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
ACKNOWLEDGEMENT

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

SECTION 4 OPERATIONAL MODES
REVISION 01

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REVISION INDEX COVER SHEET
GUIDANCE SYSTEM OPERATIONS PLAN

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

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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**NOTE:**

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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 republished 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 Also, Section 6 will not be published for SKYLARK.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 back-
ground.

The AGC is programmed to initiate a Program only in response to the initia-
tion of a specific mission task and will continue the programmed sequence of com-
putations 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 downmoded to Coarse Align and the No Attitude lamp on the DSKY is actuated except during Average-G when the "config" window of DAPDATR1 indicates Saturn configuration.

(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.
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 V53</td>
<td>Request identified by V51 at completion of &quot;MARK&quot;s 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</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>V.N. Flashing</td>
<td>V.N. Flashing</td>
<td>V.S. Flashing</td>
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</tbody>
</table>

### Key in "ENTR"

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<thead>
<tr>
<th>Action</th>
<th>Action</th>
<th>Action</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No CMC</td>
<td>No CMC</td>
<td>CMC assumes ASTRO did not comply, terminates flashing Verb-Noun, and continues</td>
<td>CMC assumes ASTRO complied</td>
</tr>
<tr>
<td>CMC assumes ASTRO did not comply, terminates flashing Verb-Noun, and continues</td>
<td>CMC assumes ASTRO complied, continues</td>
<td>In R23 CMC assumes ASTRO has taken sufficient marks, In R56 response is not accepted</td>
<td>CMC takes loaded data, terminated flashing Verb-Noun and continues</td>
</tr>
</tbody>
</table>

### Key in "PRO"

<table>
<thead>
<tr>
<th>Action</th>
<th>Action</th>
<th>Action</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMC assumes displayed data is correct, terminates flashing Verb-Noun, and continues</td>
<td>CMC assumes ASTRO complied, continues</td>
<td>In R23 CMC assumes ASTRO has taken sufficient marks, In R56 response is not accepted</td>
<td>CMC takes loaded data, terminated flashing Verb-Noun and continues</td>
</tr>
<tr>
<td>In R23 CMC assumes ASTRO has taken sufficient marks, In R56 response is not accepted</td>
<td>CMC takes loaded data, terminated flashing Verb-Noun and continues</td>
<td>CMC returns to earliest point in sequence</td>
<td>CMC takes loaded data, terminated flashing Verb-Noun and continues</td>
</tr>
</tbody>
</table>

### Key in "Terminate" (V34E)

<table>
<thead>
<tr>
<th>Action</th>
<th>Action</th>
<th>Action</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies with program in progress</td>
<td>Varies with program in progress</td>
<td>Varies with program in progress</td>
<td>Varies with program in progress</td>
</tr>
</tbody>
</table>

### Key in "Recycle" (V32E)

<table>
<thead>
<tr>
<th>Action</th>
<th>Action</th>
<th>Action</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>No CMC</td>
<td>No CMC</td>
<td>Incorrect</td>
<td>Incorrect</td>
</tr>
<tr>
<td>Incorrect Response</td>
<td>Incorrect Response</td>
<td>V51: No CMC Action</td>
<td>V51: No CMC Action</td>
</tr>
</tbody>
</table>

**Press MARK button**

If there is no request for a mark at the time of key depression (P20 option 0, 4 not operating) the PROG Light is turned on. Marking is also allowed during P20 option 0 or 4 without the presence of a please mark verb. Pressing MARK will cause CMC to read 2 optics angles. CMC reads 2 optics angles, 3 CDU angles, and time; terminates flashing Verb-Noun if a suitable number of marks have been made and continues.

**ASTRONAUT RESPONSE TO DSKY DISPLAYS AND CMC RESULTANT ACTION**

*Table 4-1*
Fig. 4-1 Display and Control Panel
4.3 GNCS Failure Monitor

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

4.3.1 AGC Warning

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

(a) SCAFAL - Occurs if scaler stage 17 (1.28-sec, period) fails to produce pulses. This provides a check on the timing for all logic alarms.

(b) COUNTER FAIL - Occurs if counter increments happen too frequently or else fail to happen following an increment request. "Too frequently" means continuous counter requests and/or incrementing for from 0.625 to 1.875 ms.

c) SCADBL - Occurs if the 100 pps scaler stage operates at a pulse rate of 200 pps or more.

d) PARITY FAIL - Occurs if any accessed word in fixed or erasable memory whose address is octal 10 or greater contains an even number of "ones".

e) RUPT LOCK - Occurs if interrupt is either too long or too infrequent. The criterion for "too long" is phase dependent, varying in duration from 140 ms to 300 ms. Likewise the criterion for "too infrequent" varies in absence from 140 ms to 300 ms.

(f) TC TRAP - Occurs if too many consecutive TC or TCF instructions are run or TC or TCF instructions are too infrequent. The criterion for "too many" varies in duration from 5 ms to 15 ms. The criterion for "too infrequent" varies in absence from 5 ms to 15 ms.
(g) NIGHT WATCHMAN - Occurs if the computer should fail to access address octal 67 within a period whose duration varies from 0.64 sec. to 1.92 sec.

(h) V FAIL - Occurs if the AGC voltages (28, 14, 4) are out of limits. This signal produces STRT1 if it stays on for a period of between 157 and 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:

\[
\begin{align*}
4 \text{ V Supply} &> 4.4 \text{ V} \\
4 \text{ V Supply} &< 3.65 \text{ V} \\
14 \text{ V Supply} &> 16 \text{ V} \\
14 \text{ V Supply} &< 12.5 \text{ V} \\
28 \text{ V Supply} &< -22.6 \text{ V}
\end{align*}
\]

(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 4000\text{h} 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 operate a latch is set in the CMC which maintains the GNCS Caution alarm and the RESTART lamp on the DSKY until the latch is reset by the program or until the latch is manually reset by pressing the RSET button. For further detail see section 4.3.4.

(b) Temperature out of Limits. The CMC receives a signal from the IMU when the stable member temperature is in the range 126.3°F to 134.3°F. In the absence of this signal, the Caution alarm and the TEMP lamp on the DSKY are actuated.

(c) Gimbal Lock. When the CMC determines that the middle gimbal angle (MGA) of the IMU is greater than 70°, the Caution alarm and the Gimbal Lock lamp on the DSKY are actuated. When MGA exceeds 85° the ISS is downmoded to Coarse Align and the No Attitude lamp on the DSKY is actuated except during Average-G when the "config" window of DAPDATR1 indicates Saturn configuration.
(d) Program Alarm. Under a variety of situations a program alarm is generated. One example is that of a PIPA fail when the vehicle is not in a thrusting mode. Under program control the CMC inhibits this program alarm for 10 sec. after system turn-on. The program alarm actuates the Caution alarm and the Program light on the DSKY. For further information see Section 4.3.4.

4.3.4 Restart and Program Alarms

Program Alarms

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

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

   a. "BAILOUT" alarms, designated by a five-digit alarm code with 3 as the first digit, e.g. 31201.
   
   These alarms cause suspension of non-restartable program activity and continuation of only that program activity which is restartable. This type of alarm condition is generally due to temporary overloading of the system; the BAILOUT procedure will relieve the situation and allow continuation of the program.

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

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

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

*When a POODOO abort condition triggers a BAILOUT recovery procedure, the POODOO alarm code is retained.
3. If neither of the above applies, current program flow is terminated and a flashing V37 is displayed, requesting astronaut selection of a new program.

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 0xx0x. If the astronaut desires to bypass the channel representation, he should load C31FLWRD via V21 N01 to the values shown in Tables I and II.
### 4.4 AGC Logic/Ground/Crew Interface Diagrams Description

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

The diagrams contain the following:

1) Program Control - Indication of sequence interruptions and the following display notation:
   - PRIO (Priority) - denotes a priority display
   - HOLD - denotes that the verb-noun and data will continue to be displayed until the astronaut takes DSKY action.
   - TEMP HOLD (Temporary HOLD) - denotes that the duration of the display on the DSKY (non-flashing) is controlled by the AGC.
   - POSS HOLD (Possible HOLD) - denotes that the display is a possible path taken by the AGC.
   - MON (Monitor) - denotes that the displayed data is automatically updated and displayed by the AGC.
   - SNAP - denotes that the displayed data is not automatically updated (monitored) by the AGC.

2) AGC

3) Ground

4) Crew

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

<table>
<thead>
<tr>
<th>PHASE</th>
<th>PROGRAM NUMBER</th>
<th>PROGRAM TITLE</th>
<th>PCG/PCN</th>
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<td>PRE-LAUNCH AND SERVICE</td>
<td>00</td>
<td>CMC IDLING</td>
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<tr>
<td></td>
<td>01</td>
<td>INITIALIZATION</td>
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<tr>
<td></td>
<td>02</td>
<td>GYRO COMPASSING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>03</td>
<td>OPTICAL VERIFICATION OF GYRO COMPASSING</td>
<td></td>
</tr>
<tr>
<td></td>
<td>04</td>
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<td>05</td>
<td>------*</td>
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<td>06</td>
<td>CMC POWER DOWN</td>
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<td>07</td>
<td>SYSTEM TEST**</td>
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<td></td>
<td>09</td>
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<td></td>
<td>10</td>
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<tr>
<td>11</td>
<td>EARTH ORBIT INSERTION MONITOR</td>
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<td>20</td>
<td>UNIVERSAL TRACKING</td>
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<td>21</td>
<td>GROUND TRACK DETERMINATION</td>
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<td>25</td>
<td>CONTINGENCY VHF RANGE RATE</td>
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<td>27</td>
<td>CMC UPDATE</td>
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<td>TIME OF LONGITUDE</td>
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<td>30</td>
<td>EXTERNAL DELTA V</td>
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<td>31</td>
<td>NC1 TARGETING</td>
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<td>32</td>
<td>NC2 TARGETING</td>
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<td>33</td>
<td>NCC TARGETING</td>
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<td>TPM TARGETING</td>
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<td>37</td>
<td>RENDEZVOUS FINAL PHASE</td>
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<tr>
<td>38</td>
<td>PLANE CHANGE TARGETING</td>
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<td></td>
</tr>
</tbody>
</table>
THRUSTRING
  40 SPS
  41 RCS

ALIGNMENT
  50 ATM ORIENTATION DETERMINATION
  51 IMU ORIENTATION DETERMINATION
  52 IMU REALIGN
  53 BACKUP IMU ORIENTATION DETERMINATION
  54 BACKUP IMU REALIGN
  55 ATM STAR TRACKER GIMBAL ANGLE

ENTRY
  60 ENTRY - PREPARATION
  61 ENTRY - CM/SM SEPARATION AND PRE-ENTRY MANEUVER
  62 ENTRY-INITIALIZATION
  63 ENTRY - POST 0.05G
  64 ENTRY - UP CONTROL
ENTRY - BALLISTIC
ENTRY - FINAL PHASE

PCST THRUSTING

70
71
72
73
74
75
76
77
78
79

CSM VELOCITY VECTOR UPDATE

ROUTINE

ROUTINE TITLE

00
01
02
03
04
05
06
07
08
09

FINAL AUTOMATIC REQUEST TERMINATE
ERASABLE AND CHANNEL MODIFICATION
IMU STATUS CHECK
CSM DAP DATA LOAD
DOCKED DAP DATA LOAD

MINKEY CONTROLLER
VHF RANGE READ

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SPS THRUST FAIL
STATE VECTOR INTEGRATION (MID TO AVE)

COARSE ALIGN

AUTOMATIC OPTICS POSITIONING
SIGHTING MARK
SIGHTING DATA DISPLAY
GYRO TORQUING
ALTERNATE LOS SIGHTING MARK

ATTITUDE MANEUVER
TRACKING ATTITUDE
CREW-DEFINED MANEUVER
RENDEZVOUS FINAL ATTITUDE
OPTICS ANGLES TRANSFORM
CMC IDLING PROGRAM (P00)

REV 00 05/19/71

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 CSM AND OWS 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-GNCS 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 ICDOUS (V16 N20) OR BY MONITORING THE FDAI BALL.
(3) THE PROGRAM IS MANUALLY SELECTED BY THE ASTRONAUT BY FSK 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 V96 CAN CAUSE INCORRECT N-MATRIX AND STATE VECTOR SYNCHRONIZATION.

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CMC GROUND CREW

PROG CONT

CMC PROG

SELECTION

CREW PROG

SELECTION

......

DO K00 TO START CMC

IDLING PROGRAM P00

DISPLAY PROGRAM P00

KEY IN CMC IDLING PROGRAM (P00)

V37E 03E

#10
INITIALIZATION PROGRAM (P01)

REV 00 05/19/71

PURPOSE:

1. TO INITIATE 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. EASABLE LOCATIONS HAVE BEEN PROPERLY INITIALIZED: (ALIMUTH, +1; LATITUDE, +1; LAJNCHAZ, +1; IMU COMPENSATION PARAMETERS)

PROG
CONT
CWC
GRUND
CREW

---

DO RO 10 START INITIALIZATION PROGRAM (P01)
DISPLAY PROGRAM 01

---

KEY IN INITIALIZATION PROGRAM (P01)
V37EO1E

---

MONITOR DSKY:
OBSERVE DISPLAY OF PROGRAM 01

---

IS NODEP01 FLAG SET?

---

N
Y
LIGHT PROGRAM
ALARM LIGHT
AND STORE
ALARM CODE
21321
-----

EXIT P01

--------------------------------
COMMAND ISS ZERO
CDU ROUTINE

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

WAIT ABOUT 8
SECONDS

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

TURN ON "NO ATT"
LIGHT

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

OBSERVE "NO ATT"
LIGHT ON

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

COMMAND COARSE ALIGN
IN ISS.
COARSE ALIGN TO
DESIRED PLATFORM
ORIENTATION
REMOVE COARSE ALIGN COMMAND (RELEASE PLATFORM).

TURN OFF "NO ATT" LIGHT

OBSERVE "NO ATT" LIGHT OFF

TERMINATE PROGRAM 01 AND GO TO GYRO COMPASSING PROGRAM (P02)

MONITOR DSKY: OBSERVE TERMINATION OF P01 AND DISPLAY OF P02

EXIT P01

CHANGE CONTROL NOTES
GYROCOMPASSING PROGRAM (PO2)

**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 KEYPD 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>PROG</th>
<th>CONT</th>
<th>CMG</th>
<th>GROUND</th>
<th>CREW</th>
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CHANGE CONTROL NOTES
OPTICAL VERIFICATION OF GYRO COMPASSING (P03)  

PREAMBLE:  
(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.
TURN OFF OPERATOR ERROR LIGHT

PRESS RESET TO TURN OFF OPERATOR ERROR LIGHT

EXIT

EXIT

START OPTICAL VERIFICATION OF GYRO COMPASSING PROGRAM (P03), DISPLAY PROGRAM 03

MONITOR Display: OBSERVE DISPLAY OF PROGRAM 03

CONTINUE GYRO COMPASSING

WAIT 0.5 SECONDS

SET TARG IDENT TO 00001 IN R3 OF 'RUN 30'
PASTE VJ5N30 AND
THEN V06N41 (DO NOT
OVERWRITE R3)

---

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 OSKY:
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

---

P03/SKYLARK
ELEVATION:  
V06 #1  
R1-TAG AZ  
R2-TAG ELEV  
R3-TAG IDENT  
TARG AZ-TARGET  
AZIMUTH-ANGLE CLOCKWISE FROM TRUE NORTH TO THE TARGET IN DEGREES TO NEAREST .01 DEGREE  
TARG ELEV-TARGET  
ELEVATION-ANGLE FROM THE LOCAL HORIZONTAL (OF NAV BASE) TO THE TARGET IN DEGREES TO NEAREST .001 DEGREE  
TARG IDENT-TARGET  
IDENTIFIER-IDENTIFIES AZIMUTH AND ELEVATION FOR TARGET 1 OR 2  

WAIT FOR KEYBOARD ENTRY  

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA  
KEY IN V21E, V22E, OR V24E AND LOAD NEW DATA  

P, NEW  
R, DATA  
C,  
E, STORE NEW  
G, DATA  

COMPUTE LOS TO TARGET NUMBER ONE
AND DRIVE OPTICS,
IF ALLOWED.

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

MONITOR DSMK:
OBSERVE VERB
FLASH TO REQUEST
PLEASE MARK

NOTE: YOUNG AND R1
WILL NOT BE BLANK IF
ENTERED FROM MARK
REQ. AFTER V50N25,
R1 = 00016 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 PER-
FORM TERMINATE MARK
SEQUENCE
V50 N25
R1-00016
R2-BLANK
R3-BLANK

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

WAS SIGHTING SATIS-
FACTORY?
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
WAIT FOR MARK
TERMINATE FLASH UPON RECEIPT OF MARK

WHEN SIGHTING ON TARGET 2 IS SATISFACTORY PRESS MARK BUTTON

STORE MARK DATA

FLASH VERB-NOUN TO REQUEST PLEASE PERFORM TERMINATE MARK SEQUENCE
V50 N25 R1-DOJ16 R2-BLANK R3-BLANK

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

WAS SIGHTING SATISFACTORY?
YES NO

WAIT FOR KEYBOARD ENTRY
REJECT
PRESS MARK REJECT BUTTON

TERMINATE FLASH UPON RECEIPT OF PROCEED OR REJECT KEY IN PROCEED
REJECT PROCEED
TERMINATE FLASH UPON RECEIPT OF TERMINATE OR PROCEED OR NEW DATA

P R E M E N
O R M I
E N A 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 (LEG PANEL 100) ARE OFF AND THE CMC STANDBY LIGHT (DSKY) 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 LEG DSKYS 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 DSKY ENTRY.

<table>
<thead>
<tr>
<th>PROGRAM CONT</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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<tbody>
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<tr>
<td>DO RDO TO START CMC POWER DOWN PROGRAM (P06)</td>
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<tr>
<td>V37E 06E</td>
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</tbody>
</table>
WAIT FOR KEYBOARD ENTRY

KEY IN PROCEED (STANDBY) BUTTON AND HOLD IN

TERMINATE FLASH UPON RECEIPT OF STANDBY ENTRY

STANDBY ENTER ENTRY V33E, (PROCEED) TERM INATE

TURN ON STANDBY LIGHT

OBSERVE STANDBY LIGHT TO COME ON.

RELEASE PROCEED (STANDBY) BUTTON

PUT CMC IN STANDBY BLANK ALL DSKY LIGHTS

MONITOR DSKY: OBSERVE ALL DSKY LIGHTS TO GO BLANK.
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.

RESET NOOFLAG

UPDATE CMC TIME COUNTER

KEY IN PROCEED (STANDBY) BUTTON AND HOLD ON

OBSERVE STANDBY LIGHT TO GO OFF

RELEASE PROCEED (STANDBY) BUTTON
EARTH ORBIT INSERTION MONITOR PROGRAM (P11)  

REV 00  05/19/71

PURPOSE:

1. TO INDICATE TO THE ASTRONAUT THAT THE CMC HAS RECEIVED THE LIFTOFF DISCRETE.

2. TO GENERATE AN ATTITUDE ERROR INDICATION ON THE FOA1 ERROR NEEDLES, SCALED FOR THE 50/15/15 SETTING; FROM LIFTOFF TO THE BEGINNING OF PITCHOVER/ROLLOUT THE ATTITUDE ERROR IS EQUAL TO THE DIFFERENCE BETWEEN THE CURRENT VEHICLE ATTITUDE AND THE ATTITUDE STORED AT LIFTOFF. DURING PITCHOVER/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 STORED 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 (IJ) FOR STEERING.

   (B) MANUAL CONTROL - SIV-8 STAGE ONLY:
       THE ASTRONAUT MAY SELECT THE SATURN STICK FUNCTION VIA V46E (DAP 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 SIV8. 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>
<thead>
<tr>
<th>PROG</th>
<th>CONT</th>
<th>CMC</th>
<th>GROUND</th>
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<tr>
<td>START EONI MONITOR PROGRAM (P11)</td>
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<td>MONITOR DSKY: OBSERVE DISPLAY OF</td>
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<tr>
<td>DISPLAY PROGRAM II</td>
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<td>PROGRAM II</td>
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</table>

#10
COMPUTE INITIAL STATE VECTOR

COMPUTE REF3MMAT

SET REF3MMAT FLAG

STORE LIFTOFF ATTITUDE

WAIT 0.5 SEC BEFORE STARTING ATTITUDE ERROR COMPUTATION

CALL ROUTINE TO LOAD 1GDU DACS WITH PITCH, ROLL, AND YAW ATTITUDE ERRORS DERIVED FROM PRESENT ATTITUDE AND STORED LIFTOFF ATTITUDE UNTIL PRESENT TIME EQUALS T1 (STORED IN ERASABLE MEMORY) AT WHICH TIME THE

MONITOR:

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

NOTE: DURING A NOMINAL LAUNCH AND AFTER SEPARATION OF THE LET
STORED LIFTOFF ATTITUDE IS REPLACED BY THE SOLUTION TO THE STORED 6X4 ORDER PITCH POLYNOMIAL, AND A ROLL 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 (V37EXXE), OR THE SATURN STICK FUNCTION (V466).

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-V1 INCREASING
R2-HDOT FOLLWS NOMINAL HISTORY
R3-H INCREASING

-------
HOLD

DISPLAY ON DSKY:

V 06  V 62
R1 - V1
R2 - HDOT
R3 - H

VI-INERTIAL VELOCITY MINTERE, 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 V37EXXE

048
UNIVERSAL TRACKING PROGRAM (P20)

PREVIOUS PAGE BLANK

051

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 DWS WITHOUT CONSTRAINING ROTATION ABOUT VECTOR (VECPNT). THIS OPTION IS USED TO ACQUIRE THE OSC IN THE SXT FIELD.

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

OPTION 2 - PERFORM ROTATION ABOUT SPECIFIED SPACECRAFT VECTOR AT SPECIFIED RATE AND BEGINNING AT SPECIFIED TIME. THIS OPTION IS NORMALLY USED TO EFFECT PIC. THIS OPTION DOES NOT EMPLOY OPTICS DRIVE.

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

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

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

RENDEZVOUS FLAG- CONTROLS THE PERMANENT TERMINATION OF THE TOTAL RENDEZVOUS NAVIGATION PROCESS. OPTION 0, 4, THESE OPTIONS WILL ONLY RUN OR RESUME RUNNING WHEN THIS FLAG IS SET. SET BY P20 SELECTION OF OPTION 0 OR 4. RESET BY P20 SELECTION OF OPTION 1, 2 OR 5, SELECTION OF CMC IDLING PROGRAM (P00), CMC POWER DOWN PROGRAM (P06), CONTINGENCY VHF RANGE RATE PROGRAM (P25), RENDEZVOUS THRUST MONITOR PROGRAM (P48), OR BY V56E. P00000 OR V34E FROM R80 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.


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 R00 AND BY V58E. SET BY TAKING RHC OUT OF DETENT WHEN THE S2 CONTROL SWITCH IS NCM AND WHEN THE THC IS NOT CLICKING. CDU RATE DRIVE IS NOT PERFORMED IF THE STICK FLAG IS SET. SET BY RCS DAP WHEN MIDDLE GIMBAL ANGLE IS GREATER THAN + OR - 75 DEGREES DURING AN AUTOMATIC MANEUVER.

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

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

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

V50N10 FLAG - SET BY V37EXXE (EXCEPT XX=00) AND BY V58E; RESET BY R61.

UTFLAG- CONTROLS THE PERMANENT TERMINATION OF THE UNIVERSAL TRACKING PROGRAM P20, OPTIONS 1, 2, 5. THESE OPTIONS WILL ONLY RUN OR RESUME RUNNING WHEN THIS FLAG IS SET. SET BY SELECTION OF P20 OPTIONS 1, 2, OR 5. 
RESET BY SELECTION OF P20 OPTIONS 0 OR 4 AND BY SELECTION OF CMM IDLING PROGRAM (P00), CMM POWER DOWN PROGRAM (P06), BY V96E, PVD0D0, IMU TOPP0F, OR V34E FROM R63.

R27FLAG- SET BY V76E AND RESET BY V77E 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 CMM IDLING PROGRAM (P00), CMM POWER DOWN PROGRAM (P06), V34E FROM R60 OR R22, OR BY V56E. P00 SELECTION WILL TERMINATE P20 AND ANY OTHER PROGRAM IN PROCESS AND ESTABLISH P00. ALL OTHER PROGRAMS SELECTED WILL CHANGE THE PROGRAM NUMBER DISPLAYED ON THE DSKY BUT WILL NOT TERMINATE P20. THIS PROGRAM IS DESIGNED TO OPERATE AUTOMATICALLY AND SIMULTANEOUSLY WITH ANOTHER PROGRAM WITHOUT REQUIRING USE OF THE DSKY IN LESS NON-NOMINAL CIRCUMSTANCES REQUIRE CMM COMMUNICATION WITH THE ASTRONAUT. IF V56E IS KEPT IN THE DSKY AND P20 IS THE ONLY PROGRAM RUNNING, ROUTINE R00 WILL BE INITIATED.

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

(A) KEYING IN OF VERB 933
(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 CMM 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 CMM TO COUNT THE NUMBER OF VHF RANGING MARKS USED TO CHANGE EITHER STATE VECTOR.
THESE COUNTERS ARE CERED BY SEVERAL DISTINCT EVENTS, THEY ARE:

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

(B) KEYING V36E (REQUEST FOR FRESH START)

(9) SUMMARY OF EXTENDED VERBS ASSOCIATED WITH THE PROGRAM:
V54E - DO R23 - ALLOWS BACKUP MARKING ON THE OWS.
V57E - ALLOWS CREW TO CHANGE SETTING OF FULL TRACK FLG.
V58E - RESET STICK FLAG, SET V53N18 FLAG - ALLOW AUTO MANEUVERS
V67E - W-MATRIX RSS ERROR DISPLAY
V76E - ENABLE R27 (DURING P20 OPTION 0, 4)
V77E - DISABLE R27 (DURING P20 OPTION 0, 4)
V80E - SET STATE VEC3R FLAG TO OWS. DATA WILL UPDATE OWS STATE VEC.
V81E - SET STATE VEC3R FLAG TO CAS. DATA WILL UPDATE CAS STATE VEC.
V87E - SET VHF RANGE FLG - ALLOWS R22 TO ACCEPT RANGE DATA.
V88E - RESET VHF RANGE FLG - STOPS ACCEPTANCE OF RANGE DATA BY R22.
V93E - RESET RENVFLG - CAUSE INITIALIZATION OF W-MATRIX FOR RENDEZVOUS AT VFXT DATA INCORPORATION

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

<table>
<thead>
<tr>
<th>PROGRAM</th>
<th>COMPATIBLE OPTIONS</th>
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<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>
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<tr>
<td>P30</td>
<td>X X X X X</td>
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<td>P31-P38</td>
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<td>P52</td>
<td>X</td>
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<tr>
<td>P54</td>
<td>X</td>
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</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 (TD)
N76 - R1 - RANGE - VHF RANGE TO OWS IN NAU. M1. TO .01 NM
R2 - RANGE-RATE - RANGE-RATE BETWEEN CASM, OWS CALCULATED BY VHF RANGE-RATE FILTER IN FPS TO NEAREST .1 FPS. NEGATIVE SIGN INDICATES CLOSING
R3 - TDO TIME FROM NOW TO OPTIMIZATION TIME (N72) IN MIN AND SEC TO NEAREST SEC. THE VALUE IS .59859 IF R3 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.

| T0 OPTIMIZATION |
| TIME (N72) |
| TFD | -95 SEC | -20 SEC | +95 SEC |
| O | OPTIMIZING INTERVAL |

| N76 CURRENT | CONVERGING | CONVERGING | CONVERGING | CURRENT |
| R1 RANGE | RANGE | RANGE | RANGE |
| R2 RANGE-RATE | RANGE-RATE | RANGE-RATE | RANGE-RATE |
| R3 TFD | TFD | TFD | TFD |

| N77 CURRENT | RANGE AT TD-95 | RANGE AT TD-95 | OPTIMIZED RANGE |
| R1 RANGE | RANGE-RATE AT TD-95 | RANGE-RATE AT TD-95 | OPTIMIZED RANGE-RATE |
| R2 RANGE-RATE | CURRENT RANGE |

| R3 PHI | CURRENT PHI | 00001 | PHI AT N72 TIME | CURRENT PHI |

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<tr>
<th>PROG CONT</th>
<th>CNC</th>
<th>GROUND</th>
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<tbody>
<tr>
<td>AUTOMATIC</td>
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<tr>
<td>PROGRAM</td>
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<tr>
<td>SELECTION</td>
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DO 400 TO START
UNIVERSAL TRACKING
PROGRAM (P20)
DISPLAY P20

KEY IN UNIVERSAL TRACKING PROGRAM (P20)
V37E20E

#10
MONITOR DSKY:

ENTRANCE
WHEN
V3TE20E
IS KEVE)
AND WHEN
THE REN-
DEZVOUS
FLAG OR
UTFLAG
IS AL-
READY
SET BUT
WHEN 20
IS NOT
IN THE
MODE
LIGHTS
(SEE
R00)

GU TO
"F"
BELOW

DO IMU STATUS CHECK ROUTINE (R02)

SET DEADBAND TO DAP DEADBAND

DO IMU STATUS CHECK ROUTINE (R02)
RESET R27FLAG

SET STATE VECTOR
FLAG TO THE CSM

SET V50N18 FLAG

SET TRACK FLAG

SET ASSUMED OPTION
IN R2 = 0.

IS AUTOSEQ FLAG
SET?

NO     YES

SET ASSUMED
GAMMA, RHO,
AND OMEGON
T0 PREFER-
RED VALUES
GAMMA=0.00
DEG
RHO=-35.00
DEG
OMICRON=
30.00 DEG

---

---

***

GO TO
**
BELOW

---

---

PGS
HOLD
SNAP

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

MONTOR DSKY:

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

R1 IS OPTION CODE
FOR ASSUMED TRACKING
MODE.

IS THIS THE CORRECT
OPTION CODE?

R2 IS ASSUMED
OPTION:
0 = RENDEZVOUS
1 = TARGET POINTING VEC-POINT
2 = ROTATION
4 = RENDEZVOUS
V0679
R1 = RATE
R2 = DEADBAND
R3 = BLANK

R1 = SPACECRAFT RATE
IN DEG/SEC TO THE
NEAREST .001 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

STOR New
DATA

IS OPTION = 4 OR 5?

Y
N
PCSS OLD

FLASH VERB- NOUN TO REQUEST RESPONSE AND DISPLAY PLANET POSITION VECTOR.
Y08NX3
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 IT 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.

*NEW
*DATA
*R
*G
*E
*O

STORE NEW DATA

KEY IN V25E AND LOAD CORRECT POSITION VECTOR COMPONENTS.

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

ARE THE POSITION VECTOR COMPONENTS CORRECT?

Y
N

KEY IN PROCEED
(CAS AN) CS(x) 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

R : DD
PZ0 CALL POU
(SEE ROJ) TYPE INTEGRATION

IS THIS WINKEY SELECTION
IF P20?

NO YES
GO TO "RE", 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 KB7 FLAG
----------------------------------------
IS OPTION = 2?
  .N  .Y

IS T < R67TIME?
  .Y  .N

WAIT UNTIL R67TIME

DO ROTATION ROUTINE (R67)

THE ROTATION ROUTINE (R67) IS NOW AUTOMATIC

DO I DESIRE TO TERMINATE P20?
  .Y  .N

GO TO
  #...
BELOW
START R27 TIME
MONITOR

SET R21 MARK FLAG TO
ALLOW OPTICS MARKS

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

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

IS THIS A FORCED
MANEUVER DURING
MINKEY - (PLANE
CHANGE OR P37)?
(PCMANFLG SET?)

RETURN
TO MINKEY
CONTROLLER
(R07)

SET TARGFLG FOR USE
BY AUTO OPTICS

#930

#940

#950

#960

#970
POSITIONING ROUTINE
(R52).

CALL THE AUTO OPTICS
POSITIONING ROUTINE
(R52).

THE AUTO OPTICS POSi-
TIONING ROUTINE
(R52) AND THE TRACK-
ING ATTITUDE ROUTINE
(R61) ARE NOW AUTO-
MATIC.

DO I DESIRE TO
TERMINATE P207?

Y  N

G

DO I DESIRE TO
SELECT CMC IDLING
PROGRAM (P00)?

Y  N

WAIT FOR KEYBOARD
ENTRY.

SELECT CMC
IDLING PROGRAM
(P00).

KEY IN
V37E00E

RESPONSE TO V56E
OR V37E00E
IMMEDIATELY.

V  .V
S  .J

KEY IN
V56E
G3 TO CNC
IDLING PROGRAM
(P00) VIA R00
(NOTE: P00
WILL RESET
THE RENDEZVOUS,
UTFLAG,
R57FLAG,
R21FLAG,
TRACK, AND UP-
DATE FLAGS AND
ALSO TERMINATE
THE AUTO
OPTICS POSI-
TIONING ROUT-
LINE (R52)
AND THE RENDE-
ZVOUS TRACKING
DATA PROCESS-
ing ROUTINE
(R22)

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

RESET
THE REN-
DEZVOUS,
UTFLAG,
R57FLAG,
R21FLAG,
TRACK,
AND UP-
DATE
FLAGS AND
TERMINATE
THE AUTO
OPTICS

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

OBSERVE
DISPLAY OF P00.

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

EXIT P20

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

EXIT P20
POSITIONING ROUTINE (R52)

AND THE RENDEZVOUS TRACKING DATA PROCESSING ROUTINE (R22).

RESTORE

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

MISS P20 THE ONLY PROGRAM RUNNING?

Y N

**

DO ROUTINE R00 ...

DO ROUTINE R03 ...

**

EXIT EXIT

P20 P20

000 P20/SKYLARK
GROUND TRACK DETERMINATION PROGRAM (P21)  

REV 00 05/19/71

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.

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00 KEY TO START GROUND TRACK
DETERMINATION PROGRAM (P21). 
DISPLAY PROGRAM 21

---

01 KEY IN GROUND TRACK
DETERMINATION PROGRAM (P21)
V37E21E

---

02 MONITOR DSKY:
OBSERVE DISPLAY OF
PROGRAM 21

---

SFT TRACK FLAG

---

PRECEEDING PAGE BLANK NOT FILMED
SET CMC ASSUMED
OPTION TO 00001.

HOLD          FLASH VERB-NOuN TO
SNAP           REQUEST RESPONSE AND
               DISPLAY OPTION CODE
FOR ASSUMED VEHICLE
               (OWS OR CSM)
       VO4 VO6
       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

WAIT FOR KEYBOARD
ENTRY

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

IS THE ASSUMED
OPTION CORRECT?

        .Y   .N

KEY IN
PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA.

        .P   .NEW
        .R   .DATA
        .O   .
        .C   ----------------
       +E   STORE
ZERO T LAT LONG
DISPLAY REGISTERS R1, R2, AND R3 WILL INITIALLY READ 0000

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 MCC COMPUTE
PARAMETERS FOR THE
PRESENT TIME?

N
Y

AM I SATISFIED
WITH THE DIS-
CALCULATE VELOCITY
AND FLIGHT PATH
ANGLE FOR DISPLAY IN
473 AT ASTRONAUT
REQUEST.

CALCULATE LATITUDE,
LONGITUDE AND ALTITUDE OF VEHICLE AT
Y LAT LONI.

CALCULATE ALTITUDE
FOR DISPLAY IN 473
AT ASTRONAUT
REQUEST.

HOLD SNAP
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY LATITUDE,
LONGITUDE AND
ALTITUDE:
V06 #43
R1-LAT
R2-LONG
R3-ALT

LAT-LATITUDE OF
VEHICLE, + IS NORTH,
IN DEGREES TO NEAR-
EST 0.01 DEGREE.

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

#190

#200

#210

#220

#230
LONG-LATITUDE OF VEHICLE, + IS EAST, IN DEGREES TO NEAREST .01 DEGREE.

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

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

N

WAIT FOR KEYBOARD ENTRY

WHEN FINISHED WITH DISPLAY KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF RECYCLE OR PROCEED

WHEN FINISHED WITH DISPLAY KEY IN RECYCLE V32E
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 NTZ WITH A TIME IN THE FUTURE, OPTIMIZATIONS WILL OCCUR AUTOMATICALLY EVERY 4 MINUTES, BEGINNING WITH THAT TIME (NTZ) SELECTED BY THE ASTRONAUT.
(3) THIS PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PREVIOUS PAGE BLANK NOT PRINTED.

