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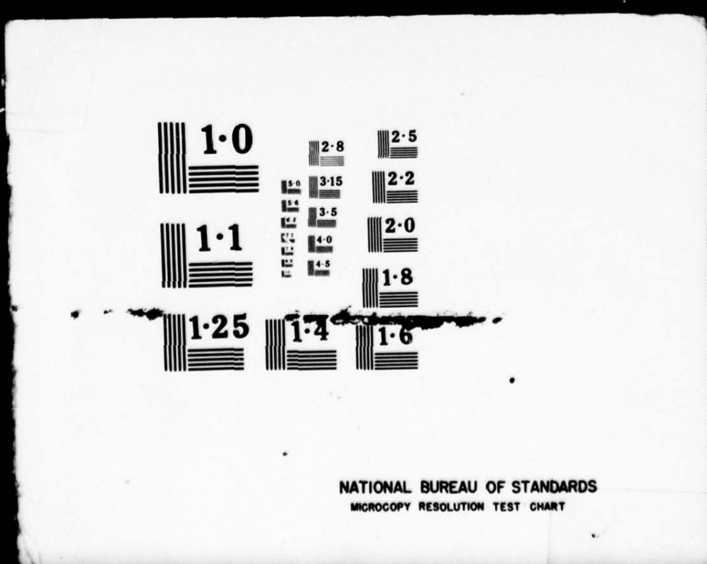

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SPECIFICATIONS FOR IDAMST SOFTWARE (MISSION ANALYSIS)

The Boeing Aerospace Company
Boeing Military Airplane Development
Seattle, Washington 98124

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Final Technical Report April 1976 - June 1976

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This final report was submitted by the Boeing Aerospace Company, Military Airplane Development, Seattle, Washington 98124, under contract F33615-76-C-1099, job order 2003 01 05, with the Air Force Avionics Laboratory, System Avionics Division. Mr. Lawrence L. Gutman/AFAL/AAA-1 was the project engineer. This report has been reviewed and cleared for open publication and/or public release by the Aeronautical Systems Division Office of Information (ASD/OIP) in accordance with AFR 190-17 and DODD 5230.9. There is no objection to unlimited distribution of this to the National Technical Information Service (NTIS). Publication of this report does not constitute Air Force approval of the reports findings or conclusions. It is published only for the exchange and stimulation of ideas.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The objective of this program was to define the operational flight program and the operational test program for an Integrated Digital Avionics System (DAIS) for the Medium STOL (IDAMST) airplane. This effort is part of an Air Force Avionic Laboratory Program to specify a candidate avionics design based on DAIS technology. The approach involved the development of software requirements derived from the system analysis of the hardware baseline and the operational analysis of the AMST mission. The software requirements → (over)

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were developed into a specific IDAMST software design. The design is described in terms of functional, architectural, and configurational characteristics. The design documents consist of four Computer Program Development Specifications, Type B5 per MIL-STD-490 and MIL-STD-483. The IDAMST software design was based on DAIS architecture and adapted as required to meet the IDAMST requirements. The DAIS architecture proved to be flexible allowing the design to be extended to IDAMST without major change. The IDAMST system defined satisfies the functional and operational requirements of the AMST. The design consists of a dual redundant processor with a reprogrammable backup processor.

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FOREWORD

This report describes the results of a study performed for the Air Force Avionics Laboratory by the Boeing Aerospace Company, Military Airplane Development, under Contract F-33615-76-C-1099 of Project 2003.

The report describes the software documentation developed to define the IDAMST system for the AMST. The report details the approach used to define, design, and specify the ground and flight operational programs. The work was performed during April through June 1976, under the direction of Mr. David G. Tubb, Program Manager.

The author wishes to acknowledge the significant contribution to the program of Messrs. John Andrews, Al Crossgrove, Downey Cunningham, Harvey Kanemote, Paul Kappus, Joe Musgrave, Doug Smith, and Dr. Leroy Smith of The Boeing Company, Jim Gracia and William Hirt of Harris ESD, and Larry Gutman and Gary Wambold of the Air Force Avionics Laboratory.

This report was submitted by the author July 1976, has been reviewed, and is approved for publication.

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SECTION I
INTRODUCTION

The data contained herein is the product of Mission Analysis Work performed in compliance with the Air Force Avionics Laboratory (AFAL) Work Statement included in Contract No. F33615-76-C-1099. That contract supports the Phase I development of software specifications for the Integrated Digital Avionics for the Advanced Medium STOL Transport (IDAMST). Development of the specifications is an extension of a study performed by AFAL which defined the IDAMST conceptual design. The final report for that study was published by AFAL/AAA in March of 1975.

Under the AMST program the Air Force is funding the development of two aircraft designs by two contractors. The Boeing Company is responsible for production and initial testing of two prototype YC-14 aircraft while McDonnell-Douglas will perform the same tasks on the YC-15. A fly-off between the four aircraft will be exercised under Air Force direction to determine which of the two competitive models will become the basic design for C-130 replacement.

Since the prototype aircraft are primarily intended to demonstrate relative aircraft performance, their avionic suits employ fairly conventional components. But it is expected that the design selected as a result of the fly-off will be configured for production to incorporate advanced avionics equipment. The level of automation and integration of the components will in part be determined by studies directed toward assessing how well various crew sizes can handle the required functions involved in performing AMST missions. The IDAMST studies being conducted by AFAL are directed towards employing advanced concepts evolved from the DAIS program to develop a candidate design for the AMST aircraft operated by a two-man flight crew.

Both Boeing and McDonnell-Douglas have participated in the IDAMST study, each developing hardware and software configurations that could be potentially incorporated into their respective production designs. The following paragraphs in this section provide a brief introduction to the IDAMST C-14 and the missions to which it is addressed.

The C-14 will be a twin engine cargo aircraft which derives its STOL capability from the aerodynamic effects of upper surface blowing. Under the IDAMST concept, the avionics equipment will operate as an automated/integrated system. The equipment list supporting required C-14 mission functions is shown on Figure 1. All flight and subsystem control will be exercised by a minimum sized crew. For this study, the flight crew was assumed to consist of a pilot and copilot. An additional crew member will be required to perform Load/Jump Master duties associated with cargo compartment management.

C-14 missions will include tactical deployment to distant theaters of operation; precision air drops of personnel and equipment from all altitudes down to practical minimums; Low Altitude Parachute Extraction (LAPE) of equipment; and STOL operations including rapid offload of equipment and/or personnel in forward combat areas. Most significantly, the aircraft must be capable of performing all of the functions included in the deployment and precision air drop elements under Instrument Meteorological Conditions (IMC). These then are the elements which form the basis of the IDAMST Mission Analysis study.

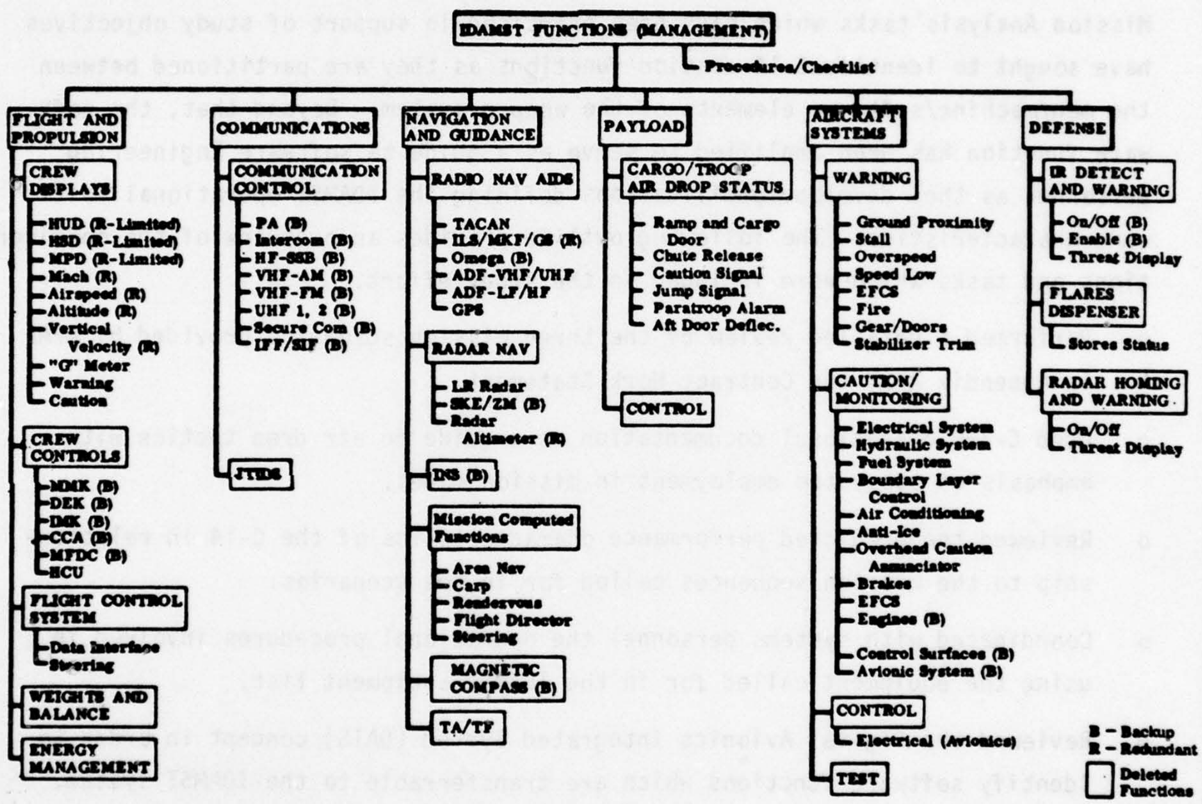


FIGURE 1

IDAMST Equipment List Correlated with Mission Function

SECTION II

STUDY OBJECTIVES AND TECHNICAL APPROACH

2.1 This study has had as its objective the definition of software requirements which would be required to support the development and operation of an IDAMST system. Study emphasis has been concentrated on the navigation, communication, and other system functions uniquely associated with AMST mission. Outside of the scope of the study has been those functions which support flight control.

Mission Analysis tasks which have been exercised in support of study objectives have sought to identify C-14 mission functions as they are partitioned between the man/machine/software elements of the weapon system. Beyond that, the software function has been amplified to serve as a guide to software Engineering personnel as they develop specifications defining the IDAMST operational software characteristics. The following outline provides an overview of the considerations and tasks which were included in the study effort.

- o Performed a detailed review of the three mission scenarios provided by AFAL in Appendix A of the Contract Work Statement.
- o Used C-130 operational documentation as a guide to air drop tactics with emphasis on subsystem employment in mission modes.
- o Reviewed the predicted performance characteristics of the C-14 in relationship to the mission sequences called for in the scenarios.
- o Coordinated with systems personnel the operational procedures involved in using the equipment called for in the IDAMST equipment list.
- o Reviewed the Digital Avionics Integrated System (DAIS) concept in order to identify software functions which are transferrable to the IDAMST system.
- o Developed time lines for all AFAL mission scenario sorties.

  These diagrams graphically broke individual sorties down according to time frame to correlate: aircraft flight modes with respect to speed, altitude and subsystem employment; terrain features; local weather; friendly forces and systems in the proximity (other C-14's, air traffic control, command and control units, drop zone, etc.); the presence of enemy aircraft and ground based air defense units including ECM. The complete time line analyses for the three day mission scenario are included in Section III.

- Developed composite mission scenario.

  When the time line analysis was complete, it was obvious that each of the individual sorties flown during the three day scenario contained segments which imposed unique demands on the C-14 crew/system combination while other portions of the sorties contained task performance which typically is repeated throughout the three day mission. Figures 2 through 4 illustrate the situation with the heavy lines representing segments of interest. In order to focus the development of Subsystem Sequence Diagrams (SSD's) and Functional Sequence Diagrams (FSD's) on C-14 tasks where analysis of IDAMST was needed, these segments were integrated to form a composite mission. Figure 5 graphically summarizes the events included in that mission. The segments which are contained in the six circled regions have been designated subjects of second level FSD analysis, to be discussed shortly.

- Developed Subsystem Sequence Diagrams (SSD's)

  Events occurring in the composite scenario call for rapid execution of a large number of individual tasks which contribute to the successful performance of tactical functions associated with mission objectives. At any one time, tasks simultaneously being performed may include navigation, communication, IFF, SKE, ECM, etc. In varying degrees each task requires coordinated crew and subsystem operations interfaced through the use of dedicated software programs. When all of the individual programs required by the composite scenario are assembled, they then become the repertoire which enables the C-14 to selectively perform any of the functions included in the AMST Required Operating Capability during a given sortie. The individual programs included in the repertoire are system-function related, rather than scenario related. For each unique system function, there is a specific sequence of operations which can be illustrated using flow diagram techniques. These schematics are referred to as Subsystem Sequence Diagrams (SSD's). Figure 6 illustrates the role of SSD's in the IDAMST analysis, and also serves to introduce the subject of Functional Sequence Diagrams. The SSD's developed during this study are included in Section IV.

- Developed Functional Sequence Diagrams (FSD's)

  As Figure 6 implies, FSD's are directly related to the mission scenario. In fact, they are the graphical single thread which link individual SSD's to tasks to be performed in the scenario.

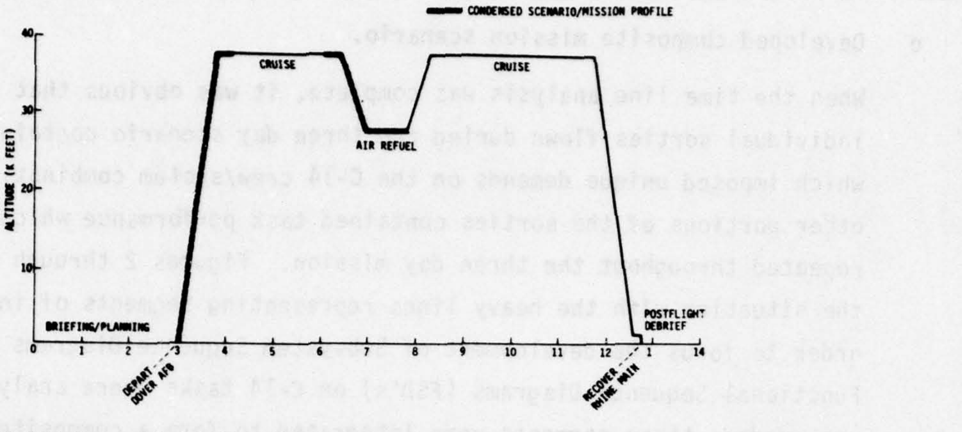


FIGURE 2: Flight Profile for First Day's Mission

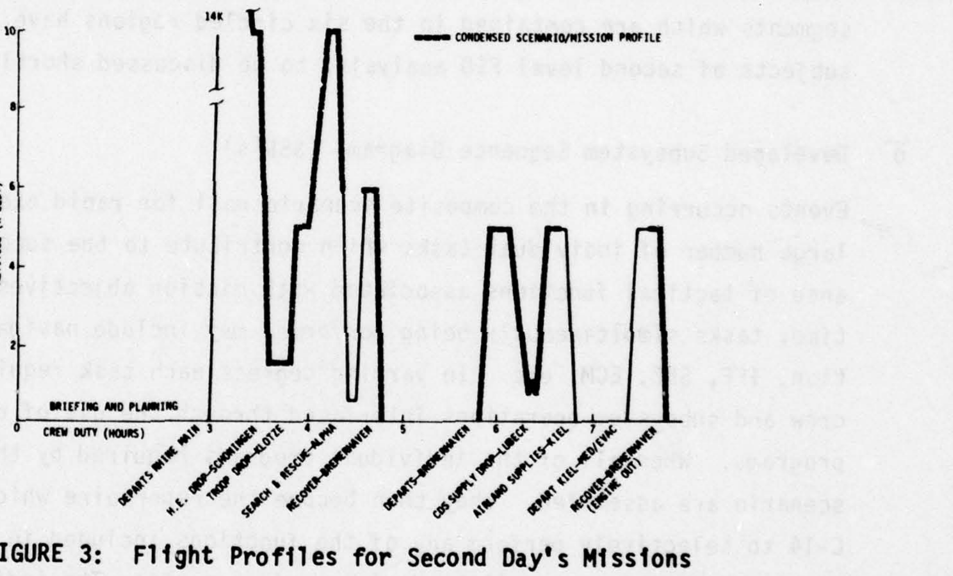


FIGURE 3: Flight Profiles for Second Day's Missions

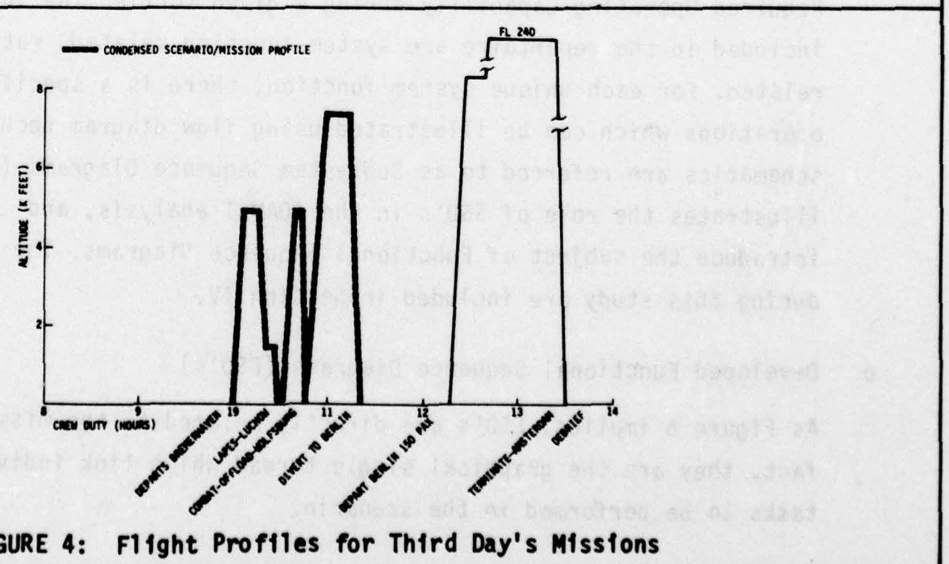


FIGURE 4: Flight Profiles for Third Day's Missions

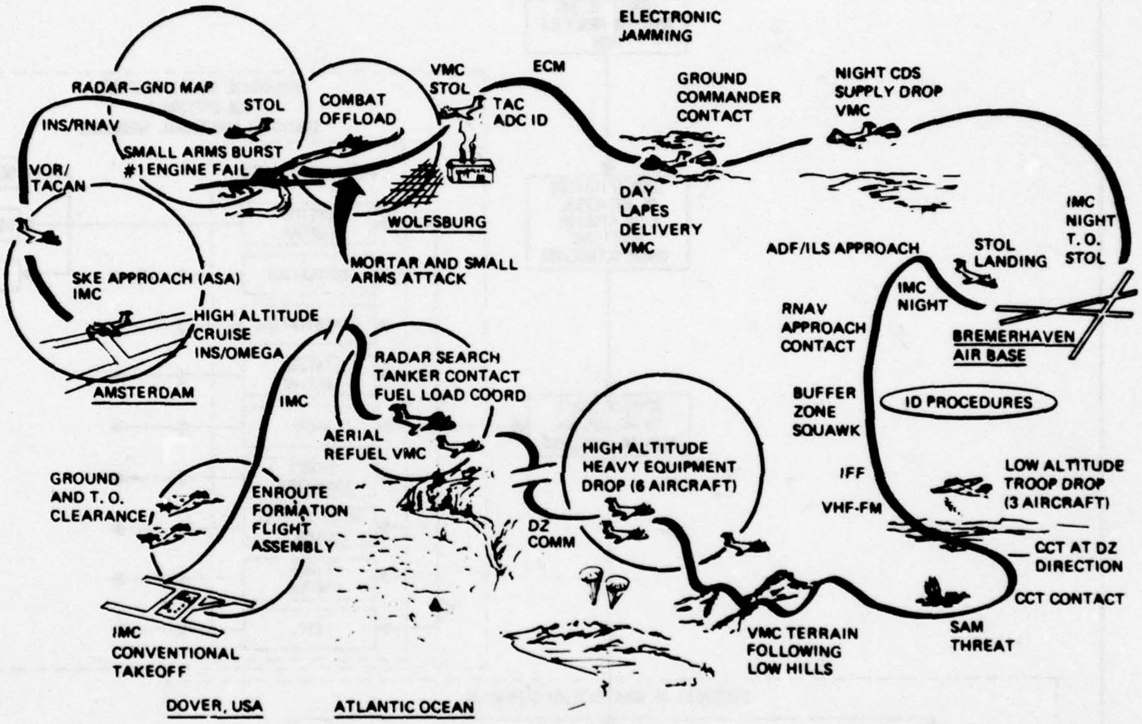


FIGURE 5: IDAMST Composite Mission Scenario

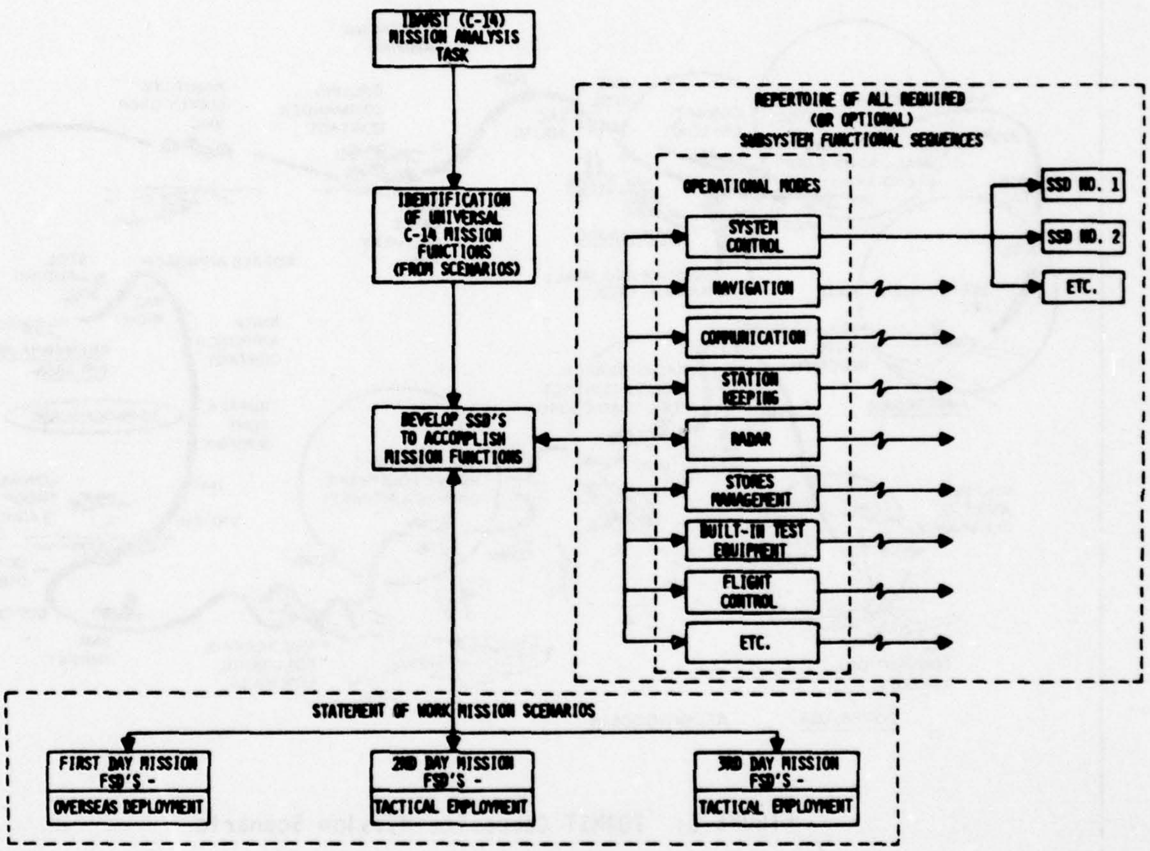


FIGURE 6: Interrelationship of IDAMST Mission Analysis Elements

As an analytical tool, FSD's are useful in several different ways. First they serve as a test to determine the availability and completeness of SSD's. Where deficiencies exist, the void can be identified as the subject of additional SSD development. Second, by correlating the simultaneous SSD functions called for by the FSD at a particular time in the scenario, it is possible for the analyst to scope man/machine task loading in gross terms.

Two FSD levels of indenture are included in this report.

The First Level has been used to facilitate the analysis of a complete single sortie selected from the various missions flown in the three day scenario. This FSD format provides insight as to the simultaneous activities of the three (pilot, copilot and loadmaster) man flight crew with indices to the detailed SSD operations that are required to respond to postulated scenario events. Section V contains all of the First Level FSD's and associated analysis generated during the study.

The Second Level FSD has been used as the basis for analysis applied to instances of high task loading occurring in the composite scenario. (Reference the six circled regions of Figure 5). This particular approach focuses attention on the interaction of the individual crewman with those software and hardware elements which best enable him to respond to scenario events. While the technique still relies on SSD references to provide ultimate detail, the Second Level FSD itself amplifies information on software/hardware functional requirements. Section VI includes the Second Level FSD's dealing with composite scenario events.

SECTION III
TIME LINE ANALYSES

A detailed overview of the flight crew tasks and functions was obtained by describing on a rigid time base the actions necessary to establish the scenario flight profile. As can be seen in the following pages, each action is defined within the total context of the flight. Any interfering requirement is evident. Consequently, each action can be identified in relation to all other actions be they aircraft, flight crew, or ground related. This format quickly points out potential excessive workload problems.

As a result of the following analysis, potentially excessive workload areas were noted and were then analyzed further in the Level 2 FSD's of Section VI.

The time line analyses cover the three composite missions selected for detailed study and cover the following flight modes:

	TIME
Mission I	
Aerial Refueling (Formation)	0640 - 0712
High Altitude H.E. Airdrop	0312 - 0336
Low Altitude Airdrop	0336 - 0400
Mission II	
CDS Airdrop (Formation)	0548 - 0624
Airborne Radar Approach	0624 - 0638
Mission III	
LAPES Delivery	1000 - 1032
STOL & Combat Offload	1032 - 1048
Departure Engine Failure	1046 - 1052
VOR & ILS Approach	1052 - 1104

