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

SECTION 4 OPERATIONAL MODES
(REV. 01)

May 1972

CHARLES STARK DRAPER LABORATORY
CAMBRIDGE, MASSACHUSETTS, 02139
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GUIDANCE SYSTEM OPERATIONS PLAN
FOR MANNED CM EARTH ORBITAL MISSIONS USING PROGRAM SKYLARK 1

SECTION 4 OPERATIONAL MODES
REVISION 01

Signatures appearing on this page designate approval of this document by NASA/MSC.

Approved: Date: 6/9/72
John R. Garman
Section Chief, Guidance Program Section
Manned Spacecraft Center, NASA

Approved: Date: 6/9/72
John E. Williams, Jr.
Chief, Simulation and Flight Software Branch
Manned Spacecraft Center, NASA

Approved: Date: 6/9/72
James C. Stokes, Jr.
Chief, Flight Support Division
Manned Spacecraft Center, NASA
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.

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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 (Revision 01)

This section incorporates the following NASA/MSC approved changes and becomes the control document for SKYLARK 1 (ART REV 72).

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For the computer-printed pages, all changes are indicated in the "PROG CONT" column by + signs bracketing the affected area and by the authorizing PCR/PCN number.
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 Also, Section 6 will not be published for SKYLARK.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 DOWNLINK 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° 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° from its zero position. When MGA exceeds ±85° 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. COS (θ - φ) - 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.

4-8
The standard procedure for a manual keyboard operation consists of a sequence of 7 key depressions:

VERB $V_1$ $V_2$ NOUN $N_1$ $N_2$ 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.
<table>
<thead>
<tr>
<th>ASTRONAUT RESPONSE</th>
<th>DISPLAY OF INFORMATION</th>
<th>REQUEST FOR ASTRO ACTION</th>
<th>REQUEST FOR DATA LOAD</th>
<th>REQUEST FOR OPTICS MARK</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type of information identified by V, N followed by up to three available registers of information, R1, R2, R3,</td>
<td>Request identified V50, V97, V99, or V37,</td>
<td>Request identified by V50 and type of data by N. Loaded data appears in registers R1, R2, R3, at completion, key in &quot;ENTER&quot;.</td>
<td>Request identified by V51 at completion of &quot;MARK&quot;. Identify target (final entry is &quot;ENTER&quot;)</td>
</tr>
<tr>
<td>CMC Awaiting ASTRO Response</td>
<td>CMC Not Awaiting ASTRO</td>
<td>CMC Always Awaiting ASTRO Response</td>
<td>CMC always awaiting ASTRO response</td>
<td>CMC Always Awaiting ASTRO Response</td>
</tr>
<tr>
<td>V_N Flashing</td>
<td>V_N Static</td>
<td></td>
<td>V_N Flashing</td>
<td>V51 Flashing</td>
</tr>
<tr>
<td>Key in &quot;ENTR&quot;</td>
<td>No CMC Action</td>
<td>No CMC Action</td>
<td>CMC assumes ASTRO did not comply, terminates flashing Verb-Noun, and continues</td>
<td>CMC takes loaded data, terminated flashing Verb-Noun and continues</td>
</tr>
<tr>
<td>Key in &quot;PRO&quot;</td>
<td>CMC assumes displayed data is correct, terminates flashing Verb-Noun, and continues</td>
<td>No CMC Action</td>
<td>CMC assumes ASTRO compiled, continues flashing Verb-Noun, and continues</td>
<td>In R23 CMC assumes ASTRO has taken sufficient mark, in R36 response is not accepted</td>
</tr>
<tr>
<td>Key in &quot;Terminate&quot; (V34E)</td>
<td>Varies with program in progress</td>
<td>No CMC Action</td>
<td>Varies with program in progress</td>
<td>Varies with program in process</td>
</tr>
<tr>
<td>Key in &quot;Recycle&quot; (V32E)</td>
<td>CMC returns to earlier point in sequence</td>
<td>No CMC Action</td>
<td>Incorrect Response</td>
<td>Incorrect response</td>
</tr>
<tr>
<td>Press MARK button</td>
<td>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 8 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 R23.</td>
<td>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</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 470μsec. 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
- 4 V Supply < 3.65V
- 14 V Supply > 16 V
- 14 V Supply < 12.5V
- 28 V Supply < -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 (i) 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.

(l) 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) \( \cos(\theta - \phi) \) - 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 operation 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 \(126.3^\circ F \) to \(134.3^\circ F\). 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 \(70^\circ\), the Caution alarm and the Gimbal Lock lamp on the DSKY are actuated. When MGA exceeds \(85^\circ\) 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 DAPDATRI1 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 AxxDx8.

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 Oxx0x. 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

<table>
<thead>
<tr>
<th>A value</th>
<th>Meaning</th>
<th>D value</th>
<th>Meaning</th>
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<tr>
<td>1</td>
<td>G&amp;N control FREE</td>
<td>1</td>
<td>OPTICS Mode CMC</td>
</tr>
<tr>
<td>2</td>
<td>G&amp;N control ATT. HOLD</td>
<td>2</td>
<td>OPTICS Mode ZERO</td>
</tr>
<tr>
<td>3</td>
<td>G&amp;N control AUTO</td>
<td>3</td>
<td>OPTICS Mode MANUAL</td>
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<tr>
<td>5</td>
<td>SCS control FREE</td>
<td>5</td>
<td>OPTICS Mode CMC</td>
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<tr>
<td>6</td>
<td>SCS control ATT. HOLD</td>
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<td>OPTICS Mode ZERO</td>
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<td>7</td>
<td>SCS control AUTO</td>
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Table II

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<th>D value</th>
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<tr>
<td>4.4</td>
<td>AGC Logic/Ground/Crew Interface Diagrams Description</td>
</tr>
</tbody>
</table>

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.
### 4.4.1 THIS LIST REPRESENTS THE PROGRAMS AND Routines DIAGRAMMED IN SECTION 4.4.2 F3R PROGRAM SKYLARK.
REV 00  05/19/71

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* 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 008,009,010,011,014,015,016,017,018,019,021,032,036,040,042,040,045,043, PCN 410,457, SL MEMO #219
CMC IDLING PROGRAM (P00)  

PURPOSE:  
1. To provide a program to fulfill the following requirements:  
   (A) Provide an indication to the crew that the CMC is engaged in no control or computational operations which 
       might require consideration for coordination with other crew tasks in progress.  
   (B) To maintain the GNCs in a condition where manual attitude maneuvers can be made by the crew with 
       minimal concern for the GNCs (see Assumption 2).  
   (C) Maintain the CMC in a condition of readiness for entry into other programs except during state vector 
       extrapolation.  
2. To update the GCM and other state vectors every four time steps.  

ASSUMPTIONS:  
1. The IMU may or may not be on. If on, the IMU is inertially stabilized but not necessarily aligned to an 
   orientation which is known to the CMC.  
2. If non-GNC controlled attitude maneuvers are made by the crew, care must be taken to avoid IMU gimbal lock. 
   The IMU gimbal angles may be monitored by observing the ICUS (V16 N20) or by monitoring the FDI/8 ball.  
3. The program is manually selected by the astronaut by DSKY entry.  
4. This program is automatically selected by V96E, which may be done during any program. State vector integration 
   is permanently inhibited following V96E. Normal integration functions will resume after selection of any program or 
   extended verb. P00 integration will resume when P00 is reselected. Usage of V96E can cause incorrect W-matrix and 
   state vector synchronization.  

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<th>GROUND</th>
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On K00 to start CMC  
IDLING PROGRAM 00  
DISPLAY PROGRAM 00  

KEY IN CMC IDLING PROGRAM (P00)  
V37E 03E  

#10
MONITOR SKY:
OBSERVE DISPLAY OF PROGRAM DD

IS QUIT FLAG SET?

N

Y

RFSET
QUIT
FLAG

SET
NOOFLAG
TO INHIBIT
NEW
PROGRAM
SELECTION.
ACTION

EXTRAPOLATE PERMANENT STATE VECTORS
FORWARD TO PRESENT TIME AS DEFINED IN SECTION 5

RESET NOOFLAG TO PERMIT NEW PROGRAM SELECTION.
INITIALIZATION PROGRAM (P01)

REV 00 05/19/71

PURPOSE:
1. TO INITIALIZE THE PLATFORM FOR THE PRELAUNCH PROGRAMS.
2. TO PROVIDE AN INITIAL STABLE MEMBER ORIENTATION FOR GYRO COMPASSING (P02).

ASSUMPTIONS:
1. THE PROGRAM IS MANUALLY SELECTED BY DSKY ENTRY.
2. ERASABLE LOCATIONS HAVE BEEN PROPERLY INITIALIZED (AZIMUTH, +1: LATITUDE, +1: LAJNCHAZ, +1: IMU COMPENSATION PARAMETERS)

PROG
CONT

CWC

GRUND

CREW

..CREW

.PROGRAM

..SELECTION

..*

---------- DO R00 TO START

.INITIALIZATION

.PROGRAM (P01)

.DISPLAY PROGRAM 01

---------- KEY IN INITIALIZATION PROGRAM (P01)

V3TE01E

----------

MONITOR DSKY:

OBSERVE DISPLAY OF

PROGRAM 01

----------

IS N000P01 FLAG SET?

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.N

.Y

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GYRO COMPASSING PROGRAM (P02)

Purpose:
1. To provide the proper stable member orientation for launch.

Assumptions:
1. This program may be interrupted to perform the optical verification of gyro compassing program (P03).
2. V75 will be keyed in and displayed during this program to permit crew backup of the liftoff discrete.
3. The program is automatically selected by the initialization program (P01).
4. This program has the capability (via V78E) to change launch azimuth of the stable member while gyrocompassing.

<table>
<thead>
<tr>
<th>PROC CONT</th>
<th>GROUN</th>
<th>CREW</th>
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</thead>
<tbody>
<tr>
<td>*AGC</td>
<td>*PGRG</td>
<td>*SELE</td>
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<td></td>
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</tr>
<tr>
<td>START GYRO COMPASSING PROGRAM (P02)</td>
<td>MONITOR USKY:</td>
<td></td>
</tr>
<tr>
<td>DISPLAY PROGRAM 02</td>
<td>OBSERVE DISPLAY OF</td>
<td></td>
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<tr>
<td></td>
<td>PROGRAM 02</td>
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</tbody>
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R3-Blank

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

MONITOR OSKY:
OBSERVE VERB-NOUN
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 V21E AND
LOAD NEW LAUNCH
AZIMUTH

TERMINATE FLASH
UPON RECEIPT OF PRO-
CEED OR NEW DATA

KEY IN PROCEED

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

SET TIMER
CHANGE CONTROL NOTES

- ENTER
- V/5
- SEND NOTIFICATION OF LIFT-OFF
- WAIT FOR NOTIFICATION OF LIFTOFF FROM GROUND
- TERMINATE P32 AND GO TO EARTH ORBIT INSERTION MONITOR PROGRAM (P11)
- MONITOR SKY: IS AGC RECEIPT OF LIFTOFF INDICATED BY DISPLAY OF P11?
  - Y
  - N
  - EXIT P02
- PRESS ENTER TO INITIATE P11
- EXIT P02

#200
#210
#220
#230
OPTICAL VERIFICATION OF GYRO COMPASSING (P03)  REV 00  05/19/71

PURPOSE:  (1) TO PROVIDE AN OPTICAL CHECK FOR VERIFICATION OF ALIGNMENT OF THE STABLE MEMBER OF THE ISS DURING GYRO COMPASSING PRIOR TO LAUNCH.

ASSUMPTIONS:  (1) THE PROGRAM IS MANUALLY SELECTED BY DSKY ENTRY.
(2) THE ASTRONAUT HAS ZEROED THE OPTICS JUST PRIOR TO PROGRAM (P03) SELECTION.
(3) A MINIMUM OF 45 MINUTES BETWEEN V78E AND P03 (V65E) INSURES PROPER DAMPING OF TRANSIENTS.
(4) IN ORDER TO PREMATURELY TERMINATE THIS PROGRAM AND RETURN TO P02 THE ASTRONAUT MAY KEY IN V34E ON ANY FLASHING DISPLAY.

---

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PASTE VJ5N30 AND
THEN V66N41 (DO NOT
OVERWRITE R3)

HOLD
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

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

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

TARGET IDENT-TARGET
IDENTIFIER-IDENTIFIES
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

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

Y N
<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V06 #41</td>
<td>Elevation of Target 2, azimuth and elevation</td>
</tr>
<tr>
<td>R1-TARG AZ</td>
<td>Target azimuth from true north to the target, in degrees to nearest .01 degree</td>
</tr>
<tr>
<td>R2-TARG ELEV</td>
<td>Target elevation from the local horizontal (of nav base) to the target, in degrees to nearest .001 degree</td>
</tr>
<tr>
<td>R3-TARG IDENT</td>
<td>Target identifier identifies azimuth and elevation for target 1 or 2</td>
</tr>
</tbody>
</table>

Wait for keyboard entry

Key in Proceed

Terminate Flash upon receipt of proceed or new data

Key in v21e, v22e, or v24e and load new data

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

Compute LOS to Target number one
AND DRIVE OPTICS,
IF ALLOWED.

FLASH VERB TO
REQUEST PLEASE MARK
V5IN BLANK
R1-BLANK
R2-BLANK
R3-BLANK

(NOTE: YOUN AND R1
WILL NOT BE BLANK IF
ENTERED FROM MARK
REJ. AFTER V5ON25,
R1 = 00316 DISPLAY)

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

SELECT MANUAL OPTICS
MODE

WAIT FOR MARK
TERMINATE FLASH UPON
RECEIPT OF MARK

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

#230

#240

#250

#260

#270
STORE MARK DATA

FLASH VERB-NOUN TO REQUEST PLEASE PERFORM TERMINATE MARK SEQUENCE
V50 N25 R1-00016 R2-BLANK R3-BLANK

MONITOR OSKY: OBSERVE FLASHING VERB-NOUN TO REQUEST PLEASE PERFORM TERMINATE MARK SEQUENCE

WAS SIGHTING SATISFACTORY?

Y
N

WAIT FOR KEYBOARD ENTRY
REJECT
PRESS MARK REJECT BUTTON

TERMINATE FLASH UPON RECEIPT OF PROCEED OR REJECT KEY IN PROCEED

REJECT PROCEED

ERASE LAST SET OF MARK

#280

#290

#300

#310

#320
CALCULATE SM MISALIGNMENT

HOLD - FLASH VERB-NOuN TO REQUEST PROCEED AND SNAP - 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

MONITOR DSKY:
- OBSERVE FLASHING VERB-NOuN AND DISPLAY MISALIGNMENT ANGLES

#430
#440
#450
#460
#470
WAIT FOR KEYBOARD ENTRY

CONFERENCE WITH GROUND, ARE GYRO MISALIGNMENT ANGLES ACCEPTABLE?

N  Y

SHALL I CONTINUE WITH BAD DATA?

N  Y

KEY IN TERMINATE V34E

** ** ** ** EXIT

HAVE I ZEROED THE X AND Y GYRO ERROR?

N  Y

KEY IN V24E AND LOAD R1 AND R2 WITH ZERODES.
TERMINATE FLASH UPON RECEIPT OF TERMINATE OR PROCEED OR NEW DATA

KEY IN PROCEED

P T NEW
R E DATA
O M
E I
D N
T E

STORE NEW DATA

TERMINATE P03 AND REDISPLAY P02. CONTINUE GYRO COMPASSING.

EXIT P03
CMC POWER DOWN PROGRAM (P06)  

REV 00  05/19/71

PURPOSE:  
(1) TO TRANSFER THE CMC FROM THE OPERATE TO THE STANDBY CONDITION.

ASSUMPTIONS:  
(1) WHEN THIS PROGRAM IS TURNED ON THE ASTRONAUT MUST POWER DOWN THE CMC TO STANDBY. HOWEVER, THE PROGRAM IS NOT RESTART PROTECTED.  
(2) THE NORMAL CONDITION OF READINESS OF THE GNCs WHEN NOT IN USE IS STANDBY. ALL THE G/Y CKT BKRS (PANEL 5) ARE CLOSED, THE IMU AND OPTICS G/N POWER SWITCHES (LEB PANEL 100) ARE OFF AND THE CMC STANDBY LIGHT (OSKY) IS ON. IN THIS CONDITION THE IMU IS IN STANDBY WITH ONLY HEATER POWER ON, OPTICS POWER IS OFF AND THE CMC IS IN STANDBY.
(3) A POSSIBLE CONDITION OF READINESS OF THE GNCs WHEN NOT COMPLETELY ON IS THE SAME AS STANDBY (2) ABOVE, EXCEPT THE CMC STANDBY LIGHT ON THE MAIN AND LEB OSKYS IS OFF. IN THIS CONFIGURATION THE CMC IS RUNNING FOR COMPUTATIONAL PURPOSES THAT DO NOT REQUIRE THE IMU OR OPTICS.
(4) IF THE COMPUTER POWER IS SWITCHED OFF IT WILL BE NECESSARY TO PERFORM A COMPUTER FRESH START (V36E) TO INITIALIZE THE ERASABLE STORAGE. THE CMC UPDATE PROGRAM (P27) WOULD HAVE TO BE DONE TO UPDATE THE STATE VECTOR AND COMPUTER CLOCK TIME.
(5) THE CMC IS CAPABLE OF MAINTAINING AN ACCURATE VALUE OF GROUND ELAPSED TIME (GET) FOR ONLY 23 HRS WHEN IN THE STANDBY MODE. IF THE CMC IS NOT BROUGHT OUT OF THE STANDBY CONDITION TO THE RUNNING CONDITION (SEE (3) ABOVE) AT LEAST ONCE WITHIN 23 HOURS THE CMC VALUE OF GET MUST BE UPDATED.
(6) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY OSKY ENTRY.

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<table>
<thead>
<tr>
<th>PROG CONT</th>
<th>CREW PROG</th>
<th>SELECTION</th>
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</thead>
<tbody>
<tr>
<td>CMC</td>
<td>Ground</td>
<td>CREW</td>
</tr>
<tr>
<td>Display Program 06</td>
<td>Key in CMC Power Down Program (P06)</td>
<td>V37E 06E</td>
</tr>
<tr>
<td>Do 800 to start CMC</td>
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<tr>
<td>Power Down</td>
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<tr>
<td>Program (P06)</td>
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SET NODEFLAG

RESET REFSTMAT, DRIFT AND TRACK FLAGS

RESET RENDEZVOUS AND IMUSE FLAGS

RESET UFFLAG

STORE CMC CLOCK TIME.

HOLD REQUEST PLEASE PUT
SNAP CMC IN STANDBY:
  V5J N25
  R1-00062
  R2-BLANK
  R3-BLANK

MONITOR DSKY: OBSERVE DISPLAY
OF PROGRAM 06

MONITOR DSKY: OBSERVE VERB-NOUN
FLASHING TO REQUEST
PLEASE PUT CMC IN
STANDBY:
NOTE: WHEN IT IS DESIRED TO BRING THE CMC FROM STANDBY TO OPERATE THE FOLLOWING PROCEDURES APPLY:

WAIT FOR STANDBY ENTRY

TURN OFF STANDBY LIGHT

CLEAR STANDBY ENABLE DISCRETE.

RELEASE PROCEED (STANDBY) BUTTON

RESET NOFLAG

UPDATE CMC TIME COUNTER
EARTH ORBIT INSERTION INSTRUMENTS (P11)

PURPOSE:
(1) TO INDICATE TO THE ASTRONAUT THAT THE CMC HAS RECEIVED THE LIFTOFF DISCRETE.
(2) TO GENERATE AN ATTITUDE ERROR INDICATION ON THE FOAL ERROR NEEDLES, SCALED FOR THE 50/15/15 SETTING; FROM LIFTOFF TO THE BEGINNING OF PITCHING/ROLLOUT THE ATTITUDE ERROR IS EQUAL TO THE DIFFERENCE BETWEEN THE CURRENT VEHICLE ATTITUDE AND THE ATTITUDE STORED AT LIFTOFF. DURING PITCHING/ROLLOUT THE ATTITUDE ERROR IS EQUAL TO THE DIFFERENCE BETWEEN THE CURRENT VEHICLE ATTITUDE AND THE CMC NOMINAL COMPUTATION OF VEHICLE ATTITUDE BASED ON THE STOKE POLYNOMIALS IN PITCH AND ROLL.
(3) TO DISPLAY CMC COMPUTED TRAJECTORY PARAMETERS.
(4) CMC TAKEOVER OF SATURN DURING BOOST
   (A) AUTOMATIC CONTROL - ALL STAGES:
       SHOULD THE SATURN PLATFORM FAIL (DURING ANY STAGE OF EARTH ORBIT INSERTION) THE ASTRONAUT MAY SET THE LAUNCH VEHICLE GUIDANCE SWITCH FROM IU TO CMC. THIS STORES THE CURRENT ATTITUDE ERRORS AS A BIAS. THE ATTITUDE ERROR ROUTINE FOR EACH CYCLE THEREAFTER WILL COMPUTE THE ATTITUDE ERROR, SUBTRACT THE BIAS, AND TRANSMIT THE DIFFERENCE INFORMATION TO THE SATURN INSTRUMENTATION UNIT (II) FOR STEERING.
   (B) MANUAL CONTROL - SIV-B STAGE ONLY:
       THE ASTRONAUT MAY SELECT THE SATURN STICK FUNCTION VIA V46E (DAH CONFIG = 3). THIS WILL TERMINATE THE ATTITUDE ERROR ROUTINE.

ASSUMPTIONS:
(1) THE PROGRAM IS NORMALLY AUTOMATICALLY SELECTED BY THE GYRO COMPASSING PROGRAM (P02) WHEN THE CMC RECEIVES THE LIFTOFF DISCRETE FROM THE SIV-B. IN THE BACKUP CASE IT WOULD HAVE BEEN SELECTED BY KEYING IN V75 ENTER AS NOTED EARLIER IN P02.
(2) THE ORBITAL PARAMETERS DISPLAY ROUTINE IS AVAILABLE BY KEYING IN V82E.

<table>
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<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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<tr>
<td>CONT</td>
<td>-</td>
<td>CMC PROG</td>
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<td>SELECTION</td>
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<tr>
<td>START EUI MONITOR</td>
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<td>MONITOR OSKY:</td>
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<tr>
<td>PROGRAM (P11)</td>
<td>-</td>
<td>OBSERVE DISPLAY OF</td>
<td></td>
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<tr>
<td>DISPLAY PROGRAM</td>
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<td>PROGRAM II</td>
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<td>II</td>
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P11/SKYLARK
SEND EFFECTIVE TIME
OF LIFTOFF ON
DOWNLINK

---------------------------------

VERIFY AUTOMATIC
START OF DIGITAL
EVENT TIMER

---------------------------------

ZERO GMC CLOCK

---------------------------------

UPDATE EPHEM TO
TIME OF LIFTOFF

---------------------------------

CALL AVERAGE
G INTEGRATION
WITH DELTA V
INTEGRATION

---------------------------------

SET NODJX01
FLAG

---------------------------------

SWITCH TO POWE-
RED FLIGHT DOWN-
LIST

---------------------------------

TERMINATE GYRO-
COMPASSING

---------------------------------
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 ICU DACS WITH PITCH, ROLL, AND YAW ATTITUDE ERRORS DERIVED FROM PRESENT ATTITUDE AND STORED LIFTOFF ATTITUDE UNTIL PRESENT TIME EQUALS T01 (STORED IN ERASABLE MEMORY) AT WHICH TIME THE

MONITOR:

(A) FOAI ATTITUDE ERROR NEEDLES AS INDICATION OF CMC COMPUTATIONS OF INSERTION.

NOTE: DURING A NOMINAL LAUNCH AND AFTER SEPARATION OF THE LET

047
STORED LIFTOFF ATTITUDE IS REPLACED BY THE SOLUTION TO THE STORED 6T4 ORDER PITCH POLYNOMIAL, AND A NULL POLYNOMIAL.

AT TIME TE1 + TE2 (TE2 IS STORED IN ERASABLE MEMORY) SHUT OFF BOOST POLYNOMIAL AND CONTINUE IN ATTITUDE HOLD UNTIL SHUT OFF BY THE SELECTION OF A NEW PROGRAM (V37ExXX), OR THE SATURN STICK FUNCTION (V46Ex).

DURING MODE II, THE ASTRONAUT SHOULD NOTE THE GRADUAL SATURATION OF THE PITCH NEEDLE.

BALL INDICATES INITIAL VEHICLE ROLLOUT AND THEN GRADUAL PITCH-OVER.

(B) DSKY:
R1-VI INCREASING
R2-HDOT FOLLOWS NOMINAL HISTORY
R3-H INCREASING

HOLD

DISPLAY ON DSKY:
V06 V02
R1 - VI
R2 - HDOT
R3 - H

VI-INERTIAL VELOCITY Magnitude, IN FPS TO NEAREST FPS

HDOT - RATE OF CHANGE OF VEHICLE ALTITUDE ABOVE LAUNCH PAD RADIUS, IN FPS TO NEAREST FPS

H-VEHICLE ALTITUDE ABOVE THE LAUNCH PAD RADIUS, IN NAUTICAL MILES TO NEAREST .1 NM

---

VERIFY SATURN SHUT DOWN

---

TERMINATE P11 AND GO TO PROGRAM SELECTED

---

KEY IN V37ExXX
UNIVERSAL TRACKING PROGRAM (P20)

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 OWS WITHOUT CONSTRAINING ROTATION ABOUT VECTOR 
(VECOPT). THIS OPTION IS USED TO ACQUIRE THE OWS IN THE SXT FIELD.

OPTION 1 - POINT SPECIFIED SPACECRAFT VECTOR AT SPECIFIED HEAVENLY BODY WITHOUT CONSTRAINING ROTATION 
ABOUT VECTOR (VECOPT). 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 PIC. THIS OPTION DOES NOT EMPLOY OPTICS DRIVE.

OPTION 4 - POINT SPECIFIED SPACECRAFT VECTOR ALONG LOS TO OWS, ALSO CONSTRAINING ROTATION ABOUT VECTOR 
(3-AXIS). THIS OPTION IS USED TO ACQUIRE THE OWS 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 OWS OR CSM STATE VECTOR (AS SPECIFIED BY THE ASTRONAUT BY OSKY ENTRY) ON THE BASIS OF 
OPTICAL TRACKING DATA AND/OR VHF RANGE DATA (OPTIONS 0 AND 4 ONLY). TO UPDATE THE CSM AND OWS 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 RMC 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-OWS DOCKED) HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM, IN ORDER FOR THE 
GNCS TO PERFORM THE AUTOMATIC ATTITUDE MANEUVERS THE ASTRONAUT SHOULD USE IN V46E (V45E FOR CSM-OWS DOCKED) AT SOME 
TIME PRIOR TO THE FIRST MANEUVER.

(4) THE OWS 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 (P08), CMC POWER 
DOWN PROGRAM (P06), CONTINGENCY VHF RANGE RATE PROGRAM (P25), RENDEZVOUS THRUST MONITOR PROGRAM (P48), OR BY 
V56E. P00000 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 ENHANCES 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 V37EXXE, P00000 AND V56E.

P20/SKYLARK
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, V36E, 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 ROO AND BY V58E. SET BY TAKING RHC OUT OF DETENT WHEN THE 52 CONTROL SWITCH IS CMC AND WHEN THE THC IS NOT SLICKING. CDU RATE DRIVE IS NOT PERFORMED IF THE STICK FLAG IS SET. SET BY RCS DAP WHEN MIDDLE GIMBAL ANGLE IS GREATER THAN 9 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 CSB BY P20 TURN ON AND V88E. SET TO Downs BY V88E.

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

AZIFLAG - SET BY SELECTION OF MINKEY AND P20 (OPTION 4 OR 5) TO CONSTRAINT ATTITUDE ABOUT POINTING VECTOR. RESET BY SELECTION OF P20 (OPTION 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.

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), V36E 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 KEWED INTO THE DSKY AND P20 IS THE ONLY PROGRAM RUNNING, ROUTINE ROO 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 CEREO BY SEVERAL DISTINCT EVENTS, THEY ARE:

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

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

V54E - DO R23 - ALLOWS BACKUP MARKING ON THE OWS.
V57E - ALLOWS CREW TO CHANGE SETTING OF FULL TRACK FLAG.
V58E - RESET STICK FLAG, SET V53N8 FLG - ALLOW AUTO MANEUVERS
V61E - W-MATRIX RSS ERROR DISPLAY
V66E - ENABLE R27 (DURING P20 OPTION 0,4)
V76E - DISABLE R27 (DURING P20 OPTION 0,4)
V8OE - SET STATE VECTOR FLAG TO OWS. DATA WILL UPDATE OWS STATE VECTOR
V8IE - 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 RENVFLG - CAUSE INITIALIZATION OF W-MATRIX FOR RENDEZVOUS AT VFX DATA INCORPORATION

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

<table>
<thead>
<tr>
<th>PROGRAM</th>
<th>COMPATIBLE OPTIONS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER:</td>
<td>0 1 2 4 5</td>
</tr>
<tr>
<td>P21*</td>
<td>X X X X X</td>
</tr>
<tr>
<td>P27</td>
<td>X X X X</td>
</tr>
<tr>
<td>P29*</td>
<td>X X X X X</td>
</tr>
<tr>
<td>P30</td>
<td>X X X X X</td>
</tr>
<tr>
<td>P31-P38</td>
<td>X X X X X X</td>
</tr>
<tr>
<td>P52</td>
<td>X</td>
</tr>
<tr>
<td>P54</td>
<td>X</td>
</tr>
</tbody>
</table>

* 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 R27 OPTIMIZATION (TO)
N76 - R1 - RANGE - VHF RANGE TO OWS IN NAUT. M. 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 NOW TO OPTIMIZATION TIME (n72) IN MIN AND SEC TO NEAREST SEC. THE VALUE IS +59259 IF I3 OPTIMIZATION WAS REQUESTED.

N76 CONTAINS EITHER CURRENT OR CONVERGING VALUES OF RANGE-RATE AS SHOWN IN TABLE BELOW.
**N77**

- **R1** - RANGE
- **R2** - RANGE-RATE
- **R3** - PHI or -00001 - The angle in degrees to nearest .01 degree between the local horizontal and the sextant line-of-sight.

**N77 CONTAINS CURRENT, CONVERGING OR OPTIMIZED VALUES OF RANGE AND RATE. THE ANGLE PHI IS EITHER THE CURRENT ANGLE OR THE ANGLE AT OPTIMIZATION TIME.**

<table>
<thead>
<tr>
<th>TF0</th>
<th>-95 SEC</th>
<th>-20 SEC</th>
<th>+95 SEC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

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### N76 CURRENT

<table>
<thead>
<tr>
<th>R1</th>
<th>RANGE</th>
<th>CONVERGING RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2</td>
<td>RANGE-RATE</td>
<td>CONVERGING RANGE-RATE</td>
</tr>
<tr>
<td>R3</td>
<td>TF0</td>
<td>TF0</td>
</tr>
</tbody>
</table>

### N77 CURRENT

<table>
<thead>
<tr>
<th>R1</th>
<th>RANGE</th>
<th>RANGE AT TD-95</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2</td>
<td>RANGE-RATE</td>
<td>RANGE-RATE AT TD-95</td>
</tr>
<tr>
<td></td>
<td>TF0</td>
<td>TF0</td>
</tr>
</tbody>
</table>

### 489

<table>
<thead>
<tr>
<th>R3</th>
<th>PHI</th>
<th>CURRENT PHI</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHI AT N72 TIME</td>
<td>CURRENT PHI</td>
<td></td>
</tr>
</tbody>
</table>

---

**PROG CONT**

- AUTOMATIC
- PROGRAM
- SELECTION

---

**CNC GROUND CREW**

- CREW
- PROGRAM
- SELECTION

---

**DO ROO TO START**

- KEY IN UNIVERSAL
- TRACKING PROGRAM (P20)
- DISPLAY P20

---

**#10**

---

---
MONITOR DSYS:
OBSERVE DISPLAY
OF P20

ENTRANCE
WHEN
V3TE2OE
IS KEVED
AND WHEN
THE REN-
DEZVOUS
FLAG OR
UTFLAG
IS AL-
READY
SET BUT
WHEN 20
IS NOT
IN THE
MODE
LIGHTS
(SEE
ROD)

GU TO
"F"
BELOW

DO IMU STATUS CHECK
ROUTINE (RO2)

SET DEADBAND TO DAP
DEADBAND
RESET RZ7FLAG

SET STATE VECTOR FLAG TO THE CSM

SET VSON18 FLAG

SET TRACK FLAG

SET ASSUMED OPTION IN R2 = 0.

IS AUTOSEQ FLAG SET?

NO     YES

SET ASSUMED GAMMA, RHO,
AND OMICRON
10 PREFER-
RED VALUES
GAMMA=0.00
DEG
RHO=-35.00
DEG
OMICRON=-
00.00 DEG
--------------------------

....

GO TO
"B"
BELOW

PGSS
HOLD
SNAP
Flash verb-noun to
request response and
display option code
For assumed tracking
mode:
VO4N36
R1 - 00024
R2 - 0000X
R3 - BLANK
R1 is option code
for assumed tracking
mode.

R2 is assumed
option:
0 = Rendezvous
(VECPOINT)
1 = Target point-
ing (VEC-
POINT)
2 = Rotation
4 = Rendezvous

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

IS THIS THE CORRECT
OPTION CODE?

Y N
ANGLES AND Y-AXIS
CONSTRAINT
X - 0
K1 - GAMMA
K2 - RH
R3 -OMICRON
ALL ANGLES IN DEGREES TO NEAREST .01 DEGREE.
REFER TO SECTION 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
0
C
E
D

PRESS
YIELD
SAAP
FLASH VERB-NOUN TO REQUEST RESPONSE AND
DISPLAY ROTATION
PANE AND DEADBAND.

MONITOR SKY
USE VERB-NOUN FLASH TO REQUEST
RESPONSE AND DISPLAY.
V06N79
R1 - RATE
R2 - DEADBAND
RJ - 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

NEW DATA

STORE NEW DATA

IS OPTION = 4 OR 5?

N

Y
RESET RENDEZVOUS
FLAG

IS OPTION = 27

-Y
+Y

GO TO "C"
BELOW

01
POSS

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

R1 - OODE
R2 - BLANK
R3 - BLANK

R1-DE-DESIR ED CELESTIAL BODY CODE
IS THIS THE CORRECT
CODE?

- Y
- N

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
CAT.

NEW

P
PCSS TOLD
SMAP

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY PLANET POSITION VECTOR.
V0XN=3
R1 - X PL
R2 - Y PL
R3 - Z PL

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

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.

STORNE NEW DATA.

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

ARE THE POSITION VECTOR COMPONENTS CORRECT?

Y
N

KEY IN V25E AND LOAD CORRECT POSITION VECTOR COMPONENTS.

NEW DATA

KEY IN PROCEED

064 P20/SKYLARK
(CAS ANI CSN) TO THE PRESENT TIME USING PRECISION INTEGRATION.

SET RENDEZVOUS FLAG

CALL THE RENDEZVOUS TRACKING DATA PROCESSING ROUTINE (R22)

THE RENDEZVOUS TRACKING DATA PROCESSING ROUTINE (R22) IS NOW AUTOMATIC

RLDO P20 (SEE ROJ) CALL POU TYPE INTEGRATION

IS THIS WINKEY SELECTION JF P20?

NO YES
RETURN TO MINKEY
CONT ROLLER ROTI

"F"

IS TRACK FLAG SET?
Y N

IS REFSHMAT FLAG SET?
Y N

SET R61 COUNTER
EQUAL TO ZERO

IS UTFLAG SET?
Y N
GO TO REM BELOW

COMMAND ZERO VEHICLE RATE

IS HOLDFLAG NEGATIVE?

Y N

SET HOLDFLAG ZERO

SET DAP REFERENCE TO DESIRED DAP CDUS

CLEAR R21MARK DEADBAND FLAG

RESET H67 FLAG
START R27 TIME MONITOR

SET R214 MARK FLAG TO ALLOW OPTICS MARKS

DO TRACKING ATTITUDE ROUTINE (R61) WHICH MAY CALL ATTITUDE MANEUVER ROUTINE (R60)

IS THIS A FORCED MANEUVER DURING MINKEY - (PLANE CHANGE OR PLANET)? (PCMANFLG SET?)

NO
YES

RETURN TO MINKEY CONTROLLER (R07)

SET TARGIFLG FOR USE BY AUTO OPTICS
G3 TO CNC
IDLING PROGRAM
(P00) VIA R00
(NOTE: P00 WILL RESET THE RENDEZVOUS,
UTFLAG,
R67FLAG,
R21FLAG,
TRACK, AND UP-DATE FLAGS AND
ALSO TERMINATE THE AUTO OPTICS POSI-
TIONING ROUTINE (R52)
AND THE RENDEZVOUS TRACKING DATA PROCESS-
ING ROUTINE (R22)

RESET
THE REN-
DEZVOUS,
UTFLAG,
R67FLAG,
R21FLAG,
TRACK,
AND UP-
DATE
FLAGS AND TERMINATE THE AUTO OPTICS
POSITIONING ROUTINE (R52)
AND THE
RENEZVOUS TRACKING DATA
PROCESSING ROUTINE (R22).
RESTORE

+01 CAP DB.
+ COMMAND
+ ZERO
+ VEHICLE
+ RATE

**489**

**489**

IS P20 THE ONLY PRO-
GRAM RUNNING?

**489**

**489**

EXIT P20

**489**

**489**

EXIT P20

DO ROUTINE R00

**489**

DO ROUTINE R00

**489**

EXIT P20

**489**

EXIT P20
GROUND TRACK DETERMINATION PROGRAM (P21)

PURPOSE: (1) TO PROVIDE THE ASTRONAUT DETAILS OF HIS GROUND TRACK WITHOUT THE NEED FOR GROUND COMMUNICATION.

ASSUMPTIONS: (1) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

(2) THIS PROGRAM MAY BE SELECTED WHILE THE CSM IS IN EARTH ORBIT TO DEFINE THE GROUND TRACK OF EITHER THE DWS OR CSM.

(3) THIS PROGRAM ASSUMES THE VEHICLE WHOSE GROUND TRACK PARAMETERS ARE CALCULATED TO REMAIN IN FREE FALL FROM THE PRESENT TIME UNTIL T LAT LONG.

<table>
<thead>
<tr>
<th>PROG CONT</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- KEY IN GROUND TRACK DETERMINATION PROGRAM (P21)
- V37E21E

- MONITOR DSKY
- OBSERVE DISPLAY OF PROGRAM 21

- SFT TRACK FLAG
| SET CMC ASSUMED |
| OPTION TO 00001 |

| HOLD     | FLASH VERB-NOUN TO |
| SNAP     | DISPLAY OPTION CODE |
| FOR ASSUMED VEHICLE |
| (OWS OR CSM) |
| V04 V06  | 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 |

| MONITOR SKY: |
| REQUEST RESPONSE AND |
| DISPLAY |
| FLASH TO REQUEST RESPONSE AND DISPLAY |
| OF OPTION CODE FOR ASSUMED VEHICLE |
| (OWS OR CSM) |

| IS THE ASSUMED OPTION CORRECT? |
| "Y" | "N" |

| WAIT FOR KEYBOARD ENTRY |
| KEY IN |
| PROCEED |

| TERMINATE FLASH UPON |
| RECEIPT OF PROCEED OR NEW DATA |
| "P" | "NEW" |
| "R" | "DATA" |
| "G" | "STORE" |
| "E" | "STORE" |

| KEY IN V22E |
| AND LOAD THE DESIRED OPTION INTO R2 |

| 080 | P2/1/SKYLARK |
ZERO T LAT LONG
DISPLAY REGIS-
TERS, R1, R2,
AND R3 WILL
INITIALLY READ
CO000

HOLD
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY T LAT LONG:
Y06 Y34
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.

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

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

N Y

AM I SATISFIED
WITH THE DIS-
PLAYED TIME?

\[ \begin{align*}
\text{N} & \quad \text{Y} \\
\text{ARE ALL THREE REGISTERS EQUAL TO ZERO?} \\
\text{Y} & \quad \text{N}
\end{align*} \]

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF NEW DATA OR PROCEED

\[ \begin{align*}
\text{NEW DATA} & \quad \text{R} \\
\text{STORE} & \quad \text{C} \\
\text{NEW} & \quad \text{E} \\
\text{DATA} & \quad \text{D}
\end{align*} \]

KEY IN V25E AND LOAD NEW DATA.

IS T LAT LONG ZERO?

\[ \begin{align*}
\text{N} & \quad \text{Y} \\
\text{CHANGE T LAT LONG TO PRESENT TIME}
\end{align*} \]
CALCULATE VELOCITY
AND FLIGHT PATH
ANGLE FOR DISPLAY IN
N73 AT ASTRONAUT
REQUEST.------------------

CALCULATE LATITUDE,
LONGITUDE AND ALTITU-
DE OF VEHICLE AT
T LAT LONG

CALCULATE ALTITUDE
FOR DISPLAY IN N73
AT ASTRONAUT
REQUEST.

HOLD

FLASH VERB- NOUN TO
REQUEST RESPONSE AND
DISPLAY LATITUDE,
LONGITUDE AND
ALTITUDE:
VOL N43
R1-LAT
R2-LONG
R3-ALT

LAT-LATITUDE OF
VEHICLE; + IS NORTH,
IN DEGREES TO NEAR-
est .01 DEGREE.

MONITOR SKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF LATITUDE, LONGI-
TUDE AND ALTITUDE

#190

#200

#210

#220

#230
CONTINGENCY VHF RANGE RATE PROGRAM (P25)  
REV 01  03/20/72

PURPOSE:
(1) TO DISPLAY TO THE ASTRONAUT RANGE AND RANGE RATE FROM A SOURCE INDEPENDENT OF THE VEHICLE STATE VECTORS.
(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.
(3) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

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PRECEDING PAGE BLANK NOT FILLED.

---

P25/SKYLARK
TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

KEY IN V25E AND LOAD NEW DATA.

NOTE: IF OPTIMIZATION SEQUENCE ALREADY ESTABLISHED,
CHANGE N72 ONLY WHEN -02825 < TFO < -01935.

STORE NEW DATA

CALCULATE TFO FOR POSSIBLE DISPLAY IN N76.

CALL VHF RANGE RATE MARK PROCESSING ROUTINE [R27]

The VHF range rate mark processing routine is now running. Range and range rate data are from VHF only. They are independent of the state vectors.

IF OPTIMIZATION IS TO BE PERFORMED, A NEW OPTIMIZATION WILL OCCUR AUTOMATICALLY EVERY 4 MIN FOLLOWING THE FIRST.

P25/SKYLARK
IS NOUN 72 ZERO?