P25/SKYLARK
HOLD
SNAP
FLASH VERB-NOUN TO
REQUEST RESPONSE
AND DISPLAY TIME
OF R27 OPTIMIZATION.
V06 N72
R1 - R27 OPT-HRS
R2 - R27 OPT-MINS
R3 - R27 OPT-SECS
R27 OPT - TIME AT
WHICH RANGE RATE
WILL BE OPTIMIZED TO
NEAREST .01 SEC.
(ZEROES INDICATE NO
OPTIMIZATION DESIRED)
MONITOR SKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF TIME OF R27
OPTIMIZATION.

DO I WISH TO
OPTIMIZE RANGE RATE?

AM I SATISFIED
WITH THE DIS-
PLAYED TIME?

ARE ALL
THREE
REGISTERS
EQUAL TO
ZERO?

WAIT FOR KEYBOARD
ENTRY

KEY IN
PROCEED

YES
NO

YES
NO

YES
NO

NO
YES

#40
#50
#60
#70
#80
+01  TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

+04  "PROCEED" NEW DATA

+089  STORE NEW DATA

+00   -----------------------------------------

+00   CALCULATE TFO FOR POSSIBLE DISPLAY IN N76.

+00   -----------------------------------------

+00   CALL VHF RANGE RATE MARK PROCESSING ROUTINE [R27]

+01  IS NOUN 72 ZERO?

+00   NO    YES

+00   -----------------------------------------

+00   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.

+00   IF OPTIMIZATION IS TO BE PERFORMED, A NEW OPTIMIZATION WILL OCCUR AUTOMATICALLY EVERY 4 MIN FOLLOWING THE FIRST.
---

**IS NOUN 72 ZERO?**

---

**NO.**

**YES.**

---

**PASS OLD 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 RATE ARE CURRENT VALUES.**

**TFO - TIME FROM NOW TO OPTIMIZATION TIME (N72) IN MIN**

---

090 P25/SKYLARK
AND SEC TO NEAREST SEC. THE VALUE IS +99899 IF NO OPTIMIZATION WAS REQUESTED.

**01 **

**001 **

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF RECYCLE OR PROCEED

DO I WANT TO ALTER THE PRESENT OPTIMIZATION SEQUENCE?

NO YES

WAIT FOR KEYBOARD ENTRY

WHEN FINISHED WITH DISPLAY KEY IN PROCEED.

NOTE: NEXT DISPLAY NOT VALID UNTIL TFD = +00802

WHEN FINISHED WITH DISPLAY KEY IN RECYCLE V32E

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

MONITOR OK: 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 -0.0001
THROUGHOUT P25.

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

** IF R27 OPT NOT 0:
  TFO < -0.0135 RANGE,
  RANGE RATE ARE
  CURRENT VALUES;
  -0.0135 < TFO <
  +0.0002 RANGE,
  RANGE RATE FIXED
  AT LAST CURRENT
  VALUE;
  +0.0002 < TFO <
  +0.0135 RANGE,
  RANGE RATE ARE
  OPTIMIZING VALUES;
  TFO > +0.0135 RANGE,
  RANGE RATE ARE
  CURRENT VALUES.
**TIME IS HERE**
INCREMENT BY 4
MIN. TF7 NOW COUNTS
DOWN FROM 32825 TO
NEXT OPT TIME.

**I WANT TO ALTER**
THE PRESENT OPTIMIZATION SEQUENCE?

NO YES

WAIT FOR KEYBOARD ENTRY
WHEN FINISHED WITH DISPLAY KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF RECYCLE OR PROCEED
WHEN FINISHED WITH DISPLAY KEY IN RECYCLE Y32E

P D E R C Y L E D

DO ROUTINE R00
DO ROUTINE R03
CMC UPDATE PROGRAM (P27)  
REV 01 03/20/72

PURPOSE:
(1) TO INSERT INFORMATION INTO THE CMC VIA THE DIGITAL D-PLINK 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 IMU MAY BE IN STANDBY OR OPERATE CONDITION.
(2) CMC UPDATES ARE OF FIJR CATEGORIES:
(A) PROVIDE AN UPDATE FOR CMC LIFTOFF TIME (V73).
(B) PROVIDE AN ACTUAL INCREMENT FOR THE CMC CLOCK ONLY (V73).
(C) PROVIDE LOAD CAPABILITY FOR A BLOCK OF SEQUENTIAL ERASABLE LOCATIONS (1-18 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 POO, PJZ, OR P20 (OPTIONS 1, 2, OR 5), AND IF THE DSKY IS AVAILABLE.
(5) THE UPTF ACCEPT/BLOCK SWITH MUST BE IN ACCEPT FOR TELEMETRY UPDATE.
(6) THE PROGRAM IS MANUALLY SELECTED BY THE ASTRONAUT BY DSKY ENTRY OR BY THE GROUND BY D-PLINK 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.

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<tr>
<td>CONT</td>
<td>NFT</td>
<td>VRTH</td>
<td>CRE</td>
</tr>
</tbody>
</table>
SELECT THE DESIRED TYPE OF UPDATE:
  V70-LIPOFF
  TIME-INCREMEN'T
  V71-CONTIGUOUS
  BLOCK UPDATE
  V72-SCATTER
  UPDATE
  V73-3CTAL TIME INCREMENT

INTERRUPT PRESENT
PROGRAM AND TURN
ON UPLINK ACTY LITE

START CNC UPDATE
PROGRAM

IS ANOTHER EXTENDED
VERB, A MARKING DIS-
PLAY, OR A PRIORITY
DISPLAY ACTIVE?

Y  N

TURN ON OPERATOR
ERROR LITE

IS ANOTHER EXTENDED
VERB, A MARKING DIS-
PLAY, OR A PRIORITY
DISPLAY ACTIVE?

Y  N

OBSERVE OPER-
ATOR ERROR
LITE ON, AND
UPLINK ACTY
LITE ON

#20

#30

#40

#50

#60
IS PROGRAM P20, AND IS JTF Flag 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
FCR DOWNLINK TRANSMISSION

DISPLAY PROGRAM 2?

IS THIS A TIME INCREMENT UPDATE

V70 OR V731?

"N", "Y"

FROM BELOW SET COMPNUMB

EQUAL TO 2

FLASH VERB/NOUN TO REQUEST LOAD OF INDEX IN MACHINE

ADDRESS SPECIFIED IN POSS

HOLD V21 N31

Snap R1-BLANK R2-BLANK R3-AAAA

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
SELF MINIMUM INDEX IS 3; MAXIMUM IS 20.

WAIT FOR KEYBOARD ENTRY

TRANSMIT TERMINATE

GO TO "A" BELOW

TRANSMIT INDEX VALUE

TERMINATE FLASH UPON RECEIPT OF TERMINATE OR INDEX

I E N D  I E X
N A T E
E

GO TO "A" DISPLAY BELOW INDEY
THE TRANSMITTED WORDS WILL BE CORRECTED.

WAIT FOR KEYBOARD ENTRY

DO I WISH TO TERMINATE?

Y N

DO I WISH TO CORRECT ANY DATA?

Y N

TRANSMIT TERMINATE V34E

GO TO *A* BELOW

TRANSMIT OCTAL IDENTIFIER

TRANSMIT PROCEED V33E
TERMINATE FLASH UPON RECEIPT OF TERMINATE, PROCEED, OR XXE.

- T P X
- E R X
- O E
- C
- E
- E
- A D
- E

IS XX GREATER THAN 0 AND EQUIVALENT TO OR

GO TO LESS THAN COMPNUMB?

Y N

GO TO "D" ABOVE

CALCULATE ADDRESS OF DATA LOAD TO BE CORRECTED

GO TO "C" ABOVE

INVERT VERIFLAG

MONITOR DOWNLIST THAT PROCEED HAS BEEN SUCCESSFULLY
DELAY TRANSFER OF DATA LOADS UNTIL INTEGRATION COMPLETED

STALL INTEGRATION UNTIL DATA TRANSFER

IS THIS A LIFTOFF TIME UPDATE (V70)?

Y N

WOULD UPDATE CAUSE THE CMC CLOCK TIF OVERFLOW?

Y N

TURN ON OPERATOR ERROR LITE

MONITOR SKY OBSERVE OPERATOR ERROR LITE
GO TO "A" BELOW

INCREMENT TEMPAN
AND DECREMENT
STATE VECTOR
TIME TAGS AND
CMC CLOCK

GO TO "A" BELOW

ARE ALL LOADED ADDRESSES LEGAL?
NOTE 1 - FOR V72
COMPANY 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 SKY:
OBSERVE OPERA-
TOR ERROR LITE

P27/SKYLARK
GO TO "A"
BELOW

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

WAS THIS A STATE
VECTOR UPDATE?

N
Y

"A"
FROM ZERO
CHANNEL

"A"
FROM
ABOVE

77

"A"
FROM
ABOVE

TURN OFF UPLINK ACTY LITE

MONITOR DOWNLINK

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

CHANGE DWNLNK LIST
TO ORIGINAL

PZ7, AND RE-
TURN TO P00,
P02, OR P20.

TERMINATE P27 AND GO
TO PROGRAM WHICH WAS
TIME OF LONGITUDE PROGRAM (P29)      REV 00  05/19/71

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.

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DO Dow 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"

P29/SKYLARK
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, R1, R2, AND R3 WILL INITIALLY READ 0000.

HOLD
SNAP

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY BASE TIME: V06 N34

MONITOR $SKY: OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY
R1-BASE TIME-HRS
R2-BASE TIME-MINS
R3-BASE TIME-SECS

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

--------------------------------- OF BASE TIME ---------------------------------

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

N Y

--------------------------------- A4 I SATISFIED ---------------------------------
WITH THE DISPLAYED TIME?

N Y

--------------------------------- ARE ALL XIII REGISTERS EQUAL TO ZERO? ---------------------------------

Y N

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

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

114
TERMINATE FLASH UPON
RECEIPT OF NEW DATA
OR PROCEED

NEW P
DATA R
C
STORE E
NEW E
DATA D

IS BASE TIME ZERO?
N Y

CHANGE BASE TIME
TO PRESENT TIME

HOLD

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY LONGITUDE:
006 443
R1 - BLANK

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

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY LATITUDE,
LONGITUDE AND
ALTITUDE:

V0G V43
R1-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.

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

MONITOR DSKY:

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

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

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

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

118
TERMINATE FLASH UPON RECEIPT OF RECYCLE OR PROCEED

WHEN FINISHED WITH DISPLAY KEY IN RECYCLE V32E

DO ROUTINE R00

DJ ROUTINE R00

CHANGE CONTROL NOTES

REV 00 PCN 410,457
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 V(ILV)) 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 ON TO COMPLETE THIS PROGRAM.

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

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

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DO 000 TO START EXTERNAL DELTA V PROGRAM (P30) DISPLAY PROGRAM 30

---

KEY IN EXTERNAL DELTA V PROGRAM (P30) V3TE J0E

---

MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 30

---

#10

#20

P30/SKYLARK
TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

P NEW DATA
R
D
C
E STORE NEW DATA
D

HOLD FLASH VERB-NOUN TO REQUEST RESPONSE AND

SNAP DISPLAY THREE STORED COMPONENTS OF DELTA V(LV):

V06N8L
R1-DELTA VX (LV)
R2-DELTA VY (LV)
R3-DELTA VZ (LV)

DELTA VX (LV):
COMPONENT OF IMPULSIVE DELTA V AT TIG ALONG VRX, IN FPS TO NEAREST .1 FPS.

DELTA VY (LV):
COMPONENT OF IMPULSIVE DELTA V AT TIG ALONG VRY, IN FPS TO NEAREST .1 FPS.

KEY IN V25E AND LOAD THE DESIRED TIG.

MONITOR DSKY:
OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF THREE STORED COMPONENTS OF IMPULSIVE DELTA V ALONG CSM LOCAL VERTICAL AXES AT TIG.

AM I SATISFIED WITH THESE VALUES?

Y
N
DELTA V2 (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

----------

KEY IN
PROCEED

----------

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

----------

P
R
D
C
E
E
STO RE NEW DATA
D

----------

SET EXTERNAL
DELTA V FLAG

----------

RESET UPDATE FLAG
(SEE P29)
BASED ON THE STORED
TARGET PARAMETERS
COMPUTE NECESSARY
DEPENDENT VARIABLES
FOR EVALUATION OF THE
THRUSTING MANEUVER
INCLUDING PERIGEE
ALTITUDE, APOGEE
ALTITUDE AND DELTA V
REQUIRED (SEE SECTION 5.3 OF R693).

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY CALCULATED
THRUSTING PARAMETERS:
VO6 NA2
R1-APOGEE ALT
R2-PERIGEE ALT
R3-DELTA V

APOGEE ALTITUDE
OF APOGEE ABOVE THE
LAUNCH PAD RADIUS
IN NAUTICAL MILES TO
THE NEAREST .1 NM.

PERIGEE 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 TAKEOFF
IN FPS TO NEAREST .1 FPS

NOTE: IF APOGEE ALT OR
PERIGEE ALT EXCEEDS
SCALE, THE DISPLAY
WILL BE 9999.9 NM.

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

IS A GROUND STATION
AVAILABLE FOR CONFIRMATION OF THESE
PARAMETERS?

Y. .N
SELECT ONE OF THE FOLLOWING FIVE ALTERNATIVES:

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

(2) IF THE CALCULATED DATA IS NOT SATISFACTORY ADJUST THE CALCULATED PARAMETERS BY RESELECTING P30 AS NECESSARY AND CHANGING THE LOADED AIM PARAMETERS UNTIL CMC COMPUTED PARAMETERS ARE SATISFACTORY. THEN PERFORM THE THRUST 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 CO-ORDINA-
TION IS AVAILABLE
THEN RESELECT
P30, LEAVE AIM
PARAMETERS
UNCHANGED ETC.
(5) SELECT A NEW
PROGRAM AS DE-
SIRED AND PERFORM
THRUSTING MANEU-
VER USING BACKUP
PROCEDURE.

3.1

4.

5.

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

Y

N

SELECT ONE OF
THE FOLLOWING
FOUR ALTERNA-
TIVES:
(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, et cetera.

(3) Select the CMC Update Program (P27), load new AIM parameters from the CMC uplink, or by crew DSKY input. Observe new AIM parameters, et cetera.

(4) Terminate P30 by selecting a new program as desired and performing thrusting maneuver using backup procedures.

---

Wait for keyboard entry. 

Key in program selection as desired V37E--E

---

1. 
2. 
3. 
4. 

---
GO TO PROGRAM SELECTED.

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW PROGRAM.

P NEW PROGRAM
R
D
E
E 30 TO PROGRAM SELECTED VIA ROUTINE ROO
D

EXIT P30

IS REF$MAT FLAG SET?

Y
N
**COMPUTE IMU MIDDLE GIMBAL ANGLE AT TIG FOR THE PRESENT IMU ORIENTATION 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 N45
- R1 - MARK CTRS
- R2 - TFI
- R3 - MGA

MARK CTRS - THE NUMBER OF MARKS PROCESSED BY THE RENDEZVOUS TRACKING DATA PROCESSING ROUTINE (R22) SINCE THE LAST W-MATRIX REINITIALIZATION (REFER TO ASSUMPTION #8 OF P20). THE REGISTER WILL DISPLAY XXBXX 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. IN MIN AND SEC TO NEAREST SEC. MAXIMUM READING IS 599.99. (BEFORE + AFTER TIG.)

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

WAIT FOR KEYBOARD ENTRY — TERMINATE FLASH UPON RECEIPT OF PROCEED
DO ROUTINE R00

---

DO ROUTINE R00

***************

(NOTE: CONSIDERING
VALUE OF DELTA V,
FUEL AVAILABLE,
STATUS OF PROPULSION
HARDWARE, AND TIME
AVAILABLE TO RE-AL-
IGN THE IMU TO AVOID
GIMBAL LOCK SELECT A
PROPLUSION SYSTEM
AND THE APPROPRIATE
THRUSTING PROGRAM
ystem. AT
M1 IS THIS TIME, 
(PS-PS500, RCS
or earlier.)
The maneuver coord-
inate with ground
ify, if required.)

MUST LEARN
OF THE
SYSTEM USED
IN MCC COM-
PUTATIONS
OF DATA LOAD
---

---

EXIT P30

---

CHANGE CONTROL NOTES

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

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 CMG 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, NCC MANEUVERS ARE CONSTRAINED TO BE HORIZONTAL MANEUVERS.
(3) THE NSR MANEUVER IS CONSTRAINED TO RESULT IN COELLIPTIC ORBITS FOLLOWING THE MANEUVER.
(4) THE FOLLOWING TIME CONSTRAINTS APPLY:

(5) THE ALTITUDES BETWEEN THE CWS ORBIT AND THE CSM AT BOTH NCC AND NSR TIME ARE SPECIFIED (DSKY INPUT).

(6) CMG 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 P2O 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. (HOWEVER, IF THE UPDATE FLAG IS NOT SET THE MARKS WILL NOT BE INCORPORATED OR ACCUMULATED) SEE P2O 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 RECEIPT OF PROCEED OR NEW DATA

STORE DATA

HOLD

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

V06 VST
R1 = HALFREVS
R2 = DELTA H(NCC)
R3 = DELTA H(NSR)

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

DELTA H(NCC) - THE ALTITUDE BETWEEN THE ACTIVE AND PASSIVE VEHICLE ORBITS AT T1 (IN NC1). 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
VEHICLE ORBITS AT TIG(NSR), 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

*PRO NEW DATA

STORE DATA

FLASH VERB-NOUN TO SNAP REQUEST RESPONSE AND DISPLAY STORED TIG(TPI):
VO6 N37 RL-TIG(TPI)-MRS R2-TIG(TPI)-MINS R3-TIG(TPI)-SECS

MONITOR DSKY: OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF STORED TIG(TPI)
BASED ON THE STORED
TARGET PARAMETERS,
COMPUTE AND STORE
THE FOLLOWING
PARAMETERS:
TIGNC21 IN N28
TIGNCC1 IN N11
TIGNSR1 IN N13
*01 DELTA VILVI FOR NC1
+ IN NB1
+ DELTA VENC21 IN R1
+ N84
+ DELTA HENC21 IN R2
+ N84
+ 489 DELTA VENC1) IN R3
+ N84
++ DELTA VILVI FOR NSR
+ 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 00622).

(D) FAILURE IN THE
QORPD1 ITERATION
(_ALARM CODE 00623).
TERMINATE FLASH UPON RECEIPT OF PROCEED

HOLD

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

DELTA V(LV) - COMPONENT OF IMPULSIVE DELTA V AT TIG(NCI) ALONG (XY) X, IN FPS TO NEAREST .1 FPS.

DELTA V(YLV) - COMPONENT OF IMPULSIVE DELTA V AT TIG(NCI) ALONG V,Y, IN FPS TO NEAREST .1 FPS.

DELTA V(ZLV) - COMPONENT OF IMPULSIVE DELTA V AT TIG(NCI) ALONG -X, IN FPS TO
NEAREST +1 FPS
WHERE R IS CSM GEOCENTRIC RADIUS VECTOR AND V IS CSM INERTIAL VELOCITY VECTOR AT T1(INCL)

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

STORAGE DATA

SET EXTERNAL DELTA V FLAG

IS FINAL FLAG SET?

Y

N

144}

172

P31/SKYLARK

#490

#500

#510

#520

#530

#540

P31/SKYLARK
SET MGA DISPLAY IN R3 BELOW TO -00002

-----------

IS REFSMMAT FLAG SET?
-----------

Y

N

-----------

COMPUTE IMU

MIDDLE GIMBAL

ANGLE AT TIG

(INCL) FOR THE

PRESENT IMU

ORIENTATION

WITH THE CSM

+X AXIS

ALIGNED WITH

THE INITIAL

THRUST VECTOR

-----------

SET MGA DISPLAY IN R3

(BELOW) = "B"

-00002

-----------

MOVE THE SKY:

MONITOR VERB-NOUN TO

REQUEST RESPONSE AND

DISPLAY MARK

COUNTERS, TFI AND

MGA:

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

OBSERVE VERB-NOUN

FLASH TO REQUEST

RESPONSE AND DISPLAY

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

MARK COUNTERS - THE
NUMBER OF MARKS PROC-
CESS BY THE REM-
DEZVOUS TRACKING
DATA PROCESSING
ROUTINE (RZ2)

SINCE THE LAST
W-MATRIX REINITIAL-
IZATION (REFER TO
ASSUMPTION 81 OF
R20), THE REGISTER
WILL DISPLAY XBBXX
WHERE THE TWO MOST
SIGNIFICANT DIGITS
COMPREHEND THE VHF
RANGING MARK COUNTER
AND THE TWO LEAST
SIGNIFICANT DIGITS
COMPREHEND THE OPTICS
MARK COUNTER.

NOTE: THE OPTICS
MARK COUNTER DOES
NOT DISTINGUISH
AMONG BACKUP AND
PRIMARY MARKS.)

TFI-TIME FROM
T I(GNC11). IN MIN AND
SEC TO NEAREST SEC.
MAX READING IS 59B59
SIGN IS - BEFORE, +
AFTER TIGNC11).

MGA-MIDDLE GIMBAL
ANGLE AT T I(GNC11) 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.

(B) CV THE LAST PASS WHEN THE I40 IS NOT ALIGNED THE VALUE IS -J0002.

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

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

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

-------------------------------
TERMINE FLASH UPON RECEIPT OF PROCEED OR RECYCLE

-------------------------------
PROCEED RECYCLE

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

-------------------------------
GO TO "A" ABOVE

#640

#650

#660

#670

#680
GO TO "A" ABOVE

IS FINAL FLAG SET?

Y + N

SET FINAL FLAG

RESET UPDATE FLAG

GO TO "A" ABOVE

SET MANEUFLG

IS THIS MINKEY?
(IS AUTOSEQ FLAG SET?)

N + Y
CHANGE CONTROL NOTES

REV 00  PCR 042, 448, PCN 411, SL MEM #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 NCC MANEUVERS ARE CONSTRAINED TO BE HORIZONTAL MANEUVERS.
(3) THE NSR MANEUVER IS CONSTRAINED TO RESULT IN COELLiptIC ORBITS FOLLOWING THE MANEUVER.
(4) THE FOLLOWING TIME CONSTRAINTS APPLY:
   B) THE TIME BETWEEN THE NC2 AND NCC MANEUVERS IS INDIRECTLY SPECIFIED BY SPECIFYING THE NUMBER OF REVOLUTIONS INVOLVED IN THE TRANSFER BETWEEN THE MANEUVERS (PAD-LOAD).
(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. (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 MINKEY CONTROLLER (ROT).
CONT

* AUTOMATIC
  PROGRAM SELECTION

* CREW
  PROGRAM SELECTION

* ...

DO 100 TO START
NCZ TARGETING
PROGRAM (P32)
DISPLAY P32

* ...

KEY IN NCZ TARGETING PROGRAM (P32)
V37E 32E

* ...

MONITOR DSKY:
OBSERVE DISPLAY OF
P32

* ...

* "START"

* ...

SET UPDATE FLAG

* ...

SET TRACK FLAG

* ...

* ...

* ...

* ...
RESET PCFLG

SET NC12FLG

"START"

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

YO6 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

MONITOR OSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF STORED TIG (NC2)

AM I SATISFIED WITH
THIS VALUE?

Y
N

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

DELTA H(INSR)+THE
ALTITUDE BETWEEN THE
ACTIVE AND PASSIVE
VEHICLE ORBITS AT
TIGINSR. 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

#150
#160
#170
#180
#190
HOLD
FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY STORED TIG (TPi):
V06 N37
R1-TIG(TPI)-HRS
R2-TIG(TPI)-MINS
R3-TIG(TPI)-SECS
TIG(TPI) - TIME OF TPI IGNITION (GET), IN HRS, MINS, SECS, TO NEAREST .01 SEC

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

AM I SATISFIED WITH
WITH THIS VALUE?
Y N

RECORD THIS VALUE

WAIT FOR KEYBOARD ENTRY
KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF PROCEED, OR NEW DATA:
*P *NEW
*R *DATA
*D
*C
*E STORE DATA
D

GO TO *BB BELOW
RESET FINAL FLAG

GO TO "A" "B" "C" "D" "E" "F" "G" "H" "I" "J" "K" "L" "M" "N" "O" "P" "Q" "R" "S" "T" "U" "V" "W" "X" "Y" "Z"

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

TIG(NCC) IN N11
TIG(NSR) IN N13
DELTA VILV FOR NC2 IN N81
DELTA V(NCC)
IN R1 OF N84
DELTA V(NSR) RSS IN R3 OF N84
DELTA VILV FOR NSR IN N82
ESTABLISH ALARM IF:

(A) FAILURE IN THE PHASE MATCH ITERATION. (ALARM CODE 00000)

(B) FAILURE IN NCC HEIGHT MANEUVER ITERATION

#250
#260
#270
#280
#290
(ALARM CODE 00001)

(C) FAILURE IN THE ZJTER
(PHASE) LJP
(ITERATION)
(ALARM CODE 00002)

(D) FAILURE IN THE WRTP1
(ITERATION)
(ALARM CODE 00003)

---

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

---

IS THIS ALARM 00002?

---

. N  . Y

---

IS FINAL FLAG SET?

---

. N  . Y

---

SET UPDATE FLAG

---

"A"

---

#300

#310

#320

#330

#340
RETURN TO "START"

IS THIS ALARM 00602?

Y = N

600

601

603

SET N81=0

IS FINAL FLAG SET?

Y = N

SET UPDATE FLAG
HOLD

MONITOR DSKY:

TO REQUEST RES-

ONSE AND DISPLAY

DELTA VINCC),

DELTA HINC), AND

+DI

DELTA VNSR):

W8 NS

+1-DELTA VINC)

+2-DELTA HINC)

+3- DELTA VNSR)

+)

DELTA VINC) -

REQUIRED IMPUL-

SIVE DELTA V TO

ACCOMPRIISH NCC

MANEUVER AT

TIG(NCC), IN FPS

TO NEAREST 0.1

FPS

+489

DELTA HINC) - 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 VNSR) -

RSS OF THE REQU-

IRED IMPULSIVE

DELTA V TO

ACCOMPRIISH THE

NSR MANEUVER AT

TIG(NSR), IN FPS

TO NEAREST 0.1

FPS.

NOTE: TIG(NSR)
IS AVAILABLE BY KEYING IN VO6413.

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED

P R O C E E D

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY CALCULATED COM-

HOLD

SNAP

MONITOR DSKY: OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE
PONENTS OF DELTA VILV FOR NC2:
VO = 481
R1=DELTA VX(LV)
R2=DELTA VY(LV)
R3=DELTA VZ(LV)
DELTA VX(LV) -
COMPONENT OF IMPULSIVE DELTA V AT TIGIN(C2) ALONG VXR. IN FPS TO NEAREST .1 FPS.
DELTA VY(LV) -
COMPONENT OF IMPULSIVE DELTA V AT TIGIN(C2) ALONG VXR. IN FPS TO NEAREST .1 FPS.
DELTA VZ(LV) -
COMPONENT OF IMPULSIVE DELTA V AT TIGIN(C2) ALONG VXR. IN FPS TO NEAREST .1 FPS.
WHERE R IS GSM
GEODECENTRICAL VECTORS AND V IS
GSM INERTIAL VELOCITY VECTOR AT TIGIN(C2).

AND DISPLAY OF DELTA VILV FOR NC2.
NOTE: N81 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 REDEFINE THE DELTA VILV FOR NC2 COMPONENTS FOR THE SUBSEQUENT THRUSTING MANEUVER.)

WAIT FOR KEYBOARD ENTRY

KEY IN V25E AND LOAD DESIRED DELTA V VALUES

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

IS REF MMMHAT FLAG SET?

Y  N.

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

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

"B"

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 W-MATRIX
REINITIALIZATION
(REFER TO ASSUMPTION
(8) OF P20). THE
REGISTER WILL
DISPLAY XXXXX
WHERE THE TWO MOST
SIGNIFICANT DIGITS
IS THE VHP RANGING
MARK COUNTER AND THE
TWO LEAST SIGNIF
ICANT DIGITS IS THE
OPTICS MARK COUNTER.
(NOTE: THE OPTICS
MARK COUNTER DOES
NOT DISTINGUISH BE-
TWEEN PRIMARY AND
SECONDARY.)

TFI - TIME FROM TIG
(NC2), IN MIN AND
SEC TO NEAREST SEC.
MAX READING IS 59859.
SIGN IS - BEFORE, +
AFTER TIG(NC2).

MGA - MIDDLE GIMBAL
ANGLE AT TIG(NC2)
IF CSM X AXIS IS
ALIGNED WITH INITIAL
THRUST DIRECTION.
IN DEGREES TO NEAR-
EST .01 DEGREE.
SIGN IS ALWAYS +
EXCEPT:

(A) WHEN DISPLAY-

TFI AND MGA.

#690

#700

#710

#720

#166
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
-00002.

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

WAIT FOR KEYBOARD ENTRY

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

KEY IN PROCEED

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

TERMINATE FLASH UPON RECEIPT OF PROCEED,
OR RECYCLE.

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

KEY IN RECYCLE V32E

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

G0 TO "A" ABOVE

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

RESET UPDATE

----------------------------------
FLAG

IS FINAL FLAG SET?

SET FINAL FLAG

RESET UPDATE FLAG

SET MANUFGL

IS THIS MINKEY?
ITS AUTOSEQ FLAG

GO TO "A" ABOVE

GO TO "A" ABOVE
NC2 TARGETING PROGRAM (P33)

PURPOSE:
(1) TO CALCULATE PARAMETERS ASSOCIATED WITH THE NC2 MANEUVER FOR LAMBERT STEERING DELTA V BURNS.
(2) TO CALCULATE THESE PARAMETERS BASED UPON MANEUVER DATA APPROVED AN KEYED INTO THE DSKY 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) THIS PROGRAM IS BASED UPON PREVIOUS COMPLETION OF THE NC2 TARGETING PROGRAM (P32).

Therefore:
(1) 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 HORIZONTAL PLANE DEFINED AT THE ACTIVE VEHICLE POSITION.
(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 ANY FLASHING DISPLAY AND TAKE OFFICE MARKS AND/OR HE MAY ALLOW VHF RANGING MARKS TO ACCUMULATE. (H)EVER, IF THE JPDATE 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 MIKEY CONTROLLER (R07).

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ON R00 TO START NC2 TARGETING PROGRAM (P33)

KEY IN NC2 TARGETING PROGRAM (P33) V37E 33E

#10
GO TO "A"

BASED ON THE STORED TARGET PARAMETERS,
COMPUTE THE FOLLOWING PARAMETERS:
DELTA V(LV) FOR NCC
DELTA V(LV) FOR NB1
DELTA V(LV) FOR NSR
STORE DELTA V(LV)
FOR NSR IN NB2.
NOTES: THE COMPUTATIONS INCLUDE THE
OUT-OF-PLANE AT NSR.
The negative of the
y dot cm is written
into r2 of nb2.
Establish alarm
if no solution
can be reached.

IS FINAL FLAG
SET?

176
FLASH VERB-NN: TO REQUEST RESPONSE
PULSE AND DISPLAY DELTA V(LV) FOR NSR:
VOS N82 R1-DELTA VX(LV)
R2-DELTA VY(LV)
R3-DELTA VZ(LV)

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

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

DELTA VZ(LV) - COMPONENT OF IMPULSIVE 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 DSKY: OBSERVE VERB-NN: NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF DELTA V(LV) FOR NSR.

#380
#390
#400
#410
#420
WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH
UPON RECEIPT OF
PROCEED

STORE DELTA V(LV)
FOR NCC, COMPUTED
ABOVE, IN N81

FLASH VERB- NOUN
TO REQUEST RES-
PONSE AND DISPLAY
CALCULATED COM-
PONENTS OF DELTA
V(LV) FOR NCC:
V06 N81
R1-DELTA V(XLV)
R2-DELTA V(YLV)
R3-DELTA V(ZLV)

DELTA V(XLV) -
COMPONENT OF IMP-
PULSIVE DELTA V
AT T1G(NCC) ALONG
(RXVYR), IN FPS

AM I SATISFIED
WITH THESE
DELTA VY(LV) - COMPONENT OF IMPULSIVE DELTA V AT TIGENCY (C) ALONG VX R. IN FPS TO NEAREST .1 FPS

VALUES?

(Note: Crew has the option at this time to redefine the components for the subsequent thrusting manuever.)

Y  N

WAIT FOR KEYBOARD ENTRY

KEY IN V25E AND LOAD DESIRED VALUES

RECORD THESE VALUES

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

P  NEW
R  DATA
S  STORE DATA
E  D

P33/SKYLARK
COMPUTE AND STORE
TARGET VECTOR FOR
P40/P41.

"N"

 IS FINAL FLAG SET?

 "N"   "Y"

 SET MGA
 DIS-
 PLAY
 (IN R3)
 (BELOW)
 =  -00001.

 IS REF5MAT FLAG SET?

 "Y"   "N"

 COMPJTE IMU
 MIDDLE SIMBAL
ANGLE AT TIC
(INC) FOR THE
PRESEN'T IMU
ORIENTATION
WITH THE CSM
+K AXIS ALIGN-
ED WITH THE
INITIAL THRUST
VECTOR

SET MGA DIS-
PLAY IN R3
(BEL W) =
-J0002.

HOLD

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

MARK COUNTERS - THE
NUMBER OF MARKS PRO-
CESSED BY THE REN-
DEVOUS 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 BE-
TWEEN BACKUP AND
PRIMARY MARKS.)

TFI - TIME FROM TIG
(NCC). IN MIN AND
SEC TO NEAREST SEC.
MAX READING IS 598.59.
SIGN IS - BEFORE +
AFTER TIG(NCC).

MGA - MIDDLE GIMBAL
ANGLE AT TIG(NCC)
IF GIM +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
PASS WHEN THE IMU
IS NOT ALIGNED
THE VALUE IS
-00032. IN DEGREES
TO NEAREST .01
DEGREE

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

WAIT FOR KEYBOARD ENTR

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

KEY IN PROCEED.
RESET UPDATE
FLAG

GO TO
"A"
ABOVE

SET MANEUFLG

IS THIS MINKEY?
(IS AUTOSEQ FLAG
SET?)

Y
N

CHANGE
W-MATRIX
REINITIALI-
ZATION
VALUES TO
2000 F,
ZFPS

DO ROUTINE ROO

DO ROUTINE ROO
NSR TARGETING PROGRAM (P34).

REV 01 03/20/72

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 KEPT 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 V1(P31), V2(P32), NCC(P33) TARGETING PROGRAMS. THEREFORE:
(A) AT A SELECTED T/P TIME (NOW IN STORAGE) THE LINE OF SIGHT BETWEEN THE CSM AND THE OBS 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 OBS ORBIT. HOWEVER, OUT-OF-PLANE PARAMETERS ARE COMPUTED FOR T/G (NSR) AND ARE AVAILABLE BY KEYING VGN (P3) AT FL V16 A45 AFTER A COMP CYCLE. IN ADDITION, THE NS1 DISPLAY IS MODIFIED TO ESTABLISH AN ANTIDOTE AT NSR.

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

(3) IF P20 IS IN OPERATION WHILE THIS PROGRAM IS OPERATING THE ASTRONAUT MAY HOLD AT ANY FLASHING DISPLAY AND TAKE OPTICS MARKS AND/OR HE MAY ALLOW VHF RANGING MARKS TO ACCUMULATE. HOWEVER, IF THE 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 CMC GROUND CREW

> AUTOMATIC
> PROGRAM
> SELECTION
> ...
> ...

DO 1000 TO START NSR TARGETING PROGRAM (P34)
DISPLAY P34

KEY IN NSR TARGETING PROGRAM (P34)
V37E 34E

#10
MONITOR DSKY: OBSERVE DISPLAY OF P34

"START"

SET TRACK FLAG

SET UPDATE FLAG

RESET PcFLAG

"START"

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY STORED TIG

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

HOLD

SNAP (NSR): Y06 Y13

#20

#30

#40

#50

#60
GO TO "A"
BELOW

"A"

SET EXTERNAL
DELTA V FLAG
---------------------------------

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

*A

*D

*A

*R

*L

*M

*A

*R

*M

POSS

HOLD

SNAP

FLASH VERB:
MONITOR SKY:
DOES ALARM
CODE DISPLAY IN-
DICATE COMPUTAT-

*
PLAY ALARM

CODE:

V05NO9
R1-
R2-
R3-

THE EXPECTED
ALARM AT THIS
TIME IS 00611

FINAL DIFFICULTY?