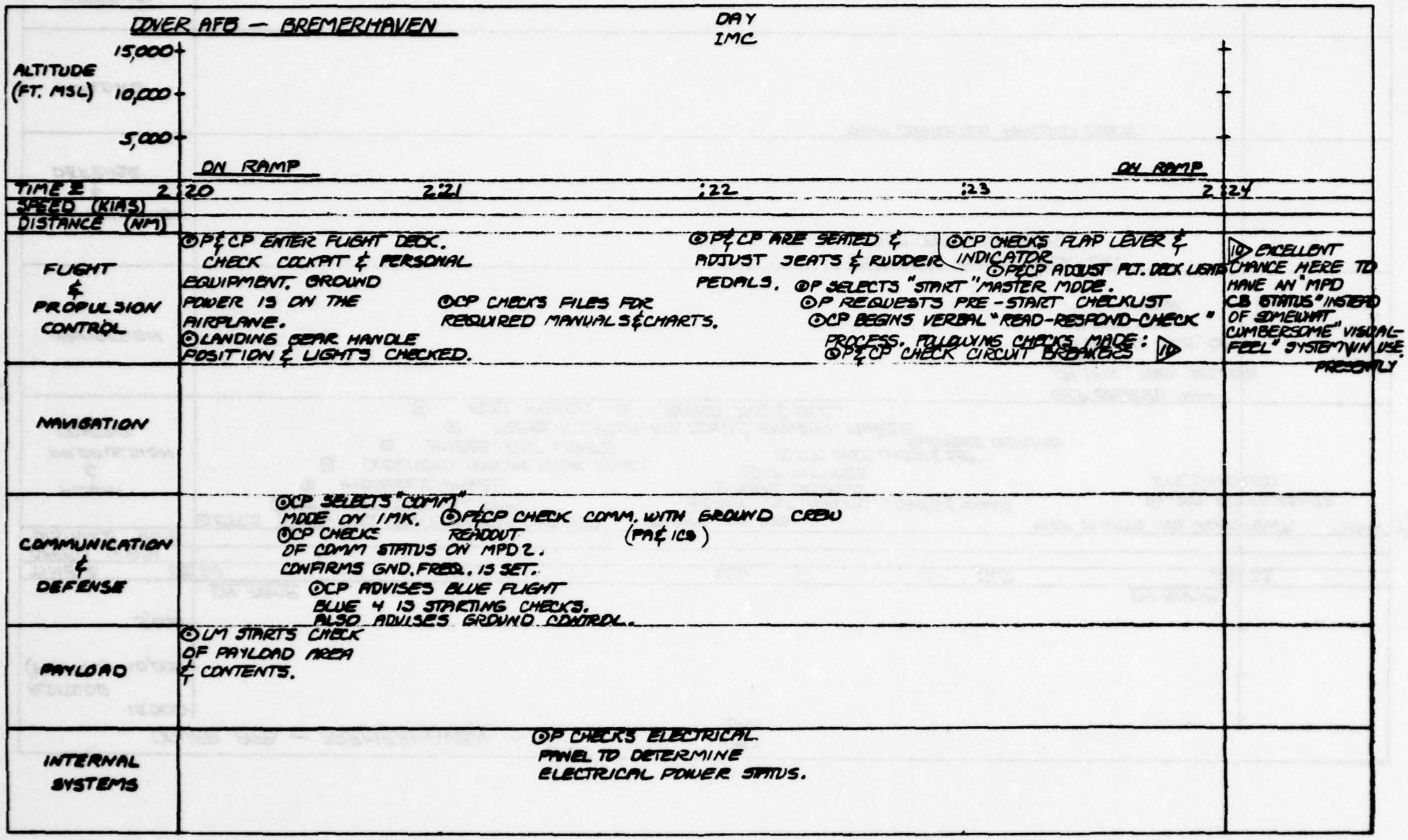


FIGURE NO. 7 Mission I - Aerial Refueling

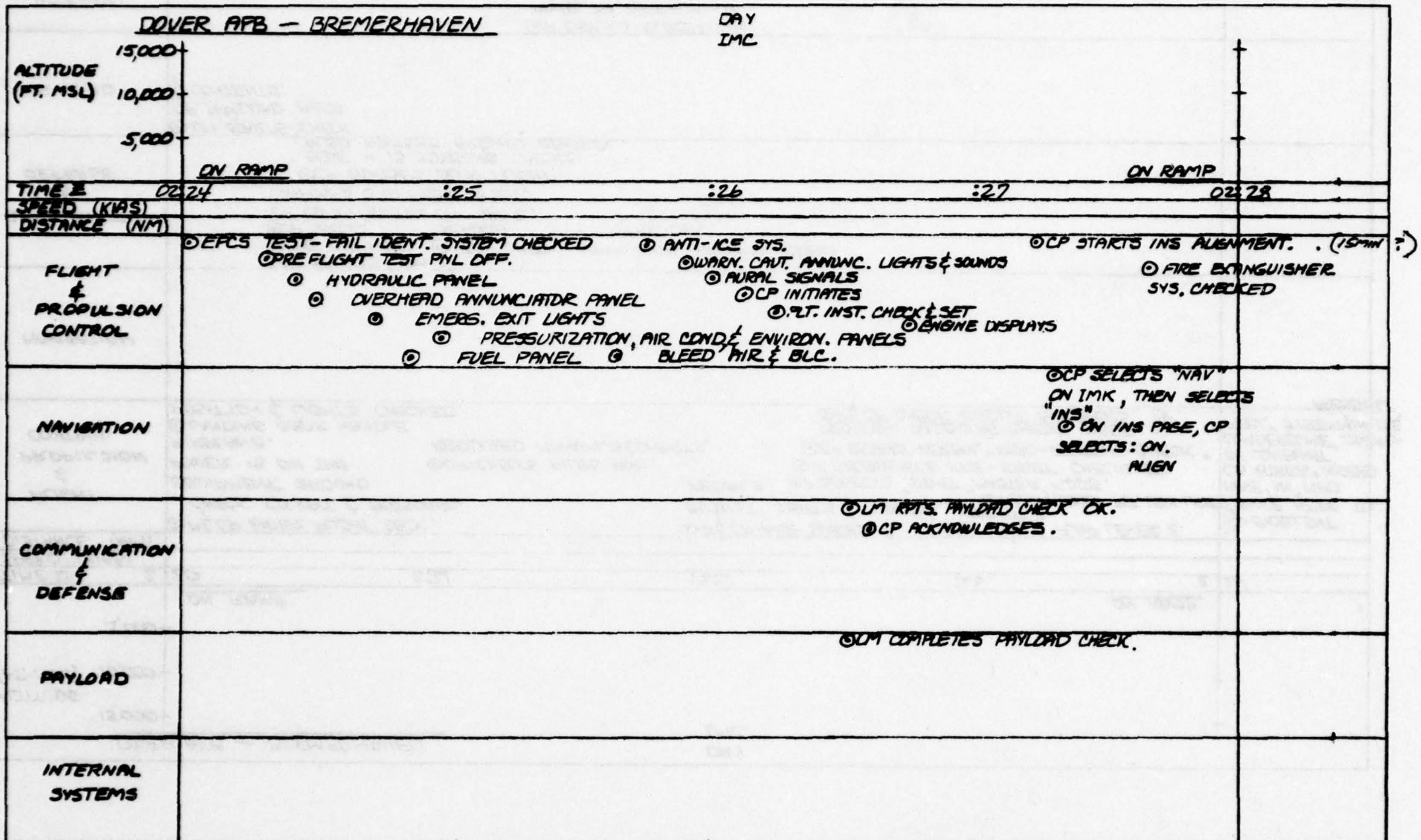


FIGURE NO. 8 Mission I - Aerial Refueling

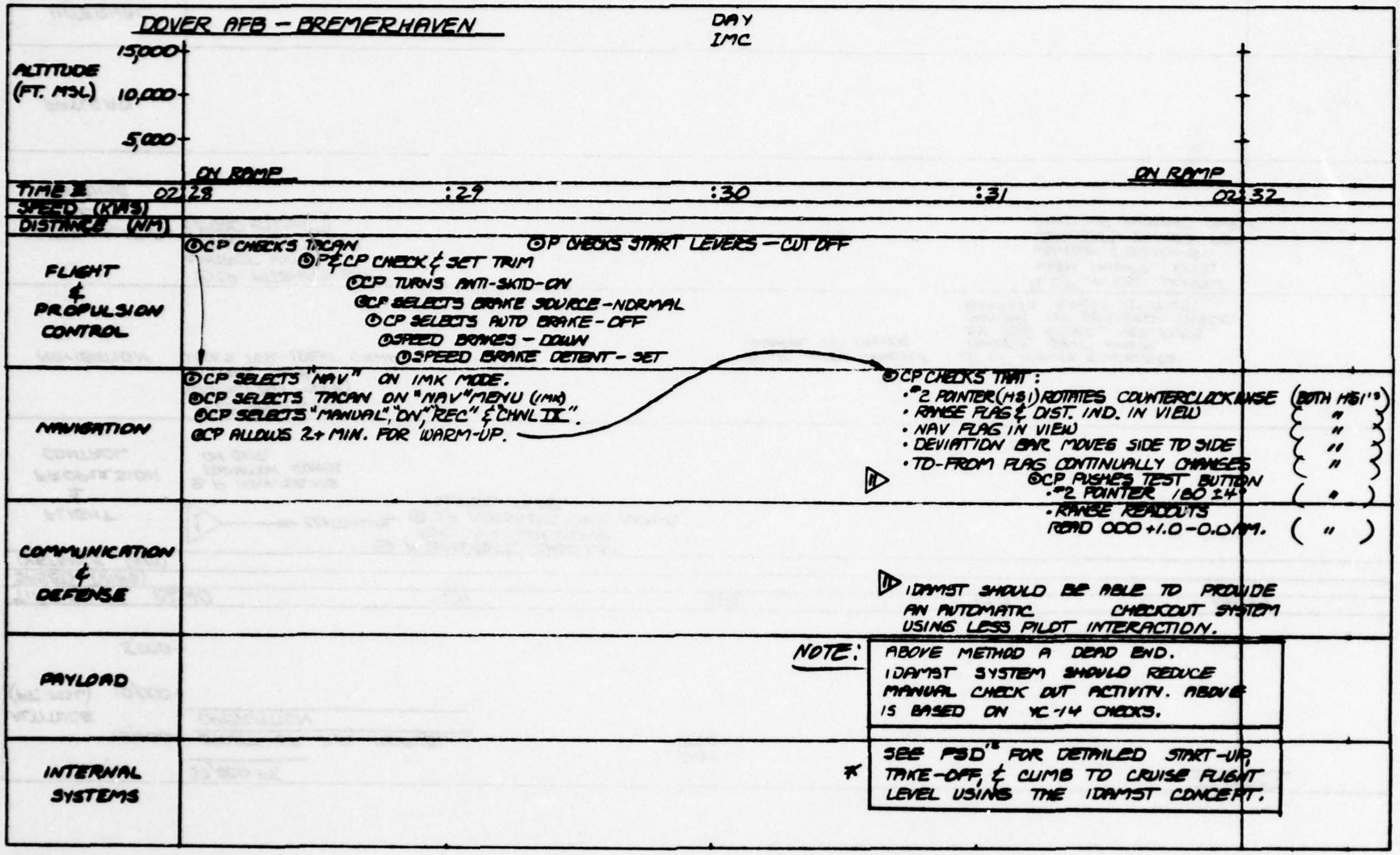


FIGURE NO. 9 Mission I - Aerial Refueling

	06:40	:41	:42	:43	06:44
ALTITUDE (FT. MSL) 15,000 / 10,000 / 5,000	37,000 FT. START OF AIR REFUEL OPERATION		DAY VMC		37,000 FT.
TIME Z	06:40	:41	:42	:43	06:44
SPEED (KIAS)					
DISTANCE (NM)					
FLIGHT & PROPULSION CONTROL	1 → CONTINUAL (•) P MONITORING FORMATION STATUS ON SKE.	(•) P REQUESTS CHECKLIST FOR AIR REFUELING (•) CP PRESSES AIR REFUEL MASTER MODE.			
NAVIGATION	(•) CP READJUSTS RADAR (BCN MODE) AT MAX. RANGE LOOKS FOR IDENT SIGNAL. →		(•) CP NOTES POSSIBLE SIGNAL OF TANKER	(•) CP IDENTS & VERIFIES TANKER IDENT SIGNAL ON BCN. RADAR. VERIFIES TANKER ON DESIRED TRACK. REPORTS RANGE TO PILOT.	
COMMUNICATION & DEFENSE	(•) CP ATTEMPTS UHF CONTACT WITH DESIGNATED TANKER (ESSO 69)(UHF¹)			(•) CP INITIAL CONTACT WITH TANKER. RPTS. RANGE & BEARING. REQUESTS TANKER TO CONTINUE PRESENT COURSE	
PAYLOAD					
INTERNAL SYSTEMS					