NO. YES.

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY RENDEZVOUS
PARAMETERS:
- V16 N76
- R1 - RANGE
- R2 - RANGE RATE
- R3 - TFO

RANGE - VHF RANGE
TO SKYLAB IN
NAUTICAL MILES TO
NEAREST .01 NM.

RANGE RATE - RANGE
RATE BETWEEN CSM AND
SKYLAB CALCULATED
BY VHF RANGE RATE
FILTER IN FPS TO
NEAREST .1 FPS.
NEGATIVE SIGN INDICATES CLOSING.
NOTE: F3R - 01835
< TFO < +01835 RANGE.

RANGE RATE ARE
BEING OPTIMIZED.
OTHERWISE, RANGE,
RANGE RATE ARE
CURRENT VALUES.

TFO - TIME FROM
NOW TO OPTIMIZATION
TIME (N72) IN MIN
AND SEC TO NEAREST SEC. THE VALUE IS +59859 IF NO OPTIMIZATION WAS REQUESTED.

---

DO I WANT TO ALTER THE PRESENT OPTIMIZATION SEQUENCE?

<table>
<thead>
<tr>
<th>No</th>
<th>Yes</th>
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</thead>
</table>

---

WAIT FOR KEYBOARD ENTRY

WHEN FINISHED WITH DISPLAY KEY IN PROCEED.
NOTE: NEXT DISPLAY NOT VALID UNTIL TFO = 00802

---

TERMINATE FLASH UPON RECEIPT OF RECYCLE OR PROCEED

WHEN FINISHED WITH DISPLAY KEY IN RECYCLE V32E

---

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

MONITOR OSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST RESPONSE AND DISPLAY
V16 N77
R1 - RANGE
R2 - RANGE RATE
R3 - THETA/PHI/CODE

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 BY VHF RANGE
RATE FILTER. IN FPS
TO NEAREST .1 FPS;
NEGATIVE SIGN INDIC-
ATES CLOSING.

THETA/PHI/CODE -
USED AS A CODE;
FIXED AT -00001
THROUGHOUT P25.

NOTE: IF R27 OPT=0,
RANGE AND RANGE RATE
ARE CURRENT VALUES.

**
**

IF R27 OPT NOT 0:

TFO < -01835 RANGE;
RANGE RATE ARE
CURRENT VALUES;

-01835 < TFO <
+00802 RANGE;
RANGE RATE FIXED
AT LAST CURRENT
VALUE;

+00802 < TFO <
+01835 RANGE;
RANGE RATE ARE
OPTIMIZING VALUES;

TFO > +01835 RANGE;
RANGE RATE ARE
CURRENT VALUES.
CMC UPDATE PROGRAM (P27)

REV 01 03/20/72

PURPOSE:
(1) TO INSERT INFORMATION INTO THE CMC VIA THE DIGITAL JPLINK BY TRANSMISSION FROM THE GROUND OR VIA THE DSKY KEYBOARD BY CREW MANUAL INPUT.

ASSUMPTIONS:
(1) THE CMC MUST BE IN THE OPERATE CONDITION. THE IUJ MAY BE IN STANDBY OR OPERATE CONDITION.

(2) CMC UPDATES ARE OF PJX CATEGORIES:
    (A) PROVIDE AN UPDATE FOR CMC LIFTOFF TIME (V7J).
    (B) PROVIDE AN UCTAL INCREMENT FOR THE CMC CLOCK ONLY (V73).
    (C) PROVIDE LOAD CAPABILITY FOR A BLOCK OF SEQUENTIAL ERASABLE LOCATIONS 1-16 INCLUSIVE LOCATIONS WHOSE ADDRESS IS SPECIFIED (V71).
    (D) PROVIDE LOAD CAPABILITY FOR 1-9 INCLUSIVE INDIVIDUALLY SPECIFIED ERASABLE LOCATIONS (V72).

(3) A COMPLETE DESCRIPTION OF THE CMC UPLINK FORMAT IS INCLUDED IN SECTION 2 OF R-693.

(4) UPDATE IS ALLOWED IN THE CSM WHEN THE CMC IS IN P00, PJ2, OR P20 (OPTIONS 1, 2, OR 5), AND IF THE DSKY IS AVAILABLE.

(5) THE UPTEL ACCEPT/BLOCK SWITCH MUST BE IN ACCEPT FOR TELEMETRY UPDATE.

(6) THE PROGRAM IS MANUALLY SELECTED BY THE ASTRONAUT BY DSKY ENTRY OR BY THE GROUND BY JPLINK TRANSMISSION.

(7) THE AUTOMATIC MODE OF UPDATE IS PROGRAM SELECTION AND UPDATE VIA THE GROUND BY UPLINK TRANSMISSION. THE ONLY DIFFERENCE BETWEEN THIS AND MANUAL SELECTION BY THE ASTRONAUT IS THAT THE DSKY RESPONSES ARE KEPT IN BY THE ASTRONAUT RATHER THAN TRANSMITTED.

<table>
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<tr>
<td>PROG</td>
<td>CONT</td>
<td></td>
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</tbody>
</table>

| | NOTIFY CREW OF INTENTION TO UPDATE, SPECIFY IFY PARAMETERS AND COORDINATE TIME. | VERIFY THAT UPDATE WILL BE SATISFACTORY | WORK IN | PROGRESS AND CMC ACTIVITY. |
| | | | | |
IS PROGRAM P20, AND IS JTFLAG SET?

YES  NO

IS PROGRAM P00 OR P02 OR ARE PROGRAM LIGHTS BLANKED DUE TO A FRESH START?

Y  N

TURN ON OPERATOR ERROR LITE. TURN OFF UPLINK ACTY LITE.

SELECT UPDATE PROGRAM (P27) DOWNLIST

EXIT

EXIT

IS PROGRAM P23 OPTION 1, 2 OR 3 OPERATING?

N  Y

MONITOR DSKY: IS PROGRAM P00 OR P02 OR ARE THE PROGRAM LIGHTS BLANKED DUE TO A FRESH START?

N  Y

OBSERVE OPERATOR ERROR LITE ON AND UPLINK ACTY LITE OFF.

"P27/SKYLARK"
FCR DOWNLINK TRANSMISSION

DISPLAY PROGRAM 27

IS THIS A TIME INCREMENT UPDATE [V70 OR V73]? 

"N" FROM BELOW SET COMPNUMB 

"Y" FROM BELOW SET COMPNUMB 

FLASH VERB/NOUN TO REQUEST LOAD OF INDEX IN MACHINE ADDRESS SPECIFIED IN POSS R3 AND DISPLAY:

HOLD V21 N31 OBSERVE VERB/

SNAP R1-BLANK NOUN FLASH AND 

R2-BLANK DISPLAY OF

R3-AAAAA AAAAA

AAAAA—MEMORY LOCATION 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 ITSELF.

MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 27

GO TO "A" BELOW

#120

#130

#140

#150
SELF MINIMUM INDEX
IS 3; MAXIMUM IS 20.

WAIT FOR KEYBOARD ENTRY

TRANSFORM TERMINATE
V34E

GO TO "A"
BELOW

TRANSMIT INDEX
VALUE

TERMINATE FLASH UPON RECEIPT OF TERMINATE OR INDEX

GO TO "A" DISPLAY
BELOW INDEX
VALUE IN R1 AS IT IS LOADED

---------

IS INDEX LESS THAN 3 OR GREATER THAN 20?

---------

Y

N

...

GO TO "j" ABOVE

---------

STORE INDEX IN COMPNUMB

---------


---------

CALCULATE ADDRESS FOR STORAGE OF NEXT DATA LOAD

---------

"C" FROM BELOW

---------
**I**.

**J**.

**E**.

**T**.

**D**.

**F**.

**M**.

**A**.

**L**.

**N**.

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**N**.

**A**.
THE TRANSMITTED
WORDS WILL BE
CORRECTED.

------------------

DO I WISH TO
TERMINATE?

------------------

WAIT FOR KEYBOARD
ENTRY

------------------

Y  N

------------------

DO I WISH TO COR-
RECT ANY
DATA?

------------------

Y  N

------------------

TRANSMIT
TERMIN-
ATE V34E

------------------

------------------

GO TO
'A'
BELOW

------------------

TRANSMIT
OCTAL
IDENTIFI-
ER

------------------

------------------

TRANSMIT
PROCEED
V33E

------------------

------------------
TERMINATE FLASH UPON RECEIPT OF TERMINATE, PROCEED, OR XE.

- If X is greater than X, GO TO LESS THAN "A" COMPNUMB?
- Y: N
- ***
- "GO TO "D" ABOVE"
- ***
- "GO TO "C" ABOVE"

- INVERT VERIFLAG
- MONITOR DOWN--LIST THAT PROCEED HAS BEEN SUCCESSFULLY
IS THIS AN OCTAL TIME INCREMENT (V73)?

• Y  • N

WOULD THE INCREMENT CAUSE THE CMC CLOCK TO OVERFLOW?

• Y  • N

TURN ON OPERATOR ERROR LITE

MONITOR OSKY: OBSERVE OPERATOR ERROR LITE

GO TO "A" INCREMENT BELOW CMC CLOCK BELOW

GO TO "A" BELOW

IS ORBITAL INTEGRATION IN PROGRESS?

• Y  • N
GO TO "A" BELOW

INCREMENT TEMP.
AND DECREMENT
STATE VECTOR
TIME TAGS AND
CME CLOCK

GO TO "A" BELOW

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

N
Y

TURN ON OPERATOR ERROR LITE
MONITOR OSKY: OBSERVE OPER
ATOR ERROR LITE
GO TO "A" BELOW

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

WAS THIS A STATE VECTOR UPDATE?

"A" "A" "A"
N Y
FROM ZERO FROM FR34 FROM
ABOVE CHANNEL ABOVE ABOVE

77

TURN OFF UPLINK ACTIVITY

MONITOR DOWNLINK

MONITOR DSKY: SUCCESSFUL UPDATE IS INDICATED BY UPLINK ACTIVITY LITE OUT, OPERATOR ERROR LITE OUT, AND RETURN TO PO2, PO2, OR P20.

CHANGE DOWNLINK LIST TO ORIGINAL

TERMINATION OF P27, AND RETURN TO PO0, PO2, OR P20.

TERMINATE P27 AND GO TO PROGRAM WHICH WAS
**Purpose:**

1. To provide the astronaut estimated time of passage over a selected longitude.

**Assumptions:**

1. The program is selected by the astronaut by DSKY entry.
2. This program may be selected to find the time of longitude of either the OWS or CSM.
3. This program assumes the vehicle whose ground track parameters are calculated to remain in free fall from the selected start time until time of longitude crossing.

<table>
<thead>
<tr>
<th>Program</th>
<th>CMC</th>
<th>Ground</th>
<th>Crew</th>
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</table>

- Do rod to start time of longitude program (P29).
- Display program 29

---

Key in time of longitude program (P29) V37E29E

Monitor DSKY: observe display of program 29

---

"A"

---

*Previous page blank*
WAIT FOR KEYBOARD ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

P NEW
R DATA
O
C STORE
E NEW
D DATA

ZERO BASE TIME DISPLAY REGISTERS RL, R2, AND R3 WILL INITIALLY READ C0000.

HOLD
SNAP

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY BASE TIME: V00 N34

MONITOR DSKY: OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY
R2 = LONG
R3 = BLANK
LONG = DESIRED LONGITUDE OF VEHICLE.
* IS EAST, IN DEGREES TO NEAREST .01 DEGREE.

----
TUDE

----
AM I SATISFIED WITH THE DISPLAYED LONTITUDE?

* Y * N

----
WAIT FOR KEYBOARD ENTRY

----
TERMINATE FLASH UPON RECEIPT OF NEW DATA OR PROCEED

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

----
KEY IN Y22E AND LOAD NEW DATA.

----
COMPUTE TIME TO NEXT CROSSING OF DESIRED
LONGITUDE AFTER BASE TIME.

HOLD  FLASH VERB- NOUN TO REQUEST RESPONSE AND DISPLAY T LAT LONG:
SNAP  VOG 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


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

032E
HOLD * FLASH VERB-NOUN TO
          REQUEST RESPONSE AND
SNAP * DISPLAY LATITUDE,
      LONGITUDE AND
     ALTITUDE:

     V00-4/3
     RL-LAT
     R2-LONG
     R3-ALT

LAT-LATITUDE OF
VEHICLE AT LONGI-
TUDE CROSSING. IS
NORTH, IN DEGREES
TO NEAREST .01 DE-
GREE.

LONG-DESIRED LONGI-
TUDE OF VEHICLE. IS
EAST, IN DEGREES
TO NEAREST .01
DEGREE.

ALT-ALTITUDE OF
VEHICLE AT LONGI-
TUDE CROSSING;
MEASURED ABOVE THE
LAUNCH PAD RADIUS.
IN NAUTICAL MILES
TO NEAREST .1 NM.

---

DO I WISH TO OBTAIN
PARAMETERS FOR A
DIFFERENT BASE TIME
AND LONGITUDE?
N   Y

---

WAIT FOR KEYBOARD
ENTRY

WHEN FINISHED
WITH DISPLAY
KEY IN PROCEED

---

#320

#330

#340

#350

#360

#370
TERMINATE FLASH UPON RECEIPT OF RECYLE OR PROCEED

WHEN FINISHED WITH DISPLAY KEY IN RECYLE V92E

GO TO "A" ABOVE

DO ROUTINE R00

DJ ROUTINE R00

EXIT P29
EXTERNAL DELTA V PROGRAM (P30)

REV 03  05/19/71

PURPOSE:

(1) TO ACCEPT TARGETING PARAMETERS OBTAINED FROM A SOURCE (S) EXTERNAL TO THE CMC AND COMPUTE THEREFROM THE REQUIRED VELOCITY AND OTHER INITIAL CONDITIONS REQUIRED BY THE CMC FOR EXECUTION OF THE DESIRED MANEUVER. THE TARGETING PARAMETERS INSERTED INTO THE CMC ARE THE TIME OF IGNITION (TIG) AND THE IMPULSIVE DELTA V ALONG CSM LOCAL VERTICAL AXES AT TIG.

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

ASSUMPTIONS:

(1) THE TARGET PARAMETERS (TIG AND DELTA VI(V)) MAY HAVE BEEN LOADED FROM THE GROUND DURING A PRIOR EXECUTION OF P27.

(2) THE EXTERNAL DELTA V FLAG IS SET DURING THIS PROGRAM TO DESIGNATE TO THE THRUSTING PROGRAM THAT EXTERNAL DELTA V STEERING IS TO BE USED.

(3) THE ISS NEED NOT BE IN TO COMPLETE THIS PROGRAM.

(4) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

<table>
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<tbody>
<tr>
<td>DO ROG TO START EXTERNAL DELTA V PROGRAM (P30)</td>
<td>-</td>
<td>-</td>
<td>V3TE 3OE</td>
</tr>
<tr>
<td>DISPLAY PROGRAM 30</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

PRECEDING PAGE BLANK NOT FILMED
DELTA Vr (LV):
COMPONENT OF
IMPULSIVE DELTA V AT
TIG ALONG -R, IN FPS
TO NEAREST .1 FPS

WHERE R IS CSM GEO-
CENTRIC RADIUS
VECTOR AND V IS CSM
INERTIAL VELOCITY
VECTOR AT TIG.

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

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

SET EXTERNAL
DELTA V FLAG

RESET UPDATE FLAG
(SEE P20)

KEY IN ProCEED

KEY IN V25E AND
LOAD THE DESIRED
COMPONENTS OF
DELTA V
CASE

FLASH VERB-NOUN TO

REQUEST RESPONSE AND

DISPLAY CALCULATED

THRUSTING PARAMETERS:

V06 N42

R1-APQ ALT

R2-PER ALT

R3-DELTA V

APQ ALT - ALTITUDE

OF APQEE 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.

DELTA V - MAGNITUDE

OF IMPULSIVE DELTA V

VECTOR AT TIG IN FPS

TO NEAREST .1 FPS

NOTE: IF APQ ALT OR

PER ALT EXCEEDS

SCALE; THE DISPLAY

WILL BE 9999.9 NM

MONITOR SKY:

OBSERVE VERB-NOUN

FLASH TO REQUEST

RESPONSE AND DISPLAY

OF CALCULATED

THRUSTING PARAMETERS

IS A GROUND STATION

AVAILABLE FOR CON-

FIRMATION OF THESE

PARAMETERS?
MONITOR CMC
COORDINATE
DOWNLINK TELE-
METRY OF APO
ALT, PEA ALT
AND DELTA V RE-
QUIRED. COORDI-
NATE EVALUATION
OF CMC COMPUTED
PARAMETERS WITH
ASTRONAUT

SELECT ONE OF THE
FOLLOWING FIVE
ALTERNATIVES:

(1) IF THE CALCUL-
LATED DATA IS
SATISFACTORY,
PERFORM THE THRU-
STING MANEUVER
USING THE CMC
CALCULATED PARA-
METERS WITHOUT
GROUND CONFIRMA-
TION.

(2) IF THE CALCUL-
LATED DATA IS NOT
SATISFACTORY AD-
JUST THE CALCUL-
ATED PARAMETERS BY
RESELECTING P30
AS NECESSARY AND
CHANGING THE
LOADED AIM PARA-
METERS UNTIL CMC
COMPUTED PARAMET-
ERS ARE SATISFAC-
TORY. THEN
PERFORM THE THRU-
STING MANEUVER.

(3) REMAIN AT
THIS POINT IN THE
CMC PROGRAM UNTIL
GROUND COORDINA-
TION IS AVAIL-
ABLE.
(4) SELECT A NEW
PROGRAM AS DE-
SIRED UNTIL
GROUND COORDINA-
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.

3  2.1.

4.

5.

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

N  Y.

SELECT ONE OF
THE FOLLOWING
FOUR ALTERNATIVES:
1. Adjust the calculated parameters by reselecting P30 as necessary and changing the loaded aim parameters until CMC computed parameters 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 selecting a new program as desired and perform thrusting maneuver using backup procedures.

Wait for keyboard entry. KEY IN PROGRAM SELECTION AS DESIRED V37E--E
GO TO PROGRAM SELECTED.

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW PROGRAM.

**P** NEW PROGRAM
**R**
**O**
**C**
**E**
**E**
**D**
SELECTED VIA ROUTINE ROO

IS REF*MAT FLAG SET?

**Y**
**N**

EXIT P30

EXIT P30
COMPUTE IMU MID-
DLE GIMBAL ANGLE
AT TIG FOR THE
PRESENT IMU OR-
IEN TATION WITH
THE CSM #2 AXIS
ALIGNED WITH THE
INITIAL THRUST
VECTOR.

SET MGA DISPLAY
IN R3 (BELOW) =
-00002.

HOLD
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY MARK CTRS
TFI AND MGA:
V16 #45
R1-MARK CTRS
R2-TFI
R3-MGA

MARK CTRS - THE NUM-
BER OF MARKS PROCES-
SED BY THE RENDEZ-
VOUS TRACKING DATA
PROCESSING ROUTINE
(R22) SINCE THE LAST
W-MATRIX REINITIAL-
IZATION (REFER TO
ASSUMPTION (8) OF
P20). THE REGISTER
WILL DISPLAY XXXXX
WHERE THE TWO MOST
SIGNIFICANT DIGITS
IS THE VHF RANGING
MARK COUNTER AND
THE TWO LEAST SIGNI-
FICANT DIGITS IS THE
OPTICS MARK COUNTER.
NOTE: THE OPTICS
MARK COUNTER DOES
NOT DISTINGUISH BE-
TWEEN BACKUP AND
PRIMARY MARKS.

TFI - TIME FROM
TIG, IN MIN AND SEC
TO NEAREST SEC.
MAXIMUM READING IS
9999.9. (+ BEFORE
+ AFTER TIG.)

MGA-MIDDLE GIMBAL
ANGLE AT TIG IF
+X CSY 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

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED

PRO
DO ROUTINE P30

(Nota: Considering value of delta v, fuel available, status of propulsion hardware, and time available to realign the IMU to avoid gimbal lock select a propulsion system at this time, -P61- to perform or earlier, the maneuver. Coordinating with ground if required.)

If possible, the astronaut must learn of the system used in MCC commands and data load.

EXIT P30

CHANGE CONTROL NOTES

REV 00 PCN 410,457
NCI TARGETING PROGRAM (P31)  

REV 01 03/20/72

PURPOSE:
(1) TO CALCULATE THE PARAMETERS ASSOCIATED WITH THE NCI 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 NCI MANEUVER FOR APPROVAL
BY THE ASTRONAUT/GROUND.
(4) TO STORE THE NCI 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 NCI, NC2, VCC MANEUVERS ARE CONSTRAINED TO BE HORIZONTAL MANEUVERS.
(3) THE NSR MANEUVER IS CONSTRAINED TO RESULT IN COEILLIPTIC ORBITS FOLLOWING THE MANEUVER.
(4) THE FOLLOWING TIME CONSTRAINTS APPLY:
   A) THE TPI TIME AND THE TIME BETWEEN THE NCC AND NVR MANEUVERS ARE SPECIFIED (DSKY INPUT AND PAD-LOAD
      RESPECTIVELY).
   B) THE TIMES BETWEEN THE NCI 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 CSM 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 ASTRONAUT MAY HOLD AT ANY FLASHING DISPLAY AND TAKE
    OPTICS MARKS AND/OR HE MAY ALLOW VHF RANGING MARKS TO ACCUMULATE. 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).
TERMINATE FLASH UPON RECIPIENT OF PROCEED OR NEW DATA

PRO NEW DATA

STORE DATA

HOLD

FLASH VERB-NOUW TO REQUEST RESPONSE AND DISPLAY STORED HALF-REV, DELTA H(NCC), AND DELTA H(NSR)

V06 V57
R1 - HALFREVS R2 - DELTA H(NCC) R3 - DELTA H(NSR)

HALFREVS - NUMBER OF 1/2 REV'S BETWEEN NC1 AND NC2

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

DELTA H(NSR) - THE ALTITUDE BETWEEN THE ACTIVE AND PASSIVE
BASED ON THE STORED TARGET PARAMETERS, COMPUTE AND STORE THE FOLLOWING PARAMETERS:

TIG(NC2) IN N28
TIG(NCC) IN N11
TIG(NSR) IN N13

++
+01 DELTA VILV1 FOR NC1
++ DELTA VENC21 IN R1
++ DELTA HNC21 IN R2
++ DELTA V(NCC) IN R3
++ DELTA VILV1 FOR NSR
++

IN N81
N84
N84
N84
IN N82

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).

(C) FAILURE IN THE OUTER (PHASE) LOOP ITERATION.
(ALARM CODE 00621).

(D) FAILURE IN THE QDRIPI ITERATION.
(ALARM CODE

---
006031

NO
ALARM

IS THIS ALARM 00002?

Y
N

IS FINAL FLAG SET?

Y
N

SET UPDATE FLAG

"A"

POSS

M0LD

SNAF

---

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

V05 NO9
41-
42-
43-

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

MONITOR DSKY: DOES ALARM CODE INDICATE COMPUTATIONAL DIFFICULTY?

Y
N

DO I WISH TO CONTINUE?

Y
N

---
TERMINATE FLASH UPON RECEIPT OF PROCEED

---

PRO

---

HOLD

---

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY CALCULATED COMPONENTS OF DELTA V(V/LV) FOR NC1:

- V06 481
- R1-DELTA VX(LV)
- R2-DELTA VY(LV)
- R3-DELTA VZ(LV)

DELTA VX(LV) - COMPONENT OF IMPULSIVE DELTA V AT T1(T1C1) ALONG VX, IN FPS TO NEAREST .1 FPS.

DELTA VY(LV) - COMPONENT OF IMPULSIVE DELTA V AT T1(T1C1) ALONG VY, IN FPS TO NEAREST .1 FPS.

DELTA VZ(LV) - COMPONENT OF IMPULSIVE DELTA V AT T1(T1C1) ALONG VZ, IN FPS TO NEAREST .1 FPS.

---

MONITOR DSKY:

---

OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY UP DELTA V(V/LV) FOR NC1

NOTE: N81 VALUES WILL BE ZERO IF PRO WAS KEYED AFTER ALARM 600, 601 OR 623

---

AM I SATISFIED WITH THESE VALUES?

- Y
- N

---

RECORD THESE VALUES

---

P31/SKYLARK
NEAREST -1 FPS.
WHERE R IS CSM GEO-CENTRIC RADIUS VECTOR AND V IS CSM INERTIAL VELOCITY VECTOR AT T(TQ).

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

*PRO NEW DATA

STORE DATA

SET EXTERNAL DELTA V FLAG

*GR

IS FINAL FLAG SET?

.Y .
VI6 N45
R1-MARK COUNTERS
R2-TFI
R3-MGA

MARK COUNTERS - THE
NUMBER OF MARKS PRO-
CESSSED BY THE REN-
DEZVOUS TRACKING
DATA PROCESSING
ROUTINE (R22)

SINCE THE LAST
N-MATRIX REINITIAL-
IZATION (REFER TO
ASSUMPTION B1 OF
P20). THE REGISTER
WILL DISPLAY XBXBX
WHERE THE TWO MOST
SIGNIFICANT DIGITS
COMPOSE THE VHF
RANGING MARK COUNTER
AND THE TWO LEAST
SIGNIFICANT DIGITS
COMPOSE 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 AXES IS
ALIGNED WITH INITIAL
THRUST DIRECTION, IN
DEGREES TO THE
NEAREST .01 DEGREE.
SIGN IS ALWAYS +
EXCEPT:

(A) WHEN DISPLAYED

TFI AND MGA

---

WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

---

Y  N

---

DO I WISH TO
TERMINATE THE
AT ANY TIME
OTHER THAN THE
LAST PASS
THROUGH THE
PROGRAM THE
VALUE IS
-J0001.

(8) CV THE LAST
PASS WHEN THE
140 IS NOT
ALIGNED THE
VALUE IS
-J0002.

------

WAIT FOR KEYBOARD
ENTRY

------

KEY IN
PROCEED

------

KEY IN
PROCEED

------

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

------

PROCEED
RECYCLE

------

RESET UPDATE
FLAG

------

GO TO
"AN"
ABOVE
CHANGE CONTROL VOTES

REV 00  PCR 042,448, PCN 411, SL MEMJ #2
REV 01  PCN 489
NC2 TARGETING PROGRAM (P32)

PURPOSE:
(1) TO CALCULATE PARAMETERS ASSOCIATED WITH THE NC2 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 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 OWS IS SELECTED TO BE A PRESCRIBED ANGLE (E) FROM THE HORIZONTAL PLANE DEFINED AT THE ACTIVE POSITION.
(2) THE NC2 AND NC3 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:
   B) THE TIME BETWEEN THE NC2 AND NC3 MANEUVERS IS INDIRECTLY SPECIFIED BY SPECIFYING THE NUMBER OF REVOLUTIONS INVOLVED IN THE TRANSFER BETWEEN THE MANEUVERS (PAD-LOAD).

++
01
++

(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 ASTRONAUT MAY HOLD AT ANY FLASHING DISPLAY AND TAKE
OPTICS MARKS AND/OR He MAY ALLOW VIF 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 OSKY ENTRY OR INTERNALLY BY THE WINKEY CONTROLLER (R07).
RESET PCFLAG

SET NC12FLG

"START"

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY STORED TIG (NC2):
Y06 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

AM I SATISFIED WITH THIS VALUE?
Y
N

RECORD THIS VALUE
TIG(NCC). SIGN IS +
WHEN THE ACTIVE
VEHICLE IS BELOW THE
PASSIVE VEHICLE, IN
NAUTICAL MILES TO
NEAREST 0.1 NM

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

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
OR NEW DATA.

P NEW
R DATA
D
C
E
E
D STORE DATA

LOAD THE DESIRED
VALUES

#150
#160
#170
#180
#190
RESET FINAL
FLAG

GO TO
"A"
"B"
BELOW

BASED ON THE STORED TARGET PARAMETERS, COMPUTE AND STORE THE FOLLOWING PARAMETERS:
TIG(NCC) IN N11
TIG(NSR) IN N13
DELTA V(ILV) FOR
+01
NC2 IN N81
+ DELTA V(NCC)
+ IN R1 OF N84
+ DELTA V(NSR) RSS
+ IN R3 OF N84
DELTA V(ILV) FOR
MSR IN N82
ESTABLISH ALARM IF:

(A) FAILURE IN
THE PHASE MATCH
ITERATION.
(ALARM CODE
00500)

(B) FAILURE IN
NCC HEIGHT MAN-
EUVER ITERATION
(ALARM CODE
00031)

(C) FAILURE IN
THE METER
(PHASE) L1UP
ITERATION
(ALARM CODE
00002)

(D) FAILURE IN
THE WRITING
ITERATION
(ALARM CODE
00003)

---

N : A
O : L
= A
= R
= L
= N
= R
= N

---

IS THIS ALARM
00002?

---

N : Y

---

IS FINAL FLAG
SET?

---

N : Y

---

SET UPDATE
FLAG

---

"A"

#300

#310

#320

#330

#340
HOLD  FLASH VERB-NOUN
SNAP  TO REQUEST RES-
+ + PONSE AND DISPLAY
DELTA VINCC),
+ + DELTA HINCC), AND
+ + DELTA VINSR):
+ + W0B N04
+ + R1-DELTA VINCC)
+ + R2-DELTA HINCC)
+ + R3-DELTA VINSR)
+ + DELTA VINCC) - 
+ + REQUIRED IMPUL-
+ + SIVE DELTA V TO
+ + ACCOMPLISH NCC
+ + MANEUVER AT
+ + TIG(NCC). IN FPS
+ + TO NEAREST 0.1
+ + FPS
+ + DELTA HINCC) - THE
+ + ALTITUDE BETWEEN
+ + THE ACTIVE AND
+ + PASSIVE VEHICLE
+ + ORBITS AT TIG
+ + (NCC). SIGN IS +
+ + WHEN THE ACTIVE
+ + VEHICLE IS BELOW
+ + THE PASSIVE VEH-
+ +ICLE. IN NAUTICAL
+ + MILES TO NEAREST
+ + 0.1 NM.
+ + DELTA VINSR) - 
+ + RSS OF THE REQU-
+ + IRED IMPULSE
+ + DELTA V TO
+ + ACCOMPLISH THE
+ + NSR MANEUVER AT
+ + TIG(NSR). IN FPS
+ + TO NEAREST 0.1
+ + FPS.

NOTE: TIG(NSR)
PONENTS OF DELTA VILV FOR NC2:
  V0s NB1
  R1-DELTA VX(LV)
  R2-DELTA VY(LV)
  R3-DELTA VZ(LV)

DELTA VX(LV) -
COMPONENT OF IMPULSIVE DELTA V
AT TIG(NC2) ALONG (RXVXR. IN FPS
TO NEAREST .1 FPS.

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

DELTA VZ(LV) -
COMPONENT OF IMPULSIVE DELTA V
AT TIG(NC2) ALONG -Rz. IN FPS TO
NEAREST .1 FPS.

WHERE R IS GSM
GEOCENTRIC RADIUS
VECTR AND V IS
GSM INERTIAL VELOCITY VECTOR AT
TIG(NC2).

---

WAIT FOR KEYBOARD ENTRY

AND DISPLAY OF
DELTA VILV FOR
NC2

NOTE: NB1 VALUES
WILL BE ZERO IF
PRO 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
VILV FOR NC2
COMPONENTS FOR
THE SUBSEQUENT
THRUSTING
MANEUVER.)

---

Y N

---

KEY IN V25E
AND LOAD DESIRED DELTA V VALUES

---

P32/SKYLARK
SET MGA DISPLAY IN R3 (BELOW) = -00001.

IS REFVMAT FLAG SET?

Y N.

COMPUTE IMU MIDDLE GIMBAL ANGLE AT TICX (NC2) FOR THE PRESENT IMU ORIENTATION WITH THE CSM X AXIS ALIGNED WITH THE INITIAL THRUST VECTOR.

SET MGA DISPLAY IN R3 (BELOW) = -00032.

HOLD: FLASH VERB-NOUN TO REQUEST RESPONSE AND MCN: DISPLAY MARK COUNTERS, TFI AND MGA: V16N45

MONITOR DSKY: OBSERVE VERB-NUJN FLASH TO REQUEST RESPONSE AND DISPLAY OF MARK COUNTERS.
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 OUTPUT
REINITIALIZATION
(REFER TO ASSUMPTION
(8) OF P20). THE
REGISTER WILL
DISPLAY XXXXXX
WHERE THE TWO MOST
SIGNIFICANT DIGITS
OF THE VHF RANGING
MARK COUNTER AND THE
TWO LEAST SIGNIFICANT DIGITS
IS THE OPTICS MARK COUNTER.
NOTE: THE OPTICS
MARK COUNTER DOES
NOT DISTINGUISH
BETWEEN BACKUP AND
PRIMARY MARKS.)

TFI - TIME FROM TIG
(ING2), IN MIN AND
SEC TO NEAREST SEC.
MAX READING IS 59.859.
SIGN IS - BEFORE, +
AFTER TIG(ING2).

MGA - MIDDLE GIMBAL
ANGLE AT TIG(ING2)
IF CSSM X AXIS IS
ALIGNED WITH INITIAL
THrust DIRECTION.
IN DEGREES TO NEAREST .01 DEGREE.
SIGN IS ALWAYS +
EXCEPT:
(A) WHEN DISPLAY-

Y   N

---

WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

Y   N

---

DO I WANT TO
TERMINATE THE
MARK PROCESS AND
DO THE FINAL PASS
THROUGH THE
PROGRAM?

Y   N

---

#690

#700

#710

#720
ED AT ANY TIME
OTHER THAN THE
LAST PASS THROUGH
THE PROGRAM THE
VALUE IS -00001

(B) IN THE LAST
PASS WHEN THE IMU
IS NOT ALIGNED
THE VALUE IS
-00032.

----------------------------------

WAIT FOR KEYBOARD ENTRY
----------------------------------

KEY IN PROCEED

----------------------------------

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

KEY IN RECYCLE V32E

G O T O "A" ABOVE

RESET UPDATE
SET71

Y N

CHANGE K-MATRIX
REINITIALIZATION
VALUES TO 2000 F, 2 FPS

DO ROUTINE ROO

EXIT P32

CHANGE CONTROL NOTES

REV 00 PCR 021, 042, 448, SL MEMO #2
REV 01 PCN 489
NCG TARGETING PROGRAM (PJ3)  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 KEPT 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).

(2) NC2 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 UPDATE 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 MINKY CONTROLLER (R07).

PROG CONT  CMC  GROUND  CREW

---

. AUTOMATIC . PROGRAM . SELECTION

---

. CREW . PROGRAM . SELECTION

---

. DO R00 TO START NCG TARGETING PROGRAM (P33)

---

. DISPLAY P33

---

. KEY IN NCG TARGETING PROGRAM (P33)

---

. V37E 33E

---
BASED ON THE STORED
TARGET PARAMETERS,
COMPUTE THE FOLLOW-
ING PARAMETERS:
DELTA V(ILV) FOR NCC
FOR N81
DELTA V(ILV) FOR NSR
FOR N82
STORE DELTA V(ILV)
FOR NSR IN N82.

NOTE: THE COMPUTA-
TIONS INCLUDE THE
OUT-OF-PLANE AT NSR.
THE NEGATIVE OF THE
Y DOT CM IS WRITTEN
INTO R2 OF N82.

ESTABLISH ALARM
IF NO SOLUTION
CAN BE REACHED

IS FINAL FLAG
SET?
FLASH VERB- NOUN
TO REQUEST RES-
PONSE AND DISPLAY
DELTA V(LV) FOR
NSR:

V0S N82
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
(RXV)XR. IN FPS
TO NEAREST .1 FPS

DELTA VY(LV) -
COMPONENT OF IM-
PULSIVE 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
VELOCITY VECTOR
AT TIG(NSR). IN
FPS TO NEAREST
.1 FPS

MONITOR SKY:
OBSERVE VERB-
NOUN FLASH TO RE-
QUEST RESPONSE
AND DISPLAY OF
DELTA V(LV) FOR
NSR.

RECORD THESE
VALUES
DELTA VY(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIGNC1 ALONG
VXR. IN FPS TO
NEAREST .1 FPS

DELTA VZ(LV) -
COMPONENT OF IM-
PULSIVE DELTA V
AT TIGNC1 ALONG
-V. WHERE R IS
CSM GEODETIC
RADIUS VECTOR AND
V IS CSM INERTIAL
VELOCITY VECTOR
AT TIGNC1. IN
FPS TO NEAREST
-.1 FPS

VALUES?
(NOTE: CREW HAS
THE OPTION AT
THIS TIME TO
REDEFINE THE
COMPONENTS FOR
THE SUBSEQUENT
THRUSTING MAN-
EUVER.)

Y    N

KEY IN V25E
AND LOAD DE-
SIERED VALUES

RECORD THESE
VALUES

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA.

P    NEW
R    DATA
D    STORE DATA
C    E    E    D

#470
#480
#490
#500
#510
#520
COMPUTE AND STORE TARGET VECTOR FOR P40/P41.

```

"N"

IS FINAL FLAG SET?

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

```

```

IS REFSTMAT FLAG SET?

```

```

CUMPITE IMU MIDDLE SIMBAL
```
ANGLE AT T1G
(NGC) FOR THE
PRESENT IMU
ORIENTATION
WITH THE CSM
X AXIS ALIGNED WITH THE
INITIAL THRUST VECTORS

SET MGA DISPLAY IN R3
(BELOW) =
-J000Z.

HOLD
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY MARK COUNTERS; TFI AND MGA;
V16N45
R1-MARK COUNTERS
R2-TFI
R3-MGA

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

TFI - TIME FROM TIG (TCC). IN MIN AND SEC TO NEAREST SEC.
MAX READING IS 59859.
SIGN IS - BEFORE + AFTER TIG(NECC).
MGA - MIDDLE Gimbal Angle AT TIG(NECC)
IF GSC X AXIS IS ALIGNED WITH INITIAL THRUST DIRECTION. IN DEGREES TO NEAREST .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) IN THE LAST PASS WHEN THE IMU IS NOT ALIGNED THE VALUE IS -.00032. IN DEGREES TO NEAREST .01 DEGREE

WAS THIS THE LAST PASS THROUGH THE PROGRAM?

Y N.

DO I WISH TO TERMINATE THE PROGRAM?

Y N.

DO THE FINAL PASS THROUGH THE PROGRAM?

Y N.

---

WAIT FOR KEYBOARD ENTRY

KEY IN PROCEED.
KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF PROCEED OR RECYCLE

P R E D C E E

RESET UPDATE FLAG

GO TO "A"
ABOVE

IS FINAL FLAG SET?

Y N

SET FINAL FLAG
RESET UPDATE
FLAG

GO TO
"A"
ABOVE

SET MANEUFNLG

IS THIS MINKEY?
(IS AUTOSEQ FLAG
SET?)

Y
N

CHANGE
W-MATRIX
REINITIALI-
ZATION
VALUES TO
2000 F,
2FPS
NSR TARGETING PROGRAM (P34).

PURPOSE:

(1) TO CALCULATE PARAMETERS ASSOCIATED WITH THE NSR MANEUVER FOR 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 NSR MANEUVER FOR APPROVAL BY THE ASTRONAUT/GROUND.

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

ASSUMPTIONS:

(1) THIS PROGRAM IS BASED UPON PREVIOUS COMPLETION OF THE VC1(P31), VC2(P32), NCC(P33) TARGETING PROGRAMS.

THEREFORE:

(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 (NOW IN STORAGE) FROM THE HORIZONTAL PLANE DEFINED AT THE ACTIVE VEHICLE POSITION.

(B) THE NSR MANEUVER IS ASSUMED TO BE PARALLEL TO THE PLANE OF THE OWS ORBIT. HOWEVER, OUT-OF-PLANE PARAMETERS ARE COMPUTED FOR TIG(NSR) AND ARE AVAILABLE BY KEYING V063N3F AT FL V16 N45 AFTER A COMP CYCLE. IN ADDITION, THE N81 DISPLAY IS MODIFIED TO ESTABLISH AN ANTIODE AT NSR.

(C) C43 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 VVF 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.

(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 (R07).

PROG

CONT

CNC

.GROJH0

.CREW

SELECT

.PROGRAM

.do 900 to START NSR

TARGETING PROGRAM

(p34)

DISPLAY P34

----------

KEY IN NSR TARGET-

1/45 PROGRAM (P34)

V37E 34E

#10

P34/SKYLARK
GO TO
"A"
BELOW

SET EXTERNAL
DELTA V FLAG

BASED ON THE STORED TARGET PARAMETERS, COMPUTE
THE PARAMETERS ASSOCIATED WITH NSR, AS DESCRIBED IN SECTION 5.4 OF R693.
ESTABLISH ALARM IF AJ SOLUTION CAN BE REACHED

POSS

HOLD

SNAP

FLASH VERB-
NOUN TO RE-
JUEST RESPONSE AND DIS-

MONITOR SKY:
DOES ALARM
CODE DISPLAY IN-
DICATE COMPUTATI-
PLAY ALARM
CODE:
V05N09
R1-
R2-
R3-
THE EXPECTED
ALARM AT THIS
TIME IS 00611

DO I WISH TO
READJUST TIG?

---

WAIT FOR KEY-
BOARD ENTRY

---

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
(TITPI-NSR) AND
DELTA
(TITPI-NOTP1)
ARE NOT

---

---
TIG(TPI) AS DE-
FINED IN N37
AFTER PRO TO NL3.
COMPUTED IN
HRS, MINS, AND
SECS OF WHICH
ONLY THE MINS AND
SECS ARE DIS-
PLAYED.

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.

RECORD THESE
VALUES

WAIT FOR KEYBOARD
ENTRY
TERMINATE FLASH
UPON RECEIPT OF
PROCEED

HOLD - FLAS4 VERB-NOUN
TO REQUEST PSE-
PONSE AND DISPLAY
CALCULATED COM-

#320
#330
#340
#350
#360
RECORD THESE VALUES

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA.

"R"

IS FINAL FLAG SET?

SET
MGA
DIS-
PLAY
IN RJ
(BELOW)
= -00001

#420
#430
#440
#450
#460
IS REF5MAT FLAG SET?

Y  N

COMPSTE IMU
MIDDLE GIMBAL
ANGLE AT T1G
(NSR) FOR THE
PRESEN IMU
OMIETATION
WITH THE CSM

* X AXIS ALIGN-
ED WITH THE
INITIAL THRUST
VECTOR

SET MG2 MISC-
PLAY IN R3
(BELLOW) =
-30002.