--------

N  Y

DO I WISH TO
READJUST TIG?

--------

Y  N

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
(TM-TPI-NSR) AND
DELTA
(TM-TPI-NON TPI)
ARE NOT
HOLD
  UTERR, VERB-NOUN
  TO REQUEST RESP.
  PONSE AND DISPLAY
  DELTA H (NSR),
  DELTA T(TPI-NSR)
  AND DELTA
  T(TPI-NOMTP1);
  VOQ N75
  R1-DELTA H(NSR)
  R2-DELTA T(TPI-
  NSR)
  R3-DELTA T(TPI-
  NOMTP1)

DELTA H(NSR) -
THE ALTITUDE BE-
WEEN THE ACTIVE
AND PASSIVE VE-
HICLE (ORBITS AT
TIGNSR), SIGN IS
+ WHEN THE ACTIVE
VEHICLE IS BELOW
THE PASSIVE
VEHICLE, IN NAU-
ICAL MILES TO THE
NEAREST .1 NM

DELTA T(TPI-NSR) -
TIG(TPI) AS DE-
FINE) BY THIS
PROGRAM MINUS
TIGNSR), COM-
PUTE) IN HRS,
MINS, AND SECS OF
WHICH ONLY THE
MINS AND SECS ARE
DISPLAYED.

DELTA T(TPI-
NOMTP1) -
TIG(TPI) AS DE-
FINE) BY THIS
PROGRAM MINUS

MONITOR DSKY:
OBSERVE VERB-
NOUN FLASH TO RE-
QUEST RESPONSE
AND DISPLAY OF
DELTA H (NSR)
DELTA T(TPI-NSR)
AND DELTA
T(TPI-NOMTP1).

#270

#280

#290

#300

#310
TIG(TPI) AS DE-
FINED IN 337
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 KEYPAD
ENTRY
-------------------
TERMINATE FLASH
UPON RECEIPT OF
PROCEED
-------------------

-------------------
Snap
-------------------

-------------------
HOLD
-------------------

-------------------
Monitor
-------------------

-------------------
Flash4 verb-noun
to request pes-
ponse and display
calculated com-

-------------------
Monitor
-------------------

-------------------
Observe
-------------------

-------------------
Noun flash to
request re-

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

PUNENTS OF DELTA
VILV) FOR NSR:
V96 NBI
R1-DELTA VX(IV)
R2-DELTA VY(IV)
R3-DELTA VZ(IV)

DErA VX(IV) -
COMPONENT OF IMPULSIVE DELTA V
AT TIGVNSR)
ALONG (RX)XR,
IN FPS TO NEAREST .1 FPS

DELA VY(IV) -
COMPONENT OF IMPULSIVE DELTA V AT TIGVNSR)
ALONG VX, IN FPS TO NEAREST .1 FPS

DELA VZ(IV) -
COMPONENT OF IMPULSIVE DELTA V AT TIGVNSR)
ALONG -R,
WHERE R IS CSM GEOCENTRIC RADIUS
VECTOR AND V IS
CSM INERTIAL VELOCITY VECTOR AT
TIGVNSR), IN FPS
TO NEAREST .1 FPS

AM I SATISFIED WITH THESE VALUES?
NOTE: CREW HAS THE OPTION AT THIS TIME TO REDEFINE THE DELTA V(IV)
COMPONENTS FOR THE SUBSEQUENT THRUSTING MANEUVER.

Y .N

WAIT FOR KEYBOARD ENTRY

KEY IN V25E AND LOAD DE-
STROY DELTA V VALUES
IS REFSDMAT FLAG SET?

Y or N.

COMPUTE IMU MIDDLE GIMBAL ANGLE AT T.JG (NSR) FOR THE PRESENT IMU ORIENTATION WITH THE CSM +X AXIS ALIGN-ED WITH THE INITIAL THRUST VECTOR.

SET MGA DIS-PLAY IN R3 (BELOW) = "3"

---

HOLD FLASH VERB-NUJAS monitory orky;~

\[omen\] REQUEST RESPONSE AND DISPLAY MARK COUNTERS, \( TFI \) AND \( MGA \):

\[V16\] MARK COUNTERS:

\( R1 \)-MARK COUNTERS

\( R2 \)-TFI

\( R3 \)-MGA

MARK COUNTERS - THE NUMBER OF MARKS PROCESSED BY THE RE-NDEVOUS TRACKING

* * *
DATA PROCESSING
ROUTINE (422)
SINCE LAST W-MATRIX
REINITIALIZATION
REFER TO
ASSUMPTION (B) OF
P20),
THE REGISTER WILL
DISPLAY XX.XXX 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
(NSR), IN MIN AND
SEC TO NEAREST SEC.
MAX READING IS 99999.
SIGN IS - BEFORE +
AFTER TIG(NSR).

MCA - MIDDLE GIMBAL
ANGLE AT TIG(NSR)
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) ON 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
3000J2 IN DEGREES
TO NEAREST .01
DEGREE

WAIT FOR KEYBOARD ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF PROCEED OR RECYCLE

KEY IN RECYCLE

P
R
D
C
E
L
E
E
R
RESET UPDATE FLAG

GO TO "A" ABOVE

GO TO
"A" Above

---
IS FINAL FLAG SET?
---

Y

N

---
SET FINAL FLAG
---

---
RESET UPDATE FLAG
---

---
SET MANEUFILG
---

***
GO TO

"A"

Above

---
IS THIS MINKEY?
(IS AUTOSEQ FLAG SET?)
---

Y

N

---
CHANGE
W-MATRIX
REINITIALIZATION
VALUES TO
2000 F,
TP1 TARGETING PROGRAM (P15)

PURPOSE:
(1) TO CALCULATE THE REQUIRED DELTA V AND OTHER INITIAL CONDITIONS REQUIRED BY THE CMC FOR EXECUTION OF THE TRANSFER PHASE INITIATION MANEUVER, GIVEN:
   ++
   +01
   +489
   **
   (A) TIME OF IGNITION TIG (TP1) OR THE ELEVATION ANGLE (E) IF THE CSM/OWS LOS AT TIG(TPI)
   (B) CENTRAL ANGLE OF TRANSFER (CENTANG) OF 135 DEGREES FROM TIG(TPI) 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 TP1 TARGET PARAMETERS FOR USE BY THE DESIRED THRUSTING PROGRAM.

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

(2) IF P23 IS IN OPERATION WHILE THIS PROGRAM IS OPERATING THE ASTRONAUT MAY HOLD AT ANY FLASHER 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.


   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 REASSUM THE INPUT TARGETING PARAMETERS BASED UPON DELTA V AND EXPECTED MANEUVER TIME.

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

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

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

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

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

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

(8) GEN DELTA V IN LOS COORDINATES (R89) IS AVAILABLE AT FLY V16 445 AFTER EACH COMPUTATION CYCLE.

| PROGRAM | CREW | GROUND | CMC |
RESET TPI4NFLG

RESET PCFLAG

"START"

HOLD

SNAP

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY TIG(TPI):
V0GN37
R1-TIG (TPI)-HRS
R2-TIG (TPI)-MIN
R3-TIG (TPI)-SEC

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

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

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

Y  N.

RECORD THIS VALUE.
INTEGRATION TO DETERMINE THE INITIAL POSITION AND VELOCITY OF THE TARGET AT INTERCEPT TIME. WHEN THIS NOW USE THE INDICATED NUMBER OF OFFSETS.

E-ELEVATION ANGLE BETWEEN THE CSM/OWS LOS AND THE CSM LOCAL HORIZONTAL AT T1G/1 (PI) REFERENCED TO THE DIRECTION OF FLIGHT (SEE SECTION 5.4 OF R693). 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 or 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

P
R
D
C
E
D

RESET COMP E FLAG

IS E SPECIFIED TO BE +00000?

Y
N

SET COMP E FLAG

238
P35/SKYLARK #210

#220

#230

#240

#250

210 P35/SKYLARK
FINISH SEE ABOVE.

---

RECORD THIS VALUE

---

WAIT FOR KEYBOARD ENTRY

---

KEY IN PROCEED

---

TERMINATE FLASH UPON RECEIPT OF PROCEED

---

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

---

P
N
O
A
L
R
M
E
C
D
G

---

#300
#310
#320
#330
#340
WAS A NEW TIME LOADED IN N37?

```
Y   N
```

SET E=0

```
GO TO "A"
ABOVE
```

IS NN =0?

```
Y   N
```

USING CONIC INTEGRATION AND NO OFFSETS COMPUTE THE PARA-
METERS ASSOCIATED WITH TPI AND TPF AS DESCRIBED IN SECTION 5.4 OF R693.

USING PRECISION INTEGRATION AND NH OFFSETS COMPUTE THE PARAMETERS ASSOCIATED WITH TPI AND TPF AS DESCRIBED IN SECTION 5.4 OF R693.

RESET EXTERNAL DELTA V FLAG

POSSIBLE

MOLD

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

MONITOR DISK:

OBSERVE VERB- NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF CALCULATED DELTA
DELTA (TP1-NOM-TP1):
VITPI, DELTA
VITPI, AND
DELTA (TP1-NOM-TP1).

DELTA VITPI-REQUIRED IMPULSIVE
DELTA V TO ACCOM-
PLISH TP1 MANEU-
VER AT TIG(TP1).
IN FPS TO NEAREST
.1 FPS.

DELTA VITPF1-REQUIRED IMPULSIVE
DELTA V TO ACCOM-
PLISH TPF MANEU-
VER AT TIME OF
INTERCEPT. IN FPS
TO NEAREST .1 FPS.

DELTA (TP1-NOMTP1) -
TIG(TP1) AS DE-
FINED BY THIS
PROGRAM MINUS
TIG(TP1) 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
COMPONENTS OF DELTA V(LV)
FJR TPI:
V06N81
R1-DELTA
VX(LV)
R2-DELTA
VY(LV)
R3-DELTA
VZ(LV)

DELTA VX(LV) - COMPONENT OF IMPULSIV
Delta V at Ti(TPI) along (AXY)xp. in
FPS to nearest .1 FPS.

DELTA VY(LV) - COMPONENT OF IMPULSIV
Delta V at Ti(TPI) along
VAR. IN FPS TO
NEAREST .1 FPS.

DELTA VZ(LV) - COMPONENT OF IMPULSIV
Delta V at Ti(TPI) along
VAR. IN FPS TO
NEAREST .1 FPS.

WHERE R IS THE
CSM GEOCENTRIC
RADIUS VECTOR
AND V IS THE
CSM INERTIAL
VELOCITY VECTOR AT
Ti(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 RE-DEFINE THE
DELTA V(LV) COMPONENTS
FOR THE SUBSEQUENT THRU-
STING MANEUVER. THIS
CAPABILITY WILL NORMALLY
BE EXERCISED TO CORRECT
OUT OF PLANE NESS BY FIRST
SELECTING THE
RENDEZVOUS
OUT-OF-PLANE
DISPLAY ROUTINE (R36)
(YVEO), AND THEN MODIFYING DELTA
VY(LV).)

Y N
WAIT FOR KEYBOARD ENTRY

KEY IN VIEW AND LOAD THE DESIRED VALUES

RECORD THESE VALUES

TERMINATE

FLASH UPON RECEIPT OF PROCEED OR NEW DATA

P NEW DATA
R DATA
O
G
E STORE DATA
D

WAS VIEW DATA LOADED?

N Y
CALCULATE NEW TARGET VECTOR BASED ON NEWLY LOADED DELTA V(DEL) FOR TPI.

"Bn"

IS FINAL FLAG SET?
N, Y.

SET MGA DISPLAY IN R31BELOW)
= -00001.

IS REFSMART FLAG SET?
Y, N.

COMPUTE T(MU MIDDLE GIMBAL ANGLE AT TIG
(TF1) FOR THE
PRESENT IMU
ORIENTATION
WITH THIS VEH-
ICLE'S *X
AXIS ALIGNED
WITH THE
INITIAL
THRUST VECTOR

----------

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

----------

HOLD
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY MARK CTRS
TFI AND MGA:
V6N65
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 XXBXXX
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 59959. SIGN IS - BEFORE OR 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 -0002.
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

KEY IN PROCEED.
RESET UPDATE
* FLAG

GO TO
* "A"
* ABOVE

SET MANEUFLG

IS THIS MINKEY?
(IS AUTOSEQ FLAG
SET?)

Y
N

CHANGE 4-MATRIX
RFINITIALIZATION
VALUES TO 2000 F,
2FPS

DC ROUTINE R00

UU ROUTINE R00

EXIT P35

EXIT P35
TPM TARGETING PROGRAM (P35)

PURPOSE:
(1) TO CALCULATE THE REQUIRED DELTA V AND OTHER INITIAL CONDITIONS REQUIRED BY THE CMC FOR CSM EXECUTION OF THE NEXT MIDCOARSE 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.


THE ASTRONAUT COULD 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 V01.

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

(7) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY OR INTERNALLY BY THE MINKEY CONTROLLER (RO7).
MONITOR SKY:
OBSERVE DISPLAY OF
PROGRAM 36

SET TPIMNFLG

RESET FINAL FLAG

SET TRACK FLAG (SEE P201)

SET UPDATE FLAG
(SEE P231)

RESET PGENFLG

GO TO "A"
USING CUBIC INTEGRATION AND OFFSET SETS CALCULATE THE REQUIRED VELOCITY FOR THE MID-COURSE CORRECTION

USING PRECISION INTEGRATION AND OFFSETS CALCULATE THE REQUIRED VELOCITY FOR THE MIDCOURSE CORRECTION

RESET EXTERNAL DELTA V FLAG

IS FINAL FLAG SET?

N Y
THRUSTING MANEUVER:

\[ Y = \frac{F}{m} \]

---

WAIT FOR KEYBOARD ENTRY

KEY IN V25E AND LUAD THE DESIRED DELTA V VALUES.

---

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

P NEW DATA
HAS NEW DATA LOADED?

Y  Y

CALCULATE AT F 464 TARGET VECTORS BASED ON NEWLY LOADED DELTA v LISH.

"Y"

IS FINAL FLAG SET?

Y

P36/SKYLARK
SET MGA DISPLAY
IN R3(BELOW) = -00011.

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

IS REFSTMAT FLAG
SET?
---------------------

Y \ N

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

COMPUTE IMU
MIDDLE GIMBAL
ANGLE AT TIG
(ITPM) FOR THE
PRESENT IMU
ORIENTATION
WITH THE CSM
* X AXIS ALIGNED
NEO WITH THE
INITIAL
THRESHOLD VECTOR

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

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

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

HOLD

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

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

MONITOR DIRXY:

OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY

#310
#320
#330
#340
#350

234
VILPN6
V1-MARK CTRs
V2-TFI
V3-MGA

MARK CTRs - THE
NUMBER OF MARKS PRO-
CESSSED BY THE RENO-
EZYS TRACKING DATA
PROCESSING ROUTINE
(R22) SINCE THE LAST
W-MATRIX REINITIAL-
IZATION.
(REFER TO ASSUMPTION
B) OF P201.
THE REGISTER WILL
DISPLAY XXXXX WHERE
THE TWO MOST SIGNIF-
ICANT DIGITS IS THE
VHF HANING 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
(1PM) IN MIN AND SEC
TO NEAREST SEC. MAX
READING IS 59.59.
SIGN IS - BEFORE +
AFTER TIG(1PM).

MGA-MIDDLE GIMBAL
ANGLE AT TIG(1PM) IF
CSM + X AXIS IS ALI-
GED WITH INITIAL
THUST DIRECTION.
SIGN IS ALWAYS +
EXCEPT:

(A) WHEN DISPLAY-
ED AT ANY TIME

OF MARK CTRs, TFI
AND MGA.

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 PRO-
GRAM?

. Y      . N

. Y      . N
OTHER THAN THE LAST PASS THROUGH THE PROGRAM THE VALUE IS
-00001. IN DEGREES TO THE NEAREST .01 DEGREES.

WAIT FOR KEYBOARD ENTRY

KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF PROCEED OR RECYCLE

KEY IN RECYCLE W32E

GO TO "A" ABOVE
IS FINAL FLAG SET?

Y   N.

SET FINAL FLAG

GO TO "AH"
ABOVE

SET MANEUFLG

IS THIS MINKFY?
(IS AUTJSEQ FLAG SET?)

Y   N
CHANGE CONTROL NOTES

RFV 00  PCR J11, 421, 423, PCN 412, 455, SL4 #2
REUNION FINAL PHASE PROGRAM (P37)

IFV 01 03/20/72

PURPOSE:
(1) TO ESTABLISH X-AXIS TRACKING (P20, WITH RHQ AND GAMMA=0 DEG.)
(2) TO SELECT P31 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 DSYS ENTRY OR BY THE PINEY CONTROLLER.

PROC
CONT CMC GROUND CREW

. AUTOMATIC . CREW
. PROGRAM . PROGRAM
. SELECTION . SELECTION
.

DO K30 TO START
REUNION FINAL PHASE PROGRAM (P37)
DISPLAY P37

#10

#20

#30

SET UPDATE FLAS

---
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.

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<th>CREW</th>
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</table>

DD 00 TO START
PLANE CHANGE TARGETING PROGRAM (P38)
DISPLAY PROGRAM 38

KEY IN PLANE CHANGE TARGETING PROGRAM (P38) V37E 38E
R1-TIG-HRS
R2-TIG-MINS
R3-TIG-SECS

TIG - TIME OF LAST
MANEUVER IN HRS,
MINS, SEC TO NEAREST
.01 SEC.

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

OF LAST TIG

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

AM I SATISFIED WITH
THIS VALUE?

. Y

. N

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

RECORD THIS
VALUE

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

WAIT FOR KEYBOARD
ENTRY

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

KEY IN PROCEED

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

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

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

. PRU . NEW DATA

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

STORE DATA

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

SET EXTERNAL DELTA V
FLAG

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

KEY IN V25E
AND LOAD
DESIRED VALUE

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

#70

#80

#90

#100

#110
TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

KEY IN Y25E AND LOAD DESIRED TIG

NEW DATA
STORE DATA
DATA

GO TO "B"
REFLOW

RESET UPDATE FLAG

COMPUTE OUT-OF-PLANE PARAMETERS AS DESCRIBED IN SECTION
SIVE DELTA V AT TIG FOR PC ALONG VXVX. IN FPS TO NEAREST .1 FPS.

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

DELTA V(VL) - COMPONENT OF IMPUL-SIVE DELTA V AT TIG FOR PC ALONG -X, IN FPS TO NEAREST .1 FPS.

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

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

PROCEED NEW DATA

STRIKE NEW DATA

AM I SATISFIED WITH THESE VALUES?

Y

RECORD THESE VALUES

KEY IN PROCEED

KEY IN V22E AND LOAD DESIRED DELTA V VALUE.

NOTE: OVERWRITING X1, R2, R3 WITH O DURING MINKEY SEQUENCE WILL CAUSE EVIANCE INTO PS2 FOLLOW-ING P3B TO BE BYPASS.

IF NB1 = 0,0,0 EITHER VIA THE
DSKY OR MINKEY
SEQUENCE A 01301
ALARM
(ARC SINE = ARC
COSINE ARGUMENT
TOO LARGE) MAY
RESULT.

IS FINAL FLAG SET?
---
N  Y

SET MGA DISPLAY
IN R3 (BELOW) =
-00001

IS REFWSMAT
FLAG SET?
---
Y  N

COMPUTE IMU
MIDDLE GIM-
BAL ANGLE
AT TIGIPC)
FOR THE
PRESENT
IMU ORIEN-
TATION WITH
THE CS4 +X
AXIS ALIGNED
WITH THE
INITIAL
THRUST
VECTOR

SET MGA
DISPLAY
HOLD

FLASH VERB-NU N TO REQUEST RESPONSE AND DISPLAY MARK COUNTERS, TFI AND MGA:

V16 #5
R1-MARK COUNTER
R2-TFI
R3-MGA

MARK COUNTERS - THE NUMBER OF MARKS Processed by the Rendezvous Tracking Data Processing Routine (422) since the last N-Matrix REINITIALIZATION. The register will display XX8XX where the two most significant digits comprise the VHF ranging mark counter and the two least significant digits comprise the optics mark counter. (Note: the optics mark counter does not distinguish between backup and primary marks.)

TFI-TIME FROM TIG(PG)
In MIN and SEC TO NEAREST SEC. MAX READING IS 59859. SIGN IS - BEFORE.
+ AFTER TIG(PC).

MGA-MIDDLE GIMBAL
ANGLE AT TIG(PC) IF
CSM +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

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

*************** KEY IN RECYCLE V32E

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

.PROCEED .RECYCLE

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

***************

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

GO TO

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

GO TO
"A" ABOVE

IS FINAL FLAG SET?

Y
N

SET FINAL FLAG

...

GO TO "A" ABOVE

IS THIS MINKEY?
(IS AUTJSEQ FLAG SET?)

Y
N

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

DO ROUTINE R00

DO ROUTINE R00
SPS PROGRAM (P40)  

REV  01  03/20/72

PURPOSE:

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

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

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

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

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

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

ASSUMPTIONS:

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

(2) THE REQUIRED STEERING EQUATIONS ARE IDENTIFIED BY THE PRIOR PRE-THRUST PROGRAM, WHICH EITHER SET OR RESET THE EXTERNAL DELTA V STEERING FLAG. FOR EXTERNAL DELTA V STEERING, VG IS CALCULATED ONCE FOR THE SPECIFIED TIME OF IGNITION. THEREAFTER BOTH DURING THRUSTING AND UNTIL THE CREW NOTIFIES THE CMC TRIM THRUSTING HAS BEEN COMPLETED THE CMC UPDATES VG ONLY AS A RESULT OF COMPENSATED ACCELEROMETER 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) ENGINE IGNITION MAY BE SLIPPED BEYOND THE ESTABLISHED TIG IF DESIRED BY THE CREW OR IF INTEGRATION CAN NOT BE COMPLETED ON TIME.

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

(7) ROUTINE R03 HAS BEEN PERFORMED PRIOR TO SELECTION OF THIS PROGRAM. IN ORDER FOR THE GNCS TO PERFORM THE ATTITUDE MANEUVER AND CONTROL THE THRUSTING MANEUVER THE ASTRONAUT MUST KEY IN 346E AT SOME TIME PRIOR TO THE ATTITUDE MANEUVER.

(8) P40 SHOULD NOT BE PERFORMED IN THE CSM-GNS DUCED 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 5 TURN ON BY KEYING IN V68B1.

(10) THE ORBITAL PARAMETERS DISPLAY ROUTINE (R30) MAY BE CALLED DURING THIS PROGRAM BY KEYING IN V82E.
**PROG CONT** | **CNC** | **GROUND** | **CREW**
---|---|---|---
| AUTOMATIC | CREW PROG |
| PROGRAM | SELECTION |
| SELECTION | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

----
*DO RUN TO START SPS PROGRAM (P40) DISPLAY PROGRAM 40*

----
*KEY IN SPS PROGRAM (P40) V37E 40E*

----
*MONITOR SKY: OBSERVE DISPLAY OF PROGRAM 40*

----
*SET SBFLAG*

---

---
IS EXTERNAL DELTA V FLAG SET?

* N  Y

SET CSTEER = 1
IN STEER LAW

SET CSTEER = 0
IN STEER LAW

DO IMU STATUS CHECK ROUTINE (R02)

COMPUTE INITIAL THRUST DIRECTION AND INITIAL VALUE OF VG VECTOR AND STORE IN NV1 (VG LOCAL VERTICAL)
FROM INITIAL THRUST
DIRECTION AND ENGINE
BELL TRIM ANGLES
COMPUTE PREFERRED
IMU ORIENTATION:

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

WHERE:

\( X = \text{THE CSM X AXIS} \)

\(-CSM \text{ AT IGNITION} \)

\( (\text{AT THE PREFERRED VEHICLE ATTITUDE}) \)

\( R = \text{THE CSM POSITION} \)

\( \text{RADIUS VECTOR AT TIG.} \)

STORE DESIRED ATTITUDE SPECIFICATION
(TRIMMED ENGINE BELL CENTER LINE IN DIRECTION OF INITIAL THRUST) FOR USE BY ATTITUDE MANEUVER ROUTINE (R6J). THE FINAL ATTITUDE WILL
RF computed (vec-point) during R60, and will point the trimmed engine bell in the initial thrust direction. In order to conserve RCS fuel and not constrain the non-critical roll attitude, wings may not be level in the computed final attitude.

---

Set preferred orientation flag

---

Set .5 degree deadband in RCS DAP.

---

Reset 3AXISFLG

---

Do attitude maneuver routine (R60)
OLD: FLASH VERB-NOUN TO
----------
REREQUEST PLEASE PER-
----------
SNAP: ENGIEN GIMAL
----------
DRIVE TEST ENABLE
V50 N25
RJ-00204
R2-BLANK
R3-BLANK
----------

MONITOR DSKY
----------
OBSERVE VERB-NOUN
----------
FLASH TO REQUEST
----------
PFEASE PERFORM
----------
ENGINE GIMAL DRIVE
----------
TEST ENABLE

#180

----------
SHALL I ENABLE
----------
GIMAL DRIVE TEST?
----------

N Y

#190

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

#200

TERMINATE FLASH UPUN
----------
RECEIPT OF PROCEED
----------
OR ENTER

#210

ENTER PROCEED
----------

#220

----------
INITIALIZE ENGINE
----------
GIMALS TO 0
----------
DEGREES IN PITCH
----------
AND YAW AND PER-
----------
FORM GIMAL DRIVE
----------
TEST SEQUENCE AT
----------
2 SEC/STEP:
----------
PITCH / YAW
----------
1 2 / 0
2 -2 / 0
3 J / 0
4 J / 2
5 0 / -2

----------
MONITOR GIMAL DRIVE
----------
SEQUENCE BY REFER-
----------
ENCE TO ANALOG DIALS

----------

#258
6 J 10
IN DEGREES.

WAIT 4 SECONDS

DRIVE SPS ENGINE
BELL TO TRIM POSITION

TEMP HOLD
DISPLAY ON DSKY:
MON TV6 TH
R1 - TPI
R2 - VG
R3 - DELTA VM

TFI - TIME FROM
SPS IGNITION, IN
MIN, SEC TO NEAR-
EST SEG. MAX
READING IS 59859,
(SIGN IS - BEFORE
NOMINAL TIP, +
THEREAFTER).

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

MONITOR DSKY:
OBSERVE DISPLAY OF
TF1, VG, AND DELTA VM
DELTA V MEASURED
DELTA V MAGNITUDE
IN FPS TO NEAREST
.1 FPS. THIS DISPLAY
SHOULD BE
SURGED UNTIL AVER-
AGE-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-CJUN AND R1,
R2, R3 AT TFI = -35

DO STATE VECTOR
INTEGRATION (MID T)
AVE) ROUTINE (R41).
OBSERVE THAT THE
COMPUTER ACTIVITY
LIGHT IS ON UNTIL
COMPLETION OF
ROUTINE 41

MONITOR DSKY;
OBSERVE THAT DISPLAY
GOES BLANK
SEC

WAIT UNTIL TFI = -30 SEC

RESET PREFERRED ORIENTATION FLAG

REDISP LAY VO64N40 NON-FLASHING AND CALL AVERAGE G ROUTINE.

AT TFI = -35 SEC

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.

WAIT UNTIL TFI = -5 SEC

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?

"A" 

--

IS THIS BURN TO BE IMPULSIVE?

N Y

---

IS BURN TIME > 1?

N Y

---

COMMAND X ULLAGE TRANSLATION USING THC WHEN INDICATED BY CHECKLIST

---

RESET SBFLAG

---

IS SBFLAG SET?

N Y

---

INITIALIZE COMPLEX IMPULSIVE BURN INPUTS
STORE BURN TIME

MONITOR DSKY:

OBSERVE ULLAGE BUILD UP IN R3.

CHANCE VERB BUT RETAIN PRESENT NOUN AND DISPLAYS IN R1, R2, R3; FLASH VERB-NOUN TO REQUEST PLEASE PERFORM ENGINE ON ENABLE:

V99 N40
R1 - TF1
R2 - VG
R3 - JELTA VM

WAIT FOR KEYBOARD ENTRY

SHALL I PERMIT IGNITION OR RE-IGNITION?

Y

Y

KEY IN PROCEED

SHALL I ATTEMPT TO COMPLETE THE
THRUSTING MANEUVER BY USE OF THE RCS.

\[ \begin{align*}
N & \cdot Y \\
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\end{align*} \]

* --- KEY IN ENTER
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RESUME NO FLASH
VOG N140 DISPLAY UPON RECEIPT OF PROCEED.
TERMINATE FLASH UPON RECEIPT OF ENTER OR TERMINATE.

\[ \begin{align*}
P & \cdot E \cdot T \\
R & \cdot N \cdot E \\
D & \cdot T \cdot R \\
C & \cdot E \cdot M \\
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* --- CLEAR TVC
* --- INTERFACE
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\end{align*} \]
G3 TO "D" BELOW

CLEAR TVC INTERFACE

DO ROUTINE ROD

EXIT

IS TFI MINUS?

Y

N

WAIT UNTIL TFI=0

COMMAND ENGINE ON

IS THIS AN IMPULSIVE BURN?

Y

N
IS SFLAG SET?

Y   N

CALL COMPLEX
IMPULSIVE
RUN ROUTINE
AS DESCRIBED
IN SECTION
5.3 OF THIS
DOCUMENT

SHUT OFF RCS DAP
SHUT OFF RCS DAP

WAIT ABOUT \( \frac{1}{4} \) SECONDS
WAIT ABOUT \( \frac{1}{4} \) SECONDS

TURN ON TVC DAP
TURN ON TVC DAP

WAIT ABOUT 1.6 SEC-
WAIT ABOUT 1.6 SEC-
ONDS

TURN OFF ALL
(CHANNEL 5)
RCS TRANS-
LATION

“3”

CALL CROSS PRO-
DUCT STEERING
ROUTINE AS DESCRIBED
IN SECTION 5.3
OF THIS DOCUMENT.
NOTE: IF AT ANY
TIME DURING THE
THROTTLING PERIOD
THE ROUTINE DETECTS
A “THROT FAILURE”
IT WILL CEASE
STEERING (RATE COM-
MAND SET TO ZERO),
WILL STOP CALCULAT-
ING TIME FROM CUTOFF
AND WILL DISABLE
C.G. TRACKING. IT
WILL TURN ON THE
SPS THRUST FAIL
ROUTINE (R40).
IN THE EVENT THIS
ROUTINE DETECTS VG
INCREASING IT WILL
TURN ON PROGRAM

ONDS

TURN OFF ALL
(CHANNEL 5)
RCS TRANS-
LATION

“3”

CALL CROSS PRODUCT
STEERING ROUTINES
ALARM LIGHT AND STORE ALARM CODE 1407.

THRETH "THREAT" OK "FAILURE"

DO THE SPS THREAT FAIL ROUTINE (R40).

TEMP

HOLD CHANGE TFI DISPLAY TO TFC IN R1

MON - VGR 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

MONITOR SPS THRUSTING:
1. DSKY:
R1-TFC SHOULD BE DECREASING
R2-VG SHOULD BE DECREASING.

R3-Delta VM SHOULD INCREASE

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

3. SPS CHAMBER PRESSURE (PC) SHOULD BE NORMAL

--

Y   N
--

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

--

L   A
R   E
A   L
--

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 FTC
AT CURRENT
VALUE (WILL
NORMALY
SHOW +2
SECONDS)

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
RCS PROGRAM (P41)

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 ×-AXIS WERE ALIGNED TO THE THRUST VECTOR. THE CREW IS THEREBY GIVEN AN OPPORTUNITY TO PERFORM THE MANEUVER WITH:
   (A) THE PRESENT IMU ORIENTATION (NOT RECOMMENDED IF MIDDLE GIMBAL ANGLE IS GREATER THAN 45 DEGREES), IF THE IMU HAS NOT BEEN ALIGNED WITHIN THE LAST 3 HRS; REALIGNMENT IS DESIRABLE.
   (B) A NEW ORIENTATION ACHIEVED BY SELECTION OF P52.
(3) TO DO THE VEHICLE MANEUVER TO THE THRUSTING ATTITUDE.
(4) TO PROVIDE SUITABLE DISPLAYS FOR MANUAL EXECUTION OF THE THRUSTING MANEUVER.

ASSUMPTIONS:
(1) THE TARGET PARAMETERS HAVE BEEN CALCULATED AND STORED IN THE CMC BY PRIOR EXECUTION OF A PRE-THRUSTING PROGRAM.
(2) THE REQUIRED STEERING EQUATIONS ARE IDENTIFIED BY THE PRIOR PRETHRUST PROGRAM, WHICH EITHER SET OR RESET THE EXTERNAL DELTA V STEERING FLAG. FOR EXTERNAL DELTA V STEERING, Vg IS CALCULATED ONCE FOR THE SPECIFIED TIME OF IGNITION. THEREAFTER BOTH DURING THRUSTING AND UNTIL THE CREW NOTIFIES THE CMC THAT 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/ν45E 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 V1644 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**
**SELECTION**

**CREW PROG-
SELECTION**

---

DO ROO TO START RCS
PROGRAM (P41)
DISPLAY PROGRAM 41

---

KEY IN RCS PROGRAM
(P41)
V37E 41E

---

MONITOR O5KY:
OBSERVE DISPLAY OF
PROGRAM 41

---

SET CSTEER = 0.

---


---

DO IMU STATUS CHECK
ROUTINE (RO2)

---

DO IMU STATUS CHECK
ROUTINE (RO2)

---

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

N
Y

SET DOCKED
DEADBAND INTO
DOCKED DAP

SET MINIMUM
DEADBAND IN RCS DAP

RESET 3AXISFLG
DO ATTITUDE MANEUVER ROUTINE (R60)

**+**
**C1**
**TEMP**
**HOLD**

--- DISPLAY (NO FLASH) ---

**+**
**V06N35**
**+**
**R1 VGX(CONT)**
**+**
**R2 VGY(CONT)**
**+**
**R3 VGZ(CONT)**

**+**
**VGX(CONT), VGY(CONT)**
**+**
**VGZ(CONT) - COMPONENTS OF THE VG**
**+**
**VECTOR AT T I G R E**
**+**
**SOLVED A L O V G P R E S E N T**
**++**
**CSM X, Y, AND Z CONTROL AXES RESPECTIVELY, UPDATED W.R.T.**
**VEHICLE ATTITUDE**
**EVERY 1 SECOND IN**
**FPS TO NEAREST .1**
**FPS.**

--- SET TDEC=TIG-30 SEC ---

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

--- DO ATTITUDE MANEUVER ROUTINE (R60) ---

**+**
**MON**

--- MONITOR DSKY: ---

**+**
**OBSERVE NON-FLASHING VERB-NOUN**
**DISPLAY OF VG COMPONENTS.**

--- SELECT A/P AND MODE CONTROL AS DESIRED. ---
Completion of Routine 41.

WAIT UNTIL TFI = -35 SEC

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

WAIT UNTIL TFI = -30 SEC

RESET PREFERRED ORIENTATION FLAG

CALL AVERAGE G INTEGRATION AND V G UPDATE [IN- STANTANEOUS V G VECTOR].

#200

#210

#220

#230

#240
DISPLAY V16N85 NON-FLAShING AND DISPLAY THE VALUES OF VG IN CONTROL AXIS COMPUTED FOR THE PRESENT TIME (NOT TiG) UP-DATED EVERY TWO SECONDS.

WAIT UNTIL TF1 = ZERO

HOLD FLASh VERB-NOuN TO REQUEST RESPONSE AND NON -
V16N85 +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 PPS TO Monitor DSky: Observe DISPLAY OF VG IN CONTROL AXIS AT TF1 = 30 SEC. THE AVERAGE G ROUTINE IS TURNED ON. OBSERVE COMPUTER ACTIVITY LIGHT BLINKS ON EVERY 2 SECONDS DURING AVERAGE G.
NFAREST .1 FPS.

