APOLLO

E-1956

AN AUTOMATED DOCUMENTATION TECHNIQUE FOR INTEGRATING APOLLO CREW PROCEDURES AND COMPUTER LOGIC

by
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MIT

CAMBRIDGE 39, MASSACHUSETTS

APOLLO

GUIDANCE AND NAVIGATION

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Presented at the 7th IEEE Symposium on Human Factors in Electronics, Minneapolis, Minnesota, May 5, 6, 1966

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COPY # 66

ACKNOWLEDGMENT

This report was prepared under DSR Project 55-238, sponsored by the Manned Spacecraft Center of the National Aeronautics and Space Administration through Contract NAS 9-4065.

The publication of this report does not constitute approval by the National Aeronautics and Space Administration of the findings or the conclusions contained therein. It is published only for the exchange and stimulation of ideas.

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ABSTRACT

This paper describes a document devised by MIT, which relates 1) on board computer activity, 2) related ground computer activity, and 3) sequencing of airborne systems intimately related to the guidance and navigation (G&N) system, to human operator activity during the Apollo Mission G&N operations. The document serves as a tool for computer programmers, provides a testing device for evaluating mission operations in the various simulators and also serves as a training device. The crew checklist used to define G&N and related airborne system operating procedures is in a form that could be directly used for flight operations. The documentation technique evolved allows rapid information retrieval and updating. Various forms of the data can be extracted for use in mission planning, computer programming, operations analysis, or crew training.

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AN AUTOMATED DOCUMENTATION TECHNIQUE FOR INTEGRATING APOLLO CREW PROCEDURES AND COMPUTER LOGIC

I. SUMMARY

This paper describes a documenting format and technique devised by Massachusetts Institute of Technology, Instrumentation Laboratory, which relates ground link and on-board computer activity to crew activity during Apollo Guidance and Navigation (G&N) operations. The document, titled "Apollo Computer Logic - Checklist Interface", performs several important functions:

1. It serves as a working document within MIT for coordinating the activities of the Space Guidance Analysis, Systems, and Display and Human Factors groups in the generation of the G&N Operations plans.

2. It serves as a working document for doordinating the activities and inputs related to G&N operations for MIT the Spacecraft Prime Contractors, North American Space Information Systems Division and Grumman Aircraft Engineering Corp., and NASA Manned Space Center.

3. It provides an early determination of requirements for use in writing programs which define computer logic flow required to accomplish specific G&N tasks.

4. It provides a testing device in simulators for evaluation of mission operations and the man-machine interface.

5. It may be used as a training device and, in abbreviated form, as an in-flight crew checklist.

The computerized process for producing the document permits a fast update of logic and/or procedures.

II. INTRODUCTION

The Computer Logic-Checklist Interface document was evolved in defining the detailed G&N computer programs and operational procedures to be used on Apollo missions. The Apollo mission differs from previous U.S. Manned Spacecraft Missions in that the G&N system provides a total onboard capability for guidance and navigation. This added capability has necessarily complicated the man-machine interface problem. To enable the reader to appreciate the magnitude of this problem the following is a brief description of the primary guidance and navigation system for the Command and Service Module (CSM), and the Lunar Excursion Module (LEM). More complete descriptions can be found in the referenced documents.

1. Functions of G&N System

The G&N system has the capability to control the spacecraft path throughout its mission which, for the basic Lunar landing mission illustrated in Figure 1, contains fifteen distinct guidance and navigation phases. Also required, Figure 2, is the capability to guide aborts from all phases prior to trans-earth injection. In order to perform these functions, three distinct tasks must be accomplished.

1. Determine position and velocity on present spacecraft orbit.
2. Compute future spacecraft orbit or landing point and the initial conditions for the required maneuver.
3. Control application of thrust or lift so as to achieve the desired new orbit or landing point.

Tasks 1 and 2 are performed periodically during free fall phases - an activity we refer to as navigation. Task 3 is performed continuously during powered maneuvers - an activity we refer to as guidance. Guidance of the Apollo Spacecraft is inertial, i.e. applied force is sensed by accelerometers mounted on a gyroscopically stabilized platform and processed by a computer which generates steering and engine cut-off commands. (Figure 3).