MOLD:
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY MARK COUNTERS, TFI AND MG2;

MARK COUNTERS - THE
NUMBER OF MARKS PRO-
CENSED BY THE REN-
NEVIOUS TRACKING

MONITOR SKY:

OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF MARK COUNTERS, TFI AND MG2.
DATA PROCESSING
ROUTINE (422)
SINCE LAST W-MATRIX
REINITIALIZATION
REFER TO
ASSUMPTION (B) OF
P20).
THE REGISTER WILL
DISPLAY XXXX WHERE
THE TWO MOST SIGNIF-
ICANT DIGITS IS THE
VHF RANGING MARK
COUNTER AND THE TWO
LEAST SIGNIFICANT
DIGITS IS THE OPTICS
MARK COUNTER.
NOTE: THE OPTICS
MARK COUNTER DOES
NOT DISTINGUISH BE-
TWEEN BACKUP AND
PRIMARY MARKS.)

TFI - TIME FROM TIG
(INSR). IN MIN AND
SEC TO NEAREST SEC.
MAX READING IS 5999.
SIGN IS - BEFORE +
AFTER TIGNSR).

MGA - MIDDLE GIMBAL
ANGLE AT TIGNSR)
IF CSM +X AXIS IS
ALIGNED WITH INITIAL
THRUST DIRECTION, IN
DEGREES TO NEAREST
.01 DEGREE
SIGN IS ALWAYS +
EXCEPT;

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

(b) IN THE LAST
WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

---

.Y N.
---

---

.DO I WISH TO
TERMINATE THE
MARK PROCESS AND
DO THE FINAL PASS
THROUGH THE
PROGRAM?

---

.Y N.
---
PASS WHEN THE IMU IS NOT ALIGNED
THE VALUE IS -300° ±2 IN DEGREES
TO NEAREST .01 DEGREE

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED OR RECYCLE

RESET UPDATE FLAG

GO TO
TPM TARGETING PROGRAM (TPS)

PURPOSE:
1. To calculate the required delta V and other initial conditions required by the CVC for execution of the transfer phase initiation maneuver, given:
   ++
   *01
   [+489
   ++
   (a) Time of ignition TIG (TP1) or the elevation angle (E) of the CSM/OWS LOS at TIG(TP1)
   (b) Central angle of transfer (CENTANG) of 135 degrees from TIG(TP1) to intercept time (TIG(TPI)).
2. To calculate TIG (TP1) given E or E given TIG (TP1).
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. All computations 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 the thrusting maneuver at a time.
2. If P23 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 VMF ranging marks to accumulate. However, if the update flag is not set, the marks would not be incorporated or accumulated. See P23 for detailed description.
3. Once the parameters required for computation of the maneuver have been completely specified, the value of the actual vehicle central angle of transfer is computed and stored. This number will be available for display to the astronaut through the use of V06952.
4. 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 of the angle i.e. within this zone the astronaut should reassess the input targeting parameters based upon delta V and expected maneuver time.
5. When determining the initial position and velocity of the target at intercept time, either conic or precision integration may be used.
6. 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 - SELECTS PROGRAM WHICH DESIGNATES THAT LAMBERT STEERING IS REQUIRED FOR EXECUTION OF THIS MANEUVER BY THE THRUSTING PROGRAM SELECTED AFTER COMPLETION OF THIS PROGRAM.
7. There is no requirement for ISS operation to perform this program.
8. This program is selected by the astronaut by DSKY entry or internally by the computers controller (ROC).
9. The delta V in LOS coordinates (N59) is available at FL V16 N45 after each computation cycle.

SIGN  CVC  GROUND  CREW
INTEGRATION TO DETERMINE THE INITIAL POSITION AND VELOCITY OF THE TARGET AT INTERCEPT TIME. WHEN NEEDED USE THE INDICATED NUMBER OF OFFSETS.

E-ELEVATION ANGLE BETWEEN THE CSM/WDS LOS AND THE CSM LOCAL HORIZONTAL AT TIG(TPI) REFERENCED TO THE DIRECTION OF FLIGHT (SEE SECTION 5.4 OF AO93 FOR DETAILED DESCRIPTION). FROM 0 TO 360 IN DEGREES TO NEAREST .01 DEGREE.

WAIT FOR KEYBOARD ENTRY

MAKE THE TARGETING CALCULATIONS USING CONIC 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
THE DESIRED DATA

RECORD THESE VALUES.

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

D NEW DATA
R DATA
C STORE DATA
E
D

RESET COMP E FLAG

IS E SPECIFIED TO BE +00000?

Y
N.

SET COMP E FLAG

#210

#220

#230

#240

#250
RESERVED FINAL FLAG

GO TO "A"
BELOW

"A"

DID I SPECIFY E TO BE *00000?

IS COMPAO E FLAG SET?

COMPUTE E FOR SPECIFIED TIGETPIJ

PCSS

OLD

SNAP

FLASH VERB-
NOUN TO RE-
QUEST RESPONSE
AND DISPLAY
CALCULATED E:
V06 N95
R1-NN
R2-E
R3-GLANK

NOTE: FOR DE-
TIG(TPI):
VOGN3T
R1-TIG(TPI)
-MS
R2-TIG(TPI)
-MNS
R3-TIG(TPI)
-SECS.

(Note: For definition see above.)

---

RESPOND 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

---

Wait for key-
board entry

Terminate
flash upon
receipt of
proceed.

---

PRO

---

Is this minkey?
(is autoed)
flag set?

---

Y  N

---

Is final flag
set?

---

Y  N

---

242
P35/SKYLARK
METERS ASSOCIATED WITH TPI AND TPF AS DESCRIBED IN SECTION 3.4 OF R693.

------

USING PRECISION INTEGRATION AND MINIMUM OFFSETS COMPUTE THE PARAMETERS ASSOCIATED WITH TPI AND TPF AS DESCRIBED IN SECTION 3.4 OF R693.

------

RESET EXTERNAL DELTA V FLAG

------

POSS

MOLD

SNAP

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

MUNITOR DSKY:

OBSERVE VERB-

NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF CALCULATED DELTA

------
DELTA (TPI-NOM-TPI):
  V00N58
  R1-DELTA V(TPI)
  R2-DELTA V(TPFI)
  R3-DELTA (TPI-NOMTPI)

DELTA V(TPI) - REQUIRED IMPULSIVE
DELTA V TO ACCOMPLISH TPI MANEUVER AT TIG(TPI).
IN FPS TO NEAREST .1 FPS.

DELTA V(TPFI) - REQUIRED IMPULSIVE
DELTA V TO ACCOMPLISH TPF MANEUVER AT TIME OF
INTERCEPT. IN FPS TO NEAREST .1 FPS.

** +01
**
**
**
**
**
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**
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**
**
**
**

TIG(TPI) AS DEFINED 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.

RECORD THESE VALUES

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH

KEY IN PROCEED
UPON RECEIPT OF
PROCEED

IS FINAL FLAG
SET?

SET TPIMNFLG.

SET UP DATE
FLAG
(SEE P20)

POSS
HOLD

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

SNAP

MONITOR OSKY:
OBSERVE
VERB-NOUN
FLASH TO RE-
QUEST RES-
01 COMPONENTS OF DELTA V(LV)
  FDR TPI:
  V06N91
  R1-DELTA VXX(LV)
  R2-DELTA VY(LV)
  R3-DELTA VZ(LV)
  DELTA VX(LV) - COMPONENT OF IMPULSIVE DELTA V AT T1G(TPI) ALONG (4XVX) IN FPS TO NEAREST .1 FPS.
  DELTA VY(LV) - COMPONENT OF IMPULSIVE DELTA V AT T1G(TPI) ALONG VX, IN FPS TO NEAREST .1 FPS.
  DELTA VZ(LV) - COMPONENT OF IMPULSIVE DELTA V AT T1G(TPI) ALONG VX, IN FPS TO NEAREST .1 FPS.

WHERE R IS THE CSM GEOCENTRIC RADIUS VECTOR AND V IS THE CSM INERTIAL VELOCITY VECTOR AT T1G(TPI).

PULSE AND DISPLAY OF DELTA V(LV) FOR TPI

---------

AM I SATISFIED WITH THESE VALUES? (NOTE: CREW HAS THE OPTION AT THIS TIME TO REDEFINE THE DELTA V(LV) COMPONENTS FOR THE SUBSEQUENT THRUSTING MANEUVER. THIS CAPABILITY WILL NORMALLY BE EXERCISED TO CORRECT OUT OF PLANE-NESS BY FIRST SELECTING THE RENDEZVOUS OUT-OF-PLANE DISPLAY ROUTINE (RJ6) (VY0E), AND THEN MODIFYING DELTA VY(LV).)

Y N.

---------

#640

#650

#660

#670

#680
WAIT FOR KEYBOARD ENTRY

KEY IN W2YE AND LOAD THE DESIRED VALUES

RECORD THESE VALUES

TERMINATE

FLASH UPON RECEIPT OF PROCEED OR NEW DATA

P NEW
R DATA
O
G STORE DATA
E
D
N Y

WAS NEW DATA LOADED?
(TPI) FOR THE
PRESENT IMU
DIRECTION
WITH THIS VE-
HICLE'S M
AXIS ALIGNED
WITH THE
INITIAL
THRU T VECTOR

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

HOLD

FLASH VERB- NOUN TO
REQUEST RESPONSE AND
DISPLAY MARK CTRs
TFI AND MGA;
VL6W6
R1 = MARK CTRs
R2 = TFI
R3 = MGA

MARK CTRs - THE NUM-
BER OF MARKS PROCES-
SED BY THE RENDEZ-
VOUS TRACKING DATA
PROCESSING ROUTINE
(R22) SINCE LAST
W-MATRIX REINI-
TIALIZATION (REFER
TO ASSUMPTION #8 OF
P20). THE REGISTER
WILL DISPLAY XXXXXX
WHERE THE TWO MOST
SIGNIFICANT DIGITS
IS THE VHF RANGING
MARK COUNTER AND THE
TWO LEAST SIGNIFICANT DIGITS IS THE OPTICS MARK COUNTER.
NOTE: THE OPTICS MARK COUNTER DOES NOT DISTINGUISH BETWEEN BACKUP AND PRIMARY MARKS.

TFI-TIME FROM TIG(TPI)* IN MIN AND SEC TO NEAREST SEC.
MAX READING IS 5959.
SIGN IS BEFORE * AFTER TIG(TPI).

MGA-MIDDLE GIMBAL ANGLE AT TIG(TPI) IF CSM* X AXIS IS ALIGNED WITH INITIAL THRUST DIRECTION.
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 -0003.
IN DEGREES TO THE NEAREST .01 DEGREES.

WAS THIS THE LAST PASS THROUGH THE PROGRAM?

_________________________ ____________________________
Y N

_________________________ ____________________________
DO I WISH TO TERMINATE THE MARKING PROCESS AND DO THE FINAL PASS THROUGH THE PROGRAM?

_________________________ ____________________________
Y N

_________________________ ____________________________
WAIT FOR KEYBOARD ENTRY PROCEED.
RESET UPDATE
FLAG

GO TO
"A"
ABOVE

SET MANEUFGL

IS THIS MINKEY?
(IS AUTOSQ FLAG
SET?)

\[ Y \]
\[ N \]

CHANGE X-MATRIX
REINITIALIZATION
VALUES TO 2000 FOR
2FPS

DC ROUTINE R00

UU ROUTINE R00

EXIT P35
TPM TARGETING PROGRAM (P36)

REV 00 05/19/71

PURPOSE:
1. To calculate the required delta V and other initial conditions required by the CMC for CSM execution of the next midcourse correction of the transfer phase of an active CSM rendezvous.

ASSUMPTIONS:
1. If P2) 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 the 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).
2. 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 input targeting parameters based upon delta V and expected maneuver time.

3. The operation of this program utilizes the following flags:

- 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.
- Final flag - selects final program display after crew has selected the final maneuver computation cycle.

4. The time of intercept (TINT) was defined by previous completion of the TPI TARGETING PROGRAM (P35) and is presently available in CMC storage.

5. The delta V in LV Coordinates is available in N41.

6. There is no requirement for ISS operation to perform this program.

7. The program is selected by the astronaut by OSK oder entry or internally by the Minkey controller (RO7).

<table>
<thead>
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<th>PROG CMNT</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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<td>AUTOMATIC</td>
<td>PROGRAM</td>
<td>SELECTION</td>
<td>CREW</td>
</tr>
<tr>
<td>90 RAD TO START TPM</td>
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</tr>
<tr>
<td>TARGETING PROGRAM (P36)</td>
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</tr>
<tr>
<td>DISPLAY PROGRAM 36.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

KEY IN TPM TARGETING PROGRAM (P36) V37E 35E

#10

P36/SKYLARK
"HI

RFLW

*

*

---------

RESET UPDATE FLAG
---------

*

---------

DEFINE TIG(TPM) =
T + "A" MINUTES
WHERE;

"A" WILL BE
STORED IN FIXED
MEMORY (3 MIN).
---------

---------

EXTRAPOLATE CSM
AND JWS STATE VECTORIZATION TO TIG(TPM)
USING PRECISION
INTEGRATION.
---------

---------

IS NY = 0?
AS SPECIFIED BY
P35
---------

4

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*
USING CIRCULAR INTEGRATION AND OFFSETS CALCULATE THE REQUIRED VELOCITY FOR THE MID-COURSE CORRECTION

USING PRECISION INTEGRATION AND OFFSETS CALCULATE THE REQUIRED VELOCITY FOR THE MID-COURSE CORRECTION

RESET EXTERNAL DELTA V FLAG

IS FINAL FLAG SET?
POSS
MOLD
SNAP

SET P35FLAG

SET UPDATE
FLAG

FLASHER
NO: TO REQ-
UEST RESPONSE
AND DISPLAY
CALCULATED
COMPONENTS
OF
DELTA V LOS:
V06959
R1-DELTA V
LOS 1
R2-DELTA V
LOS 2
R3-DELTA V
LOS 3

DELTA V LOS -
LINE OF SIGHT
COMPONENTS IN
FPS TO YEAR-
EST .1 FPS
IF FOR DEFINI-
TION SEEK
SECT 5.4
J.P.693)

MONITOR
OSKY:
OBSERVE
VERB-NOUN
FLASH TO
REQUEST RE-
SPONSE AND
DISPLAY OF
DELTA V LOS

AM I SATIS-
FIED WITH
THESE
VALUES?
(NOTE: CREW
HAS THE OPA-
TION AT
THIS TIME
TO REDEFINE
THE COM-
ONENTS FOR
THE SUBSE-
QUENT

P36/SKYLARK
THRUSTING MANEUVER.

WAIT FOR KEYPAD ENTRY

KEY IN

V25E

AND

LUAD

THE DESIRED

DELTAV

VALUES.

RECORD THESE VALUES

TERMINATE

FLASH UPON RECEIPT OF PROCEED OR

NEW DATA

NEW DATA

PROCEED.
SET YGA DISPLAY IN K3(BELOW) = -00011.

----------
IS REF?W HAT FLAG SET?
----------
Y  N

----------
COMPUTE IMU MIDDLE GIMBAL ANGLE AT TIP (TPM) FOR THE PRESENT IMU ORIENTATION WITH THE CSM. X AXIS ALIGNED WITH THE INITIAL THRUST VECTOR.

----------
SET YGA DISPLAY IN K3 (BELOW) = -00032.

----------
FLASH VERB-ADJ TO MONITOR display:
MONITOR DISPLAY:
MONITOR VERB-ADJ TO DISPLAY OF MARKERS AND TFI AND YGA:

----------
MONITOR VERB-ADJ TO DISPLAY OF MARKERS AND TFI AND YGA:
MONITOR VERB-ADJ TO DISPLAY OF MARKERS AND TFI AND YGA:

#310
#320
#330
#340
#350
VlNHS
RI-MARK CTRS
R2-TFI
R3-MGA

MARK CTRS - THE
NUMBER OF MARKS PRO-
CESSION BY THE RENO-
EZVOS TRACKING DATA
PROCESSING ROUTINE
(R22) SINCE THE LAST
W-MATRIX REINITIAL-
IZATION.
(REFER TO ASSUMPTION
@) OF P201.
THE REGISTER WILL
DISPLAY XXXXX WHERE
THESO MOST SIGNIF-
ICANT DIGITS IS THE
VHF RANGING MARK
COUNTER AND THE TWO
LEAST SIGNIFICANT
DIGITS IS THE OPTICS
MARK COUNTER.

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

TFI-TIME FROM TIG
(TPM) IN MIN AND SEC
TO NEAREST SEC. MAX
READING IS 59959.
SIGN IS - BEFORE +
AFTER TIG(TPM).

MGA-MIDDLE GIMBAL
ANGLE AT TIG(TPM) IF
CSM X AXIS IS ALI-
NED WITH INITIAL
THRUST DIRECTION.
SIGN IS ALWAYS +
EXCEPT:

(A) WHEN DISPLAYED
AT ANY TIME

WAS THIS THE LAST
PASS THROUGH THE
PROGRAM?

Y  N

DO I WISH TO
TERMENATE THE
MARK PROCESS AND
DO THE FINAL PASS
THROUGH THE PRO-
GRAM?

Y  N
OTHER THAN THE
LAST PASS THROUGH
THE PROGRAM THE
THE VALUE IS
-1000001

(II) IN THE LAST
PASS WHEN THE IMU
IS NOT ALIGNED
THE VALUE IS
30000 DEGREES
TO THE
NEAREST .01
DEGREES.

-----------------------------------------------

WAIT FOR KEYBOARD
ENTRY

-----------------------------------------------

KEY IN
PROCEED

-----------------------------------------------

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

-----------------------------------------------

KEY IN RECYCLE
V32E

-----------------------------------------------

R E
C Y
L E
A

GO TO
"A"
ABOVE

-----------------------------------------------
KNEEZE VUS FINAL PHASE PROGRAM (P37)

PURPOSE:
1. To establish x-axis tracking (P20), with rho and gamma = 0 deg.
2. To select R31, intervally to provide range and range rate information prior to the braking phase of rendezvous.

ASSUMPTIONS:
1. This program is selected by the astronaut by DSKY entry or by the Minkey controller.

<table>
<thead>
<tr>
<th>PROC CONT</th>
<th>CWC</th>
<th>GROUND</th>
<th>CREW</th>
</tr>
</thead>
</table>
|            | AUTOMATIC
|            | PROGRAM
|            | SELECTION
|            | ***
| ---       | ---   | ---    | ***
| DO R30 TO START
| RENDEZVOUS FINAL PHASE PROGRAM (P37)
| DISPLAY P37
|            | KEY IN RENDEZVOUS FINAL PHASE PROGRAM (P37)
|            | V37E 37E
|            | ***
|            | ***
|            | ***
|            | ***
|            | ***
|            | ***
|            | ***
|            | ***
|            | ***
|            | ***
|            | ***
|            | ***
|            | ***

#10

#20

#30
CHANGE CONTROL NOTES

REV 00  PCR J16, SL XP40 #2
REV 01  PCR 489
PLANE CHANGE TARGETING PROGRAM (P38)

**PURPOSE:**
1. To calculate parameters associated with the plane change (PC) maneuver for delta V burns.
2. To calculate these parameters based on 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 PC maneuver for approval by astronaut/ground.
4. To store the PC target parameters for use by the desired thrusting program.

**ASSUMPTIONS:**
1. This program assumes a stored TIG from the last maneuver, an uplinked TIG or TIG crew-loaded in N39.
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 update 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 by the minkey controller (ROT).
6. This program is normally used to target a plane change burn 90 degrees central angle from the last maneuver.

<table>
<thead>
<tr>
<th>PROC CONT</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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<tbody>
<tr>
<td>AUTOMATIC</td>
<td>CREW</td>
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<td>*PROGRAM</td>
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<td>DD 000 TO START</td>
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<tr>
<td>PLANE CHANGE</td>
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<tr>
<td>TARGETING PROGRAM</td>
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<td>(P38)</td>
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<tr>
<td>DISPLAY PROGRAM 38</td>
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</tbody>
</table>

**#10**
MONITOR DSKY:
OBSERVE DISPLAY OF
PROGRAM 38

"START"

SET TRACK AND UPDATE
FLAGS

SET PCFLAG

RESET FINAL
FLAG

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY LAST TIC:
VJ6 439

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
#120

**COMPUTE THE TIME 1/4 PERIOD FROM THE TIME IN N39 AND STORE IN N33**

**+01 HOLD**

**SNAP**

- FLASH VERB-NOU N TO REQUEST RESPONSE AND DISPLAY COMPUTED TIG FOR PC:
  - VO6 = 43
  - R1-TIG = HRS
  - R2-TIG = MIN
  - R3-TIG = SECS

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

- AM I SATISFIED WITH THIS VALUE?
  - Y

- RECORD THIS VALUE

- WAIT FOR KEYBOARD ENTRY

- KEY IN PROCEED

#140

**MONITOR SKY**

- OBSERVE VERB-NOU N FLASH TO REQUEST RESPONSE AND DISPLAY OF COMPUTED TIG FOR PC, COMPUTED TO OCCUR 90 DEGREES AFTER LAST TIG.

#150

**#160**

**GO TO**
TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA...

**P**
**R**
**C**
**E**
**S**
**D**

GO TO "80" RFLOW

**A**

RESET UPDATE FLAG

COMPUTE OUT-OF-PLANE PARAMETERS AS DESCRIBED IN SECTION
**SOLVE DELTA V AT TIG**
**FOR PC ALONG**
**(RXVXR). IN FPS TO**
**NEAREST .1 FPS.**

**DELTA Y(LO) -**
**COMPONENT OF IMPUL-
SIVE DELTA V AT**
**TIG FOR PC ALONG XKR.**
**IN FPS TO NEAREST**
**.1 FPS.**

**DELTA Z(LO) -**
**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 UPON**
**RECEIPT OF PROCEED**
**OR NEW DATA.**

**PROCEED WITH**
**DATA**

**STRIKE NEW**
**DATA**

---

**AM I SATISFIED WITH**
**THESE VALUES?**

**Y**

**RECORD THESE**
**VALUES**

---

**KEY IN PROCEED**

**KEY IN V22F AND**
**LOAD DESIRED**
**DELTA V VALUE.**

**NOTE: OVERWRITING**
**AI, R2, R3 WITH 0**
**DURING MINKEY**
**SEQUENCE WILL**
**CAUSE EVIENCE**
**INTO PS2 FOLLOW-
**ING P38 TO BE**
**BYPASSED.**

**IF NBI = 0,0,0**
**LATER VIA THE**
I-N

[IN R3
(BELLOH
= -00002
-------

HOLD
-----
FLASH VERB-NUON TO
REQUEST RESPONSE AND
DISPLAY MARK
COUNTERS, TFI AND
MGA:
V16 N#5
R1-MARK COUNTERS
R2-TFI
R3-MGA

MARK COUNTERS - THE
NUMBER OF MARKS
PROCESSED BY THE
RENDEZVOUS TRACKING
DATA PROCESSING
ROUTINE ( #22) SINCE
THE LAST M-MATRIX
REINITIALIZATION.
THE REGISTER WILL
DISPLAY XXBX WHERE
THE TWO MOST SIGN-
IFICANT DIGITS COM-
PRIS THE VHF RAN-
GING MARK COUNTER
AND THE TWO LEAST
SIGNIFICANT DIGITS
COMPRISE THE OPTICS
MARK COUNTER.
(Note: The optics
Mark counter does
NOT DISTINGUISH BE-
TWEEN BACKUP AND
PRIMARY MARKS.)

TFI-TIME FROM TIG(PCI)
IN MIN AND SEC TO
NEAREST SEC. MAX
READING IS 59899.
SIGN IS - BEFORE,
+ AFTER TIG(0C).
MGA-MIDDLE GIMBAL
ANGLE AT TIG(0C) IF
COS +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.

WAIT FOR KEYBOARD
ENTRY

---------------------

KEY IN PROCEED

---------------------

KEY IN PROCEED

---------------------

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

---------------------

PROCEED

---------------------

RECYCLE

---------------------

GO TO

---------------------

GO TO
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, if 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 off 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 cannot be completed on time.

6. The SPS thrusting program does not monitor the SG 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 FSD attitude error needle commands until the CMC solution indicates engine JEF 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 V06E at some time prior to the attitude maneuver.

8. P40 should not be performed in the CSM-OWS ducky 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 S turn on by keying in V09B1.

10. The orbital parameters display routine (R30) may be called during this program by keying in V02E.
(11) THE CMC ISSUES AN SIV-B CUTOFF COMMAND (CHANNEL 12 3IT 14) FOR POSSIBLE BACK-UP USE.

THIS SIGNAL IS RECOGNIZED BY SATURA 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 V16N33 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 (R37).

<table>
<thead>
<tr>
<th>PROG</th>
<th>GROUND</th>
<th>CREW</th>
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<td>AUTOMATIC</td>
<td>CREW PROG</td>
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<tr>
<td>DO R00 TO START SPS</td>
<td>KEY IN SPS</td>
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<tr>
<td>PROGRAM (P40)</td>
<td>PROGRAM (P40)</td>
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<tr>
<td>DISPLAY PROGRAM 40</td>
<td>V37E 40E</td>
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<tr>
<td>SET SBFLG</td>
<td>MONITOR DSKY:</td>
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<td>OBSERVE DISPLAY OF</td>
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<td></td>
<td>PROGRAM 40</td>
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</table>
FROM INITIAL THRUST
DIRECTION AND ENGINE
BELL TRIM ANGLES
COMPUTE PREFERRED
IMU ORIENTATION:

\[
\begin{align*}
X &= \text{UNIT}\ (X) \\
  &= -S4 -CSM \\
Y &= \text{UNIT}\ (X \times R) \\
  &= -S4 -CSM - \\
Z &= \text{UNIT}\ (X \times Y) \\
  &= -S4 -SM -S4
\end{align*}
\]

WHERE:

\[
X = \text{THE CSM X AXIS} \\
-\text{CSM AT IGNITION} \\
\text{(AT THE PREFERRED VEHICLE ATTITUDE)}
\]

\[
R = \text{THE CSM POSITION RADIUS} \\
\text{VECTOR AT TIG.}
\]

STORE DESIRED ATTITUDE SPECIFICATION
(TRIMMED ENGINE BELL CENTER LINE IN DIRECTION OF INITIAL
THRU XT) FOR USE BY ATTITUDE MANEUVER
ROUTINE (R6)). THE FINAL ATTITUDE WILL
# 110

Routine (602)
Do attitude maneuver

# 160

# 190

# 140

# 130

Routine (602)
Do attitude maneuver

Reset 2D display

Deadband in CGS and set 9 degree

Orientation flag
Set prepared

Pitch final attitude
Be level in the com
Tod, MRSD may not
Correction flag all-
RCS fuel and not
In order 1, compensate
Thrust direction
In the initial
Trimmed engine defl
And will point the
Print out this 609
Of completed tac.
IN DEGREES.

WAIT 4 SECONDS

DRIVE SPS ENGINE BELL TO TRIM POSITION

TEMP HOLD DISPLAY ON DSky:

MON

VF1 - VF2 R1 - VF1 R2 - VF2 R3 - DELTA VM

TF1 - TIME FROM SPS IGNITION, IN MIN, SEC TO NEAREST SEC, MAX READING 159859, (SIGN IS BEFORE Nominal TIG, # THEREAFTER).

VF - MAGNITUDE OF THE VELOCITY TO BE GAINED BY THRUSTING MANEUVER, IN FPS TO NEAREST .1 FPS

OBSERVE DIAL INDICATION OF ENGINE BELL DRIVING TO TRIM POSITION

MONITOR DSky:

OBSERVE DISPLAY OF TF1, VF, AND DELTA VM.
DELTA V4 MEASURED
DELTA V MAGNITUDE IN FPS TO NEAREST .1 FPS. THIS DISPLAY SHOULD BE GUARDED UNTIL AVERAGE G IS STARTED.

SET TOE = TIG
-30 SEC

DO STATE VECTOR INTEGRATION (MID TO AVE) ROUTINE (R41).

WAIT UNTIL TFI = -35 SEC

BLANK DISPLAY OF VERB-NCJN AND R1, R2, R3 AT TFI = -35

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

REDISPLAY V06M4O NON-FLASHING AND CALL AVERAGE G ROUTINE.

WAIT UNTIL TFI = -30 SEC

RESET PREFERRED ORIENTATION FLAG

MONITOR DSKY:
OBSERVE REDISPLAY OF TFI, VG, DELTA VM.
AT TFI = -30 SEC,
TO INDICATE THAT THE AVERAGE G ROUTINE IS TURNED ON. OBSERVE THAT THE COMPUTER ACTIVITY LIGHT BLINKS ON EVERY 2 SECONDS DURING AVERAGE G.

MONITOR DSKY:
IN THE PERIOD FROM TFI = -30 SEC UNTIL TFI = -25 SEC DOES DELTA VM BECOME GREATER THAN 2.0 FPS INDICATING EXCESSIVE
PIPA BIAS ERROR?
---------
N Y

IS THIS BURN TO BE IMPULSIVE?
---------
N Y

IS BURN TIME > 1?
---------
N Y

RESET SBFLAG

IS SBFLAG SET?
---------
N Y

INITIALIZE COMPLEX IMPULSIVE BURN INPUTS

COMMAND X ULLAGE TRANSLATION USING THC WHEN INDICATED BY CHECKLIST

GO TO BACKUP PROCEDURES

#370
#380
#390
#400
#410
STORE BURN TIME

OBSERVE ULLAGE BUILD UP IN R3.

CHANGE VERB BUT RETAIN PRESENT NOUN AND DISPLAYS IN R1, R2, R3; FLASH VERB-NOUN TO REQUEST PLEASE PERFORM ENGINE ON ENABLE: V99 N40 R1 - TFI R2 - VG R3 - JELTA VM

WAIT FOR KEYBOARD ENTRY

CALL I PERMIT IGNITION OR RE-IGNITION?

* Y

* * * * * * *

KEY IN PROCEED

* * *

* *

SHALL I ATTEMPT TO COMPLETE THE
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<tr>
<td>TURN OFF ALL (CHANNEL 5)</td>
<td>TURN OFF ALL (CHANNEL 5)</td>
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<tr>
<td>RCS TRANSLATION</td>
<td>RCS TRANSLATION</td>
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<tr>
<td>CALL CROSS PRODUCT STEERING ROUTINE AS DESCRIBED IN SECTION 5.3 OF THIS DOCUMENT.</td>
<td>CALL CROSS PRODUCT STEERING ROUTINES</td>
</tr>
<tr>
<td>NOTE: IF AT ANY TIME DURING THE THRUSTING PERIOD THE ROUTINE DETECTS A &quot;THRUST FAILURE&quot; IT WILL CEASE STEERING (RATE COMMAND SET TO ZERO), WILL STOP CALCULATING TIME FROM CUT OFF AND WILL DISABLE C.G. TRACKING. IT WILL TURN ON THE SPS THRUST FAIL ROUTINE (P40).</td>
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ALARM LIGHT AND
STORE ALARM CODE
1407.

- THRUST
- "THRU"!
- "OK"
- "FAIL"!

- DO THE SPS THRUST
- FAIL ROUTINE
- (R40).

- MONITOR SPS
- THRUSTING:
- "R1-TFC"
- SHOULD BE
- DECREASING

- TEMP
- HOLD
- CHANGE TFI DISPLAY
- TO TFC IN R1
- MON
- "V06 N40"
- "R1 - TFC"
- "R2 - VG"
- "R3 - DELTA VM"

- TFC - TIME FROM
- ENGINE CUTOFF.
- IN MIN AND SEC TO
- NEAREST SEC
- MINUS BEFORE CUTOFF

- MONITOR DSKY:
- OBSERVE CHANGE OF
- TFI DISPLAY TO TFC
- IN R1

- #660
- #670
- #680
- #690
- #700
<table>
<thead>
<tr>
<th>R2-WE SHOULD BE DECREASING</th>
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<tbody>
<tr>
<td>H3-DELTA VA SHOULD INCREASE</td>
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</table>

2. FDAI-AT: ERROR SHOULD BE LESS THAN 0.5 DEGREE TO DEGREE OR EQUAL TO -- DEGREE/SEC. 

3. SPR GUMMER PRESSURE SHOULD BE NORMAL 

## Monitor DSKY: 

- AS TVC AND VG PO TO ZERO THROTTLE SHOULD STOP 

- Go to backup procedures
CMC TERMINATES ENGINE 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 #693)

WAIT ABOUT 2.5 SECONDS

SET WIDE DEADBAND IN RCS DAP

TURN OFF TVC DAP AND DISABLE TVC INTERFACE
FREEZE TFC AT CURRENT VALUE (WILL NORMALLY SHOWN +2 SECONDS)

WAIT ABOUT 0.6 SEC

TURN RCS OAP ON AND WAIT ABOUT 1 SEC FOR JET FIRINGS.

MOVE MAIN PANEL DELTA V THRUST NORMAL A+B SWITCHES TO OFF.

MAINTAIN VG COMPUTATIONS AFTER CUTOFF FOR POSSIBLE NULLING BY RCS TRIMMING MANEUVER
SET MINIMUM DEADBAND IN RCS GAP

+01

FLASH VERB-NOU TO
REQUEST RESPONSE AND
DISPLAY:
- VI6 485
- RL-VGX(CONT)
- RZ-VGY(CONT)
- R3-VGZ(CONT)
- VGX(CONT), VGY(CONT),
  VGZ(CONT) -
  COMPONENTS OF THE
  VG VECTOR RESOLVED
  ALONG THE PRESENT
  CSM X, Y, AND Z CON-
  TROL AXES. THE VG
  VECTOR WILL BE UP-
  DATED BY THE STEER-
  ING LOOP DURING
  EACH COMPUTATION
  +409
  CYCLE.
  IN FPS TO THE
  NEAREST .1 FPS.

MONITOR SKY:
OBSERVE VERB-NOU
FLASH TO REQUEST RE-
SPONSE AND DISPLAY
OF VG COMPONENTS.

TO NULL OUT VG COM-
PONENTS COMMAND MAN-
UAL TRANSLATIONS AND
ROTATIONS. (NOTE:
THIS MANEUVER IS AT
THE OPTION OF THE
CREW).
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 PS2.
(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-OWS DOCKED) HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM. IN ORDER FOR THE GNCS TO PERFORM THE ATTITUDE MANEUVER AND MAINTAIN ATTITUDE CONTROL THE ASTRONAUT MUST KEY IN V46E (V45E IF CSM-OWS 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 NOUN 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 V16443 FOR MINS-SECS (R1), OR V16435 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).
CONT

* AUTOMATIC PROGRAM * CREW PROGRAM
* SELECTION * SELECTION

---

DO ROO TO START RCS PROGRAM [P41]
DISPLAY PROGRAM 41

---

KEY IN RCS PROGRAM (P41)
V37E 41E

---

MONITOR DSKY:
OBSERVE DISPLAY OF PROGRAM 41

---

SET CSTEER = 0.

---

DO IMU STATUS CHECK ROUTINE [R02]

---

DO IMU STATUS CHECK ROUTINE [R02]

---

COMPUTE INITIAL THRUST DIRECTION AND INITIAL VALUE OF VG VECTOR AND STORE IN

---

#10

---

#20

---

#30

---

#40
NOUN 81 (VG LOCAL VERTICAL)

--------------------------------------
* *
* *
* *
--------------------------------------

COMPUTE PREFERRED IMU ORIENTATION:

X = UNIT (T)
-SM -

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

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

WHERE:
T = INITIAL THRUST VECTOR
R = THE CSM POSITION
T = RADIUS VECTOR AT TIG

--------------------------------------
* *
* *
* *

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

SET PREFERRED ORIENTATION FLAG

IS DOCKED DAP RUNNING?

Y

SET DOCKED DEADBAND INTO DOCKED DAP

SET MINIMUM DEADBAND IN RCS DAP

RESET 3AXISFLG
COMPLETION OF ROUTINE 41.

WAIT UNTIL TFI = -35 SEC

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

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

WAIT UNTIL TFI = -30 SEC

RESET PREFERRED ORIENTATION FLAG

CALL AVERAGE G INTEGRATION AND VG UPDATE (INSTANTANEOUS VG VECTOR).

#200

#210

#220

#230

#240
DISPLAY V16NB5 NON-FLASING AND DISPLAY THE VALUES OF VG IN CONTROL AXIS COMPUTED FOR THE PRESENT TIME (NOT TIG) UPDATED EVERY TWO SECONDS.

WAIT UNTIL TFI= ZERO

HOLD FLASH VERB-NOUN TO REQUEST RESPONSE AND
MON: V16NB5 +01 R1-VGX(CONT) + R2-VGY(CONT) + R3-VGZ(CONT) + VGX(CONT), VGY(CONT) VGZ(CONT) - COMPONENTS 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 DURING EACH COMPUTATION CYCLE. IN FPS TO

MONITOR DSKY: OBSERVE DISPLAY OF VG IN CONTROL AXIS AT TFI = 30 SEC. THE AVERAGE G ROUTINE IS TURNED ON, OBSERVE COMPUTER ACTIVITY LIGHT BLINKS ON EVERY 2 SECONDS DURING AVERAGE G.
THUST MONITOR PROGRAM (P47)

REV 01 03/20/72

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 USUALLY 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 V02E.
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  GROUND  CREW

---
DO 00 TO START
THUST MONITOR -----------
PROGRAM (P47) -----------
DISPLAY P47.

---

#10

KEY IN THRUST MONITOR PROGRAM (P47) V37E47E
MONITOR DSky: OBSERVE DISPLAY OF PROGRAM 47.

DO IMU STATUS CHECK ROUTINE (RO2)

DO STATE VECTOR INTEGRATION (MID TO AVE) ROUTINE (R41).

CALL AVERAGE G ROUTINE.

++ 0

+ HOLD - FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY DELTA V (CONT)
+ V16483
+ R1-DELTA VX (CONT)
+ R2-DELTA VY (CONT)
+ R3-DELTA VZ (CONT)

MONITOR DSky: OBSERVE FLASHING VERB-NOUN TO REQUEST RESPONSE AND DISPLAY OF EACH COMPONENT OF DELTA V (CONT).
DELTA VX (CONT) - COMPONENT OF INTEGRATED ACCELERATION ALONG CSM CONTROL +X AXIS.
IN FPS TO NEAREST .1 FPS.

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

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

NOTE1: R1, R2, AND R3 WILL READ 00000 INITIALLY AND WILL REMAIN 0 (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 FOAI BALL TO AVOID GIMBAL LOCK

#70

#80

#90

#100

#110
WAIT FOR KEYBOARD ENTRY

SHALL I ZERO THE DISPLAY IN ORDER TO MONITOR ANOTHER BURN?

N  Y

KEY IN RECYCLE V32E

TERMINATE FLASH UPON RECEIPT OF PROCEED OR RECYCLE

RECYCLE PROCEED

REINITIALIZE ACCEL
RENDEZVOUS THRUST MONITOR PROGRAM (P48)  REV 01 03/20/72

PURPOSE:

1. TO DISPLAY TO THE ASTRONAUT RANGE AND RANGE RATE FROM A SOURCE INDEPENDENT OF VEHICLE STATE VECTORS.
2. TO DISPLAY CMC CALCULATED PARAMETER THETA.
3. TO ALLOW THE ASTRONAUT TO SELECT A FOUR-MINUTE SEQUENCE OF TIMES FOR WHICH THE RANGE RATE WILL BE OPTIMIZED.
4. TO MONITOR VEHICLE ACCELERATION DURING A NON-GCMS CONTROLLED THRUSTING MANEUVER.
5. TO DISPLAY THE DELTA V APPLIED TO THE VEHICLE BY THIS THRUSTING MANEUVER.

ASSUMPTIONS:

1. THE VHF MUST BE OPERATING.
2. IT IS NORMALLY REQUIRED THAT THE ISS BE ON FOR 15 MINUTES PRIOR TO A THRUSTING MANEUVER.
3. THE RESPONSIBILITY OF AVOIDING GIMBAL LOCK DURING EXECUTION OF THIS PROGRAM IS UPON THE ASTRONAUT.
4. RANGE, RANGE RATE, AND PHI (COMPUTED FROM STATE VECTORS) MAY BE DISPLAYED BY CALLING R34 WITH V85E.
5. THE ORBIT PARAMETER DISPLAY ROUTINE MAY BE CALLED DURING THIS PROGRAM BY KEYING IN V82E.
6. THIS PROGRAM IS NORMALLY USED DURING RENDEZVOUS FINAL PHASE.
7. THIS PROGRAM SHOULD BE TURNED ON A FEW MINUTES PRIOR TO THE PLANNED THRUSTING MANEUVER TO ALLOW R27 CONVERGENCE AND TERMINATED AS SOON AS POSSIBLE FOLLOWING THE MANEUVER IN ORDER TO KEEP IMJ COMPESSATION AND AVERAGE G COMPUTATION ERRORS AT A MINIMUM.
8. *X OR -X TRANSLATION IS ASSUMED TO OCCUR ONLY ALONG THE LINE-OF-SIGHT TO THE ISS.
9. NO *X OR -X TRANSLATION SHOULD BE PERFORMED DURING AN OPTIMIZATION.
10. THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY OR INTERNALLY BY MOUSE CONTROLLER (ROT).
DO ROO TO START RENDEZVOUS THRUST MONITOR PROGRAM (P48).
DISPLAY P48.

DO IMU STATUS CHECK ROUTINE (R02)

KEY IN RENDEZVOUS THRUST MONITOR PROGRAM (P48).
V37E4BE

MORATOR 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.

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

DO IMU STATUS CHECK ROUTINE (R02)

#10
#20
#30
#40
#50
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.

CALCULATE TFD FOR POSSIBLE DISPLAY IN N76.

CALL AVERAGE-G ROUTINE

IS CYCLFLAG SET?

N

Y

CALL VHF RANGE RATE MARK PROCESSING ROUTINE (R27)

THE VHF RANGE RATE MARK PROCESSING ROUTINE IS NOW RUNNING. RANGE AND RANGE RATE DATA ARE FROM VHF ONLY. THEY ARE INDEPENDENT OF THE STATE VECTORS.
HOLD REQUEST VERB-NOU N TO DISPLAY RENDEZVOUS PARAMETERS:
V16 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
191 (AND OPTIMIZED TO N72 TIME IF IN
191 OPTIMIZATION OPTION)
291 BY VHF RANGE RATE FILTER, IN FPS TO
291 NEAREST .1 FPS NEGATIVE SIGN INDICATES CLOSING.

THETA - ANGLE BE-
291TWEEN CSM #1 AXIS AND THE LOCAL HORIZONTAL PLANE.
419 FROM 0 TO 360 DEG-
291REES, IN DEGREES TO NEAREST .01 DEGREE.
NOTE: IF R27 OPT = 0, RANGE,
RANGE RATE AND THETA ARE CURRENT VALUES.