COMMAND MANUAL TRANSLATIONS AND ROTATIONS TO NULL VG COMPONENTS

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED

PRO

TRANSMIT ORBITAL DATA TO CREW

RECEIVE ORBITAL DATA FROM GROUND

DO ROUTINE ROO

DO ROUTINE ROO

EXIT P41

EXIT P41

CHANGE CONTROL NOTES

RFV 00 PCR 011, 043
RFV 01 PCR 489
THrust 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 normally used during rendezvous final phase. If the crew desired to do any final phase thrusting maneuvers automatically under GNCS control they must be accomplished via selection of the TP1 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, H00, and H may be called by keying in V16N62E.
7. The orbital parameters display routine may be called during this program by keying in V82E.
8. This program should be turned on just prior to the planned thrusting maneuver and terminated as soon as possible following the maneuver in order to keep IMU compensation and average G computation errors at a minimum.
9. This program is selected by the astronaut by DSKY entry.

<table>
<thead>
<tr>
<th>Prog Cont</th>
<th>CMC</th>
<th>Ground</th>
<th>Crew</th>
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<tbody>
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<tr>
<td>Do R00 to Start</td>
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<td>Thrust Monitor</td>
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<tr>
<td>Program (P47)</td>
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<tr>
<td>Display P47.</td>
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KEY IN THRUST MONITOR PROGRAM (P37)
V37E47E

#10

P47/SKYLARK
MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 47.

DO IMU STATUS CHECK ROUTINE (R02)

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

CALL AVERAGE G ROUTINE.

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.

NOTE 1: R1, R2, AND R3 WILL READ 00000 INITIALLY AND WILL REMAIN SC (EXCEPT FOR ACCELEROMETER BIASES) UNTIL A THRUSTING MANEUVER IS STARTED. THEY WILL BE UPDATED EVERY 2 SEC.

NOTE 2: 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
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-GNC'S 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 NORMAL TO REQUIRE 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 R27 WITH V05E.
(5) THE ORBIT PARAMETER DISPLAY ROUTINE MAY BE CALLED DURING THIS PROGRAM BY KEYING IN V02E.
(6) THIS PROGRAM IS USUALLY 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 TO KEEP IMPACT COMPENSATION AT A MINIMUM.
(8) +X OR -X TRANSLATION IS ASSUMED TO OCCUR ONLY ALONG THE LINE-OF-SIGHT TO THE DWS.
(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 MINKEY CONTROLLER (ROT).
DO ROO TO START RENDEZVOUS THRUST MONITOR PROGRAM (P48).
DISPLAY P48.

KEY IN RENDEZVOUS THRUST MONITOR PROGRAM (P48).
V37E48E

MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 48.

RESET RENDEZVOUS FLAG

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

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)

DO IMU STATUS CHECK ROUTINE (R02)

290
DO STATE VECTOR INTEGRATION MID TO AVE ROUTINE (R41).

---

CALCULATE TFD FOR POSSIBLE DISPLAY IN N76.

---

CALL AVERAGE-G ROUTINE

---

IS CYCLEFLAG 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.

---

#60

---

#70

---

#80

---

#90

---

#100

---

291
IS NOUN 72 ZERO?

NO

YES

POSS

MON

REINITIALIZE ACCELEROMETER INTEGRATION

IS NOUN 72 ZERO?

YES

NO

FLASH VERB-NOUN TO REQUEST RESPONSE AND MONITOR DSKY:

DISPLAY RECONVIEOUS PARAMETERS:

- V16 N76
- R1 - RANGE
- R2 - RANGE RATE
- R3 - TPO

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: FOR -01835 < TPO < +01835
- RANGE, RANGE RATE
<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>DO I WANT TO ALTER THE PRESENT N72 TIME?</td>
</tr>
<tr>
<td>00</td>
<td>NO YES</td>
</tr>
<tr>
<td>409</td>
<td>WAIT FOR KEYBOARD ENTRY</td>
</tr>
<tr>
<td>01</td>
<td>WHEN FINISHED WITH DISPLAY KEY IN PROCEED</td>
</tr>
<tr>
<td>409</td>
<td>KEY IN V25N72E AND LOAD DESIRED N72 TIME.</td>
</tr>
<tr>
<td>01</td>
<td>TERMINATE FLASH UPON RECEIPT OF RECYCLE OR PROCEED</td>
</tr>
<tr>
<td>01</td>
<td>WHEN FINISHED WITH DISPLAY KEY IN RECYCLE V25E</td>
</tr>
<tr>
<td>01</td>
<td>P48/SKYLARK</td>
</tr>
<tr>
<td>010</td>
<td>P48/SKYLARK</td>
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<tr>
<td>012</td>
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<td>P48/SKYLARK</td>
</tr>
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<td>0150</td>
<td>P48/SKYLARK</td>
</tr>
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<td>0180</td>
<td>P48/SKYLARK</td>
</tr>
<tr>
<td>0190</td>
<td>P48/SKYLARK</td>
</tr>
<tr>
<td>0200</td>
<td>P48/SKYLARK</td>
</tr>
</tbody>
</table>
HOLD

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY RENDEZVOUS
PARAMETERS:
V16 N77
R1 - RANGE
R2 - RANGE RATE
R3 - THETA

RANGE = VHF RANGE
TO SKYLAB IN NAUTI-
CAL MILES TO
NEAREST .01 NM.

RANGE RATE = RANGE
RATE BETWEEN CSM AND
SKYLAB CALCULATED
AND OPTIMIZED TO
NT2 TIME IF IN
OPTIMIZATION OPTION
BY VHF RANGE RATE
FILTER, IN FPS TO
NEAREST .1 FPS
NEGATIVE SIGN INDICATES CLOSING.

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

MONITOR SKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF RANGE, RATE, AND THETA.
NOTE: RANGE RATE
OPTIMIZATION IS DIS-
CUSSED IN G5OP
SECTION 5, R27.

#210

#220

#230

#240

#250
RANGE RATE AND THETA ARE CURRENT VALUES.
IF N27 NOT 3:
  +01
    TFO < -01B35 RANGE,
    RANGE RATE ARE CURRENT VALUES;
    -01B35 < TFO <
    +00B00 RANGE,
    RANGE RATE FIXED AT LAST CURRENT
    VALUE;
    +00B00 < TFO <
    +01B35 RANGE,
    RANGE RATE ARE OPTIMIZING VALUES;
  459
  **
    TFO < -00B20;
    THETA IS CURRENT VALUE;
    -00B20 < TFO <
    +00B02; THETA =
    -000001
    TFO > +00B02;
    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

**
TERMINATE FLASH UPON RECEIPT OF RECYCLE OR PROCEED

WHEN FINISHED WITH DISPLAY KEY IN RECYCLE V32E

HOLD FLASH VERB-NOUM TO:

MON

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

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

DELTA V(CONTI)-COMPONENT OF INTEGRATED ACCELERATION ALONG CSM CONTROL +X AXIS. IN FPS TO NEAREST +1 FPS.

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

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

NOTE: R1, R2, AND R3 WILL READ 00000 INITIALLY AND WILL REMAIN 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 (A14) 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 YBB. 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.
SET P50.1FLG

---

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

Y . . .
N
(00002) (00003)

---

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

---

GO TO
"A"
BELOW

---

DO IMU STATUS CHECK
ROUTINE (R02).

---

SFT CELESTIAL RODY
CODE = 46 (UCTAL)

---

DO SIGHTING MARK
ROUTINE (R93).
CALCULATE LOS VECTOR TO SUN AT MARK TIME IN BASIC REFERENCE COORDINATES.

**01**

- **IS CELESTIAL BODY CODE 00?**
  - **N**
  - **Y**

- **WAS CELESTIAL BODY CODE 00 SELECTED?**
  - **Y**
  - **N**

- **IS THE CELESTIAL BODY CODE 46 OR 47?**
  - **N**
  - **Y**

- **IT IS ASSUMED THAT THE ASTRONAUT WILL NEVER SELECT CODES 46 OR 47 FOR STAR TRACKER**
  - **N**
  - **Y**

- **OBTAIN STAR VECTOR FROM STORED EPHEMERIS**
  - **N**
  - **Y**

- **CALCULATE CELESTIAL BODY VECTOR FOR THE BODY DEFINED BY THE STAR CODE**
  - **N**
  - **Y**
COS

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

VO6N8B
R1-X PL
R2-Y PL
R3-Z PL

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

Y PL - SAME AS X PL FOR Y COMPONENT.

Z PL - SAME AS X PL FOR Z COMPONENT.

WAIT FOR KEYBOARD ENTRY

MONITOR DSKY:

OBSERVE VERB-NOUN RESPONSE AND DISPLAY OF PLANET POSITION VECTOR.

ARE THE POSITION VECTOR COMPONENTS CORRECT?

KEY IN PROCEED
TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW
DATA.

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

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

IS STORED ORIENTA-
TION DETERMINATION
TECHNIQUE CODE
00001?
P50.1FLG SET?
Y  N.
(30002)

KEY IN V25E AND
LOAD CORRECT
POSITION VECTOR
COMPONENTS

#250

#260

#270

#280

#290
CALCULATE NEW Y AXIS OF ATM USING NEW Z AXIS, STAR TRACKER MARK DATA, AND LOS VECTOR TO CELESTIAL BODY

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

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

MONITOR SKY: OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY
V06 N23
R1 - ALPHA ATM
R2 - BETA ATM
R3 - GAMMA ATM

R1 - ALPHA ATM
R2 - BETA ATM
R3 - GAMMA ATM
ARE THE DOCKING
ANGLES WHICH SPECIFY
THE ATM AXES ORIEN-
TATION WITH RESPECT
TO THE NAV BASE.
EACH IN DEGREES TO
THE NEAREST .01 DEG.
(SEE SECTION 5.8 OF
R693).

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

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
CHANGE CONTROL NOTES

REV 00  PCR 413,434
REV 01  PCN 489
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 RESTRAINTS UPON THE CSM ATTITUDE CONTROL MODES IN THIS PROGRAM.

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

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

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

(6) ANY PROPORTIONAL SET OF COMPONENTS MAY BE LOADED INTO #88. HOWEVER, UNIT VECTORS ARE RECOMMENDED.

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

---

PROG CONT CMC GROUND CREW

*CHEW PROG
*SELECTION
* *

---

DO WCO TO START IMU
ORIENTATION DETERMI-
NATION PROGRAM (P51)
DISPLAY PROGRAM 51

---

KEY IN IMU
ORIENTATION DETERMI-
NATION PROGRAM (P51)
VITE SIE
HOLD  FLASH VERB-NOUN TO  MONITOR DSKY:
SNAP  REQUEST PLEASE PER-
      FORM CELESTIAL BODY
      ACQUISITION:
       V50 N25
       R1 = 0015
       R2 = BLANK
       R3 = BLANK

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

Y Y

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

ARE 2 CELESTIAL
BODIES VISIBLE IN
THE SGT 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 SCA

MONITOR FCAI BALL IS GIMBAL LOCK IMPENDING?

Y N

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

Y N

WAIT FOR KEYBOARD ENTRY

KEY IN ENTER

TERMINATE FLASH UPON RECEIPT OF PROCEED OR ENTER

KEY IN PROCEED

P E
R N
POSS TEMP
HOLD SNAP

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

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

RESET REF3MMAT
FLAG

COMMAND ISS TO
COARSE ALIGN
MODE

TURN ON "NO ATT"
LIGHT

OBSERVE "NO ATT"
LIGHT ON

COARSE ALIGN ISS

TERIVATE COARSE
ALIGN MODE IN
ISS, RESUME ATTITUDE HOLD OF VEHICLE

TURN OFF "NO ATT" LIGHT

WAIT FOR "NO ATT" LIGHT OFF

GO TO "C" ABOVE

GO TO "C" ABOVE

DO SIGHTING MARK ROUTINE (R53) FOR CELESTIAL BODY #1

DO SIGHTING MARK ROUTINE (R53) FOR CELESTIAL BODY #1. SXT IS PREFERABLE TO SCT FOR CSM OPTICS MARKS.

IS CELESTIAL BODY CODE 00?

IS THE TARGET A STAR OR THE EARTH OR SUN?

IS THE CELESTIAL BODY CODE 46 OR
OBTAIN STAR VECTOR FROM STORED EPSHEMERALS

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

PCSS

HOLD

SNAP

FLASH VERB-

NJUV TO RE-

QUEST RESPONSE AND DISPLAY PLANET POSITION VECTOR:

VO6N8N

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.

TIJ THE FIFTH PLACE

MONITOR SKY:

OBSERVE VERB-NJUN FLASH TO REQUEST RESPONSE AND DISPLAY OF PLANET POSITION VECTOR.

Y  N
T XXXX.
Y PL = SAME AS
X PL FOR Y
CAMPMENT.
Z PL = SAME AS
X PL FOR Z
CAMPMENT.

WAIT FOR KEY-
ENTRY

TERMINATE
FLASH UPON
RECEIPT OF
PROCEED UR NEW
DATA.

P NEW
R NATA
C
E
D NAW

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

KEY IN
PROCEED

KEY IN V25E AND
LOAD CORRECT
POSITION VECTOR
COMPONENTS

#320
#330
#340
#350
#360
DO SIGHTING MARK ROUTINE (R53) FOR CELESTIAL BODY #2

IS CELESTIAL BODY COJE 00?

N Y

IS THE CELESTIAL BODY COJE 46 OR 47?

N Y

OBTAIN STAR VECTOR FROM STORED EPHEMERIS

CALCULATE CELESTIAL BODY VECTOR FOR THE BODY DEFINED BY THE STAR CODE.
CELESTIAL COORDINATES AS DEFINED BY CELESTIAL BODIES #1 AND #2, STORE AS PRESENT PLATFORM ORIENTATION (REFS-MMAT)

SET REFS-MMAT FLAG

DO ROUTINE R00

... EXIT P51

CHANGE CONTROL NOTES

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

#510

#520

#530
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 sextant, the Att Sun sensor, or the Att 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

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

WHERE:
- \( R \) = The geocentric radius vector at time TiALIGN
- Selected by the Astronaut
- \( V \) = The inertial velocity vector at time TiALIGN selected by the Astronaut.

(C) Refsmat
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.

\[
\begin{align*}
X & = \text{UNIT}(COS45 \times Y \times SIN45) \text{ before the maneuver (after maneuver if } \text{COS(45) } g_{Y} < 0) \\
& = -SM -SM -SM \\
& \text{LV} \\
X & = \text{UNIT}(COS45 \times Y \times SIN45) \text{ after the maneuver (before maneuver if } \text{COS(45) } g_{Y} < 0) \\
& = -SM -SM -SM \\
Y & = \text{UNIT}(Z \times X) \\
& = -SM -SM -SM \\
Z & = Z \\
& = -SM -SM -SM \\
\end{align*}
\]

WHERE: Subscript 'o' refers to the orientation existing before the alignment.

ASSUMPTIONS: (1) The configuration may be SIVB/GSM, SKYLAB/GSM, or GSM. 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 GRYO TORQUING OPTION (ENTER ON V50N25, R1=13 OR PRO ON V50N25, R1=20) OR THE GYRO TRIM PORTION OF COARSE ALIGN ROUTINE (R90), THE DAP WILL MANEUVER THE VEHICLE TO FOLLOW THE PLATFORM.

(3) THIS PROGRAM MAKES NO PROVISION FOR AN ATTITUDE MANEUVER TO RETURN THE VEHICLE TO A SPECIFIC ATTITUDE. SUCH A MANEUVER IF DESIRED MUST BE DONE MANUALLY. AN OPTION IS PROVIDED HOWEVER TO POINT THE 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>
</tr>
</thead>
<tbody>
<tr>
<td>.AUTOMATIC</td>
<td>.CREW PROG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.PROGRAM</td>
<td>.SELECTION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.SELECTION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>***</td>
<td>**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>--DO ROO TO START IMU--</td>
<td>KEY IN IMU REALIGN PROGRAM (P52)</td>
<td></td>
<td></td>
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<tr>
<td>REALIGN PROGRAM (P52)</td>
<td>PROGRAM (P52)</td>
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</tr>
<tr>
<td>DISPLAY PROGRAM 52</td>
<td>V37E 52E</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

#10

---

#20
DO IMU STATUS CHECK ROUTINE (R02)

IS AUTOSEQ FLAG SET?

Y

N

IS UFLAG SET AND IS P20 OPTION=2?

Y

N

SET TRACK FLAG

COMPUTE PLANE

CHANGE ORIENT-

ATION FOR GIMBAL

ANGLE COMPUTATION

(NOTE: AT THIS

TIME ANY PREFERRED

ORIENTATION

STORED IN THE

CMC IS LOST).

SET PREFERRED ORIENTATION FLAG
GO TO "A" BELOW

IS PREFERRED ORIENTATION FLAG SET?
  Y   N

SET OPTION CODE
  IN R2 BELOW =00001

SET OPTION CODE
  IN R2 BELOW =00003.
RI - TALIGN - HRS
R2 - TALIGN - MINS
R3 - TALIGN - SECS

TALIGN - TIME (GET)
AT WHICH VEHICLE
POSITION AND VELO-
CY CITY VECTORS ARE SE-
LECTED TO DEFINE IMU
AND CSM NOMINAL ORI-
ENTATION. IN HRS,
MINS AND SECS TO
NFAREST .31 SEC.

JF TALIGN.

TALIGN WILL APPEAR
HERE AS 00000,
03000, 00000, WHICH
IF ACCEPTED WILL
INDICATE THAT THE
NOMINAL ORIENTATION
WILL BE DEFINED FOR
A TALIGN AUTOMATI-
CALLY SELECTED AS
THE PRESENT TIME.

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

Y  N

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

NEW DATA
NEW DATA
NEW DATA
NEW DATA

KEY IN

PROCEED

KEY IN V23E

AND LOAD

THE DESIRED

TALIGN IN

R1, R2, AND
R3.
IS T(ALIGN) DEFINED TO BE = 0?

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
R2-1G PITCH
R3-MG YAW

ALL GIMBAL ANGLES IN
DEGREES TO NEAREST
.01 DEGREE

AFTER PROPOSED GSM/
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?

.Y

MANEUVER VEHICLE WITH
HOLD

+01

SNAP

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

+489

V80N25
RI-00J013
RZ-BLANK
R3-BLANK

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

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

#580

#590

#600

#610

#620
PRECISE ALIGNMENT, AND ISSUE THESE PULSES. THIS ALTERNATE METHOD INTRO- DUCES A PREDICTABLE ERROR INTO THE CMC'S KNOWLEDGE OF THE STABLE MEMBER ORIENT- TATION AND TAKES A PREDICTABLE PERIOD OF TIME FOR COMPLE- TION. 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

TERMINATE FLASH UPON RECEIPT OF PROCEED OR ENTER

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

P  ENTER
R
D
C "0"
E
D

-------------- COMPUTE TORQUING ANGLES REQUIRED

--------------
TO ACHIEVE NEW ORIENTATION.

RESET REFSSMAT FLAG

PULSE IRIG'S THROUGH TORQUING ANGLES AND DISPLAY PRESENT ICDO ANGLES UNTIL COMPLETION.

TEMP HND V16N20 R1-OG ROLL R2-OG PITCH R3-OG YAW

ALL GIMBAL ANGLES IN DEGREES TO NEAREST .01 DEGREES.

STORE THE DESIRED IMU ORIENTATION IN REFSSMAT AND SET REFSSMAT FLAG

GO TO "C" BELOW

MONITOR DSKY: OBSERVE VERB-NOJN DISPLAY OF PRESENT GIMBAL ANGLES UNTIL COMPLETION OF PULSE TORQUING

NOTE 1: IT IS NOT NECESSARY TO MAINTAIN A FIXED INERTIAL ORIENTATION OF SPACECRAFT 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)
MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
CELESTIAL BODY
ACQUISITION:
NOTE: THE CMC WILL
ATTEMPT TO SELECT
TWO CELESTIAL BODIES
SUITABLE FOR SIGHT-
ING BY USE OF THE
OPTICS. IF THE
OPTICS ARE NOT BEING
USED THE ROUTINE MAY
HAVE NO VALUE.

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

WAIT FOR KEYBOARD
ENTRY

KEY IN ENTER

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

TERMINATE FLASH UPON
RECEIPT OF ENTER OR
PROCEED

ENTER  PROCEED

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

TWO  TWO
STARS  STARS
AVAILABLE, NOT
AVAILABLE

PCSS
HOLD
SNAP

FLASH VERB-NOUN
TO REQUEST RES-
PONSE AND DIS-
PLAY ALARM CODE:
V05N09
R1
R2
R3
EXPECTED ALARM
CODE AT THIS
TIME IS 405

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

Y    N

SHALL I BYPASS
STAR SELECTION
SELECT STAR #1 FOR USE BY AUTO OPTICS
POSITIONING ROUTINE (R52)

+01

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

VOLNO
R1=OQCODE
R2=BLANK
R3=BLANK
R1=C=SOURCE OF SIGHTING DATA
D=GS4 OPTICS
D=SXT/SCT
1=ATM SUN SENSOR
2=ATM STAR
TRACKER

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

#920
#930
#940
#950
DE=CELESTIAL BODY CODE

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

IS CODE SATISFACTORY?

WAIT FOR KEYBOARD ENTRY

Y N

KEY IN Z21E AND CHANGE CODE

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

KEY IN PROCEED

NEW DATA

STORE NEW DATA

NEW P

NEW R

NEW C

NEW E

NEW D
POSITION VECTOR:
V05 NBB
R1-X PL
R2-Y PL
R3-Z PL

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

Y PL - SAME AS X PL FOR Y COMPONENT.

Z PL - SAME AS X PL FOR Z COMPONENT.

WAIT FOR KEYBOARD ENTRY

TERMINATE
FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

P NEW DATA
R DATA
C
E STORE NEW DATA

KEY IN V25E AND LOAD CORRECT POSITION VECTOR COMPONENTS

KEY IN PROCEED
OBTAIN STAR VECTOR FROM STORED Ephemeris

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

POS
SNAP

FLASH VERB- NJUN TO REQUEST RESPONSE AND DISPLAY PLANET POSITION VECTOR:
V06498 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).

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

ARE THE POSITION VECTOR COMPONENTS CORRECT?

Y N

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED OR ENTER

DO ROUTINE ROO
CHANGE CONTROL NOTES

REV 00  PCR 013, 040, 043, 415, 416, 424, PCN 410, 436, 457
REV 01  PCN 489
**Backup IMU Orientation Determination Program (P53)**

**Purpose:**
1. To determine the inertial orientation of the IMU using a backup optical device, the ATM sun sensor, or the ATM star tracker.

**Assumptions:**
1. The IMU may be:
   
   (A) Off (Standby)
   
   (B) On, and aligned or not aligned since turn on.

   If (A) is true, the IMU must be turned on before this program can be performed.
   
   If (B) is true this program can be completed.

2. The program and its routines have the same display sequence as P51 except that RP6 is called in place of RP3.

3. The CSM attitude control mode selected is at the option of the crew.

4. Time and RCS fuel may be saved, and subsequent IMU alignment decisions greatly simplified if this program is performed in such a way as to leave the IMU inertially stabilized at an orientation as close as possible to the optimum orientation required by future CMC programs.

5. If ATM sun sensor is used as source of sighting data, CSM must be docked to orbital assembly, ATM must be in solar inertial attitude, and ATM orientation with respect to NAV base must be known.

6. If ATM star tracker is used as source of sighting data, CSM must be docked to orbital assembly, and ATM orientation with respect to NAV base must be known.

7. The program is selected by the astronaut by osky entry.

<table>
<thead>
<tr>
<th>Prog</th>
<th>CMC</th>
<th>Ground</th>
<th>Crew</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cont</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Do RUD to Start
Backup IMU Orientation Determination Program (P53)
Display Program 53

---

Key in Backup IMU Orientation Determination Program (P53)
V37E 53E
MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 53

IS ISS JN?

Y  N

TURN ON PROGRAM ALARM 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 P53 VIA ROO.

DO ROUTINE ROO

DO ROUTINE ROO

EXIT P53

EXIT P53

356 P53/SKYLARK
HOLD

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

MONITOR OSKY:
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?

N
Y

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

SHALL I MANEUVER THE CSM TO ACQUIRE A CELESTIAL BODY?

N
Y
WITH THE ROTATIONAL HAND CONTROLLER ORIENT THE CSM

MONITOR FCAI 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
O T
POSS
TEMP
HOLD
SNAP

DISPLAY ON DSKY:
V=1 W=2
R1=00000
R2=00000
R3=00000

WHERE R1, R2,
AND R3 REPRESENT
COORDINATE ANGLES
TO BE COARSE
ALIGNED TO (DG,
IG, MG, RESPECTI-
VELY).

RESET REFSMAT
FLAG.

COMMAND ISS TO
COARSE ALIGN
MODE

TURN ON "NO ATT"
LIGHT

OBSERVE "NO ATT"
LIGHT ON

COARSE ALIGN ISS

TERMINATE COARSE
ALIGN MODE IN

MONITOR DSKY:
OBSERVE DISPLAY
OF COARSE ALIGN
VERB AND ICDO
ANGLES (ALL
00000) FOR COARSE
ALIGNMENT
ISS. RESUME ATTITUDE HOLD OF VEHICLE.

TURN OFF "NO ATT" LIGHT

WAIT FOR "NO ATT" LIGHT OFF

++

+01

+

+409

++

DO ALTERNATE LOS SIGHTING MARK ROUTINE (RS6) FOR CELESTIAL BODY #1

DO ALTERNATE LOS SIGHTING MARK ROUTINE (RS6) FOR CELESTIAL BODY #1

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

DO ALTERNATE LOS SIGHTING MARK ROUTINE (RS6) FOR CELESTIAL BODY #2

DO ALTERNATE LOS SIGHTING MARK ROUTINE (RS6) FOR CELESTIAL BODY #2
<table>
<thead>
<tr>
<th>CALCULATE CELESTIAL BODY #2 VECTOR W.R.T. IMU</th>
</tr>
</thead>
<tbody>
<tr>
<td>DO SIGHTING DATA DISPLAY ROUTINE (R54)</td>
</tr>
<tr>
<td>E     E</td>
</tr>
<tr>
<td>X     X</td>
</tr>
<tr>
<td>T     T</td>
</tr>
<tr>
<td>&quot;A&quot;   &quot;B&quot;</td>
</tr>
<tr>
<td>CALCULATE IMU INERTIAL ORIENTATION W.R.T. CELESTIAL COORDINATES AS DEFINED BY CELESTIAL BODIES #1 AND #2. STORE AS PRESENT PLATFORM ORIENTATION (REFSMAT)</td>
</tr>
<tr>
<td>SET REFSMAT FLAG</td>
</tr>
<tr>
<td>DO ROUTINE R00</td>
</tr>
<tr>
<td>DO ROUTINE R00</td>
</tr>
</tbody>
</table>
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
\[
\begin{align*}
X &= \text{UNIT}(X, Y, Z) \\
-3m &= -3m -3m \\
Y &= \text{UNIT}(X, Y, Z) \\
-3m &= -3m -3m \\
Z &= \text{UNIT}(-R) \\
-3m &= -3m -3m
\end{align*}
\]
WHERE:
R = THE GEOCENTRIC RADIUS VECTOR AT TIME T (ALIGN) SELECTED BY THE ASTRONAUT
V = THE INERTIAL VELOCITY VECTOR AT TIME T (ALIGN) SELECTED BY THE ASTRONAUT.

(C) REFSMMAT
SEE ASSUMPTION 4.

ASSUMPTIONS: (1) THE DOKED 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 CCC AND THE MODE SWITCH IS IN ATTITUDE HOLD OR AUTO DURING THE GYRO TORQUING ROUTINE (R55) OR THE GYRO TORQUING OPTION (ENTER ON V50N25, R1=13), OR THE GYRO TRIM POSITION OF COARSE ALIGN ROUTINE (R55), 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.

(4) THE ISS IS ON AND HAS BEEN ALIGN TO A KNOWN ORIENTATION WHICH IS STORED IN THE CMC (REFSMMAT). 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 DOKED 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 DOKED 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 NBB. HOWEVER, UNIT VECTORS ARE RECOMMENDED.

(8) 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>
</tr>
</thead>
<tbody>
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<td>CONT</td>
<td></td>
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</tr>
</tbody>
</table>

---

DO ROO TO START
BACKUP IMU REALIGN
PROGRAM (P54)
DISPLAY PROGRAM 54

START BACKUP IMU RE-
ALIGN PROGRAM (P54)
V37E 54E

---

MONITOR OSKY:
OBSERVE DISPLAY OF
PROGRAM 54

---

DO IMU STATUS CHECK
ROUTINE (R02)

DO IMU STATUS CHECK
ROUTINE (R02)

---

IS UFLAG SET AND IS
P20 OPTION = 2?

NO. .YES

---

SET TRACK
FLAG

---

364
IS PREFERRED ORIENTATION FLAG SET?

* Y 
* N

SET OPTION CODE IN R2 BELOW = 00001.

SET OPTION CODE IN R2 BELOW = 00003

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY OPTION CODE FOR ASSUMED IMU ORIENTATION SELECTION:

R1-00001
R2-0000X
R3-BLANK

R1 IS THE OPTION CODE FOR ASSUMED IMU ORIENTATION

MONITOR SKY:

OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF OPTION CODE FOR ASSUMED IMU ORIENTATION SELECTION
ORIENTATION FOR GIMBAL ANGLE COMPUTATION

GO TO "A" BELOW

IS STORED ORIENTATION CODE 00002?

Y (NGM) N (REF)

***

GO TO "B" BELOW

STORE 00000, 00000, 00000 FOR DISPLAY AS T (ALIGN)

POSS HOLD SNAP

FLASH VERB-NOUIND REQUEST RESPONSE AND DISPLAY T (ALIGN):

MONITOR DSKY:

OBSERVE VERB-NOUIND FLASH TO REQUEST RESPONSE AND DISPLAY OF T (ALIGN).
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
0000, WHICH IF AC-
CEPTED WILL INDICATE
THAT THE NOMINAL
ORIENTATION WILL BE
DEFINED FOR A
T (ALIGN) AUTOMA-
TICALLY SELECTED AS
THE PRESENT TIME

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

Y    N

WAIT FOR KEYBOARD
ENTRY

KEY IN

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

P  NEW
R  DATA
O  
E  
E  STORE
D  NEW
        DATA

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

DEFINE T(A)ALIGN) = T PRESENT

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

COMPUTE NOMINAL ORIENTATION FOR THE PREVIOUSLY DEFINED T(A)ALIGN). SELECT THIS ORIENTATION FOR GIMBAL ANGLES COMPUTATION.

(NOTE: AT THIS TIME ANY PREFERRED ORIENTATION STORED IN THE CMC IS LOST).
READ VEHICLE ATTITUDE FROM GIMBAL ANGLES

COMPUTE GIMBAL ANGLES AT SELECTED IMU ORIENTATION AND PRESENT VEHICLE ATTITUDE

++
POS HLD
++
V06 NZ2
++
R1-0G ROLL
++
R2-1G PITCH
++
R3-MG YAW

ALL GIMBAL ANGLES IN
DEGREES TO NEAREST .01 DEGREE

IS MIDDLE GIMBAL ANGLE SATISFACTORY?

Y  N

BY SUITABLE MODE SELECTION ENSURE THAT VEHICLE IS AS INERTIALLY STABLE AS POSSIBLE TO 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?

N  Y

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

.*R*P*NEW*E*PROG*C*Q*C*E
.*L*E GO TO .E*E*SELECTED

++01 POSS HOLD

FLASH VERB-NOUN TO SNAP REQUEST PLEASE PERFORM +489 FORM NORMAL OR GYRO TORQUE COARSE ALIGN:

V50N25 R1-00013 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 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 .002 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 . ENTER
. R .
. D .
. E .
. E .
. D .

--- COMPUTE TORQUING
ANGLES REQUIRED
TO ACHIEVE NEW
ORIENTATION ---

---

RESET REFSMAT
FLAG

---

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

---

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

VLG 920
R1-0G ROLL
R2-IG PITCH
R3-0G YAW

ALL Gimbal ANGLES
IN DEGREES TO
NEAREST .01
DEGREES:

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

STORE THE DESIRED
IMU ORIENTATION
IN REFMSMAT
AND SET REFMSMATION
FLAG

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

GO TO
"CH"
BELOW

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

SELECT FINAL DESIRED
IMU ORIENTATION FROM
STORAGE FOR USE BY
THE COARSE ALIGN
ROUTINE (RS0)

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

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.

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

#530

#540

#550

#560

#570
SECTION 5.6 OF R6931.

---

TWO STARS AVAILABLE

---

POSS

---

HOLD

---

FLASH VERB-NO UN-OD

---

SNAP

---

REQUEST RES-

---

PONE AND DIS-

---

PLAY ALARM CODE:

---

VOSNO9

---

R1-

---

R2-

---

R3-

---

EXPECTED ALARM

---

CODE AT THIS

---

TIME IS 405

---

MONITOR OSKY:

---

DOES ALARM

---

CODE DISPLAY

---

INDICATE THAT TWO

---

STARS ARE NOT AVAIL-

---

ABLE IN THE 5XT

---

FIELD OF VIEW?

---

Y

---

N

---

SHALL I BYPASS

---

STAR SELECTION

---

ROUTINE AND

---

SELECT MY OWN

---

CELESTIAL

---

BODY?

---

Y

---

N

---

MANEUVER

---

VEHICLE UN- TIL A SUIT-

---

ABLE CELE-

---

STIAL BODY IS ACQUIRED

---

---

WAIT FOR KEY-

---

BOARD ENTRY

---

KEY IN PRO-

---

CEED
CODE
VJINTO
R1=QJODE
R2-BLANK
R3-BLANK
R1-G=SOURCE OF SIGHTING DATA
O-BACKUP OPTICAL DEVICE
1-ATM SUN SENSOR
2-ATM STAR TRACKER
DE=CELESTIAL BODY CODE

NOTE: NO DISPLAYS RESULTS OF SUCCESSFUL STAR SELECTION ROUTINE OTHERWISE CONTAINS RESIDUAL DATA.

WAIT FOR KEYBOARD ENTRY

SOURCE CODE AND CELESTIAL BODY CODE

IS CODE SATISFACTORY?

+Y +V

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
DATA
P
R
O
C
E
D
STORE NEW DATA

IS CELESTIAL BODY
CODE NEGATIVE?

Y
N
RESET PREFERRED ORIENTATION FLAG.

--

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

MONITOR SKY:
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.

N
Y

WAIT FOR KEYBOARD ENTRY
KEY IN
ENTER
ATM STAR TRACKER GIMBAL ANGLE PROGRAM (P55)       REV 01 03/20/72

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 (P50) 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 DROPPED TO THE ORBITAL ASSEMBLY.

(7) THE FORMAT OF N19 (OCTAL 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 USING ENTRY.

PRG CONT  C4C GROUND CREW

. CREW
. PROG
. SELECTION
.
...
...

DO YOU ID START ATM 
STAR TRACKER GIMBAL 
ANGLE PROGRAM (P55),
DISPLAY PROGRAM 55 

SET CMC ASSUMED
OPTION CODE IN R2
1BELOW] TO 00001

--

HOLD

SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY OPTION CODE
FOR ASSUMED INPUTS
TO PROGRAM:
V04 N06
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

--

MONITOR DSKY:
OBSERVE DISPLAY
OF PROGRAM 55

--

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF OPTION CODE FOR
ASSUMED INPUTS TO
PROGRAM

--

IS THIS THE SET OF
INPUTS THAT I DE-
SIRE?

--

Y

N
REFERENCE COORDINATES AT MARK TIME.