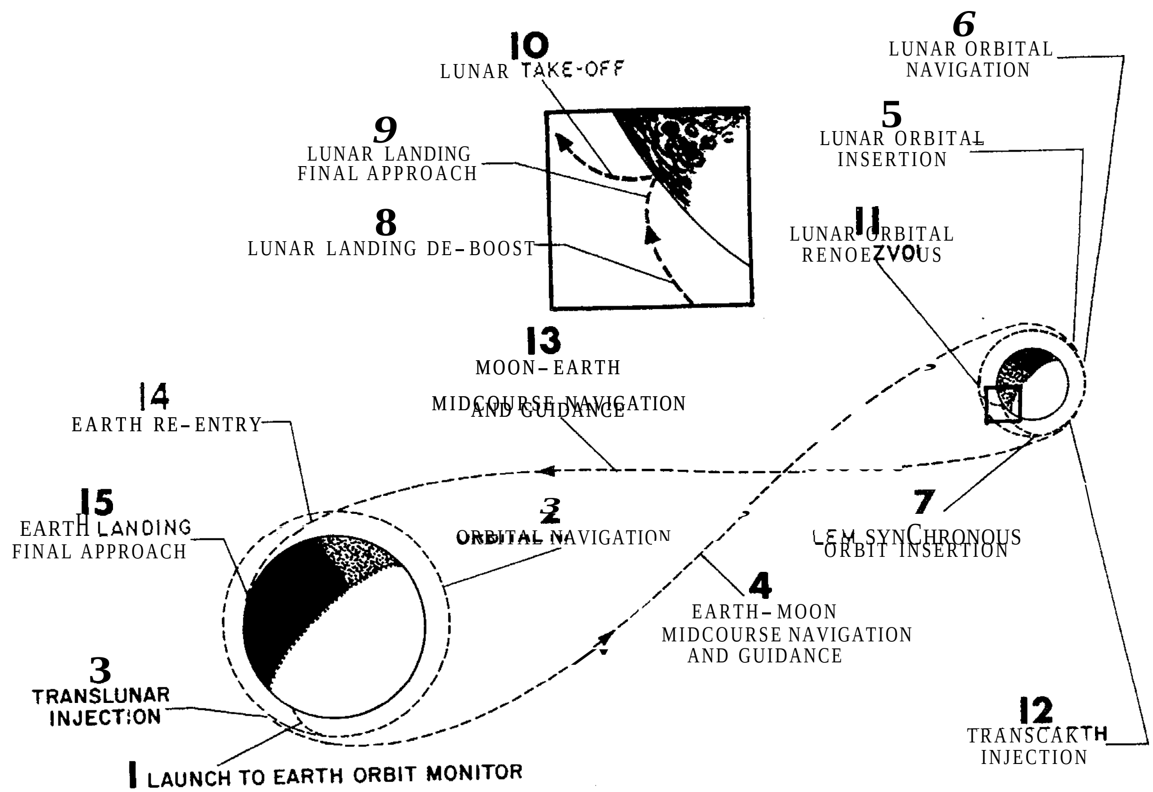


Fig. 1 Mission Phase Summary

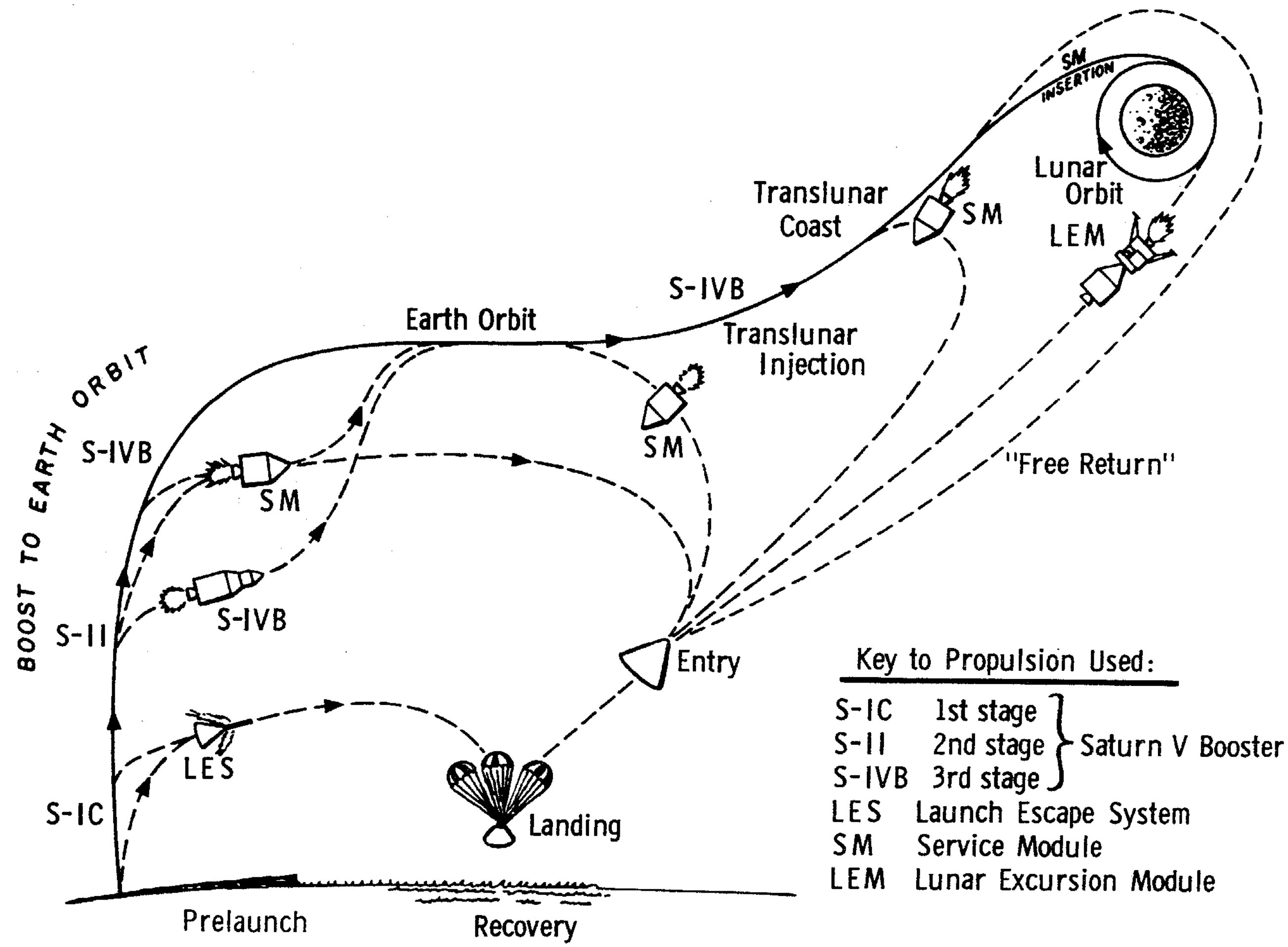


Fig. 2 Mission Abort Paths

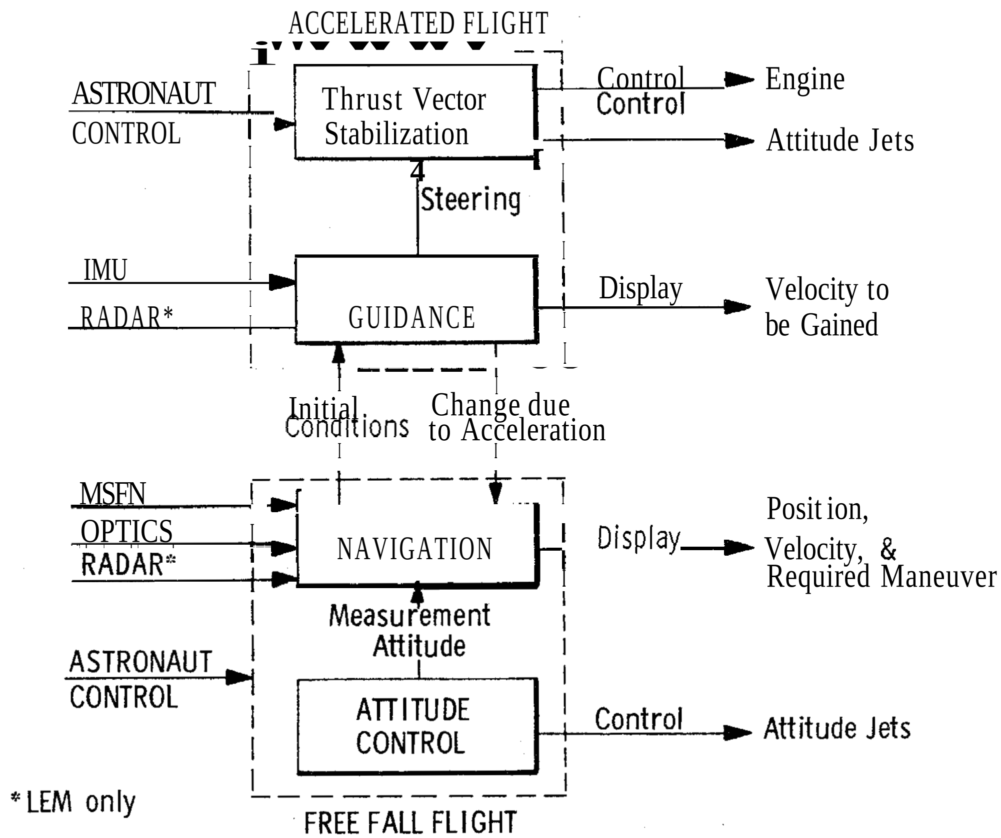


Fig. 3 Apollo Guidance Navigation - Function Flow

The Lunar Excursion Module G&N system also utilized radar and astronaut-visual inputs during the final approach to landing and therefore the LEM may be said to use radar-visual-inertial-guidance;

Figure 4 summarizes the navigation mission phases and Figure 5 summarizes the guidance mission phases for the basic lunar landing mission. These figures indicate the flexibility and capability which the guidance system must have.

2. G&N System Description

The primary G&N system consists of the following basic units:

CSM Installation		LEM Installation	
IMU	Inertial Measurement Unit	IMU	Inertial Measurement Unit
AGC	Apollo Guidance Computer	LGC	LEM Guidance Computer
PSA	Power Servo Assembly	PSA	Power Servo Assembly
CDU	Coupling Data Units	CDU	Coupling Data Units
SXT	Sextant	AOT	Alignment Optical Telescope
SCT	Scanning Telescope	D&C	Display and Controls
D&C	Display and Controls	RR	Rendezvous Radar
		LR	Landing Radar

Grumman Aircraft Engineering Corporation is the contractor for the rendezvous and landing radars for these installations.

The other G&N units listed have been designed and developed by the MIT Instrumentation Laboratory with associate contractors: AC Electronics Division of GMC, Sperry Gyroscope Company, Raytheon Company and the Kollsman Instrument Corporation. A general description of the basic units of the primary G&N system is as follows:

IMU, Inertial Measurement Unit

The inertial measurement unit is the primary inertial sensing device. Three gyros and three accelerometers are mounted on the innermost gimbal of the three degree-of-freedom gimbal structure. External forces acting upon the vehicle are sensed by the accelerometers of

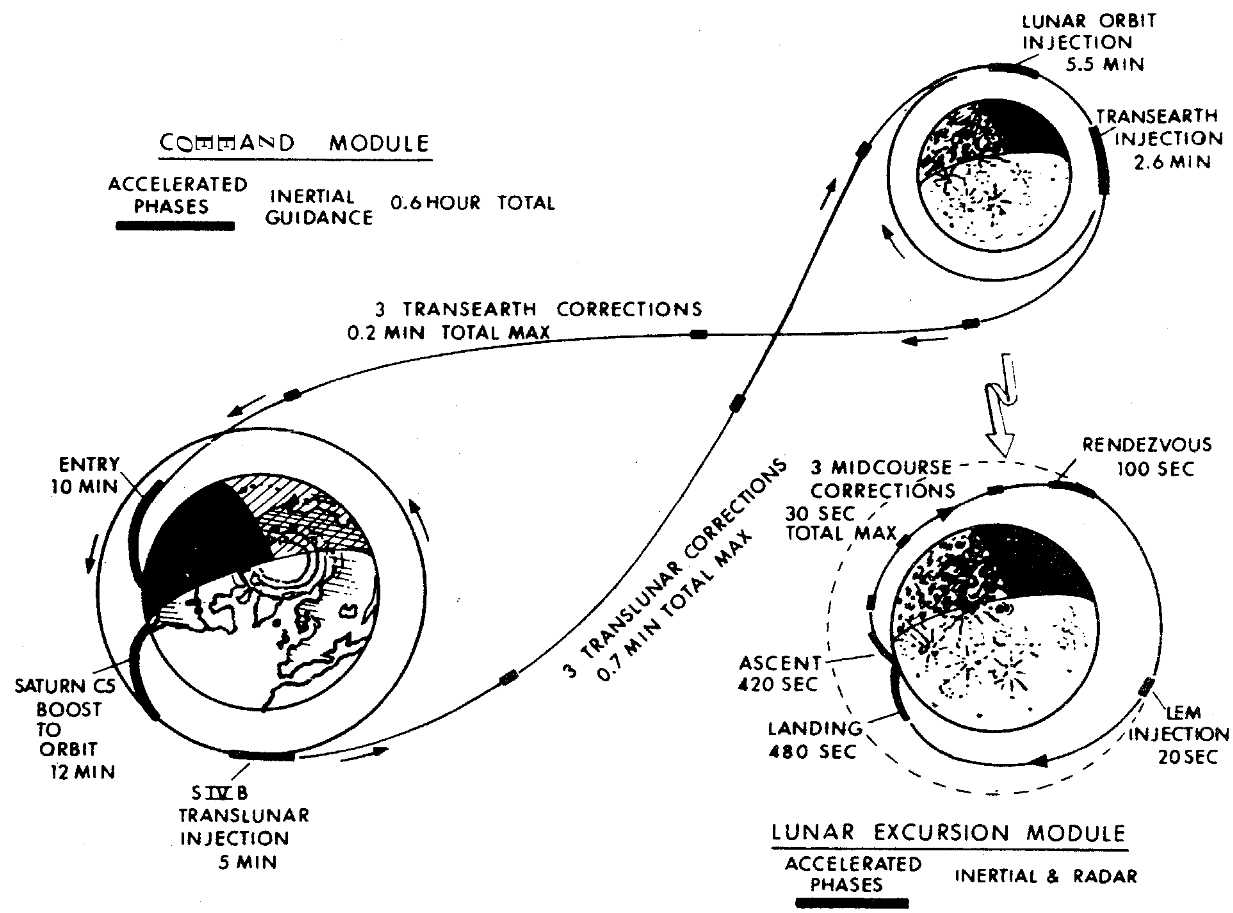


Fig. 4 Guidance Mission Phases

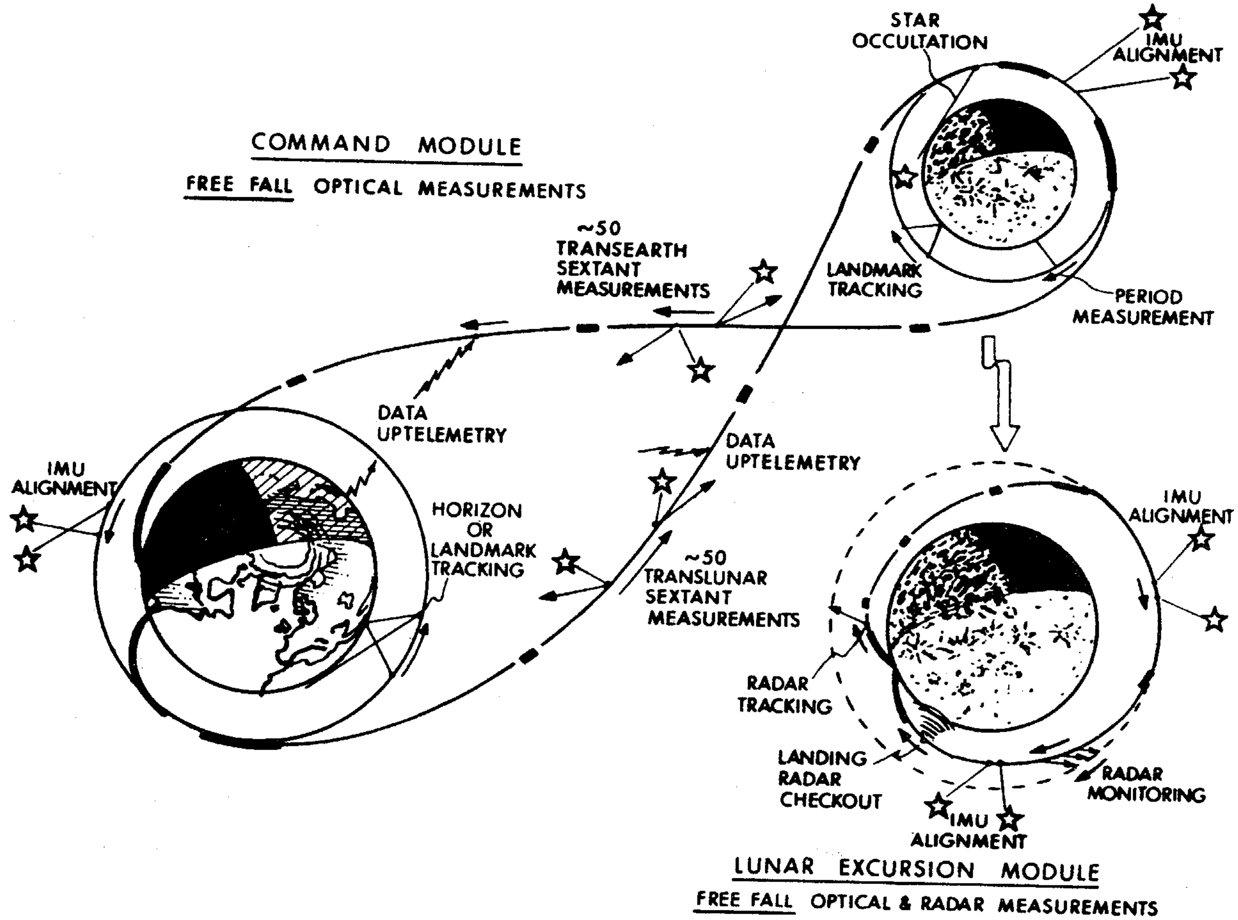


Fig. 5 Navigation Mission Phases

this unit, which produce signals representing incremental changes in vehicle velocity. Signals proportional to changes in the attitude of the vehicles are generated by the three gimbal angle resolvers of the IMU, and are transmitted to the computer through the coupling data units (CDU). Accelerometer outputs are transferred directly to the computer. Installation of the IMU with other G&N units is shown in Figure 6.

AGC, Apollo Guidance Computer

The computer is the data processing center of the guidance and navigation system. It is a general purpose, parallel, digital computer having a large fixed rope core memory for guidance programs, It has an additional erasable ferrite core memory sufficient to meet the operational requirements of all mission phases. Angle inputs to the computer from the IMU and optics are through the CDUs. Direct inputs to counters in the computer are made from the IMU accelerometers. Discrete input and output signals inform and allow the computer to control various G&N modes of operation., Astronaut inputs and commands are made through the data entry keyboard on the main display console or the navigation station control panel. The major outputs of the computer are direct engine commands, and thrust angle *or* attitude commands through the CDUs to the vehicle stabilization and control system (SCS). The computer display panel is the major astronaut monitoring unit for the G&N system. Installation of the AGC with other G&N units is shown in Fig. 6 for the CSM and Fig. 7 for the LEM.