IF 27 UPT NOT 3:

**01
TFD < -01835 RANGE,
RANGE RATE ARE CURRENT VALUES;
-01835 < TFD < +03802 RANGE,
RANGE RATE FIXED AT LAST CURRENT VALUE;
+03802 < TFD < +01835 RANGE,
RANGE RATE ARE OPTIMIZING VALUES;
**459
TFD < -00920:
THETA IS CURRENT VALUE;
-00920 < TFD < +00920: THETA = -00001
TFD > +03802:
THETA IS OPTIMIZED VALUE.

DO I WANT TO ALTER THE PRESENT N12 TIME?

**01
WAIT FOR KEYBOARD ENTRY

WHEN FINISHED WITH DISPLAY KEY IN PROCEED

**300
KEY IN V25N72E
AND LOAD
DESIRED N72
TIME.

TERMINATE FLASH UPON
RECEIPT OF RECYCLE
OR PROCEED

WHEN FINISHED
WITH DISPLAY KEY
IN RECYCLE V32E

HOLD
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY DELTA V
(CONT):  
V16N83
R1-DELTA VX(CONT)
R2-DELTA VX(CONT)
R3-DELTA VX(CONT)
DELTA VX(CONT)-COMPONENT OF INTEGRATED
ACCELERATION ALONG
CSM CONTROL +X AXIS.
IN FPS TO NEAREST
+1 FPS.
DELTA VX(CONT)-COMPONENT OF INTEGRATED
ACCELERATION ALONG
CSM CONTROL +Y AXIS.
IN FPS TO NEAREST .1 FPS.
DELTA V[CONT]-COM-
REMOVE JF INTEGRATED
ACCELERATION ALONG
CSM CONTROL +Z AXIS.
IN FPS TO NEAREST .1 FPS.

NOTE: R1, R2, AND R3
WILL READ 00000 IN-
ITIALLY AND WILL RE-
MAIN SO (EXCEPT FOR
ACCELEROMETER BIASES)
UNTIL A THRUSTING
MANEUVER IS STARTED.
THEY WILL BE UPDATED
EVERY 2 SEC.

WAIT FOR KEYBOARD
ENTRY

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

--

SHALL I TERMINATE
THIS PROGRAM?

Y  N

SHALL I ZERO
THE DELTA V
DISPLAY?

N  Y

KEY IN
RECYCLE
V32E.
ATM ORIENTATION DETERMINATION PROGRAM (P50)

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 NBB. 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  C4C  GROUND  CREW
POSS HOLD SNAP

FLASH VERB- NOUN TO REQUEST RESPONSE AND DISPLAY PLANET POSITION VECTOR:
- V08 NB
- 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 1.XXXX).
Y PL - SAME AS X PL FOR Y COMPONENT.
Z PL - SAME AS X PL FOR Z COMPONENT.

WAIT FOR KEYBOARD ENTRY

MONITOR SKY:
OBSERVE VERB- NOUN
FLASH TO REQUEST RESPONSE AND DIS- PLAY OF PLANET POSITION VECTOR.

ARE THE POSITION VECTOR COMPONENTS CORRECT?

KEY IN PROCEED
V06 N23
R1 - ALPHA ATM
R2 - BETA ATM
R3 - GAMMA ATM

OF DOCKING ANGLES

R1 - ALPHA ATM
R2 - BETA ATM
R3 - GAMMA ATM
ARE THE DOCKING
ANGLES WHICH SPECIFY
THE ATM AXES ORIENT-
ATION WITH RESPECT
TO THE NAV BASE.
EACH IN DEGREES TO
THE NEAREST .01 DEG.
(SEE SECTION 5.6 OF
P693).

-------------------------------

WAIT FOR KEYBOARD
ENTRY

AM I SATISFIED
WITH DOCKING
ANGLES?

- Y - N

-------------------------------

KEY IN V25E
AND LOAD NEW
ANgLes

-------------------------------

DO I WISH TO
UPDATE ATM AXES?

- Y - N

-------------------------------
IMU ORIENTATION DETERMINATION PROGRAM (PS1)  

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) 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) THERE ARE NO RESTRICTIONS 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 TAB. HOWEVER, UNIT VECTORS ARE RECOMMENDED.

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

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<td>DO KNO TO START IMU</td>
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<td>ORIENTATION DETERMI-</td>
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<tr>
<td>NATION PROGRAM (PS1)</td>
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<td>V37E 51E</td>
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MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 51

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 INDICATING THAT THE IMU IS NOT ON?

Y

N

TURN ON THE IMU AND RESELECT P51 VIA R60.

DO ROUTINE R60

DO ROUTINE R60

EXIT

"C"

EXIT

"C"
HOLD
-------
FLASH VERB- NOUN TO
REQUEST PLEASE PER-
FORM CELESTIAL BODY
ACQUISITION:
V50 N25
R1-00015
R2- BLANK
R3- BLANK

SNAP

MONITOR DSKY:
-------
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
CELESTIAL BODY
ACQUISITION

SHALL I MANEUVER THE
CSM TO POSITION THE
IMU INNER GIMBAL
AXIS IN A PREFERRED
DIRECTION?

\( Y \)
\( N \)

WITH THE ROTATION
CONTROL RCIATE
THE CSM UNTIL THE
PITCH AXIS IS IN
THE PREFERRED
DIRECTION

ARE 2 CELESTIAL
BODIES VISIBLE IN
THE SCT FIELD OF
VIEW (FOR CSM
OPTICS AS SIGHT-
ING SOURCE)?

\( Y \)
\( N \)
WITH THE ROTATION CONTROL
ORIENT THE CSN
UNTIL 2 CELESTIAL BODIES
ARE VISIBLE IN THE SIGHT

MONITOR FOCA BALL
IS GIMBAL LOCK IMPENDING?

Y N

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

N Y

WAIT FOR KEYBOARD ENTRY

KEY IN ENTER

TERMINATE FLASH UPON RECEIPT OF PROCEED OR ENTER

KEY IN PROCEED

P E
R N
DISPLAY ON DSKY:
V4.1 N22
R1-00000
R2-00000
R3-00000
WHERE R1, R2,
AND R3 REPRESENT
CDU/ISS ANGLES
TO BE COARSE
ALIGNED TO IOG,
IG, MG, RESPECTI-
VIVELY.

RESET REFSSMAT
FLAG

COMMAND ISS TO
COARSE ALIGN
MODE

TURK ON "NO ATT"
LIGHT

OBSERVE "NO ATT"
LIGHT ON

COARSE ALIGN ISS

RELEASE COARSE
ALIGN MODE
GET THE PLANET positional vector.

CALCULATE the vector for the body defined by the star code.

PRINT the vector.

MONITOR the sky:

ARE the planet vector components correct?

Y  N
I

Y PL - SAME AS
X PL FOR Y
CJMPT NENT.

Z PL - SAME AS
X PL FOR Z
CJMPT NENT.

---------

WAIT FOR KEY-
HARD ENTRY

---------

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED OR NEW
DATA.

---------

P NEW
R CAYA
D
C
E
E STORE NEW
D CAYA

---------

CALCULATE CELESTIAL
REDY #1 VECTOR
WRT. IMU

---------

318
CELESTIAL COORDINATES AS DEFINED BY CELESTIAL BODIES #1 AND #2, STORE AS PRESENT PLATFORM ORIENTATION (REFSMмат)  

SET REFSMMAT FLAG

DO ROUTINE R00

EXIT PS1  

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 SFXTANT, 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
\[
\begin{align*}
X &= \text{UNIT}(X \times Z) \\
-\text{SM} & & -\text{SM} \\
Y &= \text{UNIT}(V \times R) \\
-\text{SM} & & - \text{SM} \\
Z &= \text{UNIT}(-R) \\
-\text{SM} & & - \text{SM}
\end{align*}
\]

WHERE:
\[
R = \text{THE GEOCENTRIC RADIUS VECTOR AT TIME TALIGN)} \\
- \text{SELECTED BY THE ASTRONAUT}
\]
\[
V = \text{THE INERTIAL VELOCITY VECTOR AT TIME TALIGN) SELECTED BY THE ASTRONAUT.}
\]

(C) REFOMAT
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.

\[
\begin{align*}
X &= \text{UNIT}(X \cos 45 + Y \sin 45) \text{ BEFORE THE MANEUVER (AFTER MANEUVER IF} \cos(CDYU), VGY < 0) \\
-\text{SM} & & -\text{SM0} & & -\text{SM0} & & \text{LV} \\
X &= \text{UNIT}(X \cos 45 - Y \sin 45) \text{ AFTER THE MANEUVER (BEFORE MANEUVER IF} \cos(CDYU), VGY < 0) \\
-\text{SM} & & -\text{SM0} & & -\text{SM0} & & \text{LV} \\
Y &= \text{UNIT}(X \times X) \\
-\text{SM} & & -\text{SM} & & -\text{SM} \\
Z &= Z \\
-\text{SM} & & -\text{SM0}
\end{align*}
\]

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 V53N25, R1=20) OR THE GYRO TRIM PORTION OF COARSE ALIGN ROUTINE (R90), THE CAP 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 SXT 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.

<table>
<thead>
<tr>
<th>PROG CONT</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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</thead>
<tbody>
<tr>
<td>AUTOMATIC</td>
<td>.CREW PROG</td>
<td>.SELECTION</td>
<td>.SELECTION</td>
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<tr>
<td>PROGRAM</td>
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<tr>
<td>SELECTION</td>
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</tbody>
</table>

DO ROO TO START IMU KEY IN IMU REALIGN PROGRAM (P52) PROGRAM (P52) V37E 52E #10

DISPLAY PROGRAM 52

MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 52 #20

-----------------------------

324 P52/SKYLARK
V0+ AJ6
R1-00J01
R2-00J0X
R3-BLANK

R1 IS THE OPTION
CODE FOR ASSUMED
IMU ORIENTATION
SELECTION

R2 IS THE CMC
ASSUMED OPTION:
00001-PREFERRED
00002-SECONDARY
00003-REFERENCE

IS THIS THE IMU ORI-
ENTATION I DESIRE?

Y

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

P
NEW
R
CODE
O
C
F
STORE CODE
N

IS STORED ORIENTA-
TION CODE 00001?

Y

WAS PREFERRED ORIEN-
TATION SELECTED?

Y

N

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

T(ALIGN)- TIME (GET)
AT WHICH VEHICLE
POSITION AND VELO-
City Vectors ARE SE-
SELECTED TO DEFINE IMU
AND CSM NOMINAL ORI-
ENTATION. IN HRS,
MINS AND SECS TO
NEXTEST .31 SEC.

-------------------------

JF T(ALIGN).

-------------------------

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) AUTOMAT-
ICALLY SELECTED AS
THE PRESENT TIME

-------------------------

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

Y
N

-------------------------

WAIT FOR KEYBOARD
ENTRY

-------------------------

KEY IN
PROCEED

-------------------------

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

-------------------------

P NEW
R DATA
D
C
E STORE
J NEW

-------------------------

#230

#240

#250

#260

#270
IS T(ALIGN) DEFINED TO BE = 07

Y N

DEFINE T(ALIGN) = T PRESENT

FIND CSM STATE AT T(ALIGN) USING PRECISION INTEGRATION MODE

COMPUTE NOMINAL ORIENTATION FOR THE PREVIOUSLY DEFINED T(ALIGN). SELECT THIS ORIENTATION FOR GIMBAL ANGLES COMPUTATION. (NOTE: AT THIS
TIME ANY PREFERRED ORIENTATION STORED IN THE CMC IS LOST.

"A" FROM ABOVE

READ VEHICLE ATTITUDE FROM GIMBAL ANGLES

COMPUTE GIMBAL ANGLES AT SELECTED IMU ORIENTATION AND PRESENT VEHICLE ATTITUDE

"A" FROM ABOVE

+01
+ HOLD
+ SNAP
+ FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY THE RESULTING GIMBAL ANGLES: V06 N22.

MONITOR DSKY: OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF GIMBAL ANGLES
R1-OG ROLL
R2-IG PITCH
R3-MG YAW

ALL GIMBAL ANGLES IN
DEGREES TO NEAREST
.01 DEGREE

AFTER PROPOSED GSW/
IMU ALIGNMENT

IS MIDDLE GIMBAL
ANGLE SATISFACTORY?

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

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

N
Y

MANEUVER VEHICLE WITH
ROTATION CONTROLLER

UPDATE THE DISPLAY OF RESULTING GIMBAL ANGLES
KEY IN RECYCLE V32E

SELECT NEW PROGRAM
KEY IN V37E.XE

EXIT P52

KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF PROCEED RECYCLE OR NEW PROGRAM

P R P NEW
E R PROG

P52/SKYLARK
FLASH VERB- NOUN TO
REQUEST PLEASE PER-
FORM NORMAL OR GYRO
TORQUE COARSE ALIGN:

RI-00103
R2-BLANK
R3-BLANK

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
PRECISE ALIGNMENT, AND ISSUE THESE PULSES. THIS ALTERNATE METHOD INTRODUCES A PREDICTABLE ERROR INTO THE CMC'S KNOWLEDGE OF THE STABLE MEMBER ORIENTATION AND TAKES A PREDICTABLE PERIOD OF TIME FOR COMPLETION.

AN APPROXIMATION OF THIS ERROR AND THE TIME TO TORQUE CAN BE MADE BY CALCULATING THE SUM OF THE GIMBAL ANGLE CHANGES, MULTIPLYING BY 2 FOR TIME TO TORQUE IN SECONDS, AND MULTIPLYING BY .002 FOR ERROR IN DEGREES. SHALL I REALIGN IN THE NORMAL WAY?

Y N

--------- KEY IN PROCEED

--------- KEY IN ENTER

TERMINATE FLASH UPON RECEIPT OF PROCEED OR ENTER

P ENTER
R D
C "D"
E D

COMPUTE TORQUING ANGLES REQUIRED
TO ACHIEVE NEW
ORIENTATION.

RESET REFSTMAT
FLAG

PULSE IRIG'S
THROUGH TORQUING
ANGLES AND DIS-
PLAY PRESENT ICDO
ANGLES UNTIL
COMPLETION.

TEMP
VIGN20
HOLD
R1-0G ROLL
R2-0G PITCH
R3-0G YAW

MON
ALL GIMBAL ANGLES
IN DEGREES TO
NEAREST .01
DEGREES.

STORE THE DESIRED
IMU ORIENTATION
IN REFSTMAT AND
SET REFSTMAT FLAG

GO TO
"C"
BELOW

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

GO TO
"C"
BELOW
SELECT FINAL DESIRED IMU ORIENTATION FROM STORAGE FOR USE BY THE COARSE ALIGN ROUTINE (R50)

DO COARSE ALIGN ROUTINE (R50)

STORE THE PRESENT IMU ORIENTATION IN REF3MMAT AND SET REF3MMAT FLAG
MONITOR ORK: OBSERVE VERB-ADJECTIVE
FLASH TO REQUEST
PLEASE PERFORM
CELESTIAL BODY
ACQUISITION:
NOTE: THE CMC WILL
ATTEMPT TO SELECT
TWO CELESTIAL BODIES
SUITE FOR SIGHTING BY USE OF THE
OPTICS. IF THE OPTICS ARE NOT BEING
USED THE ROUTINE MAY
HAVE NO VALUE.

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

N
Y

WAIT FOR KEYBOARD
ENTRY

KEY IN ENTER

MANEUVER VEHICLE UN-
TIL SUITE STARS
MAY BE ACQUIRED.
MONITOR FOAI BALL
TO AVOID GIMBAL
LOCK. (NOTE: ASTRO-
NAUT MAY USE OPTICS
TO ASSIST ATTITUDE
CHOICE OR MAY MANEU-
VER AT RANDOM.)

---

TERMINATE FLASH UPON RECEIPT OF ENTER OR PROCEED

---

ENTER PROCEED

---

KEY IN PROCEED

---

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

---

TWO STARS AVAILABLE
TWO STARS NOT AVAILABLE

---

PCSS HOLD SNAP

---

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY ALARM CODE:
V05N09 R1 R2 R3

---

EXPECTED ALARM CODE AT THIS TIME IS 405

---

MONITOR SKY:
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

---
SELECT STAR #1 FOR USE BY AUTO OPTICS
POSITIONING ROUTINE (R52)

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

VOLNO
R1-OJCODE
R2-BLANK
R3-BLANK

R1-C=SOURCE OF SIGHTING DATA
O-CSI OPTICS (SXT/SCT)
1-ATM SUN SENSOR
2-ATM STAR
TRACKER
DE-CELESTIAL BODY
CODE
+01

NOTE: N70 DISPLAYS
RESULTS OF
SUCCESSFUL
STAR SELECTION
ROUTINE OTHERWISE CONTAINS
RESIDUAL DATA
+489

------------------------------
IS CODE SATISFACTORY?
Y
N
------------------------------
KEY IN V21E
AND CHANGE
CODE
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TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA
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KEY IN
PROCEED
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STORE NEW DATA
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NEW
DATA
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NEW
P
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NEW
DATA
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PROC
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STORE NEW DATA
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D
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#960
#970
#980
#990
#1000
LIGHT

IS CELESTIAL BODY CODE 007?

N Y

IS THE CELESTIAL BODY CODE 46 OR 47?

N Y

OBTAIN STAR VECTOR FROM STORED Ephemeris

CALCULATE CELESTIAL BODY VECTOR FOR THE BODY DEFINED BY THE CELESTIAL BODY CODE.

POS HOLD

P52/SKYLARK

SNAP

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY PLANET

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

#1060

#1070

#1080

#1090

#1100

346 P52/SKYLARK
POSITION VECTOR:
V0X N0B
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 (.XXXX).
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 DATA
.D
.C
.E
.E STORE NEW DATA
.D DATA

KEY IN PROCEED

KEY IN V25E AND LOAD CORRECT POSITION VECTOR COMPONENTS
| IS THIS A MINKEY | IS THIS A MINKEY |
| PLANE-CHANGE | PLANE-CHANGE |
| ALIGMENT? | ALIGMENT? |
| (AUTOSEQ FLAG | SET?) |
| N | Y |
| RESET PCFLAG |
| DO ROUTINE | DO ROUTINE |
| R00 | R00 |
| EXIT P52 | EXIT P52 |

OLD - FLASH VERB-NOUN TO
REQUEST PLEASE PER-
SNAP - FORM FINE ALIGNS:
V50 M25
R1-00014
R2-BLANK
R3-BLANK

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

DO I WANT TO REDO
THE CELESTIAL BODY
SIGHTINGS, SIGHTING DATA TEST, AND GYRO TORQUING TO VERIFY THE ACCURACY OF ALIGNMENT?

NOTE: IF THE SIGHTING DATA WAS BAD OR THE TORQUING ANGLES WERE LARGE THE ASTRONAUT SHOULD PROCEED AND REDO THE ALIGNMENT.

---

WAIT FOR KEYBOARD ENTRY

KEY IN ENTER

---

TERMINATE FLASH UPON RECEIPT OF PROCEED OR ENTER

KEY IN PROCEED

---

P E
R N
O T
C E
E R
D A
B

GO TO "B"

ABOVE

---

GO TO "B"

ABOVE

---

DO ROUTINE RdO

DO ROUTINE RdO

---
# BACKUP IMU ORIENTATION DETERMINATION PROGRAM (P53)

**REV 01 03/20/72**

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

**ASSUMPTIONS:**
(1) THE IMU MAY BE:

<table>
<thead>
<tr>
<th>(A) OFF (STANDBY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(B) ON, AND ALIGNED OR NOT ALIGNED SINCE TURN ON.</td>
</tr>
</tbody>
</table>

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 P51 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 INITIALLY 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.

<table>
<thead>
<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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<tbody>
<tr>
<td>CONT</td>
<td></td>
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<td>CREW PROG</td>
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<td>SELECTION</td>
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</table>

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DO RUD TO START
BACKUP IMU ORIENTA-
TION DETERMINATION
PROGRAM (P53)
DISPLAY PROGRAM 53

---

KEY IN BACKUP IMU
ORIENTATION DETERMI-
NATION PROGRAM (P53)
V37E 53E

---

#10

---

P53/SKYLARK
MONITOR SKY: OBSERVE DISPLAY OF PROGRAM 53

IS ISS ON?

Y

N

TURN ON PROGRAM
ALARM AND STORE
ALARM CODE
00210

DO ROUTINE ROO

DO ROUTINE ROO

EXIT
P53

#20

#30

#40

#50

#60

356 P53/SKYLARK
HOLD

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

MONITOR OSKY:
ORIGIN VERB- NOUN
FLASH TO REQUEST
PLEASE PERFORM CELE-
STIAL BODY ACQUI-
SION

---

SHALL I MANEUVER THE
CSM TO POSITION THE
IMU INNER GIMBAL
AXIS IN A PREFERRED
DIRECTION?

Y

WITH THE ROTATION
CONTROL ROTATE
THE CSM UNTIL THE
PITCH AXIS IS IN
THE PREFERRED
DIRECTION

---

SHALL I MANEUVER
THE CSM TO AC-
QUIRE A CELESTIAL
BODY?

Y
WITH THE ROTATIONAL HAND CONTROLLER ORIENT THE CSM

MONITOR FCAL BALL IS GIMBAL LOCK IMPENDING?

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

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED OR ENTER

KEY IN PROCEED
POSS TEMP HOLD SNAP

DISPLAY ON DSKY:
V41 W22
R1-00000
R2-00000
R3-00000

WHERE R1, R2,
AND R3 REPRESENT
COU/ISS ANGLES
TO BE COARSE
ALIGNED TO (DG,
IG, MG, RESPECT-
IVELY).

RESET REFSHMAT
FLAG:

COMMAND ISS TO
COARSE ALIGN
MODE

TURN ON "NO ATT"
LIGHT

OBSERVE "NO ATT"
LIGHT ON

TERMINATE COARSE
ALIGN MODE IN

MONITOR DSKY:
OBSERVE DISPLAY
OF COARSE ALIGN
VERB AND ICOU
ANGLES (ALL
00000) FOR COARSE
ALIGNMENT
BACKUP IMU REALIGN PROGRAM (P54)

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 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 (X ZJ
  -SM  -SM  -SM
Y = UNIT (X R J
  -SM  -SM  -SM
Z = UNIT (-R)
  -SM  -SM  -SM
WHERE:
R = THE GEODETIC RADIUS VECTOR AT TIME T (ALIGN) SELECTED BY THE ASTRONAUT
V = THE INERTIAL VELOCITY VECTOR AT TIME T (ALIGN) SELECTED BY THE ASTRONAUT.

(C) REFMS MAT
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 W45 OR W46 (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 (ENTER ON V50/25, RI=13), OR THE GYRO TRIM OPTION OF COARSE ALIGN ROUTINE (R53), 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 (REFMS MAT). 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 AT 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 AT STAR TRACKER IS USED AS SOURCE OF SIGHTING DATA, CSM MUST BE DOCKED TO ORBITAL ASSEMBLY, AND ATM ORIENTA-
TION 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 OSKY ENTRY.

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<th>PROG CONT</th>
<th>CMC</th>
<th>GROUND</th>
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<tbody>
<tr>
<td>DO 000 TO START</td>
<td>START BACKUP IMU REALIGN PROGRAM (P54)</td>
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<td>BACKUP IMU REALIGN PROGRAM (P54)</td>
<td>V37E 54E</td>
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<td>DISPLAY PROGRAM 54</td>
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<td>MONITOR OSKY: OBSERVE DISPLAY OF PROGRAM 54</td>
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<td>DO IMU STATUS CHECK ROUTINE (R02)</td>
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<td>IS UFLAG SET AND IS P20 OPTION = 2?</td>
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<td>NO.</td>
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<td>SET TRACK FLAG</td>
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SELECTION

R2 IS THE COG
ASSUMED OPTION:
00001-PREFERRED
00002-UNPREFERRED
00003-REFSYMAT

IS THIS THE IMU ORIENTATION I DESIRE?

Y    N

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

P    NEW
R    CODE
O    C
E    STORE CODE
D    C

IS STORED ORIENTATION CODE 00001?

N    Y

WAS PREFERRED ORIENTATION SELECTED?

N    Y

SELECT PREFERRED 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.

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

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

WAIT FOR KEYBOARD
ENTRY

KEY IN
PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

KEY IN V25E AND
LOAD THE DESIRED
T(ALIGN) IN R1,
R2, AND R3.
IS TALIGN) DEFINED TO BE = 0?

Y

N

DEFINE T ALIGN) = T PRESENT

FIND CSM STATE AT TALIGN USING PRECISION INTEGRATION

COMPUTE NOMINAL ORIENTATION FOR THE PREVIOUSLY DEFINED TALIGN. SELECT THIS ORIENTATION FOR GIMBAL ANGLES COMPUTATION. (NOTE: AT THIS TIME ANY PREFERRED ORIENTATION STORED IN THE CMC IS LOST).
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 ENSURE ACCURACY OF IMU COARSE ALIGNMENT.

WAIT FOR KEYBOARD ENTRY

KEY IN PROCEED

DO I WISH TO MANEUVER VEHICLE TO AN ATTITUDE WHICH WILL PROVIDE A MORE SUITABLE MGA?

Y  N

MANEUVER VEHICLE WITH ROTATION CONTROLLER

UPDATE THE DISPLAY OF RESULTING GIMBAL ANGLES

KEY IN RECT-
TERMINATE FLASH UPON RECEIPT OF PROCEED
RECYCLE OR NEW PROGRAM

+++ 01
POSS
HOLD

FLASH VERB-NOUN TO SNAP
REQUEST PLEASE PERFORM
FORM NORMAL OR GYRO TORQUE COARSE ALIGN:

++
V50/25
R1-Q0013
R2-BLANK
R3-BLANK

---

THE NORMAL METHOD OF ACHIEVING IMU

++

CME V12E

---

SELECT NEW PROGRAM AS DESIRED
KEY IN V37E--E

---

GO TO PROGRAM SELECTED

EXIT P54

+++ 01
POSS
HOLD

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

---

THE NORMAL METHOD OF ACHIEVING IMU

+++ 01
POSS
HOLD

---

372
REALIGNMENT IS TO ACCEPT THIS REQUEST BY KEYING IN PROCEED WHICH WILL CAUSE THE CMC TO COARSE ALIGN AND 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 NUMBER OF TORQUING PULSES REQUIRED BY EACH IRIG (X,Y,Z) IN ORDER TO ACHIEVE PRECISE ALIGNMENT, AND ISSUE THESE PULSES. THIS ALTERNATE METHOD INTRODUCES A PREDICTABLE ERROR INTO THE CMC'S KNOWLEDGE OF THE STABLE MEMBER ORIENTATION AND TAKES A PREDICTABLE PERIOD OF TIME FOR COMPLETION. AN APPROXIMATION OF THIS ERROR AND THE TIME TO TORQUE CAN BE MADE BY CALCULATING THE SUM OF THE GIMBAL ANGLE CHANGES, MULTIPLYING BY 2 FOR TIME TO TORQUE IN SECONDS, AND MULTIPLYING BY .302 FOR ERROR IN DEGREES.
SHALL I REALIGN IN THE NORMAL WAY?

Y  N

KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF PROCEED OR ENTER

KEY IN ENTER

P
R
O
E
E
D

COMPUTE TORQUING ANGLES REQUIRED TO ACHIEVE NEW ORIENTATION.

RESUME REFSMMAT FLAG

PULSE IRIG'S THROUGH TORQUING ANGLES AND DISPLAY PRESENT ICDU ANGLES UNTIL

MONITOR DSKY:

OBSERVE VERB-NOUN DISPLAY OF PRESENT GIMBAL ANGLES UNTIL COM
TFMP
HOLD
MON

All gimbal angles in degrees to nearest .01 degree.

Store the desired IMU orientation in REFSMATERIAL and set REFSMATERIAL flag.

Go to "M" below.

Select final desired IMU orientation from storage for use by the coarse align routine (RSO).
(1) I WISH TO HAVE THE CMG ASSIST ME IN SELECTING TWO CELESTIAL BODIES SUITABLE FOR ALIGNMENT?

- NO
- YES

WAIT FOR KEYBOARD ENTRY

KEY IN ENTER

MANEUVER VEHICLE UNTIL SUITABLE CELESTIAL BODIES MAY BE ACQUIRED. MONITOR FMDI BALL TO AVOID GIMBAL LOCK.

(Note: Astronaut may use optics to assist attitude choice or may maneuver at random.)

TERMINATE FLASUPON RECEIPT OF ENTER OR PROCEED

ENTER • PROCEED

DC STAR SELECTION ROUTINE (REFER TO...
SECTION 5.6 OF
R6931.

---

TWO STARS AVAILABLE NOT AVAILABLE

---

POSS
HOLD
SNAP

---

FLASH VERB-OWN
REQUEST RESPONSE
PONG AND DISPLAY ALARM CODE:
VOSNO9
R1- R2- R3-
EXPECTED ALARM CODE AT THIS TIME IS 405

---

MONITOR SKY:
DOES ALARM CODE DISPLAY INDICATE THAT TWO STARS ARE NOT AVAILABLE IN THE 5XT FIELD OF VIEW?

---

Y N

---

SHALL I BYPASS STAR SELECTION ROUTINE AND SELECT MY OWN CELESTIAL BODY?

---

Y N

---

MANEUVER VEHICLE UNTIL A SUITABLE CELESTIAL BODY IS ACQUIRED

---

WAIT FOR KEYBOARD ENTRY KEY IN PROCEED
CODE
VJINTJ
R1=OJCODE
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?

Y   N

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-
ESTIAL BODY CODE MUST FALL WITHIN THE LEGAL RANGE OR AN OPERATOR ERROR WILL RESULT

DO I WISH TO CHANGE THE CODE?

N  Y

KEY IN V21E AND CHANGE CODE.

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

NEW R
DATA

STORE NEW DATA

IS CELESTIAL BODY CODE NEGATIVE?

Y  N
TURN ON OPERATOR ERROR LIGHT.

---

IS CELESTIAL BODY CODE >47 (OCTAL)?

  Y  N

  Is C=1 . (ATM SUN SENSOR)?

    Y  N

  IS DE=45 (SUN)?

    N  Y

  TURN ON OPERATOR ERROR LIGHT.

  ---
IS CELESTIAL BODY CODE 007

N Y

IS THE CELESTIAL BODY CODE 46 OR 47?

N Y

OBTAIN STAR VECTOR FROM STORED EPHemeris

CALCULATE CELESTIAL BODY VECTOR FOR THE BODY DEFINED BY THE CELESTIAL BODY CODE

POSS

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

V06N88 R1-X PL R2-Y PL

SNAP

MONITOR DSKY:

OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF PLANET POSITION VECTOR.
R3-Z PL

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

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
Q
E STORE NEW DATA

DO ALTERNATE LOS SIGHTING MARK ROUTINE (R).
RESET PREFERRED ORIENTATION FLAG.

HOLD

FLASH VERB–NOUN TO REQUEST PLEASE PERFORM FINE ALIGN
V50 N25 R1–00014 R2–BLANK R3–BLANK

MONITOR OSKY: OBSERVE VERB–NOUN FLASH TO REQUEST
PLEASE PERFORM FINE ALIGN.

DO I WANT TO REDO THE CELESTIAL BODY SIGHTINGS, SIGHTING DATA TEST, AND GYRO TORQUING TO VERIFY THE ACCURACY OF ALIGNMENT?
NOTE: IF THE SIGHTING DATA WAS BAD OR THE TORQUING ANGLES WERE LARGE THE ASTRONAUT SHOULD PROCEED AND REDO THE ALIGNMENT.

WAIT FOR KEYBOARD ENTRY

KEY IN ENTER
TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR ENTER

-------------------
P
R
Q
C
E
E
T

...

GO TO
"G"
ABOVE

-------------------
DO ROUTINE ROO

-------------------
DO ROUTINE ROO

EXIT
PS4

CHANGE CONTROL NOTES

REV 00  PCR 313, 340, 343, 415, 416, PCN 410, 436
REV 01  PCN 489
ATM STAR TRACKER GIMBAL ANGLE PROGRAM (P55)  

**PURPOSE:**  
(1) TO COMPUTE AND DISPLAY THE GIMBAL ANGLES REQUIRED BY THE ATM STAR TRACKER IN ORDER TO POINT AT A DESIRED CELESTIAL BODY.  

**ASSUMPTIONS:**  
(1) THE ATM ORIENTATION DETERMINATION PROGRAM (P55) HAS BEEN USED PRIOR TO THE SELECTION OF THIS PROGRAM TO DETERMINE THE ATM SENSOR ATTITUDE VECTORS (Y - ATM AND Z - ATM).  

(2) TWO OPTIONS ARE AVAILABLE:  
(A) OPTION 1 - USES IMU ORIENTATION TO DETERMINE ATM STAR TRACKER GIMBAL ANGLES  
(B) OPTION 2 - USES CSM OPTICS MARK AND LOS TO SUN TO DETERMINE ATM STAR TRACKER GIMBAL ANGLES  

(3) THE ASTRONAUT IDENTIFIES THE CELESTIAL BODY TO BE ACQUIRED BY THE STAR TRACKER. SUN OR EARTH ARE NOT TO BE SELECTED AS CELESTIAL BODIES FOR THE STAR TRACKER.  

(4) THE IMU MAY BE:  
(A) ON AND ALIGNED (FOR OPTION 1)  
(B) OFF (FOR OPTION 2)  

(5) ATM MUST BE IN SOLAR INERTIAL ATTITUDE IN ORDER TO USE OPTION 2.  

(6) THE CSM MUST BE DOCKED TO THE ORBITAL ASSEMBLY.  

(7) THE FORMAT OF N19 (OCULAR AZIMUTH ANGLE) IS SUITABLE FOR LOADING DIRECTLY INTO ATM COMPUTER.  

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

(9) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY ENTRY.
SET CMC ASSUMED
OPTION CODE IN R2
BELOW TO 00001

HOLD

SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY OPTION CODE
FOR ASSUMED INPUTS
TO PROGRAM:
V04 NO6
R1 - 00013
R2 - 0000X
R3 - BLANK

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

IS THIS THE SET OF
INPUTS THAT I DE-
SIRED?
WAIT FOR KEYBOARD ENTRY.

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

P.

R.

W.

E.

F.

G.

STORE NEW CODE

KEY IN V22E AND LOAD THE DESIRED SENSORS CODE IN #2

IS CELESTIAL BODY-IMU ORIENTATION OPTION (00001) STORED?

Y

N

(00001) (00002)

DO SIGHTING MARK ROUTINE (R53)

DO SIGHTING MARK ROUTINE (R53)

CALCULATE LTVS VECTOR TO SUN IN BASIC
PLANET POSITION VECTOR:
V00NBB
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 (XXX).

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 DATA.

P NEW DATA
R NEW DATA
C NEW DATA
E STORE NEW DATA
D NEW DATA
V06 N88
R1 - X PL
R2 - Y PL
R3 - Z PL

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

---- -----

---- -----

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---- -----
TRANSFORM VELOCITY VECTOR
FROM BASIC REFERENCE
COORDINATES TO ATM
SENSOR COORDINATES
IF OPTION CODE
00001 WAS SELECTED,
TRANSFORMATION USES
IMU ORIENTATION. IF
OPTION CODE 00002
WAS SELECTED, TRANS-
FORMATION USES
MATRIX CALCULATED
ABOVE FROM SUN
VECTOR AND R53 MARK
DATA.)

* *

CALCULATE STAR
TRACKER GIMBAL
ANGLES (PSI , PSI)
3 1
FOR POINTING TRACKER
AT SPECIFIED CELES-
TIAL BODY

* *

ARE STAR TRACKER
GIMBAL ANGLE VALUES
WITHIN THE PERMISSI-
BLE RANGE?
-87 DEG < PSI
3
< +87 DEG
-40 DEG < PSI
1
< +40 DEG

. N . Y
* *
**Monitor DSky:**

**Observe program alarm light cn if star tracker gimbal angles not within permissible range. Key VOSNOS to verify alarm code 00107.**

**Hold:**

Flash verb-noun to request response and display star tracker gimbal angles:

- V06 NL
- R1-Azimuth (PSI 3)
- R2-Elevation (PSI 1)
- R3-Blank

Azimuth-outer gimbal angle of the atm star tracker. In arc minutes to the nearest arc minute.

Elevation-inner gimbal angle of the atm star tracker. In arc minutes to the nearest arc minute.

*Are star tracker gimbal angles satisfactory?*

- Y

**Wait for keyboard entry:**

Key in recycle, VJ3E
TERMINATE FLASH UPON RECEIPT OF PROCEED OR RECYCLE

* * *

R E C E I P T O F P R O C E E D

* * *

R E C Y C L E

* * *

GO TO "A"

ABOVE

* * *

HOLD

FLASH VERB-NOUN TO REQUEST RESPONSE AND

SNAP

DISPLAY STAR TRACKER AZIMUTH IN OCTAL:

VO4 N19
R1 OSABC
R2 00DE0

OCTAL DISPLAY FOR USE AS INPUT TO THE ATM COMPUTER

S= SIGN OF R1 OF N14
  0 = +
  1 = -

ABCD = ABSOLUTE VALUE:

(OCTAL EQUIVALENT OF R1 OF N14)

* * *

MONITOR DSKY:

OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF STAR TRACKER AZIMUTH (OCTAL).

* * *

IS OCTAL AZIMUTH VALUE SATISFACTORY?

* * *

N Y

* * *
# 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.

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<tr>
<th>PROG CONT</th>
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<td>CREW PROG SELECTION</td>
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<td>v37e 61e</td>
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- DO ROO TO START
- ENTRY-PREPARATION PROGRAM (P61)
- DISPLAY PROGRAM 61

---

$\#10$

---

$\#20$

- MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 61
- DO IMU STATUS CHECK ROUTINE [R02]
DO STATE VECTOR INTEGRATION (MID TO AVE) ROUTINE (R41)
CALL AVERAGE G ROUTINE

IS UNIT (V X R)
WITHIN 30 DEG OF +Y?

Y . N

IS UNIT (V X R)
WITHIN 30 DEG OF -Y?

Y . N

-------------------------------
POS TEMP
HOLD SNAP

------------------------------
COMMAND PROGRAM
ALARM AND DISPLAY
VO5 NO9
R1-
R2-
R3-
EXPECTED ALARM CODE AT THIS TIME 01427?

------------------------------
OBSERVE PROGRAM
ALARM LIGHT ON DSKY AND DISPLAY OF ERROR CODE IF MU REVERSED. ZERO ROLL ON FDAL BALL WILL MEAN LIFT DOWN.

------------------------------
PRESS

TEMP

MOLD

SNAP

------------------------------
COMMAND PROGRAM
ALARM AND
DISPLAY
VO5 NO9
R1-
R2-
R3-

EXPECTED ALARM
CODE AT THIS
TIME IS 01426

------------------------------
WAIT 10 SEC

------------------------------

OLD

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 - LATITUDE OF DESIRED
IMPACT POINT, IN
DEGREES TO NEAREST .01 DEG. + IS NORTH

IMPACT LONG - LONGITUDE OF DESIRED
IMPACT POINT, IN
DEGREES TO NEAREST .01 DEG. + IS EAST

------------------------------

OBSERVE PROGRAM
ALARM LIGHT ON DSKY
AND DISPLAY OF ERROR
CODE (IMU UNSATISFACTORY)

------------------------------

MONITOR DSKY:
OBSERVE VERB- NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF S/C ENTRY DATA.

------------------------------

#90

#100

#110

#120
G FOR FREE FALL AND
ENTRY AT NOMINAL
BANK ANGLE (L/D = .10) IN GS TO
NEAREST .51 G.

VPRED - PREDICTED
INERTIAL VELOCITY
AT 400,000 FT
ALTITUDE ABOVE
THE FISCHER
ELLIPTOID,
IN FPS TO NEAREST
FPS.

GAMMA EI - FLIGHT
PATH ANGLE. ANGLE
BETWEEN INERTIAL
VELOCITY AND THE
LOCAL HORIZONTAL
AT THE ENTRY INTER-
FACE ALTITUDE AT
400,000 FT ALTIT-
UDE ABOVE THE
FISCHER ELLIPSOID,
IN DEGREES TO
NEAREST .51 DEG.

MINUS INDICATES
FLIGHT PATH IS BELOW
THE HORIZONTAL PLANE.
WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED

HOLD

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY:

V16 N63
R1-RTGO
R2-VIO
R3-TFE

RTGO - RANGE TO GO FROM A PRELOADED ALTITUDE (SEE NOTE)
ABOVE THE FISCHER ELLIPSOID TO THE SPLASH POINT IN NAUTICAL MILES TO NEAREST .1 NM.

VIO - PREDICTED INERTIAL VELOCITY AT A PRELOADED ALTITUDE (SEE NOTE) ABOVE THE FISCHER ELLIPSOID IN FPS TO NEAREST FPS.

TFE - TIME FROM NOW TO A PRELOADED ALTITUDE (SEE NOTE) ABOVE THE FISCHER ELLIPSOID IN MIN
AND SEG TO NEAREST SEC. MAX READING IS 59950. ABOVE * 
BELOW ALTITUDE, TFE IS DECREMENTED 
AT A 2 SECOND RATE, CONTINUING UNTIL .050 IS SENSED. 

NOTE: THE ALTITUDE IS PRELJADED IN ERASABLE. 
TYPICAL VALUE = 284,643 FT. 

WAIT FOR KEYBOARD ENTRY 
TERMINATE FLUSH UPON RECEIPT OF PROCEED OR RECYCLE 

KEY IN PROCEED 

KEY IN RECYCLE V32E 

TERMINATE PROGRAM 61 AND JO ON TO ENTRY - CM/SM SEPARATION AND PRE-ENTRY MANEUVER PROGRAM (P62) 

MONITOR O/SKY: OBSERVE TERMINATION OF P61 AND DISPLAY OF P62
ENTRY - CM/SM SEPARATION AND PRE-ENTRY MANEUVER
PROGRAM (P62)

PURPOSE:
1. TO NOTIFY CREW WHEN THE UNCS 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(ROTGO,V10,TIE) BY KEYING IN V16NG63E.

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#10

KEY IN ENTRY-CM/SM SEPARATION AND PRE-ENTRY MANEUVER PROGRAM (P62)
V37E 62E

#20

MONITOR NS3(ROTGO,V10,TIE) BY KEYING IN V16NG63E

P62/SKYLARK
DO IMU STATUS CHECK ROUTINE R02.

HAS THIS PROGRAM BEEN ENTERED AUTOMATICALLY FROM P61?

Y  N

DO STATE VECTOR INTEGRATION (MID TO AVE) ROUTINE (R41).

CALL THE AVERAGE G ROUTINE

IS UNIT (V X R)

WITHIN 30 DEG OF +Y ?