IS CELESTIAL BODY CODE 00?  
\nN \ Y

IS THE CELESTIAL BODY CODE 46 OR 47?  
\nN \ Y

OBTAIN STAR VECTOR FROM STORED EPHEMERIS

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

MONITOR DSKY: OBSERVE VERB-NOUN
RUNSE AND DISPLAY

FLASH VERB-NOUN TO REQUEST Flash to request
TRANSFORM VECTOR
FROM BASIC REFERENCE
COORDINATES TO ATU
SENSOR COORDINATES
IF OPTION CODE
0001 WAS SELECTED,
TRANSFORMATION USES
IMU ORIENTATION. IF
OPTION CODE 0002
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 CELE-
S 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 DSF: OBSERVE PROGRAM**

**ALARM LIGHT ON IF STAR TRACKER GIMBAL ANGLES NOT WITHIN PERMISSIBLE RANGE. KEY VD030093 TO VERIFY ALARM CODE 00107.**

---

**HOLD**

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY STAR TRACKER GIMBAL ANGLES:

- VD0 NL4
- R1-azimuth (PS1)
- 3
- R2-elevation (PS1)
- 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
- Y

---

**WAIT FOR KEYBOARD ENTRY**

KEY IN RECYCLE, VJ32E
TERMINATE FLASH UPON RECIPIENT OF PROCEED OR RECYCLE

---

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

---

**GO TO**
**"A"**
**ABOVE**

---

**GO TO**
**"A"**
**ABOVE**

---

**HOLD**
**FLASH VERB-NOUN TO**
**REQUEST RESPONSE AND**
**DISPLAY STAR TRACKER**
**AZIMUTH IN OCTAL:***
**VO4 N19**
**R1 OSABC**
**R2 QODEJ**

---

**OCTAL DISPLAY FOR**
**USE AS INPUT TO THE**
**ATM COMPUTER**

---

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

---

**ABCD= ABSOLUTE VALUE:**

---

**Y**

---

$\text{MONITOR DSKY:}$

---

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

---

**IS OCTAL AZIMUTH VALUE SATISFACTORY?**

---

$\text{N}$ $\text{Y}$

---
<table>
<thead>
<tr>
<th>Wait for Keyboard Entry</th>
<th>Key in Recycle, V32E</th>
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**Terminate Flash Upon Receipt of Proceed or Recycle**

- K
- E
- C
- Y
- L
- D
- E
- G
- "A"
- Above

---

**Do Routine ROO**

---

**Do Routine R02**

---

**Exit P55**

---

**Exit P55**
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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<thead>
<tr>
<th>PROG CONT</th>
<th>CNC</th>
<th>GROUND</th>
<th>CREW</th>
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<tr>
<td>DOE ROO TO START</td>
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<td></td>
<td>KEY IN ENTRY-PREPARATION PROGRAM (P61)</td>
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<tr>
<td>ENTRY-PREPARATION PROGRAM (P61)</td>
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<td></td>
<td>V37F 61E</td>
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<tr>
<td>DISPLAY PROGRAM 61</td>
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<th>PROG CONT</th>
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<tbody>
<tr>
<td>DOE IMU STATUS CHECK</td>
<td></td>
<td></td>
<td>MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 61</td>
</tr>
<tr>
<td>ROUTINE [R02]</td>
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<tr>
<td>Doe IMU STATUS CHECK ROUTINE [R02]</td>
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</table>

---

#10

---

#20
DO STATE VECTOR
INTEGRATION (MID TO
AVE) ROUTINE [R41]

CALL AVERAGE G
ROUTINE

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

N

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

N

POSS
TEMP
HOLD
SNAP

COMMAND PROGRAM
ALARM AND
DISPLAY
V05 NO9
R1-
R2-
R3-
EXPECTED ALARM
CODE AT THIS
TIME IS 0142?

DO STATE VECTOR
INTEGRATION (MID TO
AVE) ROUTINE [R41]

OBSERVE THAT THE
COMPUTER ACTIVITY
LIGHT IS ON UNTIL
COMPLETION OF ROU-
TINE 41.

ALARM LIGHT ON DSKY
AND DISPLAY OF ERROR
CODE [IMU RE-
VERSED, ZERO ROLL
ON FDAI BALL WILL
MEAN LIFT DOWN].
PCSS

TEMP

HOLD

SNAP

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

EXPECTED ALARM
CODE AT THIS
TIME IS 01426

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

WAIT 10 SEC

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

HOLD

SNAP

---------------
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STORED DATA
VO5 NO1
R1-IMPACT LAT
R2-IMPACT LONG
R3-HEADS UP/DOWN

IMPACT LAT - LATI-
ITUDE OF DESIRED
IMPACT POINT, IN
DEGREES TO NEAREST
.01 DEG. IS NORTH

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

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

OBSERVE PROGRAM
ALARM LIGHT ON DSKY
AND DISPLAY OF ERROR
CODE (1MU UNSATIS-
FACTORY)

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

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

---------------
G FOR FREE FALL AND
ENTRY AT NOMINAL
BANK ANGLE (L/D = .10) IN GS TO
NEAREST .1 G.

VPRED—PREDICTED
INERTIAL VELOCITY
AT 400,000 FT
ALTITUDE ABOVE
THE FISCHER
ELLIPSOID.
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 .1 DEG.

MINUS INDICATES
FLIGHT PATH IS BELOW
THE HORIZONTAL PLANE.

RECORD DATA IF
NECESSARY

P6L/SKYLARK
WAIT FOR KEYBOARD ENTRY
TERMINATE FLASH UPON RECEIPT OF PROCEED

MID
FLASH VERB-NUiN TO REQUEST RESPONSE AND DISPLAY:
V16 N63
R1 - RTGO
R2 - V10
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.
V10 - 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

MON
MONITOR DSKY:
OBSERVE VERB-NUiN TO REQUEST RESPONSE AND DISPLAY OF EMS INITIALIZATION PARAMETERS

AM I SATISFIED WITH THE VALUE FOR TFE?

Y

N

RECORD DATA FOR EMS INITIALIZATION

#230

#240

#250

#260

#270
AND SEC TO NEAREST
SEC, MAX READING IS
5959, ABOVE +
BELOW ALTITUDE.
TFE IS DECREMENTED
AT A 2 SECOND RATE,
CONTINUING UNTIL
0.05 IS SENSED.

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

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

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

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

MONITOR T/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 UNGS 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 SATISFIERTY ALIGNED FOR ENTRY.
(3) THE PROGRAM IS AUTOMATICALLY SELECTED BY THE ENTRY-PREPARATION PROGRAM (P61) OR IT MAY BE SELECTED MANUALLY.
(4) IN ADDITION TO THE AUTOMATIC DISPLAYS, THE ASTRONAUT MAY MONITOR NS3(RTOGO,VIO,TFE) BY KEYING IN V16N63E.

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<tr>
<th>PROG CONT</th>
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<td>CMC PROG</td>
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<tr>
<td>DD ROD (CREW PROG SELECTION ONLY - NO ROD FOR ENTRANCE FROM P61) TO START ENTRY-CM/SM SEPARATION AND PRE-ENTRY MANEUVER PROGRAM (P62), DISPLAY PROGRAM 62</td>
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<tr>
<td>MONITOR OSKYS OBSERVE DISPLAY OF PROGRAM 62</td>
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</table>

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#20
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?

Y N

IS UNIT (V X R)
WITHIN 30 DEG OF -Y 71-54
---------
-Y -N

POSS TEMP HCLD SNAP

---------

COMMAND PROGRAM ALARM AND DISPLAY
- Y5 N09
- R1-
- R2-
- R3-

EXPECTED ALARM CODE AT THIS TIME IS 01427

---------

POSS TEMP HCLD SNAP

---------

COMMAND PROGRAM ALARM AND DISPLAY
- V05 N09
- 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 HOLL ON FDAN BALL WILL MEAN LIFT DOWN.)

---------

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

---------

#80

#90

#100

#110

#120
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 CALCULATION EVERY TWO SECONDS UNTIL COMPLETION OF THIS PROGRAM. THESE GIMBAL ANGLES ARE STORED IN NOUN 22.

HOLD • FLASH VERB-NOUM

******** TO REQUEST PLEASE

SNAP • PERFORM CM/SM SEPARATION

V50 N25
R1 = 00341
R2 = BLANK
R3 = BLANK

MONITOR SKY:

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

CM/SM • CM/SM
NOT • SEPARATED
RATED

PRIOR TO COMMANDING CM/SM SEPARATION THE GNC AUTO PILOT SHOULD BE SWITCHED TO FREE MODE
T0 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 SEPARA-
TION DISTANCE AND
KEY IN PROCEED.
TURN ON ENTRY DAP
AND MAINTAIN ATTITUDE HOLD.

HOLD

SNAP

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY STORED DATA

VO6 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

HEADS UP/DOWN - DEFINES ENTRY ROLL ATTITUDE
*00001 FOR HEADS UP/
LIFT DOWN
-00001 FOR HEADS
DOWN/LIFT UP

AM I SATISFIED WITH THESE VALUES?

*Y  N

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

KEY IN V25E AND LOAD DESIRED
PARAMETERS

---

P: NEW
R: DATA
D: 
E: 
E: STORE DATA
D: 

---

ESTABLISH ATTITUDE
COMMANDS FOR ENTRY
DAP NECESSARY TO
GIVE CORRECT ANGLE
OF ATTACK INTO ATMOS-
HERE:
ROLL COMMAND —
BASED ON PREVIOUS
DEFINITION OF HEADS
UP/DOWN
ALPHA COMMAND —
TRIM ANGLE OF ATTACK
(TRIM ALPHA)
BETA COMMAND — ZERO
FOR LIFT DOWN
THIS ATTITUDE WILL
BE OBTAINED AFTER A
SIMPLE PITCH DOWN
MANEUVER FROM THE
SEPARATION ATTITUDE.
FOR LIFT UP AN ADDI-
TIONAL 180 DEGREES
OF ROLL IS REQUIRED.

---

TURN ON ENTRY DAP

---

#280
#290
#300
#310
#320
IS THE ANGLE ALPHA ALREADY WITHIN 45 DEGREES?

Y N

TEMP HOLD DISPLAY ON DSKY DESIRED FINAL GIMBAL ANGLES:
V06 V22
R1- JO ROLL
R2- JO PITCH
R3- JO 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.

MONITOR DSKY: OBSERVE TERMINATION OF P 62 AND DISPLAY OF P 63
ENTRY-INITIALIZATION PROGRAM (P63)

PURPOSE:
1. TO INITIALIZE THE ENTRY EQUATIONS.
2. TO CONTINUE TO HOLD THE CM TO THE CORRECT ATTITUDE WITH RESPECT TO THE ATMOSPHERE FOR THE ONSET OF ENTRY DECELERATION.
3. TO ESTABLISH ENTRY DSKY DISPLAYS.
4. TO SENSE .05G AND DISPLAY THIS EVENT TO THE CREW, BY SELECTING THE ENTRY-POST 0.05G PROGRAM (P64).

ASSUMPTIONS:
2. IN ADDITION TO N64(G,Y1,R TO GO) THE ASTRONAUT MAY MONITOR THE FOLLOWING NOUNS BY KEYING IN V16NXXE:
   N63 (RTOGU, VI0, TFE)
   N68 (BETA, VI, HDOU)
   N74 (BETA, VI, G)

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<thead>
<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
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<tr>
<td>CMCG</td>
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<tr>
<td>START ENTRY - INITIALIZATION PROGRAM (63)</td>
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<tr>
<td>DISPLAY PROGRAM 63</td>
<td>MONITOR DSKY:</td>
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<td>OBSERVE DISPLAY OF</td>
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<td>PROGRAM 63</td>
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<tr>
<td>PERFORM ENTRY INITIALIZATION</td>
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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 JOSG 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:

4DN R1-G

R2-VI
R3-R TO GO

MONITOR DSKY:

OBSERVE DISPLAY OF G, VI AND 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
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 PINT.

2. SELECT FINAL PHASE (P67) WHEN 0.2G OCCURS IF V HAS <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 OISKY 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 NOUS BY KEYING IN V16NXXE:
   N64 (G, VI, RT TO GO)
   N68 (BETA, VI, HDOT)

---

PROG CONT  CMC  GROUND  CREW

---

START ENTRY-POST 0.05 G PROGRAM (P 64)

---

DISPLAY PROGRAM 64      MONITOR OISKY: OBSERVE DISPLAY OF PROGRAM 64

---

#10

#20
TEMP HOLD

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

COMMAND CM ATTITUDE IN ACCORDANCE WITH CMC ENTRY LOGIC

SET 0.05 G ENTRY
SWITCH ON SCS
CONTROL PANEL TO ON

MONITOR G+N CONTROL OF ENTRY:

(A) FDAI:
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
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 DISPLAY P67

CHANGE CONTROL VOTES
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 ASTRONAUT IF THE BACKUP PROCEDURES SHOULD BE IMPLEMENTED.
3. TO SENSE EXIT (DRAG ACCELERATION LESS THAN 7 FPS) AND THEREUPON TO SELECT THE ENTRY - BALLISTIC PROGRAM (P66).
4. WHERE RDOT IS NEGATIVE AND THE V IS SUFFICIENTLY LOW (V-VL-C18 VE), PROGRAM WILL EXIT DIRECTLY TO P67 (FINAL PHASE).

ASSUMPTIONS:
1. THIS PROGRAM IS AUTOMATICALLY SELECTED BY THE ENTRY - P3ST 0.052 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 VISNX: N64 (G, VI, R TO GO) N68 (BETA, VI, RDOT)
3. MANUAL RESPONSE TO N69 IS NOT NECESSARY TO TERMINATE P65. SELECTION OF EITHER P66 OR P67 BY ENTRY GUIDANCE PROVIDES AUTOMATIC TERMINATION.

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

CMC CMC PROG SELECTION
GROUND START ENTRY - UP CONTROL PROGRAM (65)
CREW

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

DISPLAY PROGRAM 65

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

MONITOR DSKY: OBSERVE DISPLAY OF PROGRAM 65

---------------
HOLD

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
MON
DISPLAY PRE-COMPUTED
EXIT CONDITIONS
VL6 VL6
R1 - BETA
R2 - DL
R3 - VL

BETA - COMMANDED
BANK ANGLE IN DEG-
REES TO NEAREST 0.01
DEGREE

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

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

---

MOVITOR DSKY:

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

---

#30

#40

#50

#60

---

DO EITHER:
WAIT FOR KEYBOARD ENTRY
TERMINATE FLASH UPON RECEIPT OF PROCEED OR
FLASH IS AUTOMATICAETLY TERMINATED UPON RECEIPT OF
ENTRY GUIDANCE OF P66 OR P67.

---

P
R
O
C
E

---

432
NOTE: BACKUP PROCEDURES SHOULD BE IMPLEMENTED IF THIS DSky DISPLAY AND/OR EMS INDICATE DIVERGENCE FROM ACCEPTABLE OPERATIONAL ENVELOPE.

FOR A NOMINAL LUNAR MISSION ENTRY CMC WILL GO DIRECTLY TO P66 WHEN DRAG ACCELERATION FALLS BELOW EXIT (SKIP OUT) THRESHOLD OF Q7 FPS SQUARED.

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

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

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 OUT) PHASE FOR ATMOSPHERIC RE-ENTRY.
(2) TO SENSE RE-ENTRY (DRAG ACCELERATION BUILDS UP TO QTF + 0.5 FPS OR APPROX. 0.2G) AND THEREUPON 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 V16NXXE:
N64 (G, VI, R TO GO)
N68 (BETA, VI, HOOT)
N74 (BETA, VI, G)
ESTABLISH ATTITUDE
COMMANDS FOR ENTRY
DAP NECESSARY TO
GIVE CORRECT ANGLE
OF ATTACK INTO THE
ATMOSPHERE:
ROLL COMMAND-
MAINTAIN LAST
COMPUTED VALUE
FROM ENTRY
GUIDANCE UNLESS
ACCELERATION GOES
BELOW .05 G IN
WHICH CASE 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
4CLD - DISPLAY ON DSKY:
MON - THE DESIRED GIMBAL
ANGES TO WHICH THE
ENTRY DAP WILL ORI-
ENT THE CM

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

MONITOR GNC'S CONTROL
OF ENTRY:
V06* V22
R1-GS ROLL
R2-13 PITCH
R3-MG YAW

ALL COMMANDED GIMBAL
ANGLES IN DEGREES TO
NEAREST 0.01 DEGREE.

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

SALL: 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
HEL D UNTIL TERMINA-
TION OF P66.
PITCH AND YAW
ATTITUDE IS DETER-
MINED BY THE VEHICLE
POSITION AND VELO-
CITY W.R.T. THE
ATMOSPHERE. THIS
ATTITUDE IS ZERO
SIDESLIP AND ANGLE
OF ATTACK NEAR THE
TRIM VALUE.

NOTE: THREE AXIS DAP
CONTROL WAS REGAINED
WHEN LESS THAN 0.05
G WAS SENSED AND
WILL BE RELINQUISHED WHEN Q.J5 G IS AGAIN SENSED.

---

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

---

EXIT P66

---

MONITOR DSKY: OBSERVE TERMINATION OF P66 AND DISPLAY OF P67

---

EXIT P66

CHANGE CCNTRL NOTES
ENTRY - FINAL PHASE PROGRAM (P67)

**PURPOSE:**
1. To continue entry guidance after $Q_f + 0.5$ $\text{fps}^2$ (or approx. 0.2G) until termination of steering when the CM velocity wrt Earth is 1000 $\text{ft/sec}$ (altitude is approximately 65,000 $\text{ft}$).
2. To continue entry sky displays.

**ASSUMPTIONS:**
1. The program is automatically selected by:
   - P65 when RDOT is negative and the $V$ is sufficiently low ($V-V \text{C18 neg}$)
   - P66 when drag acceleration builds up to $Q_f + 0.5$ $\text{fps}^2$ (or approx. 0.2G)
   - P64 if no upcontrol solution exists with $Vl > 18000$ $\text{fps}$
2. The astronaut may monitor the following nouns by keying in V16NXXE:
   - N64 (G, VI, R to GO)
   - N68 (BETA, VI, HDOT)
   - N74 (BETA, VI, G)

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</table>

START ENTRY-FINAL PHASE PROGRAM (P 67)

DISPLAY PROGRAM 67

* * *

**MONITOR DSKY:**
Observe display of program 67

---

P57/SKYLARK
TEMP
HOLD
MCN

DISPLAY ON DSKY:
V06 V66
R1-BETA
R2-X RNG ERR
R3-DWN RNG ERR

MONITOR G+N CONTROL
OF ENTRY:

(A) 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 (DECRE-
ASING) POSITIVE
FOR OVERTAKE,
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 OVERTAKEN.

---

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 NORTH)

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 UNDESIRED 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)

REV 01 03/20/72

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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*CREW

*PROGRAM

*SELECTION

---

#01

+01

DO ROO TO START CSM VELOCITY VECTOR UPDATE PROGRAM (P77)

+409

DISPLAY P77

---

#10

KEY IN GSM VELOCITY VECTOR UPDATE PROGRAM (P77)

V37E77E

---

#20

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.

SNAP.

MOVIE OR SKY:
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

N

KEY IN PROCEED

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

P

R

D

C

E

D

NEW
DATA
STORE DATA

KEY IN V25E
AND LOAD THE
CORRECT TIG
**HOLD**

FLASH VERB-NOUN
TO REQUEST RESPONSE
AND DISPLAY THREE
COMPONENTS OF DELTA
V(LV)

**SNAP**

DELTA V(LV)-
COMPONENT OF DELTA V
APPLIED AT TIG
ALONG (AXV)X. IN
FPS TO NEAREST .1
FPS.

**MONITOR DSKY**

OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
THREE COMPONENTS OF
DELTA V APPLIED
ALONG LOCAL VERTICAL
AXES AT TIG.

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

DELTA V(LV)-
COMPONENT OF DELTA V
APPLIED 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

ARE THE VALUES
DISPLAYED THE
FINAL AUTOMATIC REQUEST TERMINATE
ROUTINE (R00)

REV 01 03/20/72

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 P0000 TYPE ABORT (WITHOUT AVERAGE 0 ACTIVE AND WITH NO EXTENDED VERMS ACTIVE) HAS OCCURRED.

   (A) IF A PROGRAM HAS COMPLETED ALL ITS FUNCTIONS AND MINKEY IS RUNNING (AUTOSE0 SET) CONTROL WILL GO TO
   THE NEXT POINT IN THE MINKEY CONTROLLER (R07) INSTEAD OF FLASHING V37.
   (B) PREMATURE TERMINATION OF AN OPERATION WILL TURN OFF MINKEY (RESET AUTOSE0).

2. THE COMPUTER CHECKS ON THE UNIVERSAL TRACKING PROCESS FOLLOWING ANY V37EXXE IN THE FOLLOWING WAYS:

   (A) IF P20 IS THE NEW PROGRAM KEYED IN AND IS NOT PRESENTLY RUNNING AND WAS RUNNING IN THE BACKGROUND IT WILL BE STARTED AS A NEW PROGRAM.
   (B) IF P20 IS THE NEW PROGRAM KEYED IN AND P20 IS PRESENTLY RUNNING (I.E. 20 DISPLAYED IN THE PROG LIGHTS) IT WILL BE STARTED AS A NEW PROGRAM (I.E. RE-INITIALIZED).
   (C) IF P20 IS THE NEW PROGRAM KEYED IN AND IS NOT PRESENTLY THE ONLY PROGRAM RUNNING (I.E. A PROGRAM OTHER THAN P20 IS DISPLAYED IN THE PROG LIGHTS AND P20 IS RUNNING IN THE BACKGROUND THE PROG LIGHTS WILL BE CHANGED TO 20 AND P20 WILL START AT P20 RESTART POINT WITH THE FLGS SET TO ALLOW TRACKING. IN ADDITION R22 WILL START AT THE R22 RESTART POINT FOR OPTIONS 0,4 AND ALLOW STATE VECTOR UPDATES; P00 TYPE INTEGRATION WILL START IN THE REMAINING OPTIONS.
   (D) IF P00 IS SELECTED, THE RENDEZVOUS FLAG AND UFALG ARE RESET (SH1J OFF P20) AND P00 IS STARTED.
   (E) IF A PROGRAM OTHER THAN P20 AND P00 IS KEYED IN, THE NEW PROGRAM WILL BE STARTED AND THE PROG LIGHTS WILL DISPLAY THE NEW PROGRAM. THE COMPUTER WILL THEN ATTEMPT TO RESTART P20 AND WILL BE SUCCESSFUL IF P20 WAS RUNNING IN THE BACKGROUND AND THE NEW PROGRAM WILL ALLOW TRACKING.
   (F) IF NEW PROGRAM SELECTED IS P31-P38 AND P20, OPTION 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 IMJ IS NOT ALIGNED (REFSMAT FLAG SET) P20 WILL NOT BE STARTED.

3. IF THE IMJ IS ALIGNED AND THE NEW PROGRAM SELECTED IS P31-P38, P1 V50 N25 R1=17 WILL BE DISPLAYED TO REQUEST CREW TO AUTHORIZE MINKEY SEQUENCE. THIS FLASHING DISPLAY MARKS THE TRANSITION FROM R00 TO MINKEY CONTROLLER (R07).

PROG CMC GROUND CREW
WAIT FOR KEYBOARD ENTRY TERMINATE FLASH ON RECEIPT OF DF XXE

RECEIVE V37XXE TO REQUEST NEW PROGRAM

"A" ENTRY FROM V96 WITH PROGRAM PDO SPECIFIED

TURN OFF MINKEY CONTROLLER (RESET AUTOSEQ FLAG)

RESET TPIMNFLG

RESET PCMANFLG
STOP ACCEPTING VHF RANGE DATA
(RESET VHF FLAG)

INVALIDATE MARK BUFFER

IS MAJOR MODE SELECTED GREATER THAN 79?

NO YES

TURN ON OPERATOR ERRJR

EXIT

IS THE IMU ALIGNED (REFSMMAT FLAG SET)?

NO YES

IS MAJOR MODE P31-P38?

NO YES

GO TO
GO TO THE POINT IN
THE MINKEY CONTRO-
LER ROUTINE (ROT1)
SPECIFIED BY THE
SELECTED MAJOR MODE

"B"

PROGRAM

SELEC-
TION BY
MINKEY
CONTROL-
LER (ROT1)

IS THE IMU BEING
INITIALIZED?
(IMODES30 BIT 6=1)

N . Y

TURN ON PROGRAM
ALARM LIGHT AND
STORE ALARM CODE
1520

MONITOR OSKY:
DOES PROGRAM
ALARM LIGHT COME
ON INDICATING THAT
THE IMU IS STILL
BEING INITIALIZED?

N . Y

RESET ALARM
LIGHT.

IS THE TVC DAP ON OR
SO THAT REGARDLESS OF THE SELECTED PROGRAM, ROJ WILL SELECT POQ.

IS NEW PROGRAM POQ?

Y N

IS NOOFLAG SET TO INHIBIT SELECTION OF A NEW PROGRAM OTHER THAN POQ?

Y N

TURN ON PROGRAM ALARM LIGHT AND STORE ALARM CODE 1920

---

MONITOR DSKY: DOES PROGRAM ALARM LIGHT COME ON, INDICATING THAT NEW PROGRAM SELECTION IS NOT PERMITTED AT THIS TIME?

Y N

EXIT

---

DOES THE NEW PROGRAM EXIST?

Y N

RESET ALARM LIGHT AND WAIT FOR COM-
STOP RATE DRIVE FROM P2J)

---------

---------

IS HOLDFLAG NEGATIVE?

Y N

---------

SET HOLDFLAG ZERO

---------

SET DAP REFERENCE TO DESIRED DAP CDUS

---------

RESET TARG1FLG

---------

RESET SUFLAG, P55.1FLG, P50.1FLG

---------
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   Y
  
IS UTFLAG SET?
  YES   NO
DISPLAY NEW PROGRAM

RELEASE DISPLAY SYSTEM

GO TO RESTART POINT IN P20 (AND R22 IF APPROPRIATE)

EXIT

DISPLAY NEW PROGRAM AND GO TO PROGRAM SELECTED.

RELEASE DISPLAY SYSTEM.

MONITOR DSky: OBSERVE DISPLAY OF NEW PROGRAM.

GO TO PROGRAM SELECTED
ERASABLE AND CHANNEL MODIFICATION ROUTINE (RO1)

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 ECA DR OF AN ERASABLE LOCATION OR THE NUMBER OF A CHANNEL:
                       IF R1>30, THE ADDRESS IS ASSUMED TO BE AN ECA DR;
                       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 JN-ZER0 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.

<table>
<thead>
<tr>
<th>PROG</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>

START IMU STATUS CHECK ROUTINE (R02)

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

IS THE ISS ORIENTATION KNOWN FLAG SET? (CHECK REF_fsmat FLAG)
-------------

Y   N
    
 IS THE ISS ON?
-------------

Y   N
    

#10

#20

RO2/SKYLARK
CSM DAP DATA LOAD ROUTINE (RO3)

REV 00 05/19/71

PURPOSE:
(1) TO LOAD AND VERIFY CMG 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 V46 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 KEYS 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 DSKY ENTRY.
(4) THIS ROUTINE IS NOT AVAILABLE IF UNDER THRUST VECTOR CONTROL.

PROG CONT
CMG GROUND CREW

CREW
ROUITE
SELECTION

START CSM DAP DATA LOAD ROUTINE (RO3)

--------------------- KEY IN V48E

#10

#20
QUAD
1-USE QUAD
D-DEADBAND CODE:
0-0.5 DEG
1-2.0 DEG
E (LSB)-MANEUVEK
RATE CODE:
0-0.5 DEG/SEC
1-0.2 DEG/SEC
2-1.5 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

KEY IN PROCEED

KEY IN V21E,
V22E, OR V24E AND
LOAD DESIRED DATA
CODES IN R1, R2

#70
#80
#90
#100
#110
#120
PITCH TRIM AND YAW
TRIM-SPS ENGINE BELL TRIM ANGLES AT
IGNITION DATA
TAKEN IN DEGREES TO NEAREST .01
DEGREE.

DO THESE VALUES
AGREE WITH MY CARRY ON DATA?
Y. N

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

LOAD DESIRED DATA

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

EXIT R03

CHANGE CONTROL NOTES

REV 00 PCR 040

484 R03/SKYLARK
DOCKED DAP DATA LOAD (R04)  

REV 00  05/19/71

PURPOSE: (1) TO LOAD AND VERIFY SMC DIGITAL AUTOPILOT DATA FOR DOCKED DAP.

(2) AFTER COMPLETION OF THIS ROUTINE, KEYING V45E 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.

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

*CREW
.ROUTINE
.SELECTION

---

START DOCKED DAP DATA LOAD ROUTINE (R04)  KEY IN V45E

---

IS ANOTHER EXTENDED VERB A MARKING DISPLAY OR A PRIORITY DISPLAY ACTIVE?

---

.N .Y

---

TURN ON OPERATOR ERROR

---
LIGHT

---

.* * * *

EXIT R04

---

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY DAP CONFIGU-
RATION DATA:
V35 V37
R1 - ABCDE
R2 - OCGDE
R3 - OCGDE

R1:
A - AC/BD ROLL
CONTROL SPECI-
FICATION
B - QUADS AC
FOR X TRAN-
SLATION
O - BD
PREFERRED
C - QUADS BD
FOR X TRAN-
SLATION
O - DONT USE
1 - USE
D - PITCH CONTROL
O - USE TOR-
QUE COU-

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF DAP CONFIGURATION
DATA

AM I SATISFIED WITH
DAP CONFIGURATION
DATA?

Y N
R2: CHANNEL 5 JET INHIBIT

TO INHIBIT JETS, SELECT CORRESPONDING OCTAL VALUES FROM FOLLOWING TABLE AND LOAD THEIR SUM (CODE) IN R2.

<table>
<thead>
<tr>
<th>JET</th>
<th>BIT #</th>
<th>OCTAL VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3(1)</td>
<td>1</td>
<td>00001</td>
</tr>
<tr>
<td>C4(1)</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>B4(8)</td>
<td>6</td>
<td>00040</td>
</tr>
<tr>
<td>R3(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.

<table>
<thead>
<tr>
<th>JET</th>
<th>BIT #</th>
<th>OCTAL</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1(9)</td>
<td>1</td>
<td>00001</td>
<td></td>
</tr>
<tr>
<td>B2(12)</td>
<td>2</td>
<td>00002</td>
<td></td>
</tr>
<tr>
<td>D1(11)</td>
<td>3</td>
<td>00004</td>
<td></td>
</tr>
<tr>
<td>D2(10)</td>
<td>4</td>
<td>00010</td>
<td></td>
</tr>
<tr>
<td>A1(13)</td>
<td>5</td>
<td>00020</td>
<td></td>
</tr>
<tr>
<td>A2(16)</td>
<td>6</td>
<td>00040</td>
<td></td>
</tr>
<tr>
<td>C1(15)</td>
<td>7</td>
<td>00100</td>
<td></td>
</tr>
<tr>
<td>C2(14)</td>
<td>8</td>
<td>00200</td>
<td></td>
</tr>
</tbody>
</table>

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

LOAD DESIRED DATA

*P
*R
*O
*E
*STOR
.D
.D
.D
.D
.D
.D
.D
.D
RESET 500**FLG AND 501**FLG

HOLD
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY DAP RATE AND
DEADBAND
V06 N89
R1 - DAP RATE
R2 - DAP DEADBAND
R3 - BLANK

R1-DOCKED DAP RATE
IN DEG/SEC TO
NEAREST .0001
DEG/SEC
R2-DOCKED DAP DEAD-
BAND IN DEGREES
TO THE NEAREST
.01 DEG.

WAIT FOR KEYBOARD
ENTRY

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR NEW DATA

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
RESPONSE AND DISPLAY
OF DAP RATE AND
DEADBAND

AM I SATISFIED WITH
THIS DAP DATA?

Y N

KEY IN
PROCEED

LOAD DESIRED
DATA

.P
.NEW
.R
.DATA
CHANGE CONTROL NOTES

REV 00  PCR 040, 454
MINKEY CONTROLLER ROUTINE (RO7)

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 V466 AT SOME TIME PRIOR TO SELECTION OF A RENDEZVOUS TARGETING PROGRAM.
(2) THE INITIALIZATION VALUES FOR THE W-MATRIX (WRENDPOS AND WRENVEL) 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 ROO AT "B".

P31
P01 INI-
TIAION
POINT
FROM ROO

SNAP
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 RENDEZVOUS USING
THE MINKEY SEQUENCE?

WAIT FOR KEYBOARD
ENTRY

YES

NO
START MINKEY
(SET AUTODEQ
FLAG)

CALL THE NC1 TARGETING PROGRAM (P31).

IS MAGNITUDE OF
DELTA V (LV) (RSS OF
NBI) GREATER THAN OR
EQUAL TO 10 FPS?

YES

CALL SPS THrusting
PROGRAM (P40)

CALL THE RCS THRUSTING
PROGRAM (P41)

NU

#140

#150

#160

#170
ROO

---

FLAG

---

EXIT RO7

---

MAS P20 STARTED
WITH HEADS
ORIENTATION
SPECIFIED
(AZIMFLAG SET)?

---

NO

---

YES

---

SET AZIMFLAG

---

IS HEADS UP DESIRED
(HDSUPFLG SET)?

---

YES

---

NO

---

SET OMEGACN=0
DEGREES
(R3 OF N78)

---

SET OMEGACN=180
DEGREES
(R3 OF N78)  

---

IS W-MATRIX VALID FOR RENDEZVOUS NAVIGATION (RENDFLG SET)?

---

NO  YES

---

SET FLAGS FOR AUTO W-MATRIX REINITIALIZATION (MANEUFGL, 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
HOLD

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
*P
*E
*R
*N

KEY IN PROCEED

#380

#390

#400

#410

#420
SET UMICRON=0 DEGREES (R3 OF N78)

SET OMICRON=180 DEGREES (R3 OF N78)

IS W-MATRIX VALID FOR KNEEZY NAVIGATION (RENDWFLG SET)?

NO

YES

SET FLAGS FOR AUTO W-MATRIX REINITIALIZATION (MANEUFILG, PTV93FLG)

RESET PRFLAG
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 [P41]

GO TO THE NSR INITIALIZATION POINT IN THIS ROUTINE "X" BELOW

P34
NSR TARGETING INITIALIZATION POINT FROM R00

HOLD

FLASH VERB-NOUN TO
REQUEST PLEASE PERFORM 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 RENDEZVOUS USING THE MINKEY SEQUENCE?

NO YES

#570

#580

#590

#600

#610
WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF ENTER, PROCEED OR TERMINATE

. V34E . P . E
    . R . N
    . O . T
RESET . E . R
AUTOSEQ . E .
FLAG . D .

DO ROUTINE
EXIT ROUTE

WAS P20 STARTED WITH HEADS ORIENTATION SPECIFIED (AZIMFLAG SET)?

. NO . YES

SET AZIMFLAG
PROGRAM (P41)

GO TO THE TPI
TARGETING
INITIALIZATION
POINT IN THIS
ROUTINE
"F" BELOW

P35
TPI TARGET-
TING INITIA-
LIZATION
POINT FROM
ROO

HOLD
SNAP

FLASH VERB-NOUN TO
REQUEST PLEASE PER-
FORM MINKEY SEQUENCE
V50 V25
R1-O3017
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?

BEGIN

WAIT FOR KEYBOARD ENTRY

TERMINATE FLASH UPON RECEIPT OF ENTER, PROCEED OR TERMINATE

DO ROUTINE

EXIT ROUT

WAS P20 STARTED WITH HEADS ORIENTATION SPECIFIED (AZIMFLAG SET)?

END
SET AZIMFLAG

IS HEADS UP DESIRED
(HDUPFLG 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 (MANEUF, PTV93FLG)
RESET PCFLAG
START MINKEY
(SET AUTOSEQ FLAG)

CALL THE TPI TARGETING PROGRAM (P35)

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 PROGRAM (P41)

GU TJ THE TPM TARGETING INITIALIZATION POINT IN THIS ROUTINE "S" BELOW

P34 TPM TARGETING INITIALIZATION POINT FROM R00

FLASH VERB-NOUN TO MONITOR 0SKY: OBSERVE VERB-NOUN
SNAP REQUEST PLEASE PERFORM MINKEY SEQUENCE 050 025

FLASH TO REQUEST PLEASE PERFORM
NAVIGATION
(RENDXFLG SET)?

NO

YES

SET FLGS FOR AUTO W-MATRIX REINITIALIZATION (MANEJFLG,
PTV93FLG)

RESET PCFLG

START MINKEY (SET AUTOSEQ FLAG)

"Q"

CALL THE TPM TARGETING PROGRAM
GREATER THAN OR
EQUAL TO 10 FPS?