PSA, Power Servo Assembly

The power servo assembly is a support item and is used in all operations involving the IMU, Optics and AGC. It provides various levels and types of d-c and a-c power to the rest of the G&N system. In addition, it serves as a location for various other support electronics such as the servo control amplifiers for the IMU and optics drives.

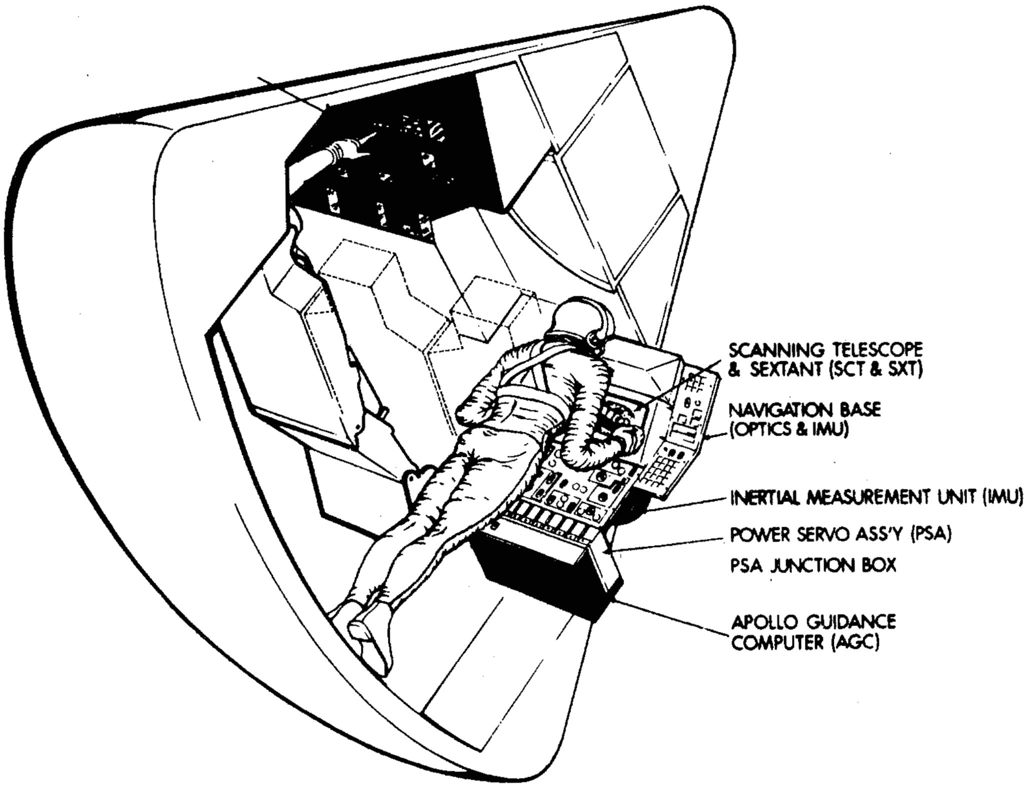


Fig. *6* Location of the **G&N** System in the Command Module

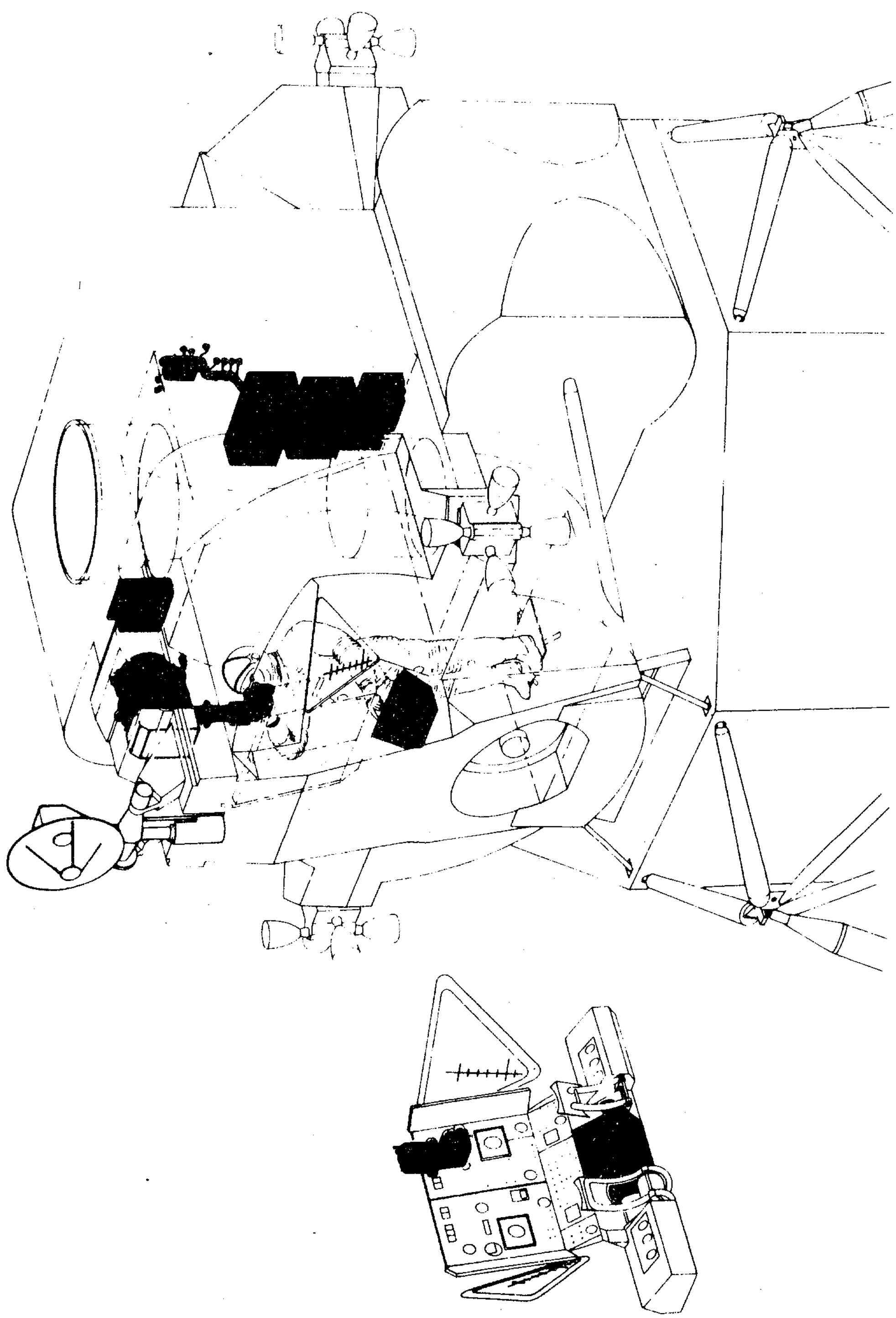


Fig. 7. LEM PGNCS Installation.

The installation of the PSA is also shown in Figure 6 and 7.

CDU, Coupling Data Unit

The five coupling data units are used to transfer angular information between the guidance computer and the IMU, optics, and the vehicle stabilization and control system. The CDU is essentially an analog-digital conversion device.

SXT Sextant, SCT Scanning Telescope

These two optical units are mounted with the IMU on a rigid framework, called the navigation base. The SXT is a two line-of-sight instrument used for translunar midcourse navigation angle sightings. It is a narrow field, high power instrument with two-degree-of-freedom articulation. The SCT is a single line-of-sight, unity power instrument of wide field used for general viewing and earth and lunar landmark sightings during orbital navigation phases, Both SXT and SCT are operated in the CSM by two optics CDUs, one for each degree of freedom. Installation of this unit in CSM with other G&N units is shown in Fig. 6.

D&C, Display and Control

A G&N display and control panel is shown in Fig. 8 for the CSM lower equipment bay installation.

The center installation, second from the top in Fig. 8 is the SXT and SCT eyepieces, left and right respectively, with the optics display and control panel located directly below.

The computer display and control is shown on the right in Fig. 8. The communication between the astronaut and computer is accomplished with this unit. The computer display, top right, consists of three, two-digit displayed numbers labelled "program", "verb" and "noun" and three, five-digit general word, read-out displays, The two-digit

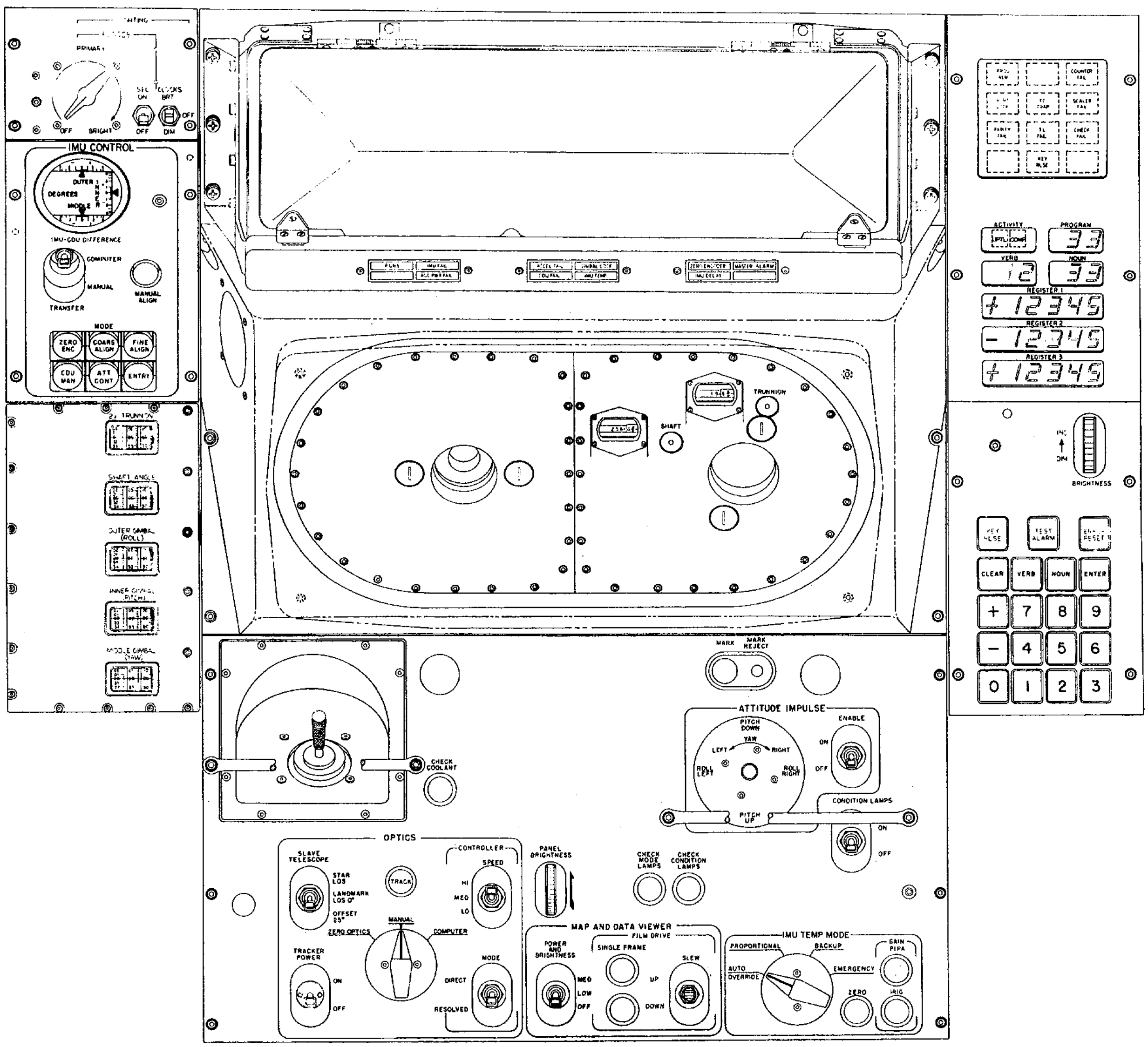


Fig. 8 G&N System Displays and Controls in the Lower Equipment Bay

displays are coded for various modes and instructions. The "program" display indicates the major operation mode of the computer. The "verb" and "noun" displays are used together and coded to give numerous possibilities of meaningful phrases or instructions. Examples of typical verb and noun combinations are:

Verb	Noun
Display Decimal	Present CDU angles
Calculate	Orbit Parameters
Terminate Display	Pitch Angle

When the computer wishes to communicate a request for data, or signal an alarm to the astronaut, the "verb" and "noun" numbers flash until the astronaut takes action. The astronaut enters data to the computer through the 12 button keyboard directly below the computer display in Fig. 8. A slightly abridged version of the computer control and display unit is mounted on the main display area of the CSM between the center and left astronauts, and operates in parallel with the unit in the lower equipment bay.