IS UNIT (V X R)
WITHIN 30 DEG OF
- Y
- Y
- N

---

POSS
TEMP
HCLD
SNAP

-----

COMMAND PROGRAM ALARM AND DISPLAY
VJS NO9
R1-
R2-
R3-

---

EXPECTED ALARM CODE AT THIS TIME IS 01427

-----

POSS
TEMP
HCLD
SNAP

-----

COMMAND PROGRAM ALARM AND DISPLAY
VOS NO9
R1-
R2-
R3-

---

EXPECTED ALARM CODE AT THIS TIME IS 01426

-----

WAIT 10 SEC

-----

INITIALIZE ENTRY DAP AND-body ATTITUDE

---

OBSERVE PROGRAM
ALARM LIGHT ON DSKY
AND DISPLAY OF ERROR CODE (IMU REVERSED.
ZERO ROLL ON PDAI BALL WILL MEAN LIFT
dOWN.)

---

OBSERVE PROGRAM
ALARM LIGHT ON DSKY
AND DISPLAY OF ERROR CODE (IMU UNSATIS-
FACTORY)
CALCULATIONS AND LEAVE IN STANDBY STATE.

CALCULATE THE REQUIRED GIMBAL ANGLES TO GIVE CORRECT ANGLE OF ATTACK OF THE CM INTO THE ATMOSPHERE AT THIS TIME AND CONTINUE CALCULATING EVERY TWO SECONDS UNTIL COMPLETION OF THIS PROGRAM. THESE GIMBAL ANGLES ARE STORED IN NOUN 22.

HOLD - FLASH VERB- NOUN

TO REQUEST PLEASE SNAP - PERFORM CM/SM SEPARATION

V50 N25
R1 - 00341
R2 - BLANK
R3 - BLANK

MONITOR SKY:

OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM CM/SM SEPARATION

CM/SM - CM/SM
NOT - SEPARATED
RATED -

PRIOR TO COMMANDING CM/SM SEPARATION THE GNC AUTOPILOT SHOULD BE SWITCHED TO FREE MODE
TO PREVENT RCS ACTIVITY IMMEDIATELY AFTER SEPARATION

MOVE CM/SM SEP SWITCH TO UP ON CREW SAFETY PANEL

WAIT FOR KEYBOARD ENTRY TERMINATE FLASH UPON RECEIPT OF PROCEED.

WHEN SATISFIED THAT CM/SM SEPARATION HAS SATISFACTORILY OCCURRED WAIT -- SEC FOR ADEQUATE SEPARATION DISTANCE AND KEY IN PROCEED.

TURN OFF CSM RCS JAP
IS THE ANGLE ALPHA
ALREADY WITHIN 45
DEGREES?

+ Y
- N

TEMP HOLD DESIRED FINAL GIMBAL ANGLES:
V06 V22
R1 - JO ROLL
R2 - IG PITCH
R3 - MG YAW

IN DEGREES TO NEAREST .01 DEG.

WAIT UNTIL CM ANGLE OF ATTACK (ALPHA) IS WITHIN 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.

#330

#340

#350

#360

#370
ENTRY-INITIALIZATION PROGRAM (P63)

REV 00 05/19/71

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 .05G PROGRAM (P64).

ASSUMPTIONS:
2. IN ADDITION TO N64(F, V1, R TO GO) THE ASTRONAUT MAY MONITOR THE FOLLOWING NOUNS BY KEYING IN V16NXXE:
   - N63 (RTOGV, V1O, TFE)
   - N68 (BETA, VI, HDOT)
   - N74 (BETA, VI, G)

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<td>CMC PROG</td>
<td>SELECTION</td>
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<tr>
<td></td>
<td>START ENTRY INITIALIZATION PROGRAM (63)</td>
<td>DISPLAY PROGRAM 63</td>
<td>MONITOR DSKY</td>
</tr>
<tr>
<td></td>
<td>PERFORM ENTRY INITIALIZATION</td>
<td></td>
<td>OBTAIN DISPLAY OF</td>
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(P63/SKYLARK)
Routine which includes:

A-Continue calculation of initial roll angle based on the lateral range of the landing target and heads up/heads down as specified.

B-Continue calculation of desired cm pitch and yaw attitude as determined by the vehicle position and velocity w.r.t. the atmosphere. Prior to jogs this attitude is zero sideslip and angle of attack near trim value.

Maintain cm attitude for lift vector up/down, as selected, zero sideslip, and trim angle of attack.

Temp

Hold

Display on DSKY:

MONITOR DSKY:

Observe display of:

G, VI and R to go

ON

Of N64

R1-G

R2-VI

R3-R to go

#20

#30

#40

#50

#60

#70
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 COUNTING UP WHEN LEAVING TARGET.

-------------------------------
MONITOR GNCS CONTROL OF PRE -.05G CM ATTITUDE:

(1) OSKY:

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.

-------------------------------
WAIT FOR .05G INDICATION

-------------------------------
ENTRY LOGIC DETECTS -.05G

-------------------------------
CHANGE ENTRY DAP FROM ATTITUDE HOLD

-------------------------------
IN ALPHA AND BETA TO
RATE DAMPING IN
PITCH AND YAW, ROLL
UNCHANGED.

---

TERMINATE P63 AND GO
TO ENTRY-POST 0.05G
PROGRAM (P64)

---

MONITOR DSKY:
OBSERVE TERMINATION
OF P63 AND DISPLAY
OF P64

---

* Y

---

HAS 0.05 G OCCURRED
YET ACCORDING TO
EMS?

---

* Y

---

GO TO BACKUP
PROCEDURES

---

HAS 0.05G OCCURRED
YET ACCORDING TO
SEAT OF PANTS?

---

* Y

---

GO TO BACKUP
PROCEDURES

---

EXIT P63
ENTRY - POST 0.05 G PROGRAM (P64)  

LEV 00 05/19/71

PURPOSE:
1. TO START ENTRY GUIDANCE AT 0.05g SELECTING ROLL ATTITUDE, CONSTANT DRAG LEVEL, AND DRAG THRESHOLD, KA, WHICH ARE KEYED TO THE 0.05g POINT.
2. SELECT FINAL PHASE (P67) WHEN 0.2G OCCURS IF V WAS <27000 FPS AT 3.05G.
3. ITERATE FOR UPCONTROL SOLUTION (P65) IF V >27000 FPS AND IF ALTITUDE RATE AND DRAG LEVEL CONDITIONS ARE SATISFIED.
4. SELECT FINAL PHASE (P67) IF NC UPCONTROL SOLUTION EXISTS WITH V >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 V16NX: N64 (G, VI, R TO GO) N68 (BETA, VI, HDOT).

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---
START ENTRY-POST  
0.05 G PROGRAM  
(P 64)  

---
DISPLAY PROGRAM 64  

---
MONITOR DSKY:  
OBSERVE DISPLAY OF PROGRAM 64

---
SET 0.05 G ENTRY
SWITCH ON SCS
CONTROL PANEL TO ON

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.

MONITOR G+N CONTROL OF ENTRY:
(A) F/O:
ATT ERRORS LESS THAN --DEG
ATT RATES LESS THAN --DEG/SEC
BALL INDICATES LIFT VECTOR DIRECTION CORRELATION 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
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 PREDICTION 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
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 0.7 FPS) AND THEREUPON TO SELECT THE ENTRY - BALLISTIC PROGRAM
   (P66).
4. WHERE RDOT IS NEGATIVE AND THE V IS SUFFICIENTLY LOW (V - VL - CLB VE), PROGRAM WILL EXIT DIRECTLY TO P67
   (FINAL PHASE).

ASSUMPTIONS:
1. THIS PROGRAM IS AUTOMATICALLY SELECTED BY THE ENTRY - PIST 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 VISNXXE:
   N64 (G, VI, R TO GO)
   N68 (BETA, VI, HWTL)
3. MANUAL RESPONSE TO N69 IS NOT NECESSARY TO TERMINATE P65. SELECTION OF EITHER P66 OR P67 BY ENTRY GUIDANCE PRO-
   VIDES AUTOMATIC TERMINATION.
HOLD
MON

FLASH VERB- NOUN TO
REQUEST RESPONSE AND
DISPLAY PRE-COMPUTED
EXIT CONDITIONS

V16 V69
R1 - BETA
R2 - DL
R3 - VL

BETA - COMMAND
BANK ANGLE, IN DEG-
REES TO NEAREST 0.01
DEGREE

DL - DRAG ACCELERA-
TION AT SKIP OUT IN
GS TO NEAREST
0.01 G (Q7)

VL - SKIP OUT
VELOCITY, IN FPS TO
NEAREST FPS.

MOYITOR DSKY:

FLASH VERB- NOUN
OBSERVE VERB- NOUN
FLASH TO REQUEST RE-
SPONSE AND DISPLAY
OF BETA, DL, AND VL

#30

#40

#50

#60
---

**TEMP**

**HOLD**

**MCN**

---

**DISPLAY ON DSKY:**

- V06 N74
- R1 - BETA
- R2 - VI
- R3 - G

**BETA - COMMANDED BANK ANGLE, IN DEGREES TO NEAREST 0.01 DEGREE**

**VI - INERTIAL VELOCITY, IN FPS TO NEAREST FPS**

**G-ACCELERATION IN G TO NEAREST .01G**

---

**MONITOR GEN CONTROL OF ENTRY:**

- (A) F/D AI:
  - ATT ERRORS LESS THAN -- DEG
  - ATT RATE LESS THAN -- DEG/SEC

---

**COMMAND CM ATTITUDE IN ACCORDANCE WITH CMG ENTRY LOGIC**

---

**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.)

---
NOTE: BACKUP PROCEDURE SHOULD BE IMPLEMENTED IF THIS DSKY DISPLAY AND/ OR EMS INDICATE DIVERGENCE FROM ACCEPTABLE OPERATIONAL ENVELOPE

FOR A NOMINAL LUNAR MISSION ENTRY CMD WILL GO DIRECTLY TO P66 WHEN DRAG ACCELERATION FALLS BELOW EXIT (SKIP OUT) THRESHOLD OF 07 FPS SQUARED.

WHEN ROOT IS NEGATIVE AND THE VELOCITY IS SUFFICIENTLY LOW (V-VL-CLb VEG) GO DIRECTLY TO P67

MONITOR DSKY: OBSERVE TERMINATION OF P65 AND DISPLAY OF P66 OR P67

TERMINATE P65 AND GO TO ENTRY - BALLISTIC PROGRAM (P66)

EXIT P65

EXIT P65
ENTRY - BALLISTIC PROGRAM (P66)
NOTE: P66 HAS NOT BEEN TESTED AND IS THEREFORE NOT OPERATIONAL FOR SKYLARK.

PURPOSE:
1. TO MAINTAIN CM ATTITUDE DURING BALLISTIC (SKIP JUT) PHASE FOR ATMOSPHERIC RE-ENTRY.  
2. TO SENSE RE-ENTRY (DRAG ACCELERATION BUILDS UP TO QTF + 0.5 FPS OR APPROX. 0.2G) AND THEREUON TO SELECT THE ENTRY - FINAL PHASE PROGRAM (P67).

ASSUMPTIONS:
1. THIS PROGRAM IS AUTOMATICALLY SELECTED BY THE ENTRY - UP CONTROL PROGRAM (P65) WHEN DRAG ACCELERATION BECOMES LESS THAN 0.7 FPS .
2. THE ASTRONAUT MAY MONITOR THE FOLLOWING NOUNS BY KEYING IN VI6NXXE:
   NI6 (G, VI, R TO GO)
   N68 (BETA, VI, HOOT)
   N74 (BETA, VI, G)
---

ESTABLISH ATTITUDE
COMMAND 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 MAINTAIN
  ZERO DEGREES
  UNTIL TERMINATION
  OF P66.

- ALPHA COMMAND -
  TRIM ANGLE OF
  ATTACK (TRIM
  ALPHA)

- BETA COMMAND -
  ZERO.

---

CALCULATE FINAL
GIMBAL ANGLES RE-
QUIRED BASED ON PRE-
SENT STATE VECTOR.
REPEAT CALCULATION
EVERY TWO SECONDS
UNTIL TERMINATION OF
P66.

---

TEMP

*CLD DISPLAY ON DSKY:

**MON THE DESIRED GIMBAL
  ANGLES TO WHICH THE
  ENTRY DAP WILL ORI-
  ENT THE CM

********* MONITOR GNCS CONTROL
          OF ENTRY:

---

#20

#30

#40

#50

#60
V06 V22
R1-05 ROLL
R2-15 PITCH
R3-0G YAW

ALL COMMANDED GIMBAL
ANGLES IN DEGREES TO
NEAREST 0.01 DEGREE.

FDAY: ATTITUDE
ERROR NEEDLES -
DIFFERENCE BETWEEN
THE TOTAL DE-
SIRED ATTITUDE
AND THE ACTUAL
ATTITUDE (FLY TO
POLARITY).

BALL: ACTUAL GIMBAL
ANGLES READ ON BALL
SHOULD AGREE WITH
COMMANDED GIMBAL
ANGLES READ ON DSky.

COMMAND CM ATTITUDE:
IN ACCORDANCE WITH
CMC ENTRY - BALLIS-
TIC PHASE LOGIC.

ROLL ANGLE IS HELD
AT LAST COMPUTED
VALUE FROM ENTRY
GUIDANCE UNLESS
ACCELERATION GOES
BELOW 0.05G IN WHICH
CASE ZERO DEGREES IS
HELID UNTIL TERMINA-
TION OF P66.
PITCH AND YAW
ATTITUDE IS DETER-
MINED BY THE VEHICLE
POSITION AND VELO-
SITY W.R.T. THE
ATMOSPHERE. THIS
ATTITUDE IS ZERO
SIDESLIP AND ANGLE
OF ATTACK NEAR THE
TRIM VALUE.

NOTE: THREE AXIS DAP
CONTROL WAS REGAINED
WHEN LESS THAN 0.05
G WAS SENSED AND
WILL BE RELINQUISHED
WHEN 0.75 G IS AGAIN
SENSED.

---

TERMINATE P66 AND GO
TO ENTRY-FINAL PHASE
PROGRAM (P67) WHEN
DRAG ACCELERATION
REACHES 2
TO Q7F + 0.5 FPS

---

EXIT P66

---

MONITOR DSKY:
OBSERVE TERMINATION
OF P66 AND DISPLAY
OF P67

---

EXIT P66

CHANGE CONTROL NOTES
ENTRY - FINAL PHASE PROGRAM (P67)  

PURPOSE:  
(1) TO CONTINUE ENTRY GUIDANCE AFTER Q7F + 0.5 FPS  
2  
OR APPRX. 0.2G UNTIL TERMINATION OF STEERING WHEN THE CM  
VELOCITY WRT EARTH = 1000 FT/SEC (ALTITUDE IS APPROXIMATELY 65,000 FT.).  
(2) TO CONTINUE ENTRY DSKY DISPLAYS.  

ASSUMPTIONS:  
(1) THE PROGRAM IS AUTOMATICALLY SELECTED BY:  
(A) P65 WHEN RDOT IS NEGATIVE AND THE V IS SUFFICIENTLY LOW (V-VL>C18 NEG)  
(B) P66 WHEN DRAG ACCELERATION BUILDS UP TO Q7F + 0.5 FPS. (OR APPRX. 0.2G)  
(C) P64 IF NO UPCONTROL SOLUTION EXISTS WITH VL > 18000 FPS  
(2) THE ASTRONAUT MAY MONITOR THE FOLLOWING NOUNS BY KEYING IN V16NXXE:  
N64 (G, VI, R TO GO)  
N68 (BETA, VI, RDOT)  
N74 (BETA, VI, G)  

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START ENTRY-FINAL PHASE PROGRAM (P 67)  

DISPLAY PROGRAM 67  
MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 67  

#10  

#20  

P67/SKYLARK
TEMP

OLD

MCN

---------------------
DISPLAY ON DSKY:

VO6 VO6
R1-BETA
R2-X RNG ERR
R3-DWN RNG ERR

---------------------
MONITOR G+H CONTROL
OF ENTRY:

(A) FOAI:
ATT ERRORS LESS
THAN -- DEG
ATT RATES LESS
THAN -- DEG/SEC.

(B) DSKY:
R1-BETA VARIES
TO LIMIT G AND
CONTROL LIFT
VECTOR.

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.

DWN RNG ERR - CMC
SOLUTION FOR DOWN
RANGE ERROR (DECREASING) POSITIVE
FOR OVERSHEET,
NEGATIVE FOR UN-
DERSHOOT. IN NAUT-
ICAL MILES TO
NEAREST .1 NM.
(PREDANGLE-THETA)
NOTE: THE DWN RNG
ERR DISPLAY WILL
BE 9999.9 NM ONCE
THE TARGET HAS
BEEN OVERSHOT.

---------------------

R3- DWN RNG ERR
- DECREASING

---------------------
COMMAND CM ATTITUDE IN ACCORDANCE WITH CMC ENTRY LOGIC

WAIT UNTIL CM VELOCITY WRT EARTH = 1000 FPS

FLASH VERB- NOUN TO REQUEST RESPONSE AND DISPLAY:
  V16 N67
  R1-R TO GO
  R2-LAT
  R3-LONG

R TO GO-RANGE TO GO TO TARGET. IN NAUTICAL MILES TO NEAREST .1 NM. NEGATIVE AND DECREASING WHEN APPROACHING TARGET, POSITIVE AND INCREASING WHEN LEAVING TARGET.

LAT - LATITUDE OF PRESENT POSITION. IN DEGREES TO NEAREST .01 DEG. (+ IS N39TH)

LONG - LONGITUDE OF PRESENT POSITION. IN DEGREES TO NEAREST .01 DEG. (+ IS EAST)

MONITOR DSKY:
OBSERVE VERB- NOUN FLASH TO REQUEST RESPONSE AND DISPLAY PRESENT POSITION AND RANGE TO GO

HOLD CONSTANT ATTITUDE MANUALLY (PULL LIFT UP OR DOWN. DEPENDING ON R TO GO) UNTIL CHUTE DEPLOYMENT.

MONITOR ALTIMETER AND STANDBY TO BACK-
UP MESC FOR CHUTE DEPLOYMENT

----------------------------------------

WAIT FOR KEYBOARD ENTRY

----------------------------------------

WHEN CM IS ON THE CHUTES SWITCH THE SC
CONT SWITCH FROM CMC TO SCS TO PREVENT
UNDESIIRED 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

----------------------------------------

TERMINATE FLASH UPON RECEIPT OF PROCEED

----------------------------------------

- PRO

----------------------------------------

TURN OFF ENTRY DAP

----------------------------------------

----------------------------------------

DO ROUTINE R00

----------------------------------------

DO ROUTINE R00

----------------------------------------

- EXIT P67

----------------------------------------

- EXIT P67

CHANGE CONTROL VOTES
GSM 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 time.
2. RO3 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.

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</table>

*CREW
*PROGRAM
*SELECTION

++.01
++
+ DO ROO TO START GSM VELOCITY VECTOR UPDATE PROGRAM (P77)
+++ DISPLAY P77

--- KEY IN GSM VELOCITY VECTOR UPDATE PROGRAM (P77) V37E77E ---

--- MOITOR DSKY: OBSERVE DISPLAY OF PROGRAM 77 ---
OLD

Flash verb-noun to request response and display TIG V06N33
R1-TIG-HRS
R2-TIG-MINS
R3-TIG-SECS

TIG-Time of ignition (GET), in HRS, MINS, SEC to nearest .01 SEC.

Wait for keyboard entry.

Monitor OSKY:
Observe verb-noun flash to request response and display of TIG.

Is the value displayed the correct time at which the CM executed or will execute the maneuver?

Y

 Key in proceed

Terminate flash upon receipt of proceed or new data

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

Key in V25E and load the correct TIG

446
HOLD  *  FLASh VERB-NOUN
TO REQUEST RESPONSE
AND DISPLAY THREE
COMPONENTS OF DELTA 

V.(LV)

V04950
R1-DELTA VX(LV)
R2-DELTA VY(LV)
R3-DELTA VZ(LV)

DELTA VX(LV)-
COMPONENT OF DELTA V
APPLIED AT TIG 
ALONG VX XR. IN 
FPS TO NEAREST .1 
FPS.

DELTA VY(LV)-
COMPONENT OF DELTA V
APPLIED AT TIG ALONG 
VY XR. IN FPS TO NEAR-
EST .1 FPS.

DELTA VZ(LV)-
COMPONENT OF DELTA V
APPLIED AT TIG ALONG 
R. IN FPS TO NEAR-
EST .1 FPS.

WHERE R IS CSM GEO-
CENTRIC RADIUS 
VECTOR AND V IS CSM 
INERTIAL VELOCITY 
VECTOR AT TIG.

MONITOR DSKY
OBSERVE VERB-NOUN
FLASH TO REQUEST 
RESPONSE AND DISPLAY 
THREE COMPONENTS OF 
DELTA V APPLIED 
ALONG LOCAL VERTICAL 
AXES AT TIG.

WAIT FOR KEYBOARD 
ENTRY

ARE THE VALUES 
DISPLAYED THE
CORRECT ONES EXECUTED OR TO BE EXECUTED?

Y   N

------------------

KEY IN PROCEED

------------------

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

------------------

PROCEED NEW DATA

STORE DATA

------------------

SET NODEFLAG

------------------

UPDATE CM STATE VECTOR TO REFLECT THE DELTA V ADDED. DELTA V HAS BEEN TRANSFORMED FROM LOCAL VERTICAL INTO BASIC REFERENCE COORDINATES.

------------------
FINAL AUTOMATIC REQUEST TERMINATE

PURPOSE:
(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.

ASSUMPTIONS:
(1) THE CALLING PROGRAM HAS SUCCESSFULLY COMPLETED ALL ITS FUNCTIONS OR THE OPERATOR HAS PREMATURELY TERMINATED THE PROGRAM OR A POO00 TYPE ABORT (WITHOUT AVERAGE G ACTIVE ANY WITH NO EXTENDED VIP3 ACTIVE) HAS OCCURRED.
(2) THE COMPUTER CHECKS ON THE UNIVERSE 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) P20 IS RUNNING IN THE BACKGROUND THE P20 LIGHTS WILL BE CHANGED TO 20 AND P20 WILL START AT P20 START 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; POO TYPE INTEGRATION WILL START IN THE REMAINING OPTIONS.
(D) IF POO IS SELECTED, THE RENDZelhoZS FLAG AND UFLAG ARE RESET (SHIFT OFF P20) AND P20 IS STARTED.
(E) IF A PROGRAM OTHER THAN P20 AND POO 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 3 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 FMZ 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 ROO TO MINKEY CONTROLLER (K07).

PROG CMG GROUND CREW
SET HOLDFLAG
ZERO

SET DAP REFERENCE
TO DESIRED DAP
CDUS

IS MINKEY RUNNING
(AUTOSEQ FLAG SET)?

NO
YES

GO TO NEXT
POINT IN
MINKEY
CONTROLLER
(R07)

FLASH VERB 37 TO
REQUEST PLEASE PER-
FORM CHANGE OF
PROGRAM
V37 'L BLANK
R1 BLANK
R2 BLANK
R3 BLANK

MONITOR DSKY:
OBSERVE VERB 37
FLASH TO REQUEST
PLEASE PERFORM
CHANGE OF PROGRAM.
WAIT FOR KEYBOARD ENTRY TERMINATE
FLASH ON RECEIPT OF OF XE

RECEIVE V3TEXXE TO REQUEST NEW PROGRAM

"A" ENTRY FROM V96 WITH PROGRAM POD SPECIFIED

TURN OFF MINKEY
CONTROLLER (RESET AUTOSEQ FLAG)

RESET PIIMNFLG

RESET PCEMNFLG
STOP ACCEPTING VHF RANGE DATA
(RESET VHFFLAG)

INVALIDATE MARK BUFFER

IS MAJOR MODE SELECTED GREATER THAN 79?

NO  YES

TURN ON OPERATOR ERRJR

EXIT

IS THE IMU ALIGNED (REFSMAT FLAG SET)?

NO  YES

IS MAJOR MODE P31-P38?

NO  YES

GO TO
**UNIVERSAL TRACKING (P20) OPTION 1, 2 OR 5 ON (UFLAG SET)?**

**YES** | **NO**
---|---

**YES**

**NO**

**SUMMARY**

**IS UNIVERSAL TRACKING (P20) OPTION 3 OR 4 ON (RENEZVOUS FLAG SET)?**

**YES**

**NO**

**SUMMARY**
GO TO THE POINT IN
THE MINKEY CONTROLLER ROUTINE (ROT)
SPECIFIED BY THE SELECTED MAJOR MODE

"B"

PROGRAM

SELECTION BY

MINKEY

CONTROL

LER (ROT)

++

+++01
++ IS THE IMU BEING
++ INITIALIZED?
++ (IMODE=0 BIT 6=1)
++

+++489
+++ N
++ Y

---

TURN ON PROGRAM
ALARM LIGHT AND
STORE ALARM CODE
1520
---

EXIT

---

IS THE TVC DAP ON OR

MONITOR DSKY:
DOES PROGRAM
ALARM LIGHT COME ON INDICATING THAT
THE IMU IS STILL
BEING INITIALIZED?
---

+++N
++ Y
++

---

RESET ALARM LIGHT.
---
IS THE ENGINE ON?

Y

N

TERMINE THE ENGINE ON COMMAND.

TURN OFF TVG DAP

TURN OFF ALL RCS TRANSLATION AND ROTATION

WAIT ABOUT 3 SECONDS

TURN ON RCS DAP

WRITE ZEROS INTO NEW PROGRAM SELECTION

RESELECT V37

EXIT

#360

#370

#380

#390

#400
SO THAT REGARDLESS OF THE SELECTED PROGRAM, ROO WILL SELECT POO.

IS NEW PROGRAM POO?

Y N

IS NOOFLAG SET TO INHIBIT SELECTION OF A NEW PROGRAM OTHER THAN POO?

N Y

TURN ON PROGRAM ALARM LIGHT AND STORE ALARM CODE 1520

MONITOR DSKY: DOES PROGRAM ALARM LIGHT COME ON, INDICATING THAT NEW PROGRAM SELECTION IS NOT PERMITTED AT THIS TIME?

N Y

EXIT

DOES THE NEW PROGRAM EXIST?

Y N

RESET ALARM LIGHT AND WAIT FOR COM-
PLETION OF
ACTIVITY OK,
IF POB, SHUT
DOWN THE CMC
to STANDBY
BY KEYING IN
PROCEED

EXIT

SET VS0NL8FL

IS AVERAGE G ON?

N  Y

TURN AVERAGE
g OFF

IS TRACK FLAG SET?

NO  YES

EXIT

#460

#470

#480

#490

#500
STOP RATE DRIVE FROM P2J

IS HOLDFLAG NEGATIVE?

SET HOLDFLAG ZERO

SET DAP REFERENCE TO DESIRED DAP CDUS

RESET TARG1FLG

RESET S0FLAG, P55.1FLG, P50.1FLG
RESET TRACK FLAG,
RZ7UP1, RZ7UP2,
TOFLAG, P29FLAG,
P48FLAG, SNAPFLAG,
CYCLFLAG

RESET UPDATFLG

RESET R67FLAG

RESET EXTRANGE FLAG

RESET STICK FLAG

TURN OFF UPLINK ACTY LIGHT

RESET R21MARK

#610

#620

#630

#640

#650
IS NEW PROGRAM P00?

| N | Y |

- RESET N300FLAG

- RESET RENDEZVOUS FLAG

- RESET UTFLAG

IS NEW PROGRAM P20?

| N | Y |

- IS THE CURRENT PROGRAM P20?

| Y | N |

IS UTFLAG SET?

| YES | NO |
CHANGE CONTROL NOTES

REV 00  PCR 003, 011, 032, 036, 040, 453, PCN 455, 456, SKYLARK MEMO #2
REV 01  PCN 489
ERASABLE AND CHANNEL MODIFICATION
ROUTINE (ROI)

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
   0E

   (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
   0E
# IMU STATUS CHECK ROUTINE (R02)

## PURPOSE:
1. TO CHECK WHETHER IMU IS ON AND IF ON WHETHER IT IS ALIGNED TO AN ORIENTATION KNOWN BY THE CMC.
2. TO ESTABLISH A PROGRAM ALARM AND STORE AN ALARM CODE IF THE IMU IS OFF OR NOT ALIGNED TO AN ORIENTATION KNOWN BY THE CMC.

## ASSUMPTIONS:
1. THE ROUTINE IS ONLY AUTOMATICALLY SELECTED.

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**CMC ROUTINE**

**SELECTION**

```
----------------
START IMU STATUS CHECK ROUTINE (R02)
----------------

IS THE ISS ORIENTATION KNOWN FLAG SET? (CHECK REFSSMAT FLAG)
----------------

Y  N

IS THE ISS ON?
----------------

Y  N

```

---

#10

#20

---
TURN ON PROGRAM
ALARM LIGHT BUT
DO NOT CHANGE
PRESENT DISPLAY
ALARM DISPLAY
IF CALLED IS:
V0S N09
R1
R2
R3

EXPECTED ALARM
CODE IS 00210

------------------------

TURN ON PROGRAM
ALARM LIGHT BUT
DO NOT CHANGE
PRESENT DISPLAY
ALARM DISPLAY IF
CALLED IS:
V0S N09
R1
R2
R3

EXPECTED ALARM
CODE AT THIS TIME IS 00220

------------------------

Y
N

CALL PROGRAM ALARM DISPLAY (V0S N09) TO IDENTIFY ABNORMALITY. WHEN FINISHED PUSH KEY RELEASE.
CHANGE CONTROL NOTES
CSM DAP DATA LOAD ROUTINE (RO3)

REV 00  05/19/71

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 KEYPAD KEYPLEFT 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 ASTROVAT BY USKY ENTRY.

4) THIS ROUTINE IS NOT AVAILABLE IF UNDER THRUST VECTOR CONTROL.

---

RO3/SKYLARK
MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

- N
- Y

TURN ON OPERATOR ERROR LIGHT.

- ...
- ...
- EXIT

OLD SNAP

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY DAP CONFIGURATION DATA:

- V04 446
- R1-ABCDE
- R2-ABCDE
- R3-BLANK

R1 DATA CODE:
A-VEHICLE CONFIG.
CODE:
O-NO DAP
1-CSM

3-S1V8
B-QUAD AC FOR
X TRANS CODE:
O-DON'T USE
QUAD
1-USE QUAD
C-QUAD BD FOR
X TRANS CODE:
O-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 CONFIGURATION DATA?

- Y
- N

478
QUAD
1-USE QUAD
D-DEADBAND CODE:
0-0.5 DEG
1-2.0 DEG
E (LSB)-MANEUVER
RATE CODE:
0-0.5 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-USE 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
DID THE ASTRONAUT SELECT MAXIMUM DEAD-BAND (D IN R1 = 1)?

N Y

RESET MAX DB FLAG

SET MAX DB FLAG

IS WHICH DAP SET? (IS DOCKED DAP RUNNING)

N Y

TRANSFER DATA TO RCS DAP
FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY CSM WEIGHT:
V06 447
R1-XX
R2-xxxx
R3-BLANK

CSM WEIGHT=WEIGHT OF THE CSM IN POUNDS TO THE NEAREST POUND.
NOTE: R2 (LM WEIGHT) NOT APPLICABLE TO SKYLLARK

MONITOR DSKY:
OBSEERVE VERB-NOUN
FLASH TO REQUEST RESPONSE AND DISPLAY OF CSM WEIGHT

IS THE CSM WEIGHT CORRECT?
Y N

WAIT FOR KEYBOARD ENTRY

KEY IN PROCEED

KEY IN V21E AND LOAD CORRECT DATA
TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

P NEW DATA
R DATA
C
E STORE DATA
D

IS THE VEHICLE CONFIGURATION CODE EQUAL TO 0 OR 3?

Y
N

COMPUTE MASS PROPERTIES

IS VEHICLE CONFIGURATION CODE EQUAL TO 2 OR 6?

N Y
TRANSFER ENTIRE VEHICLE WEIGHT TO WEIGHT/G

TRANSFER CSM WEIGHT TO WEIGHT/G

IS WHICH DAP SET? (IS DOCKED DAP RUNNING)

N

Y

COMPUTE AND TRANSFER DATA TO RCS DAP

FLASH VERB–NOUN TO REQUEST RESPONSE AND DISPLAY GIMBAL ACTUATOR TRIM VALUES:
V06 V48
R1–PITCH TRIM
R2–YAW TRIM
R3–BLANK

MONITOR DSKY: OBSERVE VERB–NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF GIMBAL ACTUATOR TRIM VALUES
DOCKED DAP DATA LOAD (R04)  

REV 00 05/19/71

PURPOSE:  
1) TO LOAD AND VERIFY CMC DIGITAL AUTOPILOT DATA FOR DOCKED DAP.  
2) AFTER COMPLETION OF THIS ROUTINE, KEYING V4SE WILL ENABLE THE DOCKED RCS DAP AND DISABLE THE CSM-ALONE DAP OR SATURN TAKEOVER FUNCTION IF EITHER IS ACTIVE.

ASSUMPTIONS:  
1) THIS ROUTINE IS NOT USED IF TVC DAP OR ENTRY DAP IS OPERATING.  
2) THIS ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

---

START DOCKED DAP DATA LOAD ROUTINE (R04)

---

IS ANOTHER EXTENDED VERB A MARKING DISPLAY OR A PRIORITY DISPLAY ACTIVE?

---

TURN ON OPERATOR ERROR

---

#10

#20
LIGHT

* *

... . ........ . . 0 .. ... ..... ... . . . . . . . .

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R2: CHANNEL 5 JET INHIBIT

TO INHIBIT JETS, SELECT CORRESPONDING OCTAL VALUES FROM FOLLOWING TABLE AND LOAD THEIR SUM (CODE) IN R2.

CH5 FAIL OCTAL

<table>
<thead>
<tr>
<th>JET</th>
<th>BIT #</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3(1)</td>
<td>1</td>
<td>00001</td>
</tr>
<tr>
<td>C4(4)</td>
<td>2</td>
<td>00002</td>
</tr>
<tr>
<td>A3(3)</td>
<td>3</td>
<td>00004</td>
</tr>
<tr>
<td>A4(2)</td>
<td>4</td>
<td>00010</td>
</tr>
<tr>
<td>D3(5)</td>
<td>5</td>
<td>00020</td>
</tr>
<tr>
<td>D4(8)</td>
<td>6</td>
<td>00040</td>
</tr>
<tr>
<td>B3(7)</td>
<td>7</td>
<td>00100</td>
</tr>
<tr>
<td>B4(6)</td>
<td>8</td>
<td>00200</td>
</tr>
</tbody>
</table>

R3: CHANNEL 6 JET INHIBIT

TO INHIBIT JETS, SELECT CORRESPONDING OCTAL
VALUES FROM
FOLLOWING TABLE
AND LOAD THEIR
SUM (CDE) IN R3.

CH6 FAIL
OCTAL

JET BIT #
VALUE

--- ----- ---------
B1(9) 1 00001
B2(12) 2 00002
D1(11) 3 00003
D2(10) 4 00010
A1(13) 5 00020
A2(16) 6 00040
C1(15) 7 00100
C2(14) 8 00200

---

WAIT FOR KEYBOARD
ENTRY

---

KEY IN
PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

--- LOAD DESIRED
NEW
DATA

---

NEW
DATA

---

E E
STORE

---

D DATA

---

D DATA

---

488
RESET 500**FLG AND 501**FLG

HOLD * FLASHER VERB-NOUN TO REQUEST RESPONSE AND DISPLAY DAP RATE AND DEADBAND
  V06 N89
  R1 - DAP RATE
  R2 - DAP DEADBAND
  R3 - BLANK
  R1 - DAP RATE IN DEG/SEC TO NEAREST .0001 DEG/SEC
  R2 - DAP DEADBAND IN DEGREES TO THE NEAREST .01 DEG.

MONITOR SKY:
  OBSERVE VERB-NOUN
  FLASH TO REQUEST RESPONSE AND DISPLAY OF DAP RATE AND DEADBAND

AM I SATISFIED WITH THIS DAP DATA?
  Y  N

WAIT FOR KEYBOARD ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

LOAD DESIRED DATA

.P  .NEW
.R  .DATA
MINKEY CONTROLLER ROUTINE (RO7)

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 RO3 HAS BEEN PERFORMED 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 (WRENPOS 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 RO7 ENTER RO0 AT "80".

PROG CONT

CMC GROUND CREW

P31
NC1 INITIATION
POINT FROM RO0

HOLD

SNAP

FLASH VERB-NOUN TO REQUEST PLEASE PERFORM MINKEY SEQUENCE: VSO N25 R1-00J17 R2-BLANK R3-BLANK

MONITOR DSKY:

OBSERVE VERB-NOUN FLAS TO REQUEST PLEASE PERFORM MINKEY SEQUENCE

DO I WISH TO PERFORM THE RENDEZVOUS USING THE MINKEY SEQUENCE?

WAIT FOR KEYBOARD ENTRY

NO YES

RO7/SKYLARK
IS HEADS UP DESIRED (HDSUPFLG SET)?

- YES
- NO

SET OMICRON=0 DEGREES (R3 OF N78)

SET OMICRON=180 DEGREES (R3 OF N78)

IS M-MATRIX VALID FOR RENDEZVOUS NAVIGATION (RENDWFLG SET)?

- NO
- YES

SET FLAGS FOR AUTO M-MATRIX REINITIALIZATION (MANEFGL, PTV93FLG)

RESET PCFLAG
START MINKEY
(SET AUTOSEQ
FLAG)

CALL THE NC1 TARGETING PROGRAM (P31).

IS MAGNITUDE OF
DELTA V(1V) (RSS OF
NB1) GREATER THAN OR
EQUAL TO 10 FPS?

YES       NO

CALL SPS
THRUSTING
PROGRAM (P40)

CALL THE
RCS THRUSTING
PROGRAM (P41)

#140

#150

#160

#170

494
P32 INITIATION
POINT FROM ROO

HOLD
SNAP =
FLASH VERB- NOUN
TO REQUEST PLEASE
PERFORM MINKEY
SEQUENCE:
V30 N25
R1-00117
R2-BLANK
R3-BLANK

MONITOR DSKY:
OBSERVE VERB- NOUN
FLASH TO REQUEST
PLEASE PERFORM
MINKEY SEQUENCE

DO I WISH TO PERFORM
THE RENDEZVOUS USING
THE MINKEY SEQUENCE?

NO
YES

WAIT FOR KEYBOARD
ENTRY

KEY IN ENTER

TERMINATE FLASH UPON
RECEIPT OF ENTER,
PROCEED OR TERMINATE

W34E P E
R N
Q E
C R
RESET E R
AUTOSQE D
FLAG D

KEY IN PROCEED

DO ROUTINE
RESET AUTOSQE
IS W-MATRIX VALID FOR RENDEZVOUS NAVIGATION (RENWFLG SET)?

- NO
- YES

SET FLAGS FOR AUTO W-MATRIX REINITIALIZATION (MANEUFLG, PTV93FLG)

RESET PCFLAG

START MINKEY (SET AUTOSEQ FLAG)
CALL NC2 TARGETING PROGRAM (P32)

IS THE Magnitude OF DELTA V (RSS OF N81) GREATER THAN OR EQUAL TO 10 FPS?

. YES . NO

CALL SPS THRUSTING PROGRAM (P40)

CALL RCS THRUSTING PROGRAM (P41)

GO TO NCC INITIATION POINT IN THIS ROUTINE "D" BELOW
P33
NCC TARGET-ING INITIALIZATION POINT FROM R00

HOLD

SNAP

FLASH VERB-NOUN TO REQUEST PLEASE PERFORM MINKEY SEQUENCE
V50N25
R1-00Q17
R2-BLANK
R3-BLANK

MONITOR DSKY: OBSERVE VERB-NOUN
FLASH TO REQUEST PLEASE PERFORM MINKEY SEQUENCE

DO I WISH TO PERFORM THE RENDEZVOUS USING THE MINKEY SEQUENCE?

NO

YES

WAIT FOR KEYBOARD ENTRY

KEY IN ENTER

TERMINATE FLASH UPON RECEIPT OF ENTER, PROCEED OR TERMINATE

V34E PE
R N
RES

DO ROU-
TINE
RO3

EXIT RO7

WAS P20 STARTED
WITH HEADS
ORIENTATION
SPECIFIED
(\AZIMFLAG SET)?

\NO \YES

SET AZIMFLAG

IS HEADS UP DESIRED
\(\HDSUPFLG SET)?

\YES \NO

\...
START MINKEY
(SET AUTOSEQ
FLAG)

CALL THE VCC TARGETING PROGRAM (P33)

IS THE MAGNITUDE OF
DELTA V (RSS OF NB1)
GREATER THAN OR
EQUAL TO 10 FPS?

*YES *NO

CALL THE SPS
THRUSTING
PROGRAM
(P40)

CALL THE RCS
THRUSTING
PROGRAM

PROCEDURE

GO TO THE NSR INITIALIZATION POINT IN THIS ROUTINE "M" BELOW

P34 NSR TARGETING INITIALIZATION POINT FROM R00

HOLD

SNAP

FLASH VERC-NOUN TO REQUEST PLEASE PERFORM MINKEY SEQUENCE

V50 N25 R1-0017 R2-BLANK R3-BLANK

MONITOR DSKY:

OBSERVE VERC-NOUN FLASH TO REQUEST PLEASE PERFORM MINKEY SEQUENCE

DO I WISH TO PERFORM THE RENDEZVOUS USING THE MINKEY SEQUENCE?

NO YES
IS HEADS UP DESIRED
(HDSPFLG SET)?

+YES
-NO

SET DMICRON=0
DEGREES
(R3 OF 478)

SET DMICRON=180
DEGREES
(R3 OF N78)

IS M-MATRIX VALID
FOR RENDEZVOUS
NAVIGATION
(RENWFLG SET)?

+NO
+YES

SET FLAGS FOR
AUTO M-MATRIX
REINITIALIZATION
(MANEFILG,
PTV93FLG)

RESET PFLAG
START MINKEY
(SET AUTOSEQ
FLAG)

CALL THE NSR TARGET-
ING PROGRAM (P34)

IS THE MAGNITUDE OF
DELTA V (RSS OF N81)
GREATER THAN OR
EQUAL TO 10 FPS?

*YES
*NO

CALL THE SPS
THRUSTING
PROGRAM
(P40)

CALL THE RCS
THRUSTING
GO TO THE TPI TARGETING INITIALIZATION POINT IN THIS ROUTINE "F" BELOW

P35 TPI TARGETING INITIALIZATION POINT FROM 300

HOLD * FLASH VERB-NOUN TO REQUEST PLEASE PERFORM MINKEY SEQUENCE
V50 429
R1-03017
R2-BLANK
R3-BLANK

MONITOR DSKY: OBSERVE VERB-NOUN FLASH TO REQUEST PLEASE PERFORM MINKEY SEQUENCE

DO I WISH TO PERFORM THE RENDEZVOUS USING

RO7/SKYLARK
SET AZIMFLAG

IS HEADS UP DESIRED
(HDSUPFLG SET)?