FIGURE NO. 10 - Aerial Refueling Mission I

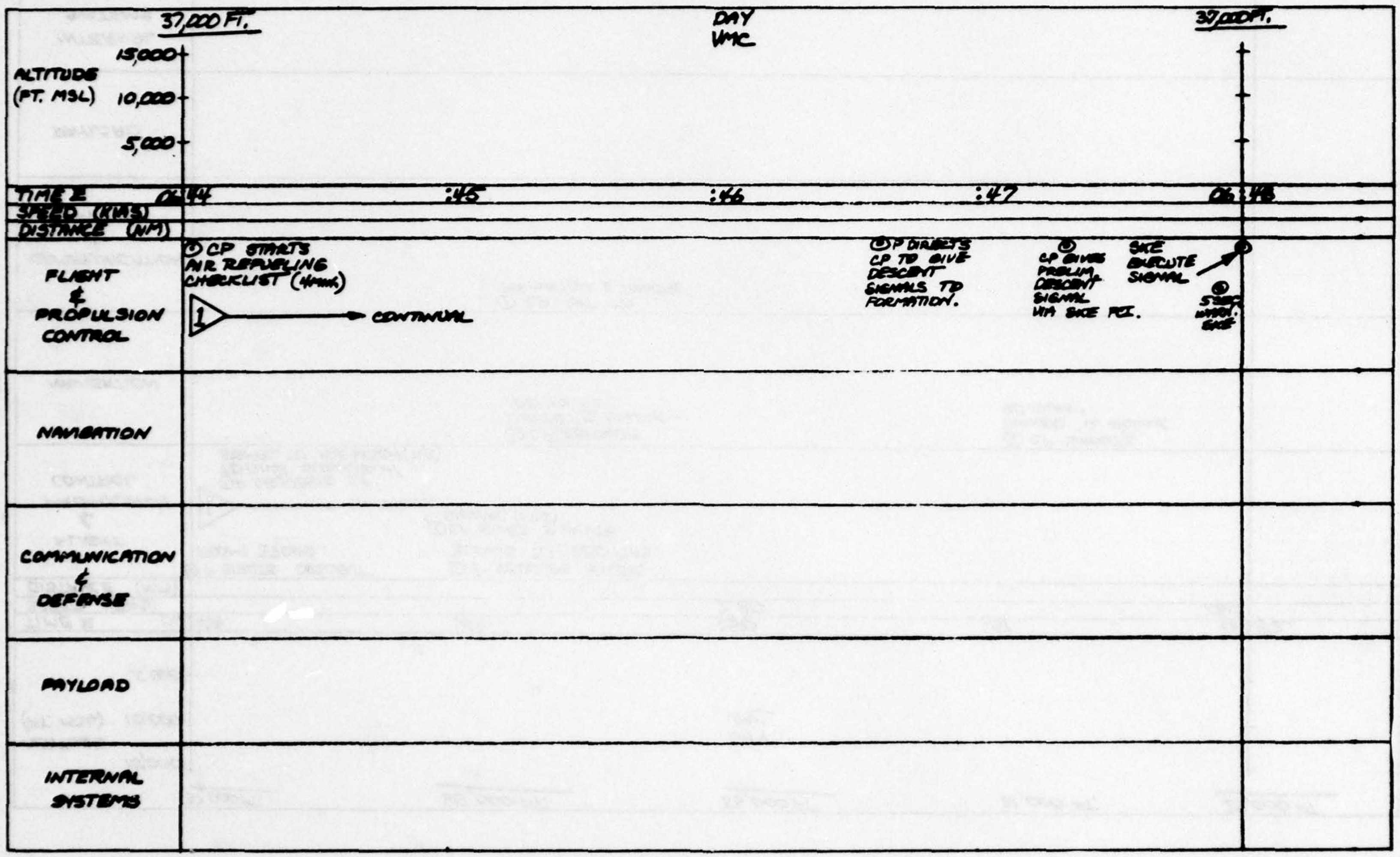


FIGURE NO. 11 - Aerial Refueling Mission I

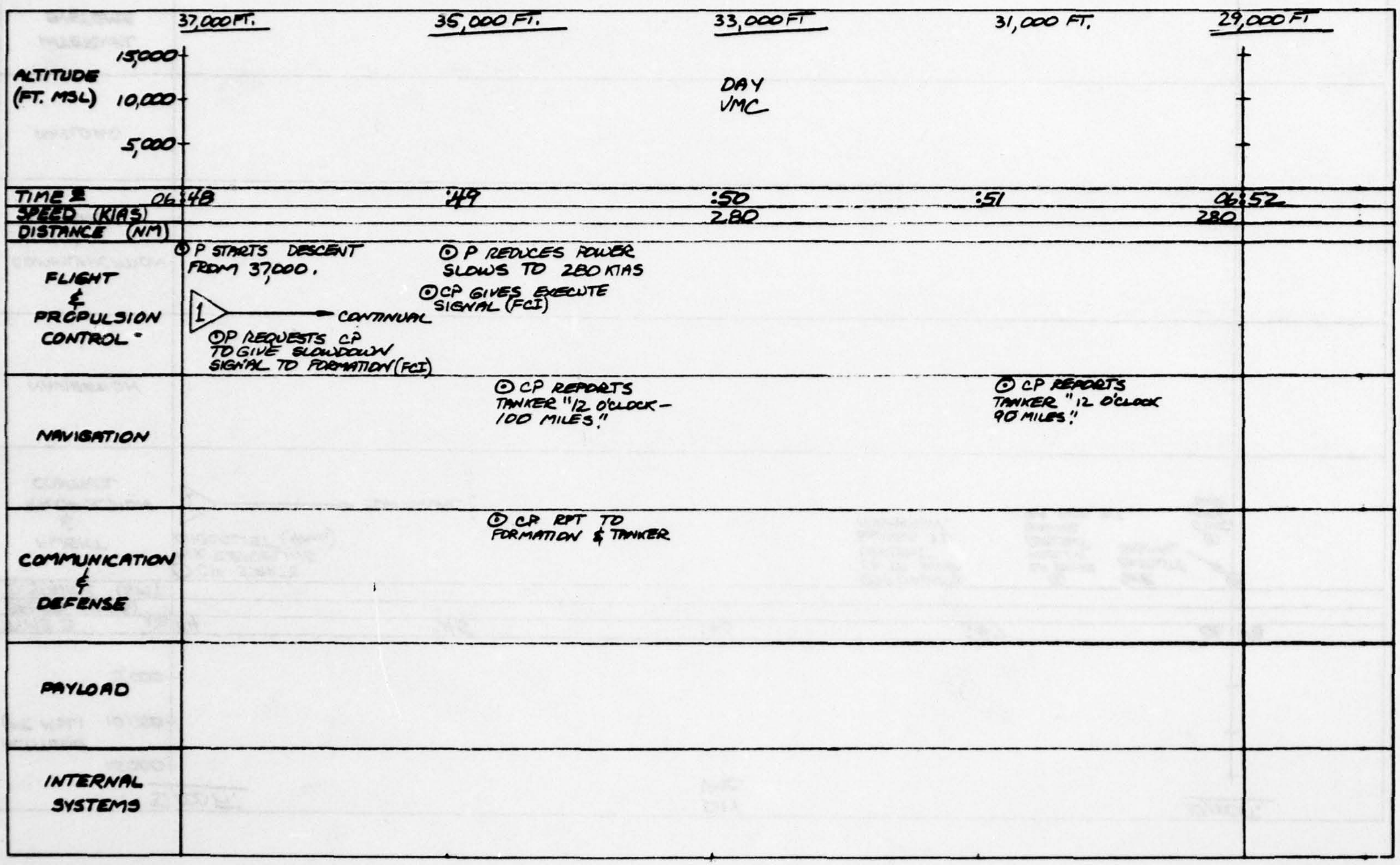


FIGURE NO. 12 - Aerial Refueling Mission I

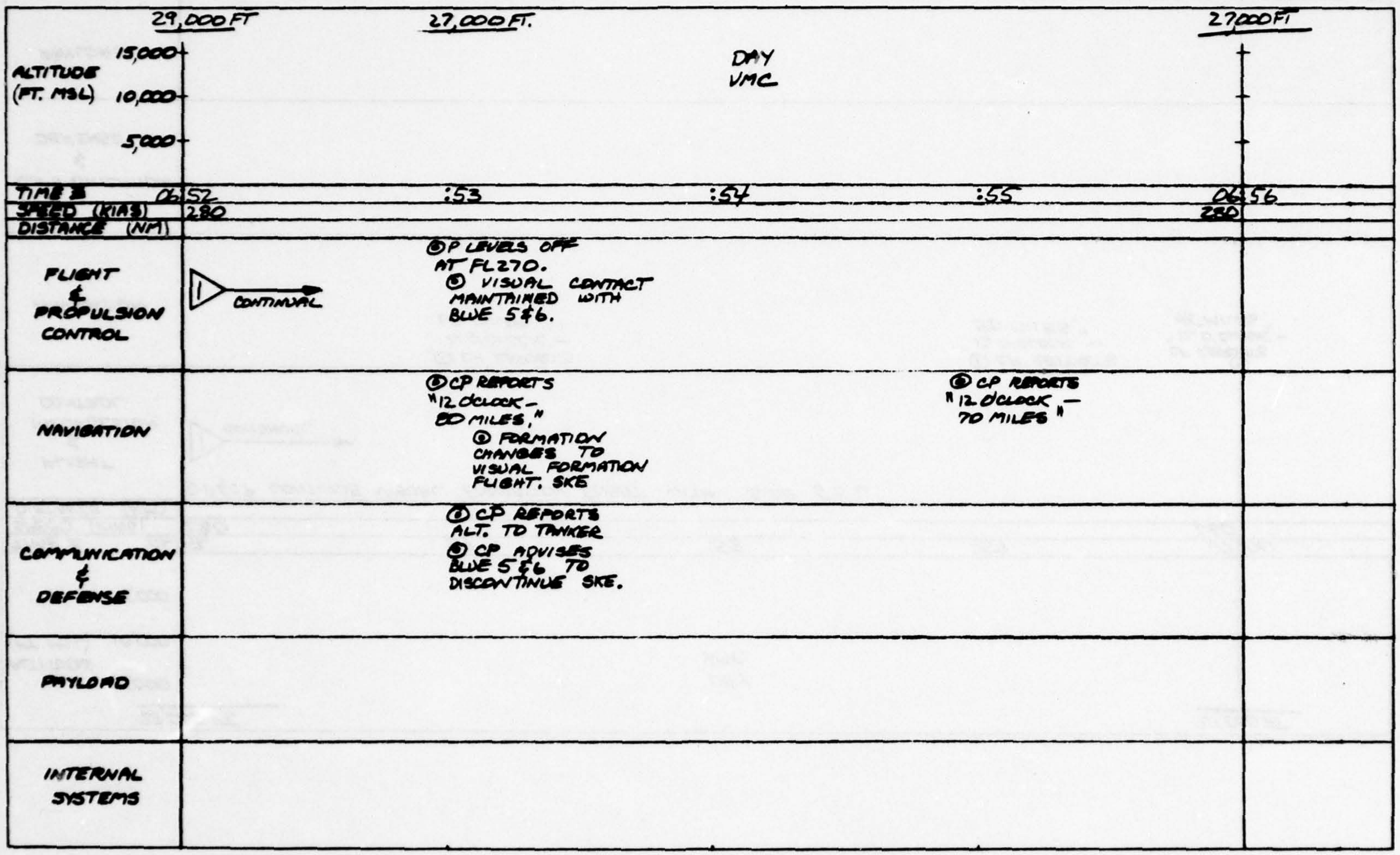


FIGURE NO. 13 - Aerial Refueling   Mission I

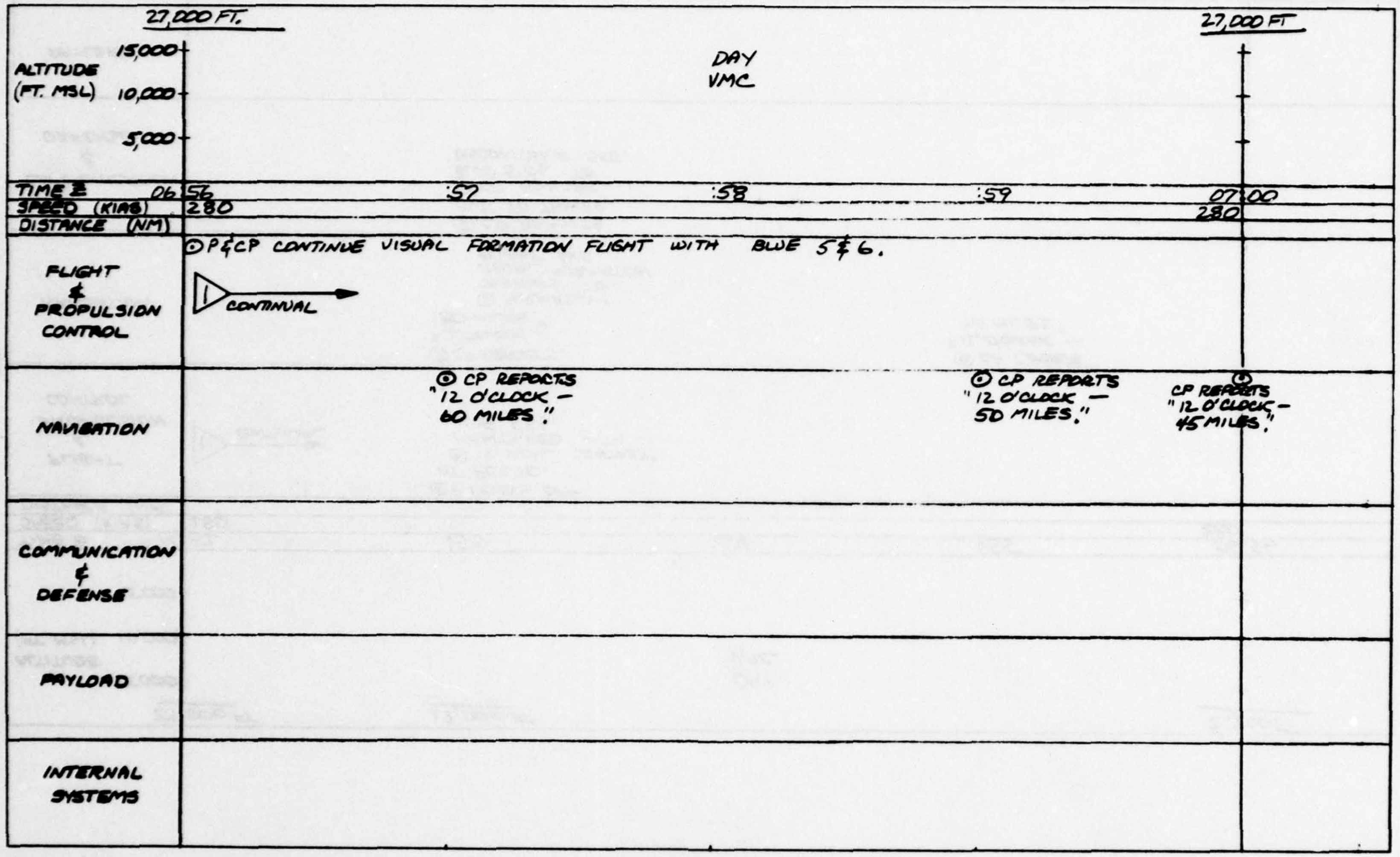


FIGURE NO. 14 - Aerial Refueling Mission I

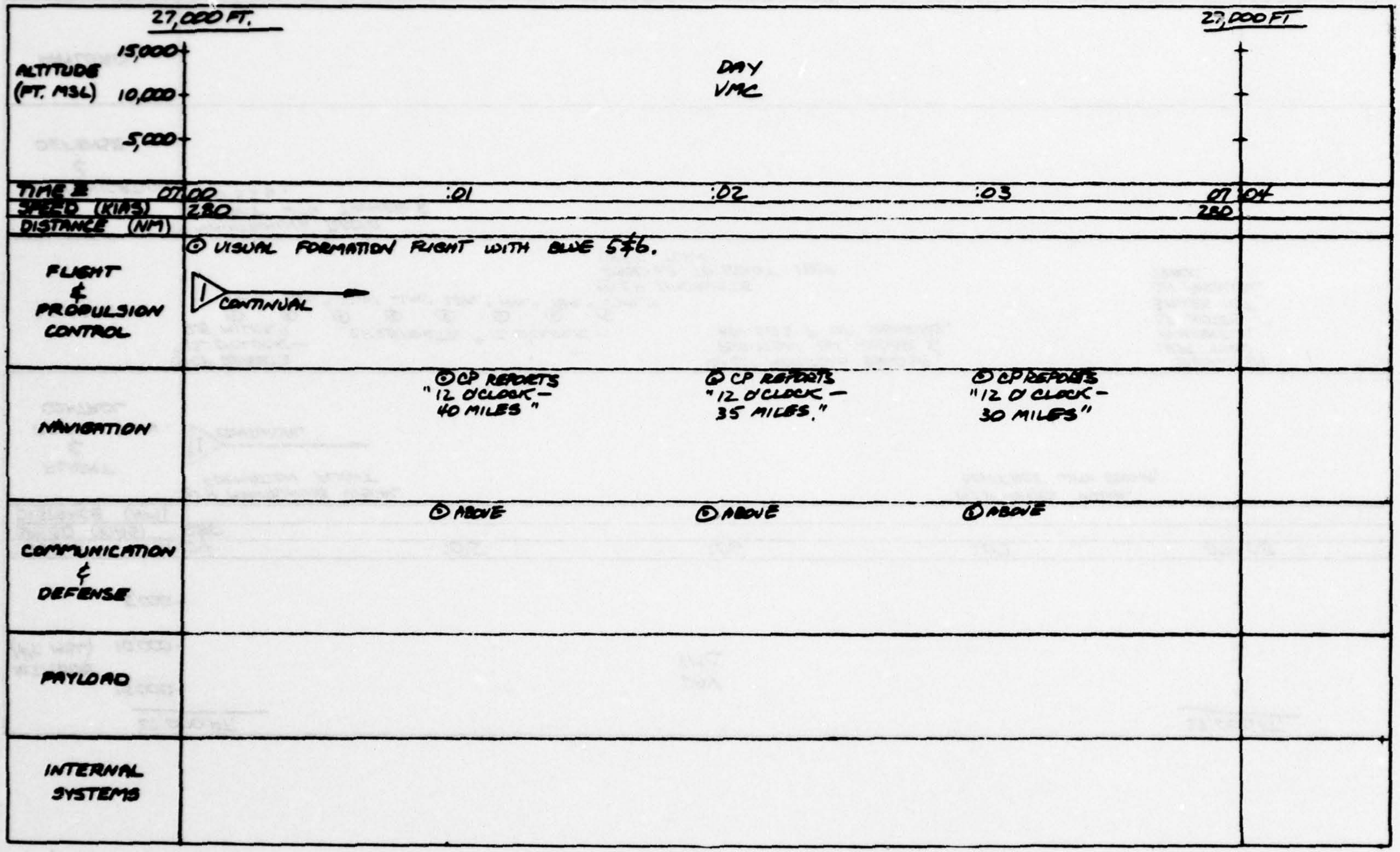


FIGURE NO. 15 - Aerial Refueling Mission I

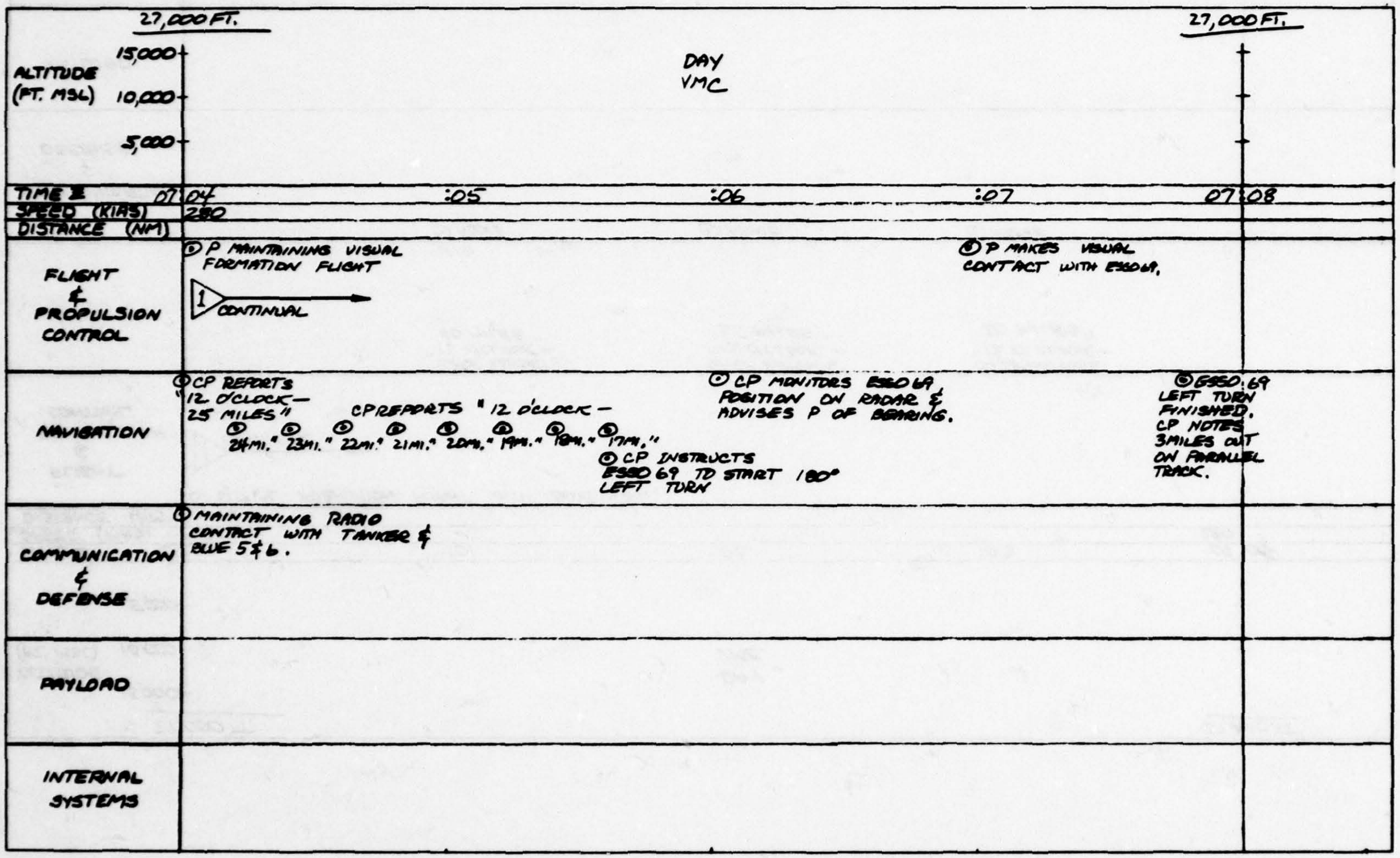


FIGURE NO. 16 - Aerial Refueling   Mission I

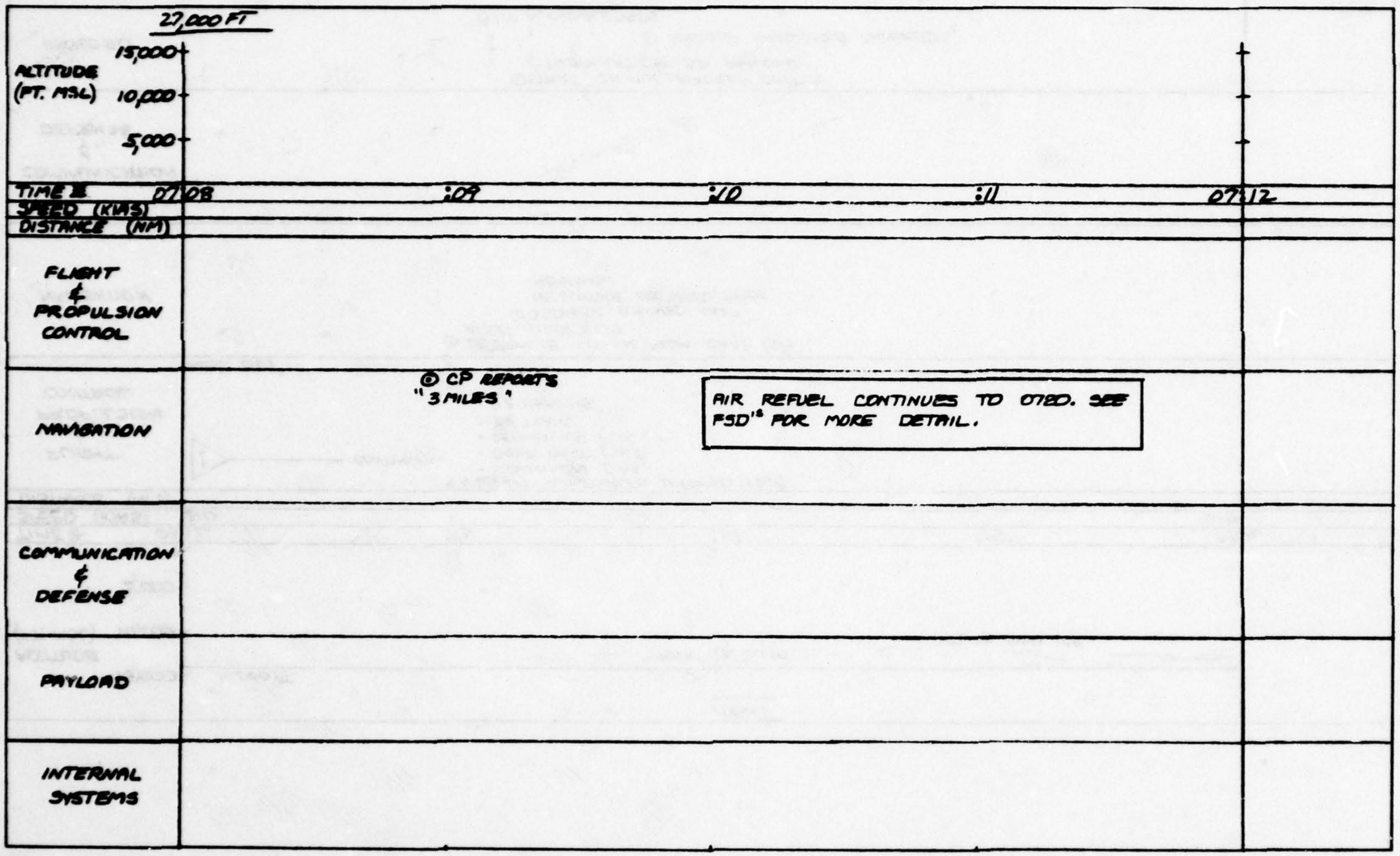


FIGURE NO. 17 - Aerial Refueling Mission I

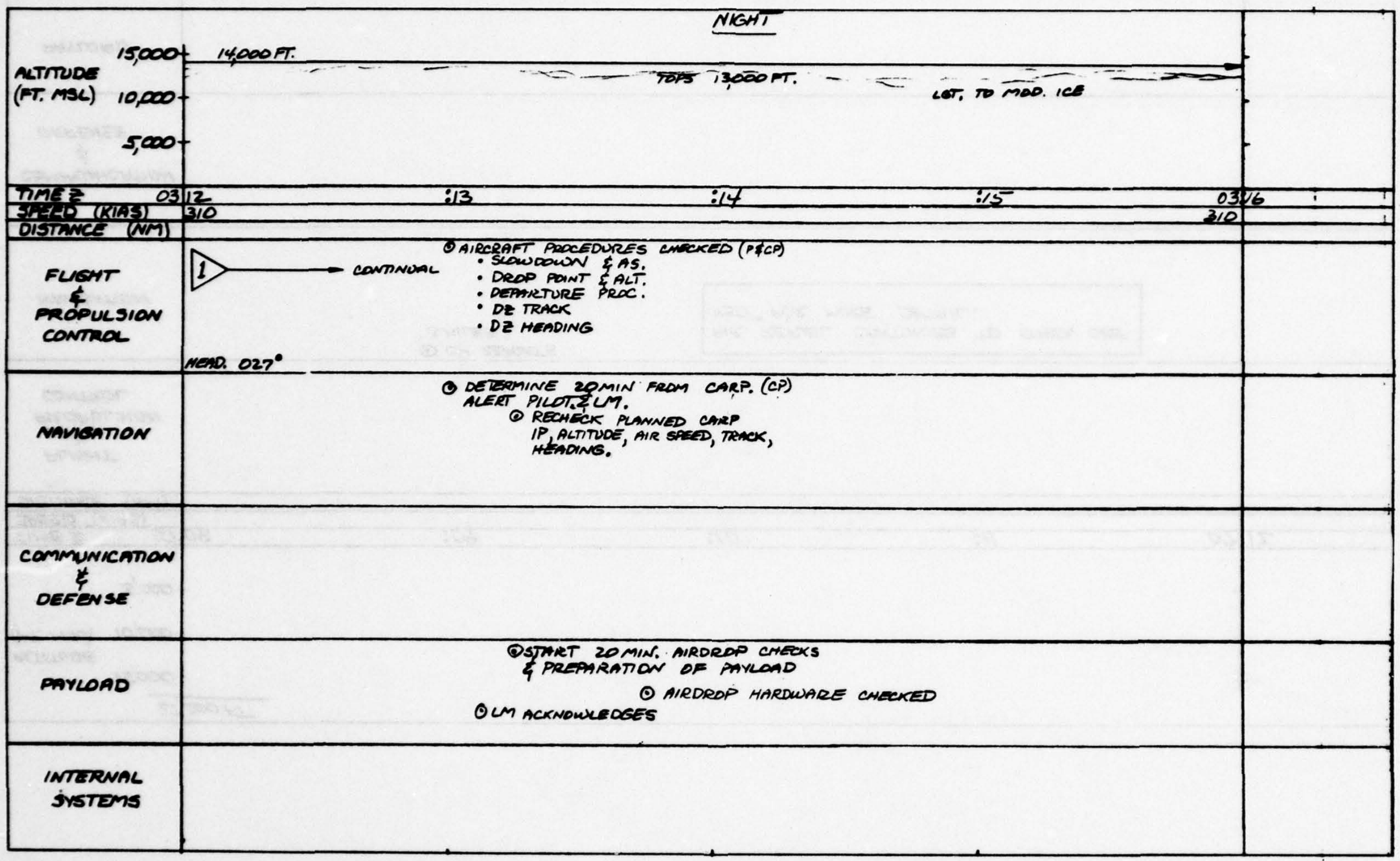


FIGURE NO. 18 Mission I - High Altitude Heavy Equipment Airdrop

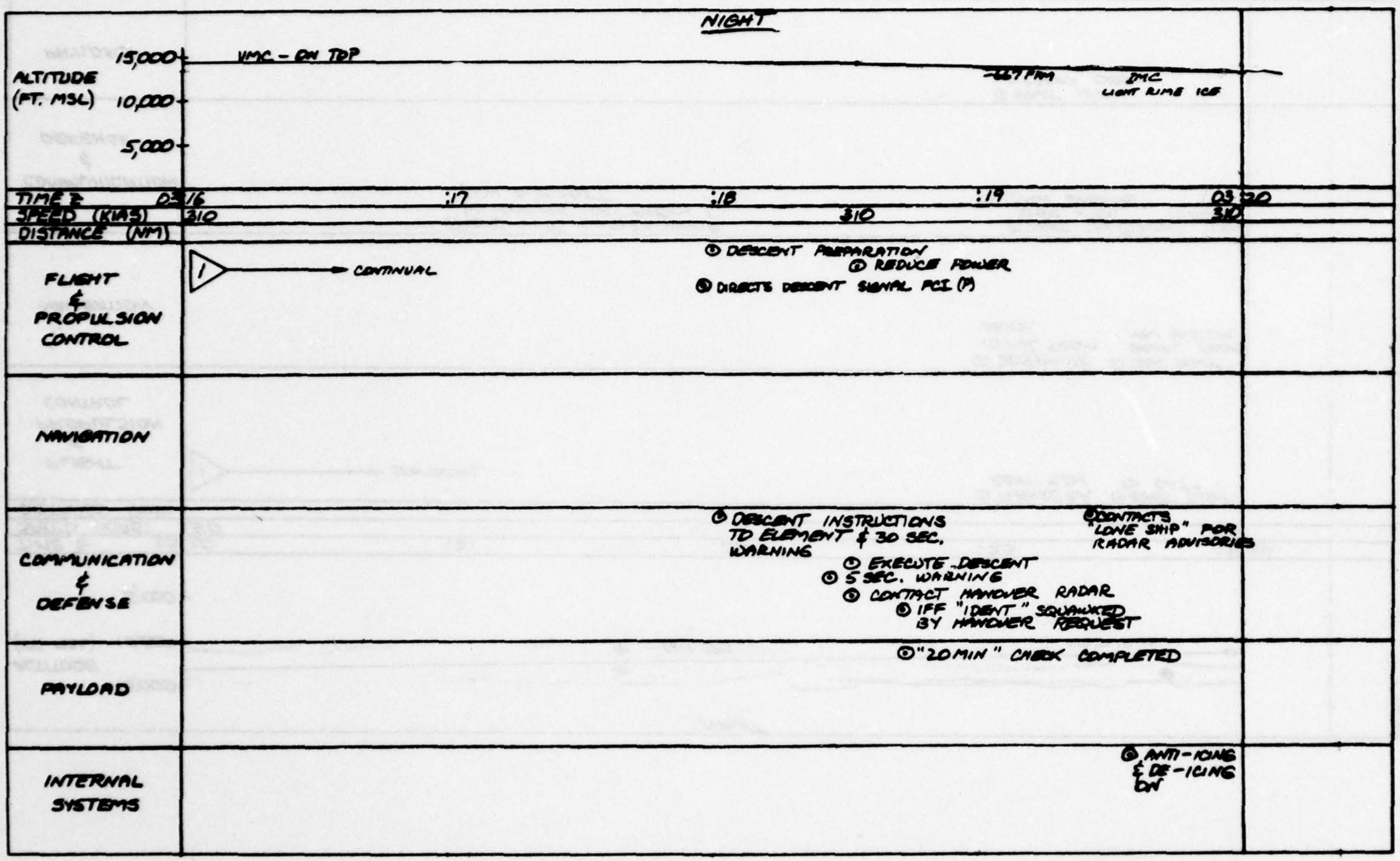


FIGURE NO. 19 Mission I - High Altitude Heavy Equipment Airdrop

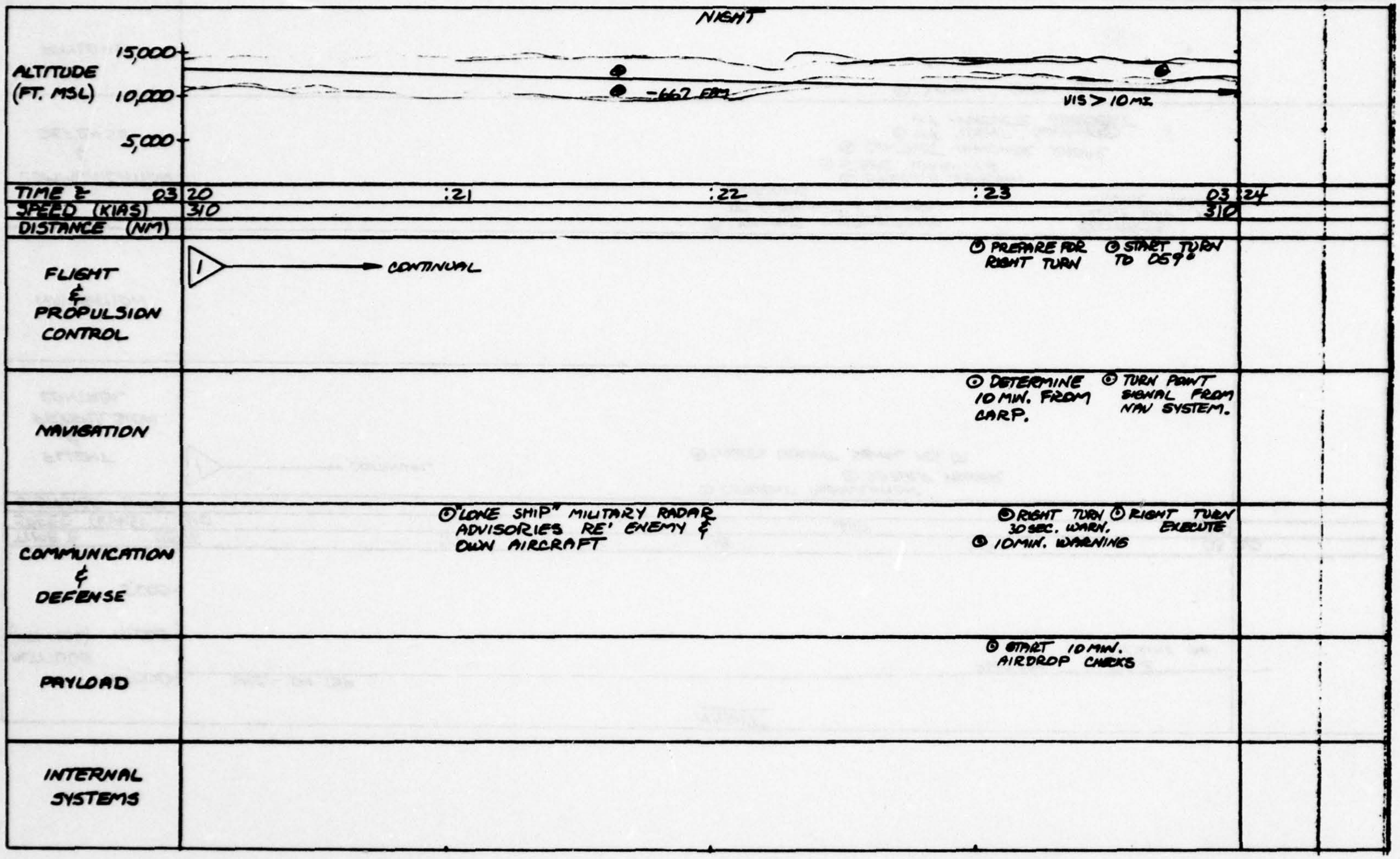


FIGURE NO. 20 Mission I - High Altitude Heavy Equipment Airdrop

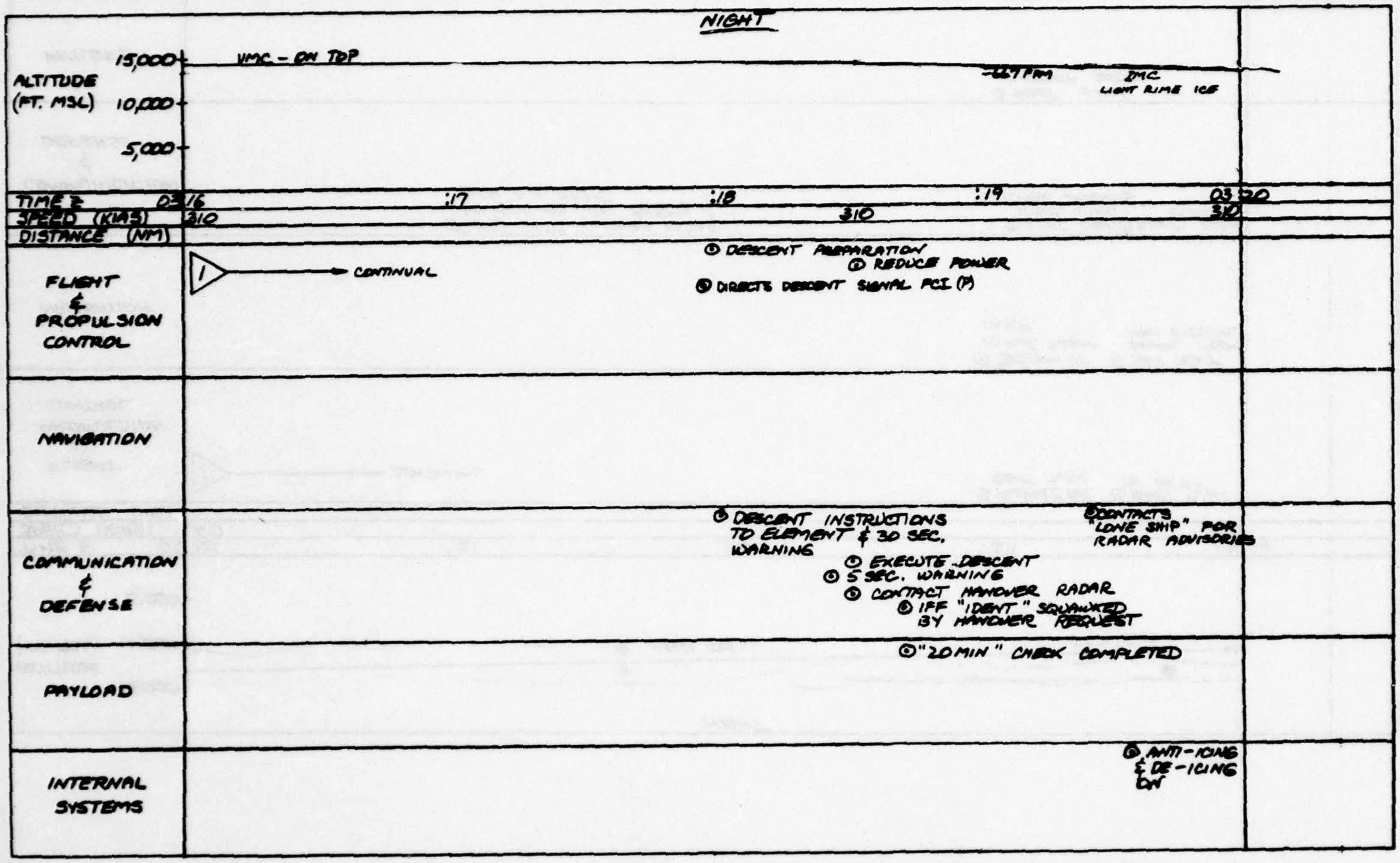


FIGURE NO. 19 Mission I - High Altitude Heavy Equipment Airdrop

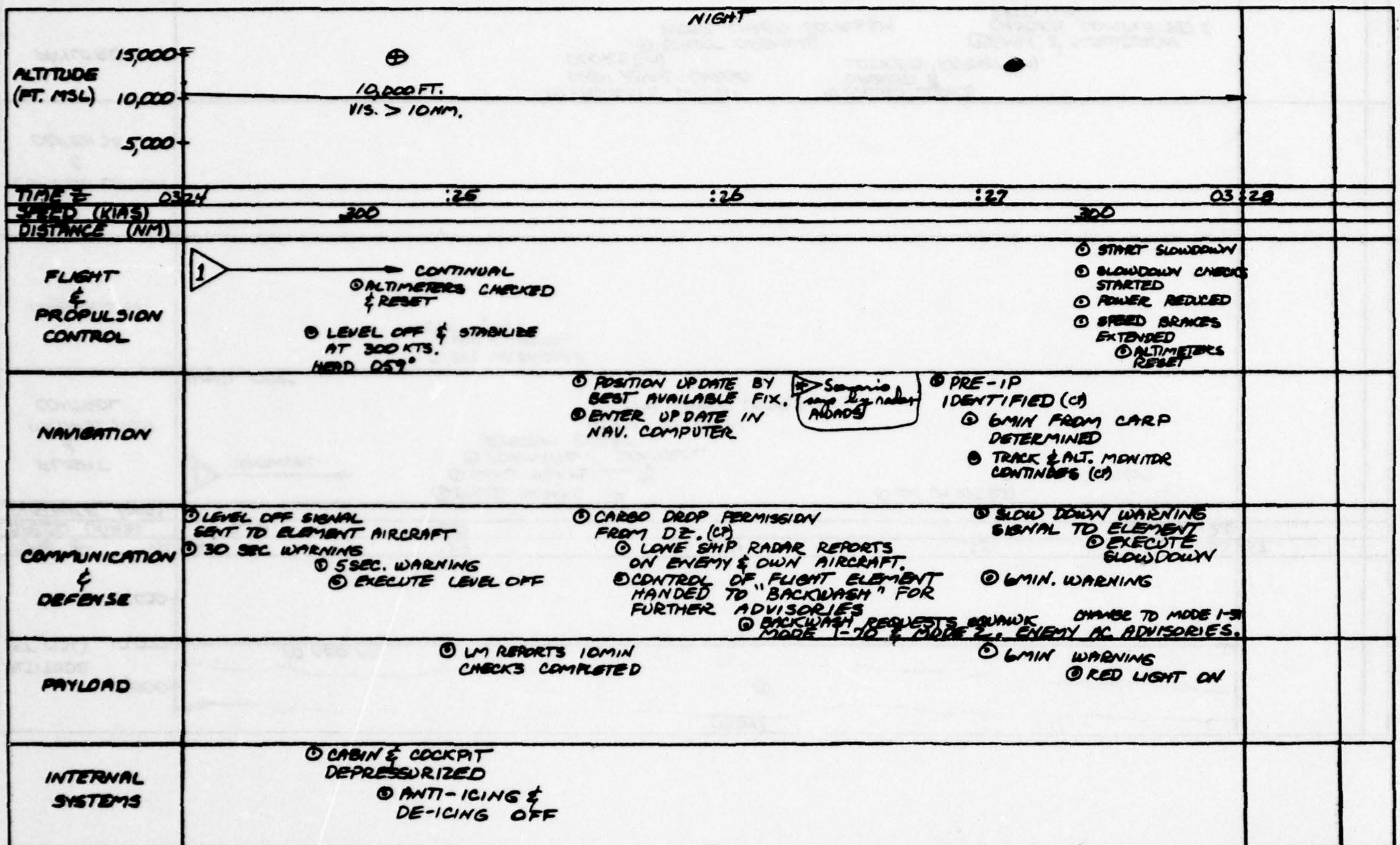