*YES

*NU

CALL THE SPS
THRUÎNG
PROGRAM

(P40)

CALL THE RCS
THRUÎNG
PROGRAM

(P41)

HOLD

FLASH VEB-NOUN TO
REQUEST PLEASE PER-
FORM MINKEY SEQUENCE
V50 'N25

MONITOR DESKTOP
SUMPVERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
(RENDWFLG SET)?

*NO  *YES

SET FLAGS FOR
AUTO W-MATRIX
REINITIALIZATION
(MANEUFLG,
PTV93FLG)

RESET PCFLAG

START MINKEY
(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

SNAP

MONITOR DSKY:
OBEERVE 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

TERMINATE FLASH UPON RECEIPT OF ENTER,
PROCEED OR TERMINATE

DO ROUTINE R00

EXIT R07

WAS P20 STARTED WITH HEADS ORIENTATION SPECIFIED?

* NO * YES

SET AZIMFLAG

521 583
RO7/SKYLARK

#1450 #1460 #1470 #1480 #1490 #1500
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 FLAGS FOR
AUTO W-MATRIX
REINITIALIZA-
TION (MANEUF LG,
PTV93FLG)

RESET PCFLAG

#1510
#1520
#1530
#1540
#1550
START MIKEY
(SEAT AUTOSEQ
FLAG)

CALL PLANE CHANGE
TARGETING PROGRAM
(P38)

IS MAGNITUDE OF
DELTA V (RSS OF N81)
EQUAL TO ZERO?

- YES
  NO

PERFORM R33

- DU THE IMU
EXIT
ROT
REALIGNMENT
PROGRAM
(P52)
---

WAS PULSE TOWING ACTUALLY PERFORMED?
- YES
- NO

---

CALL THE RCS THRUSTING PROGRAM (P41)

---

PERFORM R00

---

EXIT R07

---

IS THE MAGNITUDE OF DELTA V (RSS OF N81) GREATER THAN OR EQUAL TO 10 FPS?
- YES
- NO

---

CALL THE SPS THRUSTING PROGRAM (P40)

---
VHF RANGE READ ROUTINE (108)  

REV 00 05/19/71

PURPOSE:  (1) TO READ RANGE FROM VHF DATA LINK AND RECORD TIME OF THE READING.

ASSUMPTIONS: (1) THE VHF IS ON.

(2) THIS ROUTINE IS SELECTED BY R22 FOR VHF NAVIGATION MEASUREMENTS WHEN ENABLED BY V87F (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 61 USING THE ON-BOARD STATE VECTOR ESTIMATES.

PROG CONT

GND 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 (LOGCALAR) 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: RADARUPT WILL SIGNAL END OF READ

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

R
A
D
A
R
U
P
T

IS VHF RESTART FLAG SET?

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

N
Y

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

#30

#40

#50

#60

#70
STORE RAW RADAR DATA FOR DOWNLINK

IS DATA GOOD SIGNAL PRESENT (CHANNEL 33 BIT2)?

Y. N

TURN ON TRACKER FAIL LIGHT

TURN OFF TRACKER FAIL LIGHT

IS RAW RADAR DATA = Y?

N. Y

EXIT RO8
TO CALLER'S
ERROR RETURN

CONVERT RAW DATA
FROM N.M. TO METERS

IS EXTRANGE SET?
(IS THERE A STATE
VECTOR RANGE ESTI-
MATE FROM R61
AVAILABLE?)

Y. N

IS DIFFERENCE
BETWEEN R61
COMPUTED RANGE
AND VHF RANGE
GREATER THAN
300 N.M.?

Y. N

ADD 327.68
N.M. TO VHF
RANGE

EXIT ROB
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 IDUS 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 INCO.

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.

**Diagram:***

<table>
<thead>
<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>START RENDEZVOUS TRACKING SIGHTING MARK ROUTINE (R21)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SELECT MANUAL OPTICS MODE</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>WHEN OWS IS AT CENTER OF RETICLE PRESS MARK BUTTON</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**

- START: R21/70 05/19/71
- PRECEDING PAGE BLANK NOT FILMED
WAS SIGHTING SATISFACTORY?

- N
- Y

MARK REJECT

PRESS MARK REJECT BUTTON WITHIN 7 SEC AFTER MARK

TERMINATE WAIT UPON RECEIPT OF MARK, MARK REJECT

- M
- A
- K
- R
- E
- J
- C
- I

EXIT R21

ERASE MARK DATA IN POSITION #1 (IF ANY) OR SET REJECTFLG TO REJECT MARK BEING PROCESSED BY R22 (IF ANY)

534
RENEDEZVOUS TRACKING DATA PROCESSING ROUTINE (R22)

PURPOSE:
(1) TO PROCESS RENDEZVOUS SIGHTING MARK DATA TO UPDATE THE STATE VECTOR OF EITHER THE CSM OR DWS 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 DWS 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) V36N59 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 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 V03E
   (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

"8"

WAIT 4 SECONDS

IS RENDEZVOUS FLAG SET?

Y  N

EXIT R22

IS REF544AT FLAG SET?

Y  N
IS UPDATE FLAG SET?
"Y"  
"N"  

GO TO  
"B"  
ABOVE  

"N"  

IS THERE DATA IN MARK DATA POSITION #1?
"Y"  
"N"  

GO TO  
"A"  
BELOW  

TRANSFER DATA OUT OF MARK DATA POSITION #1 AND INTO
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 #220).
FOR DESCRIPTION
OF UPDATE PROCESS
REFER TO SECTION
5.2 OF R693

---

IS SOURCE CODE=1?

---

Y    N

---

IS THIS THE 2ND
OPTICS CORRECTION
FOR THIS MARK?

---

Y    N

---

IS REJCTFLG
SET?

---

N    Y
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

---------

VERIFY (TO BE
DEFINED) AND
DISCUSS OUT OF
TOLERANCE CON-
DITION WITH THE
GROUND, IF
POSSIBLE.

---------

SHALL I INCORPORATE
THIS UPDATE?

---------

Y . N

---------

WAIT FOR KEYBOARD
ENTRY

---------

KEY

---------

V34E

---------

KEY IN RE-
CYCLE V32E
INCORPORATE STATE VECTOR CORRECTION INTO THE STATE VECTOR DESIGNATED BY THE STATE VECTOR FLAG (SEE P20)

IS SOURCE CODE = 1?

Y  N

INCREMENT REND- EZVOUS VHF RANGING MARK COUNTER

IS THIS THE 2ND OPTICS CORRECTION FOR THIS MARK?

N  Y

GO TO "F" ABOVE

INCREMENT REND- EZVOUS OPTICS
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```

```
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```

```
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```

```
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```

```
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```

```
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```

```
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```

```
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```

```
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```

```
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```

```
EXIT EXIT
R22 R22

___________
IS TRACK
FLAG SET?

___________
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

```
"B" ABOVE

SFT SOURCE CODE TO 2

STORE TIME OF MARK IN VHTIME

GO TO "C"
ABOVE

CHANGE CONTROL NOTES

REV 00  PCR 016,017,018,025,032,439, PCN 442, SKYLARK MEMO #19
REV 01  PCN 489
RENDEZVOUS BACKUP SIGHTING MARK ROUTINE (R23)

**PURPOSE:**
(1) TO PERFORM SIGHTING MARKS IN CONJUNCTION WITH THE UNIVERSAL TRACKING PROGRAM (R20) OPTIONS 0, 4, BY USE OF A BACKUP OPTICAL DEVICE.

**ASSUMPTIONS:**
(1) THE ASTRONAUT KNOWS THE COORDINATES (OPTICS) OF THE ALTERNATE LJ5 HE MUST USE FOR THIS ROUTINE.
(2) WHEN THE CMC ACCEPTS A MARK IT RECORDS AND STORRES 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.

---

**PROGRAM:**

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

------

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
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

MOVITON 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 RZ MARK FLAG

INVALIDATE MARK BUFFER

FL ASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY ALTERNATE LOS COORDINATES
V06 N94 R1 SHAFT R2 TRUNION R3 BLANK
SHAFT-OPIMS SHAFT ANGLE IN DEGREES TO NEAREST .01 DEGREES
TRUNNION-OPICS TRUNNION ANGLE IN DEGREES TO NEAREST .01 DEGREES

MONITOR DS KY: OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY NEW ODU ANGLES.
NOTE: THE VALUE OF THESE REGISTERS SHOULD CORRESPOND TO THE CHOSEN ALTERNATE LOS.
(THE NOMINAL ANGLES TO BE USED FOR GOAS SIGHTINGS ARE:
R1-00000 R2-57470)

ARE THE DISPLAYED ANGLES CORRECT FOR THE CHOSEN LOS?
Y N

WAIT FOR KEYBOARD ENTRY

TFT - TIME FROM TIG IN MIN AND SEC TO NEAREST SEC. MAXIMUM READING IS 59:59. (-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,
 P38 ALIGNED
 IS NOT ALIGNED
 THE VALUE IS
 999.32, IN DEG-
 GREESES TO THE NEAR-
 EST "0.1 DEGREES.

NOTE: R2 AND R3
 CONTENTS VALID
 ONLY IF SELECT
 R23 AT V16N45
 DISPLAY IN
 P31-P36, P38.

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

USING THE ROTATIONAL
HAND CONTROLLER PO-
SION THE SPACE-
 CRAFT SO THAT THE
 OWS IS PRECISELY
 ALONG THE LOS
 CHosen.

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

KEY IN ENTER

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

WAS SIGHTING SATIS-
 FACTORY?

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

Y

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

KEY IN V86E
 WITHIN 7
 SECONDS

---------------------------------
TERMINATE FLASH
UPON RECEIPT
OF ENTER, Y86E
OR PROCEED
----------

V E P
8 N R
6 T D
E E C
R E
D

--------------
ERASE
MARK DATA IN POSITION #1
(IF ANY)
OR SET REJECTFLS TO REJECT MARK BEING PROCESSED BY R22 (IF ANY)

---------------
DO I WISH TO MAKE MORE MARKS?

Y N

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

---------------
EXIT
R23

#280

#290

#300

#310

R23/SKYLARK
STORE 3 IC3U'S, 
CONTENTS OF 
NOUN 94 AND 
TIME IN POSI-
TION #1 AND TAG 
DATA AS BACK UP 
DATA FOR USE BY 
R22

INVALIDATE 
MARK BUFFER

SET R2IMARK 
FLAG

CHANGE CONTROL NOTES

REV 00  PCR 011, PCN 457, SKYLARK REV 82
REV 01  PCN 489
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 NOUV 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 V2072 display. R27 will continue within R22 until R27 flag is reset by keying V77 or by start of P20 (see P20 initialization logic).

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 "known" orientation. In the case of PHI, the ISS must be on and operational and integration must not be in progress.

6. The range rate filter requires approximately 190 sec to converge to the desired accuracy.

7. If the astronaut loads NJ2 with a time in the future, optimizations will occur automatically every 4 minutes, beginning with that time (V72) selected by the astronaut.

PRN GROU CREW

CMC GROUND CREW

CMC ROUTINE SELECTION

---

DO R23:
OBTAIN R1 AND T1

---

#10

R27/SKYLARK
IS THIS CALLER'S ERROR RETURN?
- N
- Y
- 
- 
- EXIT
- R27

IS THERE A DIFFERENCE BETWEEN R1 AND R2?
- Y
- N
- 
- 

WAS R27 CALLED BY R25?
- Y
- N
- 
- 

IS THIS THE 4TH TRY FOR A DIFFERENCE?
- Y
- N
- 
- 

TEST FOR RANGE MODULO (AS DESCRIBED ABOVE.)
- 
- 
- 
- 

COMPUTE MARK (RM,TM) FOR THIS CALL TO R27.
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?)

.. 

.. 

IS TO PAST?

.. GO TO "A" BELOW

.. IS THIS OPTIMIZATION COMPLETE?

.. 

.. 

RESET SNAPFLAG
RESET SNAPFLAG

IS THE PRESENT TIME
WITHIN 20 SEC OF TD?

N

Y

SET SNAPFLAG

STORE THE CODE
-03001 INTO R3
OF N77.

BEGIN MONITORING TFO
IN YOUM 76, INSURE
THAT DWS IS AT
CENTER OF SXT RETI-
CLE AT TFO = -00800.

WAIT UNTIL TDO =

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.

---

OBSERVE OPTIMIZED VALUES OF RANGE, RANGE RATE IN N77 BEFORE TFO = +01835.
NOTE: OPTIMIZED VALUES ARE REPLACED BY CURRENT VALUES AFTER TFO = +01835.

---

SET N77FLAG

---

RESET FIXFLAG

---

EXTRAPOLATE THE RANGE STATE VECTOR AHEAD TO THE CURRENT TIME TM.

---

SET TDFLAG
THE CURRENT TIME

COMPUTE THETA FOR THE CURRENT TIME

IS FIXFLAG SET?

Y

IS THE PRESENT TIME GREATER THAN THE TIME CONTAINED IN N72?

Y

SET TDFLAG
IS N77FLAG SET?

Y
N

STORE THE RANGE STATE VECTOR (EITHER CURRENT OR CONVERGING) INTO N77.

EXIT
R27

CHANGE CONTROL NOTES

REV 00  PCR 032, SKYLARK MEMO #19
REV 01  PCR 459, PCN 468, 489
ORBITAL PARAMETERS DISPLAY ROUTINE (R30)  

REV 01 03/20/72

PURPOSE:
(1) TO PROVIDE THE ASTRONAUT PERTINENT ORBITAL PARAMETERS COMPUTED BY THE CMC TO SUPPLEMENT ORITUAL 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 TIME OF PERIGEE IN ORDER TO CAUSE THE CMC TO DO PRECISION INTEGRATION TO THAT TIME AND THEN MAKE A CONIC CALCULATION.
(4) IF TFF IS NOT COMPUTABLE BECAUSE TRAJECTORY DOES NOT INTERSECT THE INTERFACE ALTITUDE (E.G. ON THE PAD), THE CMC WILL SET TFF EQUAL TO -59859. ALSO, IF PER ALT IS GREATER THAN THE INTERFACE ALTITUDE OF 300,000 FT CMC WILL COMPUTE TPER; OTHERWISE TPER=0. TPER IS STORED IN N32 AND THE ASTRONAUT MAY CALL IT BY KEYING IN N32E.
(TPER: TIME FROM NOW TO PERIGEE ALTITUDE IN HRS, MIN, AND SEC. FOR SIGN CONVENTION; SEE ASSUMPTION 5.)
(5) SIGN CONVENTION FOR TFF AND TPER: DSKY DISPLAY IS NEGATIVE (DECREASING) AS INTERFACE ALTITUDE IS APPROACHED.
BETWEEN INTERFACE ALTITUDE AND PERIGEE ALTITUDE, DISPLAY IS POSITIVE (INCREASING). WHEN PERIGEE IS PASSED, R30 CONTINUES TO DISPLAY POSITIVE INCREASING TIME EXCEPT DURING AVERAGE-G OR ON V32 RESPONSE TO V1644. NEGATIVE (DECREASING) TIME WILL BE DISPLAYED FOR ELLIPSES 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 N50S. IF THE APOGEE IS ABOVE 300,000 FT ALTITUDE AND THE PERIGEE IS BELOW 300,000 FT ALTITUDE ABOVE THE LAUNCH PAD, SPLERROR WILL BE DISPLAYED AS THE DISTANCE BETWEEN THE PREDICTED AND THE DESIRED ABORT TARGET. IF THESE CONDITIONS ARE NOT SATISFIED, SPLERROR WILL BE DISPLAYED AS THE DISTANCE BETWEEN THE PRESENT POSITION VECTOR AND THE DESIRED ABORT TARGET.

(7) REFER TO THE NOUN LIST IN THE BACK OF THIS DOCUMENT FOR DEFINITION OF THE CONTENTS OF NOUNS 32 AND 50.
(8) THIS ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG      CMC  GROUND  CREW
CONT      

CREW

• ROUTINE
• SELECTION

START ORBITAL PARAMETERS DISPLAY ROUTINE (R30)  .................. KEY IN V82E

R30/SKYLARK
TERMINATE FLASH UPTON RECEIPT OF PROCEED OR NEW DATA

STORE NEW DATA

IS NOUN 16 ZERO?

YES, NO

SET TDEC1 TO PRESENT TIME

SET TDEC1 TO TIME IN NOUN 16

EXTRAPOLATE SELECTED VEHICLE STATE VECTOR TO TIME IN TDEC1

KEY IN V25E AND LOAD NEW DATA.
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.

COMPUTE TPER.

IS AVE G ROUTINE ON?

Y    N
TFF-TIME OF FREE FALL FROM NOW TO AN INTERFACE ALTITUDE OF 300,000 FT, FOR SIGN CONVENTION, SEE ASSUMPTION 5.

ALTIITUDE 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 PADS), THE TFF DISPLAY WILL READ -59859.
NOTE: IF PER ALT OR APO ALT EXCEEDS SCALE THE DISPLAY WILL BE 9999.9 NM.

WAIT FOR KEYBOARD ENTRY

KEY IN

RECYCLE
V32E
NOTE: THE KEYING OF RECYCLE DURING AVE G WILL HAVE NO EFFECT.

++
++
++
++
++ ++
++
++
++
++
++
++
++
++
++
++
++
++
++
NOTE:
REPLACE ALL ASSUMPTIONS FOR DEFINITION OF ADDITIONAL DISPLAYS AVAILABLE IN THIS ROUTINE.

TERMINATE FLASH UPON RECEIPT OF PROCEED OR RECYCLE

---

*P  *R  *E  *R  *E  *E  *D  *C  *C  *E  *E  *D  *E  ...

EXIT R30

CHANGE CONTROL NOTES

REV 00  PCN 410
REV 01  PCN 489
RENDEZVOUS PARAMETER DISPLAY NO 1 ROUTINE (R31)  

**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 IIS BE ON. THE IIS 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 USKY ENTRY OR AUTOMATICALLY SELECTED BY P37.  

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

```
-CMC
-ROUTINE
-SELECTION

---

START
RENDEZVOUS PARAMETER DISPLAY NO 1 ROUTINE (R31)

---

IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

---

-N
-Y

---

TURN ON OPERA-
TCA ERROR LIGHT

---
```

PRECEDING PAGE BLANK NOT FILMED

R31/SKYLARK
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 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 THETA

HOLD

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

MONITOR DSKY:

OBSERVE VERB-NOUN

FLASH TO REQUEST RESPONSE AND DISPLAY
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V16 N14</td>
<td></td>
</tr>
<tr>
<td>R1-RANGE</td>
<td></td>
</tr>
<tr>
<td>R2-RANGE RATE</td>
<td></td>
</tr>
<tr>
<td>R3-THETA</td>
<td></td>
</tr>
<tr>
<td>++01</td>
<td></td>
</tr>
<tr>
<td>+489</td>
<td>RANGE-CALCULATED</td>
</tr>
<tr>
<td></td>
<td>RANGE TO DWS. IN NAUTICAL MILES TO NEAREST .01 NM.</td>
</tr>
<tr>
<td></td>
<td>RANGE RATE-CALCULATED RANGE RATE BETWEEN CSM AND DWS. NEGATIVE SIGN INDICATES CLOSING IN FPS TO NEAREST .1 FPS</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td>#140</td>
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<tr>
<td>#150</td>
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<tr>
<td>#160</td>
<td></td>
</tr>
<tr>
<td>#170</td>
<td></td>
</tr>
<tr>
<td>IS AVERAGE G RUNNING?</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>SET TF = AVERAGE G TIME</td>
<td></td>
</tr>
</tbody>
</table>

OF RENDEZVOUS PARAMETERS. (NOTE: THESE PARAMETERS WILL BE UPDATED ABOUT EVERY 40 SECONDS.)
RENDEZVOUS PARAMETER DISPLAY NO 2 ROUTINE (R34)  CH 01 03/20/72

PURPOSE:   (1) TO DISPLAY AT ASTRONAUT REQUEST CMC CALCULATED RENDEZVOUS PARAMETERS (RANGE, RANGE RATE, PHI)

ASSUMPTIONS:  (1) RANGE AND RANGE RATE ARE CALCULATED BY THE CMC ON THE BASIS OF THE STORED OWS AND CSM STATE VECTORS AND DO NOT REQUIRE THAT THE ISS BE ON. THE ISS MUST BE ON AND ALIGNED TO A "KNOWN" ORIENTATION AND THE OPTICAL SUBSYSTEM MUST BE ON AND OPERATIONAL, IF A CORRECT DISPLAY OF PHI IS DESIRED. THE RANGE/RANGE RATE/PHI DISPLAY IS NOT INHIBITED HOWEVER IF THE IMU IS NOT ON AND ALIGNED OR THE OPTICS IS OFF.

(2) THE ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

<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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<td></td>
</tr>
</tbody>
</table>

*CREW
*ROUTINE
*SELECTION
*

START
RENDEZVOUS PARAMETER DISPLAY NO 2 ROUTINE (R34)

---

KEY IN V85E

---

IS ANOTHER EXTENDED VERB, A MARKING DIS-
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

FLASH VERB- NOUN TO REQUEST RESPONSE AND DISPLAY RENDEZVOUS PARAMETERS:
- V16 N3
- R1- RANGE
+01 R2-RANGE RATE
+ R3-PHI
+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.

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
RENDEZVOUS OUT-OF-PLANE DISPLAY ROUTINE (R36)

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 ON.
(2) THE ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

----- PROG ---- CMC ---- GROUND ---- CREW ----
CONT

CREW
ROUTINE
SELECTION

----- START THE RENDEZVOUS OUT-OF-PLANE DISPLAY ROUTINE (R36) ----

----- KEY IN V90E ----

#10

----- IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE? ----

N     Y

#20

----- TURN ON OPERATOR ERROR LIGHT ----

#30
SET T(EVENT) TO TIG.

FLASH VERB NOUN TO REQUEST RESPONSE AND DISPLAY T(EVENT) IN G.E.T.

VO6: 1/6
R1-T(EVENT)-HRS
R2-T(EVENT)-MINS
R3-T(EVENT)-SECS

T(EVENT): TIME (G.E.T.) FOR WHICH OUT-OF-PLANE PARAMETERS ARE DESIRED IN HRS, MINS, AND SECS TO NEAREST .01 SECONDS. A SPECIAL CASE IS ALL ZERES (LOADED BY ASTRONAUT) INDICATING PRESENT TIME

MONITOR OSKY: OBSERVE VERB NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF TIME AT WHICH OUT-OF-PLANE PARAMETERS ARE DESIRED.

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

N Y
AM I SATISFIED WITH THE DISPLAYED 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

STORE NEW DATA

IS T(EVENT) ZERO?

N    Y

EXTRAPOLATE CSM AND CMS VECTORS
EXTRAPOLATE CSM AND OWS STATE VECTORS TO THE TIME DEFINED BY
THE EVENT USING PRECISION INTEGRATION

CALCULATE OUT-OF-PLANE PARAMETERS:
Y CM
Y DOT CM
Y DOT OWS

HOLD MONITOR SKY:
FLASH VERB NOUN TO OBSERVE VERB NOUN
REQUEST RESPONSE AND FLASH TO REQUEST
DISPLAY RENDEZVOUS RESPONSE AND DISPLAY
OUT-OF-PLANE PARAMETERS OF RENDEZVOUS OUT-
OF-PLANE PARAMETERS

Y CM NOTE: FOR
DEFINITION OF
PARAMETERS REFER
TO SECTION 5.6 IF THIS
DOCUMENT I IN
NAUTICAL MILES TO

DO I WISH TO RECEIVE ANOTHER DATA POINT
THE NEAREST .01
NM.

Y DOT CM-RATE OF
CHANGE OF Y CM
(+ IS INCREASING
AND - IS DE-
CREASING) IN FPS
TO THE NEAREST
+1 FPS.

Y DOT OWS-RATE OF
CHANGE OF Y OWS
(+ IS INCREASING
AND - IS DE-
CREASING) IN FPS
TO THE NEAREST
+1 FPS.

FOR A DIFFERENT
TIME?

N  Y

WAIT FOR KEYBOARD
ENTRY:

KEY IN RECYCLE
Y32E

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR RECYCLE

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

EXIT
R36

EXIT
CHANGE CONTROL NOTES

REV 00  PCR 452, PCN 457
**SPS THRUST FAIL ROUTINE (P40)**

**REVISION 01 03/20/72**

**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 PROPELLER STEERING AND HAS STOPPED C.G. TRACKING.
2. IF THE ASTRONAUT KEY'S IN PROCEED ON THIS DISPLAY THRUST FAILURE DETECTION WILL BE INHIBITED FOR 2 SECONDS TO PREVENT A PREMATURE THRUST FAILURE INDICATION.
3. THIS ROUTINE IS SELECTED BY THE SPS THRUSTING PROGRAM (P40)

---

**PROG**

**CONT**

**CMC**

**GROUND**

**CREW**

---

**HOLD**

**MON**

---

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY THRUSTING PARAMETERS

V97NO

R1 XXBXX

R2 VG

R3 DELTA VM

---

MONITOR DSKY:

OBSERVE VERB NOUN

FLASH TO REQUEST RESPONSE AND DISPLAY OF THRUSTING PARAMETERS.

---

SHALL I TERMINATE THE ENGINE ON COMMAND AND RETURN TO THE V99 FLASH WHICH WILL ALLOW ME TO

---

R40/SKYLARK
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 P4O

HAS THRUST COME
BACK ON?

KEY IN PROCEED

GO TO

"B"
IN P4O

DO I WISH TO DO
A MANUAL THRUST?

602
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

R40/SKYLARK
TURN OFF TVC DAP
SELECT OR IN RCS DAP
SET S3FLAG

DRIVE SP ENGINE BELL TO TRIM POSITION.
NOTE: THE TRIM WAS JUST DEFINED BY THE C.G. TRACKING COMputation.

TURN ON RCS DAP IN 6 SEC

+++ 01
+++ 409
+++
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 G 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 CANT 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 G 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>
<td>CONT</td>
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<tr>
<td></td>
<td>CMC ROUTINE SELECTION</td>
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<tr>
<td></td>
<td>IS CALLING PROGRAM P40 OR P41?</td>
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</table>

PRECEDING PAGE BLANK NOT FILMED
T-TO-ADD= TIMEDELT = 12.5 SEC

READ PRESENT TIME, TP

IS MIFLAG SET?

Y   N

IS TDEL-TIMEDELT GREATER THAN OR EQUAL TO TP?

Y   N

TURN ON PROGRAM ALARM LIGHT AND STORE ALARM CODE 1703

RESET MIFLAG

--- 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
IS TP < 5.6 SEC FROM TDEC?

Y N

SET T-TJ-ADD = T-TD-ADD PLUS TIMEJLT

WAS TIG SLIPPED?

Y N

SET TIG-TDEC
PLUS 30 SECONDS

CHANGE CONTROL NOTES

REV 00 PCN 410,457
COARSE ALIGN ROUTINE (R50)

PURPOSE:  
(1) TO COARSE ALIGN AND GYRO TRIM THE IMU TO A DESIRED INERTIAL ORIENTATION.

ASSUMPTIONS:  
(1) THE DESIRED IMU INITIAL 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).

<table>
<thead>
<tr>
<th>PROG CONT</th>
<th>CMC</th>
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</table>

```
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 ORIENTA-
```

#10
#20
#30
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 MJDE. TERMINATE ATTITUDE HOLD OF VEHICLE

COARSE ALIGN THE IMU
TERMINATE COARSE ALIGN MODE IN ISS.
RESUME ATTITUDE HOLD OF VEHICLE

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

CALCULATE GYRO TORQUING ANGLES FOR GYRO TRIM

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

PULSE IRISGS THROUGH DESIRED ANGLES

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

EXIT R50

CHANGE CONTROL NOTES

REV 00  PCR 416
AUTOMATIC OPTICS POSITIONING ROUTINE (R52)

REV 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 (P2J).
(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.

PRECEDEING PAGE BLANK NOT FILMED
IS THE TARGET FLAG SET?

---

YES  NO

---

RESET TERMINATE FLAG

---

GO TO "B" BELOW

---

"A"

---

DO THE TRACKING ATTITUDE ROUTINE (R61).

---

IS TRACK FLAG SET? [SEE P20]

---

Y  N

---

EXIT
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 ICN'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?

Y N

DRIVE SHAFT AND CDU TRUNNION AND CDU'S DRIVE TRUNNION TO
The Star Targets Only

```
*8*
```

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 manual. 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

```
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?

N Y

PCSS
PRIO
HOLD
SNAP

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

V05409
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?

Y N

FOR STAR SIGHTINGS THERE ARE TWO OPTIONS:

(A) MANUALLY MANEUVER VEHICLE UNTIL OPTICS CAN ACQUIRE THE DESIRED TARGET.

#340

#350

#360
(B) TERMINATION OF THE PROGRAM AND ROUTINE.

MANUALLY MANEUVER VEHICLE UNTIL IT IS ESTIMATED THAT OPTICS CAN ACQUIRE THE TARGET. MONITOR F3AE 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-DESIRED TRUNION ANGLE
IN DEGREES TO NEAREST .001 DEGREE.

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

CHECK OPTICS MODE DISKETE. IS THE OSS IN CNC 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 CNJ TRUNION AND MION DRIVE CNJ’S TRUNION TO APPROX 50

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

BY SWITCHING OPTICS MODE SWITCH TO MANUAL.
SIGHTING MARK ROUTINE (R33)  

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 ICDO ANGLES, 2 OCDU ANGLES (FOR OPTICS MARKS), AND THE TIME OF THE MARK. IN ADDITION, IF THE MARK IS FOR THE AT4 STAR TRACKER THE CREW WILL BE REQUESTED TO LOAD THE STAR TRACKER GIMBAL ANGLES (R14).

(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 V37EXE.

(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.

(6) IF THE MARK IS FOR THE ATM STAR TRACKER, THE CSM MUST BE DOCKED TO THE ORBITAL ASSEMBLY AND THE STAR TRACKER GIMBAL ANGLES LOADED IN R14 SHOULD BE THOSE RECORDED BY THE CREW AT THE TIME OF THE MARK.

(7) IN P50 THE ROUTINE IS SELECTED WHEN THE CREW SELCTS OPTION 1 OR 2 IN P66. 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 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 SELCTS OPTION 2 IN P66.

(11) THE ROUTINE IS SELECTED IN THE AUTO OPTICS POSITIONING ROUTINE (R52) BY CREW SELECTION OF MANUAL OPTICS MODE OR SWITCHING OPTICS ZERO TO ZERO.

prog  cont  cmc  ground  crew

*cmc routine
*selection

R53/SKYLARK
START SIGHTING MARK ROUTINE (R 53)

SET SIGHTING MARK FLAG

"A"

HOLD

FLASH VERB TO REQUEST PLEASE MARK:

V S1 N BLANK
R1-BLANK
R2-BLANK
R3-BLANK

NOTE: NOUN AND R1 WILL NOT BE BLANK IF ENTERED FROM MARK REJ.
AFTER VSO/25: R1 = 00016 DISPLAY

IS THIS AN OPTICS SIGHTING?

Y... N
TERMINATE FLASH
UPON RECEIPT OF
PROCEED, OK MARK
REJECT

RESET MARK FLAG

**+01
**
+489
**

IS P50.1FL3 SET?

SET TERMINATE FLAG
(FOR USE BY R52).

IS THIS P50 OPTION
1 (ATM SUN SENSOR)?

N

Y

N

Y

EXIT R53

ABOVE

#200

#210

#220

#230

#240
MONTOR SKY:

OBSERVE FLASHING VERA-NOUN TO REQUEST RESPONSE AND DISPLAY OF SOURCE OF SIGHTING DATA AND CELESTIAL BODY CODE.

AM I SATISFIED WITH THIS CODE?

Y   N

HOLD SNAP

FLASH VERA-NOUN TO REQUEST RESPONSE AND DISPLAY OF SOURCE OF SIGHTING DATA AND CELESTIAL BODY CODE

00 - PLANET (ANY PLANET)
01/45 - STAR (FROM CELESTIAL BODY CODE LIST)
46 - SUN
47 - EARTH

R1-C-SOURCE OF SIGHTING DATA
0-LSM OPTICS
1-ATM SUN SENSOR
2-ATM STAR TRACKER

R1-DE-CELESTIAL BODY CODE - THE DESIGNATION OF THE CELESTIAL BODY WHICH WAS MARKED (IN OCTAL).

EXIT R53
++
+ 01
  ARE K1 AND R2 BOTH
++  GREATER THAN -10000
++ AND LESS THAN
++  +109307
++
++
++
++
++
++
++

SET TERMINATE FLAG
( FOR USE BY R52).

EXIT R53

CHANGE CONTROL NOTES

REV 00  PCR 018, 019, 036, 414, 415, PCN 457
REV 01  PCN 470, 489
SIGHTING DATA DISPLAY ROUTINE (RS4)

PURPOSE: TO TEST THE ACCURACY OF A PAIR OF CELESTIAL BODY SIGHTINGS.

ASSUMPTIONS: THE ROUTINE IS NORMALLY AUTOMATICALLY SELECTED BY THE IMU ORIENTATION DETERMINATION PROGRAM (PS1), BY THE IMU REALIGN PROGRAM (PS2), BY THE BACKUP IMU ORIENTATION DETERMINATION PROGRAM (PS3), OR BY THE BACKUP IMU REALIGN PROGRAM (PS4).

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- START SIGHTING DATA DISPLAY ROUTINE (RS4).
- CALCULATE ANGLE BETWEEN TWO CELESTIAL BODIES USING STORED EPHEMERIS DATA (ACTUAL)
- CALCULATE ANGLE BETWEEN TWO CELESTIAL BODIES USING CELESTIAL BODY VECTORS DERIVED FROM MARK ANGLES (INDICATED)
HOLD

FLASH VERB-NOU N TO REQUEST RESPONSE AND DISPLAY SIGHTING ANGLE DIFFERENCE AND SIGHTING ANGLE:
- V06 NO5
- 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-NOU N AND DIS- PLAY OF SIGHTING ANGLE DIFFERENCE AND SIGHTING ANGLE

DOES THE SIGHTING ANGLE DIFFERENCE EXCEED THE ACCEPTABLE TOLERANCE OR IS THE SIGHTING ANGLE UNACCEPTABLE?

. N . 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 (P52), OR BY THE BACKUP IMU REALIGN PROGRAM (P54).

```
PROG CONT
GND CREW

.CMC
 ROUTINE
 SELECTION

START GYRO TORQUING ROUTINE (R55)

CALCULATE REQUIRED TORQUING ANGLES FOR EACH GYRO

OLD
 SNAP

FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY

MONITOR DSKY:

- OBSERVE VERB-NOUN
- FLASH AND DISPLAY OF
- GYRO TORQUING ANGLES

R55/SKY LARK
```

#10

#20
DELTA GYRO-GYRO
TORQUING ANGLES-THE
ANGLE THRU WHICH
EACH GYRO MUST BE
TORQUED TO COMPLETE
THE FINE ALIGNMENT.
ALL ANGLES IN DEG-
REES TO NEAREST .001
DEGREE.

SHALL I PERMIT
TORQUING? CONSIDER
MAGNITUDE OF TORQU-
ING ANGLES.

N=  
Y= 

WAIT FOR KEYBOARD
ENTRY

KEY IN
RECYCLE
V32E

EXIT R55

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR RECYCLE

KEY IN PROCEED

R  
P  
E  
C  
Y  
C  
E  

EXIT R55
ALTERNATE LOS SIGHTING MARK ROUTINE (R56)

PURPOSE:
(1) TO PERFORM SIGHTING MARKS FOR THE BACKUP ALIGNMENT PROGRAMS (P3, P4).