YES

NO

SET MICRON=0
DEGREES
(R3 OF N78)

SET MICRON=180
DEGREES
(R3 OF N78)

IS M-MATRIX VALID
FOR RENDEZVOUS
NAVIGATION
(RENDWFLG SET)?

NO

YES

SET FLAGS FOR
AUTO M-MATRIX
REINITIALIZATION (MANEUFGL, PTV93FLG)

RESET PCFLAG

START MINKEY (SET AUTOSEQ FLAG)

CALL THE TPI TARGETING PROGRAM (P35)

IS THE MAGNITUDE OF DELTA V (RSS OF NB1) GREATER THAN OR EQUAL TO 10 FPS?

YES

NO
CALL THE SPS THRUSTING PROGRAM (P40)

---

CALL THE RCS THRUSTING PROGRAM (P41)

---

GU TJ THE TPM TARGETING INITIALIZATION POINT IN THIS ROUTINE "S" BELOW

---

OLD

SNAP

---

FLASH VERB-NOUN TO REQUEST PLEASE PERFORM MINKEY SEQUENCE V50 V25

---

MONITOR OSKY: OBSERVE VERB-NOUN FLUSH TO REQUEST PLEASE PERFORM
WAS P2D STARTED WITH HEADS ORIENTATION SPECIFIED (AZIMFLAG SET)?

- NO
- YES

SET AZIMFLAG

IS HEADS UP DESIRED (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
(RENDWFLG SET)?

NO  YES

SET FLGS FOR
AUTO W-MATRIX
REINITIALIZA-
TION (MANEJFLG,
PTV99FLG)

RESET PCFLAG

START MINKEY
(SET AUTOSEQ
FLAG)

"G"

CALL THE TPM TARGETING
PROGRAM
GREATER THAN OR
EQUAL TO 10 FPS?

* YES
* NO

CALL THE SPS
THRUSTING
PROGRAM
(P40)

CALL THE RCS
THRUSTING
PROGRAM
(P41)

GC TO
REND\E\V\US
FINAL PHASE
PROGRAM INITIATION
POINT IN THIS
ROUTINE
"H" BELOW

P37 RENDEZVOUS
FINAL PHASE
INITIALIZATION
POINT FROM ROO

HOLD
FLASH VERB-NOUN TO
REQUEST PLEASE PER-
SNAP FORM MINKEY SEQUENCE
V50 \N25

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
WAS P20 STARTED WITH
HEADS ORIENTATION
SPECIFIED (AZIMFLAG
SET)?

---

NO
---

YES
---

SET AZIMFLAG

---

IS HEADS UP DE-
SIRED (HDSUPFLG
SET)?

---

YES
---

NO
---

SET
OMICRON=0
DEGREES
(R3 OF N78)

---

SET
OMICRON=180
DEGREES
(R3 OF N78)

---

IS W-MATRIX VALID FOR
RENDZVOUS NAVIGATION
(RENDWFLG SET)?

---

<table>
<thead>
<tr>
<th>NO</th>
<th>YES</th>
</tr>
</thead>
</table>

---

SET FLAGS FOR
AUTO W-MATRIX
REINITIALIZATION
(MANEUFLG,
PTV93FLG)

---

RESET PCFLAG

---

START MNKEY
SET AUTOSEQ
FLAG

---

CALL RENDEZVOUS
FINAL PHASE PROGRAM
(P37)
CALL REDEZVOUS
THRUST MONITOR
PROGRAM (P48)

PERFORM ROUTINE 00
(R00)

EXIT R07

P38
PLANE CHANGE
INITIATION
POINT FROM
R03

HOLD
FLASH VERB-NOUN TO
REQUEST PLEASE PER-
FORM MINKEY SEQUENCE
V50 N25
R1-00017
R2-BLANK
R3-BLANK

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
MINKEY SEQUENCE

DO I WISH TO PERFORM
THE REDEZVOUS USING
THE MINKEY SEQUENCE?

NO   YES
IS HEADS UP DESIRED
(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
(RENWFLG SET)?

---

NO
YES

---

SET FLAGS FOR
AUTO W-MATRIX
REINITIALIZA-
TION (MANEFLG,
PTV93FLG)

---

RESET PCFLAG

---
START MIKE (SET AUTOSEQ FLAG)

CALL PLANE CHANGE TARGETING PROGRAM (P38)

IS MAGNITUDE OF DELTA V (RSS OF N91) EQUAL TO ZERO?

YES NO

PERFORM R33

DO THE IMU EXIT REALIGNMENT PROGRAM (P52)

---

523 585 ROT/SKYLARK

---
WAS PULSE TORQUING ACTUALLY PERFORMED (PCFLAG RESET)?

* NO * YES

CALL THE RCS THRUSTING PROGRAM (P41)

PERFORM ROO

EXIT RO7

IS THE MAGNITUDE OF DELTA V (RSS OF NB1) GREATER THAN OR EQUAL TO 10 FPS?

* YES * NO

CALL THE SPS THRUSTING PROGRAM (P40)
CALL THE RCS THRUSTING PROGRAM (P41)

SET PCMANFLG

CALL THE UNIVERSAL TRACKING PROGRAM (P20)

RESET PCMANFLG

CALL THE I4U REALIGNMENT PROGRAM (P52)

PERFORM ROUTINE 000

EXIT ROT
VHF RANGE READ ROUTINE (108)

PURPOSE: (1) 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).

(3) WHEN CALLED BY R22, THE VHF MEASURED RANGE IS EXTENDED BEYOND 327.67 N.M. IF INDICATED BY THE RANGE COMPUTED IN D1 USING THE ON-BOARD STATE VECTOR ESTIMATES.

PROG CONT CMC GROUND CREW

---CMC ROUTINE
-SELECTION

---START VHF RANGE READ ROUTINE (108)

---RESET BITS 1-4 OF CHANNEL 13

---SYNCHRONIZE SETTING OF RADAR ACTIVITY
BIT WITH CHANNEL 4 (LOSALAR) TO PREVENT SPLIT RADAR PULSE

SET BITS 1 AND 4 OF CHANNEL 13 TO "1" TO REQUEST RANGE READ-OUT FROM VHF DATA LINK

READ PRESENT TIME

RESET VHF RESTART FLAG

WAIT FOR READ TO BE COMPLETED

NOTE: RADARUPR WILL SIGNAL END OF READ

IS VHF RESTART FLAG SET?
TO CALLER'S
ERROR RETURN

-------------
CONVERSE RAW DATA
FROM NM TO METERS
-------------

-------------
IS EXTRANGE SET?
(IS THERE A STATE
VECTOR RANGE ESTI-
MATE FROM R61
AVAILABLE?)
-------------
Y.  NO

-------------
IS DIFFERENCE
BETWEEN R61
COMPUTED RANGE
AND VHF RANGE
GREATER THAN
300 NM?
-------------
Y.  NO

-------------
ADD 327.68
NM TO VHF
RANGE
-------------

EXIT RO8
TO CALLER'S
GOOD RETURN
RENDEZVOUS TRACKING SIGHTING MARK ROUTINE (R21)

PURPOSE:
(1) TO PERFORM SIGHTING MARKS IN CONJUNCTION WITH THE UNIVERSAL TRACKING PROGRAM (P20), OPTIONS 0, 4.

ASSUMPTIONS:
(1) SIGHTINGS ARE MADE ON THE OWS USING THE SXT.

(2) WHEN THE CMC ACCEPTS A MARK IT RECORDS AND STORES 5 ANGLES (3 ICONS AND 2 OODUS) 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.


(4) THIS ROUTINE IS AUTOMATICALLY SELECTED BY A SXT MARK OR MARK REJECT DURING P20, OPTIONS 0, 4.
WAS SIGHTING SATISFACTORY?

- N
- Y

MARK REJECT

- PRESS MARK REJECT BUTTON WITHIN 7 SEC AFTER MARK

TERMINATE WAIT UPTON RECEIPT OF MARK, MARK REJECT

- M
- R
- K
- E
- J
- C
- T

ERASE MARK DATA IN POSITION #1 (IF ANY) OR SET REJECTFLG TO REJECT MARK BEING PROCESSED 3X R22 (IF ANY)
RENDEZVOUS TRACKING DATA PROCESSING ROUTINE (R22)  
REV 01  03/20/72

PURPOSE:
(1) TO PROCESS RENDEZVOUS SIGHTING MARK DATA TO UPDATE THE STATE VECTOR OF EITHER THE CSM OR OWS AS DEFINED BY THE STATE VECTOR FLAG (SEE P23).
(2) TO PROCESS RENDEZVOUS VHF RANGING DATA TO UPDATE THE STATE VECTOR OF EITHER THE CSM OR OWS AS DEFINED BY THE STATE VECTOR FLAG (SEE P23).
(3) TO CALL R27 WHEN ENABLED BY V76E.

ASSUMPTIONS:
(1) THIS ROUTINE IS AUTOMATICALLY SELECTED BY THE UNIVERSAL TRACKING PROGRAM (P20), OPTIONS 0, 4.
(2) V36N49 DISPLAYED IN THIS ROUTINE IS A PRIORITY DISPLAY AND WILL REMAIN UP A MINIMUM OF 2 SECONDS. RESPONSE AFTER 2 SECONDS WILL CAUSE THE PROGRAM TO CONTINUE AS DESCRIBED.
(3) V87E ENABLES VHF UPDATES. V37E X XE AND V88E INHIBIT VHF UPDATES.
(4) THERE IS A RENDEZVOUS OPTICS MARK COUNTER AND A VHF RANGING MARK COUNTER IN THE CMC TO COUNT THE NUMBER OF MARKS INCORPORATED INTO EITHER STATE VECTOR. THESE COUNTERS CAN BE ZEROED BY THE FOLLOWING:
   (A) W-MATRIX REINITIALIZATION
   (B) KEYING V36E (FRESH START)
(5) W-MATRIX INITIALIZATION FOR RENDEZVOUS MAY BE ENABLED IN ANY OF THE FOLLOWING WAYS:
   (A) KEY V93E
   (B) KEYING V36E
   (C) STATE VECTOR UPDATE FROM THE GROUND.
   (D) DURING MINKEY BY AUTOMATIC W-MATRIX INITIALIZATION LOGIC (SEE SECTION 5 OF THIS DOCUMENT).
(6) THE TIME OF THE LAST W-MATRIX INITIALIZATION IS AVAILABLE BY KEYING V06 N31E.
(7) IN R22 V76E ENABLES R27 AND V77E INHIBITS R27.
START RENDEZVOUS TRACKING DATA PROCESSING ROUTINE (R22)

SET VHF TIME TO PRESENT TIME

"B"

WAIT 4 SECONDS

IS RENDEZVOUS FLAG SET?

Y  N

... EXIT R22

IS REF544AT FLAG SET?

Y  N
IS TRACK FLAG SET?
  Y  N
  EXIT R22
  EXIT R22

IS R60 OPERATING?
  Y  N
  IS R2TFLAG SET?
    Y  N

DO VHF RANGE RATE MARK PROCESSING ROUTINE R27

IS SNAPFLAG SET?
  N  Y
POSITION #2

SET R22CAFGLG

CLEAR POSITION #1

SET SOURCE CODE TO 1

IS AUTOSED FLAG SET?

N

Y

EXERCISE AUTOMATIC W MATRIX REINITIALIZATION LOGIC (SEE SEC 5 OF THIS DOCUMENT).
BASED ON THE DATA
AND ITS SOURCE
(OPTICS OR VHF AND, IF OPTICS--PRIMARY OR
BACK UP)
CALCULATE THE RE-
QUIRED CORRECTION
TO UPDATE THE STATE
VECTOR DESIGNATED BY
THE STATE VECTOR
FLAG (SEE #20).
FOR DESCRIPTION
OF UPDATE PROCESS
REFER TO SECTION
5.2 OF R693

IS SOURCE CODE=1?

IS THIS THE 2ND
OPTICS CORRECTION
FOR THIS MARK?

IS REJCTFLG
SET?
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

-------------
IS THE SOURCE CODE
IN R3 = 1?
-------------

Y      N

-------------
VERIFY THAT
MARKING WAS DONE
ON THE UMS AND
DISCUSS OUT OF
TOLERANCE CON-
DITION WITH THE
GROUND, IF
POSSIBLE.
-------------

-------------
WAIT 2 SECONDS
-------------

-------------
SHALL I INCORPORATE
THIS UPDATE?
-------------

Y      N

-------------
WAIT FOR KEYBOARD
ENTRY
-------------

-------------
KEY
-------------
V36E

-------------
KEY IN RE-
CYCLE V32E
-------------
TERMINATE FLASH UPON RECEIPT OF PROCEED OR RECYCLE

P R V34E
R E
D C
C Y
E C DO P20
E L TERMINATION
D E PROCESS (V56 LOGIC)

EXIT

"E"

RESET R22CFLAG, REJCTFLG

IS SOURCE CODE = L?

Y

GO TO "A"

GO TO
INTEGRATE STATE VECTOR CORRECTION INTO THE STATE VECTOR DESIGNATED BY THE STATE VECTOR FLAG (SEE P20).

IS SOURCE CODE = 1?

INCREASE REND- ERON'S VHF RANGING MARK COUNTER.

IS THIS THE 2ND OPTICS CORRECTION FOR THIS MARK?

GO TO "E" ABOVE.

INCREASE REND- ERON'S OPTICS.
MARK CENTER

GO TO

"B"

"F"

ARRIVE ABOVE

"A"

WAIT 4 SECONDS

IS RENDEZVOUS FLAG SET?

Y, N

IS REF SMRT

FLAG SET?

Y, N

611
227/SKYLARK
IS TRACK FLAG SFT?

Y. \ N

* * *

IS R60 UPFRATING?

Y. \ N

* * *

IS R27FLAG SET?

Y. \ N

DO VHF RANGE RATE MARK PROCESSING ROUTINE R27

* * *

IS SNAPFLAG SET?

N. \ Y

* * *
IS UPDATE FLAG SET?

Y
N
...  
GO TO
"A"
ABOVE

IS VHFB RANGE FLAG SET?

N  Y
...  
GO TO
"D"
ABOVE

++
+01
HAS AT LEAST 1 MINUTE ELAPSED ON THE VHFB TIMER?
++

Y  N
...  
GO TO

++
CALL VHF RANGE READ ROUTINE (RO8)

++

++

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
SFT SOURCE CODE TO 2

STORE TIME OF MARK IN VHFTIME

GO TO "CM" ABOVE

CHANGE CONTROL NOTES

REV 00  PCR 016,017,018,025,032,439, PCN 442, SKYLARK Memo #19
REV 01  PCN 489
RENEZVOUS BACKUP SIGHTING MARK ROUTINE (R23)

PURPOSE: (1) TO PERFORM SIGHTING MARKS IN CONJUNCTION WITH THE UNIVERSAL TRACKING PROGRAM (P20) OPTIONS 0,4, BY USE OF A BACKUP OPTICAL DEVICE.

ASSUMPTIONS: (1) THE ASTRONAUT KNOWS THE COORDINATES (OPTICS) OF THE ALTERNATE L3S HE MUST USE FOR THIS ROUTINE
(2) WHEN THE CMC ACCEPTS A MARK IT RECORDS AND STORES THE 3 ICDU'S, THE CONTENTS OF NOUN 94 AND THE TIME OF MARK IN POSITION #1. IF A MARK IS REJECTED BY KEYING IN V86E THE MARK DATA IN POSITION #1 IS ERASED OR A FLAG IS SET TO REJECT THE MARK IF R22 IS PROCESSING A MARK.
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.
(3) THIS ROUTINE IS MANUALLY SELECTED BY THE ASTRONAUT BY KEYING IN V54E.

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- START RENDEZVOUS BACKUP SIGHTING MARK ROUTINE (R23)
- IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?
  - N.
  - Y.
- TURN ON OPERATOR ERROR LIGHT

KEY IN V54E
IS RENDEZVOUS FLAG SET?

*Y  *N

IS TRACK FLAG SET (SEE P20)?

*Y  *N

TURN ON PROGRAM ALARM
LIGHT. NOTE:
ALARM CODE
IF CALLED BY
ASTRONAUT
IS:
V05N09
R1-
R2-
R3-
EXPECTED
ALARM CODE
AT THIS TIME
IS 406

MONITOR DSky:
DOES PROGRAM
ALARM INDICATE
THAT THE UNIVERSAL
TRACK PROGRAM P20
OPTION 0,4 IS NOT IN
PROCESS?

*Y  *N

THIS ROUTINE
MAY NOT BE SE-
TESTED AT THIS
TIME. PRESS
ALARM RESET TO
RESET PROGRAM

EXIT
RESET R2 MARK FLAG

INVALIDATE MARK BUFFER

HOLD SNAP

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY ALTERNATE LOS COORDINATES
VO6 NS4
R1 SHAFT
R2 TRUNNION
R3 BLANK

SHAFT-OPTICS SHAFT ANGLE IN DEGREES TO NEAREST .01 DEGREES
TRUNNION-OPTICS ANGLE IN DEGREES TO NEAREST .01 DEGREES

ALARM

* *

EXIT

MONITOR SKY:
Observe verb-noun
FLASH TO REQUEST RESPONSE AND DISPLAY NEW OCUU ANGLES.

NOTE: THE VALUE OF THESE REGISTERS SHOULD CORRESPOND TO THE CHOSEN ALTERNATE LOS.

THE NOMINAL ANGLES TO BE USED FOR COAS SIGHTINGS ARE:
R1-00000
R2-57470

ARE THE DISPLAYED ANGLES CORRECT FOR THE CHOSEN LOS?
Y N

WAIT FOR KEYBOARD ENTRY:
TERMINATE FLASH UPON RECEIPT OF NEW DATA OR PROCEED

NEW DATA PROCEED

STORE NEW DATA

FLASH VERB-NOUN TO REQUEST PLEASE PERFORM ALTERNATE LOS SIGHTING MARK AND DISPLAY MARK CTRS, TFI, AND MGA:
- V53N5
- R1-MARK CTRS
- R2-TFI
- R3-MGA

MONITOR DSKY: OBSERVE VERB-NOUN FLASH TO REQUEST PLEASE PERFORM ALTERNATE LOS SIGHTING MARK, AND DISPLAY OF MARK CTRS, TFI, AND MGA.
MARK CT45- THE NUMBER OF MARKS PROCESSED BY THE RENDEZVOUS TRACKING DATA PROCESSING ROUTINE (R22) SINCE LAST W-MATRIX REINITIALIZATION (REFER TO ASSUMPTION (B) OF P20). THE REGISTER 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 59059. (+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 DISPLAYED AT ANY TIME OTHER THAN THE LAST PASS THROUGH P31-P36, P38, THE VALUE IS +00001
(b) during P30,

or on the last

pass of P31-P36,

P39 when the IMU

is not aligned

the value is

-900.2, in deg-

gress to the near-

est .01 degrees.

NOTE: R2 and R3

contents valid

only if select

R23 at V1645

display in

P31-P36, P38.

-------------

using the rotational

hand controller po-
sition the space-
craft so that the

dws is precisely

along the dos

chosen.

-------------

wait for keyboard

entry

-------------

key in enter

-------------

was sighting satis-

factory?

-------------

n y

-------------

key in 086e

within 7

seconds

-------------
TERMINATE FLASH
UPON RECEIPT
OF ENTER, Y966
OR PROCEED

---

V E P
N R
O D
E C
E E
D

---

ERASE
MARK DATA
IN POSITION #1
(IF ANY)
OR SET
REJECTFLG
TO REJECT
MARK BEING PROCESSED BY
R22 (IF ANY)

---

DO I WISH TO MAKE MORE MARKS?

---

Y N

---

KEY IN PROCEED

---

EXIT
R23
VHF RANGE RATE MARK PROCESSING ROUTINE (R27)

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 TO SPECIFIED IN NOV 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 R27 FLAG BY KEYING V76E AND KEYING PRO ON THE FLASHING V06N72 DISPLAY. R27 WILL CONTINUE UNTIL R27 FLAG 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 V37EXE OR BY KEYING V76E AND PRO.
(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 "KOWN" ORIENTATION. THE ISS MUST BE ON AND OPERATIONAL AND INTEGRATION MUST BE IN PROGRESS.
(6) THE RANGE RATE FILTER REQUIRE 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 (V72) SELECTED BY THE ASTRONAUT.

PRNG CONT
.CMC GROUND CREW

.CMC
.ROUTINE
.SELECTION

DO R28:
OBTAIN R1 AND T1

-------------------------------------------------------------------------------------
#10

R27/SKYLARK
IS THIS CALLER'S
ERROR RETURN?

* Y
* Y
* * *
* EXIT
* R27

IS R27UP1 FLAG SET?

* Y
* N
* * *
* STORE 1ST VHF READ

 WAS R27 CALLED BY >25?

* Y
* Y
* * *
* TEST FOR RANGE
* MODULO BY COMPARING
* LAST TWO VHF READS,
* MODIFY INDICATED
* RANGE BY 327-68 M.H.
* IF TEST IS POSITIVE

DO R33:
OBTAIN R2 AND T2

#20
#30
#40
#50
#60

562  R27/SKYLARK
UPDATE THE RANGE STATE VECTOR EITHER TO THE CURRENT TIME (IF FIXFLAG IS CLEAR), OR TO THE TIME IN NOUN 72 (IF FIXFLAG IS SET), PER SECTION 5 OF R693.

IS FIXFLAG SET? (I.E., IS R27 PRESENTLY OPTIMIZING?)

* Y  N

* Y

* N

IS TO PAST?

* N  Y

* Y

* N

* Y

RESET SNAPFLAG
IS THE PRESENT TIME WITHIN 20 SEC OF TD?

**N**

**Y**

**SET SNAPFLAG**

**STORE THE CODE -03001 INTO R3**

BEGIN MONITORING TFO IN YOUM 76, INSURE THAT DWS IS AT CENTER OF SXT RETICLE AT TFO = -00800.

**WAIT UNTIL TD=0**

**SNAP CDU'S AND COMPUTE PHI FOR TD**

**OBSERVE PHI (TD) APPEAR IN N77 AT APPROX TFO = +00802.
STORE FINAL OPTIMIZED R, R DOT (RANGE, RANGE RATE) INTO N77.

SET N77FLAG

RESET FIXFLAG

EXTRAPOLATE THE RANGE STATE VECTOR AHEAD TO THE CURRENT TIME TM.

SET T0FLAG
IS THE PRESENT TIME Tm GREATER THAN THE TIME CONTAINED IN N72?

++
+01  IS T4 GREATER THAN (T0 - 95 SEC)? I.E.,
+459  IS IT TIME TO BEGIN
++  OPTIMIZING ON A NEW N72?

Y  N

SET N77FLAG

SET FIXFLAG

EXTRAPOLATE THE RANGE STATE VECTOR AHEAD TO THE TIME IN N72.
ORBITAL PARAMETERS DISPLAY ROUTINE (R30)

PURPOSE:
1) TO PROVIDE THE ASTRONAUT PERTINENT ORBITAL PARAMETERS COMPUTED BY THE CMC TO SUPPLEMENT ORITAL INFORMATION PROVIDED HIM BY THE GROUND.

ASSUMPTIONS:
1) THE COMPUTATIONS MADE DURING THIS ROUTINE ARE UPDATED ABOUT EVERY TWO SECONDS ONLY IF THE AVERAGE G ROUTINE IS ON WHEN THIS ROUTINE IS CALLED.
2) THE VALUE OF TFF OR TPER WILL BE MADE TO COUNT DOWN IF THE AVERAGE G ROUTINE IS NOT ON WHEN THIS ROUTINE IS CALLED.
3) IF AVERAGE G 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 IF 300,300 FT CMC WILL COMPUTE TPER, OTHERWISE TPER=0. TPER IS STORED IN N32 AND THE ASTRONAUT MAY CALL IT BY KEYING IN N326.
5) SIGN CONVENTION FOR TFF AND TPER: OSKY 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 ECLIPSES IN THESE CASES.
6) IF THIS ROUTINE IS CALLED WHILE THE EARTH ORBIT INSERTION MONITOR PROGRAM (P11) IS ON OR WHEN IN CMC IDLING PROGRAM (P00), THE CMC WILL DISPLAY SPLERROR IN N50 BY KEYING IN V50S. IF THE APODEE IS ABOVE 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 OSKY ENTRY.

PROG

CONT

CMC GROUND CREW

CREW

REVIEW

SELECTION

START ORBITAL PARAMETERS DISPLAY ROUTINE (R30)

------------------------ KEY IN V82E

R30/SKYLARK
R1-00002
R2-00030
R3-BLANK

R1 IS THE OPTION CODE FOR ASSUMED VEHICLE.

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

ASSUMED VEHICLE (OWS OR CSM)

IS THE VEHICLE (OWS OR CSM) ASSUMPTION CORRECT?

Y

WAIT FOR KEYBOARD ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

P NEW CODE DATA
O D E C E D

STORE CODE DATA

KEY IN V22E AND LIAD THE DESIRED VEHICLE (OWS OR CSM) CODE IV-TO R2.
TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA

KEEP IN V25E AND LOAD
NEW DATA

PROCEED NEW DATA

STORE NEW DATA

IS NOUN 16
ZERO?

YES, NO

SET TDEC1 TO PRE-
SENT TIME

SET TDEC1 TO TIME IN
NOUN 16

EXTRAPOLATE SELECTED
VEHICLE STATE VECTOR
TO TIME IN TDEC1
USING PRECISION EQUATIONS

COMPUTE AP3 ALT, PER ALT, AND TFF. (SEE ASSUMPTION 4.)

IS PER ALT GREATER THAN 300,000 FT?

N Y

SET TPER EQUAL TO ZERO.

IS AVE & ROUTINE ON?

Y N
IS THE CURRENT P00?

N  Y

Y  N

COMPUTE SPLERROR

HOLD FLASH VERB-NOUN TO

MONITOR DSKY:

ON

REQUEST RESPONSE AND

FLAS TO REQUEST

DISPLAY ORBIT PARA-

RESPONSE AND DIS-

METERS:

PLAY OF APO

V16 N4

ALT

ALT, PER ALT

R1-AP ALT

AND TFF

R2-PER ALT

R3-TFF

APO ALT-ALTITUDE

IS AVERAGE G ROUTINE

OF APOLGE ABOFE

ON?

THE LAUNCH PAD

DO I WISH TO

RADIUS, IN NAU-

HAVE THE CAL-

CAL MILES TO NEAR-

SPLERROR

EST. 1 NM.

PER ALT-ALTITUDE

DO I WISH TO

OF PERIGEE ABOVE

HAVE THE CAL-

THE LAUNCH PAD

SPLERROR

RADIUS, IN NAU-


CAL MILES TO NEAR-

EST. 1 NM.
TFF - TIME OF FREE FALL FROM NOW TO AN INTERFACE ALTITUDE OF 300,000 FT. FOR SIGN CONVENTION, SEE ASSUMPTION 5.

ALTIMETER 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 ALTITUDE (E.G. ON THE PAD), THE TFF DISPLAY WILL READ -59859.

NOTE: IF PER ALT OR APO ALT EXCEEDS SCALE THE DISPLAY WILL BE 9999.9 NM.

* Y 
* N 

WAIT FOR KEYBOARD ENTRY

KEY IN RECYCLE V32E

NOTE: THE KEYING OF RECYCLE DURING AVE G WILL HAVE NO EFFECT.

++
++
++
++
++
++
++
**RENDEZVOUS PARAMETER DISPLAY NO 1 ROUTINE (R31)**

**REV 01 03/20/72**

**PURPOSE:**
1. To display at astronaut request CMC calculated rendezvous parameters (range, range rate, theta)

**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 in. The ISS must be on and aligned to a "known" orientation if a correct display of theta is desired. The range/range rate/theta display is not inhibited however if the IMU is not on and aligned.
2. The routine is selected by the astronaut by sky entry or automatically selected by P37.