FIGURE NO. 21 Mission I - High Altitude Heavy Equipment Airdrop

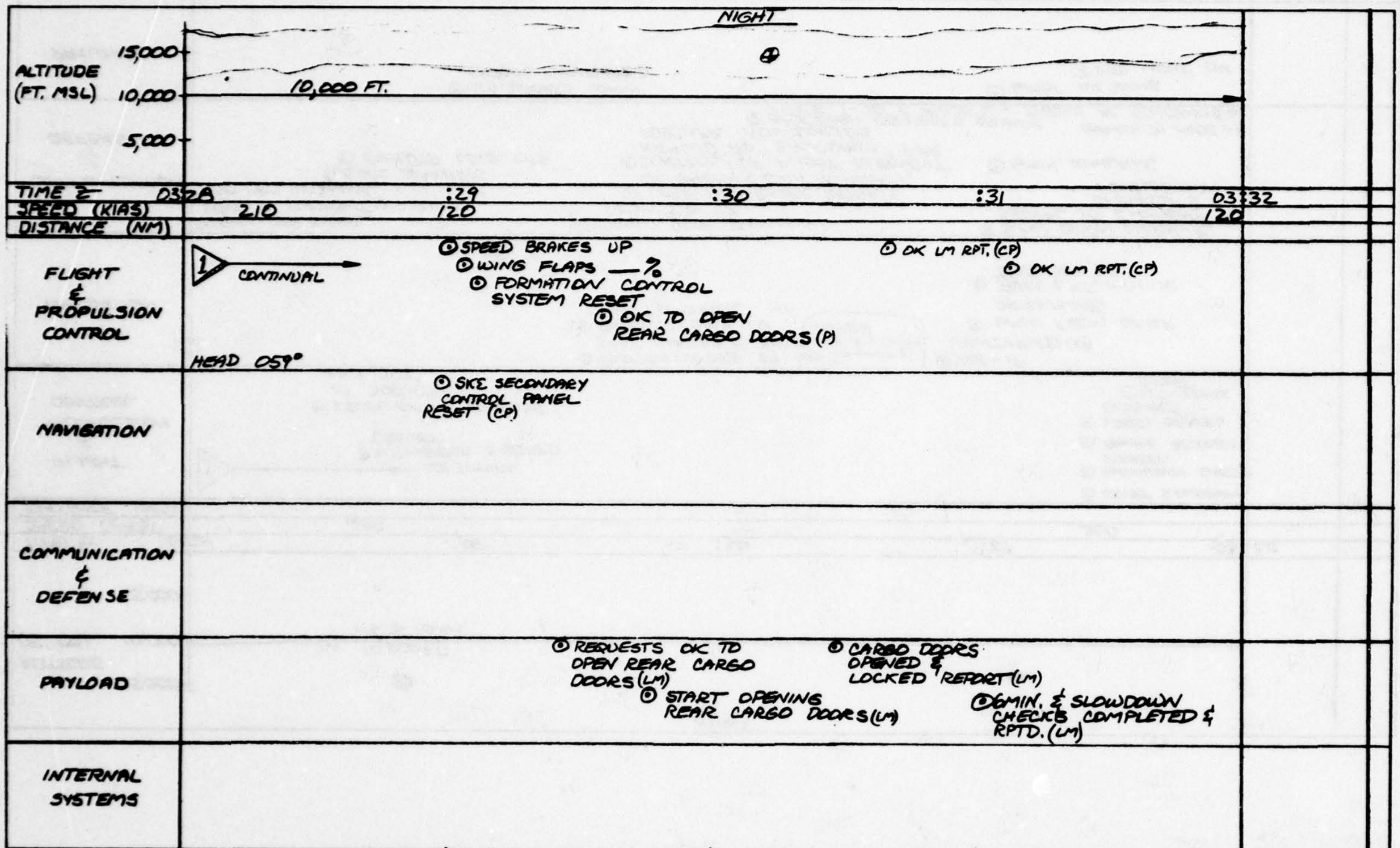


FIGURE NO. 22 Mission I - High Altitude Heavy Equipment Airdrop

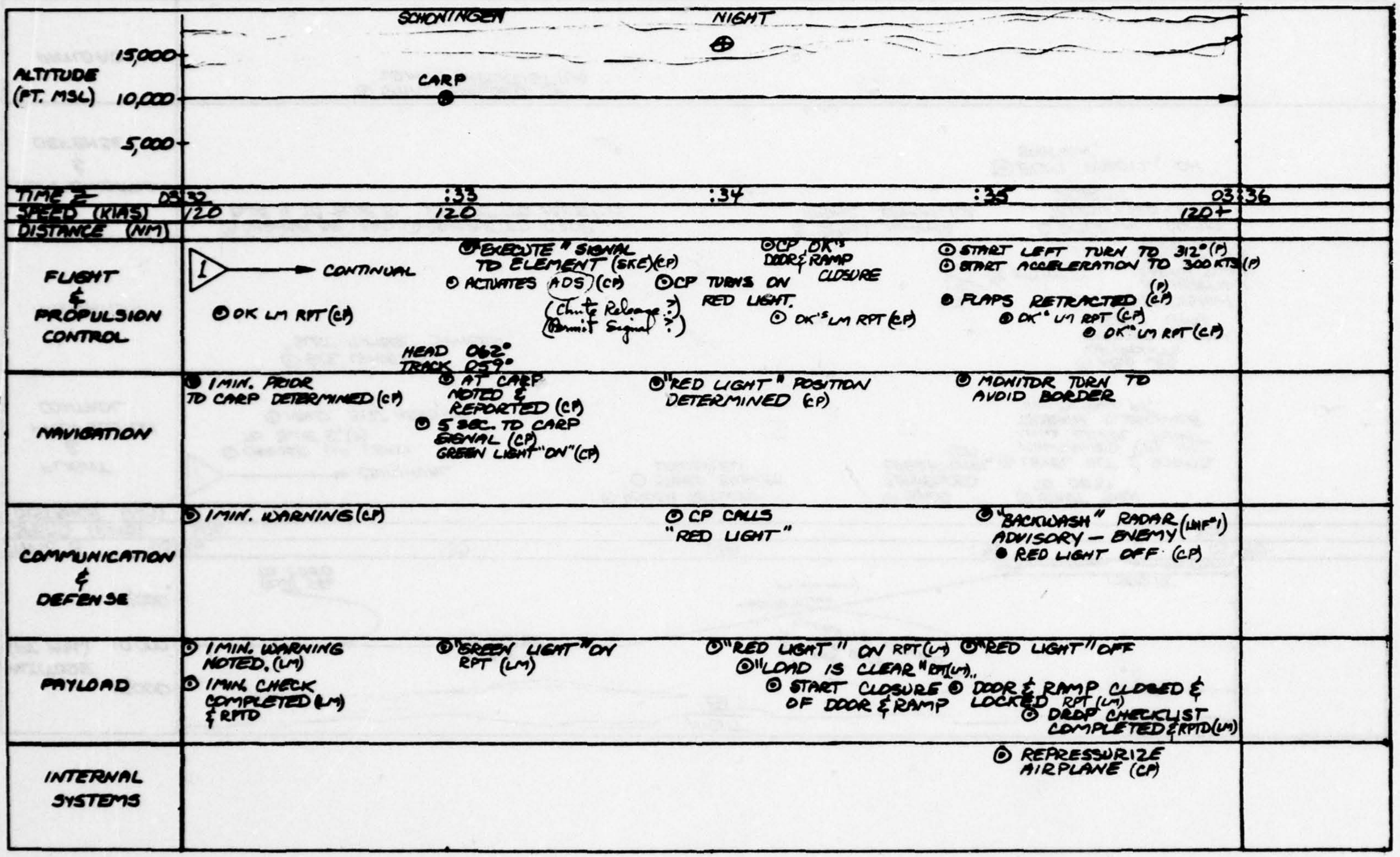


FIGURE NO. 23 Mission I - High Altitude Heavy Equipment Airdrop

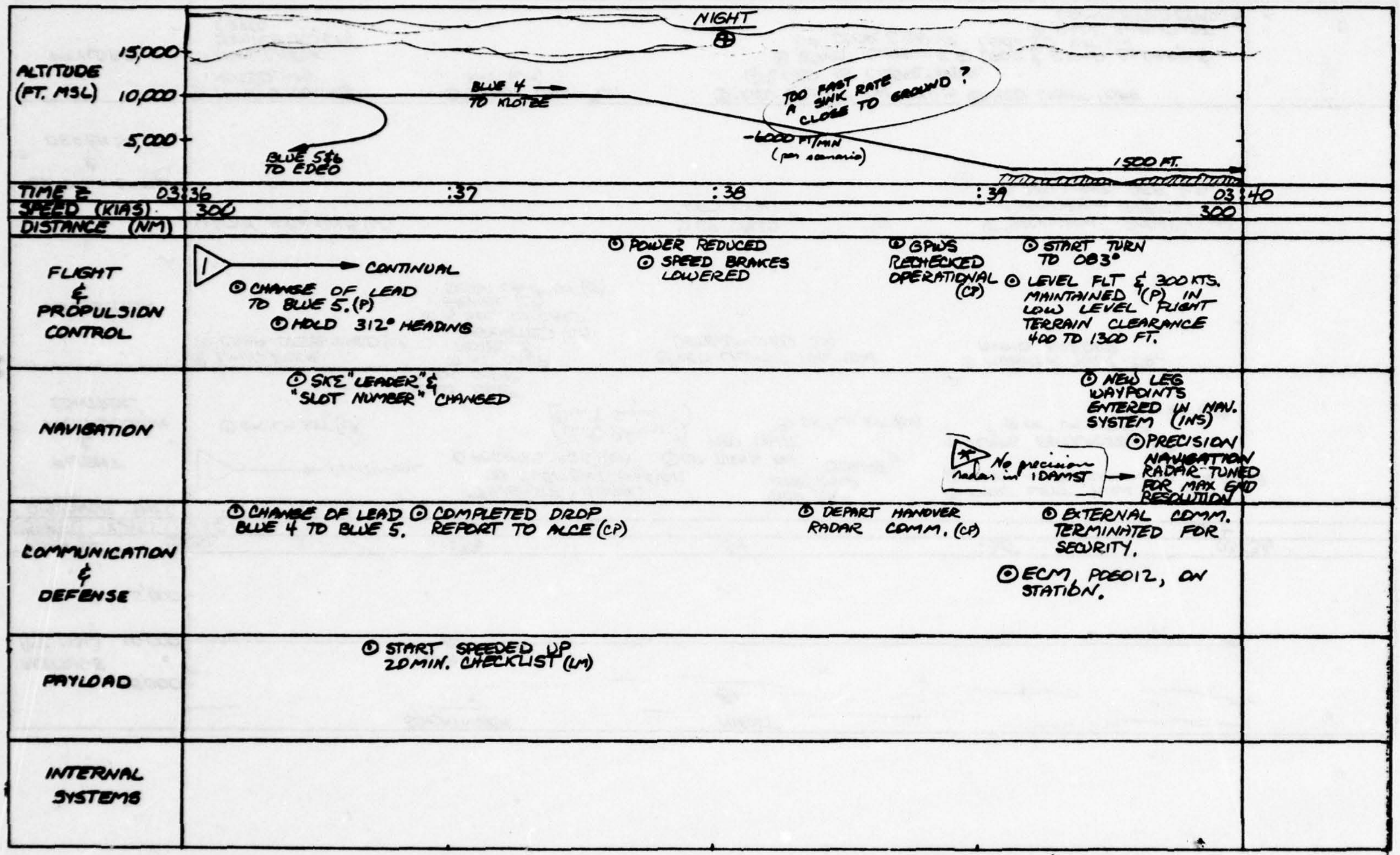


FIGURE NO. 24 Mission I - Low Altitude Airdrop

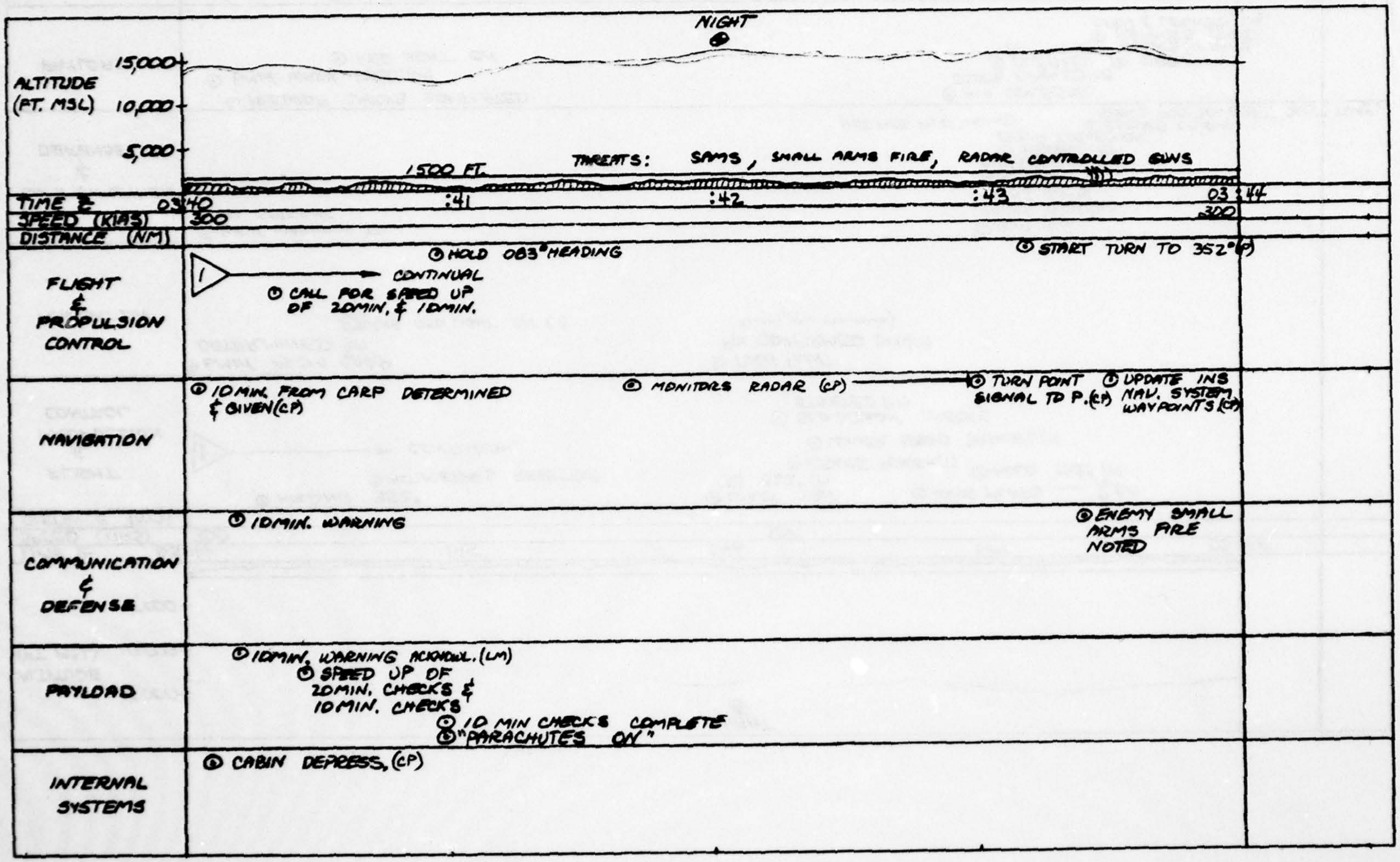


FIGURE NO. 25 Mission I - Low Altitude Airdrop

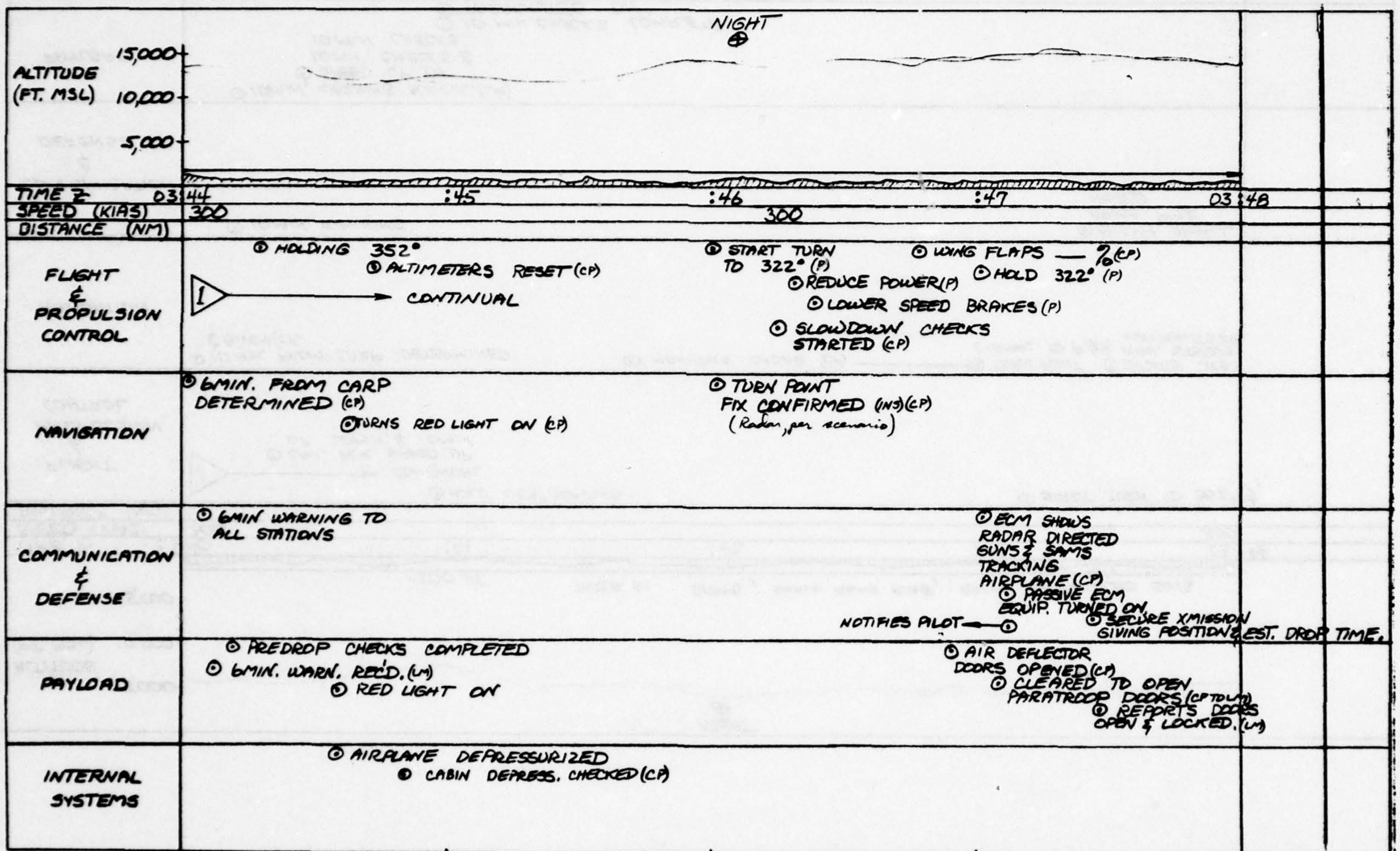


FIGURE NO. 26 Mission I - Low Altitude Airdrop

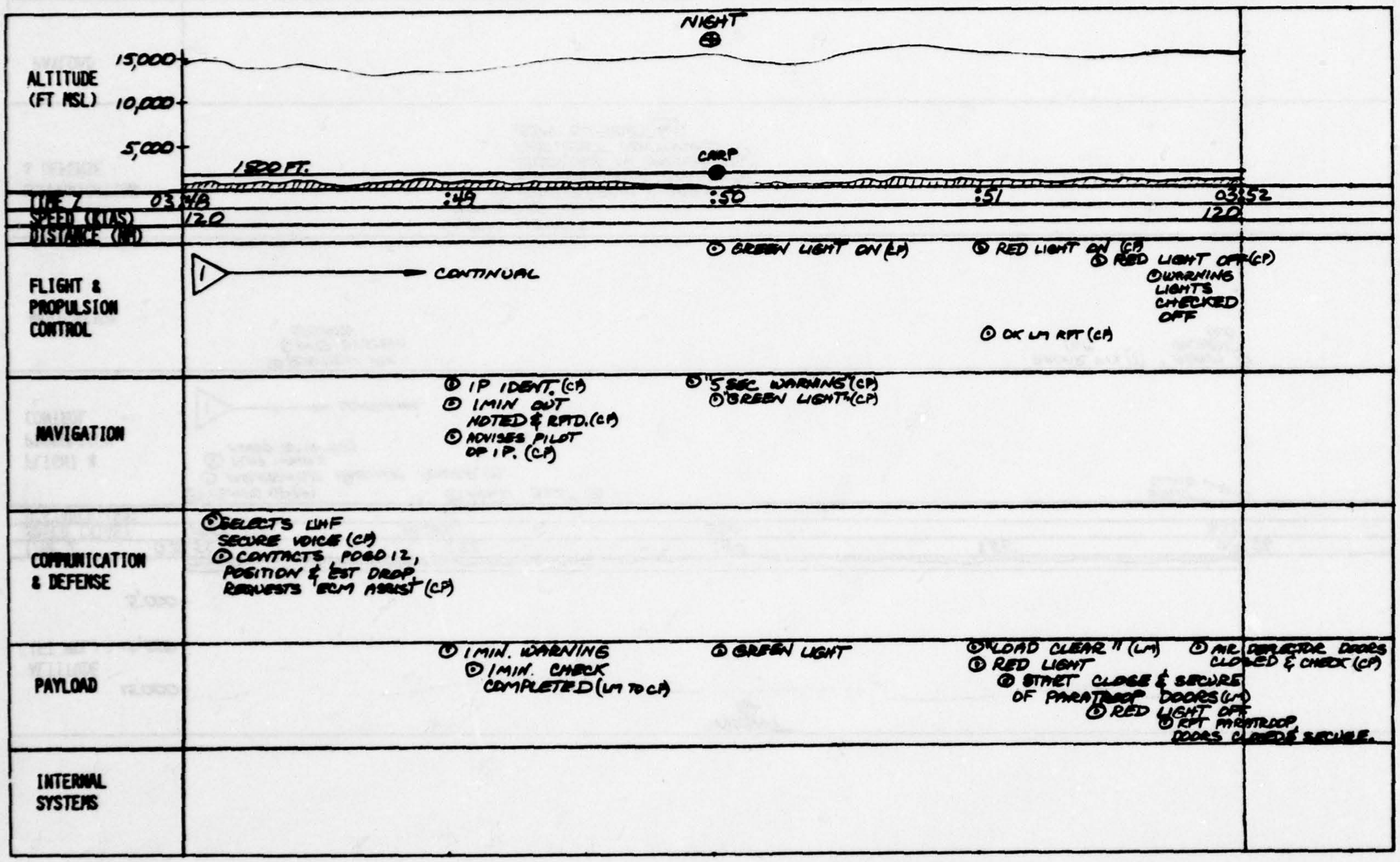


FIGURE NO. 27 Mission I - Low Altitude Airdrop

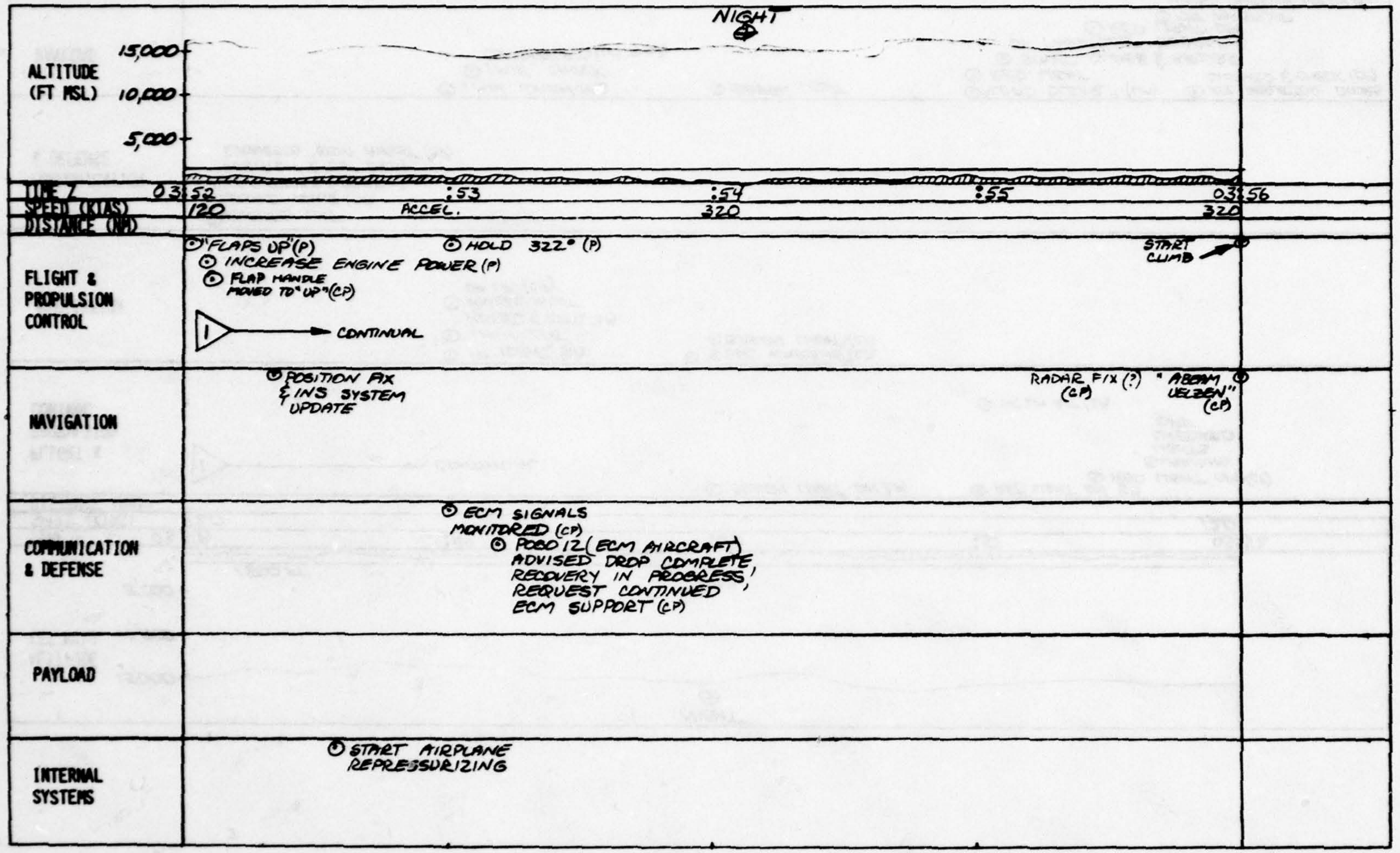


FIGURE NO. 28 Mission I - Low Altitude Airdrop

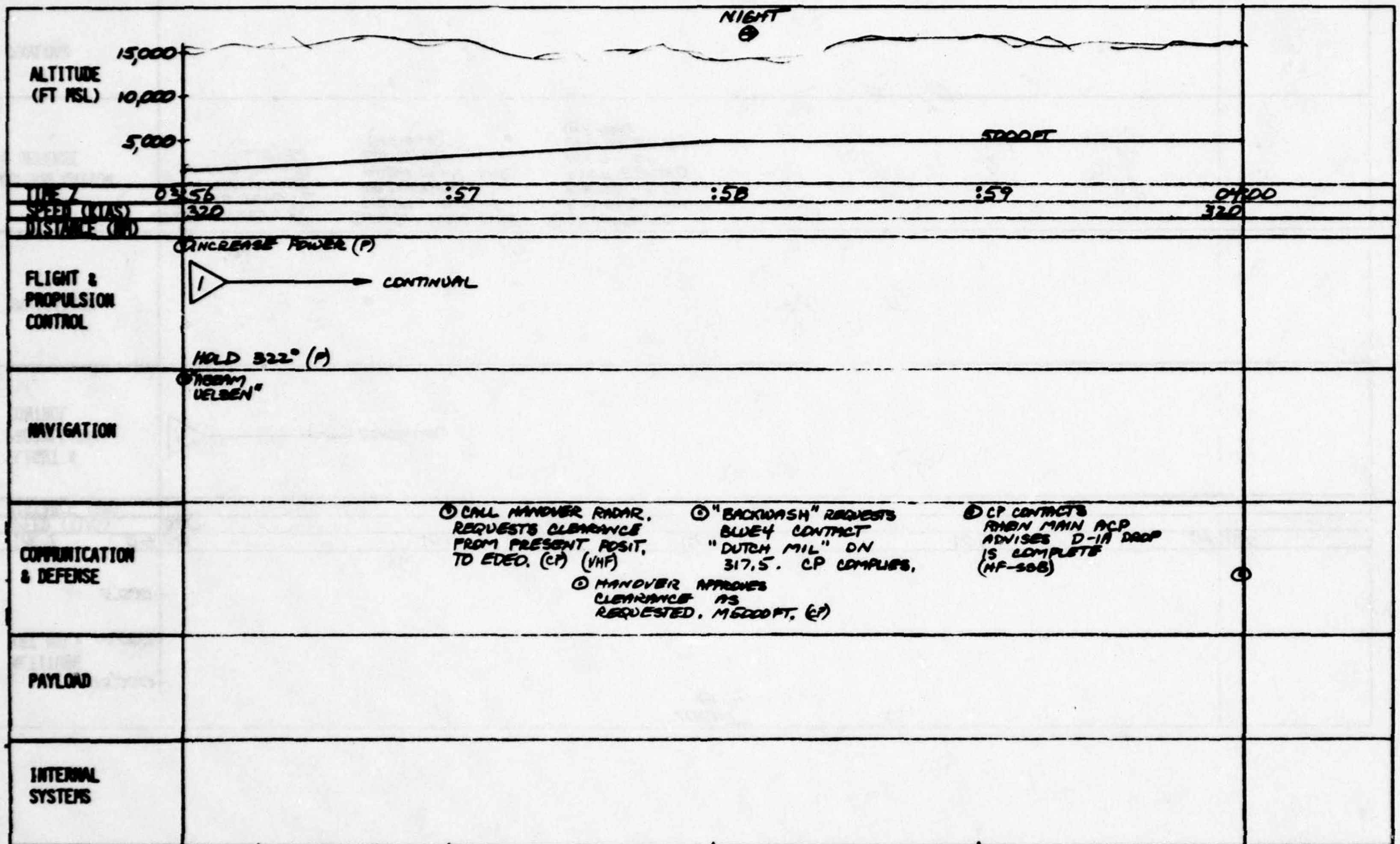


FIGURE NO. 29 Mission I - Low Altitude Airdrop

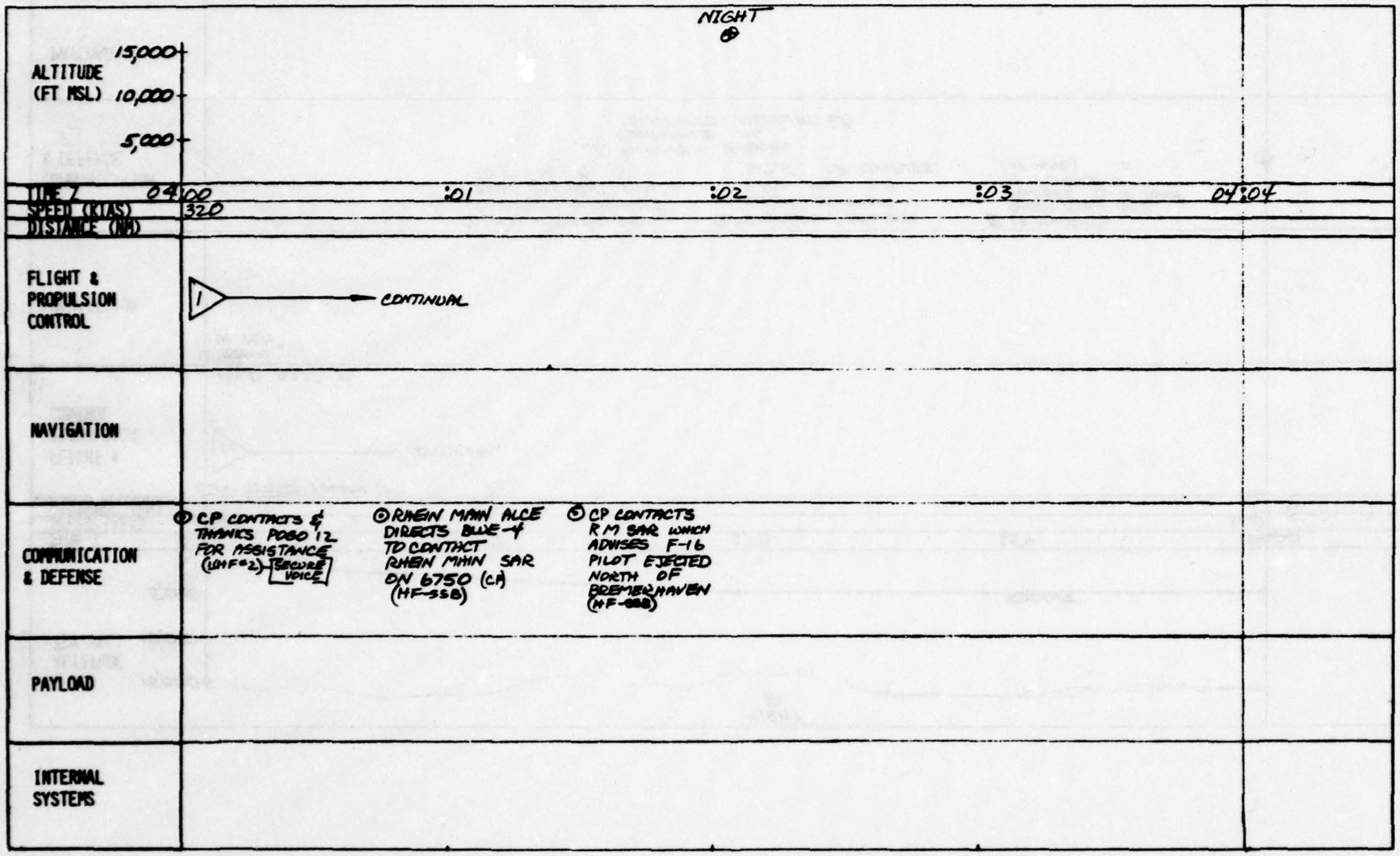


FIGURE NO. 30 Mission II - Container Delivery System Airdrop

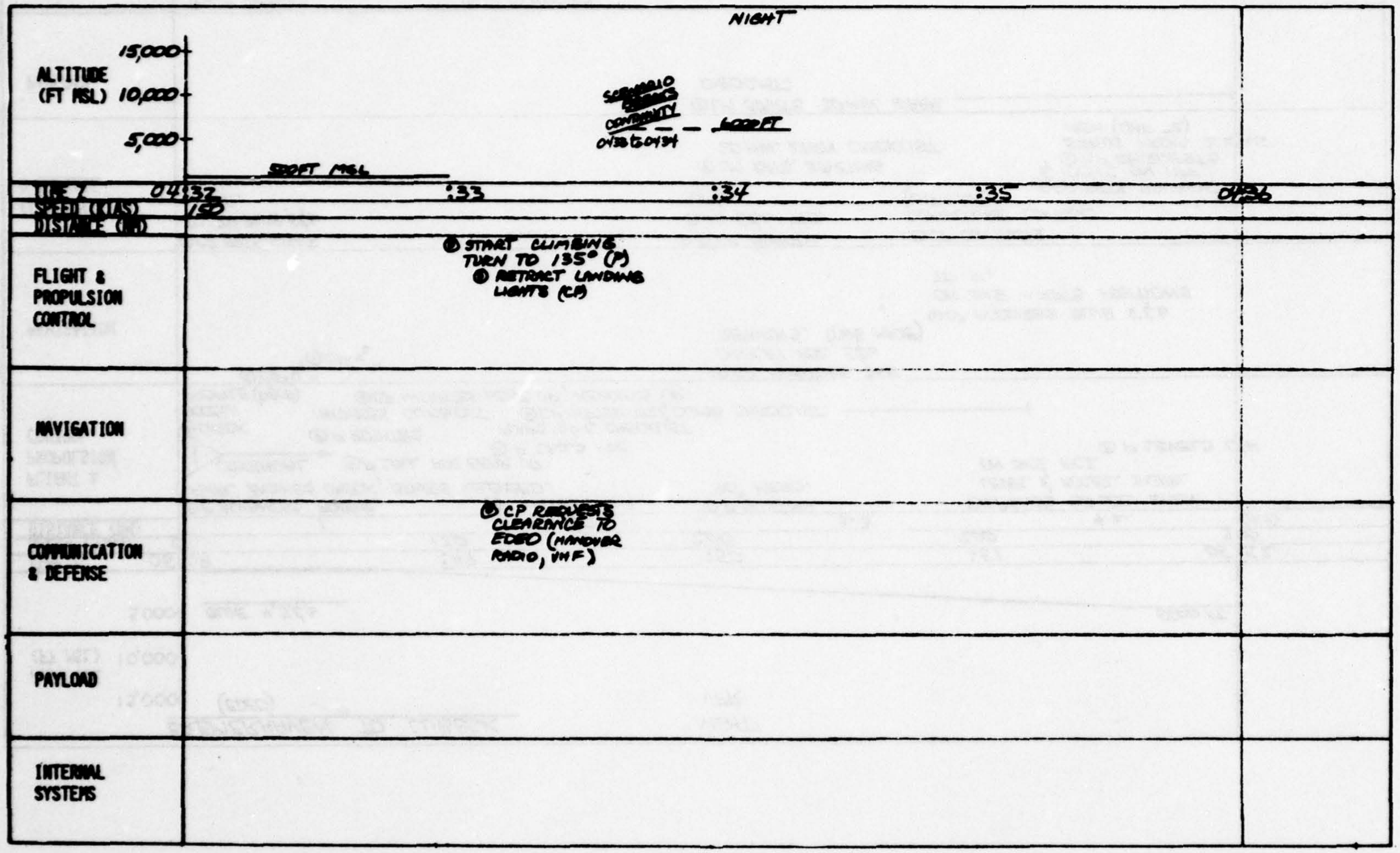


FIGURE NO. 31 Mission II - Container Delivery System Airdrop

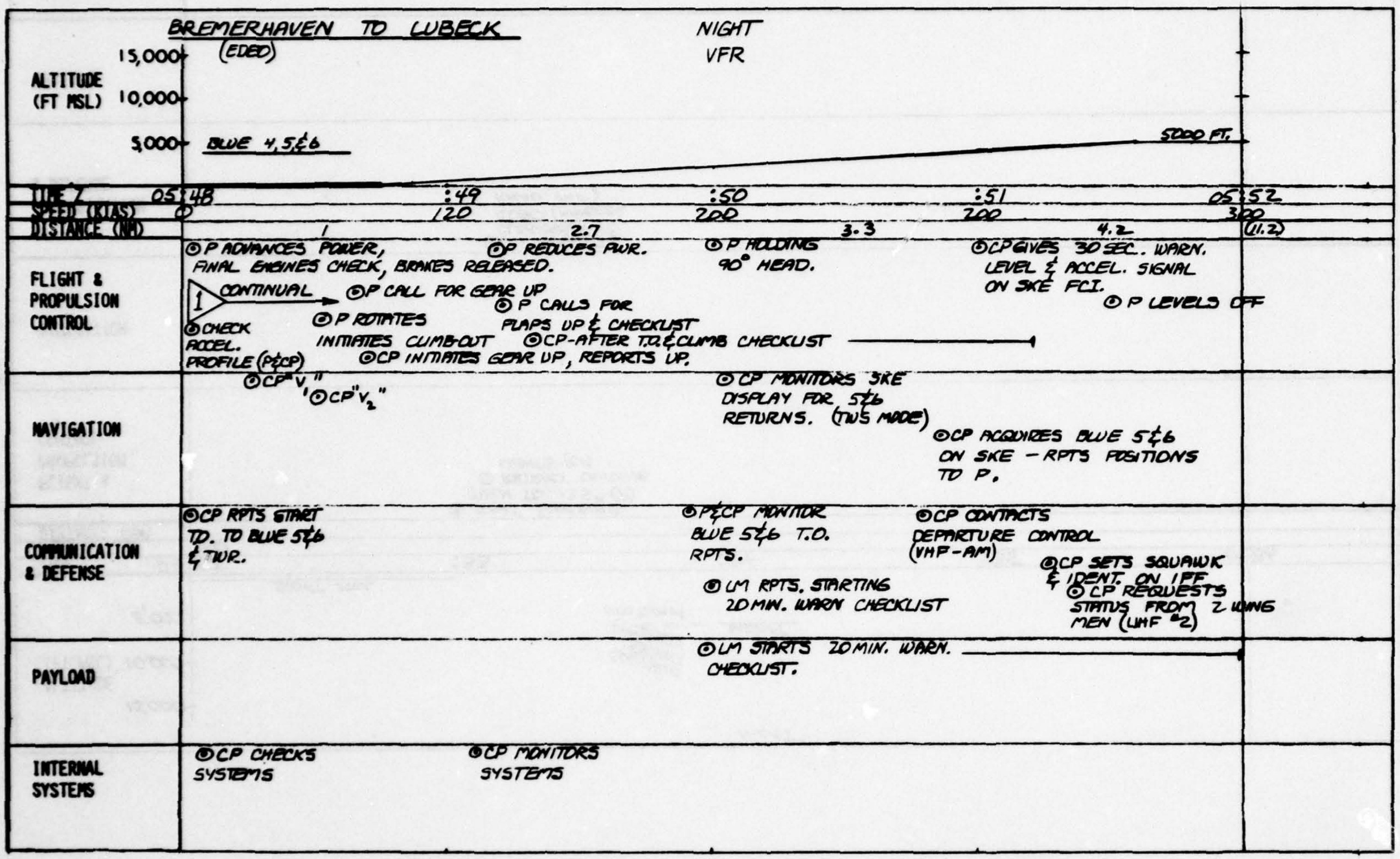


FIGURE NO. 32 Mission II - Container Delivery System Airdrop