AOT, Alignment Optical Telescope

The optical subsystem used in the LEM vehicle is different from that in the CSM in that a single, non-articulating telescope is used for IMU alignment. This is a unity power instrument with wide field of view, and can be positioned in three distinct viewing positions or a fourth position for storage during non-use. The AOT has a manually rotated reticle with visual read-out.

RR, Rendezvous Radar

The rendezvous radar is a tracking radar which normally operates against a transponder unit on the other vehicle. Basic inputs to LGC from the RR will be tracking angles, range and range rate signals, LR, Landing Radar

The landing radar will be installed on the LEM and will provide the LGC altitude and velocity signals during the powered landing maneuver. The landing radar uses a four beam antenna array. Three beams are used for CW velocity sensing, and the fourth beam provides altitude in a FM-CW mode.

111. DOCUMENT DESCRIPTION

1. General

To properly coordinate the crew activity with computer activity while performing G&N tasks, a document was evolved which met the following basic requirements:

a: The document must define the computer logic flow necessary for the accomplishment of a G&N task. Each task (eg. Perform landmark tracking) is performed by a computer program which specifies a sequence of computer jobs.

b. It must define all parameters which will be displayed to the crew by the computer or by supporting instrumentation. Similarly, it must also define all the required crew inputs into the AGC necessary for continuing the programmed logic flow.

c. It must define the points in the logic flow at which the computer is programmed to "hold" and wait for a computer specified crew input, This affords the crew time to observe and acknowledge displays, make operational decisions and accomplish required resetting of controls.

d. It must define the points in the program logic flow at which specified data may be required and obtained from ground stations by either communications link with the crew or telemetry uplink directly to the computer.

2. Format

The format of the document is simple and straightforward (see App. A). The program is first identified and its purpose stated in detail. Since the programs are generated on a building block concept, the purpose will define this program in its relation to the other programs which it affects. The assumptions state prerequisites for proper program operation. The assumptions include initial status of controls, initial operational modes of subsystems, and specific means of implementing the program.

A brief description of the contents of each of the columns contained in the document follows:

a. PROG CONT (Program Control)

This column is used to flag the points at which the computer will stop in its sequence and hold for an astronaut instruction. POSS HOLD is a possible hold dependent upon the particular program logic path followed. Also indicated in this column are the mode changes required in the inertial subsystem and the stabilization and control system to effect proper operation of the G&N system.

b. AGC

This column defines the computer logic. The arrows and lines indicate the logic flow and the interface with the crew. Also indicated are all AGC displays and their definitions.

c. GROUND

This column defines the interface between the AGC and the ground (downlink or uplink telemetry) and between the ground and the crew (voice).

d. CREW

This column defines the crew operation in the interface between the crew and 1) the airborne computer, 2) related ground computer activity and 3) related functions of the Service Module Propulstion System (SPS), the vehicle Stabilization and Control System (SCS), the vehicle Reaction and Control System (RCS), and the Mission Events Sequence Controller (MESC).

e, CHECKLIST

This column contains a crew operations checklist keyed to the computer interface operation. The checklist can stand alone as a complete guide for crew performance. It provides the following:

1) defines the displays the crew should observe while following the program logic
2) defines detailed individual crew action required including all relevant switch and control positioning
3) provides notes, cautions and warnings for the crew when appropriate
4) defines displays which occur during abnormal operation and desired crew response

f. TIME

This column indicates normal time required to accomplish functional steps in the ckecklist. This time is reset to zero at the start of each step.

g. TOTAL TIME

This column indicates a cumulative time to perform the program. These times, which are generated by performing the document's crew check list in available spacecraft simulators, are useful for mission planning, programming evaluation and training.

3. Program Features and Logic Flow

A typical program Coast-Landmark Tracking Navigation Program (P22), is attached (App. A) to demonstrate the use of this document and point out features not previously mentioned. A normal mission requires about 50 of such programs. Note that crew checklist items are keyed to the adjacent program logic.

The first arrow shows how the program is nominally selected, Some programs can be selected manually only (by a keyboard entry), some automatically only (by the AGC), and the others by either of these methods.

A "hold" and a computer request for crew action are indicated by flashing an appropriate verb-noun (e.g. in P22, line #460: flash V50 N25 for "Please perform checklist" and display in register #1 code 00011 for "manual optics positioning").

Routines such as the Auto Optics Positioning Routine (R28) that are called by the program (e.g., P22, line #570) .may be indicated by a logic box as shown or printed out in entirety if desired. (See R28 printout attached).

Points of computer testing for correct G&N status or out-of-limits operation are indicated and the associated alarms are specified in the program (e.g., R27, line #145).

Displays of computer data which are updated every second are indicated by verb 16. A static display (e.g., P22, line #590) is indicated by verb 06.

The normal method for terminating the program is indicated. The AGC may: 1) request entry of the next logical program and wait for the program's selection before proceeding. 2) automatically go to the AGC idling program, *or* 3) automatically go to the next required program.

Decision points where the operator may elect to terminate the program early are also indicated.

IV DOCUMENTATION TECHNIQUE

1. General

It was decided to use a digital computer to produce the Apollo Computer Logic/Checklist Interface document. A computer permits rapid information retrieval and rapid update of the document. Only by having the information current can the document be a valuable tool.

The standard procedure in producing a document of this nature is to type out all changes, draft out the logic flow path, and photograph the results. This technique requires at least one week to prepare the document for printing. Whenever updating of such a document is necessary, the entire section involved must be redrawn, The computer system, however quickly produces a new, up-to-date copy.

2. Computer Selection

The MIT Instrumentation Laboratory facilities include several computational systems. Of the systems available, the H-200 computer was selected. This computer has the very basic advantages of (1) low operating cost, and (2) rapid turn-around times for processing. The peripheral equipment of 4 tape drives, card reader/punch and paper tape equipment are more than adequate for all programs written to date.

The type of programming encountered is mainly the formating and the manipulation of data files. Character type machines, such as the H-200 systems, allow very compact programs of this type to be written. This permits operation on smaller systems. Addressing problems are also simplified. Output commands, a substantial part of our programs, are accomplished with a single instruction rather than the fixed word-length technique of internal formating and manipulation before generating outputs.

3. Format Specifications

The content of the document is stored on punched cards and, in final form, on magnetic tape. Computer printouts can be obtained from either data file. All changes, additions and deletions to mission tasks (AGC programs & routines) are performed on the card file. The corrected card file is used to update the appropriate mission tape..

The headings described above were fitted into a **132** character line printer format. The data comprising each line is punched on two cards, The line division was selected *so* that logic flow is completely on the left card and the checklist is on the right card. This allows the logic flow or the checkout to be prepared independently and corrected without requiring a computer,

The programs used to obtain the printouts have been written to recognize various control symbols. Some of these occurwithin a printed line, When encountered, they cause repetitive items, such as the vertical lines (dots) to be printed. Another symbol defines a control card. The control cards require the print program to take some specific action. For example, control cards are used to insert messages, print standard headings and end the printing of a task.

A library of printing programs has been written. These programs range in complexity from very simple to highly sophisticated programs that recognize 20 control cards and respond to complex formating requests. The simpler programs will be-pass any unrecognized requests. They rapidly produce printouts from cards for proofreading and rewriting. They do not require any set-up time and are generally run by the keypunch operator. The more elaborate programs are used to produce a print-out fitting the specialized needs of various groups.

4. Document Generation

The overall flow of the document generation is shown in Fig. 9. This shows the functional relationship among NASA, the prime contractors (NAA and GAEC) and MIT.

5. Printout Generation

Two techniques are used when obtaining printouts. Data is retrieved from either cards or tape. Normal operations have evolved into the procedure of using cards to absorb change transients, and then putting the final revision on tape.

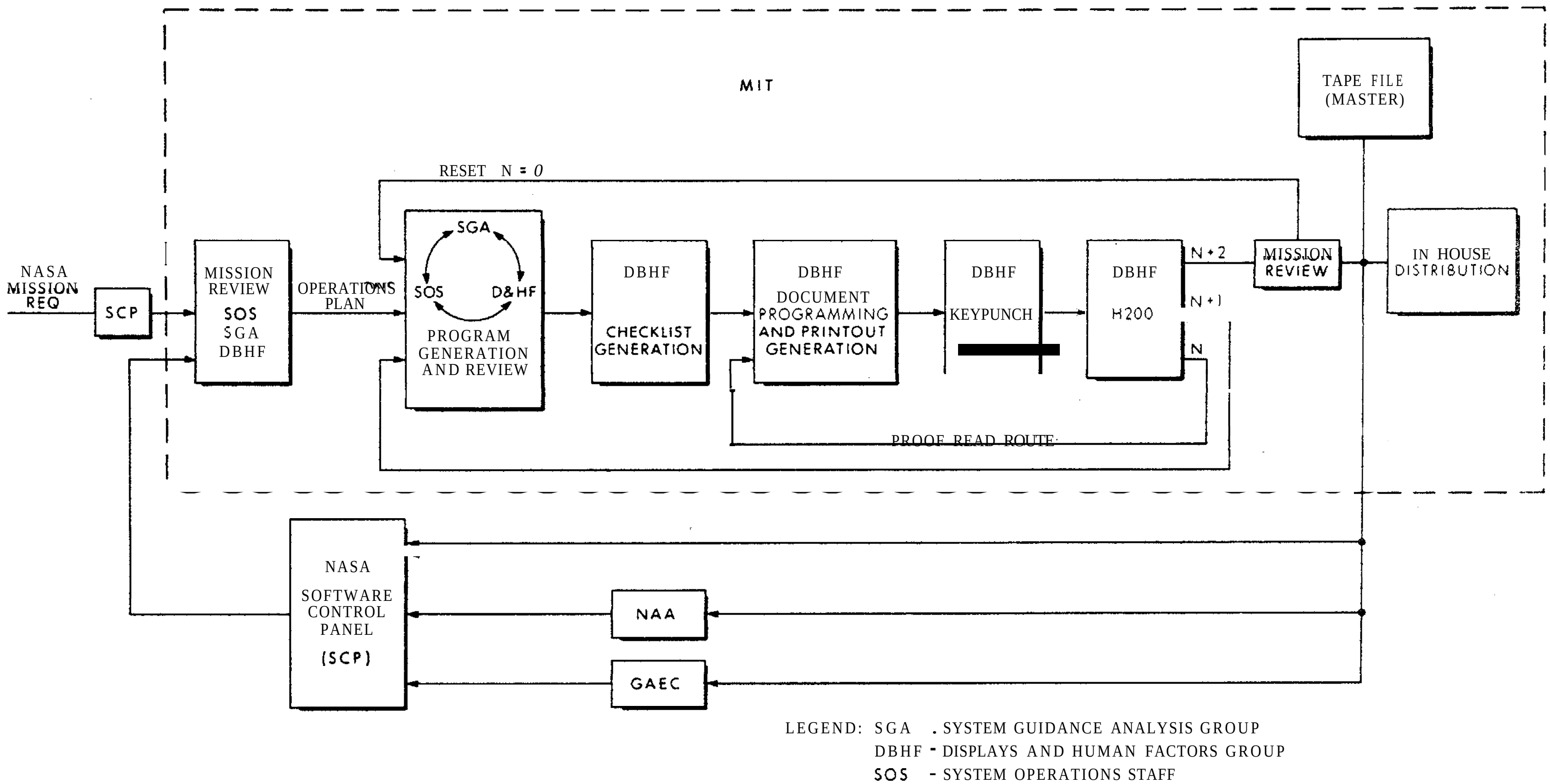


Fig. 9 Document Generation Flow

To accomplish quick turn-around times, the following procedures (Fig. 10) have proven to work adequately:

A. The rough original draft is routed through a single person for distribution to the key-punch operators. At this time, difficult logic paths are detailed and abbreviations or mathematical symbols encoded for the key-punch operators (Fig. 10).

