	V37
01600	OVERFLJW IN DRIFT TEST	OPT PRE ALIGN CALIB
01601	BAD IMU TORQUE	OPT PRE ALIGN CALIB
01703	INSUFFICIENT TIME FOR INTES., TIG WAS SLIPPED.	R41
03777	ICDU FAIL CAUSED THE ISS WARNING	T4RUPT

04777	ICDJ, PIPA FAILS CAUSED THE ISS WARNING	T4RUPT
07777	IMU FAIL CAUSED THE ISS WARNING	T4RUPT
10777	IMU, PIPA FAILS CAUSED THE ISS WARNING	T4RUPT
13777	IMU, ICDU FAILS CAUSED THE ISS WARNING	T4RUPT
14777	IMU, ICDU, PIPA FAILS CAUSED THE ISS WARNING	T4RUPT
20430	* INTEG. ABORT DUE TO SUBSURFACE S.V.	ALL CALLS TO INTEG.
20607	* NO SOLUTION FROM TIME THETA OR TIME RADIJS ROUTINE	ALL CALLS TO ROUTINE
21204	* NEGATIVE OR ZERO WAITLIST CALL	WAITLIST
21206	* SECOND JOB ATTEMPTS TO GO TO SLEEP VIA KEYBOARD AND DISPLAY PROGRAM	PINBALL
21210	* TWO PROGRAMS USING DEVICE AT SAME TIME	IMU MCDE SWITCH
21302	* SORT CALLED WITH NEGATIVE ARGUMENT	INTERPRETER
21501	* KEYBOARD AND DISPLAY ALARM DURING INTERNAL USE (NVSUB)	PINBALL
21502	* ILLEGAL FLASHING DISPLAY	GOPLAY
21521	* P01 ILLEGALLY SELECTED	P01
31104	* DELAY ROUTINE BUSY	SERVICE ROUTINES
31201	* EXECUTIVE OVERFLOW-NO VAC AREAS	EXEC
31202	* EXECUTIVE OVERFLOW-NO CORE SETS	EXEC
31203	* WAITLIST OVERFLOW-TOO MANY TASKS	WAITLIST
31211	* ILLEGAL INTERRUPT OF EXTENDED VERB	SXTMARK
32000	* DAP JASK STILL IN PROGRESS WHEN NEXT JASK ATTEMPTED	DOCKED DAP
	* INDICATES ABORT TYPE. ALL OTHERS ARE NON-ABORTIVE. 2XXXX INDICATES A GO TO ROUTINE 00 TYPE ABORT (IF EXTENDED VERB ACTIVE OR IF AVERAGE G ON DO BAILOUT TYPE ABORT) 3XXXX INDICATES A BAILOUT TYPE ABORT	489

NOTE: FOR V05 N09 DISPLAYS:
R1-XXXX (FIRST ALARM FOLLOWING ERROR RESET).
R2-XXXX (SECOND ALARM FOLLOWING ERROR RESET).
R3-XXXX (MOST RECENT ALARM)

ERROR RESET WILL SET R1 AND R2 TO ZERO, BUT
NOT AFFECT R3

CHANGE CONTROL NOTES

REV 00 PCR 016,036,448,454, PCN 457
REV 01 PCN 489

SKYLARK 1 (GSOP)

R693

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