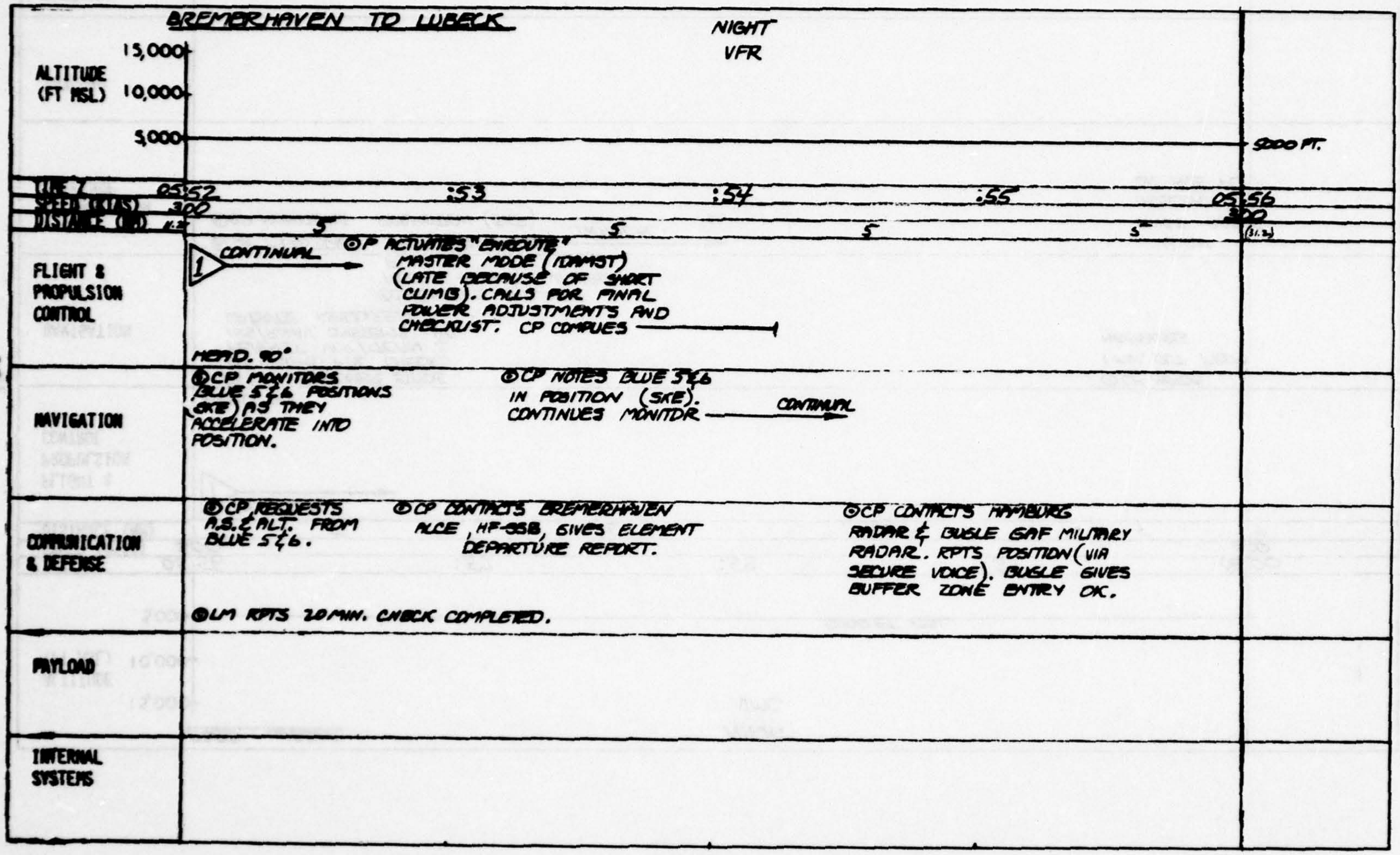


FIGURE NO. 33 Mission II - Container Delivery System Airdrop

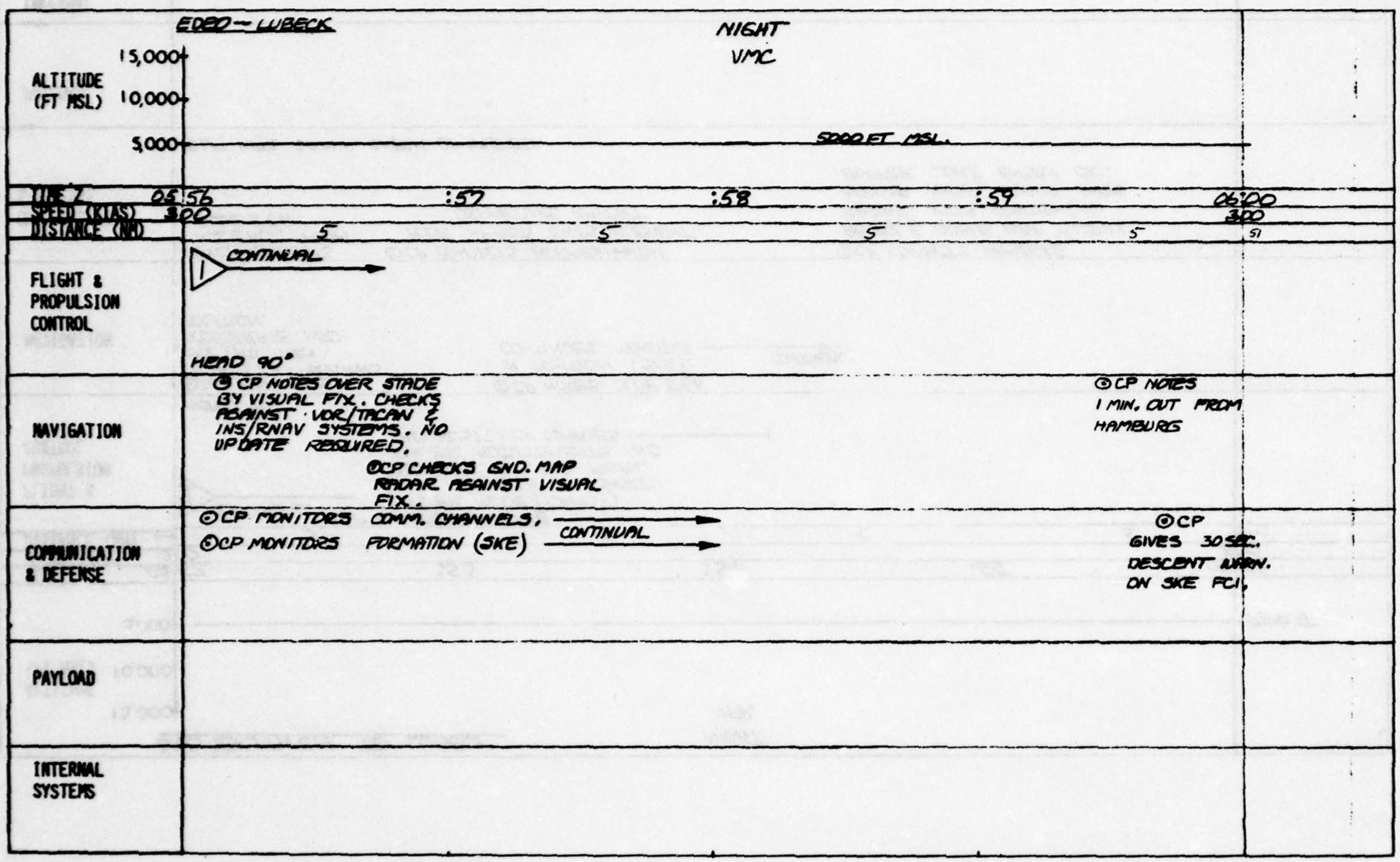


FIGURE NO. 34 Mission II - Container Delivery System Airdrop

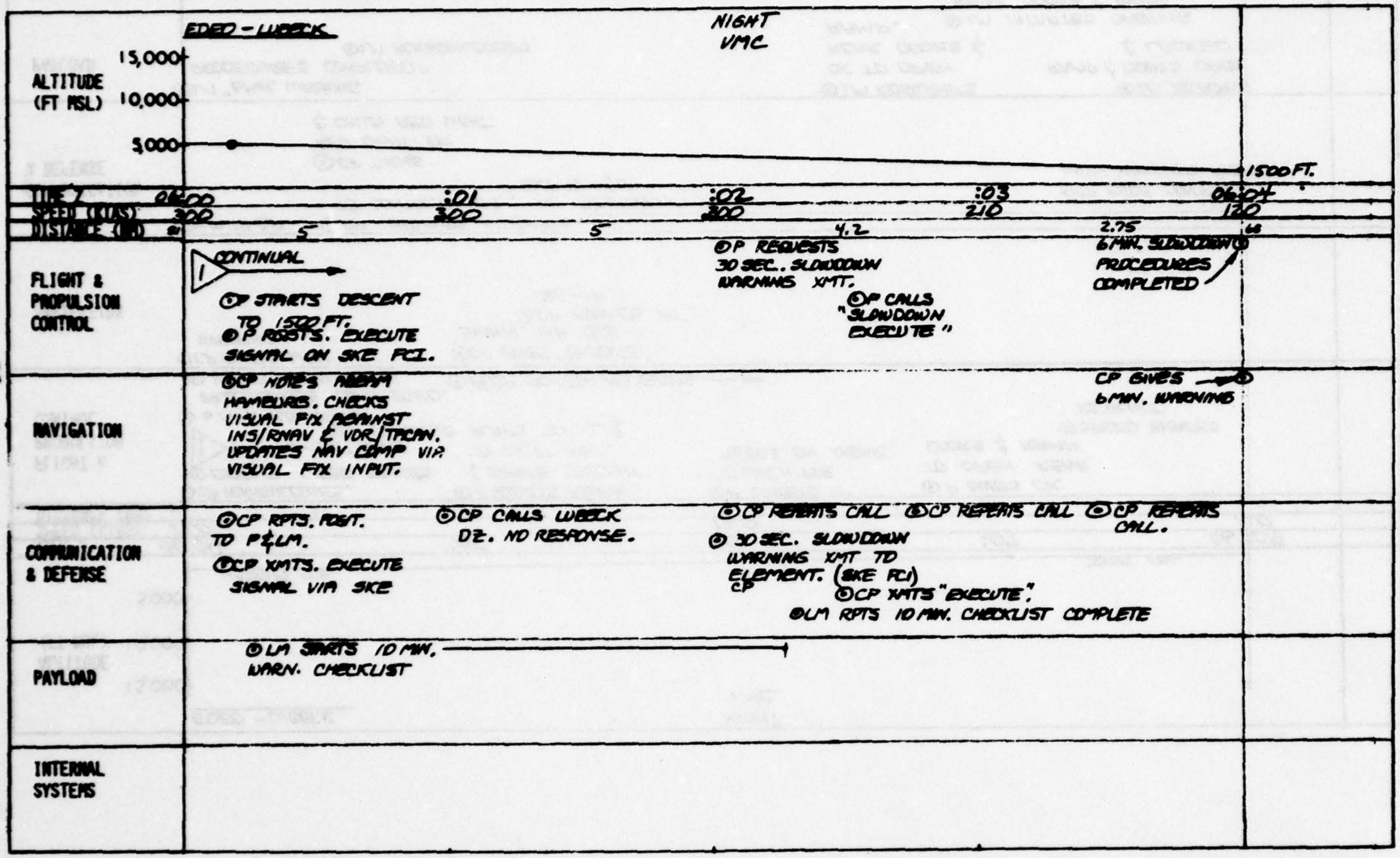


FIGURE NO. 35 Mission II - Container Delivery System Airdrop

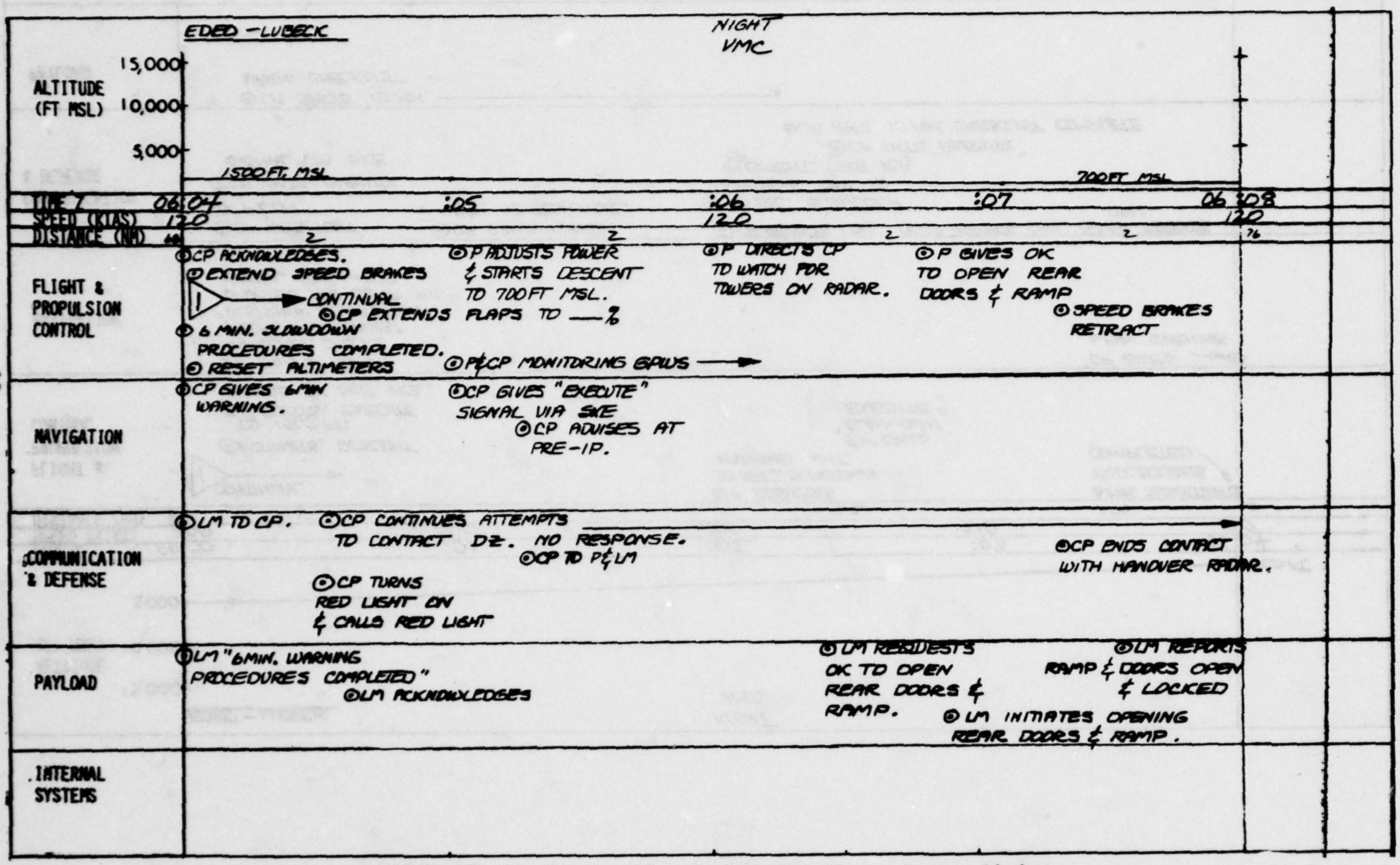


FIGURE NO. 36 Mission II - Container Delivery System Airdrop

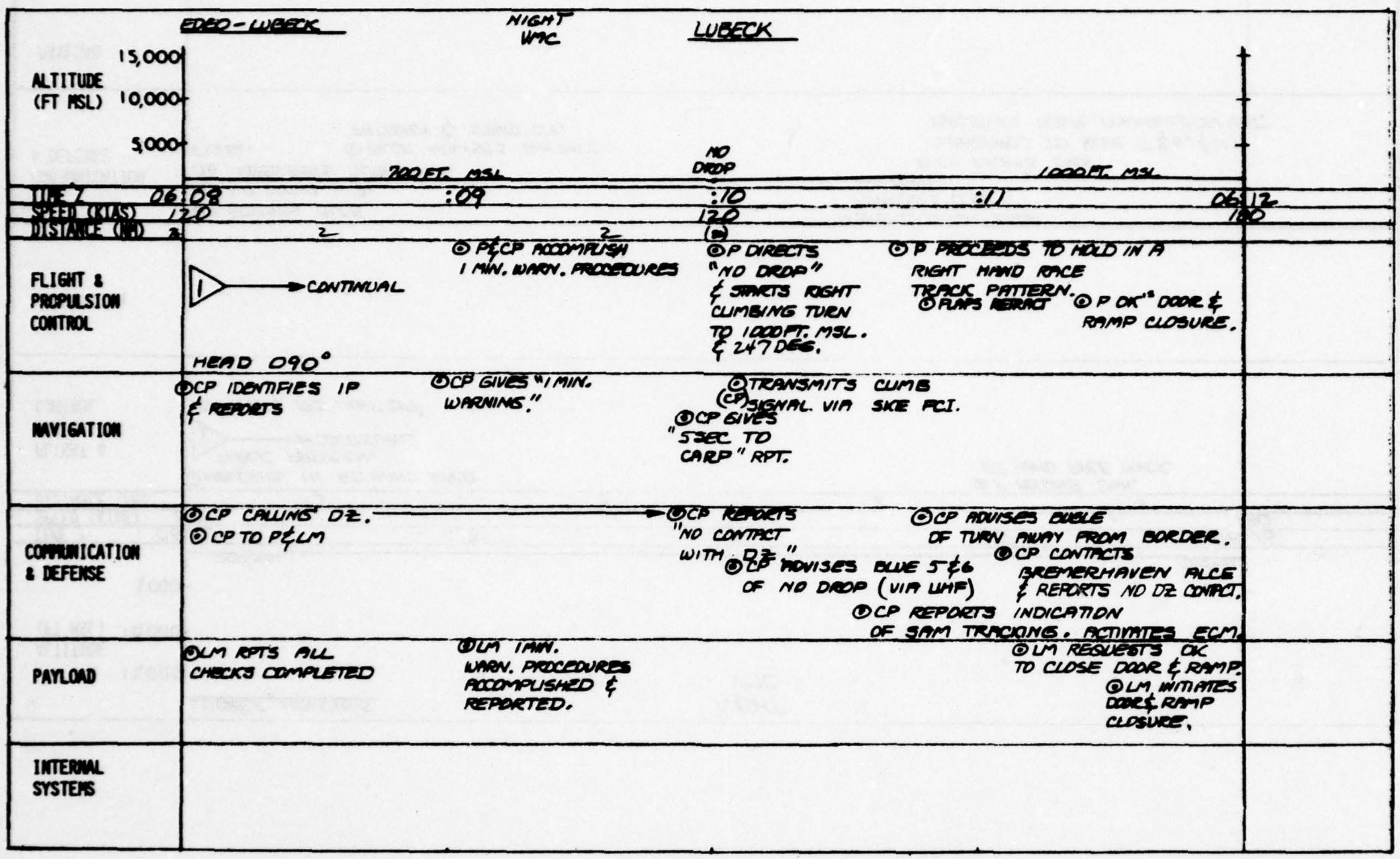


FIGURE NO. 37 Mission II - Container Delivery System Airdrop

	LUBECK, HOLDING		NIGHT VMC		
ALTITUDE (FT MSL) 15,000 / 10,000 / 5,000	1000 MSL				1000 MSL
TIME Z	06:12	:13	:14	:15	06:16
SPEED (KIAS)	180				180
DISTANCE (NM)	3	3	3	3	
FLIGHT & PROPULSION CONTROL	⊙ HOLDING IN RT. HAND RACE TRACK PATTERN. (1) → CONTINUAL ⊙ CP TURNS RED LIGHT OFF			⊙ P HOLDING 2 MIN. RT. HAND RACE TRACK.	
NAVIGATION					
COMMUNICATION & DEFENSE	⊙ CP ADVISES ALCE OF NO COMM. WITH DZ. REQUESTS ALTERNATE FREQ. ⊙ ALCE ADVISES CONTINUE PATTERN & STAND BY.			⊙ BREMERHAVEN ALCE APPROVES LUBECK AIR DROP ⊙ CP RELAYS DROP CLEARANCE TO BLUE 5 & 6. & LM. RECEIVES THEIR ACKNOWLEDGMENT.	
PAYLOAD					
INTERNAL SYSTEMS					