B. After keypunching is completed, the tasks are run from cards with the simpler programs. The output is proofread and sent back to the keypunch operator for correcting. One copy is placed in the master file which defines what is currently on cards.

C. When all corrections are completed, the final pass is made using elaborate programs. These programs allow the operator to vary the printed format by means of control cards. The final print-outs are sent to the request originators.

D. A list is kept of all changes. The program tapes are updated at regular intervals. The corrected card file is written on tape in place of the old records. Unaffected records are copied from tape. The updated tape becomes the NUMASTER. The OLDMASTER serves as a backup tape until the next tape writing, at which time it is destroyed.

E. Large scale printouts and distributions occur at mission development milestones. These printouts are made upon request from the current master tape.

The response time of the data handling system is less than two days. This is sufficient time to punch corrections, verify the results, and produce a new document.

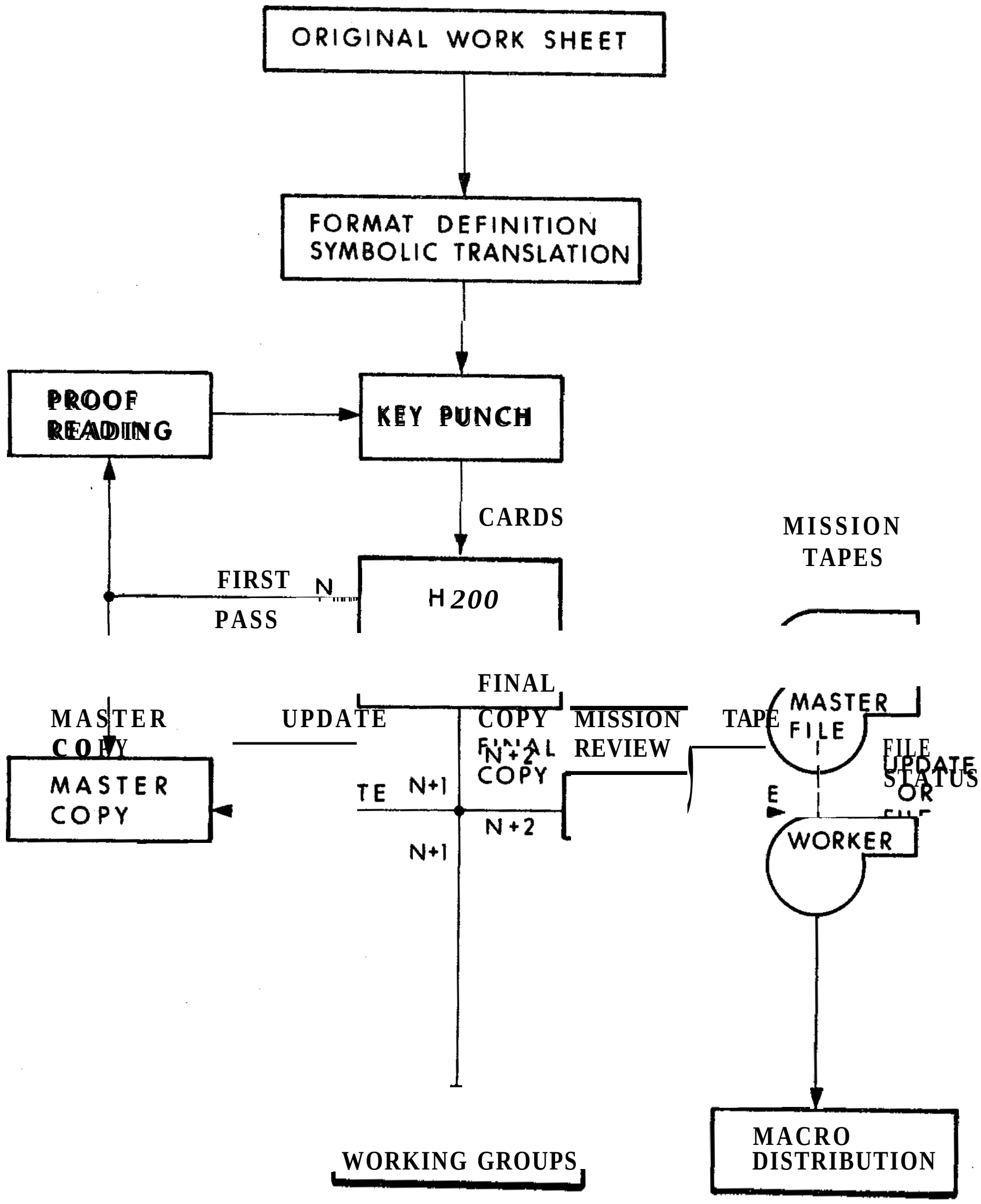


Fig. 10 Documentation Flow Chart

6. Special Requests and Computer Techniques

The master tapes are maintained to provide access to all data. They are also used to answer requests for information which differs from the standard document format.

A person could request only the AGC programs usedduring a mission phase by placing a control card for each desired program at the end of the print routine. The tape would be searched and only these printed. The form in which they appear could also be selected. "Print only the crew checklist, compressing to eliminate all spaces where no crew activity occurs and insert the checklist of all subroutines that are called", would require only one control cards and the setting of one H-200 sense switch. If it is desired to place the printout in a book without losing data under the page fold bindings, another sense switch is set and the printout skips the page folds.

A program is in use which allows the user to request that the interface document be expanded to incorporate all subroutines that occur (Fig. 11). This would normally be desired for investigating details of a specific mission phase or a group of related activities. Such a printout specifies all crew and AGC activity in detail.

Peripheral equipment required by this program includes two data tapes. The master tape, which is used for all other tape programs already contains control cards for insertion of subroutines. During normal operatinns these are ignored. A second tape contains the routines that may be requested.

During an expacded printout, each time that a routine is requested by the program, it is searched for and printed from the slave tape. Return is to the originalcall point of the program tape.

When routines are printed, their assumptions and headings are skipped. All other request cards are honored. While the routine is printing, the number column will print an -R- beside the line count. The routine may also initiate a request to insert data. Although in

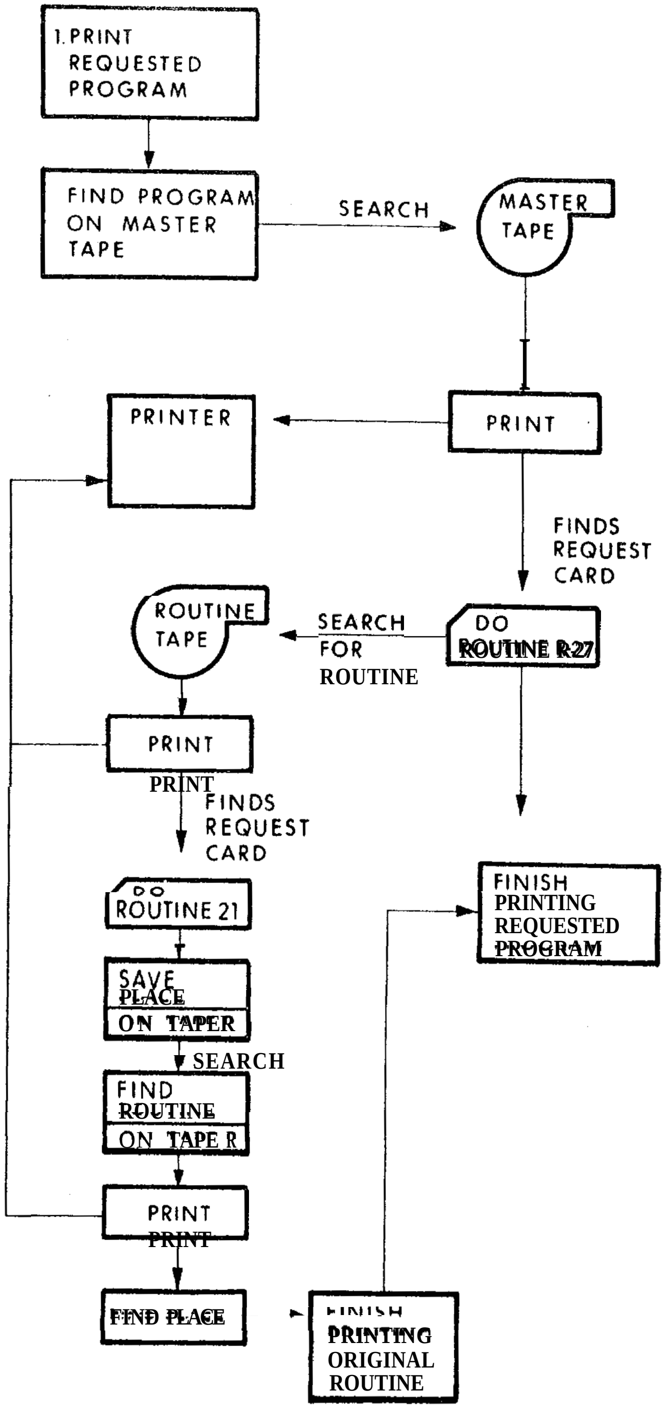


Fig. 11 2 Tape Printing Operation

this case the same tape is scanned for the routine called, return is still to the original calling point. A push down list retains where the call originated. Care must be exercised that the requesting control cards are unique in composition so that the print program may avoid looping through the same sequence.

Concluding Remark

The document described has proven to be a very valuable tool in the intra and inter communications required to define the complex computer programs and the related interfaces for the airborne guidance and navigation computer. The automated documenting technique yields fast data retrieval and quick modification turnaround,

COAST - LANDMARK TRACKING NAVIGATION MEASUREMENT PROGRAM (P 22) REV 8

PURPOSE (1) TO LOCATE AND TRACK A LANDMARK SUITABLE FOR NAVIGATION PURPOSES. THIS MAY BE DONE BY THE AGC WITH THE OPTICS AUTOMATICALLY POINTED AT A "KNOWN" (SEE ASSUMPTIONS BELOW) LANDMARK WHOSE LONGITUDE, LATITUDE, AND ALTITUDE HAVE BEEN KEYED INTO THE DSKY BY THE ASTRONAUT. IT MAY ALSO BE DONE BY THE ASTRONAUT WITH THE OPTICS MANUALLY POINTED AT A "KNOWN" LANDMARK PREDETERMINED BY THE ASTRONAUT OR A "KNOWN" OR "UNKNOWN" (SEE ASSUMPTIONS BELOW) LANDMARK SELECTED AT WILL DURING SEARCH FOR TAHGETS OF OPPORTUNITY.

(2) TO OBTAIN A SIGHTING MARK ON THE CHOSEN LANDMARK.

(3) TO CALCULATE THE ORBITAL PARAMETER CHANGES GENERATED BY THE LANDMARK LIGHTING.

(4) TO DISPLAY THE ORBITAL PARAMETEK CHANGES GENERATED, FOR DECISION AS TU THEIR VALIDITY BY THE ASTRONAUT/GROUND BEFORE THEIR INCORPORATION INTO THE AGC CALCULATION OF SC POSITION AND VELOCITY.

ASSUMPTIONS: (1) THERE ARE TWO TYPES OF LANDMARK TRACKING METHODS:

(A) "KNOWN" LANDMARK TACKING- THE TRACKING OF A LANDMARK IDENTIFIED TO THE AGC BY LATITUDE, LONGITUDE, AND ALTITUDE AFTER THE MARKS ARE COMPLETE.