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.
(3) WHEN THE ASTRONAUT KEYS IN ENTRY IN RESPONSE TO FLASHING V53, THE CMC STORES THE TIME OF THE MARK, THE THREE
ICOU ANGLES, AND THE TWO ANGLES DISPLAYED IN N94. IF THE MARK IS FOR THE ATM STAR TRACKER, THE CREW WILL BE
REQUESTED TO LOAD THE STAR TRACKER GIMBAL ANGLES (N14). THIS INFORMATION THEN REPLACES THE N94 INFORMATION
IN CMC STORAGE.
(4) THE RHC IS USED TO POSITION THE SPACECRAFT SO THAT THE ALTERNATE LOS POINTS TOWARD THE CHOSEN CELESTIAL BODY.
(5) IF THE MARK IS FOR THE ATM SUN SENSOR, THE CSM MUST BE DOCKED TO THE ORBITAL ASSEMBLY, THE ATM MUST BE IN THE
SOLAR INERTIAL ATTITUDE, AND THE ORIENTATION OF THE ATM WITH RESPECT TO THE NAV BASE MUST BE KNOWN.
(6) IF THE MARK IS FOR THE ATM STAR TRACKER, THE CSM MUST BE DOCKED TO THE ORBITAL ASSEMBLY, THE ORIENTATION OF
THE ATM WITH RESPECT TO THE NAV BASE MUST BE KNOWN, AND THE STAR TRACKER GIMBAL ANGLES LOADED INTO N14 SHOULD
BE THOSE RECORDED BY THE CREW AT THE TIME OF THE MARK.
(7) THIS ROUTINE IS AUTOMATICALLY CALLED BY P3 AND P4.
(8) ANY PROPORTIONAL SET OF COMPONENTS MAY BE LOADED IN N88. HOWEVER, UNIT VECTORS ARE RECOMMENDED.

PROG CONT
CMC GROUND CREW

---------
*CMC
*ROUTINE
*SELECTION

#10

START ALTERNATE
LOS SIGHTING
**00**

**01**

1. **NEW DATA**
   - **STORE**
   - **NEW DATA**

2. **FLASH VERB**
   - TO REQUEST PLEASE
   - PERFORM ALTERNATE
   - LOS SIGHTING
   - MARK:
     - V53N-BLANK
     - R1-BLANK
     - R2-BLANK
     - R3-BLANK

3. **MONITOR SKY:**
   - OBSERVE VERB
   - FLASH TO REQUEST
   - PLEASE PERFORM
   - ALTERNATE LOS
   - SIGHTING MARK:

4. USING THE ROTATIONAL
   HAND CONTROLLER PO-
   SITION THE SPACE-
   CRAFT SO THAT THE
   NAVIGATION STAR IS
   PRECISELY ALONG THE
   LOS CHOSEN.

5. **WAIT FOR KEYBOARD**
   - **ENTRY**
6. **TERMINATE FLASH UPON**

7. **KEY IN ENTER**
8. **PROCEED**

---

R56/SKYLARK
RECEIPT OF ENTER


HOLD FLASV VERB NOUN TO REQUEST PLEASE PERFORM TERMINATION OF THIS ROUTINE V50 425 R1 03016 R2 BLANK R3 BLANK

MONITOR DSNY: OBSERVE VERB NOJN FLASH TO REQUEST PLEASE PERFORM TERMINATION OF THIS ROUTINE

WAS THE SIGHTING SATISFACTORY?

Y N

WAIT FOR KEYBOARD ENTRY

KEY IN ENTER

TERMINATE FLASV UPON RECEIPT OF ENTER OR PROCEED

KEY IN PROCEED

+489 E N P R
ERASE MARK
DATA

HOLD
FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY SOURCE OF
SIGHTING DATA AND
CELESTIAL BODY CODE
V01 Y71
R1-OJOKE
R2-BLANK
R3-BLANK
R1-C-SOURCE OF
SIGHTING DATA
0 - BACKUP OPTICAL DEVICE
1 - ATM SUN SENSOR
2 - ATM STAR TRACKER
R1-D-CELESTIAL BODY
CODE - THE DESIGNATION OF THE
CELESTIAL BODY WHICH WAS MARKED
(IN OCTAL)

MONITOR SKY:
OBSERVE FLASHING VERB-NOUN TO REQUEST
RESPONSE AND DISPLAY SOURCE OF SIGHTING DATA AND CELESTIAL BODY CODE.

AM I SATISFIED WITH THIS CODE?
Y N

R56/SKYLARK

#170

#180

#190

#200

#210
STORED EPHEMERIS

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

POS HOLD SNAP

FLASH VERB
NOUN TO REQUEST RESPONSE
AND DISPLAY PLANET POSITION VECTOR:
V06N80 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 (IEEEEEE).
Y PL - SAME AS X PL FOR Y COMPONENT.

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

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
D
C
L E
E LOAD DATA
D

EXIT R56

CHANGE CONTROL NOTES

REV 00  PCR 043, 413, 414, 415, PCN 410, 436
REV 01  PCN 409
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 3AXISFLG IS RESET).
(b) A THREE AXIS (ORTHOGONAL) INERTIAL ORIENTATION TO WHICH THE THREE BODY AXES ARE TO BE ALIGNED (THE 3AXISFLG IS SET).
(2) THE MANEUVER MAY BE PERFORMED AUTOMATICALLY BY THE GNCS OR PERFORMED MANUALLY WITH AN OPTIONAL FINAL AUTOMATIC
   GNCS CONTROLLED TRIM MANEUVER. THIS OPTIONAL TRIM MANEUVER SHOULD BE CONSIDERED ESSENTIAL FOR MANEUVERS TO SPS THRUSTING
   ATTITUDES.
(3) THE DAP DATA LOAD ROUTINE (R03 OR R04) HAS BEEN PERFORMED PRIOR TO THIS ROUTINE.
(4) THE ROUTINE IS AUTOMATICALLY SELECTED BY THE PROGRAM OR ROUTINE REQUIRING THE ATTITUDE MANEUVER.
(5) IF THIS ROUTINE WAS SELECTED BY THE TRACKING ATTITUDE ROUTINE (R61) THE V50N18 AND THE V60N18 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 (MAGNOTJDE) CAUSES THE RCS
   DAP TO TERMINATE THE MANEUVER AND MAINTAIN ATTITUDE HOLD (SET STKFLG AND ZERO HOLDFLG).

BEGIN ATTITUDE MANEUVER ROUTINE (R60)

START ATTITUDE MANEUVER ROUTINE (R60)

OBTAIN DESIRED ATTITUDE SPECIFICATIONS

END ATTITUDE MANEUVER ROUTINE (R60)
V30 V18
R1-C0 ROLL
R2-16 PITCH
R3-MG YAW

DG - FINAL DESIRED
OUTER GIMBAL ANGLE
IN DEGREES TO
NEAREST .01 DEGREES.

IG - FINAL DESIRED
INNER GIMBAL ANGLE
IN DEGREES TO
NEAREST .01 DEGREES.

MG - FINAL DESIRED
MIDDLE GIMBAL ANGLE
IN DEGREES TO
NEAREST .01 DEGREES.

MANEUVER AND DISPLAY
OF DESIRED GIMBAL
ANGLES.

Do I wish to continue in this program?

Y Y

KEY IN
TERMINATE
V94E

 REVIEW THE PRESENTLY
DISPLAYED GIMBAL
ANGLES AND THE
PRESENT ATTITUDE. AM
I WITHIN THE PRESENT
RCS DAP DEADBAND
LIMITS IN EACH AXIS?

Y Y

Do I wish to further adjust the vehicle attitude about the desired vector?

#70

#80

#90

#100

#110
ON P20 TERMINATION PROCESS (V56 LOGIC).

EXIT EXIT

$60 $60

IS 3AXISFLAG SET?

N Y

SELECT CNC 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 VECPOINT 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 COMPROMISED

EITHER SELECT SCS CONTROL
MISED IF THE ATTITUDE IS CHANGED BY MANUAL INPUTS AFTER THIS TIME

OR PLACE MODE SWITCH NOT IN AUTO.

KEY IN PROCEED

SELECT GIMBAL ANGLES CORRESPONDING TO PREFERRED VEHICLE ATTITUDE AND PRESENT IMU ORIENTATION

PERFORM ATTITUDE MANEUVER MANUALLY USING RHC AND BY REFERENCE TO THE OUT THE WIN- DOW VIEW AND/OR THE F다이 BALL AND ATTITUDE ERROR NEEDLES.
IS S/C CONTROL CMC?
N   Y

IS THE AUTO MODE SELECTED?
N   Y

TEMP HOLD

DISPLAY FINAL GIMBAL ANGLES
V05N14
R1-OG ROLL
R2-OG PITCH
R3-MS YAW
ALL ANGLES IN DEGREES TO THE NEAREST .01 DEGREES

MONITOR DSQY:
OBSERVE NON-FLASHING VERTEX NOUN DISPLAY OF FINAL GIMBAL ANGLES UNTIL COMPLETION OF THE AUTOMATIC MANEUVER. (NOTE: IF MAG BECOMES GREATER THAN OR EQUAL TO 75 DEG (MAGNITUDE) THE MANEUVER WILL TERMINATE AND ATT HOLD IS ESTABLISHED.)

SET HOLD FLAG NEGATIVE

DID I DIRECT THE CMC TO PERFORM THE MANEUVER AUTOMATICALLY?
Y   N

#270

#280

#290

#300

#310
DO MANEUVER CALCULATION (KALCMANU) AND ICU DRIVE ROUTINE TO ACHIEVE FINAL GIMBAL ANGLES. THE MANEUVER RATE WILL BE THAT LAST DEFINED TO THE CMC BY USKY ENTRY. THIS PROCESS WILL INCLUDE A MONITOR OF THE RHC INPUTS TO THE CMC. ANY INPUT FROM THE RHC 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 FDAI BALL AND ATTITUDE ERROR NEEDLES TO AVOID GIMBAL LOCK.

SHALL I OVERRIDE THE GNCS AND COMPLETE THE MANEUVER MANUALLY?

Y  N

WAIT FOR AUTOMATIC COMPLETION

IS THIS A P20 MANEUVER DURING MINKEY?

YES  NO

EXIT R60
SET HOLDFLAG ZERO

SET JAP REFERENCE TO DESIRED JAP CDUS

IS TRACK FLAG SET?
   NO...YES
      
      IS THIS MINKEY?
      (IS AUTO-SEQ FLAG SET?)
      NO...YES
      
      EXIT RGO

PERFORM ATTITUDE MANEUVER MANUALLY USING RHC AND BY REFERENCE TO THE OUT-OF-WINDOW VIEW AND/OR THE FDAI BALL AND ATTITUDE ERROR NEEDLES.
CHANGE CONTROL NOTES

REV 00  PCR 040, PCN 456
REV 01  PCN 489
PURPOSE:

1. To compute the desired tracking attitude of the CSM which enables optics tracking of the OWS.
2. To compute the desired tracking attitude of the CSM wr CSM/OWS which enables tracking of a celestial body.
3. To call R60 if a large maneuver (see below) is required, and the V50N18 flag is set.

ASSUMPTIONS:

1. The CSM orientation about the track axis (1) 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.
<table>
<thead>
<tr>
<th>Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>750</td>
<td>R61/SKYLARK</td>
</tr>
<tr>
<td>#30</td>
<td>IS R61 COUNTER NEGATIVE?</td>
</tr>
<tr>
<td>#40</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>DECREMENT R61 COUNTER BY ONE.</td>
</tr>
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<td></td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>LOAD DEADBAND WITH R2 OF N79 OR SET DEADBAND TO MINIMUM IF ZERO WAS LOADED IN R2 OF N79</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
<tr>
<td>#70</td>
<td>SET DESIRED TIME = PRESENT TIME.</td>
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<td>...</td>
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<tr>
<td></td>
<td>...</td>
</tr>
<tr>
<td>672</td>
<td>R61/SKYLARK</td>
</tr>
</tbody>
</table>
SET?

---

N Y Y N

---

GO TO

"&"<

BELOW

BELOW

---

CALCULATE THE
DESIRE TRACKING
ATTITUDE FROM
CSM TO OWS.
(DESIRE) UNIT
VECTOR ALIGNED
WITH LOS FROM
CSM TO OWS.)
THIS ATTITUDE
WILL BE COMPUTED
(VECP0INT) TO
POINT THE DE-
SIRE UNIT VE-
CTOR AT THE OWS
BUT WILL NOT
CONSTRAIN THE
NONCRITICAL
ORIENTATION
ABOUT THAT
VECTOR.

---

CALCULATE THE
DESIRE TRACKING
ATTITUDE FROM CSM
TO CELESTIAL BODY.
(DESIRE UNIT
VECTOR ALIGNED
WITH LOS FROM CSM
TO CELESTIAL

---
BODY 1 THIS ATTITUDE WILL BE COMPUTED (VECPNT) TO POINT THE DESIRED UNIT VECTOR AT THE CELESTIAL BODY BUT WILL NOT CONSTRAIN THE NONCRITICAL ORIENTATION ABOUT THAT VECTOR.

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.

"CH"
CALCULATE DESIRED TRACKING ATTITUDE FROM CSN TO CELESTIAL BODY (DESIZED 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 CONSTRAIN 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 12. OPTIONS 4 OR 5 WILL GIVE 401 ALARM IF DESIRED ANGLES YIELD GIMBAL LUCK.

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

STORE ATTITUDE SPECIFICATION FOR
DESIRED TRACKING ATTITUDE FOR USE BY THE ATTITUDE MANEUVER ROUTINE (R60).

SET EXTRANGE (RANGE ESTIMATE AVAILABLE FROM STATE VECTORS)

IS P27 IN MODE LIGHTS?

TURN OFF UPLINK ACTY LIGHT

IS HOLDFLAG EQUAL TO A POSITIVE, NON-ZERO NUMBER?

RESET V5ON18 FLAG
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 MANEU-
VER + 20.48
SEC.)

GO TO
\#01
ABOVE

IS V50N18 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 DSKY?

Y  N

SET R61 COUNTER EQUAL TO -1.

EXIT

IS ALIMFLAG 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 V50N18 FLAG

IS CMC AUTO MODE SELECTED?

Y  N

IS STICK FLAG SET?

N  Y

CALCULATE THE DESIRED BODY RATE AS DESCRIBED IN GSOP SECTION 5.2 AND RESOLVE INTO RAS DAP CONTROL AXIS.

SET HOLDFLAG NEGATIVE
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 (P03 OR R04).
3. THIS ROUTINE CAN ONLY BE ENTERED FROM THE CMC IDLING PROGRAM (P30).

<table>
<thead>
<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>START CREW-DEFINED MANEUVER ROUTINE (R62)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CURRENT PROGRAM POO?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| CREW | ROUTINE SELECTION | | |
|------|-------------------|---|
| MONITOR OSKY: DOES OPERATOR ERROR LIGHT COME ON INDICATING THAT THIS ROUTINE CANNOT BE SELECTED AT THIS TIME? | | |

---

#10

#20

#30
SET JAXISFLG FOR USE BY ATTITUDE MANEUVER ROUTINE (R60)

DO ATTITUDE MANEUVER ROUTINE (R60)

EXIT R62

CHANGE CONTROL NOTES

REV 00 PCR 040
RENDEZVOUS FINAL ATTITUDE ROUTINE (R63)

PURPOSE:
(1) TO CALCULATE THE FINAL GIMBAL ANGLES REQUIRED TO POINT THE SPECIFIED AXIS AT THE JWS.
(2) TO DISPLAY THE GIMBAL ANGLES CORRESPONDING TO THE N78 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 P00 ONLY.
(4) THIS ROUTINE IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

Preceding page blank

PRECEDING PAGE BLANK NOT FILMED
RESET AZIMFLAG

SET ASSUMED AXIS TO:
GAMMA=0
RHO=0

HOLD

FLASH VERB-NOUN TO
REQUEST RESPONSE AND
DISPLAY DESIRED
POINTING AXIS:
V0=0
R1=GAMMA
R2=RHO
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
REIPT OF PROCEED
OR NEW DATA

NEW DATA

PROCEED

KEY IN V24E AND
LOAD NEW DATA
STORE DATA

---

EXTRAPOLATE OWS AND CSM STATE VECTORS FORWARD TO THE PRESENT TIME +1 MIN USING CINIC 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 (VECPINT) TO POINT THE DESIRED AXIS AT THE OWS BUT WILL NOT CONSTRAINT THE NON-CRITICAL ORIENTATION ABOUT THAT VECTOR.
COMPUTE REQUIRED GIMBAL ANGLES AT THE DESIRED TRACKING ATTITUDE IF THE PRESENT IMI ORIENTATION IS HELD AND STORE IN NOUN 18.

STORE ATTITUDE SPECIFICATION FOR DESIRED TRACKING ATTITUDE FOR USE BY THE ATTITUDE MANEUVER ROUTINE (R60).

M10D FLASH VERB-NOUN TO REQUEST RESPONSE
SNAP AND DISPLAY COMPUTED GIMBAL ANGLES

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?

--

. Y . N

--

DO I WISH TO
UPDATE THIS
DISPLAY?

--

. Y . N

--

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

--

R . P . T

E . R . E

C . O . R

Y . C . M

C . E . I

L . E . N

D . A

T

E

EXIT

R 63

--

EXIT

--

R 230

R 240

R 250

R 260

R 270
OPTICS ANGLES TRANSFORM ROUTINE (R64)  

REV 01 03/20/72

PURPOSE:
1. TO DISPLAY AT ASTRONAUT REQUEST THE TRACKING ANGLES CORRESPONDING TO GIVEN OPTICS ANGLES. TRACKING ANGLES (N78) SPECIFY THE SPACECRAFT AXES 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.

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

---

START OPTICS ANGLES TRANSFORM ROUTINE (R64) ...

---

IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?
Y
N

---

TURN ON OPERATOR ERROR
COMPUTE AND STORE PREFERRED TRACKING ORIENTATION FOR AXIS

SPECIFIED BY OPTICS ANGLES (ONLY GAMMA AND RHO ARE COMPUTED)

FLASH VERB- NOUN TO REQUEST RESPONSE AND DISPLAY TRACKING ANGLES:
- \( V06 \) - \( \gamma \)
- \( R1 \) - \( \Gamma \)
- \( R2 \) - \( \rho \)
- \( R3 \) - \( \mu \)

ALL ANGLES IN DEGREES TO NEAREST .01 DEG. REFER TO SECT. 5 OF THIS DOCUMENT FOR DEFINITIONS.

WAIT FOR KEYBOARD ENTRY

MONITOR DSky: OBSERVE FLASHING VERB- NOUN AND DISPLAY OF TRACKING ANGLES.

ARE TRACKING ANGLES ACCEPTABLE?

KEY V2SE RELOAD ANGLES
CHANGE CONTROL NOTES

REV 00  PCR 405
REV 01  PCN 489
ROTATION ROUTINE (R67)

PURPOSE:  
1. To compute the DAP commands for the CSM which enables rotation of the CSM about the specified axis.  
2. To perform the rotation maneuver.

ASSUMPTIONS:  
1. The routine is called by the universal tracking program (P20), for option 2.

<table>
<thead>
<tr>
<th>PROG</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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```
.CMC
ROUTINE
SELECTION

START ROTATION ROUTINE (R67)

SET R67FLAG

IS S/C CONTROL CMC?

Y  N

IS THE AUTO MODE SELECTED?