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<td>RENDEZVOUS PARAMETER DISPLAY NO 1 ROUTINE (R31)</td>
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IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

```

#10

#20

#30
IS AVERAGE G RUNNING?

* N
  * Y

SET T = PRESENT TIME

EXTRAPOLATE OWS AND CSM STATE VECTORS TO T USING COASTING INTEGRATION ROUTINE

SET T = AVERAGE G TIME.
EXTRAPOLATE OMS STATE VECTOR TO T USING COASTING INTEGRATION ROUTINE.

SET TF = PRESENT TIME

EXTRAPOLATE OWS AND CSM STATE VECTORS TO TF FROM T USING KEPLER SUBROUTINE

CALCULATE RANGE, RANGE RATE AND THETA

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

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

R31/SKYLARK
OF RENDEZVOUS PARAMETERS.
(NOTE: THESE PARAMETERS WILL BE UPDATED ABOUT EVERY 10 SECONDS.)

**V16 N54**
**R1-RANGE**
**R2-RANGE RATE**
**R3-THETA**

**+01**
**+489**
**+**

**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**

**-------**

**IS AVERAGE G RUNNING?**

**N**

**SET TF = AVERAGE G TIME**
CHANGE CONTROL NOTFS

REV 00  PCR 037,011, PCN 410, SKYLARK MEMO #2
REV 01  PCN 489
KENDEZVUJS PARAMETER DISPLAY NO 2 ROUTINE (R34)

PURPOSE:

(1) TO DISPLAY AT ASTRONAUT REQUEST CMC CALCULATED KENDEZVUJS 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 OSKY ENTRY.

---

#10

---

#20

---

#30

R34/SKYLARK
EXTRAPOLATE OWS AND CSM STATE VECTORS TO T USING COASTING INTEGRATION ROUTINE.

SET T=AVERAGE G TIME.

EXTRAPOLATE OWS STATE VECTOR TO T USING COASTING INTEGRATION ROUTINE.

SET TF = PRESENT TIME

EXTRAPOLATE OWS AND CSM STATE VECTORS TO TF FROM T USING KEPLER SUBROUTINE.
CALCULATE RANGE, RANGE RATE AND PHI

HOLD

MON

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

+01 R2-RANGE RATE
+ R3-PHI
++ 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

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
CHANGE CONTROL NOTES

REV 00  PCR 007, PCN 410
REV 01  PCN 489
RENDZVOUS 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 DWS).

ASSUMPTIONS:  
(1) THESE PARAMETERS ARE CALCULATED BY THE CMC ON THE BASIS OF THE STORED DWS AND CSM STATE VECTORS AND DO NOT REQUIRE THAT THE ISS BE 3N.
(2) THE ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

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START THE RENDEZVOUS OUT-OF-PLANE DISPLAY ROUTINE (R36)  

---

IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?  

- N  Y  

- TURN ON OPERATOR ERROR LIGHT  

---

#10  

#20  

#30
AM I SATISFIED
WITH THE DIS-
PLAYED TIME?
Y
Y

ARE ALL
THREE
REGISTERS
EQUAL TO
ZERO?
Y
N

WAIT FOR KEYBOARD
ENTRY:

KEY IN
PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

NEW
DATA
P
R
O
C
STORE NEW
DATA
E
D

IS T(EVENT) ZERO?
N
Y

EXTRAPOLATE CSM
AND RMS VECTORS
TO THE PRESENT
TIME USING
PRECISION
INTEGRATION
------------------

EXTRAPOLATE CSM
AND OWS STATE
VECTORS TO THE
TIME DEFINED BY
EVENT) USING
PRECISION
INTEGRATION
------------------

CALCULATE OUT-OF-
PLANE PARAMETERS:
Y CM
Y DOT CM
Y DOT OWS
------------------

HOLD
FLASH VERB NOUN TO
REQUEST RESPONSE AND
DISPLAY RENDEZVOUS
OUT-OF-PLANE PARA-
METERS:
V06 496
R1 Y CM
R2 Y DOT CM
R3 Y DOT OWS
Y CM-NOTE: FOR
DEFINITION OF
PARAMETERS REFER
TO SECTION
5.6 IF THIS
DOCUMENT) IN
NAUTICAL MILES TO

MONITOR OSKY:
OBSERVE VERB NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF RENDEZVOUS OUT-
OF-PLANE PARAMETERS
------------------

DO YOU WISH TO RECEIVE
ANOTHER DATA POINT
------------------
THE NEAREST .01 NM.

FOR A DIFFERENT TIME?

Y OOT CM-RATE OF
CHANGE OF Y CM
(+ IS INCREASING
AND - IS DE-
CREASING) IN FPS
TO THE NEAREST
+1 FPS.

Y OOT OWS-RATE OF
CHANGE OF Y OWS
(+ IS INCREASING
AND - IS DE-
CREASING) IN FPS
TO THE NEAREST
+1 FPS.

WAIT FOR KEYBOARD ENTRY:

KEY IN RECYCLE V32E

TERMINATE FLASH UPON RECEIPT OF PROCEED OR RECYCLE

KEY IN PROCEED

R
E
C
L
E
O
E
R
R
C
E
R
E
E
R
E
E
R

EXIT
SPS THRUST FAIL ROUTINE (P40)

PURPOSE: 

(1) TO INDICATE TO THE ASTRONAUT THAT THE GNCS HAS DETECTED A THRUST FAILURE.

(2) TO PROVIDE THE ASTRONAUT A FLASHING DISPLAY TO WHICH HE CAN RESPOND AS DESCRIBED IN THE FLOW.

ASSUMPTIONS: 

(1) THE GNCS HAS DETECTED A THRUST FAILURE AND HAS SHUT OFF CROSS PRODUCT STEERING AND HAS STOPPED C.G. TRACKING.

(2) IF THE ASTRONAUT KEYS IN PROCEED ON THIS DISPLAY THRUST FAILURE DETECTION WILL BE INHIBITED FOR 2 SECONDS TO PREVENT A PREMATURE THRUST FAIL INDICATION.

(3) THIS ROUTINE IS SELECTED BY THE SPS THRUSTING PROGRAM (P40)

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FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY THRUSTING PARAMETERS

- V97490
- R1 XXBXX
- R2 VG
- R3 DELTA VM

#10

MONITOR DSKY:

- OBSERVE VERB NOUN
- FLASH TO REQUEST RESPONSE AND DISPLAY OF THRUSTING PARAMETERS.

#20

SHALL I TERMINATE THE ENGINE ON COMMAND AND RETURN TO THE V99 FLASH WHICH WILL ALLOW ME TO
EITHER REISSUE THE ENGINE ON COMMAND OR CONTINUE ON TO THE DISPLAY OF VGX, VGY, VGZ FOR RCS THRUSTING?

WAIT FOR KEYBOARD ENTRY

KEY IN ENTER

GO TO "A" IN P40

HAS THRUST COME BACK ON?

KEY IN PROCEED

GO TO "G" IN P40

DO I WISH TO DO A MANUAL THRUST?
SET MAIN PANEL DIRECT THRUST SWITCH TO ON

KEY IN PROCEED

SHALL I TERMINATE THE ENGINE ON COMMAND AND THE SPS THRUSTING PROGRAM (P40)?

Y / N

TERMINATE FLASH UPON RECEIPT OF PROCEED, ENTER OR TERMINATE

KEY IN TERMINATE V34E
ENABLE
CG TRACKING, AND
REDISPLAY
VCON40
(NON-FLASHING)

INHIBIT
R40 FOR 2 SECONDS OFF

---

WAIT ABOUT
2.5 SEC

---

TURN OFF
TVC DAP AND DIS-
ABLE TVC INTERFACE

---

WAIT ABOUT
STATE VECTOR INTEGRATION (MID TO AVE) ROUTINE (R41)

REV 03 05/19/71

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 240 SECONDS.
2. THE ROUTINE IS ONLY AUTOMATICALLY SELECTED.

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<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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<tr>
<td>CONT</td>
<td>CMC ROUTINE SELECTION</td>
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<td>IS CALLING PROGRAM P40 OR P41?</td>
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<td>Y</td>
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<td>SET MIDIFLAG</td>
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<td>RESET MIDIFLAG</td>
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#10

#20
T-TO-ADD = TIMEDELT = 12.5 SEC

READ PRESENT TIME, TP

IS MIDIFLAG SET?

IS TDEC-TIMEDELT GREATER THAN OR EQUAL TO TP?

TURN ON PROGRAM ALARM LIGHT AND STORE ALARM CODE L703

RESET MIDIFLAG

MONITOR DSKY PROGRAM ALARM LIGHT DURING THE PERIOD FROM TIG -42.46 SECONDS TO BLANKING AT TIG-35: IF LIGHT COMES ON DURING THIS TIME IT INDICATES THAT TIG WILL BE SLIPPED AS REQUIRED TO GET THE STATE VECTOR INTEGRATED TO A NEW TIG -30 SECONDS. IF THIS ALARM CONDITION OCCURS THE
TFI DISPLAY WILL CONTINUE TO COUNT BASED ON THE ORIGINAL TIG UNTIL INTEGRATION IS COMPLETE AND A NEW TIG IS ESTABLISHED. THE DISPLAY WILL NOT BLANK HOWEVER UNTIL THE NEW TIG HAS BEEN ESTABLISHED AND TFI IS REVISED.

INTEGRATE THIS VEHICLE'S STATE VECTOR ONE TIME STEP OR TO TVEC IF LESS THAN ONE TIME STEP USING PRECISION INTEGRATION.

IS MIDIFLAG SET?

OBSERVE THAT THE COMPUTER ACTIVITY LIGHT GOES OFF WHICH INDICATES THAT THIS ROUTINE IS COMPLETE

EXIT R41
COARSE ALIGN ROUTINE (R50)

PURPOSE:
1. TO COARSE ALIGN AND GYRO TRIM THE IMU 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).

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<th>PROG</th>
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**CMC**

**ROUTINE**

**SELECTION**

---

START COARSE ALIGN ROUTINE (R50)

---

READ PRESENT IMU ORIENTATION W.R.T. THE VEHICLE (GIMBAL ANGLES)

---

SELECT PRESENT IMU INERTIAL ORIENTATION FROM STORAGE

---

CALCULATE THE INERTIAL ORIENTAT-
TION OF THE VEHICLE

SELECT DESIRED IMU INERTIAL ORIENTATION FROM STORAGE (PROVIDED BY CALLING PROGRAM).

CALCULATE REQUIRED FINAL GIMBAL ANGLES TO GIVE DESIRED IMU INERTIAL ORIENTATION

IS ANY REQUIRED GIMBAL ANGLE CHANGE GREATER THAN 1 DEGREE?

Y . . N

SWITCH ISS TO COARSE ALIGN MODE, TERMINATE ATTITUDE HOLD OF VEHICLE

COARSE ALIGN THE IMU
AUTOMATIC OPTICS POSITIONING ROUTINE (R52)

REVISION 00 05/19/71

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 OWS 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 (P29).
2. THIS ROUTINE IS SELF PERPETUATING AND IS TERMINATED BY THE SIGHTING MARK ROUTINE (P53) FOR STARS AND BY
RESETTING THE TRACK FLAG FOR OWS.

PROG CONT     CMC GROUND CREW

CMC ROUTINE
SELECTION

START AUTOMATIC
OPTICS POSITIONING
ROUTINE (R52)

RESET SIGHTING MARK
FLAG

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<table>
<thead>
<tr>
<th>IS THE TARGET SET?</th>
<th>YES</th>
<th>NO</th>
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<td>RESET TERMINATE</td>
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<td>DO THE TRACKING ATTITUDE ROUTINE (R61).</td>
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<td>IS TRACK FLAG SET?</td>
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THE LOGIC FROM THIS POINT TO "B" BELOW IS FOR THE OMS TARGET CASE ONLY.

#30

#40

#50

#60

#70
IS UPDATE FLAG SET?

\*N

\*Y

WAIT ABOUT 1.3 SECONDS

EXTRAPOLATE CSM AND OWS STATE VECTORS TO THE PRESENT TIME +2.4 SECONDS USING CONIC EQUATIONS

READ PRESENT VEHICLE ATTITUDE FROM THE ICDU'S

COMPUTE TARGET VECTOR FROM CSM TO OWS
CALCULATE THE REQUIRED OPTICS ANGLES TO POINT THE STAR LINE OF SIGHT AT THE OWS.

CHECK OPTICS MODE DISCRETE, IS THE OSS IN THE CMC MODE?

Y N

IS A TRUNNION ANGLE GREATER THAN APPROX 50 DEG. REQUIRED TO POINT THE STAR LINE OF SIGHT AT THE OWS?

N Y

DRIVE SHAFT AND TRUNNION AND CDU'S DRIVE TRUNNION TO
THE STAR TARGETS
ONLY

IS TERMINATE
FLAG SET?

---

.Y  .N

---

EXIT R52

---

CHECK OPTICS MODE
DISCRETE. IS THE
OSS IN THE CMC
MODE?

---

.Y  .N

---

THE AUTOMATIC OPTICS
POSITIONING IS NOW
RUNNING. TO MARK
ON THE TARGET,
SWITCH THE OPTICS
MODE SWITCH TO MAN-
UAL. THIS WILL CALL
THE SIGHTING MARK
ROUTINE R53. IF R53
IS TERMINATED THIS
ROUTINE WILL ALSO
TERMINATE. IF THE
ASTRONAUT SWITCHES
BACK TO CMC MODE
PRIOR TO TERMINATION
OF R53 V51 WILL
REMAIN FLASHING AND
THE ASTRONAUT MAY
CONTINUE WITH R53
BUT THE OPTICS WILL
BE POINTED AT THE
TARGET AUTOMATICALLY

---

CALL SIGHTING
MARK ROUTINE

---
(RS3) IF NOT ALREADY CALLED

WAIT .5 SEC

GO TO "B"
ABOVE

GET PRESENT IMU ORIENTATION FROM STORAGE (REFSMMAT)

READ PRESENT VEHICLE ATTITUDE FROM ICDU'S

GET STAR DATA FROM CMC STORAGE

COMPUTE TARGET VECTOR FROM CSM TO
DESIGNATED STAR.

CALCULATE THE REQUIRED 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?

PCSS PRIO HOLD SNAP

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

V50409
R1-
R2-
R3-

EXPECTED ALARM CODE AT THIS TIME IS 404

WAIT 2 SECONDS

MONITOR SKY:

DOES ALARM CODE DISPLAY INDICATE THAT THE TARGET IS NOT WITHIN THE HEMISPHERE OF OPTICS VISIBILITY?

FOR STAR SIGHTINGS THERE ARE TWO OPTIONS:

(a) MANUALLY MANEUVER VEHICLE UNTIL OPTICS CAN ACQUIRE THE DESIRED TARGET.
(B) TERMINATION OF THE PROGRAM AND ROUTINE.

**MANUALLY MANEUVER VEHICLE UNTIL IT IS ESTIMATED THAT OPTICS CAN ACQUIRE THE TARGET. MONITOR FDAI TO AVOID GIMBAL LOCK.**

---

**WAIT FOR KEYBOARD ENTRY.**

---

**TERMINATE FLASH UPON RECEIPT OF PROCEED, OR TERMINATE.**

---

**KEY IN**  
**TERMINATE.**

---

**V34E**

---

**GO TO**
SHAFT ANGLE, IN DEGREES TO NEAREST .01 DEGREE.

TRUNION-DESIRERED TRUNION ANGLE, IN DEGREES TO NEAREST .001 DEGREE.

---------------------------------------------

BY SWITCHING OPTICS MODE SWITCH TO MANUAL.

---------------------------------------------

CHECK OPTICS MODE DISKETE, IS THE OSS IN C4C MODE?

Y N

---------------------------------------------

IS THE TRUNION ANGLE REQUIRED TO POINT THE STAR LOS OF THE OPTICS AT THE TARGET GREATER THAN APPROX 50 DEGREES?

N Y

---------------------------------------------

DRIVE SHAFT AND CDJ TRUNION DRIVE CDJ'S TRUNION TO APPROX 50
SIGHTING MARK ROUTINE (RS3)

PURPOSE: (1) TO PERFORM A SATISFACTORY NUMBER OF OPTICAL SIGHTING MARKS FOR THE REQUESTING PROGRAM (OR ROUTINE).

ASSUMPTIONS: (1) SIGHTINGS ARE MADE WITH EITHER SCT, SXT, ATM SUN SENSOR OR ATM STAR TRACKER.

(2) WHEN THE CMC ACCEPTS A MARK IT RECORDS AND STORES 3 ICDU ANGLES, 2 OCDDU ANGLES (FOR OPTICS MARKS), AND THE TIME OF THE MARK. IN ADDITION, IF THE MARK IS FOR THE ATM STAR TRACKER THE CREW WILL BE REQUESTED TO LOAD THE STAR TRACKER GIMBAL ANGLES (N14).

(3) THE ROUTINE REQUIRES THAT ONE MARK BE TAKEN FOR NORMAL TERMINATION. IF THE ASTRONAUT GETS INTO THIS ROUTINE AND ELECTS NOT TO MARK HE SHOULD KEY V34E OR CALL A NEW PROGRAM BY KEYING IN V37EXK.

(4) THE ROTATION OR MINIMUM IMPULSE CONTROLLER MAY BE USED AS REQUIRED TO REDUCE THE S/C DRIFT RATE.

(5) IF THE MARK IS FOR THE ATM SUN SENSOR, THE CSM MUST BE DOCKED TO THE ORBITAL ASSEMBLY AND THE ATM MUST BE IN THE SOLAR INERTIAL ATTITUDE.


(7) IN P50 THE ROUTINE IS SELECTED WHEN THE CREW SELECTS OPTION 1 OR 2 IN N06. FOR OPTION 1 A MARK IS MADE WHEN THE ATM IS IN THE SOLAR INERTIAL ATTITUDE, FOR OPTION 2 A MARK IS MADE WHEN THE ATM IS IN THE SOLAR INERTIAL ATTITUDE AND THE ATM STAR TRACKER IS TRACKING A STAR.

(8) THE ROUTINE IS AUTOMATICALLY SELECTED BY P51.

(9) THE ROUTINE IS AUTOMATICALLY SELECTED BY THE IMU REALIGN PROGRAM (P52) WHEN THE CREW LOADS THE SOURCE CODE FOR ATM SUN SENSOR OR ATM STAR TRACKER IN N70.

(10) IN P55 THE ROUTINE IS SELECTED WHEN THE CREW SELECTS OPTION 2 IN N06.

(11) THE ROUTINE IS SELECTED IN THE AUTO OPTICS POSITIONING ROUTINE (RS2) BY CREW SELECTION OF MANUAL OPTICS MODE OR SWITCHING OPTICS ZERO TO ZERO.

PROG CONT CMC GROUND CREW

*CMC ROUTINE
*SELECTION
START SIGHTING MARK ROUTINE (R 53)

SET SIGHTING MARK FLAG

"A"

HOLD

FLASH VERB TO REQUEST PLEASE MARK:

V51 N BLANK
R1-BLANK
R2-BLANK
R3-BLANK

NOTE: NOUN AND R1 WILL NOT BE BLANK IF ENTERED FROM MARK REJ.
AFTER V5ON25, R1 = 00016 DISPLAY

IS THIS AN OPTICS SIGHTING?

Y. N
FLASH VERB NOUN TO
REQUEST PLEASE
PERFORM TERMINATE
MARK SEQUENCE:
V50 N25
R1-00016
R2-00000
R3-BLANK
-------------------------

MONITOR MKT:
OBSERVE FLASHING
VERB-NOUN TO REQUEST
PLEASE PERFORM
TERMINATE MARK
SEQUENCE
-------------------------

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

WAS MARK
SATISFACTORY?

Y  N

KEY IN
PROCEED

PRESS MARK
REJECT
BUTTON

GO TO
"MAN"
IN SIGHTING

IS SOURCE OF

DATA AT

STAR TRACKER.
IC = 2?

N

Y

IS THIS ATM

STAR TRACKER
DATA?

N

Y

SET TER-

MINATE

FLAG (FOR

USE BY

R52).

N

Y

EXIT

R53
++
+01 ARE R1 AND R2 BOTH
+ GREATER THAN -10800
+ AND LESS THAN +10800?
+ Y  N
+ TURN ON OPERATOR ERROR LIGHT
+ 470
++

SET TERMINATE FLAG
( FOR USE BY R52).
EXIT R53

EXIT R53

CHANGE CONTROL NOTES

REV 00  PCR 018, 019, 036, 413, 414, 415, PCN 457
REV 01  PCN 470, 489
SIGHTING DATA DISPLAY ROUTINE (RS4)

PURPOSE:
1. TO TEST THE ACCURACY OF A PAIR OF CELESTIAL BODY SIGHTINGS.

ASSUMPTIONS:
1. THE ROUTINE IS USUALLY AUTOMATICALLY SELECTED BY THE IMU ORIENTATION DETERMINATION PROGRAM (PS1), BY THE IMU REALIGN PROGRAM (PS2), OR THE BACKUP IMU ORIENTATION DETERMINATION PROGRAM (PS3), OR BY THE BACKUP IMU REALIGN PROGRAM (PS4).

PREVIOUS PAGE BLANK
HOLD

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY SIGHTING ANGLE DIFFERENCE AND SIGHTING ANGLE:

V06 N05
R1-SIGHTING ANGLE DIFF
R2-SIGHTING ANGLE
R3-BLANK

SIGHTING ANGLE DIFFERENCE AND SIGHTING ANGLE IN DEGREES TO THE NEAREST .01 DEGREES.

---

MONITOR DSKY:
OBSERVE FLASHING VERB-NOUN AND DISPLAY OF SIGHTING ANGLE DIFFERENCE AND SIGHTING ANGLE

---

DOES THE SIGHTING ANGLE DIFFERENCE EXCEED THE ACCEPTABLE TOLERANCE OR IS THE SIGHTING ANGLE UNACCEPTABLE?

* Y
*
*
* SHALL I PROCEED WITH BAD DATA?
* Y N
*
*
---

WAIT FOR KEYBOARD ENTRY

---

KEY IN PROCEED

---

EXIT "A"
GYRO TORQUING ROUTINE (R55)

REV 00 05/19/71

PURPOSE: 1) TO CALCULATE GYRO TORQUING ANGLES FOR FINAL (FINE) ALIGNMENT OF THE INERTIAL PLATFORM DURING AN INFLIGHT ALIGNMENT, TO DISPLAY THESE ANGLES AND TO TORQUE THE GYROS.

ASSUMPTIONS: 1) THE ROUTINE IS NORMALLY AUTOMATICALLY SELECTED BY THE IMU REALIGN PROGRAM (PS2), OR BY THE BACKUP IMU REALIGN PROGRAM (P54).

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<td>START GYRO TORQUING ROUTINE (R55)</td>
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<td>CALCULATE REQUIRED TORQUING ANGLES FOR EACH GYRO</td>
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OLD FLASH VERB-NOUN TO REQUEST RESPONSE AND SNAP DISPLAY

MONITOR DSKY:

OBSEERVE VERB-NOUN
FLASH AND DISPLAY OF
GYRO TORQUING ANGLES

R55/SKYLARK
DELTA GYRO-GYRO
TORQUING ANGLES-THE ANGLE THRU WHICH EACH GYRO MUST BE TORQUED TO COMPLETE THE FINE ALIGNMENT. ALL ANGLES IN DEGREES TO NEAREST .001 DEGREE.

SHALL I PERMIT TORQUING? CONSIDER MAGNITUDE OF TORQUING ANGLES.

WAIT FOR KEYBOARD ENTRY

VERIFY RECYCLE

TERMINATE FLASH UPON RECEIPT OF PROCEED OR RECYCLE

EXIT R55

646
ALTERNATE LOS SIGHTING MARK ROUTINE (R56)  

PURPOSE:  
1. TO PERFORM SIGHTING MARKS FOR THE BACKUP ALIGNMENT PROGRAMS (P53, P54).

ASSUMPTIONS:  
1. SIGHTINGS ARE MADE WITH EITHER (A) CSM ALTERNATE LINE OF SIGHT, (B) ATM SUN SENSOR, OR (C) ATM STAR TRACKER.
2. THE ASTRONAUT KNOWS THE COORDINATES (OPTICS) OF THE ALTERNATE LINE OF SIGHT (CASE A, ASSUMPTION 1) HE MUST USE FOR THIS ROUTINE.
4. THE RMC IS USED TO POSITION THE SPACECRAFT SO THAT THE ALTERNATE LOS POINTS TOWARD THE CHOSEN CELESTIAL BODY.
7. THIS ROUTINE IS AUTOMATICALLY CALLED BY P53 AND P54.
8. ANY PROPORTIONAL SET OF COMPONENTS MAY BE LOADED IN N88. HOWEVER, UNIT VECTORS ARE RECOMMENDED.
MARK ROUTINE (R55)

HOLD
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY ALTERNATE
LOS COORDINATES
V06 V94
R1 SHAFT
R2 TRUNNION
R3 BLANK

SHAFT-OPTICS SHAFT
ANGLE IN DEGREES TO
NEAREST .01 DEGREES
TRUNNION-OPTICS
TRUNNION ANGLE IN
DEGREES TO NEAREST
.001 DEGREES

WAIT FOR KEYBOARD
ENTRY:

Y ..N

TERMINATE FLASH
UPON RECEIPT OF NEW
DATA OR PROCEED

MONITOR DSKY:
OBSERVE VERB-NJVN
FLASH TO REQUEST RE-
SPONSE AND DISPLAY
NEW OODU ANGLES.

NOTE: THE VALUE OF
THESE REGISTERS
SHOULD CORRESPOND TO
THE CHOSEN ALTERNATE
LOS.

THE NOMINAL ANGLES
TO BE USED FOR COAS
SIGHTINGS ARE:
R1-000000
R2-57470

ARE THE DISPLAYED
ANGLES CORRECT FOR
THE CHOSEN LOS?

KEY IN V24E
AND LOAD
ANGLES.
**01**

OLD

FLASH VERB

TO REQUEST PLEASE

PERFORM ALTERNATE

LOS SIGHTING

MARK:

V53N-BLANK

R1-BLANK

R2-BLANK

R3-BLANK

OLD

MONITOR OSKY:

OBSERVE VERB

FLASH TO REQUEST

PLEASE PERFORM

ALTERNATE LOS

SIGHTING MARK:

USING THE ROTATIONAL

HAND CONTROLLER POS-

ITION THE SPACE-

CRAFT SO THAT THE

NAVIGATION STAR IS

PRECISELY ALONG THE

LOS CHOSEN.

**00**

WAIT FOR KEYBOARD

ENTRY

TERMINATE FLASH UPON

**00**

KEY IN ENTER
RECEIPT OF ENTER


FLASH VERB NOUN TO REQUEST PLEASE PERFORM TERMINATION OF THIS ROUTINE V50 425 R1 03016 R2 BLANK R3 BLANK

MONITOR SKY: OBSERVE VERB NOJN FLASH TO REQUEST PLEASE PERFORM TERMINATION OF THIS ROUTINE.

WAS THE SIGHTING SATISFACTORY?

Y N

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF ENTER OR PROCEED

KEY IN ENTER

KEY IN PROCEED

E N P R

652 R56/SKYLARK
00 - PLANET (ANY PLANET)
01/45 - STAR (FROM CELESTIAL BODY CODE LIST)
46 - SUN
47 - EARTH

---

WAIT FOR KEYBOARD ENTRY

---

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

---

* P NEW DATA
* K
* D
* C
* E
* E
* D

---

STORE

IS THE CELESTIAL BODY CODE NEGATIVE?

---

* N
* Y

---

IS THE CELESTIAL BODY CODE NEGATIVE?
IS SOURCE OF SIGHTING DATA ATM STAR TRACKER (C = 2)?

N  Y

FLASH VERB-NUJN 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 NEAREST ARC MINUTE.

ELEVATION-INNER GIMBAL ANGLE OF THE ATM STAR TRACKER, IN ARC MINUTES TO THE NEAREST ARC MINUTE.

MONITOR DSKY: OBSERVE VERB-NUJN FLASH TO REQUEST RESPONSE AND DISPLAY OF STAR TRACKER GIMBAL ANGLES, PSI AND PSI 3 1

ARE THESE THE CORRECT STAR TRACKER ANGLES?

Y  N

656 R56/SKYLARK
CALCULATE CELESTIAL BODY VECTOR FOR THE BODY DEFINED BY THE STAR CODE.

PCSS HOLD SNAP

FLASH VERB- NOUN TO RE- QUEST RESPONSE AND DISPLAY PLANET POSITION VECTOR:

V06N08
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.

ARE THE POSITION VECTOR COMPONENTS CORRECT?

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

WAIT FOR KEYBOARD ENTRY

TERMINATE
FLASH UPON RECEIPT OF PROCEED OR NEW DATA

P NEW
R DATA
J
C
E LOAD DATA
D

EXIT
R56

CHANGE CONTROL NOTES

REV 00 PCR 043,413,414,415, PCN 410,436
REV 01 PCN 489
ATTITUDE MANEUVER ROUTINE (R60)

PURPOSE:
(1) TO MANEUVER THE DWS/CSM OR CSM ALONE TO AN ATTITUDE SPECIFIED BY THE PROGRAM IN PROGRESS.

ASSUMPTIONS:
(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 3AISISFLG IS RESET).
   (B) A THREE AXIS (ORTHOGONAL) INERTIAL ORIENTATION TO WHICH THE THREE BODY AXES ARE TO BE ALIGNED (THE 3AISISFLG 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 V50N18 AND THE V06N18 IN THIS ROUTINE ARE PRIORITY DISPLAYS. THE V50N18 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 (MAGYITJDEI) CAUSES THE RCS UAP TO TERMINATE THE MANEUVER AND MAINTAIN ATTITUDE HOLD (SET STKFLG AND ZERO HOLDFLAG).

PROG CONT

CMC GROUND CREW

---

START ATTITUDE MANEUVER ROUTINE (R60)

---

OBTAIN DESIRED ATTITUDE SPECIFICA-
(NOT POSSIBLE FOR ALL CASES. SEE ASSUMPTION 1)

- N - Y

TERMINATE FLASH UPON RECEIPT OF ENTER, PROCEED, OR TERMINATE

P - T - E
R - E - N
D - R - T
C - M - E
E - I - R
D - N - A
T - Y - E

IS MAJOR MODE 007?

- N - Y

WAS THIS ROUTINE EXIT CALLED BY R60 P20?

- N - Y

SHALL I HAVE THE GNCS PERFORM THE MANEUVER AUTOMATICALLY?

- Y - N

DO ROUTINE R60

664
ON P20 TERMINATION PROCESS (V56 LOGIC).

EXIT EXIT
R60 R60

IS 3AXISFLG SET?

N Y

SELECT GNC CONTROL AND SELECT THE AUTO MODE.

SHALL I HAVE THE GNCs RECOMPUTE THE DESIRED ATTITUDE WITHOUT PERFORMING THE AUTOMATIC MANEUVER? (NOT POSSIBLE FOR ALL CASES. SEE ASSUMPTION 1)

Y N

CALCULATE FINAL VEHICLE ATTITUDE TO POINT SPECIFIC BODY FIXED VECTOR IN DESIRED DIRECTION. (VEPCPOINT ROUTINE) IN SUCH A WAY AS TO LEAVE UNCONSTRAINED THE VEHICLE ATTITUDE ABOUT THE BODY FIXED VECTOR. NOTE: GNCs CAPABILITY TO PERFORM MANEUVER AUTOMATICALLY WILL BE COMPROMISE.

EITHER SELECT SGS CONTROL
NIRD.

OR PLACE MODE SWITCH NOT IN AUTO.

SELECT GIMBAL ANGLES CORRESPONDING TO PREFERRED VEHICLE ATTITUDE AND PRESENT IMU ORIENTATION.

PERFORM ATTITUDE MANEUVER MANUALLY USING RHC AND BY REFERENCE TO THE OUT THE WINDOW VIEW AND/OR THE FDAI BALL AND ATTITUDE ERROR NEEDLES.
DID I DIRECT THE CMC TO PERFORM THE MANEUVER AUTOMATICALLY?

IS THE AUTO MODE SELECTED?

DISPLAY FINAL GIMBAL ANGLES V06N13 R1-OG ROLL R2-IG PITCH R3-HG YAW ALL ANGLES IN DEGREES TO THE NEAREST .01 DEGREES

SET HOLD FLAG NEGATIVE

TEMP HOLD

SNAP

MONITOR DSKY: OBSERVE NON-FLASHING VERB NOUN DISPLAY OF FINAL GIMBAL ANGLES UNTIL COMPLETION OF THE AUTOMATIC MANEUVER. (NOTE: IF MGA BECOMES GREATER THAN OR EQUAL TO 75 DEG (MAGNITUDE) THE MANEUVER WILL TERMINATE AND ATT HOLD IS ESTABLISHED.)

#270

#280

#290

#300

#310
DO MANEUVER CALCULATION (KALCMAN) AND ICU DRIVE ROUTINE TO ACHIEVE FINAL GIMBAL ANGLES OF THE MANEUVER RATE WILL BE THOSE LAST DEFINED TO THE CMC BY DSKY ENTRY. THIS PROCESS WILL INCLUDE A MONITOR OF THE RNC INPUTS TO THE CMC. ANY INPUT FROM THE RNC WILL BE INTERPRETED AS A MANUAL OVERRIDE AND WILL CAUSE IMMEDIATE TERMINATION OF THIS MANEUVER CALCULATION AND ICU DRIVE ROUTINE.

---

MONITOR ATTITUDE MANEUVER BY REFERENCE TO FOA BALL AND ATTITUDE ERROR NEEDLES TO AVOID GIMBAL LOCK. 

---

SHALL I OVERRIDE THE GNC'S AND COMPLETE THE MANEUVER MANUALLY?

---

Y N

---

WAIT FOR AUTOMATIC COMPLETION

---

IS THIS A P20 MANEUVER DURING MINKEY?

---

YES NO

---

IS HOLD FLAG NEGATIVE?

---

Y N

---

EXIT R60
SET HOLDFLAG ZERO

SET JAP REFERENCE TO DESIRED DAP CDS

IS TRACK FLAG SET?

NO . YES

IS THIS MINKEY? (IS AUTO-SEQ FLAG SET?)

NO . YES

EXIT R60

PERFORM ATTITUDE MANEUVER MANUALLY USING RMC AND BY REFERENCE TO THE OUT-THE-WINDOW-VIEW AND/OR THE FDAI BALL AND ATTITUDE ERROR NEEDLES.
TRACKING ATTITUDE ROUTINE (R61)

PURPOSE:
1) TO COMPUTE THE DESIRED TRACKING ATTITUDE OF THE CSM WHICH ENABLES OPTICS TRACKING OF THE DWS.
2) TO COMPUTE THE DESIRED TRACKING ATTITUDE OF THE CSM WHICH ENABLES TRACKING OF A CELESTIAL BODY.
3) TO CALL R60 IF A LARGE MANEUVER (SEE BELOW) IS REQUIRED, AND THE V5ON18 FLAG IS SET.
   TO LIGHT THE JPLINK ACTY LIGHT IF A LARGE MANEUVER (SEE BELOW) IS REQUIRED, THE V5ON18 FLAG IS NOT SET AND
   R60 IS POSSIBLE (SEE BELOW).

ASSUMPTIONS:
1) THE CSM ORIENTATION ABOUT THE TRACK AXIS (11) IS A FUNCTION OF THE EXISTING ATTITUDE AT THE TIME OF THE
   CALCULATION AND IS CALCULATED SO AS TO YIELD A MINIMUM ATTITUDE MANEUVER, UNLESS P20 (OPTIONS 4,5) IS CALLED.
2) THE ROUTINE IS AUTOMATICALLY CALLED BY THE UNIVERSAL TRACKING PROGRAM (P20) AND BY R52 DURING P20.
IS R61 COUNTER NEGATIVE?

N

Y

...

EXIT

DECREMENT R61 COUNTER BY ONE.

...

EXIT

LOAD DEADBAND WITH R2 OF N79 OR SET DEADBAND TO MINIMUM IF ZERO WAS LOADED IN R2 OF N79

SET DESIRED TIME = PRESENT TIME.
SAVE GAP REFERENCE ANGLES FOR LATER USE

FROM BELOW

EXTRAPOLATE CSM STATE VECTOR TO DESIRED TIME USING CONIC EQUATIONS

IS UFLAG SET?

N Y

EXTRAPOLATE DWS STATE VECTOR TO DESIRED TIME USING CONIC EQUATIONS

IS AZIM-FLAG IS AZIM-FLAG
SET?    SET?
- - -
- - -
- - -
- - -
- - -
- - -
GO TO GO TO
 outputs below below
- - -
-
-
-
-
-
-
-
CALCULATE THE
desired tracking
attitude from
CSM TO OWS.
desire) unit
-vector aligned
with LOS from
CSM TO OWS.)
this attitude
will be computed
(vecpoint) to
point the de-
sired unit vec-
tor at the OWS
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
-
-
-
-
-
674  R61/SKYLARK
BODY J THIS ATTITUDE WILL BE COMPUTED (VECPONINT)
TO POINT THE DESIRED UNIT VECTOR
AT THE CELESTIAL
BODY BUT WILL NOT
CONSTRAIN THE
NONCRITICAL
ORIENTATION ABOUT
THAT VECTOR.

--------------------------------------------------------

---

---

"RB"

---

-------------------
CALCULATE DESIRED
TRACKING ATTITUDE
FROM CSM TO OWS
(DESIRED UNIT VECTOR
ALIGNED WITH
LOS FROM CSM TO
OWS). THIS ATTITUDE
WILL BE COMPUTED TO POINT THE
DESIRED UNIT VECTOR
AT THE OWS AND
WILL CONSTRAIN THE
ORIENTATION ABOUT
THAT VECTOR.

-------------------

---

---

"GC"
CALCULATE DESIRED TRACKING ATTITUDE FROM CSN TO CELESTIAL BODY (DESIRED UNIT VECTOR ALIGNED WITH LOS FROM CSN TO CELESTIAL BODY). THIS ATTITUDE WILL BE COMPUTED TO POINT THE DESIRED UNIT VECTOR AT THE CELESTIAL BODY AND WILL CONSTRAN THE ORIENTATION ABOUT THAT VECTOR.

COMPUTE REQUIRED GIMBAL ANGLES AT THE DESIRED TRACKING ATTITUDE IF THE PRESENT IMU ORIENTATION IS HELD AND STORED IN NOUN 18. OPTIONS 4 OR 5 WILL GIVE 401 ALARM IF DESIRED ANGLES YIELD GIMBAL LUCK.

STORE ATTITUDE SPECIFICATION FOR
IS OPTION 3 OR 1?

YES

NO

COMPARE DESIRED
LOS DIRECTION
WITH DIRECTION
OF S/C VECTOR TO
BE POINTED
(ASSUMING CSM IS
AT DAP REFERENCE
ATTITUDE SAVED
ABOVE)

COMPARE DESIRED
CDUS WITH SAVED
DAP REFERENCE
ANGLES

IS ANGLE CHANGE(S)
GREATER THAN 10
DEGREES?

N

Y
WAS THIS THE FIRST TIME THROUGH THIS CALL OF R61?

N  Y.

COMPUTE NEW DESIRED TIME AS PRESENT TIME + EST.
TIME OF MANEUVER + 20.48 SEC.

GO TO "D" ABOVE

IS V50118 FLAG SET?

N  Y

TURN ON UPLINK ACTY LIGHT
SET R61 COUNTER EQUAL TO 3.

EXIT

IS THE PRIORITY DISPLAY IN ROUTINE 22 USING THE OSKY?

. Y . N

SET R61 COUNTER EQUAL TO -1.

EXIT

IS AZIMFLAG SET?

. Y . N
SET 3AXISFLG

RESET 3AXISFLG

RESET V50N18 FLAG

DO ATTITUDE MANEUVER ROUTINE (R60).

DO ATTITUDE MANEUVER ROUTINE (R60).

BLANK DSKY EXCEPT FOR MAJOR MODE

SET R61 COUNTER EQUAL TO 0.

*** EXIT
RESET V50118 FLAG

IS CRC AUTO MODE SELECTED?

IS STICK FLAG SET?

CALCULATE THE DESIRED BODY RATE AS DESCRIBED IN GSOP SECTION 5.2 AND RESOLVE INTO RCS DAP CONTROL AXIS.

SET HOLDFLAG NEGATIVE
INPUT THE FOLLOWING QUANTITIES TO THE Cs DAP:

(1) DESIRED BODY ATTITUDE (CURRENT DEAD-BAND CENTER)

(2) DESIRED BODY RATE (IN CONTROL AXIS COMPONENTS).

(3) AMOUNTS BY WHICH THE Cpu-DESIGNED REGISTERS SHOULD BE INCREMENTED AT 3.1 SECOND INTERVALS.

SET R61 COUNTER EQUAL TO 3.

EXIT R61

CHANGE CONTROL NOTES

REV 00  PCR 007,025,443, PCN 410,456,457
REV 01  PCN 489
CREW-DEFINED MANEUVER ROUTINE (R62)

**PURPOSE:**
(1) TO PROVIDE THE CREW WITH THE ABILITY TO SPECIFY A FINAL VEHICLE ATTITUDE FOR USE BY A CMC-CONTROLLED ATTITUDE MANEUVER.

**ASSUMPTIONS:**
(1) THE ROUTINE IS MANUALLY SELECTED BY THE ASTRONAUT BY OSKY ENTRY.
(2) THE CAP DEADBAND DURING THIS ROUTINE IS AS DEFINED BY THE LOAD DATA ROUTINE (R03 OR R04).
(3) THIS ROUTINE CAN ONLY BE ENTERED FROM THE CMC IDLING PROGRAM (P30).

<table>
<thead>
<tr>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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</table>

START CREW-DEFINED MANEUVER ROUTINE (R62)

**CURRENT PROGRAM POD?**

- **Y**
- **N**

IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

- **Y**
- **N**

**PRECEDING PAGE BLANK NOT PLANNED**
TURN ON OPERATOR ERROR LIGHT

KEY V3F000E AND THEN KEY V43E

EXIT

EXIT

HOLD

FLASH VERB-NOUIN TO REQUEST RESPONSE AND DISPLAY FINAL GIMBAL ANGLES:

V06 N22
R1- JG ROLL
R2- IG PITCH
R3- MG YAW

ALL GIMBAL ANGLES IN DEGREES TO NEAREST 01 DEGREE.

MONITOR DSKY: OBSERVE VERB-NOUIN FLASH TO REQUEST RE-

SPONSE AND DISPLAY OF FINAL GIMBAL ANGLES.

DO I WISH TO KEY IN NEW GIMBAL ANGLES TO BE USED BY ROUTINE R60?

N Y

KEY IN V25E AND LOAD NEW GIMBAL ANGLES

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

KEY IN PROCEED

NEW DATA
SET JAXISFLG FOR USE BY ATTITUDE MANEUVER ROUTINE (R60)

DO ATTITUDE MANEUVER ROUTINE (R60)
RENE Zvous FINAL ATTITUDE ROUTINE (R63)

Lev CC 05/19/71

PURPOSE:
1. TO CALCULATE THE FINAL GIMBAL ANGLES REQUIRED TO POINT THE SPECIFIED AXIS AT THE DWS.
2. TO DISPLAY THE GIMBAL ANGLES CORRESPONDING TO THE N7B ANGLES SELECTED BY THE ASTRONAUT.
3. TO CALL THE ATTITUDE MANEUVER ROUTINE (R60) FOR AUTOMATIC MANEUVER CAPABILITY.

ASSUMPTIONS:
1. THE CSM ORIENTATION ABOUT THE TRACK AXIS (11) IS A FUNCTION OF THE EXISTING ATTITUDE AT THE TIME OF THE CALCULATION AND IS CALCULATED SO AS TO YIELD A MINIMUM ATTITUDE MANEUVER.
2. TO SAVE TIME THE CSM ATTITUDE CONTROL MODE SHOULD BE PRESELECTED (FOR AUTOMATIC MANEUVERS R03 SHOULD HAVE BEEN DONE AND THE CMC AUTO MODE SELECTED).
3. THIS ROUTINE MAY BE SELECTED IN POO ONLY.
4. THIS ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PRECEDING PAGE BLANK NOT FILMED

#10

#20
IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

- N
- Y

TURN ON OPERATOR ERROR LIGHT

- MONITOR DSKY:
  DUES 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 W3TEDGE AND RESELECT THIS ROUTINE

- Y
- N

EXIT R63

DO IMU STATUS CHECK ROUTINE (R02)
RFSET AZIMFLAG

SET ASSUMED AXIS TO:
GAMMA=0
RM=0

HOLD
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY DESIRED
POINTING AXIS:
VO6N78
R1-GAMMA
R2-RM
R3-BLANK

ALL ANGLES IN
DEGREES TO THE
NEAREST .01 DEGREE.

WAIT FOR KEYBOARD
ENTRY

IS THE DATA CORRECT?

YES

NO

KEY IN
PROCEED

TERMINATE FLASH UPON
ACCEPT OF PROCEED
OR NEW DATA

NEW DATA

PROCEED

LOAD NEW DATA
 Store Data

EXTRAPOLATE OWS AND CSM STATE VECTORS FORWARD TO THE PRESENT TIME +1 MIN USING CUNIC EQUATIONS

Calculate the desired tracking attitude from CSM to OWS (desired unit vector aligned with LOS from CSM to OWS). This attitude will be computed (vecpoint) to point the desired axis at the OWS but will not constrain the non-critical orientation about that vector.
COMPUTE REQUIRED GIMBAL ANGLES AT THE DESIRED TRACKING ATTITUDE IF THE PRESENT INJ ORIENTATION IS HELD AND STORE IN NOUN 18.

STORE ATTITUDE SPECIFICATION FOR DESIRED TRACKING ATTITUDE FOR USE BY THE ATTITUDE MANEUVER ROUTINE (R60).

---

HOLD "FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY COMPUTED GIMBAL ANGLES"

SNAP "VO6 NL0
R1-GS ROLL
R2-IG PITCH
R3-MG YAW
ALL GIMBAL ANGLES IN DEGREES TO THE NEAREST .01 DEGREES"

---

MONITOR DSKY: "OBserve VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY COMPUTED GIMBAL ANGLES"

SHALL I ALLOW THE G*N TO DRIVE THE SPACE-
CRAFT TO THE
DESIRED ATTITUDE?

---

DO I WISH TO
UPDATE THIS
DISPLAY?

---

WAIT FOR KEYBOARD
ENTRY

---

KEY IN
RECYCLE
V32E

---

TO TERMINATE
THIS ROUTINE
KEY IN
V34E

---

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
RECYCLE OR TERMINATE
PROCEED

---

EXIT

---

EXIT
OPTICS ANGLES TRANSFORM ROUTINE (R64)

PURPOSE: (1) TO DISPLAY AT ASTRONAUT REQUEST THE TRACKING ANGLES CORRESPONDING TO GIVEN OPTICS ANGLES. TRACKING ANGLES (N78) SPECIFY THE SPACECRAFT AXIS TO BE POINTED BY THE TRACKING PROGRAM.

(2) TO AUTOMATICALLY ALTER THE SPACECRAFT TRACKING AXIS (AS CONTAINED IN N78) SINCE R61 CONSTRUCTS THE TRACKING VECTOR FROM THE CONTENTS OF N78.

ASSUMPTIONS: (1) OPTICS ANGLES WILL REMAIN CONSTANT DURING THE TRACKING.

(2) THE ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

---

PRECEDING PAGE BLANK NOT FILMED
ROTATION ROUTINE (R67)

REV 01 03/20/72

PURPOSE: (1) TO COMPUTE THE DAP COMMANDS FOR THE CSM WHICH ENABLES ROTATION IF 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.

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<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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</table>

- CMC
- ROUTINE
- SELECTION

---------------------
START ROTATION
ROUTINE (R67)
---------------------

SET R67FLAG
---------------------

---------------------
IS S/C CONTROL CMC?
---------------------

Y N

---------------------
IS THE AUTO MODE
SELECTED?
---------------------

Y N

R67/SKYLARK
LOAD DEADBAND WITH
R2 OF N79 OR SET
DEADBAND TO MINIMUM
IF ZERO WAS LOADED
IN R2 OF N79

"N"

IS TRACK FLAG SET?

Y

N

RESET R67FLAG

01

COMMAND ZERO

VEHICLE RATE

289

R67/SKYLARK
R67

---

COMPUTE ROTATION MATRIX
---

SET HOLDFLAG NEGATIVE
---

---

COMPUTE QAP COMMANDS FOR ONF CYCLE OF KALMANJ.
---

++

01

IS TRACK FLAG SET?
---

Y  N

++

489

IS HOLDFLAG NEGATIVE?
---

Y  N
LOAD ACTUAL CDUS
INTJ DAP DESIRED CDUS

+ +
+ 01
+ +
+ 489
++

COMMAND ZERO
VEHICLE RATE

IS HOLDFLAG NEGATIVE?

+ y
N.

SET HOLDFLAG ZERJ

SET DAP REFERENCE TO DESIRED DAP CDUS

WAIT ONE SECOND

#240
#250
#260
#270
#280
TEST DSKY LIGHTS VERB 35

**01 PURPOSE:**

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 POO.

### PROG CONT

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<th>GROUND</th>
<th>CREW</th>
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<td>CREW SELECTION</td>
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<td>MEASURED</td>
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</table>

### TEST DSKY LIGHTS

**START CREW INITIATED**

**KEY IN V35E**

**IS THE PRESENT PROGRAM POO?**

**Y**

**N**

**TURN ON OPERATOR ERROR LIGHT**

**...**

**EXIT**
SET BIT 1 OF IMODES3j TO INSURE THAT IMMUN AND OPTIMUM WILL NOT TURN OUT ANY DSKY LIGHTS.

---

TURN ON ALL DSKY LIGHTS

---

OBSERVE THAT ALL DSKY LIGHTS ARE FUNCTIONING PROPERLY

---

AFTER 5 SEC TURN OFF ALL DSKY LIGHTS

---

OBSERVE DSKY LIGHTS OFF

---

RESET BIT 1 OF IMODES3j

---

EXIT

CHANGE CONTROLS NOTES

REV 01 PCB 489
REQUEST FRESH START VERB 36

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.

<table>
<thead>
<tr>
<th>PROG</th>
<th>CREW SELECTION</th>
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<tbody>
<tr>
<td>CONT</td>
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<tr>
<td></td>
<td>START CREW INITIATED</td>
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<tr>
<td></td>
<td>FRESH START</td>
</tr>
<tr>
<td>01</td>
<td>KEY IN V36E</td>
</tr>
<tr>
<td>020</td>
<td>ZERO OUTPUT CHANNELS</td>
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<td></td>
<td>ZERO CHANNEL 77</td>
</tr>
</tbody>
</table>
SET TIME 3 = 37777
TIME 4 = 37775
TIME 5 = 37774

TERMINATE WAITLISTED TASKS

CLEAR ALL EXECUTIVE REGISTER SETS

INDICATE NO ACTIVE JOBS

MAKE ALL VAC AREAS AVAILABLE

+01
BLANK DSKY REGISTERS
(PROGRAM, VERB,
NOUN, PI, R2, R3)

+409
OBSERVE DSKY REGISTERS BLANK

++

712
14 ISS

---

INITIALIZE DOWNLINK
WITH PEJ DOWNLIST

---

CLEAR PHASE TABLE

---

INITIALIZE IMU
INHIBIT IMU FAIL
FOR APPROXIMATELY
7.90 SECONDS

---

INITIALIZE OPTICS

---

RESET EXTENDED VERB
ACTIVITY INTERLOCK
ZERO IMU CDO EXTENDED VERB 43

REV 01 03/20/72

PURPOSE: (1) TO INSURE SYNCHRONIZATION BETWEEN THE ISS CDO COUNTERS AND THE CDO COUNTERS IN THE COMPUTER.
(2) TO TERMINATE THE IMU COARSE ALIGN MODE AND ENTER THE FINE ALIGN MODE (INERTIAL IMU).

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.
(2) THE PROCESS MAY NOT BE SELECTED IF THE ISS IS IN THE COARSE ALIGN MODE AND IN SIMBAL LOCK.
(3) THE PROCESS IS INTENDED PRIMARILY FOR USE ON THE GROUND.

<table>
<thead>
<tr>
<th>PROG</th>
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<tbody>
<tr>
<td>CONT</td>
<td>CCREW SELECTION</td>
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</table>

START CREW INITIATED ZRO IMJ CDO

---

IS MODE SWITCHING OR GYRC TfwuQING IN PROCESS?

N Y

---

TURN ON OPERATOR ERROR
COARSE ALIGN CPU EXTENDED VERB 41 (WITH N20)

PURPOSE:
(1) TO ALIGN THE IMU TO GIMBAL ANGLES SPECIFIED BY THE ASTRONAUT.
(2) TO COARSE ALIGN TO 0, 0, 0 WHEN IN GIMBAL LOCK AND COARSE ALIGN.

ASSUMPTIONS:
(1) THE PROCESS IS CREW SELECTED BY USKY ENTRY.
(2) THE PROCESS MAY BE SELECTED ONLY WHEN NO OTHER EXTENDED VERB IS ACTIVE.
(3) THE ACCURACY OF THE ALIGNMENT IS TESTED TO A TOLERANCE OF ±2 DEGREES. IF THIS TOLERANCE IS EXCEEDED, THE ASTRONAUT WILL BE NOTIFIED VIA A PROGRAM ALARM.
(4) V41 MAY ONLY BE USED WITH N20 OR N91. REFER TO OPTICS COARSE ALIGN EXTENDED VERB (V41N91).
(5) THE PROCESS SHOULD NEVER BE USED DURING A PROGRAM WHICH REQUIRES THAT THE IMU BE ON AND ALIGNED.

<table>
<thead>
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<th>PROG</th>
<th>CONT</th>
<th>CPU</th>
<th>GROUND</th>
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*CREW SELECTION*

START CREW INITIATED
COARSE ALIGN CPU

---

KEY IN V41N20E

---

IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

N Y

---

PREceding page blank

V41N20/SKY
TURN ON
OPERATOR
ERROR LIGHT

-----

EXIT

-----

FLASH VERB-NOUN TO
REQUEST LOAD OF
DESIRED CDU ANGLES.

HOLD

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH REQUESTING
LOAD OF CDU ANGLES

V21N22
R1-OG ROLL
R2-OG PITCH
R3-OG YAW

ALL REGISTERS
INITIALLY BLANK

-----

#30

#40

#50

#60
ALL ANGLES IN DEGREES TO NEAREST .01 DEGREE

SHALL I LOAD COU ANGLES?

Y N

WAIT FOR KEYBOARD ENTRY

LOAD DESIRED ANGLES

TERMINATE FLASH UPON RECEIPT OF DATA OR V33E

DATA .Y .3 .3 .E

TERMINATE FLASH UPON RECEIPT OF DATA OR V33E

KEY IN V33E

DISPLAY COARSE ALIGN VERB

MONITOR NSKY:

IS MUSE SWITCHING OR GYRO TORQUING IN PROGRESS?

N Y

TURN ON OPERA TXD ERROR LIGHT

V41N20/SKY
VEHICLE (GIMBAL ANGLES)

---

ARE THE GIMBALS WITHIN 2 DEGREES OF THE DESIRED ANGLES?

* Y * N

** TURN ON PROGRAM ALARM AND STORE ALARM CODE (00211)

** MONITOR DSKY: DOES PROGRAM ALARM INDICATE THAT THE IMU GIMBALS DID NOT DRIVE TO WITHIN 2 DEGREES OF THE DESIRED ANGLES?

** Y ** N

*** EXIT

** EXIT

** EXIT

---

CHECK STATUS OF COMMUNICATION PANEL. IS AN ISS MALFUNCTION INDICATED?

* Y * N

*** EXIT

---

DO I DESIRE TO RESELECT THE
COARSE ALIGN PROCESS?
NOTE: THE DEGREE OF FAILURE MAY BE CHECKED BY COMPARING THE SPECIFIED GIMBAL ANGLES (V16N22E) WITH THE CURRENT ANGLES (V16N20E).

CHANGE CONTROL NOTES

REV 00 PCN 457
REV 01 PCN 489
COARSE ALIGN CDO EXTENDED VERB #1 (WITH N91)  REV 00 05/19/71

PURPOSE:  
(1) TO DRIVE THE OPTICS TO SHAFT AND TRUNNION ANGLES SPECIFIED BY THE ASTRONAUT.

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 MAY BE SELECTED ONLY WHEN THE CMC IS IN THE CMC IDLING PROGRAM (P30).

<table>
<thead>
<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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</table>

**CREW SELECTION**

START CREW INITIATED
OSS COARSE ALIGN

---

**KEY IN V41N91E**

---

IS CURRENT PROGRAM P00?

- Y
- N

---

TURN ON OPERATOR ERROR LIGHT

---

---

---

---

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---
IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

<table>
<thead>
<tr>
<th>N</th>
<th>Y</th>
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IS OPTICS MODE CMC?

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<td>EXIT</td>
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MONITOR PROGRAM ALARM LIGHT: IF THE PROGRAM ALARM LIGHT COMES ON AT THIS TIME, THE ASTRONAUT SHOULD KEY V09N09E TO CHECK THE ALARM CODE:

00115-SET OPTICS MODE SW-CMC RSET

00117-OPTICS NOT AVAILABLE. THE PROCESS
ARE OPTICS AVAILABLE?

Y  N

TURN ON PROGRAM
ALARM AND STORE
ALARM CODE
(OJ117)

EXIT

HOLD
FLASH VERB-NOUN TO
REQUEST LOAD OF DESIRABLE OPTICS ANGLES
V21 N92
R1 - SHAFT
R2 - TRUNNION
R3 - BLANK

ALL REGISTERS
INITIALLY BLANK

SHAFT ANGLE IN DEGREES TO NEAREST .01 DEGREE

TRUNNION ANGLE IN DEGREES TO NEAREST .001 DEGREE

SHALL I LOAD OPTICS ANGLES?

Y  N

WAIT FOR KEYBOARD ENTRY

LOAD DESIRED ANGLES
<table>
<thead>
<tr>
<th>TERMINATE FLASH UPON RECEIPT OF DATA OR V33E</th>
<th>KEY IN V33E</th>
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<tr>
<td>DATA V 3.3 E.......</td>
<td>USE ANGLES IN SAC, PAC</td>
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<tr>
<td>DISPLAY COARSE ALIGN VERB V41</td>
<td>MONITOR OSKY: OBSERVE DISPLAY OF COARSE ALIGN VERB</td>
</tr>
<tr>
<td>ENABLE CMC POSITIONING OF OPTICS TO DESIRED ANGLES</td>
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CHANGE CONTROL NOTES
PULSE TORQUE GYROS EXTENDED VERB 42

REV 01  03/20/72

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.

<table>
<thead>
<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
</tr>
</thead>
</table>

DO I DESIRE TO LOAD
A DELTA GYRO ANGLE
GREATER THAN +99.999
DEGREES?

---

. Y  . N
---

THE ASTRONAUT
MUST LOAD THE
THREE DOUBLE PRE-
CISION GGC
REGISTERS:

\[\begin{align*}
\text{KEY} & \quad \text{W21NO2E} \\
& \quad 02757E \\
& \quad XXXXXE \\
& \quad NISE \\
& \quad XXXXEEE \\
& \quad YYYYEE \\
& \quad YYYYYEE \\
& \quad ZZIZZEE \\
& \quad ZZIZZIE \\
& \quad BIT 14 OF THE \\
& \quad HIGH ORDER RE-
\end{align*}\]

#10

#20

V42/SKYLARK
PRESENTS 100 DEGREES; BIT 13, 90 DEGREES; ETC.
THE MAXIMUM NEGATIVE GYRO TORQUING ANGLE IS 37777,
37743; THE MAXIMUM POSITIVE GYRO TORQUING ANGLE IS 40000,
40034. ANY ANGLE OF GREATER MAGNITUDE THAN THE GIVEN MAXIMUM WILL RESULT IN A COMMANDED TORQUING ANGLE OF ZERO.

(NOTE: THE LOADING OF TORQUING ANGLES GREATER THAN 90 DEGREES SHOULD NOT BE PERFORMED DURING FLIGHT. THIS PROCEDURE IS INTENDED FOR USE ON THE GROUND.)

+01 START CREW INITIATED PULSE TORQUE GYROS
+489

+70 KEY V42E
IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

Y

TURN ON OPERATOR ERROR LIGHT

EXIT

FLASH VERB-NOUN TO REQUEST LOAD OF DELTA GYRO ANGLES

V21M93

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: OBTAIN VERB-NOUN

FLASH REQUESTING LOAD OF DELTA GYRO ANGLES

DID I LOAD THE GYRO TORQUING REGISTERS

HOLD
PLETE THE FINE ALIGNMENT. ALL ANGLES IN DEGREES TO NEAREST .001 DEGREES

BEFORE KEYING V42E?

Y Y

WAIT FOR KEYBOARD ENTRY

KEY IN V33E

LOAD DESIRED DELTA GYRO ANGLES

TERMINATE FLASH UPON RECEIPT OF V33E OR DATA

*V33E
*DATA

DISPLAY FINE ALIGN VERB V42

MONITOR DSKY: OBSERVE DISPLAY OF FINE ALIGN VERB

IS A MODE SWITCH OR A GYRO TORQUING IN PROGRESS?

N Y
TURN ON OPERA-
TOR ERROR LIGHT

EXIT

IS THE IMU BEING
INITIALIZED?

N.

Y.

EXIT

ENTER FINE ALIGN
MODE

++

+01

++

489

++

WAIT 2 SEC

EXIT

PULSE IRISSETHROUGH
DESIREDEANGLES

++
LOAD FOAI ATT ERROR NEEDLES (TEST ONLY)
EXTENDED VERB 43

REV 00 05/19/71

PURPOSE:
1) TO LOAD ASTRONAUT SPECIFIED ANGLES INTO THE FOAI ATTITUDE ERROR NEEDLES.

ASSUMPTIONS:
1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

2) IF LIFTOFF HAS OCCURRED, THE PROCESS MAY BE SELECTED ONLY WHEN NO OTHER EXTENDED VERB IS ACTIVE. IF LIFTOFF HAS NOT OCCURRED, ANY OTHER EXTENDED VERB IN PROCESS WILL BE OVERRIDEN.

3) THE PROCESS MAY NOT BE SELECTED IF THE IMU IS IN THE COARSE ALIGN OR ZERO IDLY время.

4) THE PROCESS IS INTENDED PRIMARILY FOR USE ON THE GROUND.

5) THE MAXIMUM ERROR ANGLE WHICH MAY BE LOADED IS ±16.88 DEGREES. ANY VALUE GREATER THAN THIS MAXIMUM WILL BE INTERPRETED AS ±16.33 DEGREES. THE ASTRONAUT SHOULD SELECT THE FOAI SCALE APPROPRIATE TO THE ERROR ANGLES HE WISHES DISPLAYED. THE MAXIMUM ANGLES WHICH MAY BE SHOWN ON THE ERROR NEEDLES ARE: PITCH AND YAW 15 DEGREES; ROLL ±50 DEGREES.

6) THE PROCESS MAY BE SELECTED ONLY IN POO.

<table>
<thead>
<tr>
<th>PROGRAM</th>
<th>CMC</th>
<th>GROUND</th>
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<td>CONT</td>
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CREW SELECTION

-------------------------
START CREW INITIATED
LOAD FOAI ATTITUDE
ERROR NEEDLES
-------------------------

KEY IN V43E

#10

IS THE CMC IDLING
PROGRAM (POO) IN
RESET ERROR COUNTER ENABLE

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH REQUESTING
LOAD OF ERROR ANGLES

HOLD
FLASH VERB-NOUN TO
REQUEST LOAD OF
ERROR ANGLES
V21 N22
R1- ROLL
R2- PITCH
R3- YAD

ALL REGISTERS INITI-
ALLY BLANK

ERROR ANGLES-
THE ANGLES TO BE
LOADED IN THE ISS
ERROR COUNTERS,
MAXIMUM ANGLE
±16.88 DEGREES.

ALL ANGLES IN
DEGREES TO NEAREST
.01 DEG

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF DATA

LOAD DESIRED
ERROR ANGLES

V43/SKYLARK
SET ERRJR COUNTER ENABLE
_______________

WAIT 20 MILLISECONDS
_______________

LOAD ISS ERROR COUNTERS
_______________

EXIT

CHANGE CONTROL NOTES
REQUEST Docked DAP Data Load Routine (R04)
EXTENDED VERB 44

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
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
*
*
*

START CREW INITIATED ACTIVATION OF CSM DAP

---

KEY IN V46E 010

IS TVC DAP ON?

---

Y
*
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* IS VEHICLE CONFIGURATION 2 OR 6?
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**
PLEASE PERFORM EXTENDED VERB 50

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
PLEASE MARK EXTENDED VERB 51

REV 00 05/19/71

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 PO3 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
PLEASE MARK ALTERNATE LOS EXTENDED VERB 53

PURPOSE: (1) TO ALLOW THE ASTRONAUT TO OBTAIN OPTICAL SIGHTING DATA BY USE OF ANY DESIGNATED ALTERNATE LINE OF SIGHT.

ASSUMPTIONS: (1) THIS VERB IS USED IN R23 AND R36 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
OLD

FLASH VERB-NOUN TO
REQUEST LOAD OF
DELTA TIME
V21 M24
R1-HOURS
R2-MINUTES
R3-SECONDS

++
+01
TIME TO NEAREST .01
SECONDS
+
ALL REGISTERS ARE
INITIALLY BLANK
+

---
DO I DESIRE TO LOAD
DELTA CLOCK TIME?
---

Y
N

WAIT FOR KEYBOARD
ENTRY

---
LOAD DESIRED
TIME INCREMENTS
---

TERMINATE FLASH UPON
RECEIPT OF DATA,

V33E, OR V34E

---

V33E .D
.V34E .T

A

---

A

---

EXIT

---

EXIT
SPECIFY SETTING OF FULL TRACK FLAG
EXTENDED VERB 57

PURPOSE:
(1) TO DISPLAY STATUS OF FULL TRACK FLAG AND ALLOW CHANGE BY DSKY ENTRY.

ASSUMPTIONS:
(1) FULLKFLG IS EXAMINE) ONLY DURING AUTOMATIC W-MATRIX INITIALIZATION FOLLOWING TPI IN RENDEZVOUS SEQUENCE.
IT INDICATES WHETHER BOTH NAVIGATION SENSORS (VHF AND SEKTANT) WILL BE USED FOLLOWING TPI.
(2) PROCESS IS CREW SELECTED BY DSKY ENTRY.
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

<table>
<thead>
<tr>
<th>PROG</th>
<th>CREW</th>
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V58/SKY LARK
ENABLE ALL JETS (DOCKED) EXTENDED
VER 59

PURPOSE:  (1) TO ALLOW THE ASTRONAUT TO QUICKLY RE-ENABLE ALL JETS IN DOCKED DAP WHICH HAD BEEN INHIBITED VIA CHANNEL 5 JET INHIBIT AND CHANNEL 6 JET INHIBIT IN DOCKED DAP DATA LOAD.

ASSUMPTIONS:  (1) THE PROCESS IS USED DURING CSM-DSM DOCKED CONFIGURATION.
(2) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

<table>
<thead>
<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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<tbody>
<tr>
<td>CONT</td>
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</tbody>
</table>

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*CREW SELECTION
***

ENABLE ALL JETS IN CH5 AND CH6

---

KEY IN V59E

---

EXIT

CHANGE CONTROL NOTES

REV 00  PCR 005,040
SET ATTITUDE ERROR REFERENCE TO PRESENT ATTITUDE
EXTENDED VERB 60

REV 00 05/19/71

PURPOSE: (1) TO SET THE ASTRONAUT TOTAL ATTITUDE REGISTERS (N17) EQUAL TO THE PRESENT ATTITUDE (N20) (PROVIDE AN "ATTITUDE SET" FOR MODE 31).

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

<table>
<thead>
<tr>
<th>PROG</th>
<th>CNC</th>
<th>GROUND</th>
<th>CREW</th>
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<tr>
<td>START CREW INITIATED</td>
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<td>KEY IN V60E</td>
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<tr>
<td>SETTING OF N17=N20</td>
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</tbody>
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#20

V50/SKYLARK
SELECT MODE 1 (DISPLAY DAP ATTITUDE ERROR)

EXTENDED VFRB 61

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.

CREW SELECTION

START CREW INITIATED MODE 1 ERROR DISPLAY KEY IN V6LE

RESET NEEDLE FLG

EXIT

CHANGE CONTROL NOTES

REV 01 PCN 489
**Purpose:**
(1) To display total astronaut attitude error (N17-N20) on the FDI attitude error needles.

**Assumptions:**
(1) The process is crew selected by Osky entry.
(2) This process may be selected at any time.