(B) "UNKNOWN" LANDMARK TRACKING- THE TRACKING AND MARKING OF A LANDMARK OR SURFACE FEATURE IDENTIFIED TO THE AGC ONLY AS A UNKNOWN LANDMARK.

(2) DURING THIS PROGRAM THE G*N SYSTEM WILL HAVE NO RESPONSIBILITY FOR ATTITUDE CONTROL OF THE VEHICLE. POSSIBLE ATTITUDE CONTROL METHODS MIGHT BE AS FOLLOWS (IN ALL CASES CARE MUST BE TAKEN TO MONITOR POSSIBLE IMPENDING G+N GIMBAL LOCK).

(A) MANUAL CONTROL MY THE PILOT OH NAVIGATOR WITH THE ROTATION CONTROL.

(B) MANUAL RATE CONTROL BY THE NAVIGATOR WITH THE MINIMUM IMPULSE CONTROL. (ASSUMED FOR THE FOLLOWING CHECK LIST)

(3) THE PROGRAM MAY BE PERFORMED WITH SIVB ATTACKED IF THE SIVB IS IN A SUITABLE ATTITUDE FOR LANDMARK TRACKING.

(4) THE ISS IS ON BUT HAS NOT NECESSARILY BEEN ALIGNED SINCE TURN ON. THEREFORE THE ISS MAY BE:

(A) ON. AND AT AN INERTIAL ORIENTATION NOT KNOWN BY THE AGC: I.E. NEVER HAVING BEEN ALIGNED SINCE TURN ON.

(B) ON. AND AT AN INERTIAL ORIENTATION KNOWN ONLY INACCURATELY BY THE AGC: I.E. HAVING BEEN ALIGNED AT LEAST ONCE SINCE TURN ON BUT NUT WITHIN THE LAST --HRS.

(C) ON. AND AT AN INERTIAL ORIENTATION KNOWN ACCURATELY BY THE AGC: I.E. HAVING BEEN ALIGNED WITHIN THE LAST --HRS.

IF (A) IS TRUE THE PROGRAM CANNOT BE COMPLETED WITHOUT Ah IMU ALIGNMENT. IF (B) I5 TRUE THE AGC MOST PROBABLY DOES NOT HAVE A SATISFACTORY IMEHTIAL REFERENCE TO ACCURATELY COMPLFTE THE PROGRAM. IF (C) IS TRUE THE AGC HAS A SATISFACTORY INERTIAL REFERENCE TO ACCUGATELY COMPLETE THE PROGRAM. CASES (B) AND (C) HOWEVER ARE FURTHER SUBJECT TO THE CONSTRAINT OF LARGE MIDDLE GIMBAL ANGLE: I.E. THE EXISTING INERTIAL ORIENTATION MAT MOT NECESSARILY BE THE OPTIMUM TO WORD GIMBAL LOCK.

(5) THE GROUND TRACK DETERMINATION ROUTINE R 23 IS AVAILABLE TO AID THE CREW IN THE SELECTION OF APPROPRIATE LANDMARKS. THIS ROUTINE MUST BE SELECTED AND COMPLETED PRIOR TO SELECTION OF P 22.

(6) THE PROGRAM IS SELECTED BY THE ASTRONAUT BY DSKY ENTRY.

PROG CONT	AGC	GROUND	CREW	CHECKLIST	TIME	TOTAL TIME
				*I. CONFIRM OR SELECT FOLLOWING SWITCH POSITIONS AT MDC IF SIVB ATTACHED		
				PANEL 8		
				1. G+N/SCS - G+N		
				2. ATTITUDE/MONITOR/ENTRY-MONITOR		#10
				3. DELTA V - OFF		
				4. LOCAL VERTICAL - OFF		
				5. LIMIT CYCLE - OFF		
				6. ATTITUDE DEADBAND - MAX		
				7. .05G ENTRY - OFF		#20
				8. DIRECT RCS - OFF		
				9. ROLL RATE GYRO - NORMAL		
				10. PITCH RATE GYRO - NORMAL		
				11. YAW RATE GYRO - NORMAL		
				12. A&C ROLL CHANNEL - OFF		#30
				13. B&D ROLL CHANNEL - OFF		
				14. PITCH CHANNEL - OFF		
				15. YAW CHANNEL - OFF		
				PANEL 23		
						#40

1. FDAI LTG - AC1 OR AC2

2. GROUP 1-AC1 - CLOSED

3. GROUP 1-AC2 - CLOSED

4. E UP 2-AC1 - CLOSED

5. GROUP 2-AC2 - CLOSED #50

6. GROUP 1-MNA - CLOSED

7. GROUP 1-MNB - CLOSED

8. GROUP 2-MNA - CLOSED

9. GROUP 2-MNB - CLOSED

10. DIRECT CONTROL MNA - CLOSED #60

11. DIXECT CONTROL-MNB - CLOSED

12. B&D ROLL MNA - CLOSED

13. B&C ROLL-MNB - CLOSED

14. B&D ROLL-MNA - CLOSED

15. B&D OLL-MNB - CLOSED #70

16. PITCH-MNA - CLOSED

17. PITCH MNB - CLOSED

18. YAW-MNA - CLOSED

19. YAW-MNB - CLOSED

20. E&N SYNC - OFF #80

21. EVENT TIMER MNA - CLOSED

22. EVENT TIMER MNB - CLOSED

23. GIMBAL MOTOR CONTROL PITCH 1
BAT A - CLOSED

24. GIMBAL MOTOR CONTROL PITCH 2
BAT B CLOSED #90

25. GIMBAL MOTOR CONTROL YAW 1
BAT A - CLOSED

26. GIMBAL MOTOR CONTROL YAW 2
BAT B - CLOSED

MISCELLANEOUS #100

1. TQANSLATION CONTRωLS - LOCK≤D

2. ROTATION CONTROLS - PINNED

PANEL 6

1. ATTITωDE S≤T - OFF #110

PANEL 7

1. NORMAL/OFF/DIRECT ON - OFF

PANEL z #120

1. FDAI SELF TEST - OFF

2. FDAI BRIGxTN≤SS - SET

3. FCSM - AUTO/OV≤RRIDE - OVEQQID≤

4. FCSM - ON/OFF/RESET - OFF

#13ω

PANEL 24

1. SCS POWER - AC1 OR AC2
(OPTIONAL-FOR FDAI CH≤CK OF
GIMBAL ANGLES)

z. RATA GYQO POWER - ωFF

3. BMAω POWER - OFF #140

. ROTATION CONTxOL POWEQ - OFF

5. TVC 1 POWER - OFF

6. TVC z POWER - ωFF

PANEL 3 #150

1. PITCH GIMBAL MOTOR 1 - OFF

2. PITCH GIMBAL MOTOR 2 - OFF

3. YAW GIMbAL MOTOR 1 - OFF

4. YAW GIMBAL MOTOR 2 - OFF

5. INJECT PHEVALVE A - OFF #160

6. INJLCT PREVALVE B - OFF

PANtL 14

1. UPTtL - BLOCK

2. DSKY BRIGHTNESS - SET #170

PANEL 22

1. IMU HTR-MNA - CLOSED

2. IMU HTR-MNB - CLOSED

3. IMU-MNA - CLOSED #180

4. IMU-MNB - CLOSED

5. COMPUTER-MNA - CLOSED

6. COMPUTER-MNB - CLOSED

7. OPTICS-MNA - CLOSED

8. OPTICS-MNB - CLOSED #190

9. AC POWER-AC1 - CLOSED

10. AC POWER-AC2 - CLOSED

11. G&N-AC POWER - AC1 OR AC2

*II. CONFIRM OR SELECT FOLLOWING SWITCH POSITIONS AT MDC IF SIVB SEPARATED #200

PANEL 8

1. G+N/SCS - SCS

2. ATTITUDE/MONITOR/ENTRY-MONITOR

3. DELTA V - OFF #210

4. LOCAL VERTICAL - OFF

5. LIMIT CYCLE - ON

6. ATTITUDE DEADBAND - MAX

7. .05G ENTRY - OFF

8. DIRECT RCS - OFF #220

9. ROLL RATE GYRO - NORMAL

10. PITCH RATE GYRO - NORMAL

11. YAW RATE GYRO - NORMAL

12. A&C ROLL CHANNEL - ON

13. B&D ROLL CHANNEL - ON #230

14. PITCH CHANNEL - ON

15. YAW CHANNEL - ON

PANEL 25

1. FDAI LTG - AC1 OH AC2 #240

2. GROUP 1-AC1 - CLOSED

3. GROUP 1-AC2 - CLOSED

4. GROUP 2-AC1 - CLOSED

5. GROUP 2-AC2 - CLOSED

6. GROUP 1-MNA - CLOSED #250

7. GROUP 1-MNB - CLOSED

8. GROUP 2-MNA - CLOSED

9. GROUP 2-MNB - CLOSED

10. DIRECT CONTROL-MNA - CLOSED

11. DIRECT CONTROL-MNB - CLOSED #260

12. A&C ROLL-MNA - CLOSED

13. A&C ROLL-MNB - CLOSED

14. BCD ROLL-MNA - CLOSED

15. B&D ROLL-MNB - CLOSED

16. PITCH-MNA - CLOSED #270

17. PITCH-MMB - CLOSED

18. YAW-MNA - CLOSED

19. YAW-MNB - CLOSED

20. GCN SYNC - OFF

21. EVENT TIMER MNA - CLOSED #280

22. EVENT TIMER MNB - CLOSED

23. GIMbAL MOTOR CONTROL PITCH 1 BAT A - CLOSED

24. GIMbAL MOTOR CONTROL PITCH 2 BAT B - CLOSED

25. GIMBAL MOTOR CONTROL YAW 1 BAT A - CLOSED #290

26. GIMBAL MOTOR CONTROL YAW 2 BAT B - CLOSED

MISCELLANEOUS

1. TRANSLATION CONTROLS - LOCKED 1300

2. ROTATION CONTROLS - UNPINNED

PANEL 6

1. ATTITUDE SET - OFF

#310

PANEL 7

1. NORMAL/OFF/DIRECT ON - OFF

PANtL 2

1. FDAI SELF TEST - OFF #320

2. FDAI BRIGHTNESS - SET

3. FCSM - AUTO/OVERRIDE - OVERRIDE

4. FCSM - ON/OFF/RESET - OFF

PANEL 24

#330

1. SCS POWER - AC1 OR AC2

2. RATE GYRO POWER - AC1 OH AC2

3. BMAG POWER - AC1 OR AC2

4. ROTATION CONTROL POWER-AC1 OR AC2

5. TVC 1 POWEH - OFF 4340

6. TVC 2 POWER - OFF

PANEL 3

1. PITCH GIMBAL MOTOR 1 - OFF

2. PITCH GIMBAL MOTOR 2 - OFF #350

3. YAW GIMBAL MOTOR 1 - OFF

4. YAW GIMBAL MOTOR 2 - OFF

5. INJECT PREVALVE A - OFF

6. INJECT PREVALVE B - OFF

#360

PANEL 14

1. UPTtL - BLOCK

2. DSKY BRIGHTNESS - SET

PANtL 22

#370

1. IMU HTR-MNA - CLOSED

2. IMU HTR-MNB - CLOSED

3. IMU-MNA - CLOSED

4. IMU-MNB - CLOSED

5. COMPUTER-MNA - CLOSED #380

6. COMPUTER-MNB - CLOSED

7. OPTICS-MNA - CLOStD

8. OPTICS-MND - CLOSED

9. AC POWER-AC1 - CLOSED

10. AC POWER-AC2 - CLOSED #390

11. G&N-AC POWER - AC1 OR AC2

*III. CONFIRM OR SELECT FOLLOWING SWITCH POSITIONS AT NAV STATION

1. FLOODLIGHT CONTROL PRIMARY - SET

Y400

2. FLOODLIGHT COkTROL SECONDARY - SET

3. IMU TRANSFER - COMPUTER

4. OPTICS SLAVE TELESCOPE - STAR LOS

5. OPTICS MODE - ZERO OPTICS

6. OPTICS HOLD - OFF

1410

7. OPTICS CONTROLLER SPEED - HI

8. OPTICS CONTROLLEH MODE - DIRECT

9. PANtL BRIGHTNESS CONTHOL - 5ET

10. IMU TEMP. MODE - AUTO OVERRIDE

11. ATTITUDE IMPULSE ENABLE - OFF

#420

12. CONDITION LAMPS - ON

13. AGC MODE - ON

14. AGC BRIGHTNESS CONTROL - SET

CREW PROG.
SELECTION

START LANDMARK TRACKING NAVIGATION MEASUREMENT PROGRAM (P 22)

KEY IN LANDMARK TRACKING NAVIGATION MEASUREMENT PROGRAM (P 22)
V 37 E 22 E

* IV. SELECT AGC PROGRAM FOR LANDMARK TRACKING NAV. MEASUREMENT #430
SELECT PROGRAM AT AN APPROPRIATE TIME PRIOR TO DESIRED LANDMARK ACQUISITION.