FIGURE NO. 38 Mission II - Container Delivery System Airdrop

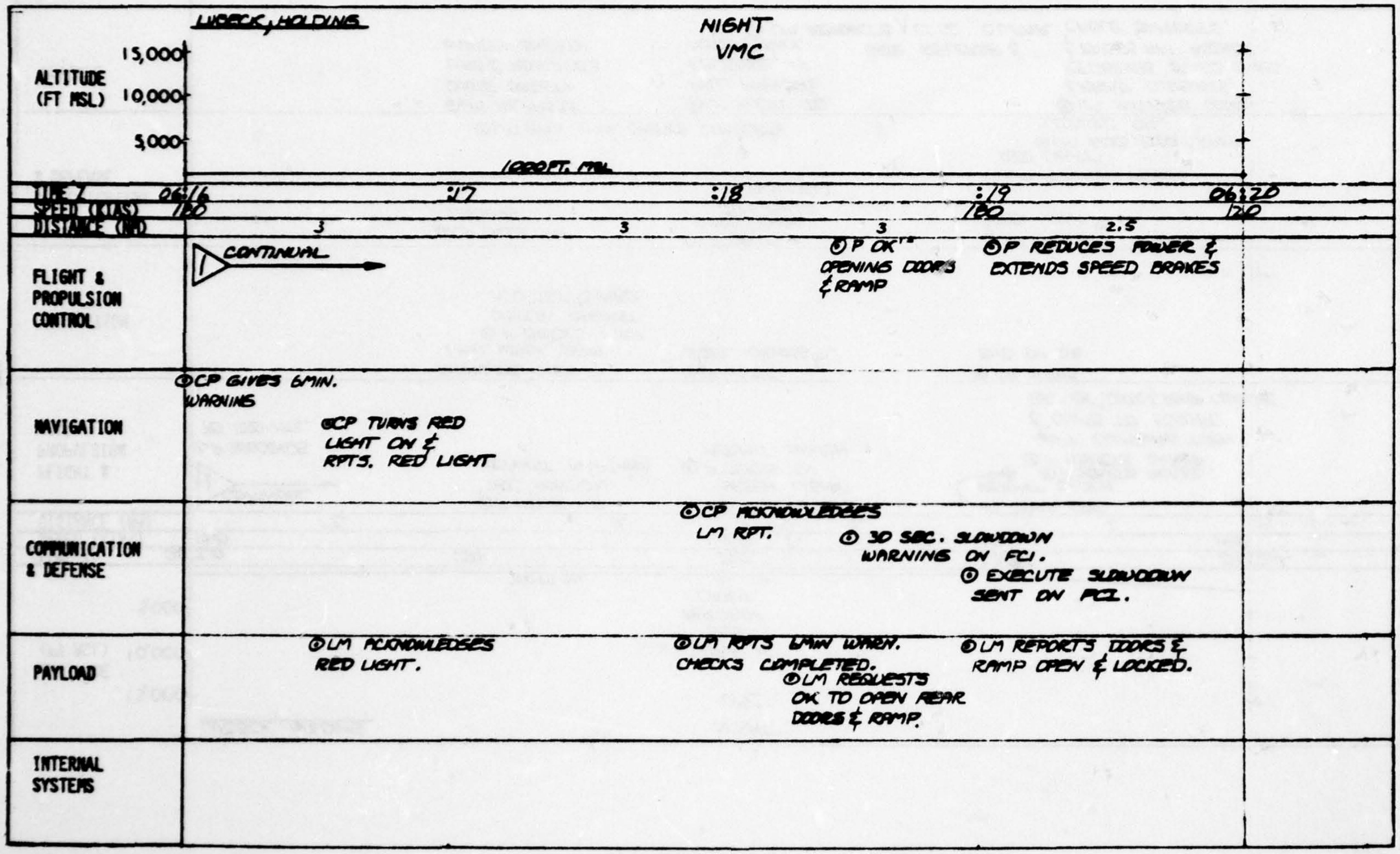


FIGURE NO. 39 Mission II - Container Delivery System Airdrop

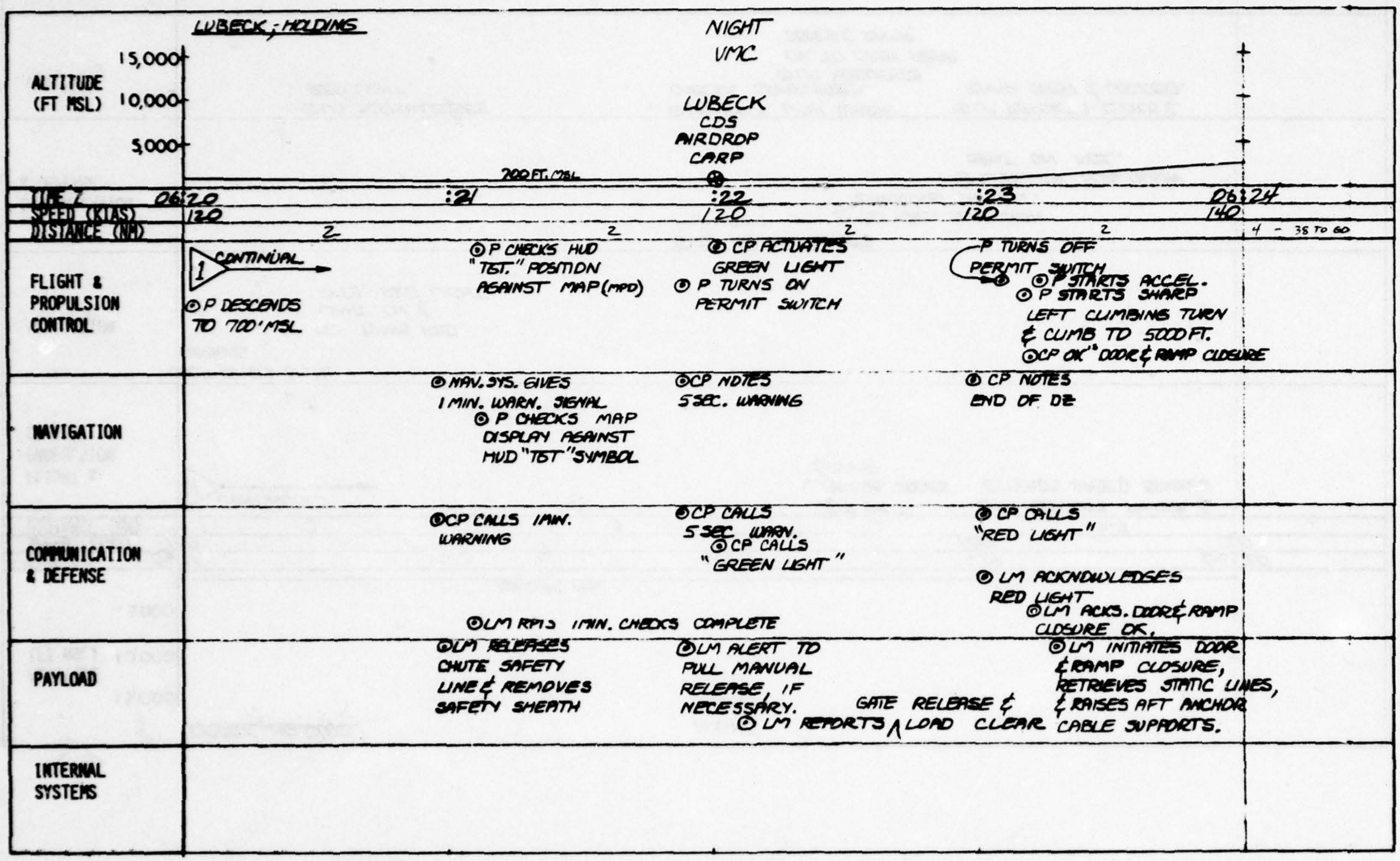


FIGURE NO. 40 Mission II - Container Delivery System Airdrop

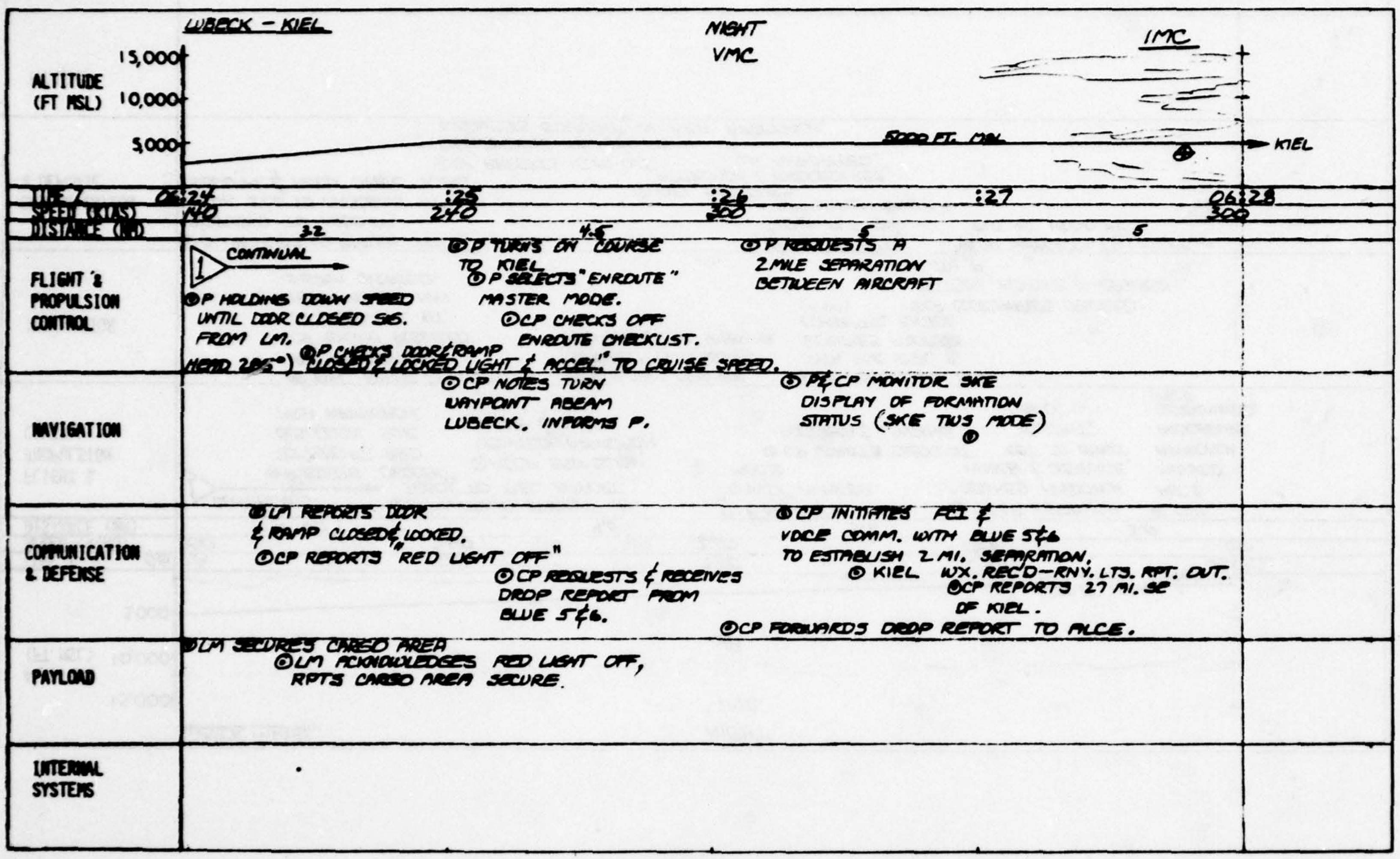


FIGURE NO. 41 Mission II - Airborne Radar Approach

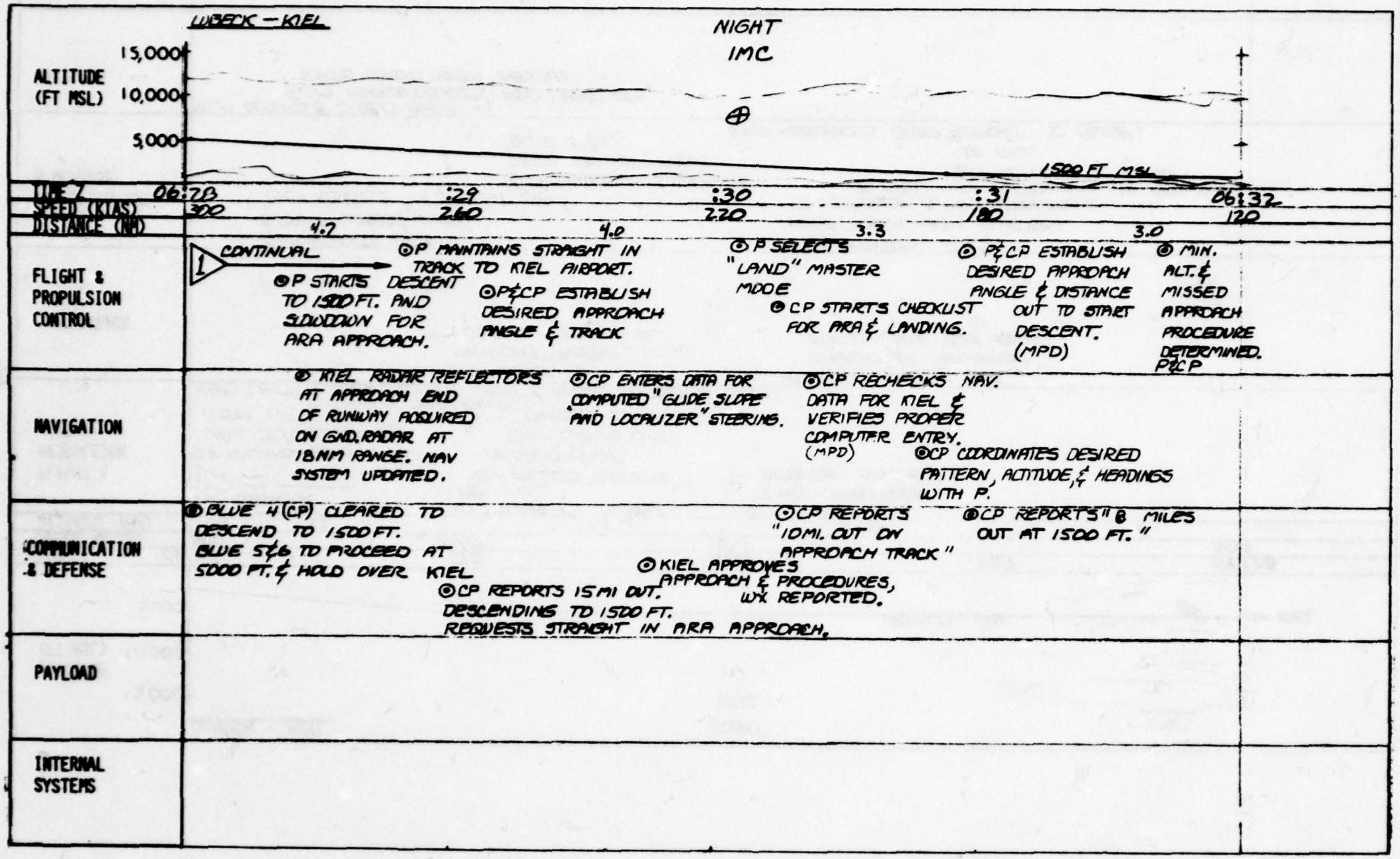


FIGURE NO. 42 Mission II - Airborne Radar Approach

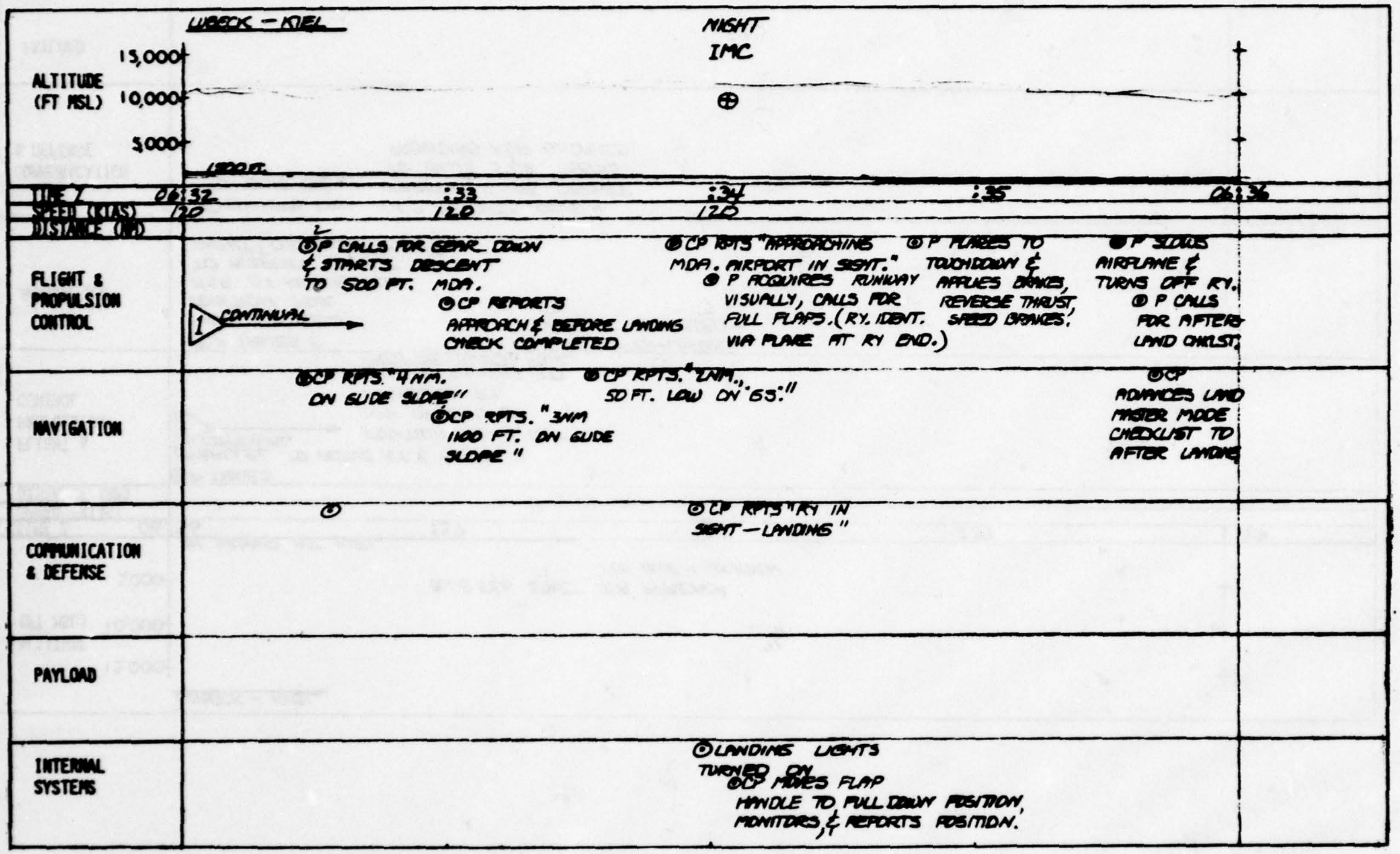


FIGURE NO. 43 Mission II - Airborne Radar Approach

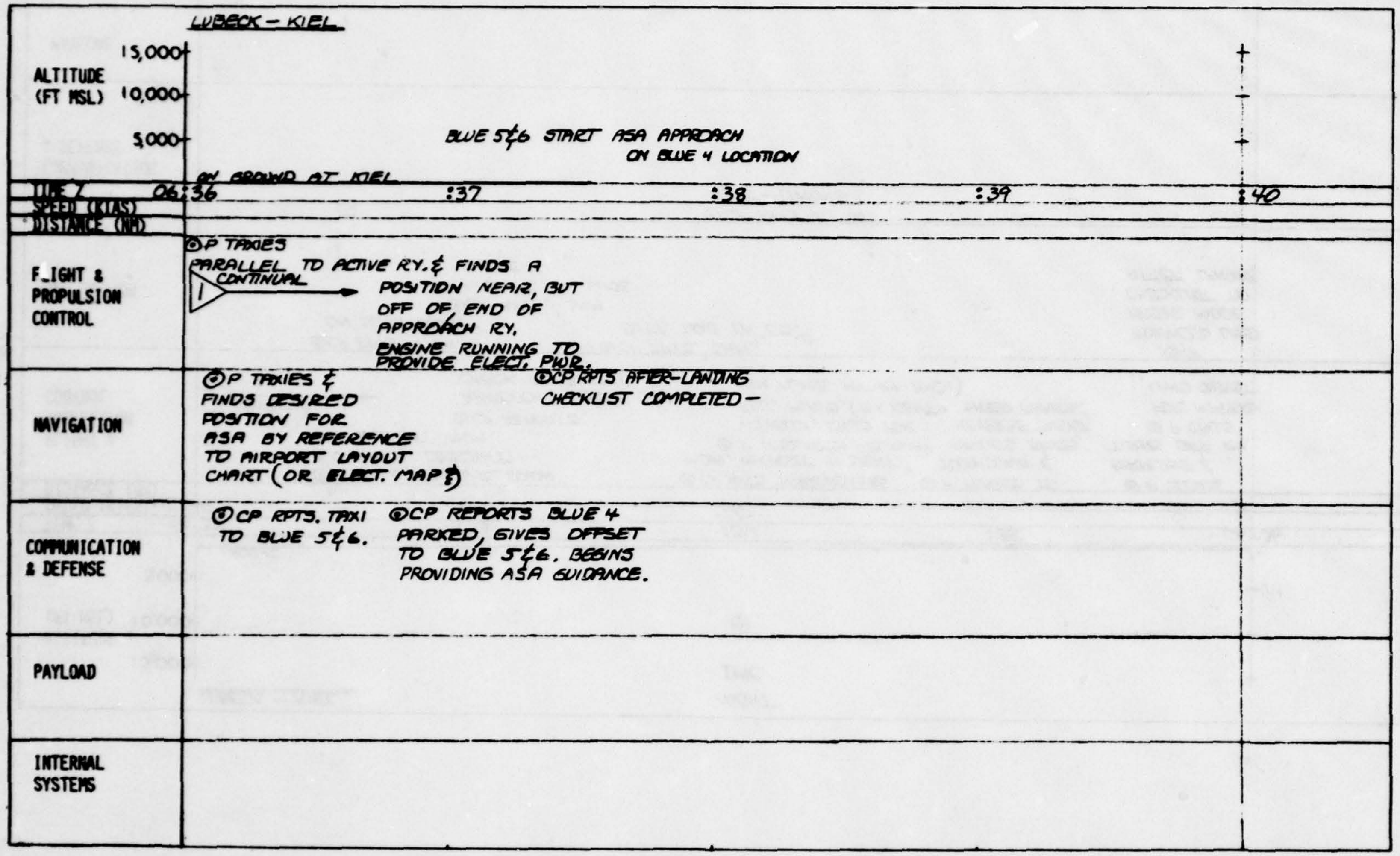


FIGURE NO. 44 Mission II - Airborne Radar Approach

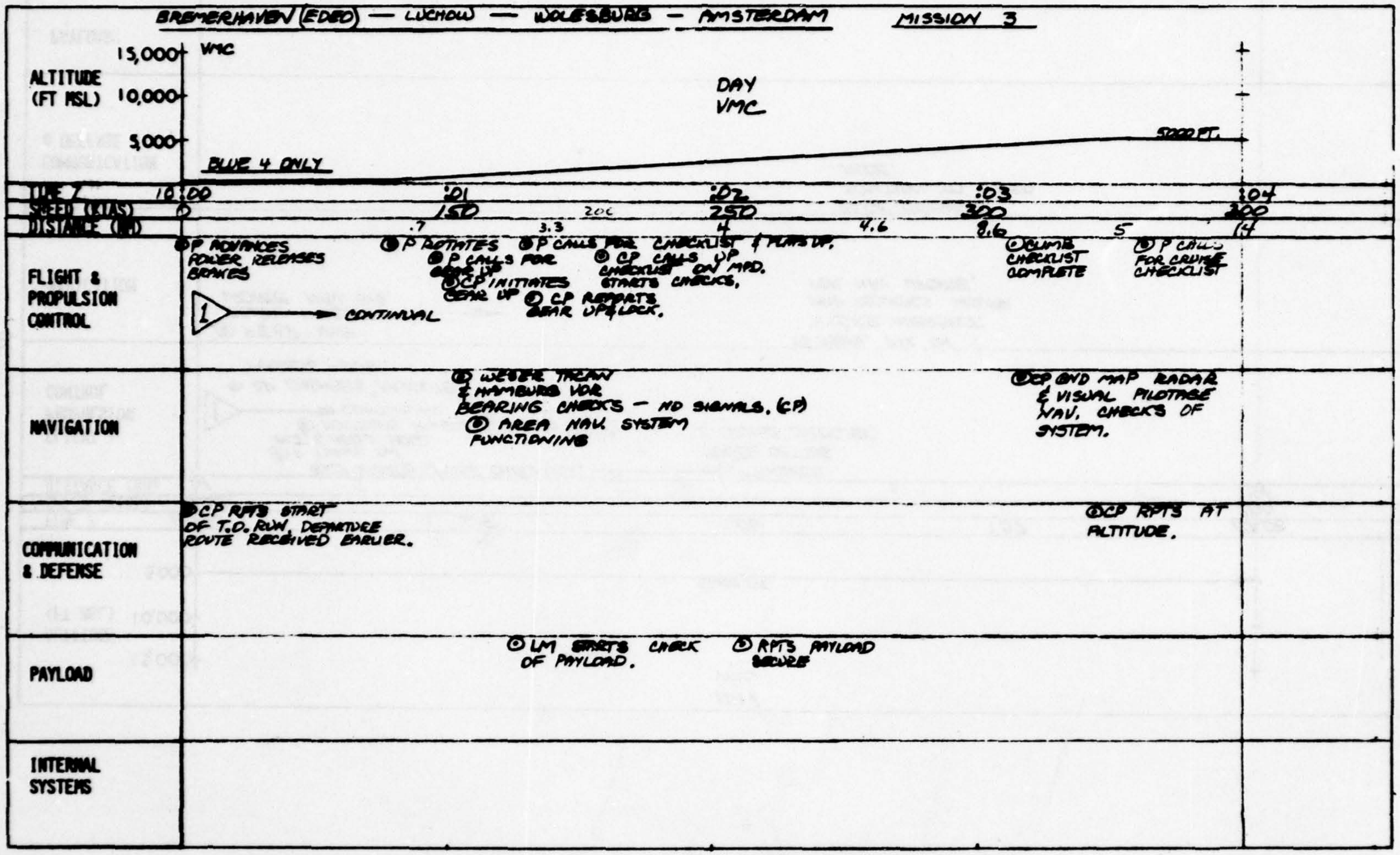


FIGURE NO. 45 Mission III - Low Altitude Parachute Extraction

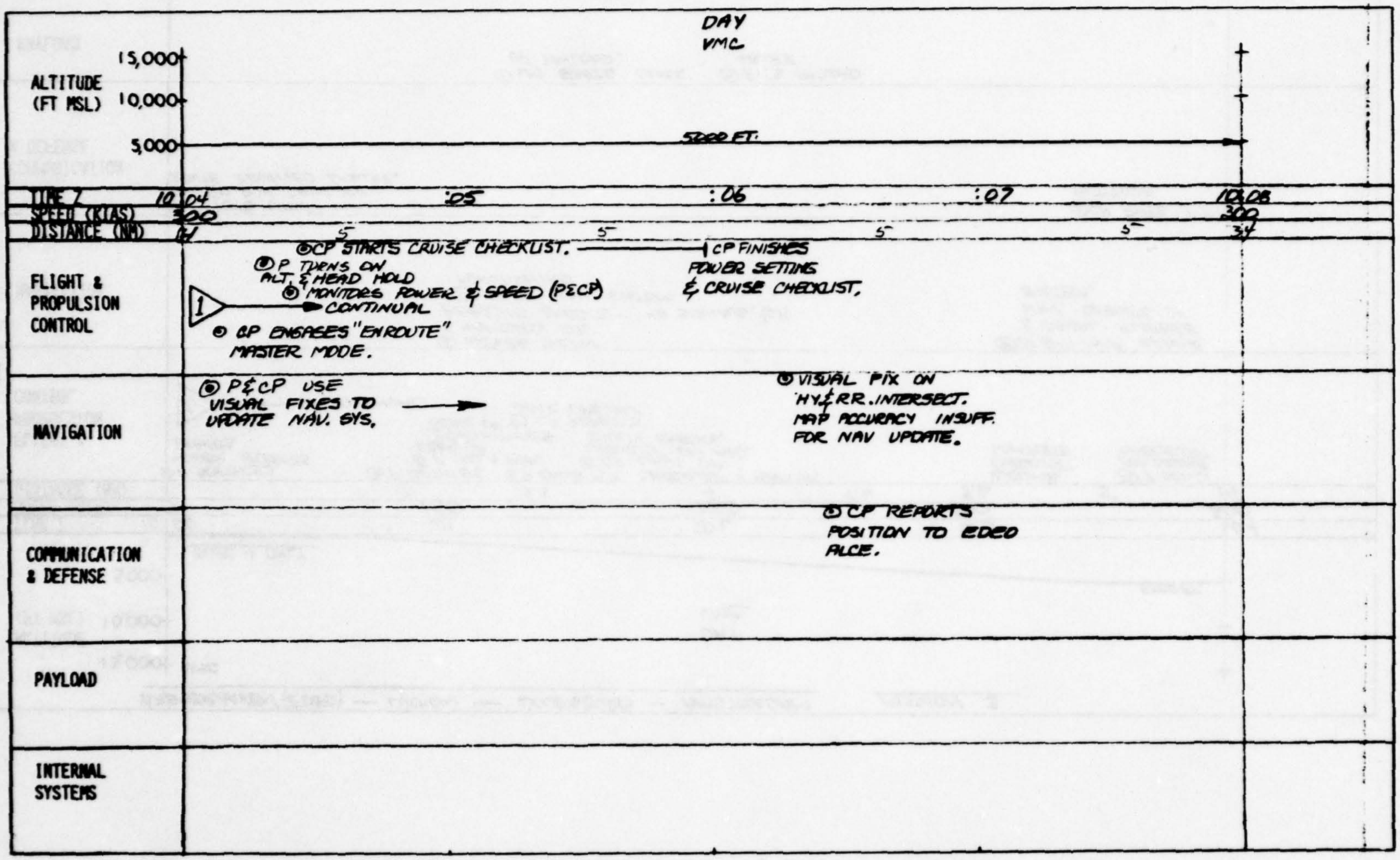


FIGURE NO. 46 Mission III - Low Altitude Parachute Extraction

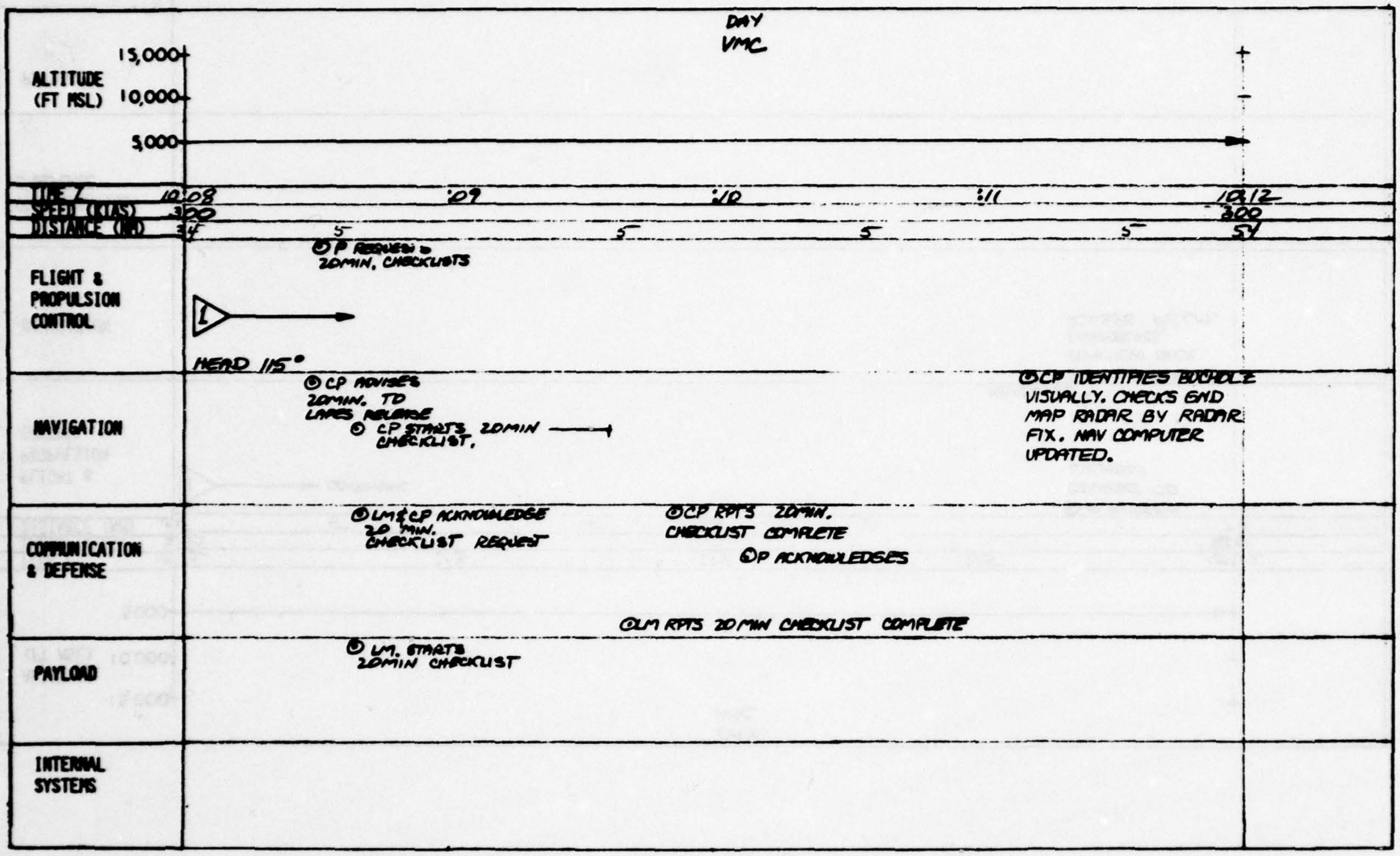


FIGURE NO. 47 Mission III - Low Altitude Parachute Extraction

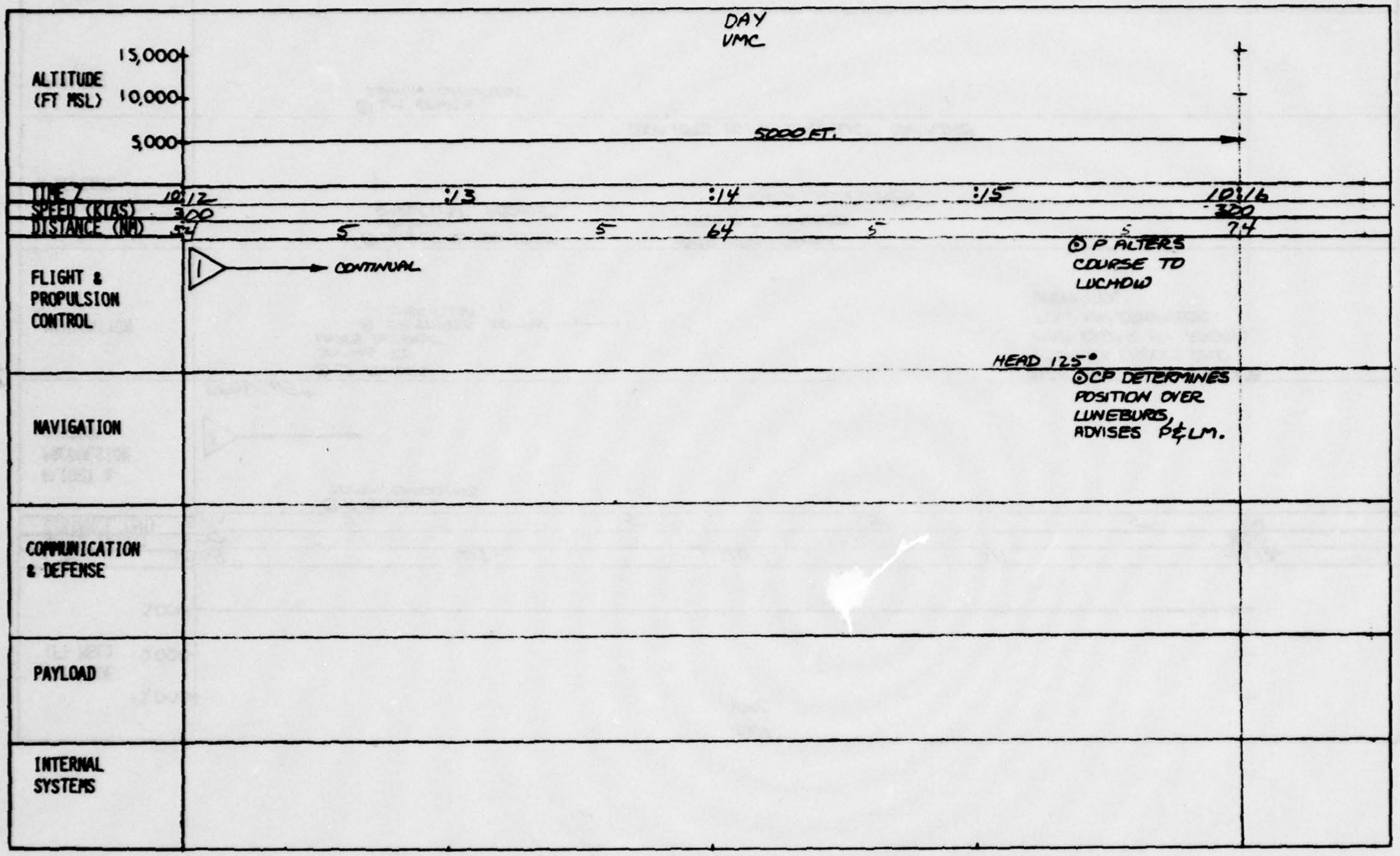


FIGURE NO. 48 Mission III - Low Altitude parachute Extraction

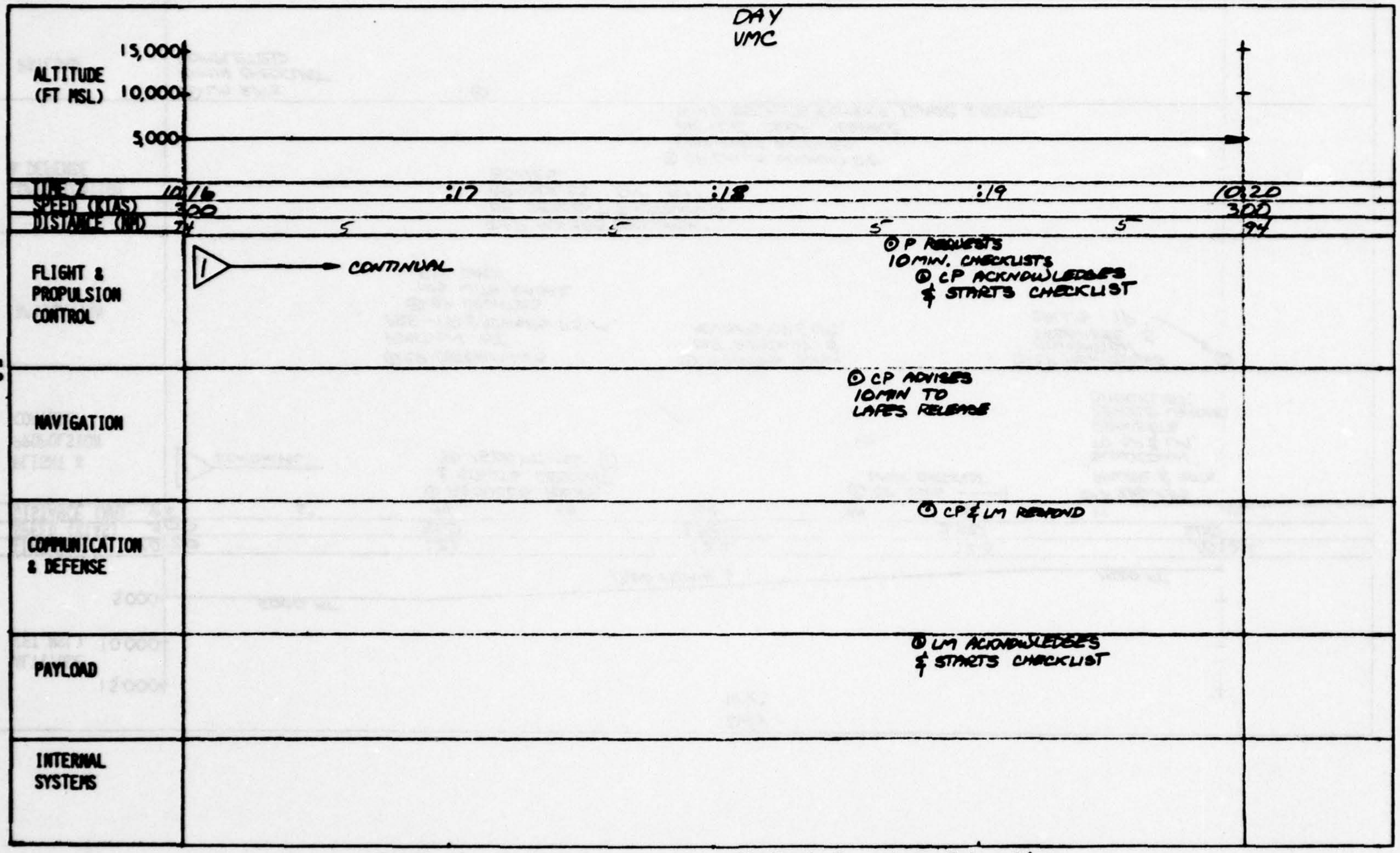


FIGURE NO. 49 Mission III - Low Altitude Parachute Extraction

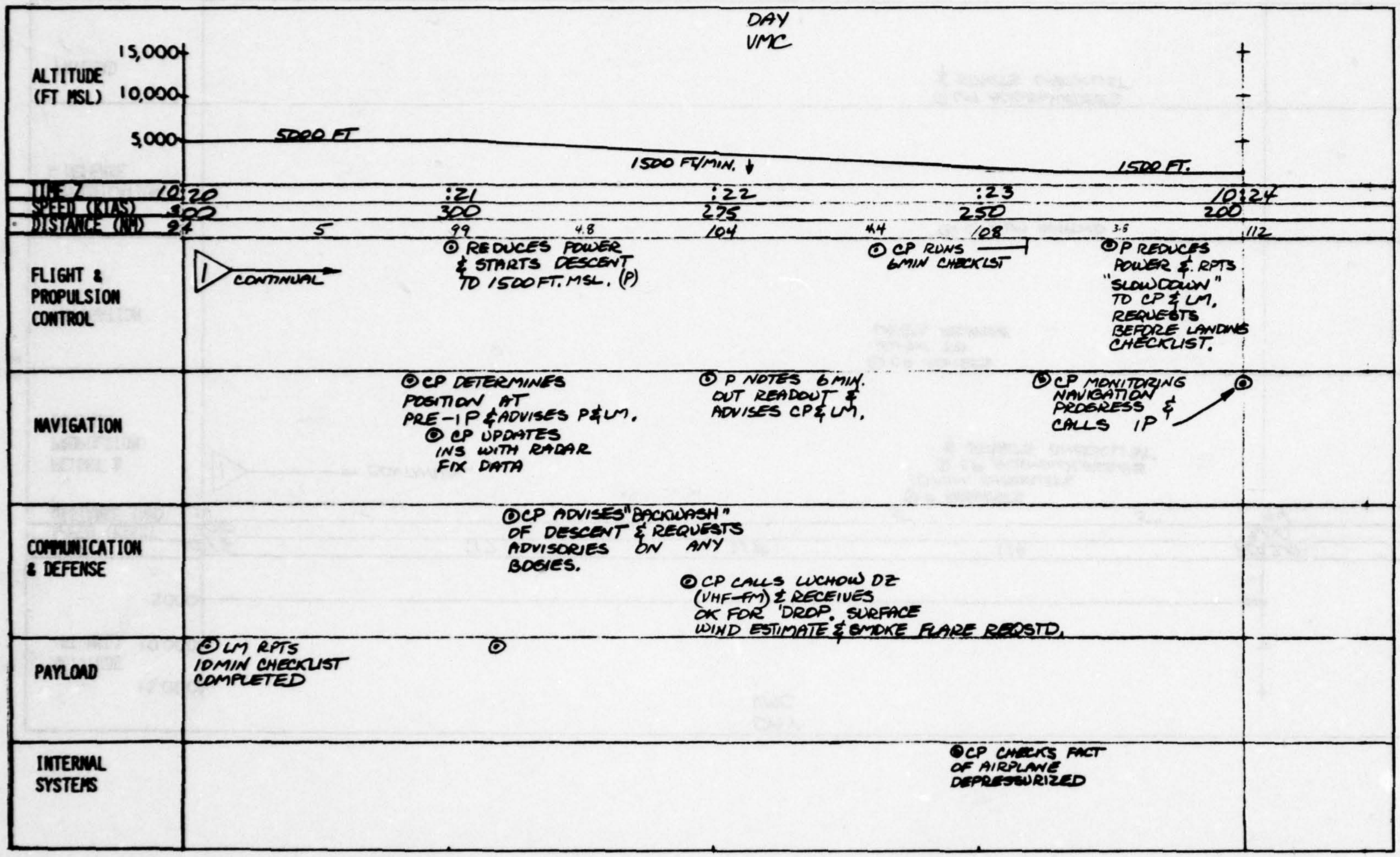


FIGURE NO. 50 Mission III - Low Altitude Parachute Extraction

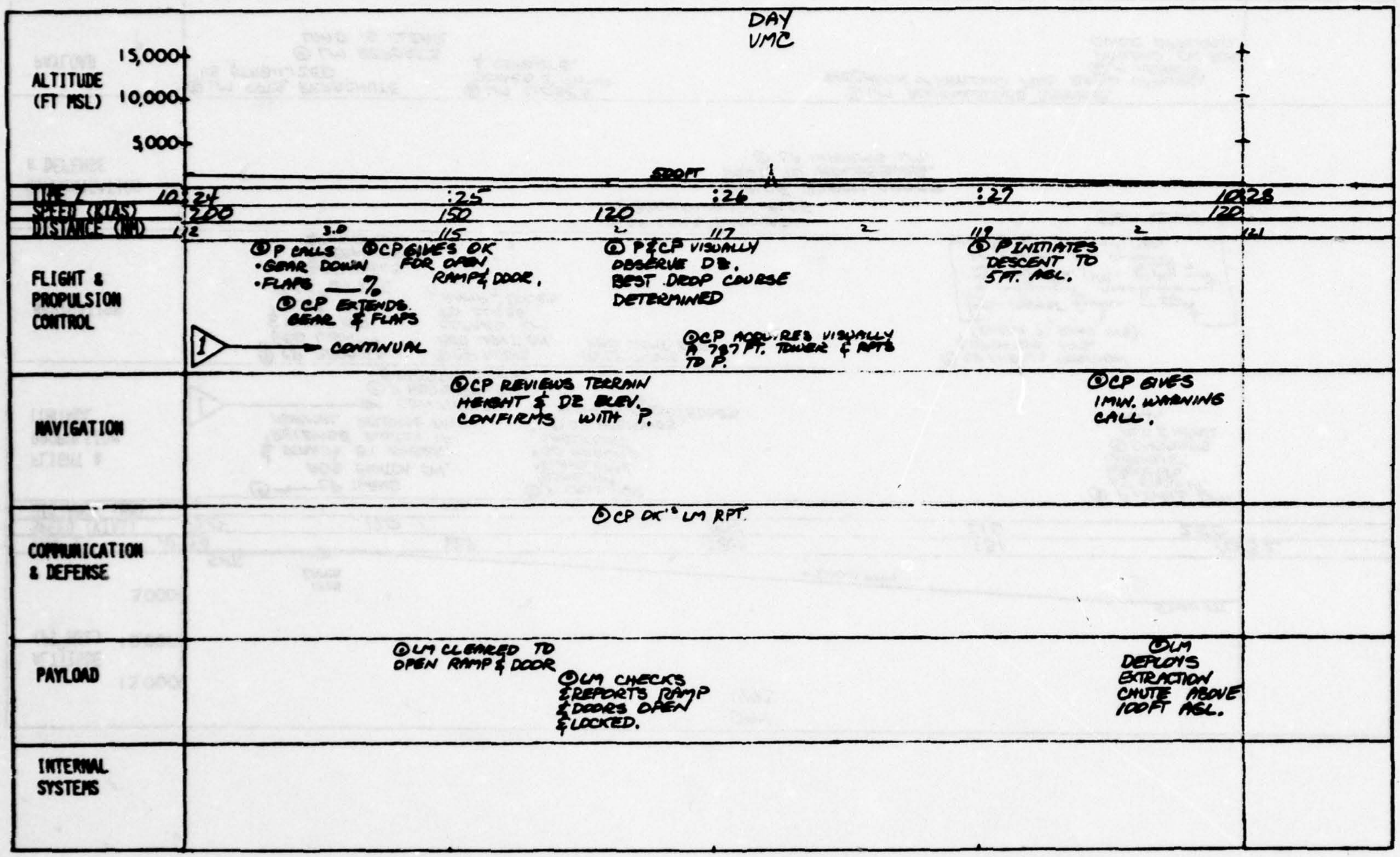


FIGURE NO. 51 Mission III - Low Altitude Parachute Extraction

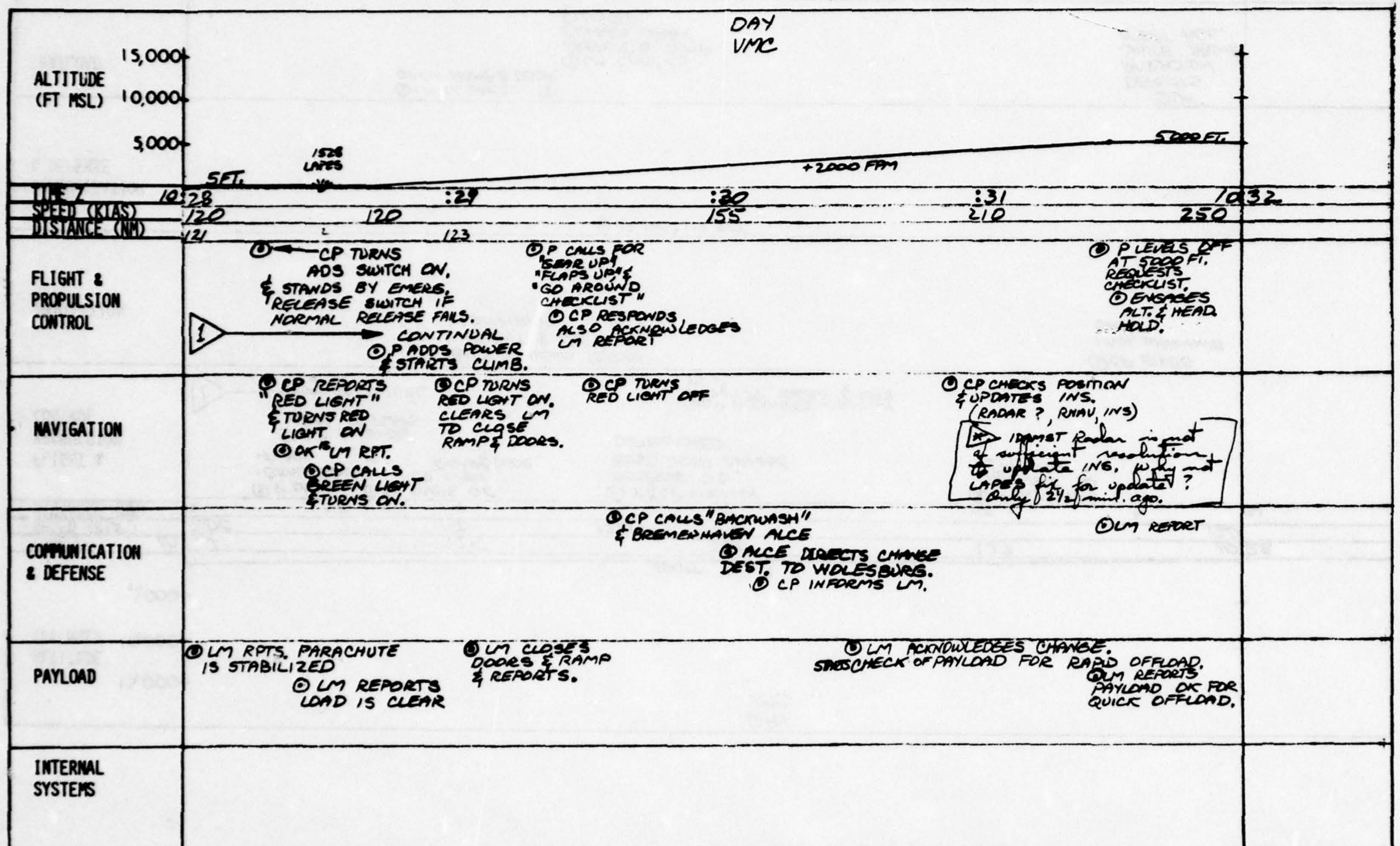


FIGURE NO. 52 Mission III - Low Altitude Parachute Extraction

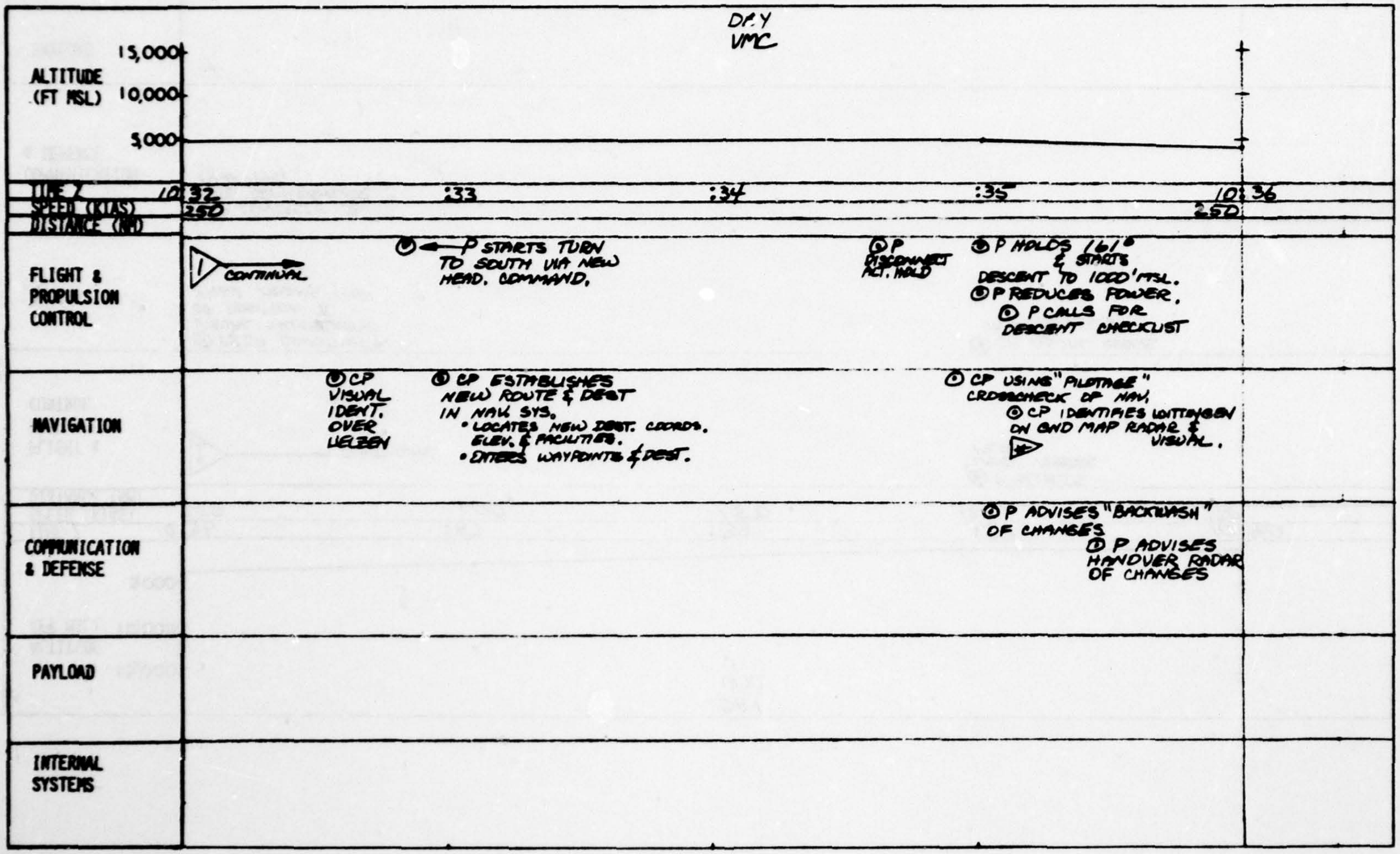


FIGURE NO. 53 Mission III - STOL & Combat Off-Load

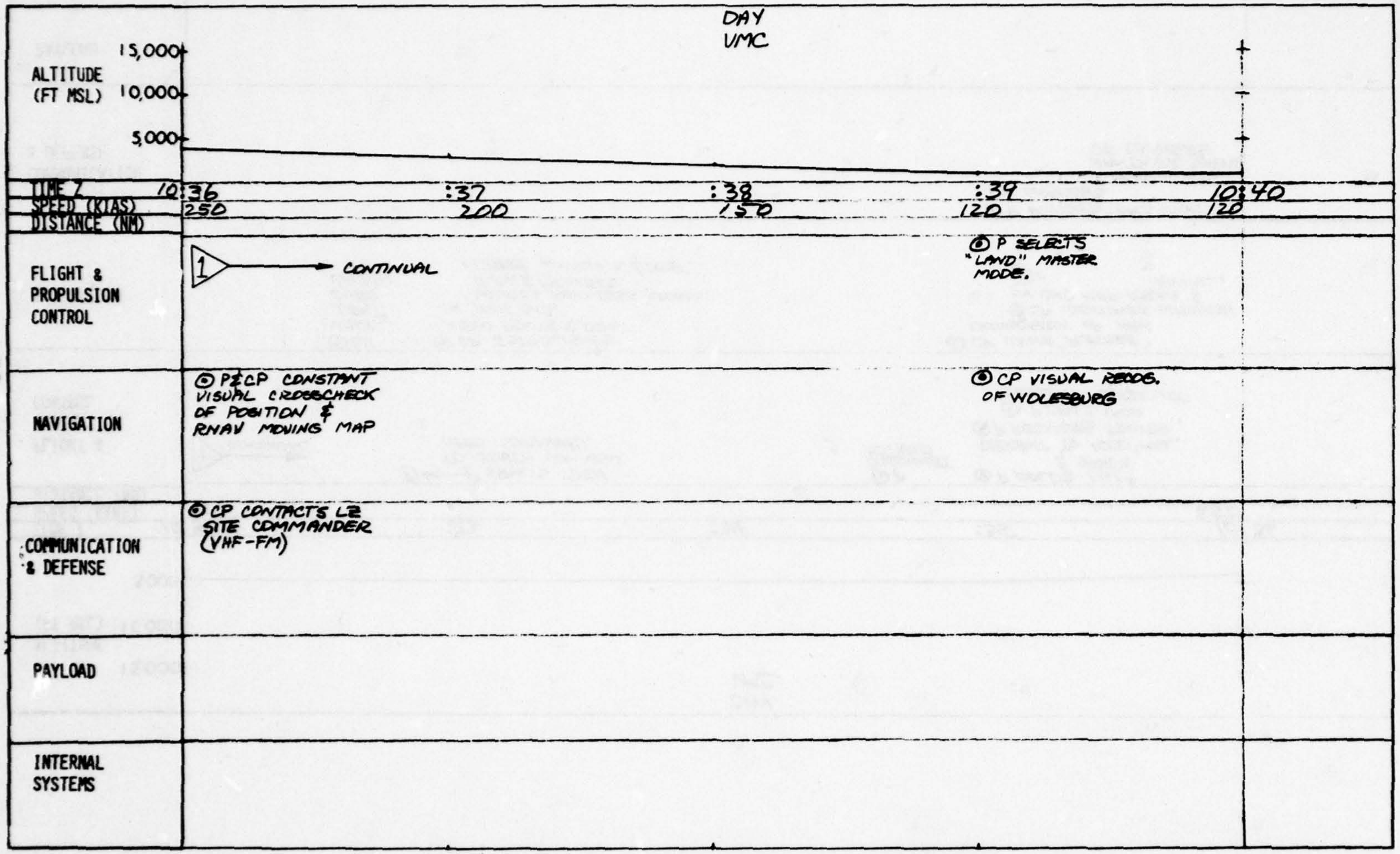


FIGURE NO. 54 Mission III - STOL & Combat Off-Load

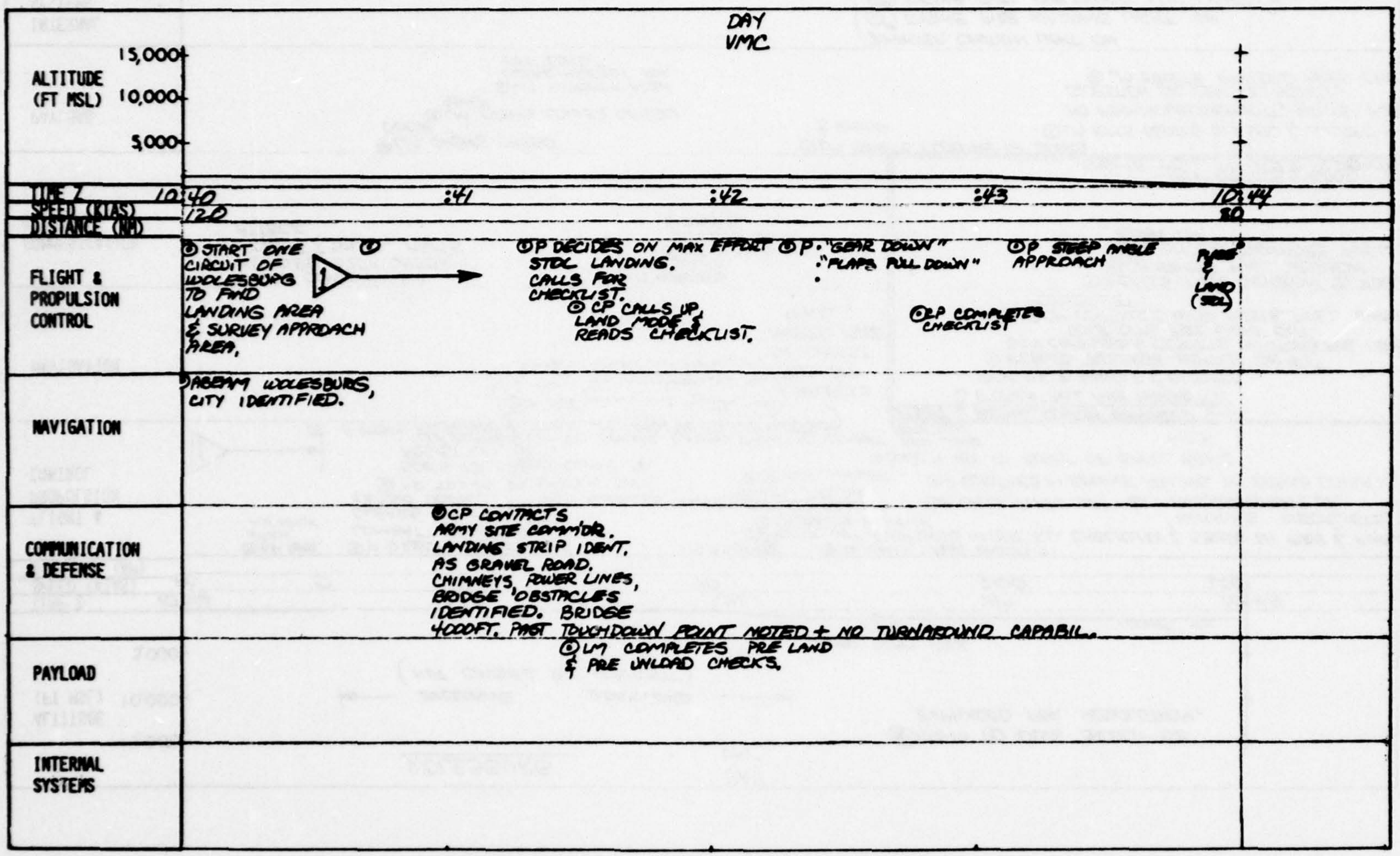


FIGURE NO. 55 Mission III - STOL & Combat Off-Load

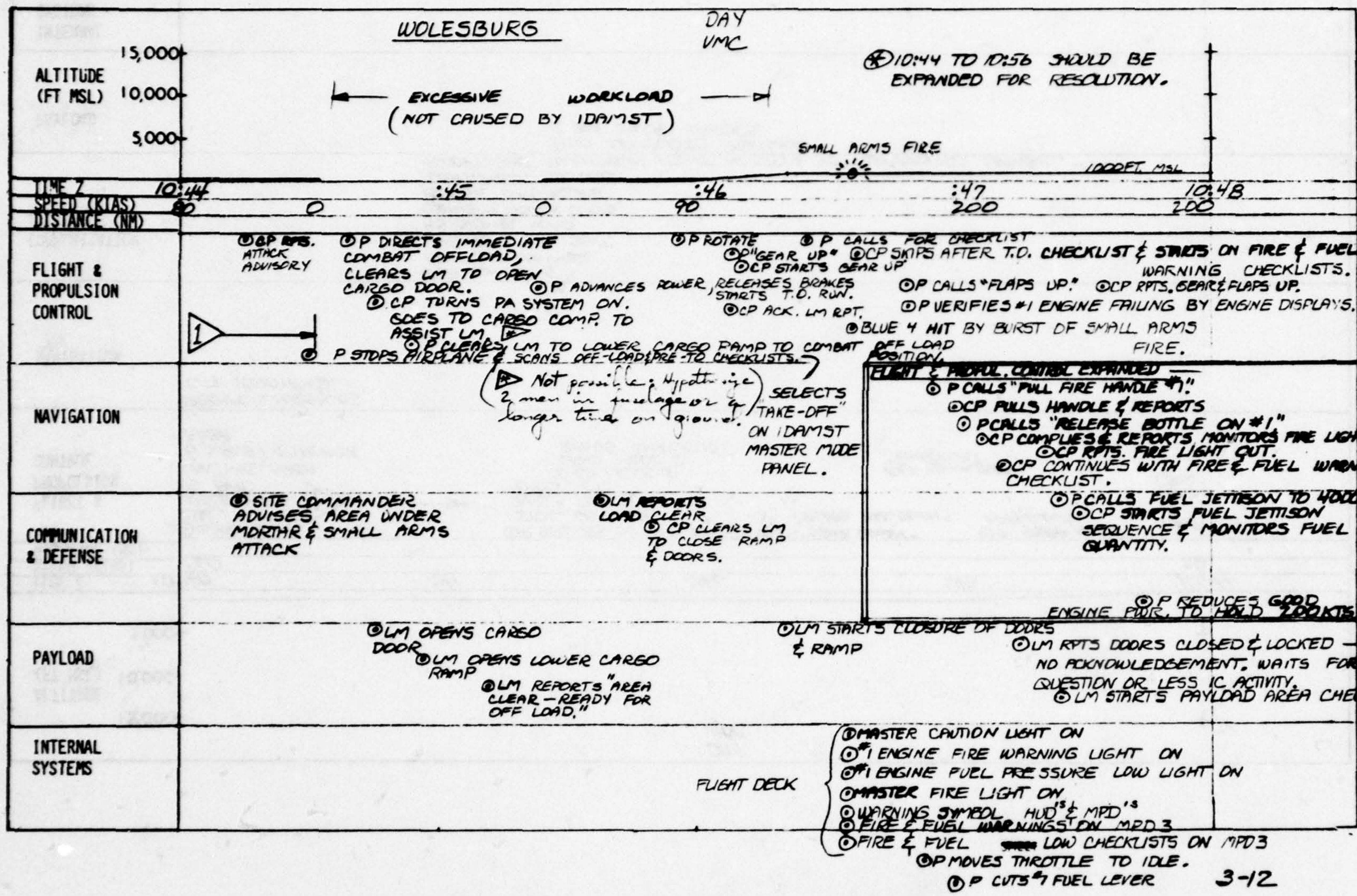


FIGURE NO. 56 Mission III - Departure & Engine Failure

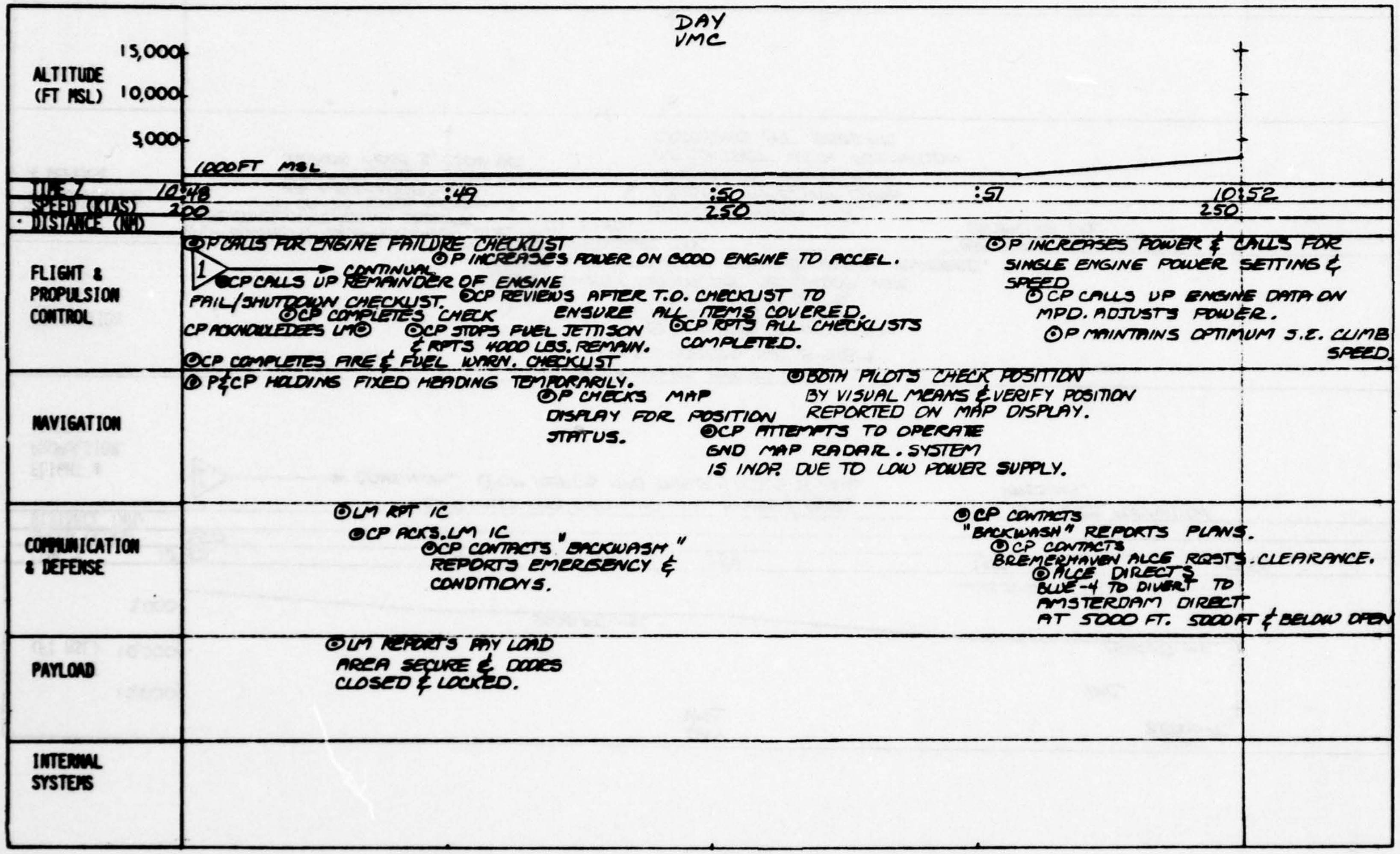


FIGURE NO. 57 Mission III - Departure & Engine Failure

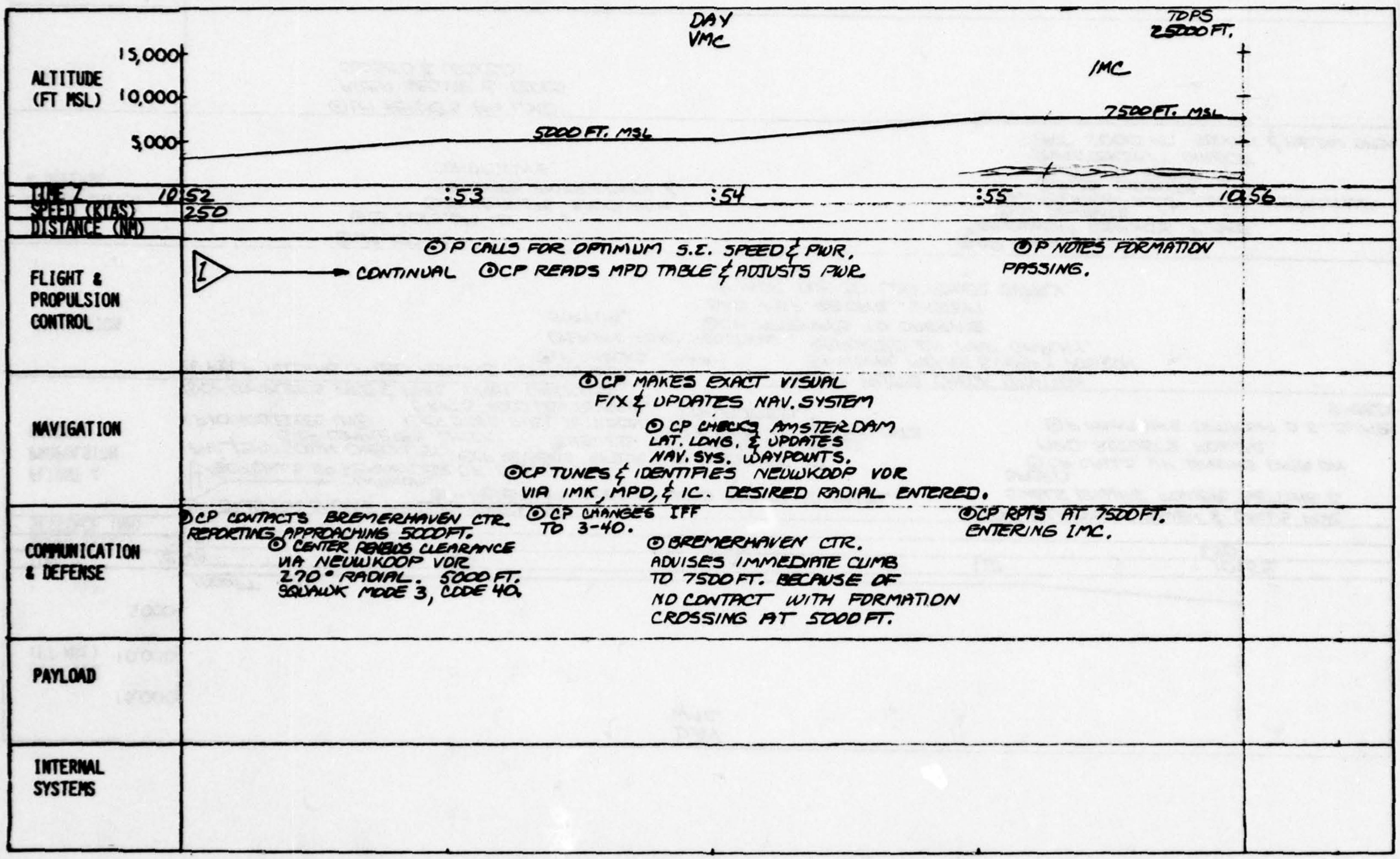


FIGURE NO. 58 Mission III - VOR & ILS Approach

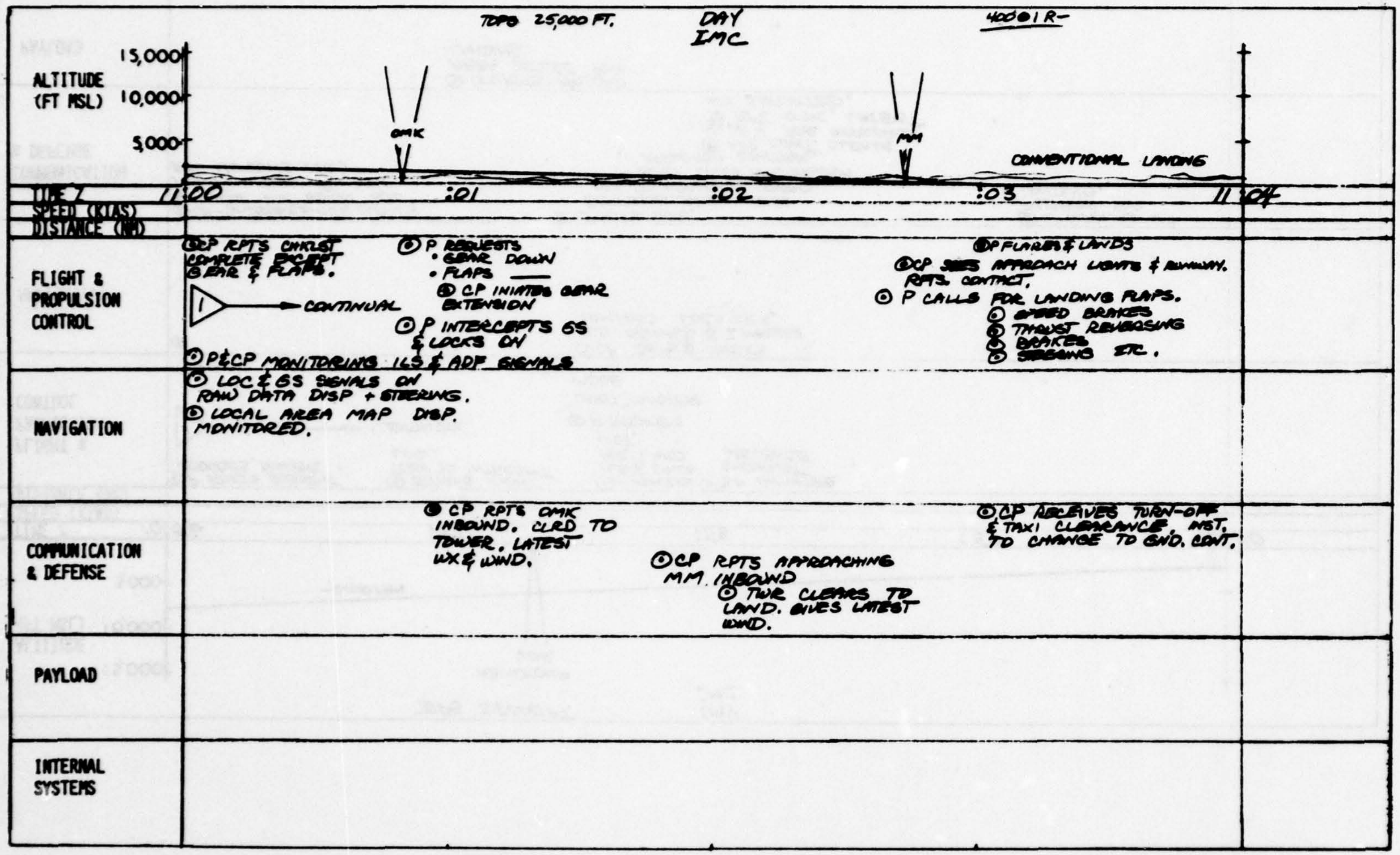


FIGURE NO. 59 Mission III - VOR & ILS Approach

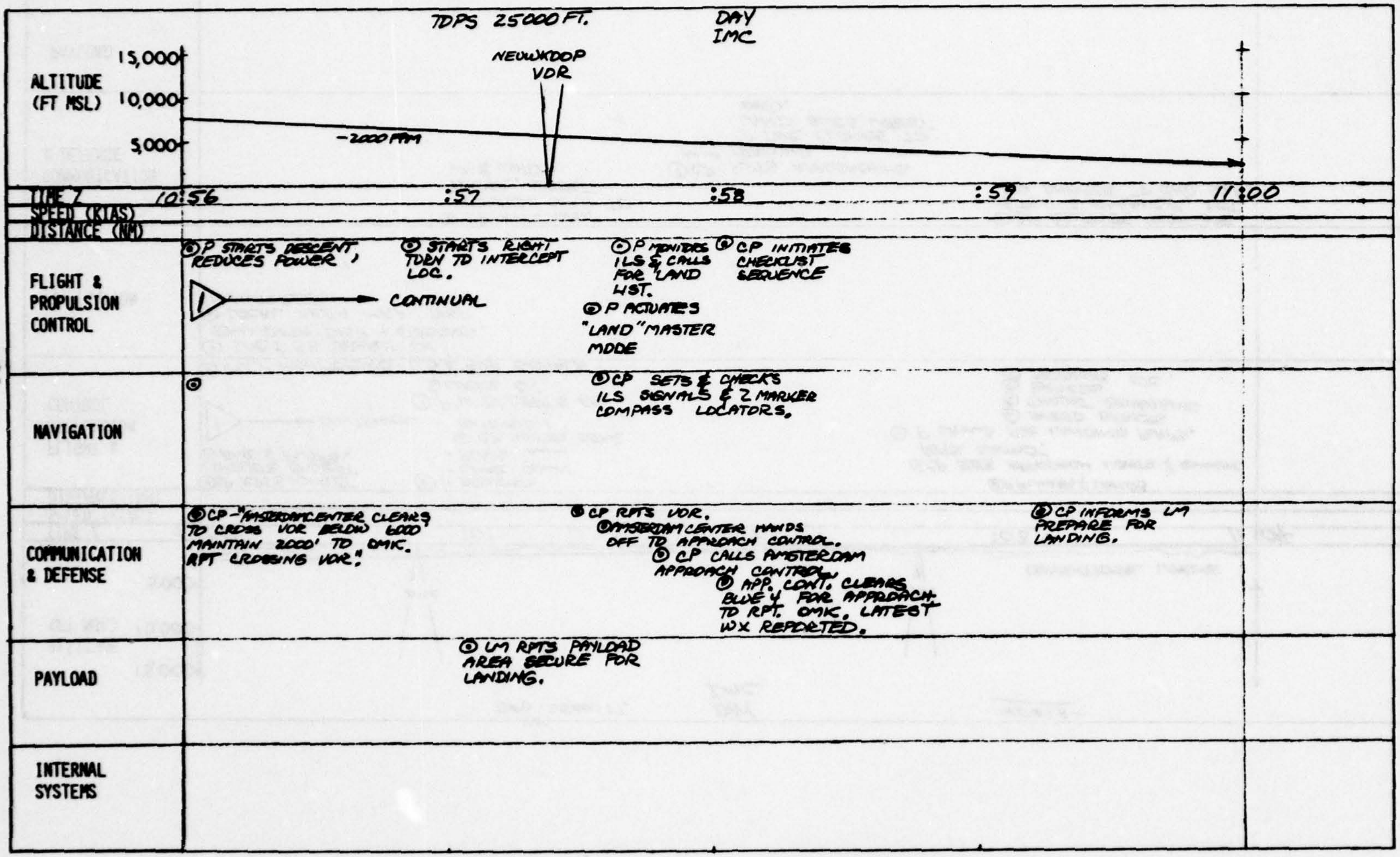


FIGURE NO. 60 Mission III - VOR & ILS Approach

SECTION IV
SUBSYSTEM SEQUENCE DIAGRAMS (SSD'S)

4.1 OVERVIEW

Prior to the start of SSD development, significant segments of the composite mission were indexed to the time lines included in Section III. This review was exercised to identify independent system functional requirements which need to exist as a ready resource for call in the performance of any mission. SSD's for each requirement were then developed to incorporate system characteristics and operational concepts consistent with those postulated for C-14 employment. When it appeared that the SSD repertoire was reasonably complete, Functional Sequence Diagramming techniques were used to test the extent to which the existing SSD group met scenario requirements. Table 1 summarizes those SSD's which have been completed. It also identifies a group of SSD's which are required but, due to time constraints, were not developed during the current study.

TABLE 1
SUBSYSTEM SEQUENCE DIAGRAMS (SSD'S) IDENTIFIED DURING THE IDAMST STUDY

FIGURE NO.	SHEET NO.	TITLE
61	1	GEN DATA INPUT/ERROR CORRECTION
62	1	TRANSFER DATA FROM ONE MPD TO SECOND MPD
64	1	COMM. SYS. - ICS/PA INITIALIZATION AND USE
65	1	COMM. SYS. CHANNEL SECTION - PRE PROGRAMMED
66	2	COMM. SYS. CHANNEL SECTION - PRE PROGRAMMED
67	1	ENERGIZE AND INIT. NAV. SYS.
68	2	ENERGIZE AND INIT. NAV. SYS.
69	3	ENERGIZE AND INIT. NAV. SYS.
70	1	EXEC. OF FLT PLAN (AUTO OR MAN) WITH RADAR FIX FOR CARP CALC.
71	1	EXEC. OF FLT PLAN (AUTO OR MAN) WITH MAN FIX
72	1	EXEC. OF FLT PLAN (AUTO OR MAN) WITH PROVISION FOR REPLANNING
73	1	STANDARD INSTRUMENT DEPARTURE (SID)/STANDARD TERMINAL AREA REQUIREMENT (STAR)
74	1	COURSE OFF-SET (BASED ON ESTABLISHED FLIGHT PLAN)

TABLE 1 (CONTINUED)

FIGURE NO.	SHEET NO.	TITLE
75	1	HOLDING PATTERN - CREW CONFIGURED
76	1	HOLDING PATTERN - CIRCULAR ABOUT AN INPUT POINT
77	1	HOLDING PATTERN - EXECUTION
78	1	SKE INITIALIZATION - PRIMARY CONTROL INPUTS
79	2	SKE INITIALIZATION - PRIMARY AND SECONDARY CONTROL INPUTS
80	3	SKE INITIALIZATION - DISPLAY INPUTS
81	4	SKE INITIALIZATION - DISPLAY INPUTS
82	5	SKE INITIALIZATION - DISPLAY INPUTS
83	1	SKE OPERATION
84	1	SET UP AND EXECUTE EQUIPMENT AIR DROPS
85	1	AUTOMATED CHECKLISTS (INFLIGHT REFUELING)
86	1	EXPENDABLES INVENTORY AND MANAGEMENT - INITIALIZATION
87	1	EXPENDABLES INVENTORY AND MANAGEMENT - OPER. UPDATE
-	TBD*	IDENT. FRIEND OR FOE (IFF)
-	TBD	DEFENSIVE SYSTEM
-	TBD	TEST SUBSYSTEM
-	TBD	RADAR CONTROL SUBSYSTEM
-	TBD	FLIGHT CONTROL SUBSYSTEM
-	TBD	MISC. AIRCRAFT SYSTEMS
-	TBD	GROUND PROXIMITY WARNING SYSTEM (GWPS)
-	TBD	SPECIAL PURPOSE ALERTS
-	TBD	AUTOMATIC DIRECTION FINDER (ADF) SUBSYSTEM
-	TBD	OPTIONAL DISPLAY MODES

* TO BE DETERMINED - Identified as an SSD requirement during the IDAMST study, but left incomplete due to time limitations.

4.2 SSD FORMAT ELEMENTS

The formats developed for Figures 61 through 87 emphasize the role of "Computer Functions" in coordinating "Cockpit Functions" with "Subsystem Functions". The area reserved for computer functions appropriately is expanded to provide information of sufficient detail to support the preparation of an IDAMST software specification. Each SSD function involves data input from a specific source, computer processing of the data, and finally output to a predetermined destination. The objective of the SSD then is to provide information on the types of messages that can be expected to be transmitted through the system, and the levels of software programs that are needed to handle them. Programming levels of indenture then span Executive Control including prioritization through applications programs incorporating all of the applications subroutines. SSD's identify software functions that are needed for functional control, but they do not distinguish between Executive and applications programs. Software engineering personnel have the responsibility for that partitioning during their analysis of SSD functions.

It will be noted that decision-logic notation is frequently used throughout the SSD's. This device allows the analyst to provide information to software personnel as to system and crew actions that are elected based on assessments of conditional situations.

It is also noted that because of the purpose that the SSD is being used for (to provide software personnel with a functional overview), the SSD format allows for feedback loops as opposed to the strict time base suggested by AFAL. This allows a more concise representation to the process displayed by the SSD.