```
PROG CONT C4C GROUND CREW

CREW SELECTION

START CREW INITIATED MODE 3 ERROR DISPLAY

KEY IN V63E

SET NEEDFLG

EXIT

RESET N20K417

FLAG

EXIT
```

#10

#20

#30
PRECEDING PAGE BLANK NOT FILMED
SET CSM STATE VECTOR INTO OWS STATE VECTOR
EXTENDED VERB 66

REV 00 05/19/71

PURPOSE:
11) TO TRANSFER THE CSM STATE VECTOR INFORMATION TO THE OWS STATE VECTOR.

ASSUMPTIONS:
11) THE TRANSFER OF THE STATE VECTOR INFORMATION MAY BE ACCOMPLISHED AT ANY TIME EXCEPT IF AVERAGE-G ROUTINE WAS IN PROCESS.

12) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

PROG CONT CMC GROUND CREW

CREW SELECTION

START CREW INITIATED STATE VECTOR TRANS-
FFR (CSM TO OWS)

---

KEY IN V66E

---

EXIT

---

IS INTEGRATION IV PROCESS?

---

Y

---

COMPLETE INTEGRATION

---

PRECEDING PAGE BLANK NOT FILMED
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 USKY ENTRY.

<table>
<thead>
<tr>
<th>PROG</th>
<th>CONT</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
</tr>
</thead>
<tbody>
<tr>
<td>++</td>
<td>01</td>
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<tr>
<td>+</td>
<td>489</td>
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<td>++</td>
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</tbody>
</table>

START W-MATRIX RSS ERROR DISPLAY PROCESS

IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

- N
- Y

TURN ON OPERATOR ERRJR LIGHT

#10

#20

030
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.

NOTE: THE LOGIC FROM THIS POINT IS NOT
UNIQUELY ASSOCIATED WITH V69. IT IS THE PROCESSING WHICH TAKES PLACE WITH ANY HARDWARE INITIATED RESTART. THE CONDITION CAUSED BY V69E AND SENSED BY THE COMPUTER HARDWARE WHICH INITIATES A RESTART IS TO TRAP: TOO MANY CONSECUTIVE TC' S

INCREMENT RESTART COUNTER

STORE DEBUGGING INFORMATION

HAS THERE BEEN AN OSCILLATOR FAIL?

IS THE AGC WARNING
ON?

... ON?

Y N

... ON?

Y N

... ON?

Y N

...

GO TO "A" BELOW

-----------------

HAVE BOTH THE MARK REJECT AND ERROR RESET BUTTONS BEEN PRESSED?

-----------------

Y N

... HAVE BOTH THE MARK REJECT AND ERROR RESET BUTTONS BEEN PRESSED?

Y N

...

GO TO "A" BELOW

-----------------

WAS ERASABLE MEMORY CHECK IN PROCESS WHEN THE RESTART OCCURRED?

-----------------

Y N

... WAS ERASABLE MEMORY CHECK IN PROCESS WHEN THE RESTART OCCURRED?

Y N

...

DO CONTROL REGISTERS HAVE DEFICIENT DATA?

-----------------

Y N

... DO CONTROL REGISTERS HAVE DEFICIENT DATA?

Y N

... DO CONTROL REGISTERS HAVE DEFICIENT DATA?
SET TIME 3 = 37777
TIME 4 = 37775
TIME 5 = 37774

REINITIALIZE CHANNELS 11 AND 13

TERMINATE WAITLISTED TASKS

CLEAR ALL EXECUTIVE REGISTER SETS

INDICATE NO ACTIVE JOBS

MAKE ALL VAC AREAS AVAILABLE
BLANK OSKY REGISTERS (PROGRAM, VERB, NOUN, R1, R2, R3)

OBSERVE OSKY REGISTERS BLANK

RESET DISPLAY/ASTRONAUT INTERFACE FLAGS

A. DO CONTROL REGISTERS HAVE DEFICIENT DATA?
B. HAVE BOTH MARK REJECT AND ERROR RESET BUTTONS BEEN PRESSED?
C. WAS AGC WARNING LIGHT TURNED ON WITHOUT OSCILLATOR FAIL?

ANY ALL
YES NO

GO TO "B"
BELOW

CLEAR SELF CHECK ERROR REGISTERS,
MODE REGISTER

ZERO JUDGEBIT
CHANNELS: 11
{"A" RELAYS}: 12
(ONC) BITS 6 AND
4 SET TO 1 IF
NECESSARY); 13
(AGC) AND
14 (ISS)

INITIALIZE DOWN-
LINK WITH POD
DOWNLIST

CLEAR PHASE TABLE

INITIALIZE IMU
(INHIBIT IMU FAIL
FOR APPROXIMATELY
7.90 SECONDS)

TERMINATE OPTICS
COARSE ALIGN
INITIALIZE OPTICS

INITIALIZE PIPA AND TELEMETRY FAIL FLAGS

RESET UPSVFLAG

EXIT

SCHEDULE 15RUPT FOR DAP PROGRAM

INITIALIZE OPTICS

INITIALIZE IMU
**01**

**TURN OFF DSKY DISCRETE LIGHTS EXCEPT**

**PROG, GIMBAL LOCK AND NO ATT.**

**089**

**OBSERVE DSKY LIGHTS OFF EXCEPT**

**PROG, GIMBAL LOCK AND NO ATT.**

**N**

**Y**

**RETURN ISS TO COARSE ALIGN**

**N**

**Y**

**IS ENGONFLG SET?**

**N**

**Y**

**TURN ENGINE ON (BIT 13 CHANNEL 11)**

**TEST PHASE TABLE.**

**IS IT CORRECT?**

**N**

**Y**

**TURN ON PROG ALARM AND**

---

#340

#350

#360

#370
PRECEIVING PAGE BLANK NOT FILMED
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, SYNCH BITS, ECADR AND TIME.
(3) THE E BANKS ARE DUMPED IN ORDER, STARTING WITH E BANK ZERO.
(4) DJUMPING 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).

<table>
<thead>
<tr>
<th>PROG CONT</th>
<th>CMC</th>
<th>GROJND</th>
<th>CREW</th>
</tr>
</thead>
</table>

---

CREW SELECTION

--

START CREW INITIATED
DOWNLINK ERASABLE
DUMP

--

KEY IN V74E

--

TERMINATE CURRENT
DOWNLIST

--

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VT4/SKYLARK
| SET E BANK COUNTER, WORD COUNTER, AND DUMP COUNTER = 0 | INITIALIZE E-BANK DUMP, DUMP TO SYNCH BITS, ECDDR AND TIMES | DUMP E-BANK | INCREMENT E-BANK COUNTER AND SET WORD COUNTER = 0 | ARE ALL 8 BANKS DUMPED AND COUNTER = 812? | Y | N | INCREMENT DUMP COUNTER AND SET E-BANK |
COUNTER=0

HAVE TWO COMPLETE
DUMP PASSES BEEN
MADE (DJMP COUNTER
=2)?

N
Y

RESTORE CURRENT
DOWNLIST

EXIT

CHANGE CONTROL NOTES
SET LIFTOFF FLAG EXTENDED VERB 75

**PURPOSE:**

(1) SET LIFTOFF BACKUP FLAG.

**ASSUMPTIONS:**

(1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

<table>
<thead>
<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONT</td>
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</tbody>
</table>

---

**Start Crew Initiated**

SET LIFTOFF FLAG

PROCESS

---

**Key In V75**

---

SET LIFTOFF BACKUP FLAG

---

**Exit**
ENABLE RANGE RATE MARK PROCESSING
ROUTINE (R27) EXTENDED VERB 76

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 (N72) 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.

PRNG
CONT
CMC
GROUND
CREW
CREW SELECTION
... #10

START CREW INITIATED EXTENDED VERB 76 PROCESS
... #20

IS ANOTHER EXTENDED VERB A MARKING DIS-PLAY, OR A PRIORITY

V76/SKYLARK
DISABLE VHF RANGE RATE MARK PROCESSING
ROUTINE (R27) EXTENDED VERB 77
REV 00 05/19/71

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
EXTENDED VERB 77
PROCESS

KEY IN V77E

RESET R27FLAG

EXIT

CHANGE CONTROL NOTES
REV 00 PCR 439

PRECEDING PAGE BLANK NOT FILLED
CHANGE GYRO COMPASS LAUNCH AZIMUTH
EXTENDED VERB 70

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 (PO2).
2. PROCESS IS CREW SELECTED BY DSKY ENTRY.
3. THE PROCESS MAY BE SELECTED ONLY DURING GYRO COMPASSING PROGRAM (PO2).

CMC GROUND CREW

---
START CHANGE GYRO COMPASS LAUNCH AZIMUTH PROCESS
---
IS THE CURRENT PROGRAM PO2?
Y N
---
TURN ON OPERATOR ERRJR LIGHT
---
MONITOR DSKY: DOES OPERATOR ERROR LIGHT COME ON INDICATING THAT THIS ROUTINE CAN NOT BE

#10

#20
SELECTED AT THIS TIME?

N. Y.

---

IN ORDER TO TURN THIS PROCESS ON
SELECT PRELAUNCH OR SERVICE INITIALIZATION PK3 -
GRAM (PK1) BY KEYING IN V34E AND RE-
SELECTING THIS PROCESS OR BY KEYING IN V34E ON MARK DISPLAY IN PK3.

---

EXIT

---

FLASH VERB- NOUN TO REQUEST PROCEED AND DISPLAY STORED LAUNCH AZIMUTH
HOLD SNAP
V06N29 R1 XSM LAUNCH AZIMUTH R2 BLANK R3 BLANK
XSM LAUNCH AZIMUTH MEASURED CLOCKWISE FROM TRJE NORTH IN DEGREES TO THE NEAREST .01 DEGREES.

---

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

---

AM I SATISFIED WITH XSM LAUNCH AZIMUTH?
Y N.

---

KEY IN PROCEED

---

KEY IN V21E AND
UPDATE OWS STATE VECTOR EXTENDED VERB 80  

PURPOSE:  (1) TO CAUSE THE RENDEZVOUS DATA PROCESSING RESULTS TO UPDATE THE OWS STATE VECTOR.

ASSUMPTION: (1) PROCESS IS CREW SELECTED BY OSKY ENTRY.

---

**PROG CONT**  **CNC**  **GROUND**  **CREW**

---

START CREW INITIATED OWS STATE VECTOR UPDATE PROCESS

---

CREW SELECTION

---

KEY IN V80E

---

EXIT

---

RESET VEHICLE UPDATE FLAG

---

EXIT

---

CHANGE CONTROL NOTES

---
### PURPOSE:
1. To cause the rendezvous data processing results to update the CSM state vector.

### ASSUMPTION:
1. Process is crew selected by DSKY entry.

### Preceding Page Blank

#### PROG CONT

| C4C | GROUND | CREW
|-----|--------|-------
|     |        |       |

- **CREW SELECTION**
- ...

---

#### START CREW INITIATED

- CSM STATE VECTOR
- UPDATE PROCESS

---

#### KEY IN VBIE

- ...
- ...
- EXIT

---

#### SET VEHICLE UPDATE

- FLAG

---

#### EXIT

---

### Change Control Notes
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.

<table>
<thead>
<tr>
<th>PROG CONT</th>
<th>CREW</th>
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</table>

START CREW INITIATED REJECT OF RENDEZVOUS BACKUP SIGHTING MARK PROCESS.

---

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
RESET VHF RANGE FLAG EXTENDED VERB BB

PURPOSE: 1) TO RESET THE VHF RANGE FLAG.

ASSUMPTION: 1) PROCESS IS CREW SELECTED BY DSK ENTRY.

PROC CONT

CREW

GROUND

ZONE

INITIATE RESET VHF RANGE FLAG PROCESS

EXIT

KEY IN ZBB

TURN OFF TRACKER

RESET VHF RANGE FLAG

[Diagram of a flowchart showing the process of resetting the VHF range flag with various steps and conditions indicated by arrows and boxes.]
REQUEST RENDEZVOUS OUT-OF-PLANE DISPLAY (R36)
EXTENDED VERB 90

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 4JTES
REQUEST BANKSUM DISPLAY
EXTENDED VERB 91

PURPOSE: (1) DISPLAY THE SUM OF EACH BANK FOR COMPARISON.

ASSUMPTIONS: (1) PDO IS OPERATING.
(2) NO OTHER EXTENDED VERB IS ACTIVE.
(3) PROCESS IS CREW SELECTED BY DSKY ENTRY

<table>
<thead>
<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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<tbody>
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<td><strong>489</strong></td>
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</tbody>
</table>

---

START CREW INITIATED
BANKSUM DISPLAY

---

IS PROGRAM PDO OPERATING?

- **Y**
- **N**

IS ANOTHER EXTENDED VERB, A MARKING DISPLAY?
OR A PRIORITY DISPLAY

ACTIVE?

------------------

N

------------------

TURN ON OPERA-

TOR ERROR LIGHT

------------------

EXIT

------------------

INITIALIZE ROUTINE

TO DISPLAY BANK SUMS

------------------

--------------------

FLASH V-N TO REQUEST

DISPLAY OF BANK SUM

V05 V01

HOLD

R1 BANK SUM

K2 BANK 

SNAP

R3 BUGGER WORD

BANK SUM-SUM OF THE

BITS OF THE CHOSEN

BANK

BANK & - NUMBER OF

BANK BEING READ,

BUGGER WORD-FACTOR

REQUIRED TO MAKE

|R1| = |R2|.

--------------------

IS THIS THE BANK I

DESIRE TO READ?

--------------------

V

--------------------

IS THE BANK SUM

THE NUMBER I EX-
ENABLE W-MATRIX INITIALIZATION EXTENDED
VERS. 93

REV 00 05/19/71

PURPOSE: (1) TO REQUEST REINITIALIZATION OF THE W-MATRIX.

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY OSKY ENTRY.
(2) THIS PROCESS RESETS THE RENDWFLG INDICATING THAT THE W-MATRIX IS NOT VALID AND MUST BE REINITIALIZED BEFORE BEING USED. THE RENDWFLG IS AUTOMATICALLY SET FOLLOWING W-MATRIX INITIALIZATION OR REINITIALIZATION.
(3) THIS PROCESS MAY BE SELECTED AT ANY TIME.

<table>
<thead>
<tr>
<th>PROG</th>
<th>CREW</th>
<th>GROUND</th>
<th>CMC</th>
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<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>START W-MATRIX INITIALIZATION</td>
<td>KEY IN V93E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RESET RENDWFLG</td>
<td></td>
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</tbody>
</table>

CHANGE CONTROL NOTES

REV 00  PCA 017,318
TERMINATE INTEGRATION AND GO TO POO
EXTENDED VERB 96

PURPOSE:
1) TO PROVIDE A MEANS OF SUSPENDING STATE VECTOR INTEGRATION.

ASSUMPTIONS:
1) IF THE COASTING INTEGRATION ROUTINE IS IN OPERATION, IT IS TERMINATED AT THE END OF THE CURRENT TIME STEP.
2) THE CURRENT PROGRAM IS TERMINATED
3) THE CMC IDLING PROGRAM IS ACTIVATED
4) DJ STATE VECTOR INTEGRATION OCCURS UNTIL THE RESELECTION OF ANY PROGRAM OR EXTENDED VERB. NJ POO INTEGRATION OCCURS UNTIL THE RESELECTION OF POO.
5) THIS ROUTINE DOES NOT MAINTAIN STATE VECTOR OR W-MATRIX SYNCHRONIZATION.
6) RESELECTION OF A NEW PROGRAM WILL REINITIALIZE THE NORMAL TIMING OF STATE VECTOR INTEGRATION.
SET V96UNFLG

GO TO IDLING PROGRAM (P00) VIA ROUTINE R00

GO TO "A"
IN R00

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 REQUEST 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
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
4.5 THIS LIST REPRESENTS THE VERBS USED IN PROGRAM SKYLARK

4.5.1 REGULAR VERBS

<table>
<thead>
<tr>
<th>Verb</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00 NOT IN USE</td>
<td></td>
</tr>
<tr>
<td>01 DISPLAY OCTAL COMP 1 IN R1</td>
<td></td>
</tr>
<tr>
<td>02 DISPLAY OCTAL COMP 2 IN R1</td>
<td></td>
</tr>
<tr>
<td>03 DISPLAY OCTAL COMP 3 IN R1</td>
<td></td>
</tr>
<tr>
<td>04 DISPLAY OCTAL COMP 1,2 IN R1,R2</td>
<td></td>
</tr>
<tr>
<td>05 DISPLAY OCTAL COMP 1,2,3 IN R1,R2,R3</td>
<td></td>
</tr>
<tr>
<td>06 DISPLAY DECIMAL IN R1 OR R1,R2 OR R1,R2,R3</td>
<td></td>
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<tr>
<td>07 DISPLAY DP DECIMAL IN R1,R2</td>
<td></td>
</tr>
<tr>
<td>08 SPARE</td>
<td></td>
</tr>
<tr>
<td>09 SPARE</td>
<td></td>
</tr>
<tr>
<td>10 SPARE</td>
<td></td>
</tr>
<tr>
<td>11 MONITOR OCTAL COMP 1 IN R1</td>
<td></td>
</tr>
<tr>
<td>12 MONITOR OCTAL COMP 2 IN R1</td>
<td></td>
</tr>
<tr>
<td>13 MONITOR OCTAL COMP 3 IN R1</td>
<td></td>
</tr>
<tr>
<td>14 MONITOR OCTAL COMP 1,2 IN R1,R2</td>
<td></td>
</tr>
<tr>
<td>15 MONITOR OCTAL COMP 1,2,3 IN R1,R2,R3</td>
<td></td>
</tr>
<tr>
<td>16 MONITOR DECIMAL IN R1 OR R1,R2 OR R1,R2,R3</td>
<td></td>
</tr>
<tr>
<td>17 MONITOR DP DECIMAL IN R1,R2</td>
<td></td>
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<tr>
<td>18 SPARE</td>
<td></td>
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<tr>
<td>19 SPARE</td>
<td></td>
</tr>
<tr>
<td>20 SPARE</td>
<td></td>
</tr>
<tr>
<td>21 LOAD COMPONENT 1 INTO R1</td>
<td></td>
</tr>
<tr>
<td>22 LOAD COMPONENT 2 INTO R2</td>
<td></td>
</tr>
<tr>
<td>23 LOAD COMPONENT 3 INTO R3</td>
<td></td>
</tr>
</tbody>
</table>
24 LOAD COMPONENT 1,2 INTO R1,R2
25 LOAD 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 SKY 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 FDI AT ERROR NEEDLES (TEST JULLY)
44 REQUEST DockED DAP DATA LOAD (R04)
45 ACTIVATE DockED DAP
46 ACTIVATE CSM DAP
47 SET OWS STATE VECTOR INTO CSM STATE VECTOR
48 REQUEST CSM DAP DATA LOAD (R03)
49 START C W-DEFINED MANEUVER (R62)
50 PLEASE PERFORM
51 PLFASF 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 FLG
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 OWS STATE VECTOR
67 REQUEST W-MATRIX RSS ERROR DISPLAY
68 SPARE
69 RESTART
70 UPDATE LIFTOFF TIME (P27)
71 UNIVERAL UPDATE-BLOCK ADR (P27)
72 UNIVERAL UPDATE-SINGLE ADR (P27)
73 UPDATE CMC TIME (OCTAL) (P27)
74 INITIALIZE ERASABLE DUMP VIA DOWNLINK
75 SET LIFTOFF FLAG
76 ENABLE RANGE LATE MARK PROCESSING (R27)
77 DISABLE RANGE RATE MARK PROCESSING (R27)
78 CHANGE GYRO COMPASS LAUNCH AZIMUTH
79 SPARE
80 UPDATE OWS STATE VECTOR
81 UPDATE CSM STATE VECTOR
82 REQUEST ORBITAL PARAMETERS DISPLAY (R30)
83 REQUEST RENDEZVOUS PARAMETER DISPLAY #1 (R31)
84 SPARE
85 REQUEST RENDEZVOUS 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 W-MATRIX INITIALIZATION
94 SPARE
95 SPARE
96 TERMINATE INTEGRATION AND GO TO P03
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
4.6 THIS LIST REPRESENTS THE NOUNS USED IN PROGRAM SKYLARK.

NOUNS SPECIFIED AS NOT BEING LOADABLE ARE MARKED (NL).

00 NCT 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
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
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12 OPTION CODE OCT OCT
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</table>
89 DOCKED DAP RATE
DOCKED DAP DEADBAND

90 PEND OUT-OF-PLANE PARAMETERS (P3X) Y CM
Y OUT CM
Y DOF OWS

91 PRESENT OCU ANGLES - SHAFT
- TRUN

92 NEW OCU ANGLES - SHAFT
- TRUN

93 DELTA GYRO ANGLES
X
Y
Z

94 ALTERNATE LOS - SHAFT
- TRUN

95 TIG (MC1)

96 PEND OUT-OF-PLANE PARAMETERS Y CM
(BY V90E)
Y DOF CM
Y DOF OWS

97 SYSTEM TEST INPUTS

98 SYSTEM TEST RESULTS
AND INPUTS

99 RSS VALUE OF POSITION ERROR
RSS VALUE OF VELOCITY ERROR
OPTION CODE

CHANGE CONTROL NOTES

REV 00PCR 010,011,017,018,019,021,032,036,046,400,413,415,420, SLM #2,19
RFV 01PCN 489
4.7 This list represents the checklist reference codes used with V50N25 for Program Skylark.

<table>
<thead>
<tr>
<th>RC CODE</th>
<th>ACTION TO BE EFFECTED</th>
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<tr>
<td>00013</td>
<td>PERFORM COARSE ALIGNMENT</td>
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<td>00014</td>
<td>PERFORM FINE ALIGNMENT</td>
</tr>
<tr>
<td>00015</td>
<td>PERFORM CELESTIAL BODY ACQUISITION</td>
</tr>
<tr>
<td>00016</td>
<td>TERMINATE MARK SEQUENCE</td>
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<td>00017</td>
<td>PERFORM MINKEY RENDEZVOUS</td>
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<tr>
<td>00020</td>
<td>PERFORM PULSE-TORQUING FOR PLANE CHANGE</td>
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<tr>
<td>00041</td>
<td>SWITCH CM/SM SEPARATION TO UP</td>
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<tr>
<td>00062</td>
<td>KEY CMC TO STANDBY</td>
</tr>
<tr>
<td>00204</td>
<td>PERFORM SPS GIMBAL TRIM</td>
</tr>
</tbody>
</table>

**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
4.8 THIS LIST REPRESENTS THE OPTION CODES USED WITH V04N06 AND V04N12 FOR PROGRAM SKYLARK.

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.

<table>
<thead>
<tr>
<th>OPTION CODE</th>
<th>PURPOSE</th>
<th>INPUT FOR R2</th>
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<tbody>
<tr>
<td>00001</td>
<td>SPECIFY IMU ORIENTATION</td>
<td>1=PREF  2=NOMINAL  3=REFS#MAT</td>
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<tr>
<td>00002</td>
<td>SPECIFY VEHICLE</td>
<td>1=THIS VEHICLE  2=OTHER VEHICLE</td>
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<tr>
<td>00004</td>
<td>SPECIFY STATE OF TRACKING=FULTKFLG</td>
<td>0=RESET (FULL)  1=SET (PARTIAL)</td>
</tr>
<tr>
<td>00012</td>
<td>SPECIFY P50 OPTION</td>
<td>1=ATM SUN SENSR  2=ATM SJN SENSOR AND ATM STAR TRACKER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3=ATM ANGLES FROM INDEPENDENT SOURCE</td>
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<tr>
<td>00013</td>
<td>SPECIFY P55 OPTION</td>
<td>1=CELESTIAL BODY AND IMU ORIENTATION  2=CELESTIAL BODY, OPTICS MARK, AND ATM SOLAR-INERTIAL ATTITJDE</td>
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<tr>
<td>00024</td>
<td>SPECIFY ASSUMED TRACKING MODE</td>
<td>0=RENEDEYOUS (VECKPOINT)  1=TARGET POINTING (VECKPOINT)</td>
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<td>2=ROTATION  4=RENEDEYOUS (3AXIS)</td>
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<td>5=TARGET POINTING (3AXIS)</td>
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CHANGE CONTROL NOTES

REV 00  PCR 013,016,036,413, PCN 457
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<th>PCR/PCN</th>
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<td>00107</td>
<td>STAR TRACKER ANGLES OUT OF LIMITS</td>
<td>P55</td>
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<td>00110</td>
<td>NO MARK SINCE LAST MARK REJECT</td>
<td>SXTMARK</td>
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<td>00113</td>
<td>NO INBITS</td>
<td>SXTMARK</td>
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<tr>
<td>00114</td>
<td>MARK MADE BUT NOT DESIRED</td>
<td>SXTMARK</td>
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<tr>
<td>00115</td>
<td>OPTICS TORQUE REQUEST WITH SWITCH NOT AT CMC</td>
<td>EXT VERB OPTICS CDU</td>
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<tr>
<td>00116</td>
<td>OPTICS SWITCH ALTERED BEFORE 15 SEC ZERO TIME ELAPSED</td>
<td>T4RUPT</td>
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<tr>
<td>00117</td>
<td>OPTICS TORQUE REQUEST WITH OPTICS NOT AVAILABLE (OPTIND=0)</td>
<td>EXT VERB OPTICS CDU</td>
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<td>00120</td>
<td>OPTICS TORQUE REQUEST WITH OPTICS NOT ZEROED T4RUPT</td>
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<td>00121</td>
<td>CDU'S NOT GOOD AT TIME OF MARK</td>
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<td>00205</td>
<td>BAD PIPA READING</td>
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<td>00206</td>
<td>ZERO ENCODE NOT ALLOWED WITH COARSE ALIGN + GIMBAL LOCK</td>
<td>IMU MODE SWITCH IMU 2</td>
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<td>00207</td>
<td>ISS TURNON REQUEST NOT PRESENT FOR 90 SEC</td>
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<td>00210</td>
<td>IMU NOT OPERATING</td>
<td>IMU MODE SWITCH, IMU 2, R02, P51, P53</td>
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<td>00211</td>
<td>COARSE ALIGN ERROR-DRIVE &gt;2 DEGREES</td>
<td>IMU MODE SWITCH</td>
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<td>PIPA FAIL BUT PIPA IS NOT BEING USED</td>
<td>IMU MODE SWITCH, T4RUPT</td>
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<td>00213</td>
<td>IMU NOT OPERATING WITH TJRN-ON REQUEST</td>
<td>T4RUPT</td>
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<td>00214</td>
<td>PROGRAM USING IMU WHEN TURNED OFF</td>
<td>T4RUPT</td>
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<td>00217</td>
<td>BAD RETURN FROM STALL ROUTINES</td>
<td>P51, P52, P53, P54</td>
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<td>IMU NOT ALIGNED (BAD REFSSMAT)</td>
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<td>DESIRED GIMBAL ANGLES YIELD GIMBAL LOCK</td>
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<td>00402</td>
<td>ENTER RESPONSE NOT ALLOWED</td>
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<td>Target Out of View (TRUN. ANGLE &gt; 90 DEG)</td>
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<td>00405</td>
<td>Two Stars Not Available</td>
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<td>00406</td>
<td>REN Navigation Not Operating</td>
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<td>00421</td>
<td>W-Matrix Over Flow</td>
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<td>00500</td>
<td>Not Enough Jets for Some Pitch or Yaw Rotation</td>
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<td>00501</td>
<td>Not Enough Jets for Some Roll Rotation</td>
<td>Docked DAP</td>
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<td>00600</td>
<td>Failure in Phase Match Iteration</td>
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<td>Failure in Height Maneuver Iteration</td>
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<td>Failure in Outer Loop Iteration</td>
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<td>00603</td>
<td>Failure in QDTP1 Iteration</td>
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<td>No TIG for Given ELEV Angle</td>
<td>P34, P35</td>
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<td>PIPA Fail Caused the ISS Warning</td>
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<td>CMG Self Test Error</td>
<td>Self Check</td>
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<td>Downlink Too Fast</td>
<td>T4Rupt</td>
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<td>01106</td>
<td>Uplink Too Fast</td>
<td>T4Rupt</td>
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<td>01107</td>
<td>Phase Table Failure, Assume Erasable Memory Is Destroyed</td>
<td>Restart</td>
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<td>01301</td>
<td>ARCSIN-ARCCOS INPUT ANGLE TOO LARGE</td>
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<td>VG Increasing</td>
<td>S40.8</td>
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<td>01426</td>
<td>IMU Unsatisfactory</td>
<td>P61, P62</td>
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<td>01427</td>
<td>IMU Reversed</td>
<td>P61, P62</td>
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<td>01520</td>
<td>V37 Request Not Permitted At This Time</td>
<td>V37</td>
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<td>01600</td>
<td>OverFlow in Drift Test</td>
<td>OPT PRE ALIGN CALIB</td>
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<td>01601</td>
<td>No IMU Torque</td>
<td>OPT PRE ALIGN CALIB</td>
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<td>01703</td>
<td>Insufficient Time For Integ., TIG Was Slipped</td>
<td>R41</td>
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<td>03777</td>
<td>ICDU Fail Caused the ISS Warning</td>
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</table>
ICDU, PIPA FAILS CAUSED THE ISS WARNING
IMU FAIL CAUSED THE ISS WARNING
IMU, PIPA FAILS CAUSED THE ISS WARNING
IMU, ICDU FAILS CAUSED THE ISS WARNING
IMU, ICDU, PIPA FAILS CAUSED THE ISS WARNING
* INTEG. ABORT DUE TO SUBSURFACE S.V.
* NO SOLUTION FROM TIME THETA OR TIME RADIUS ROUTINE
* NEGATIVE OR ZERO WAITLIST CALL
* SECOND JOB ATTEMPTS TO GO TO SLEEP VIA KEYBOARD AND DISPLAY PROGRAM
* TWO PROGRAMS USING DEVICE AT SAME TIME
* SQRT CALLED WITH NEGATIVE ARGUMENT
* KEYBOARD AND DISPLAY ALARM DURING INTERNAL USE (NVSUB)
* ILLEGAL FLASHING DISPLAY
* P01 ILLEGALLY SELECTED
* DELAY ROUTINE BUSY
* EXECUTIVE OVERFLOW—NO VAC AREAS
* EXECUTIVE OVERFLOW—NO CORE SETS
* WAITLIST OVERFLOW—TOO MANY TASKS
* ILLEGAL INTERRUPT OF EXTENDED VERB
* DAP JASK STILL IN PROGRESS WHEN

NEXT JASK ATTEMPTED

* INDICATES ABORT TYPE. ALL OTHERS ARE NON-ABORTIVE.
  2XXXX INDICATES A GO TO 4JUTE IN 90 TYPE ABORT (IF EXTENDED VERB ACTIVE OR IF AVERAGE G ON DO 489 BAILOUT TYPE ABORT)
  3XXXX INDICATES A BAILOUT TYPE ABORT

NOTE: FOR V05 N09 DISPLAYS:
R1-XXXXX (FIRST ALARM FOLLOWING ERROR RESET),
R2-XXXXX (SECOND ALARM FOLLOWING ERROR RESET),
R3-XXXXX (MOST RECENT ALARM)
## SKYLARK 1 (GSOP)

### Internal Distribution List

<table>
<thead>
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<th>Group 23A</th>
<th>Name</th>
<th>Room</th>
<th>Count</th>
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<td>Levine (4)</td>
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D-1
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