1. ENTER LANDMARK TRACKING NAV. Y440
MEASUREMENT PROGRAM (P 22)
V 37 E 22 E

DISPLAY PROGRAM 22

MONITOR DSKY:
OBSERVE DISPLAY OF PROG 22

2. CHECK AGC DISPLAYS PROGRAM 22

FLASH VERB-NOUN TO REQUEST PLEASE PERFORM SELECTION OF IMU ORIENTATION DETERMINATION PROGRAM (P51)
V50N37
R1-00051

MONITOR DSKY:
OBSERVE VERB-NOUN FLASH TO REQUEST PLEASE PERFORM SELECTION OF P(51)

* V CHECK AGC FLASHES VERB-NOUN TO REQUEST PLEASE PERFORM SELECTION OF IMU ORIENTATION DETERMINATION PROGRAM (P51) t450
V50N07
R1-00051

NOTE: IF SIVB HAS NOT BEEN SEPARATED OMIT PROGRAM 21 AND SUBSTITUTE PROGRAM 52 FOR PROGRAM 53 IN FOLLOWING PROCEDURE. t460

HAS THE ISS BEEN ALIGNED SINCE TURN ON?
N Y

IS THE. CSM STILL ON THE SIVB
N Y

DO BEFORE RESELECTING P22:
(A) COAST-CSM LOCAL VERTICAL PROGRAM

* 1. IF IMU ORIENTATION IS UNKNOWN SELECT THE FOLLOWING IN ORDER:
A. PROGRAM 21
B. PROGRAM 51
C. PROGRAM 53
D. PROGRAM 21
E. PROGRAM 22

* 2. IF IMU ORIENTATION IS KNOWN BUT NOT SATISFACTORILY ALIGNED SELECT THE FOLLOWING IN ORDER: #470
A. PROGRAM 21
B. PROGRAM 53
C. PROGRAM 21
D. PROGRAM 22

NOTE: IF THE IMU HAS NOT BEEN ALIGNED IN THE PAST --HRS. AND/OR THE POSSIBILITY OF GIMBAL LOCK EXISTS THE CREW/GROUND MUST #480

WAIT FOR KEYBOARD ENTRY.

(P21)
KEY IN
V37E21E

EXIT P22

DECIDE IF REALIGNMENT
CAN BE BY-PASSED.

* 3. IF IMU IS SATISFACTORILY
ALIGNED:
KEY IN PROCEED
V33E
Y490

HAS THE ISS BEEN
ALIGNED WITHIN THE
LAST--HRS?
#500

N Y

SHALL I ATTEMPT TO
BYPASS IMU ALIGNMENT

N: ADVISE CREW AS
TO ANTICI-
PATED G+N
ERRORS AND
SUBSEQUENT
PROCEDURES.

N Y
#510

AM I WILLING
TO RISK THE
POSSIBILITY OF
GIMBAL LOCK
DURING THE
LANDMARK TRACK
-ING?
#520

ADVISE CREW AS
TO POSSIBILITY
OF GIMBAL LOCK

N Y

IS THE CSM
STILL ON THE
SIVB

N Y
#530

DO BEFORE RE-
SELECTING P22.
(A) COAST-
CSM LOCAL
VERTICAL
PROGRAM
(P21)
KEY IN
V37E21E

#540

EXIT P22

#550

DO BEFORE RE-
SELECTING P22:
(A) INFLIGHT
ALIGNMENT-
SIVB/IMU
ALIGN PROGRAM
(P52).
KEY IN
V37E52E

X560

EXIT P2Z

#570

EXIT P22

COMMAND ISS
TO FINE ALIGN MODE.

OBSERVE ISS
SWITCH TO FINE ALIGN
MODE.

* VI CHECK FINE ALIGN MODE LIGHT ON.

#580

ISS FINE
ALIGN MODE
PRESENT

ESTABLISH ATTITUDE

* VII ESTABLISH ATTITUDE CONTROL OF THE
VEHICLE

CONTROL OF THE
VEHICLE BY SOME
MEANS OTHER THAN G&N

HOLD

FLASH VERB-NOUN TO
REQUEST PLEASE PER-
FORM MANUAL OPTICS
POSITIONING:
V50 N25
R1 - 00011

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PERFORM
MANUAL OPTICS
POSITIONING

DO I WISH TO POSIT-
ION OPTICS MANUALLY?
N Y

WAIT FOR KEYBOARD
ENTRY.

KEY IN PROCEED
V 33 E

TERMINATE FLASH UPON
RECEIPT OF ENTER OR
PROCEED.

PROCEED ENTER

GO TO
SIGHTING MARK
ROUTINE (R27)
BELOW

KEY IN ENTER

IS UNKNOWN LANDMARK
TO BE USED
Y N

* VIII IDENTIFY KNOWN LANDMARK ON APPROPRIATE LANDMARK CHART #590

* IX PERFORM AGC ASSISTED OR MANUAL ACQUISITION OF THE LANDMARK #600

* 1. CHECK AGC FLASHES VERB-NOUN TO REQUEST PLEASE PERFORM AUTO OPTICS POSITIONING: #610
V50 N25
R1-00011

* A. NAV WISHES TO POSITION OPTICS AUTOMATICALLY KEY IN PROCEED
V 33 E

* B. NAV WISHES TO POSITION OPTICS MANUALLY: PRESS ENTER #620

(1) SET OPTICS MODE SW TO MANUAL

(2) NAV. USES SXT TO MANUALLY ACQUIRE AND TRACK UNKNOWN LANDMARK OR NAV. USES SCT TO MANUALLY ACQUIRE AND TRACK KNOWN LANDMARK. #630

(3) IF LANDMARK IS SUFFICIENTLY IDENTIFIABLE TO TAKE MARKS NAV. PROCEEDS TO SIGHTING MARK ROUTINE (R 27)

(4) IF LANDMARK NOT IDENTIFIABLE NAV. SELECTS AN ALTERNATE LANDMARK OR SELECTS NEW PROGRAM AS DESIRED #640

USE SXT TO SEARCH FOR AND ACQUIRE SUITABLE LANDMARK

USE SCT TO ACQUIRE KNOWN LANDMARK #650

IS LANDMARK SUFFICIENTLY IDENTIFIABLE TO TAKE MARKS #660

N

Y GO TO SIGHTING MARK ROUTINE (R 27) BELOW #670

DO I WISH TO CONTINUE EFFORT TO TRACK A LANDMARK #680

Y

N

SELECT NEW PROGRAM AS DESIRED #690

EXIT P22

#700

DO AUTO OPTICS POSITIONING ROUTINE (R 28)

DO AUTO OPTICS POSITIONING ROUTINE (R 28)

* 2. PERFORM AUTO OPTICS POSITIONING ROUTINE (R28) FOR AGC ASSISTED LAND- MARK ACQUISITION OR PKOCEED TO 3.

#710

SET TARGET FLAG TO LANDMARK FOR USE BY SIGHTING MARK ROUTINE (R27)

#720

SET MARK INOEX TO 5 FOR USE BY THE SIGHT -ING MAHK ROUTINE (R27)

(SEE ABOVE)

(SEE ABOVE)

#730

DO SIGHTING MARK RUUTINE (R 27)

DO SIGHTING MARK ROUTINE (R 27)

* 3. PERFORM SIGHTING MARK ROUTINE (R 27)

#740

IS OPTICS POINTING COMPUTATION IN PROCESS?

Y

N

TERMINATE COMPUTATION.

#750

SELECT FIRST SIGHT-
ING MARK DATA

CALCULATE ORBITAL
PARAMETER CHANGES AS
A RESULT OF THIS
LANDMARK SIGHTING
MARK.

HOLD

FLASH VERB-NOUN TO
REQUEST PROCEED AND
DISPLAY ORBITAL
PARAMETEH CHANGES:
V06 N75
R1 - DELTA P
R2 - DELTA V

DELTA P - MAGNITUDE
OF THE DIFFERENCE
BETWEEN THE POSI-
TION STATE VECTOR
BEFORE AND AFTER
INCORPORATION OF
THE LANDMARK
SIGHTING DATA-
IN FT TO NEAKEST
FT.

DELTA V - MAGNITUDE
OF THE DIFFERENCE
BETWEEN THE VELO-
CITY STATE VECTOR
BEFORE AND AFTER
INCOHPORATION OF
THE LANDMARK
SIGHTING DATA.
IN FT/SEC TO NEAR-
EST FT/SEC.

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH AND DISPLAY OF
ORBITAL PARAMETER
CHANGES

* X CHECK AGC FLASHES VERB-NOUN TO RE-
QUEST PROCEED AND DISPLAYS ORBITAL
PARAMETER CHANGES.
V06 N75
R1 - DELTA P
R2 - DELTA V

DELTA P - MAGNITUDE OF THE DIFFER-
ENCE BETWEEN THE POSITION STATE
VECTOR BEFORE AND AFTER INCOR-
PORATION OF THE LAND MARK SIGHT-
ING DATA. IN FT TO NEAREST FT.

DELTA V - MAGNITUUE OF THE DIFFER-
LNCE BETWEEN THE VELOCITY STATE
VECTOR BEFORE AND AFTER INCOR-
PORATION OF THE LANDMARK SIGHT-
ING DATA. IN FT/SEC TO NEAREST
FT/SEC.

ARE ORBITAL
PARAMETER CHANGES
ACCEPTABLE FOR IN-
SERTION INTO AGC
CALCULATION OF
POSITION AND
VELOCITY

Y N.

#810

WAIT FOR DSKY ENTRY

KEY IN PROCEED
V 33 E

* 1. NAV ACCEPTS DATA FOR UPDATE OF
POSITION AND VELOCITY IN AGC:
KEY IN PROCEED
V 33 E

#820

TERMINATE FLASH UPON
RECEIPT OF PROCEED
OR TERMINATE

KEY IN TERMINATE
V34 E

* 2. NAV REJECTS DATA:
KEY IN TERMINATE
V 34 E

PROCEED TERMINATE

X830

UPDATE AGC DETER-
MINATION OF POSITION
AND VELOCITY

NOTE: IF THE LANDMARK WAS A
"KNOWN" LANDMARK THE AGC WILL
CALCULATE AND DISPLAY ORBITAL
PAHAMETER CHANGES FOR EACH "MARK"
TWICE. THE NAV MAY ACCEPT OR
REJECT THE. RESULTS OF EACH
CALCULATION. THIS IS DONE FOH
EACH MARK MADE (AND NOT REJECTED
BY THE NAV) UP THROUGH THC FIRST
FIVE MARKS.