Under "Cockpit Functions" there are three sub-categories:

"Crew"- Based on symbology, this column provides information on how the operator senses and acts on cockpit internal/external and system generated cues. It will be noted that no attempt is made to designate whether the crew member is the pilot or copilot. SSD's presume that either one of them have the equipment, and could have the responsibility, to perform the required tasks.

"Controls" - This column is used to designate which dedicated or multipurpose controls are used by the operator to accomplish a particular task. It is also employed to show the required sequence of operations.

"Displays"- Depending on the nature of the Function being performed, either the operator or software may select one of the multipurpose or dedicated displays for data presentation. That selection is shown in this column.

"Subsystem Functions" provide three separate sub-columns ("SYSTEMS 1, 2 OR 3"). These areas are used to illustrate how hardware systems, whose operations complement one another, are interfaced under computer control. It is recognized that systems such as the navigation system usually have their own processors and dedicated software. But for the SSD analysis all software functions are shown under "Computer Functions" rather than under the "SYSTEMS 1, 2 OR 3" columns.

The "External" column is used to show how cues originating outside of the subject C-14 effect that aircraft's system and crew functions. The cues may range from through-the-windshield visual observations to subsystem receipt of Electromagnetic radiation signals from external communication, navigation and radar systems.

The last column, "Time, Priority, Remarks", is used by the analyst to amplify the illustrated SSD flow. Wherever possible the comments have been noted adjacent to the flow segment to which they are addressed.

Table 2 provides the reader with symbology definitions used in the SSD's.

4.3 SUBSYSTEM SEQUENCE DIAGRAMS - ANALYSIS

Most of the analysis which has been performed during the study is summarized on the individual SSD sheets. The following paragraphs then will provide the reader with an introduction to each SSD subject as well as amplify points which were not noted on the diagrams.

<u>Figure 61: General Data Input Including Error Correction</u>

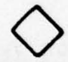
Since any set of operator generated inputs to the Integrated Multifunction Keyset (IMK) can be interrupted by errored punches, this SSD illustrates a generalized system logic for correcting those inputs. Implicit in the sequence is the requirement for automatic positioning of a cursor on the Multipurpose Display with which the operator is interacting. Through software the display control group must provide means of repositioning the cursor forward or reverse to locations of operator selection.

<u>Figure 62: Transfer Data from One MPD to a Second MPD</u>

The Function provided by this SSD recognizes the requirement for reconfiguration after a display system failure. Figure 63 illustrates display transfers growing out of a failure in MPD #1. This must be accomplished rapidly with minimum mission task interference, and with little or no loss of mission critical data. In certain instances where a data loss is inevitable due to insufficient remaining display capability, the software/hardware suit needs

TABLE 2
FSD/SSD Symbology

THE FOLLOWING SYMBOLS ARE USED IN DEVELOPING FSD'S AND SSD'S:

SYMBOL	MEANING
	RECEIVE
	ACT
	MONITOR
	TRANSMIT
	STORE DATA
	RECALL DATA FROM STORAGE.
	DECISION LOGIC

NOTE: A DOUBLE SYMBOL ( , FOR EXAMPLE) MEANS THAT THE FUNCTION IS CONTINUOUSLY PERFORMED

AMPLIFYING INFORMATION USED WITH SYMBOLS:

LEGEND	MEANING
A	AURAL
E	ELECTRONIC/ELECTRICAL
M	MECHANICAL
RF	RADIO FREQUENCY
S	SPEECH
T	TOUCH
V	VISUAL

to be flexible enough to provide for automatic prioritization with manual override available.

Figure 64: Communication System - ICS/PA Initialization and Use

When the aircraft electrical distribution system receives power from ground or internal generators, and when the computer has been initialized, the System Power Logic program enables the Intercommunications System/Public Address (ICS/PA) system to be energized. Subsequent to that, all control and use of ICS/PA equipment is independent of the computer facility.

Figures 65, 66: Communication System Channel Selection - Preprogrammed

This flow illustrates how the operator uses the IMK to assign frequencies for each radio to channel numbers in the computer. When those tuning choices have been made, displayed, and accepted ("ENTERED") - the tuning subroutine tunes each radio accordingly. If transmitter use is desired, the operator designates the set via the IMK channel keys and the computer implicitly enables the equipment as a function of the stored receiver tuning data.

Figures 67, 68, 69: Energize and Initialize Navigation System

General Note:

The IDAMST navigation system is based on Area Navigation (R-NAV) concepts. Consequently the SSD's dealing with system initialization, use, and special operational features will reference R-NAV nomenclature.

Figure 67 shows software interface management of INS hardware initialization and alignment under operator control. Simultaneous with alignment, the flow reflects operator interaction with software via the IMK in setting flight plan operational parameters. These include waypoints with their respective commanded flight levels and system computed Estimated Time-Overheads (ETOH's) based on input estimated departure times. Subsequent to that the system is set in "NAV MODE" to initiate operational functioning.

Figure 70: Execution of Flight Plan (Automatic or Manual) with Provision for Radar Fix for CARP Calculation

To enable execution of the flight plan, all of the functions required by Figure 67 must have been performed. With alignment complete, the INS monitors aircraft movement and transmits signals to the software position update filter. The computed current position is compared with the next fly-to-point

(FTP) in the flight plan. Appropriate range and bearing computations to the FTP are calculated. That data is transmitted to the flight director and, if the aircraft is under manual control, the pilot makes the required control inputs. If the aircraft is under autopilot control, steering signals are provided for autopilot updating.

This SSD also illustrates how a terrain feature observed on the radar display can be "hooked" and designated for the computer as datum for calculating a navigation fix.

Figure 71: Execution of Flight Plan (Automatic or Manual) with Provision for Manual Fix