Y  N
```
CALL KALC MANU FOR ONE CYCLE OF 

ROTATION.

DECREMENT R61 COUNTER

IS R61 COUNTER=0?

N Y

GO TO "A" ABOVE

CHANGE CONTROL NOTES

REV 00 PCN 450,456,457
REV 01 PCN 489
SET BIT 1 OF IMODES3 TO INSURE THAT IMUMON AND OPMON 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 IMODES3

EXIT

CHANGE CONTROL NOTES

REV 01 PN 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.

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<tr>
<th>PROG</th>
<th>CMC</th>
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<th>CREW</th>
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<td>CREW SELECTION</td>
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<td>+</td>
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<tr>
<td>+</td>
<td>START CREW INITIATED</td>
<td>KEY IN V36E</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>FRESH START</td>
<td>-</td>
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<td>+489</td>
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<td>ZERO OUTBIT CHANNELS</td>
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<td></td>
<td>5 (RCS PITCH AND</td>
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<td></td>
<td>YAW) AND 6 (RCS</td>
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<td>RCLL)</td>
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<tr>
<td></td>
<td>ZERO CHANNEL 77</td>
<td>-</td>
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</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, R1, R2, R3)

++ OBSERVE DSKY REGISTERS BLANK

#30
#40
#50
#60
#70
#80

712
RESET DISPLAY/
ASTRONAUT INTERFACE
FLAGS

** 01
- 489

+ **

TURN OFF DSKY
DISCRETE LIGHTS.

OBSERVE DSKY
LIGHTS OFF

CLEAN FAIL REGIS-
TERS, SELF CHECK
ERROR COUNTER, AND
RESTART COUNTER

CLEAR SELF-CHECK
ERROR REGISTERS, 
MODE REGISTER.

INITIALIZE PIPA AND
TELEMETRY FAIL FLAGS

ZERO OUTBIT CHAN-
NELS: 111 "AM"
RELAYS: 12 (GNC)
(BITS 6 AND 4 SET
TO 1 IF NECESSARY):
13 (AGC); AND
ZERO IMU CDU EXTENDED VERB 43

REV 01 03/20/72

PURPOSE: (1) TO INSURE SYNCHRONIZATION BETWEEN THE ISS CDU COUNTERS AND THE CDU 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 HORIZONTAL LOCK.
(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>
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</thead>
<tbody>
<tr>
<td>CONT</td>
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</tbody>
</table>

CREW SELECTION

START CREW INITIATED
ZER0 IMU CDU

---

IS MODE SWITCHING OR GYRC TORQUING IN PROCESS?

N Y

---

TURN ON OPERATOR ERROR

---

---
**01**

**+**

**-**

**+**

**+**

**+489**

**++**

---

**TURN OFF NO ATT LIGHT**

---

** Observe NO ATT LIGHT OFF**

---

**WAIT 32J MSEC**

---

**EXIT**

---

**CLEAR ISS COU READ COUNTERS**

---

**ENTER FINE ALIGN MODE**

---

**WAIT APPROXIMATELY 8 SEC**

---

**EXIT**

---

**CHANGE CONTROL VJTES**

**REV 01  PCN 489**
COARSE ALIGN CPU EXTENDED VERB 41 (WITH N20)  
REV 01  03/20/72

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 (V41V91).
(5) THE PROCESS SHOULD NEVER BE USED DURING A PROGRAM WHICH REQUIRE THAT THE IMU BE ON AND ALIGNED.

PROG CONT   C4C  GROUND  CREW

PRECEING PAGE BLANK NOT BLANK

#10

START CREW INITIATED COARSE ALIGN CPU

#20

IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

N  Y

V41V20/SKY
TURN ON
OPERATOR
ERROR LIGHT

EXIT

FLASH VERB-NOUN TO
REQUEST LOAD OF
DESIRED CDU ANGLES.
V2IN22
R1-OG ROLL
R2-IG PITCH
R3-MG YAW

ALL REGISTERS
INITIALLY BLANK

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH REQUESTING
LOAD OF CDU ANGLES
-- ENTER COARSE ALIGN MODE --

++ 01
++ 089
++

-- TURN ON NO ATT LIGHT \-- \-- OBSERVE NO ATT LIGHT ON --

-- IS THE IMU BEING INITIALIZED? --

++ N ++ Y

++ ++ ++ ++ ++

EXIT

-- COARSE ALIGN IMU TO STORED ANGLES (15 SECS MAX) --

-- WAIT 1.5 SECONDS --

-- READ PRESENT IMU ORIENTATION W.R.T. THE --
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 DE-
SIRED ANGLES?

N
Y

***
EXIT

CHECK STATUS OF CW
PANEL. IS AN ISS
MALFUNCTION
INDICATED?

Y
N

***
EXIT

DO I DESIRE TO
RESELECT THE
COARSE ALIGN CDO EXTENDED VERB 41 (WITH N91)  

REV 00 05/19/71

**PURPOSE:**  
1. TO DRIVE THE OPTICS TO SHAFT AND TRUCHANNEL 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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</tbody>
</table>

**CREW SELECTION**

---

START CREW INITIATED

**OSS COARSE ALIGN**

---

KEY IN V4IN91E

---

**IS CURRENT PROGRAM P00?**

Y N

---

TURN ON OPERATOR ERROR LIGHT
TERMINATE FLASH UPON RECEIPT OF DATA OR V33E

DATA V
  . 3
  . 3
  . E
  

USE ANGLES IN SAC, PAC

DISPLAY COARSE ALIGN VERB V41

MONITOR OISK: OBSERVE DISPLAY OF COARSE ALIGN VERB

ENABLE CMC POSITIONING OF OPTICS TO DESIRED ANGLES

EXIT

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.

PROG CONT CMC GROUND CREW

DO I DESIRE TO LOAD
A DELTA GYRO ANGLE
GREATER THAN +99.999
DEGREES?

--- --- --- --- ---
N Y
--- --- --- --- ---

THE ASTRONAUT
MUST LOAD THE
THREE DOUBLE PRE-
CISION OGC
REGISTERS:

<KEY V210DEE
02797E
XXXXX
NISE
XXXXXXX
YYYYY
YYYYYY
ZZZZZZ
ZZIZZI
BIT 14 OF THE
HIGH ORDER RE-
PRESENTS 180 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
+ 489 PULSE TORQUE GYROS

---

KEY V42E

---

#30

#40

#50

#60

#70

732
IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

N  Y

TURN ON OPERATOR ERROR LIGHT

EXIT

FLASH VERB-NOUN TO REQUEST LOAD OF DELTA GYRO ANGLES
V219F3 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 TORKED TO COM-

MONITOR DSKY: OBSERVE VERB-NOUN
FLASH REQUESTING LOAD OF DELTA GYRO ANGLES

DID I LOAD THE GYRO TORKING REGISTERS
<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0130</td>
<td><strong>PLEASE ENTER THE FINE ALIGNMENT.</strong> ALL ANGLES IN DEGREES TO NEAREST .001 DEGREES <strong>BEFORE KEYING V42E?</strong></td>
</tr>
<tr>
<td>0140</td>
<td>*Y *Y</td>
</tr>
<tr>
<td>0150</td>
<td><strong>WAIT FOR KEYBOARD ENTRY</strong></td>
</tr>
<tr>
<td>0160</td>
<td><strong>KEY IN V33E</strong></td>
</tr>
<tr>
<td>0170</td>
<td><strong>LOAD DESIRED DELTA GYRO ANGLES</strong></td>
</tr>
<tr>
<td>0180</td>
<td><strong>TERMINATE FLASH UPON RECEIPT OF V33E OR DATA</strong></td>
</tr>
<tr>
<td>0190</td>
<td><strong>V33E OR DATA</strong></td>
</tr>
<tr>
<td>0200</td>
<td><strong>DISPLAY FINE ALIGN VERB V42</strong></td>
</tr>
<tr>
<td>0210</td>
<td><strong>MONITOR DSKY: OBSERVE DISPLAY OF FINE ALIGN VERB</strong></td>
</tr>
<tr>
<td>0220</td>
<td><strong>IS A MODE SWITCH OR A GYRO TORGUING IN PROGRESS?</strong></td>
</tr>
<tr>
<td>0230</td>
<td>*N *Y</td>
</tr>
</tbody>
</table>
TURN ON OPERA-
TOR ERROR LIGHT

IS THE IMU BEING
INITIALIZED?

ENTER FINE ALIGN
MODE

+ +
01
+ +

TURN OFF NO ATT
LIGHT

OBSERVE NO ATT
LIGHT OFF

WAIT 2 SEC

PULSE IRIS THROUGH
DESIRED ANGLES

EXIT
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 OVERRIDDEN.

3) THE PROCESS MAY NOT BE SELECTED IF THE IMU IS IN THE COARSE ALIGN OR ZERO ICDJ MODE.

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 =16.88 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 P00.

<table>
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<th>PROG</th>
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<th>CREW</th>
<th>GROUND</th>
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CREW SELECTION

-------------
START CREW INITIATED --------------
LOAD FOAI ATTITUDE --------------
ERROR NEEDLES --------------

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

-------------
IS THE CMC IDLING
PROGRAM (P00) IN

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

---

#10

V43/SKYLARK
PROCEED?

- Y
- N

IS THE IMM MODE
COARSE ALIGN?

- N
- Y

IS THE ZERO
COU BIT SET?

- N
- Y

HAS LIFT-
OFF TAKEN
PLACE?

- N
- Y

IS ANOTHER
EXTENDED VERB,
A MARK-
TING DIS-
PLAY, OR
A PRIORITY
DISPLAY
ACTIVE?

- N
- Y

- TURN ON OPER-
ATOR ERROR
LIGHT
RESET ERROR COUNTER

FLASH VERB-NOUN TO
REQUEST LOAD OF
ERROR ANGLES

V21 N22
R1- ROLL
R2- PITCH
R3- YAW

ALL REGISTERS INITIALLY 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

DATA

LOAD DESIRED ERROR ANGLES

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH REQUESTING
LOAD OF ERROR ANGLES

V43/SKYLARK
ACTIVATE DOCKED DAP EXTENDED VERB 45

REV 00 05/19/71

PURPOSE: (1) TO ACTIVATE DOCKED RCS DAP.

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

<table>
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<tr>
<th>PROGRAM CONT</th>
<th>CMC</th>
<th>GROUND</th>
<th>CREW</th>
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</table>

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START CREW INITIATED

ACTIVATION OF DOCKED RCS DAP

---

KEY IN V45E

---

IS THIS P40?

---

N     Y

---

TURN ON
OPERATOR
ERROR LIGHT

---

EXIT
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

---IS TVC DAP ON?---

N Y

---IS VEHICLE CONFIGURATION 2 OR 67?---

Y N

---TURN ON OPERATOR ERROR---
LIGHT

PERFORM HIGH BW
TO LOW BW SWITCH-
OVER OF THE TVC
DAP

IS VEHICLE CONFIG-
URATION (R03) = 0?

IS VEHICLE COV-
RATION = 1, 2, OR 6?

ESTABLISH
SATURN

ESTABLISH
UNDOCKED
SET DWS STATE VECTOR INTO CSM STATE VECTOR
EXTENDED VERB 47

PURPOSE: 1. TO TRANSFER THE DWS STATE VECTOR INFORMATION TO THE CSM STATE VECTOR.

ASSUMPTIONS: 1. THIS TRANSFER OF THE STATE VECTOR INFORMATION MAY BE ACCOMPLISHED AT ANY TIME EXCEPT WHEN AVERAGE-3 IS ON.
2. THE PROCESS IS CREW SELECTED BY USKY ENTRY.
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 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
INCREMENT CMC TIME (DECIMAL) EXTENDED VERB 55

REV 01 03/20/72

PURPOSE: (1) TO CHANGE THE CMC CLOCK TIME USING INCREMENTS (1 OR DECREMENTS) LOADED BY THE ASTRONAUT.

ASSUMPTIONS: (1) THE PROCESS MAY BE SELECTED ONLY WHEN NO OTHER EXTENDED VERB IS ACTIVE.
(2) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

<table>
<thead>
<tr>
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<th>CREW</th>
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<tbody>
<tr>
<td>CONT</td>
<td>INITIATED</td>
<td>-</td>
<td>CREW SELECTION</td>
</tr>
<tr>
<td>-</td>
<td>CHANGE OF CMC CLOCK</td>
<td>-</td>
<td>KEY IN V55E</td>
</tr>
<tr>
<td>-</td>
<td>IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, D: A PRIORITY DISPLAY ACTIVE?</td>
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</tr>
</tbody>
</table>

N | Y

- TURN ON OPERATOR ERROR LIGHT

#10

#20

#30
SPECIFY SETTING OF FULL TRACK FLAG
EXTENDED VERB 57

REVD 00  05/19/71

PURPOSE:
1) TO DISPLAY STATUS OF FULL TRACK FLAG AND ALLOW CHANGE BY DSKY ENTRY.

ASSUMPTIONS:
1) FULLKFLG IS EXAMINED ONLY DURING AUTOMATIC M-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.

---------------------------------------------------------------------
<table>
<thead>
<tr>
<th>CREW</th>
<th>SELECTION</th>
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<tbody>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>START CREW INITIATED</td>
<td>KEY IN V57E</td>
</tr>
<tr>
<td>SPECIFY SETTING OF</td>
<td></td>
</tr>
<tr>
<td>FULL TRACK FLAG</td>
<td></td>
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<tr>
<td>PROCESS</td>
<td></td>
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<tr>
<td>IS ANOTHER EXTENDED</td>
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<tr>
<td>VERB, A MARKING DIS-</td>
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<tr>
<td>PLAY, OR A PRIORITY</td>
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<tr>
<td>DISPLAY ACTIVE?</td>
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<tr>
<td>NO</td>
<td>YES</td>
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<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>TURN ON OPERATOR</td>
<td></td>
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<tr>
<td>ERRORS LIGHT</td>
<td></td>
</tr>
</tbody>
</table>
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#10

#20

#30

V57/SKYLARK
HOLD
FLASH VERB-NOUN TO REQUEST RESPONSE AND DISPLAY OPTION CODE FOR FULL OR PARTIAL TRACKING:
V04 N12
R1-00004
R2-0000X
R3-BLANK
SNAP
R1 IS THE OPTION CODE FOR SETTING OF FULL TRACK FLAG.
R2 IS THE CURRENT STATUS OF FULTKFLG:
00001-SET FULTKFLG (PARTIAL TRACKING)
00000-RESET FULTKFLG (FULL TRACKING)

MONITOR DSKY:
OBSERVE VERB-NOUN FLASH TO REQUEST RESPONSE AND DISPLAY OF STATUS OF FULL TRACK FLAG.

WAIT FOR KEYBOARD ENTRY

IS THE ASSUMED STATUS CORRECT?

YES
NO

KEY IN PROCEED

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA.

PROCEED NEW DATA

KEY IN V22E AND LOAD THE DESIRED OPTION INTO 12.
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

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<th>PROG</th>
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START CREW INITIATED
STICK FLAG RESET
PROCESS

CREW SELECTION

KEY IN V58E

EXIT

RESET STICK FLAG

SET V50N18 FLAG

EXIT
ENABLE ALL JETS (DOCKED) EXTENDED  
VERG 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-DMS DOCKED CONFIGURATION.
(2) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

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CREW SELECTION

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ENABLE ALL JETS IN CH5 AND CH6

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KEY IN V59E

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CHANGE CONTROL NOTES

REV 00  PCR 005,040
SET ATTITUDE ERROR REFERENCE TO PRESENT ATTITUDE
EXTENDED VERB 60

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.

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SET THE REGISTERS ASSOCIATED WITH NOUN 17 EQUAL TO THE REGISTERS ASSOCIATED WITH NOUN 20.

... ...

EXIT EXIT

#10

#20
SELECT MODE 2 (DISPLAY TOTAL ATTITUDE ERROR)
(N22-N201) EXTENDED VERD 52

REV 01 03/20/72

PURPOSE:
(1) TO DISPLAY THE TOTAL ATTITUDE ERROR (N22-N20) ON THE FDAI ATTITUDE ERROR NEEDLES.

ASSUMPTIONS:
(1) THE PROCESS IS CREW SELECTED BY DSky ENTRY.
(2) THIS PROCESS MAY BE SELECTED AT ANY TIME.

PROGRAM

CMC

GROUND

CREW

CREW SELECTION

START CREW INITIATED MODE 2 ERROR DISPLAY

KEY IN V62E

SET NEEDLFLG

SET N22JRV17

FLAG

EXIT

EXIT

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V62/SKYLARK
**SELECT MODE 3 [DISPLAY TOTAL ASTRONAUT ATTITUDE ERROR (N17-N23) ON THE FDD ATTITUDE ERROR NEEDLES.**

**ASSUMPTIONS:**
1. THE PROCESS IS CREW SELECTED BY DSKY ENTRY.
2. THIS PROCESS MAY BE SELECTED AT ANY TIME.

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START CREW INITIATED

MODE 3 ERROR DISPLAY

SET NEEDFLG

EXIT

RESET N20K417

FLAG

EXIT

REV 01 03/20/72
SET CSM STATE VECTOR INTO OWS STATE VECTOR
EXTENDED VERB 66
REV 00 05/19/71

PURPOSE: (1) TO TRANSFER THE CSM STATE VECTOR INFORMATION TO THE OWS STATE VECTOR.

ASSUMPTIONS: (1) THE TRANSFER OF THE STATE VECTOR INFORMATION MAY BE ACCOMPLISHED AT ANY TIME EXCEPT IF AVERAGE-G ROUTINE WAS IN PROCESS.
(2) THE PROCESS IS CREW SELECTED BY DSKY ENTRY.

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TRANSFER THIS VEHICLE STATE VECTOR TO OTHER VEHICLE STATE VECTOR

EXIT

CHANGE CONTROL VOTES
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.

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START W-MATRIX RSS ERROR DISPLAY PROCESS

--------

KEY IN V67E

--------

IS ANOTHER EXTENDED VERB, A MARKING DISPLAY, OR A PRIORITY DISPLAY ACTIVE?

N Y

TURN ON OPERATOR ERRJR LIGHT

--------
IZATION
00001 = RENDEZVOUS
+3-MATRIX
INITIALIZA-
TION

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

WAIT FOR KEYBOARD
ENTRY.

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

TERMINATE FLASH UPON
RECEIPT OF PROCEED,
OR NEW DATA

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

P     NEW
R     DATA
Q     
C     
E     STORE NEW
D     DATA

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

EXIT

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

IS THE UPTON
CODE = 0?

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

Y

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

N

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

EXIT

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

KEY IN PROCEED

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

KEY IN V25E AND
LOAD NEW DATA.
BE SURE R3
CONTAINS REN-
DEZVOUS CODE
TO ALLOW INI-
TIALIZATION.

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

EXIT

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

V67/SKYLARK
RESTORE 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 CONDIT-
ION 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?

Y

IS THE ACC
WARNING

V69/SKYLARK
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

800
BLANK DSKY REGISTERS
PROGRAM, VERB,
NOUN, R1, R2, R3)

---------
OBSERVE DSKY
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
YES
NO

-------
GO TO
"B"
BELOW

-------
CLEAR SELF CHECK
ERROR REGISTERS,
MODE REGISTER

---

---

ZERO/JURBIT CHANNELS: 11
{"A" RELAYS}; 12
{GC} (BITS 6 AND
4 SET TO 1 IF
NECESSARY); 13
{AGC}; AND
14 (ISS)

---

---

INITIALIZE DOWN-
LINK WITH POO
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 TSRIPT FOR DAP PROGRAM

INITIALIZE OPTICS

INITIALIZE IMU
**+**
**+01**
**+**

**TURN OFF DSKY DIS-**
**+**
**CRETE LIGHTS EXCEPT**
**+**
**PROG, GIMBAL LOCK**
**+**
**AND NO ATT.**
**+**

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**IS NO ATT LIGHT ON?**
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**Y**

**RETURN ISS TO**
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**COARSE ALIGN**
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**IS ENGONFL2 SET?**
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**Y**

**TURN ENGINE ON**
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**BIT 13 CHANNEL**
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**111**

**TEST PHASE TABLE.**
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**IS IT CORRECT?**
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**Y**

**TURN ON PROG**
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**ALARM AND**
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STORk ALARM
CODE 1107

WERE ANY PHASES
ACTIVE?

Y  N

DO ROUTINE
430

DISPLAY PROGRAM
NUMBER

EXIT  EXIT

CHANGE CONTROL NOTES

REV 01  PCN 489
PRECEDED PAGE BLANK NOT FILMED
INITIALIZE ERASABLE DUMP VIA DOWNLINK
EXTENDED VFRB 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. DJMPING OF ALL EIGHT BANKS IS REPEATED TWICE (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).

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CREW SELECTION

---
START CREW INITIATED
DOWNLINK ERASABLE
DUMP

---
KEY IN V74E

---
TERMINATE CURRENT
DOWNLINK

---
EXIT

#10

#20
SET E BANK COUNTER, WORD COUNTER, AND DUMP COUNTER = 0

INITIALIZE E BANK DUMP, DUMP ID, SYNCH BITS, ECADR AND TIME1.

DUMP E BANK

INCREMENT E BANK COUNTER AND SET WORD COUNTER = 0.

ARE ALL 8 BANKS DUMPED? IE BANK COUNTER = 81?

N Y

INCREMENT DUMP COUNTER AND SET E BANK
COUNTER = 0

HAVE TWO COMPLETE DUMP PASSES BEEN MADE (DJMP COUNTER = 2)?

- N
- Y

RESTORE CURRENT DOWNSWING

EXIT

CHANGE CONTROL VOTES
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 QSKY 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 CREW
CMC GROUND SELECTION

---
START CREW INITIATED EXTENDED VERB 76
EXTEnded verb 76 PROCESS
---
KEY IN V76E
---
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.

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CREW SELECTION

START CREW INITIATED
EXTENDED VERB 77
PROCESS

KEY IN V77E

RESET R27FLAG

EXIT

CHANGE CONTROL NOTES

REV 00  PGR 439
CHANGE GYRO COMPASS LAUNCH AZIMUTH
EXTENDED VERB 78

REV 00 05/19/71

PURPOSE: (1) TO PROVIDE THE PROPER STABLE MEMBER ORIENTATION FOR LAUNCH.

ASSUMPTIONS: (1) THE PROCESS HAS THE CAPABILITY TO CHANGE THE LAUNCH AZIMUTH OF THE STABLE MEMBER WHILE GYRO COMPASSING (PO2).
(2) PROCESS IS CREW SELECTED BY DSKY ENTRY.
(3) THE PROCESS MAY BE SELECTED ONLY DURING GYRO COMPASSING PROGRAM (PO2).

PROG CONT 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
TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

NEW DATA

LOAD NEW LAUNCH AZIMUTH

STORE NEW DATA

CHANGE CONTROL NOTES
**UPDATE OWS STATE VECTOR EXTENDED VERB 80**

**PURPOSE:** To cause the rendezvous data processing results to update the OWS state vector.

**ASSUMPTION:** Process is crew selected by DSKY entry.

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

- Crew selection

---

**Start crew initiated OWS state vector update process**

---

**Reset vehicle update flag**

---

**Key in V80E**

---

**Exit**

**CHANGE CONTROL NOTES**

----

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**REV 00 05/19/71**
UPDATE CSM STATE VECTOR EXTENDED VER 3 81

REV 00 05/19/71

PURPOSE: (1) TO CAUSE THE RENDEZVOUS DATA PROCESSING RESULTS TO UPDATE THE CSM STATE VECTOR.

ASSUMPTION: (1) PROCESS IS CREW SELECTED BY DSKY ENTRY.

---

CHANGE CONTROL NOTES

---

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#10

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#20

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---

#30
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.

---

RECYCLE TO PERFORM
ALTERNATE LOS

ERASE MARK DATA
(IF ANY) IN POSITION
#1 OR SET REJCTFLG TO REJECT MARK BEING PROCESSSED BY R22 (IF ANY)

START CREW INITIATED
REJECT OF RENDEZVOUS
BACKUP SIGHTING
MARK PROCESS.

CREW SELECTION

KEY IN V86E

EXIT

PRECEDEING PAGE BLANK NOT FILLED
RESET VHF RANGE FLAG EXTENDED VERB 88

PURPOSE: (1) TO RESET THE VHF RANGE FLAG.

ASSUMPTION: (1) PROCESS IS CREW SELECTED BY DSKY 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></td>
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</tr>
</tbody>
</table>

- CREW
- SELECTION

------------------------
INITIATE RESET VHF RANGE FLAG PROCESS
------------------------
------------------------
KEY IN V88E
------------------------

----------------------
TURN OFF TRACKER LIGHT
----------------------

----------------------
RESET VHF RANGE FLAG
----------------------

EXIT

EXIT
Purpose: Request Banksum Display
Extended Verb 91

Assumptions: 11) Display the sum of each bank for comparison.
12) PDO is operating.
13) Process is crew selected by DSKY entry.

Start Crew Initiated
Banksum Display

Program 900

Is Program Operating?

Yes

Is Another Extended Marking Display?
OR A PRIORITY DISPLAY ACTIVE?

- N  - Y

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
R2 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
P11 = R2.

MOUNT DSKY:
OBSERVE V-N FLASH TO
REQUEST DISPLAY OF
BANK SUMS

IS THIS THE BANK I DESIRE TO READ?

IS THE BANK SUM THE NUMBER I EX-
ENABLE W-MATRIX INITIALIZATION EXTENDED
VER0 05/19/71

PURPOSE: (1) TO REQUEST REINITIALIZATION OF THE W-MATRIX.

ASSUMPTIONS: (1) THE PROCESS IS CREW SELECTED BY USK ENTRY.

(2) THIS PROCESS RESETS THE REWDWFLG INDICATING THAT THE W-MATRIX IS NOT VALID AND MUST BE REINITIALIZED BEFORE BEING USED. THE REWDWFLG 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>CMC</th>
<th>GROUND</th>
<th>CREW</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONT</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

CREW SELECTION

-----------------------
START CREW INITIATED
W-MATRIX INITIALIZATION

-----------------------
RESET REWDWFLG

-----------------------
EXIT

CHANGE CONTROL NOTICES

REV 90  PCR 017.319
TERMINATE INTEGRATION AND GO TO P00
EXTENDED VERB 96

REV 01 03/20/72

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) V3 STATE VECTOR INTEGRATION OCCURS UNTIL THE RESELECTION OF ANY PROGRAM OR EXTENDED VERB. N3 P00 INTEGRATION OCCURS UNTIL THE RESELECTION OF P00.
(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.

PROG CONT  CMC  GROUND  CREW

+01
+  
+  
+489
**
**
**
**
**
**
**
**

START TERMINATE INTEGRATION AND GO TO P00 PROCESS

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

KEY IN VERB 96

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

CREW SELECTION

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

GO TO P00

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

SET QUIT FLAG
THRUST FAIL DISPLAY EXTENDED VERB 97

REV 00 05/19/71

NOTE: EXTENDED VERB 97 IS USED IN THE SPS THRUST FAIL REPORT. 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
4.5 This list represents the verbs used in program Skylark

4.5.1 Regular Verbs

00 Not in use
01 Display Octal Comp 1 in R1
02 Display Octal Comp 2 in R1
03 Display Octal Comp 3 in R1
04 Display Octal Comp 1, 2 in R1, R2
05 Display Octal Comp 1, 2, 3 in R1, R2, R3
06 Display Decimal in R1 or R1, R2, R3
07 Display DP Decimal in R1, R2
08 Spare
09 Spare
10 Spare
11 Monitor Octal Comp 1 in R1
12 Monitor Octal Comp 2 in R1
13 Monitor Octal Comp 3 in R1
14 Monitor Octal Comp 1, 2 in R1, R2
15 Monitor Octal Comp 1, 2, 3 in R1, R2, R3
16 Monitor Decimal in R1 or R1, R2 or R1, R2, R3
17 Monitor DP Decimal in R1, R2
18 Spare
19 Spare
20 Spare
21 Load Component 1 into R1
22 Load Component 2 into R2
23 Load Component 3 into R3
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 DSKY LIGHTS
36 REQUEST FRESH START
37 CHANGE PROGRAM
38 SPARE
39 SPARE

4.5.2 EXTENDED VERBS

40 ZERO IMU CDU
41 COARSE ALIGN CDU (W N20,N91)
42 PULSE TORQUE GYRO
43 LOAD FDI ATT ERROR NEEDLES (TEST JULY)
44 REQUEST Docked DAP DATA LOAD (R04)
45 ACTIVATE Docked DAP
46 ACTIVATE CSM DAP
47 SET DWS STATE VECTOR INTO CSM STATE VECTOR
48 REQUEST CSM DAP DATA LOAD (RO3)
49 START C V-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 V5ON18 FLAG
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 UNIVERSAL UPDATE-BLOCK ADR (P27)
72 UNIVERSAL UPDATE-SINGLE ADR (P27)
73 UPDATE CMC TIME (OCTAL) (P27)
74 INITIALIZE ERASABLE DUMP VIA DOWNLINK
75 SET LIFTOFF FLAG
76 ENABLE RANGE LATE MARK PROCESSING (R27)
77 DISABLE RANGE RATE MARK PROCESSING (R27)
<table>
<thead>
<tr>
<th>Noun/Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>00</td>
<td>NCT IN USE</td>
</tr>
<tr>
<td>01</td>
<td>SPECIFY ADDRESS (FRAC)</td>
</tr>
<tr>
<td>02</td>
<td>SPECIFY ADDRESS (WHOLE)</td>
</tr>
<tr>
<td>03</td>
<td>SPECIFY ADDRESS (DEGREE)</td>
</tr>
<tr>
<td>04</td>
<td>ATTITUDE ERROR (NL)</td>
</tr>
<tr>
<td>05</td>
<td>ANGULAR ERROR/DIFFERENCE SIGHTING ANGLE</td>
</tr>
<tr>
<td>06</td>
<td>OPTION CODE</td>
</tr>
<tr>
<td>07</td>
<td>CHANNEL/FLAGWORD/ERASABLE OPERATOR</td>
</tr>
<tr>
<td>08</td>
<td>ALARM DATA</td>
</tr>
<tr>
<td>09</td>
<td>ALARM CODES</td>
</tr>
<tr>
<td>10</td>
<td>CHANNEL TO BE SPECIFIED</td>
</tr>
<tr>
<td>11</td>
<td>TIG (NCC)</td>
</tr>
<tr>
<td>12</td>
<td>OPTION CODE</td>
</tr>
<tr>
<td>13</td>
<td>TIG (NSR)</td>
</tr>
</tbody>
</table>
14 STAR TRACKER AZIMUTH
   ELEVATION
   0000. MIN
   0XX.XX SEC

15 INCREMENT ADDRESS
   0000. HRS
   0000. MIN
   0XX.XX SEC

16 TIME OF EVENT (USED BY EXT VERB ONLY)
   0000. HRS
   0000. MIN
   0XX.XX SEC

17 ASTRONAUT TOTAL ATTITUDE
   (USED IN MOJE 3 NEEDLES (V63))
   R XXX.XX DEG
   P XXX.XX DEG
   Y XXX.XX DEG

18 BALL ANGLES AUTO MANEUVER
   R XXX.XX DEG
   P XXX.XX DEG
   Y XXX.XX DEG

19 STAR TRACKER AZIMUTH
   OCT
   OCT

20 PRESENT ICDU ANGLES
   R XXX.XX DEG
   P XXX.XX DEG
   Y XXX.XX DEG

21 PIPAS
   X XXXXX. PULSES
   Y XXXXX. PULSES
   Z XXXXX. PULSES

22 NEW ICDU ANGLES
   R XXX.XX DEG
   P XXX.XX DEG
   Y XXX.XX DEG

23 NAV BASE TO AIM DOCKING ANGLES
   ALPHA XXX.XX DEG
   BETA XXX.XX DEG
   GAMMA XXX.XX DEG

24 DELTA TIME FOR CMC CLOCK
   0000. HRS
   0000. MIN
   0XX.XX SEC

25 CHECKLIST (USED WITH V50)
   XXXXX.

26 PRIOR/DELAY, ADDRESS, BBCON
   OCT
   OCT
   OCT

27 SELF TEST ON/JFF SWITCH
   XXXXX.

28 TIG (NC2)
   0000. HRS
   0000. MIN
   0XX.XX SEC

29 XSM LAUNCH AZ
   XXX.XX DEG
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<tr>
<th>Field</th>
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<tbody>
<tr>
<td>30 TARGET CODE</td>
<td>(GYROCOMPASSING VERIFICATION)</td>
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<tr>
<td>31 TIME OF LAST A-MATRIX REINITIALIZATION</td>
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<td>32 TIME FROM PERIGEE</td>
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</tr>
<tr>
<td>33 TIG</td>
<td></td>
</tr>
<tr>
<td>34 TIME OF EVENT</td>
<td></td>
</tr>
<tr>
<td>35 TIME FROM EVENT</td>
<td></td>
</tr>
<tr>
<td>36 TIME OF CMG CLOCK</td>
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<tr>
<td>37 TIG (TPI)</td>
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<tr>
<td>38 TIME OF STATE VECTOR</td>
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<tr>
<td>39 TIG OF LAST MANEUVER</td>
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<tr>
<td>40 TFI/TFC (NL)</td>
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<tr>
<td>41 TARGET AZIMUTH</td>
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<tr>
<td>42 APO ALT</td>
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<tr>
<td>43 LATITUDE (+ NORT4)</td>
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<tr>
<td>44 ALTITUDE</td>
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<td>PER ALT</td>
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<td>MARKS (VHF-OPTICS)</td>
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<td>TPI (NEXT BURN)</td>
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<td>MGA/CODE</td>
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<td>46</td>
<td>DAP CONFIG</td>
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<td>THIS VEHICLE WEIGHT</td>
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<td>OTHER VEHICLE WEIGHT</td>
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<td>GIMBAL PITCH TRIM</td>
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<td>GIMBAL YAW TRIM</td>
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<td>DELTA R</td>
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<td>SPARE</td>
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<td>CENTRAL ANGLE OF ACTIVE VEHICLE</td>
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<tr>
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<td>RANGE</td>
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<td>RANGE RATE</td>
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<td>PHI</td>
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<td>DELTA H (NGC)</td>
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<td>DELTA H (NSR)</td>
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<tr>
<td>58</td>
<td>DELTA V (TPI)</td>
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<td>DELTA V (TPF)</td>
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<td>DELTA Y (TPI-VOMTPI)</td>
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<td>59</td>
<td>DELTA V LOS 1</td>
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<td>DELTA V LOS 2</td>
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<td>DELTA V LOS 3</td>
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<td>G MAX</td>
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<tr>
<th>IMPACT LATITUDE</th>
<th>IMPACT LONGITUDE</th>
<th>HEADS UP/DOWN (+ UP)</th>
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<thead>
<tr>
<th>VI</th>
<th>INERTIAL VEL MAG</th>
<th>H</th>
<th>ALT RATE</th>
<th>ALT ABOVE PAD RADIUS</th>
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<tr>
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<tr>
<th>RTGO</th>
<th>RNG FROM E.I. TO SPLASH (NL)</th>
<th>VEO</th>
<th>PREDICTED INERT VEL AT E.I.</th>
<th>TFE</th>
<th>TIME FROM FROM E.I.</th>
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<tr>
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<table>
<thead>
<tr>
<th>G, DRAG ACCELERATION</th>
<th>VI</th>
<th>INERTIAL VELOCITY</th>
<th>R TO GO (+ OVSHT)</th>
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<tr>
<th>SAMPLED GVC TIME</th>
<th>(FETCHED IN INTERRUPT)</th>
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<td>OJXXXX</td>
<td>OJJXX, MNS</td>
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<table>
<thead>
<tr>
<th>RETA</th>
<th>CMD BANK ANGLE</th>
<th>CROSS RANGE ERROR (+ TGT RT)</th>
<th>DOWN RANGE ERROR (+ OVSHT)</th>
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<table>
<thead>
<tr>
<th>R TO GO (+ OVSHT)</th>
<th>LAT</th>
<th>PRESENT POSITION (+ NORTH)</th>
<th>LONG</th>
<th>PRESENT POSITION (+ EAST)</th>
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<tr>
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<th>BETA</th>
<th>CMD BANK ANGLE</th>
<th>VI</th>
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<th>HDOT</th>
<th>ALT RATE</th>
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<thead>
<tr>
<th>BETA</th>
<th>Dl</th>
<th>Vl</th>
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<td>XXXXX</td>
<td>G</td>
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<table>
<thead>
<tr>
<th>SIGHTING SOURCE - CELESTIAL BODY</th>
<th>CCDE (BEFORE MARK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OOT</td>
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<table>
<thead>
<tr>
<th>SIGHTING SOURCE - CELESTIAL BODY</th>
<th>CCDE (AFTER MARK)</th>
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<tbody>
<tr>
<td>OOT</td>
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<table>
<thead>
<tr>
<th>TIME OF R27 OPTIMIZATION</th>
<th>OJXXXX, MNS</th>
</tr>
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<table>
<thead>
<tr>
<th>ALTITUDE</th>
<th>VELOCITY</th>
<th>FLIGHT PATH ANGLE</th>
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<th>BETA</th>
<th>CMD BANK ANGLE</th>
<th>VI</th>
<th>INERTIAL VELOCITY</th>
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</thead>
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<td>XXXXX</td>
<td>XXXXX</td>
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<td>XXXXX</td>
</tr>
<tr>
<td>Column</td>
<td>Description</td>
<td>Units</td>
<td>Memory Address</td>
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<tr>
<td>--------</td>
<td>--------------------------------------------------</td>
<td>---------------</td>
<td>----------------</td>
</tr>
<tr>
<td>75</td>
<td>DELTA H (NSR) (NL)</td>
<td>XXX.XX NM</td>
<td>489</td>
</tr>
<tr>
<td></td>
<td>DELTA T (TPI-NSR)</td>
<td>XXXX.X FPS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DELTA T (TPI-NOMTP)</td>
<td>XXXX.X FPS</td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>R27 RANGE (NL)</td>
<td>XXX.XX NM</td>
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<td>R27 RANGE RATE</td>
<td>XXXX.X FPS</td>
<td></td>
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<tr>
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<td>TIME FROM R27 OPTIM</td>
<td>XXXX.X M-S</td>
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</tr>
<tr>
<td>77</td>
<td>R27 RANGE</td>
<td>XXX.XX NM</td>
<td>489</td>
</tr>
<tr>
<td></td>
<td>R27 RANGE RATE</td>
<td>XXXX.X FPS</td>
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<tr>
<td></td>
<td>R27 THETA/PHI/CODE</td>
<td>XXXX.XX DEG</td>
<td>/-00001</td>
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<tr>
<td>78</td>
<td>GAMMA RHO CMIcron</td>
<td>XXX.XX DEG</td>
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<td>XXX.XX DEG</td>
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<td></td>
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<td>XXX.XX DEG</td>
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<tr>
<td>79</td>
<td>RATE (+ INCREASING CDU)</td>
<td>X.XXX DEG/SEC</td>
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<td>DEACBAND</td>
<td>XXX.XX DEG</td>
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<td>80</td>
<td>TFI/TFC (NL)</td>
<td>XXXX.XX FPS</td>
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<td></td>
<td>VG</td>
<td>XXXX.XX FPS</td>
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<td>DELTA V (ACCUMULATED)</td>
<td>XXXX.XX FPS</td>
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<tr>
<td>81</td>
<td>DELTA VX (LV)</td>
<td>XXXX.XX FPS</td>
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<td></td>
<td>DELTA VY (LV)</td>
<td>XXXX.XX FPS</td>
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<td>DELTA VZ (LV)</td>
<td>XXXX.XX FPS</td>
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<td>82</td>
<td>DELTA VX (LV) FOR NSR</td>
<td>XXXX.XX FPS</td>
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<td>DELTA VY (LV) FOR NSR</td>
<td>XXXX.XX FPS</td>
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<tr>
<td></td>
<td>DELTA VZ (LV) FOR NSR</td>
<td>XXXX.XX FPS</td>
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<td>83</td>
<td>DELTA VX (CONF)</td>
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<td>DELTA VY (CONF)</td>
<td>XXXX.XX FPS</td>
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<td>DELTA VZ (CONF)</td>
<td>XXXX.XX FPS</td>
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<td>84</td>
<td>DELTA V (NEXT MANEUVER)</td>
<td>XXXX.XX FPS</td>
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<td>DELTA H (NEXT MANEUVER)</td>
<td>XXXX.XX NM</td>
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<td>DELTA V (THIRD MANEUVER)</td>
<td>XXXX.XX FPS</td>
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<td>VGX (CONT)</td>
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<td>VGY (CONT)</td>
<td>XXXX.XX FPS</td>
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<td>VGZ (CONT)</td>
<td>XXXX.XX FPS</td>
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<td>86</td>
<td>DELTA VX (LV)</td>
<td>XXXX.XX FPS</td>
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<td>DELTA VZ (LV)</td>
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<td>87</td>
<td>DCCMED DAP FLAG SPECIFICATION</td>
<td>OCT</td>
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<td>CHANNEL 5 JETS INHIBITED</td>
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<td>CHANNEL 6 JETS INHIBITED</td>
<td>OCT</td>
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<td>88</td>
<td>PLANET UNIT POSITION VECTOR X</td>
<td>XXXXXXX</td>
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<td></td>
<td>PLANET UNIT POSITION VECTOR Y</td>
<td>XXXXXXX</td>
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</table>
89 DOCKED DAP RATE
   DOCKED DAP DEADBAND
   XXX.XX DEG/SEC
   XXX.XX DEG

90 REND OUT-OF-PLANE PARAMETERS (P3X) Y CM
   Y OUT CM XXX.XX FPS
   Y DOT OWS XXX.XX FPS

91 PRESENT OCDU ANGLES - SHAFT
   - TRUN

92 NEW OCDU ANGLES - SHAFT
   - TRUN

93 DELTA GYRO ANGLES
   X XXX.XX DEG
   Y XXX.XX DEG
   Z XXX.XX DEG

94 ALTERNATE LOS - SHAFT
   - TRUN

95 TIG (NC1)
   OXXXX. HRS
   000XX. MIN
   XXX.XX SEC

96 REND OUT-OF-PLANE PARAMETERS Y CM
   (BY V90E)
   Y DOT CM XXX.XX FPS
   Y DOT OWS XXX.XX FPS

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 00 PCR 010,011,017,018,019,021,032,036,040,043,045,047,050, SLM #2,19
RFV 01 PCN 489
4.7  THIS LIST REPRESENTS THE CHECKLIST REFERENCE CODES USED WITH V50N25 FOR PROGRAM SKYLARK.

<table>
<thead>
<tr>
<th>R1 CODE</th>
<th>ACTION TO BE EFFECTED</th>
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<tbody>
<tr>
<td>00013</td>
<td>PERFORM COARSE ALIGNMENT</td>
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<tr>
<td>00014</td>
<td>PERFORM FINE ALIGNMENT</td>
</tr>
<tr>
<td>00015</td>
<td>PERFORM CELESTIAL BODY ACQUISITION</td>
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<tr>
<td>00016</td>
<td>TERMINATE MARK SEQUENCE</td>
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<tr>
<td>00017</td>
<td>PERFORM MINKEY RENDEZVOUS</td>
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<tr>
<td>00020</td>
<td>PERFORM PULSE-TORQUING FOR PLANE CHANGE</td>
</tr>
<tr>
<td>00041</td>
<td>SWITCH CM/SM SEPARATION TO UP</td>
</tr>
<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 OSKY

CHANGE CONTROL NOTES

REV 00  PCR 017
4.8 THIS LIST REPRESENTS THE OPTION CODES USED WITH VQ4N06 AND VQ4N12 FOR PROGRAM SKYLARK.
REV 00 05/19/71

THE SPECIFIED OPTION CODES WILL BE DISPLAYED IN R1
IN CONJUNCTION WITH FL VQ4N06 OR FL VQ4N12 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=REF5#MAT</td>
</tr>
<tr>
<td>00002</td>
<td>SPECIFY VEHICLE</td>
<td>1=THIS VEHICLE  2=OTHER VEHICLE</td>
</tr>
<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 SENSJR  2=ATM SJSN SENSOR AND ATM STAR TRACKER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3=ATM ANGLES FROM INDEPENDENT SOURCE</td>
</tr>
<tr>
<td>00013</td>
<td>SPECIFY P55 OPTION</td>
<td>1=CELESTIAL BODY AND IMU ORIENTATION  2=CELESTIAL BODY,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OPTICS MARK, AND ATM SOLAR-INERTIAL ATTITUDE</td>
</tr>
<tr>
<td>00024</td>
<td>SPECIFY ASSUMED TRACKING MODE</td>
<td>0=RENDEZVOUS (VECPPT)  1=TARGET POINTING (VECPPT)</td>
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<tr>
<td></td>
<td></td>
<td>2=ROTATION  4=RENDEZVOUS (3AXIS)  5=TARGET POINTING (3AXIS)</td>
</tr>
</tbody>
</table>

CHANGE CONTROL NOTES
REV 00  PCR 013,016,036,413, PCN 457
<table>
<thead>
<tr>
<th>CODE</th>
<th>PURPOSE</th>
<th>SET BY</th>
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<tr>
<td>00107</td>
<td>STAR TRACKER ANGLES OUT OF LIMITS</td>
<td>P55</td>
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<tr>
<td>00110</td>
<td>NO MARK SINCE LAST MARK REJECT</td>
<td>SXTMARK</td>
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<tr>
<td>00113</td>
<td>NO INBITS</td>
<td>SXTMARK</td>
</tr>
<tr>
<td>00114</td>
<td>MARK MADE BUT NOT DESIRED</td>
<td>SXTMARK</td>
</tr>
<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>
</tr>
<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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<tr>
<td>00120</td>
<td>OPTICS TORQUE REQUEST WITH OPTICS NOT ZEROED T4RUPT</td>
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<tr>
<td>00121</td>
<td>CDU'S NOT GOOD AT TIME OF MARK</td>
<td>SXTMARK</td>
</tr>
<tr>
<td>00205</td>
<td>BAD PIPA READING</td>
<td>SERVICER</td>
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<tr>
<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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<tr>
<td>00207</td>
<td>ISS TURNON REQUEST NOT PRESENT FOR 90 SEC</td>
<td>T4RUPT</td>
</tr>
<tr>
<td>00210</td>
<td>IMU NOT OPERATING</td>
<td>IMU MODE SWITCH 1, IMU 2, R02, P51, P53</td>
</tr>
<tr>
<td>00211</td>
<td>COARSE ALIGN ERROR-DRIVE &gt;2 DEGREES</td>
<td>IMU MODE SWITCH 1</td>
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<tr>
<td>00212</td>
<td>PIPA FAIL BUT PIPA IS NOT BEING USED</td>
<td>IMU MODE SWITCH 1, T4RUPT</td>
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<tr>
<td>00213</td>
<td>IMU NOT OPERATING WITH TJRN-ON REQUEST</td>
<td>T4RUPT</td>
</tr>
<tr>
<td>00214</td>
<td>PROGRAM USING IMU WHEN TURNED OFF</td>
<td>T4RUPT</td>
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<tr>
<td>00217</td>
<td>BAD RETURN FROM STALL ROUTINES</td>
<td>P51,P52,P53,P54</td>
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<tr>
<td>00220</td>
<td>IMU NOT ALIGNED (BAD REFSSMAT)</td>
<td>R02</td>
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<tr>
<td>00401</td>
<td>DESIRED GIMBAL ANGLES YIELD GIMBAL LOCK</td>
<td>INF ALIGN, IMU2,R61</td>
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<tr>
<td>00402</td>
<td>ENTER RESPONSE NOT ALLOWED</td>
<td>P52</td>
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</table>
00404 TARGET OUT OF VIEW (TRUN. ANGLE > 90 DEG) R52
00405 TWO STARS NOT AVAILABLE P52,P54
00406 RXN) NAVIGATION NOT OPERATING R23
00421 W-MATRIX OVER FLOW INTG
00500 NOT ENOUGH JETS FOR SOME PITCH OR YAW ROTATION DOCKED DAP
00501 NOT ENOUGH JETS FOR SOME ROLL ROTATION DOCKED DAP
00600 FAILURE IN PHASE MATCH ITERATION P31,P32
00601 FAILURE IN HEIGHT MANEUVER ITERATION P31,P32
00602 FAILURE IN OUTER LOOP ITERATION P31,P32
00603 FAILURE IN QDTPQ ITERATION P31,P32,P33
00611 NO TIG FOR GIVEN ELEV ANGLE P34,P35
00777 PIPA FAIL CAUSED THE ISS WARNING T4RUPT
01102 CMC SELF TEST ERROR SELF CHECK
01105 DOWNLINK TOO FAST T4RUPT
01106 UPLINK TOO FAST T4RUPT
01107 PHASE TABLE FAILURE. ASSUME ERASABLE MEMORY IS DESTROYED RESTART
01301 ARCSIN-ARCCOS INPUT ANGLE TOO LARGE INTERPRETER
01407 VG INCREASING S40.8
01426 IMU UNSATISFACTORY P61,P62
01427 IMU REVERSED P61, P62
01520 V37 REQUEST NOT PERMITTED AT THIS TIME V37
01600 OVERFLOW IN DRIFT TEST OPT PRE ALIGN CALIB
01601 dAD IMU TORQUE OPT PRE ALIGN CALIB
01703 INSUFFICIENT TIME FOR INTEGRATION, TIG WAS SLIPPED. R41
03777 ICU FAIL CAUSED THE ISS WARNING T4RUPT
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<td>04777</td>
<td>ICDU, PIPA FAILS CAUSED THE ISS WARNING</td>
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<td>07777</td>
<td>IMU FAIL CAUSED THE ISS WARNING</td>
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<td>10777</td>
<td>IMU, PIPA FAILS CAUSED THE ISS WARNING</td>
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<td>13777</td>
<td>IMU, ICDU FAILS CAUSED THE ISS WARNING</td>
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<td>14777</td>
<td>IMU, ICDU, PIPA FAILS CAUSED THE ISS WARNING</td>
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<td>20430</td>
<td>* INTEG. ABORT DUE TO SUBSURFACE S.V.</td>
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<td>20607</td>
<td>* NO SOLUTION FROM TIME THETA OR TIME RADJ AS ROUTINE</td>
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<tr>
<td>21204</td>
<td>* NEGATIVE OR ZERO WAITLIST CALL</td>
</tr>
<tr>
<td>21206</td>
<td>* SECOND JOB ATTEMPTS TO GO TO SLEEP VIA KEYBOARD AND DISPLAY PROGRAM</td>
</tr>
<tr>
<td>21210</td>
<td>* TWO PROGRAMS USING DEVICE AT SAME TIME</td>
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<tr>
<td>21302</td>
<td>* SQRT CALLED WITH NEGATIVE ARGUMENT</td>
</tr>
<tr>
<td>21501</td>
<td>* KEYBOARD AND DISPLAY ALARM DURING INTERNAL USE (NVSUB)</td>
</tr>
<tr>
<td>21502</td>
<td>* ILLEGAL FLASHING DISPLAY</td>
</tr>
<tr>
<td>21521</td>
<td>* P01 ILLEGALLY SELECTED</td>
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<tr>
<td>31104</td>
<td>* DELAY ROUTINE BUSY</td>
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<tr>
<td>31201</td>
<td>* EXECUTIVE OVERFLOW-NO VAC AREAS</td>
</tr>
<tr>
<td>31202</td>
<td>* EXECUTIVE OVERFLOW-NO CORE SETS</td>
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<tr>
<td>31203</td>
<td>* WAITLIST OVERFLOW-TOO MANY TASKS</td>
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<tr>
<td>31211</td>
<td>* ILLEGAL INTERRUPT OF EXTENDED VERB</td>
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<tr>
<td>32000</td>
<td>* DAP JASK STILL IN PROGRESS WHEN</td>
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</table>

**Next Jask Attempted**

* INDICATES ABORT TYPE. ALL OTHERS ARE NON-ABORTIVE.

489 BAILOUT TYPE ABORT

**NOTE:** FOR VOS NO9 DISPLAYS:

* RL-XXXXX (FIRST ALARM FOLLOWING ERROR RESET),
* A2-XXXXX (SECOND ALARM FOLLOWING ERROR RESET),
* A3-XXXXX (MOST RECENT ALARM)
ERROR RESET WILL SET R1 AND R2 TO ZERO, BUT
NOT AFFECT R3

CHANGE CONTROL NOTES

RFV 00  PCR 016, 036, 448, 454, PCN 457
REV 01  PCN 489
SKYLARK 1 (GSOP)

R693

Internal Distribution List

Group 23A
D. Lutkevich
Brennan
Brand
Gustafson
Higgins
Kachmar
Klump
Kriegsman
Levine (4)  

Group 23B
C. Flynn
Klawnsik
Nayar  

Group 23B
C. Taylor
Barnert
Beals
Brodeur
Cramer
Goode
Hamilton
Haslam
Lollar  

Group 23B
J. Flaherty
Albert
Berman
Engel  

Group 23C
M. Erickson
Bairnsfather
Basile
Croopnick
Fraser
Jones
Kalan
Maybeck  

DL7-211 (18)
DL7-221L (12)
DL7-221L (15)
DL7-238A (6)
DL7-215J (13)
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<th>S. Beaulieu</th>
<th>Drake</th>
<th>Dunbar (6)</th>
<th>Groome</th>
<th>Johnson</th>
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<td>Larson</td>
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<td>Group 23P</td>
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<td>Canepa</td>
<td>Fellemann</td>
<td>Heinemann</td>
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<td>Grace</td>
<td>Kido</td>
<td>Lones</td>
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</tr>
</tbody>
</table>
External Distribution List

SKYLARK 1

Charles Stark Draper Laboratory
P. O. Box 21025
Kennedy Space Center
Attn: Mr. R. O'Donnell

(5)

Charles Stark Draper Laboratory
Code EG/MIT Building 16
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