#840

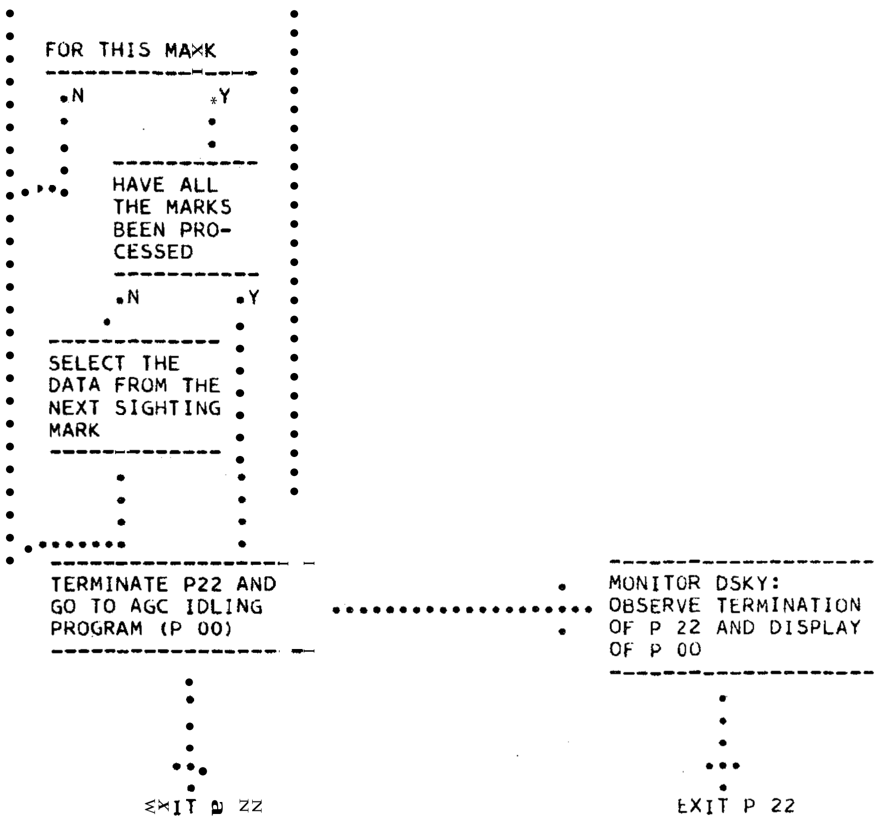
IF THE LANDMARK WAS AN
"UNKNOWN" LANDMARK THE AGC WILL
CALCULATE AND DISPLAY ORBITAL
CHANGES ONLY ONCE. FOR THL FIRST
TWO MARKS MADE (AND NOT REJECTED
BY THE NAV). THE NAV MAY ACCEPT
OR REJECT THE RESULT OF THESE
CALCULATIONS. IN THIS CASE
ALTHOUGH THE SIGHTING MARK
ROUTINE (R27) WILL ACCEPT FIVE

X850

IS THIS THE CKNOWNC
LANUMARK

Y N

HAVE THE OREITAL
PARAMETER
CHANGES BEEN
COMPUTED TWICE



UNREJECTED MARKS THE AGC WILL USE ONLY THE FIRST TWO. #860

#870

#880

* XI CHECK AGC DISPLAYS PROGRAM 00

#890

END OF RUN

APOLLO COMPUTER LOGIC CHECKLIST INTERFACE

AUTOMATIC OPTICS POSITIONING ROUTINE (R 28) REV 3

PURPOSE: (1) TO DRIVE THE G+N OPTICS TO A TARGET (STAR OR LANDMARK) DEFINED BY THE PROGRAM OR BY DSKY INPUT (ASTRONAUT).

ASSUMPTIONS: (1) THE OPTICS MODE SWITCH IS IN THE MANUAL POSITION.

(2) THE ROUTINE IS NORMALLY AUTOMATICALLY SELECTED BY THE COMMON ALIGNMENT ROUTINE (R4) DURING THE INFLIGHT ALIGNMENT-SIVB/MU ALIGN PROGRAM (P 52) OR CSM/MU ALIGN PROGRAM (P 53) OK BY THE COAST-LANDMARK TRACKING PROGRAM (P 22).

PKUG CONT | AGC | GROUND | CREW | CHECKLIST | TIML | TOTAL TIME

AGC ROUTINE SELECTION

START AUTO OPTICS POSITIONING ROUTINE (R 28)

15 THIS COAST-LANDMARK TRACKING PROGRAM (P 22)

N / Y

IS THE TARGET A STAR OR A LANDMARK

LANDMARK / STAR

#10

POSS HOLD

FLASH VERB-NOUN TO REQUEST PROCEED AND DISPLAY STORED LANDMARK IDENTITY
V06 N44
R1 - LAT
R2 - LONG
H3 - ALJ

MONITOR DSKY: OBSERVE FLASHING VERB-NOUN TO REQUEST PROCEED AND DISPLAY OF STORED LANDMARK IDENTIJY

* A. CHECK AGC FLASHES VERB-NOUN TO REQUEST PROCEED AND DISPLAY STORED LANDMARK OH STAR IDENTITY #LO

If LANDMARK:
V06 N44
R1 - LAT
R2 - LONG
R3 - ALT

LAT-LATITUDE OF LANDMARK. IN DEGREES TO NEAREST .01 DEGREES. + IS NORTH

LONG-LONGITUDE OF LANDMARK. IN DEGREES TO NEAREST .01 DEGREES.

+ IS EAST

ALT-ALTITUDE OF LANDMARK ABOVE THE MEAN EQUATORIAL RADIUS. IN NAUTICAL MILES TO NEAREST .1 NM.

AM I SATISFIED WITH THESE VALUES

Y | N

WAIT FOR KEYBOARD ENTRY

KEY IN PROCEED
V 33 E

TERMINATE FLASH UPON RECEIPT OF PROCEED OR NEW DATA

KEY IN V25 N44 AND LOAD DESIRED PARAMETERS

POSS HOLD

FLASH VERB-NOUN TO REQUEST PROCEED AND DISPLAY STORED STAR CODE
V06 N30
R1-STAR CODE

STAR CODE - STAR DESIGNATION FROM STAR CODE LIST

MONITOR DSKY:
OBSERVE FLASHING VERB-NOUN TO REQUEST PROCEED AND DISPLAY OF STORED STAR CODE

AM I SATISFIED WITH THIS STAR CODE

Y | N

LAT-LATITUDE OF LANDMARK. IN DEGREES TO NEAREST .01 DEGREES. + IS NORTH

LONG-LONGITUDE OF LANDMARK. IN DEGREES TO NEAREST .01 DEGREES. + IS EAST

ALT-ALTITUDE OF LANDMARK ABOVE THE MEAN EQUATORIAL RADIUS. IN NAUTICAL MILES TO NEAREST .1 NM.

IF STAR:
V06 N30
R1 - STAR CODE

STAR CODE - STAR DESIGNATION FROM STAR CODE LIST

* 8. IF SATISFIED WITH DATA KEY IN PROCEED
V 33 E

OR IF NOT SATISFIED WITH DATA LOAD DESIRED DATA.

FOR LANDMARKS:
V25 N44
R1 - LAT
R2 - LONG
R3 - ALT

FOR STAR:
V21 N30
R1 - CODE

WAIT FOR KEYBOARD
ENTRY

KEY IN PROCEED
V 33 E

TERMINATE FLASH
UPON RECEIPT OF
PROCEED OR NEW DATA.

KEY IN V21 N30 AND
DESIRED STAR CODE
LOAD DESIRED STAR
CODE

Y90

#100

CHECK OPTICS MODE
DISCRETE. IS THE OSS
IN THE AGC MODE

Y. N.

* C. MONITOR MODE CONTROL TEST

AGC TESTS FOR COMPUTER CONTROL OF
OPTICS BY CHECKING FOR COMPUTER
POSITION OF OPTICS MODE SWITCH

#110

* (1) POSITION: COMPUTER.
AGC PROCEEDS

POSS
HOLD.

FLASH VERB-NOUN
TO REQUEST
PLEASE PERFORM
OSS SWITCH TO
AGC MODE
V50 NZ5
R1- 00013

MONITOR DSKY:
OBSERVE VERB-NOUN
FLASH TO REQUEST
PLEASE PEHFORM OSS
SWITCH TO AGC MODE

* (2) POSITION: MANUAL OH ZERO
OPTICS.

CHECK AGC FLASHES VERB-NOUN
TO REQUEST PLEASE PERFORM OSS
SWITCH TO AGC MODE 11120
V50 N25
R1 - 00013

DO I WANT TO POSI-
TION THE OPTICS
MANUALLY

N. Y.

#130

OSS MODE
Sw AGC
CNTRL

WAIT FOR KEY-
BOARD ENTRY

SWITCH OPTICS TO
AGC MODE AND
KEY IN ENTER #140

* (A) NAV ACCEPTS REQUEST:

PLACE OPTICS MODE Sw TO
COMPUTER AND KEY IN ENTER

TERMINATE FLASH
UPON RECEIPT OF
ENTER OR PROCEED

KEY IN PROCEED
V 33 E

* (B) NAV REJECTS REQUEST; #150

KEY IN PROCEED V 33 E AND
POSITION OPTICS MANUALLY

PROCEED

ENTER

EXIT R 28

EXIT R 28 4160

ESTABLISH MONITOR OF
OPTICS DISCRETE.

#170

GET PRESENT PLAT-
FORM ORIENTATION
FROM STORAGE

#180

READ PRESENT VEHI-
CLE ATTITUDE FROM
ICDUS (ASSUME G AND
N HAS ATTITUDE CON-
TROL OF THE VEHICLE
OR ISS IS IN FINE
ALIGN MODE)

#190

CALCULATE THE RE-
QUIRED OPTICS ANGLE5
TO ACQUIRE THE
TARGET

#200

ARE REQUIRED OPTICS
ANGLES GREATER THAN
OPTICS STOPS

N. Y

TURN ON PROGRAM
ALARM LIGHT AND
DISPLAY
V05 N31
R1-00402

MONITOR DSKY:
CHECK PROGRAM ALARM
LIGHT ILLUMINATES
AND DISPLAY OF ERROR
CODE TO INDICATE
THAT TARGET IS
BEYOND DRIVE LIMITS
OF OPTICS

CAUTION: IF PROGRAM ALAKM ILLUMI- #210
NATES AND AGC DISPLAY ERROR
CODE
V05 N31
R1 - 00402

TARGET IS BEYOND OPTICS
DRIVE LIMITS. SELECT NEW
TARGET OR MANEUVER S/C IF
PRACTICAL

8220

EXIT R 28

EXIT R 28

DISPLAY ON DSKY:
V16 N57
R1 - SHAFT
R2 - TRUNNION

SHAFT-
OPTICS SHAFT ANGLE.
IN DEGREES TO NEAR-
EST .001 DEGREE.

TRUNNION-
OPTICS TRUNNION
ANGLE. IN DEGREE5
TO NEAREST .001
DEGREE.

MON1TOR DSKY:
OBSERVE DISPLAY OF
REQUIRED OPTIC5
ANGLES

*

D. CHECK A6C DISPLAYS RE-
WIRED SHAFT ANGLE AND #230
TRUNNION ANGLE
V16 N57
R1 - SHAFT
R2 - TRUNNION

SHAFT- OPTICS SHAFT ANGLE.
IN DEGREES TO NEAREST .001
DEGREE.

THUNNION- OPTICS TRUNNION ANGLE. #240
IN DEGKEES TO NEAREST .001
DEGREE.

CALL OPTICS CDU DRIVE

OBSERVE OPTICS BEING DRIVEN TO ANGLES DISPLAYED

* E. CHECK OCDUS AND TELESCOPE COUNTERS ARE DRIVEN TO OPTICS ANGLES DISPLAYED ON DSKY #250

CONTINUE CDU DRIVE AND OPTICS ANGLE DIS -PLAY UNTIL TERMI- NATE IS RECEIVED FROM CALLING ROUTINE

* F. IDENTIFY TARGET IN TELESCOPE FOV

#260

OSS MODE SW AGC CNTRL

EXIT R 28

EXIT R 28

END OF RUN

REFERENCES

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