System activities shown in this diagram are similar to those of Figure 70 with the exception that the fix is based on a terrain feature visually acquired by either the pilot or copilot.

Figure 72: Execution of Flight Plan (Automatic or Manual) with Provision for Replanning

Again, the basic flow for this FSD is derived from Figure 70. The additive feature is the operator's interaction with computer using the IMK and MPD to accomplish a flight plan change. As noted, the change could involve a single, or multiple FTP input. When the points are accepted by the operator keying "ENTER", the computer selects the closest FTP as the next execution point unless another operator specification has been made. Steering commands are then generated for flight director display and autopilot use.

Figure 73: Standard Instrument Departure (SID)/Standard Terminal Area Requirements (STAR)

SID/STAR procedures are read into computer memory from standard mission tapes prepared for C-14 employment within specific theaters of operation. SID's are called up for display by manual IMK inputs. STAR's may be called in the same way; or, if desired by the flight crew, they may be automatically called when the INS senses that designated navigation parameters have been satisfied.

Figure 74: Course Offset (Based on Established Flight Plan)

This flow shows how the flight crew can preplan course offset which, when called, provides steering commands based on the stored flight plan.

Figure 75: Holding Pattern - Crew Configured

A holding pattern of any geometry can be set up by the flight-crew using this subroutine. The pattern may be configured in either of two ways. The first involves inputting a series of LAT/LONG pairs to define the pattern limits, while the second would call for "hooking" terrain features on the moving map display in sequence, and designating those points as FTP's. For the latter, the computer converts the map points to LAT/LONG pairs for flight plan execution.

Holding Point Execution is shown on Figure 77.

Figure 76: Holding Pattern - Circular About an Input Point

By designating for the computer a center point (LAT/LONG or, alternatively, a "hooked" position on the moving map display) and a radius, the flight crew can establish a holding period in a minimum amount of time.

Figure 77: Holding Pattern Execution

This flow enables implementation of either of the previously discussed holding patterns. The software logic will implicitly provide steering commands for left-hand turns unless directed otherwise by the operator. Not shown in the flow, but important, is the requirement for a diagnostic routine to reconcile pattern parameters with commanded aircraft kinematics. Calculated output would provide the flight crew with resultant bank angles, turn times, g forces, etc.

Figures: 78, 79, 80, 81, 82: Station Keeping Equipment - Initialization

These 5 sheets indicate the input methods for the various parameters needed for SKE operation. The process is inter-reactive due to the number of options that are available to the operator in setting up the SKE. It is possible that this set-up could be preprogrammed for all aircraft participating in a sortie, but with the aircraft role differences from mission-to-mission, it seems hardly worth the added complexity.

Figure 83: Station Keeping Functional Operations

This flow summarizes all of the recieved and transmitted time based signals on which SKE operations are based. The way the signals are processed in automated functions, and the manner in which the refined data is employed is shown. Outputs are divided among those going to complementary elements in the integrated system for additional processing and use; and those which get subdivided into normal and alert messages for use in the displays group.

Figure 84: Set Up and Execution of Equipment Air Drops

An overview of interrelated functional requirements for precision air drops is shown on this flow. It tracks how integrated sensor system data (Navigation, SKE, and DZ Beacon) is used to set up modes of operation (auto and manual release techniques) with implementation functions facilitated by provisioned hardware (cargo door, tie down unlocking, and exit sequencing).

Figure 85: Automated Check Lists - Prepare for Inflight Refueling

There are a large number of check lists, procedures, and performance data presentations that can be displayed by an IDAMST type system. Some are merely for crew reference purposes (aircraft performance check lists) while others require crew/system inter-reaction. A third type is the completely automated check list which is: (1) called and executed automatically after a set of conditions has been satisfied (gear up, flaps up, aircraft on climb power - execute after take-off check list, and report results); (2) called manually, but executed under computer control. Figure 85 is an example of the latter. Subsequent to operator call-up the software commands avionic subsystem control change, and reports the results out for Display.

Wherever check lists are called for by FSD's, Figure 85, the intent is that this figure represents a check list concept rather than the precise check list called for by the FSD element.

Figure 86: Expendables Inventory and Management System - Initialization

Shown in this flow are the methods by which expendable quantity data is accounted for in the IDAMST system. The information is partially derived from sensed data with the remainder being supplied by operator input. As examples: fuel and oil filling is sensed; while cargo compartment loading is furnished via mission tape or crew input. Weight and balance reports are automatically updated on a real time basis throughout the entire sortie.

Figure 87: Expendables Inventory and Management System - Operational Updating

A real time aerodynamic analysis routine combined with the functions shown in the flow would be required to facilitate the operation of a full scale energy management system for the C-14. In its simplest operation, the concepts shown in Figure 87 would assist the crew during in-flight mission replanning, and assessments of safety margins. In the extreme, output data could be furnished directly to subroutines which could determine optimized weight distribution, control surface configuration, and power applications to produce maximum airplane performance in a given mission.

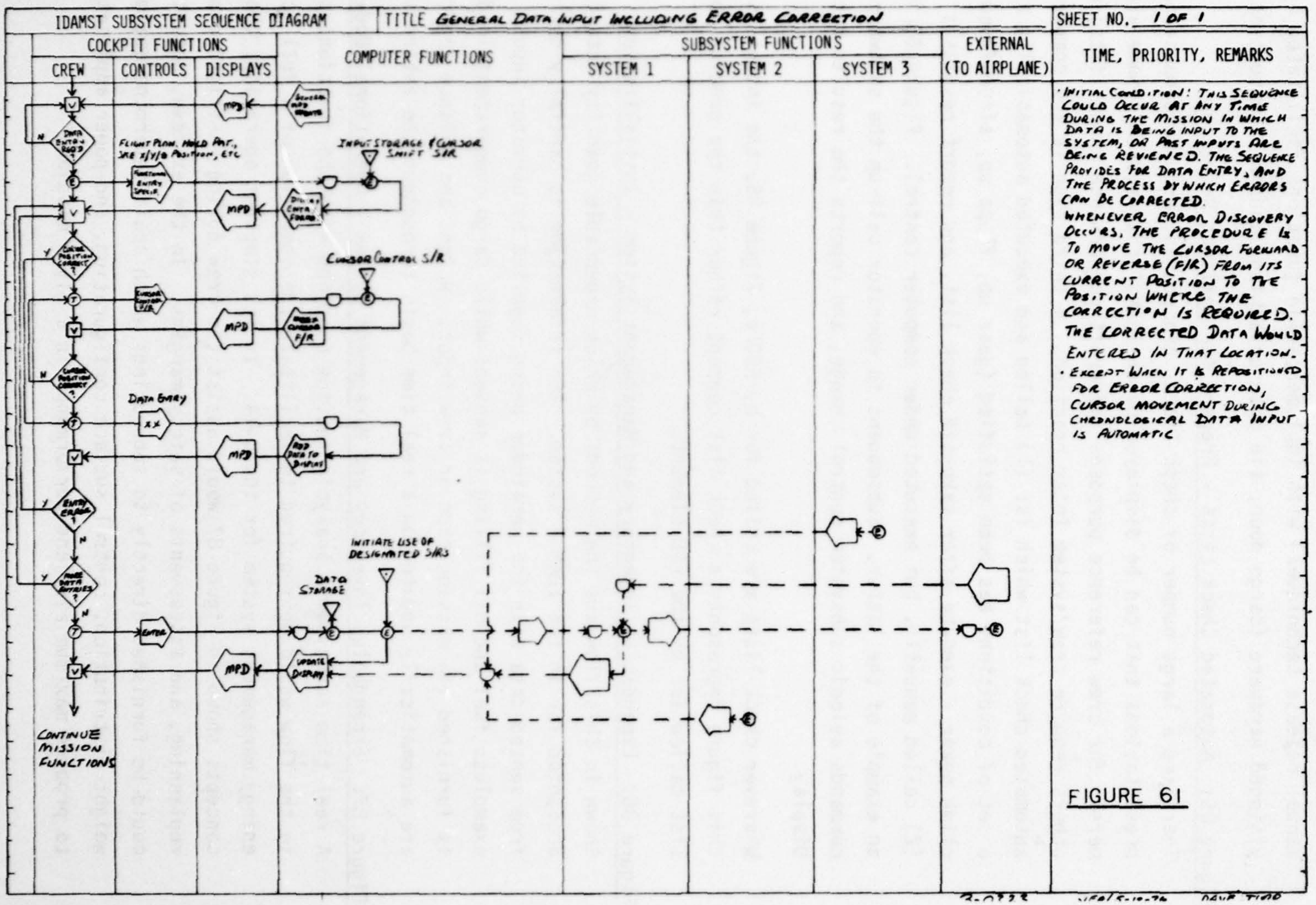


FIGURE 61: General Data Input Including Error Correction

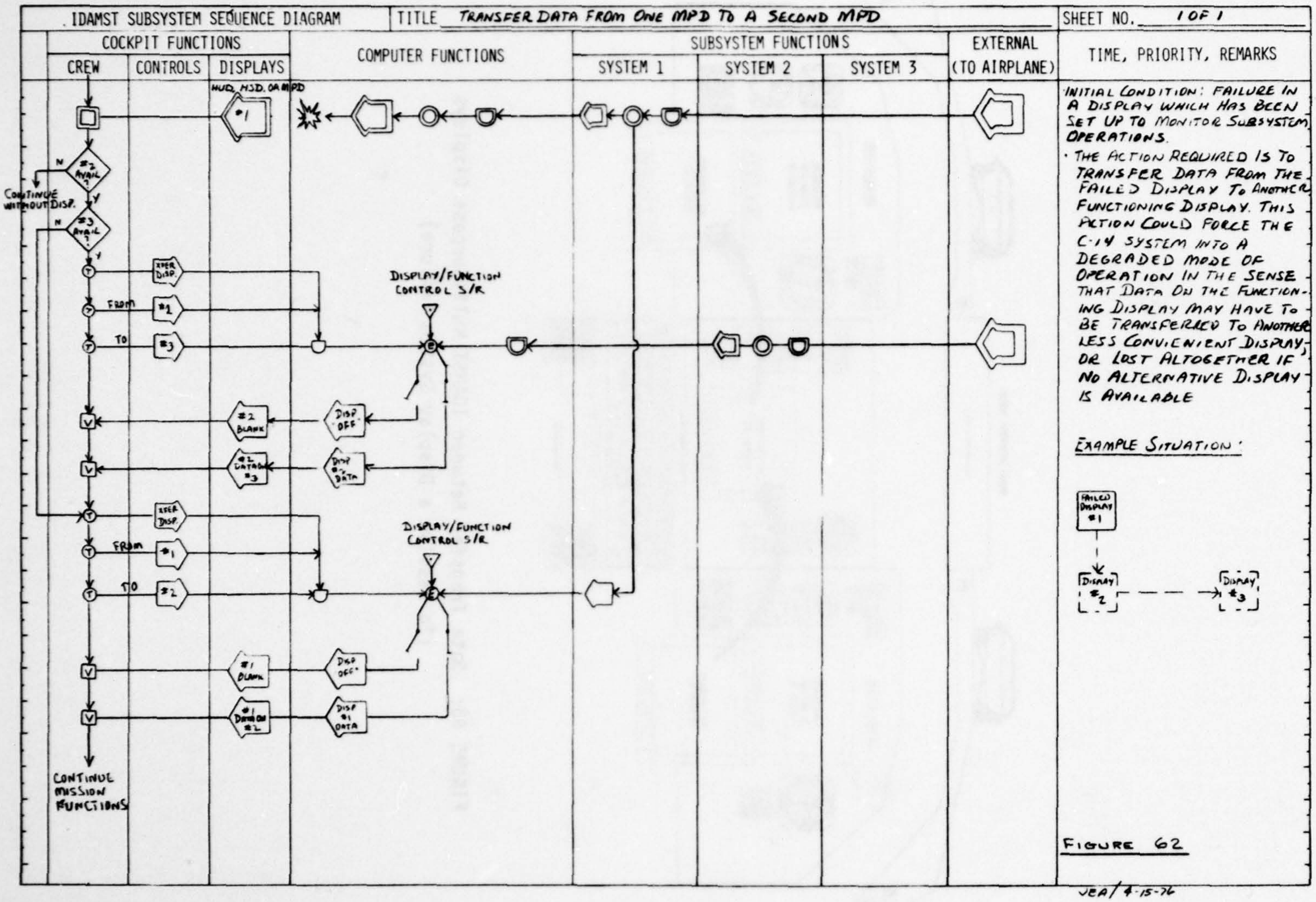


FIGURE 62: Transfer Data from One MPD to a Second MPD

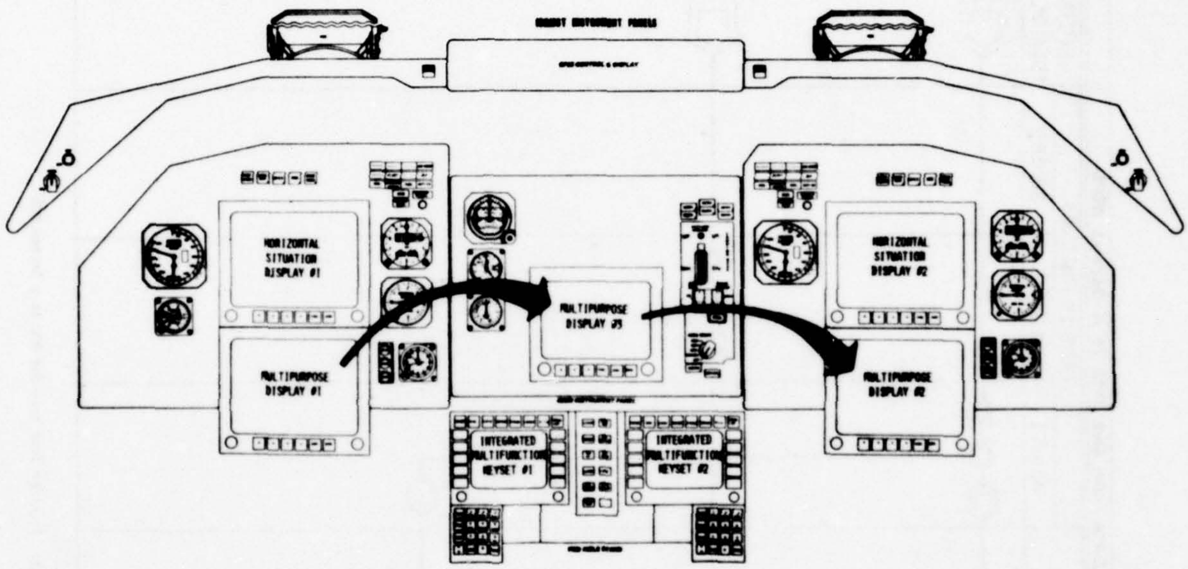


FIGURE 63: Data Transfer Between IDAMST Multipurpose Displays (To Resolve a Display System Failure)

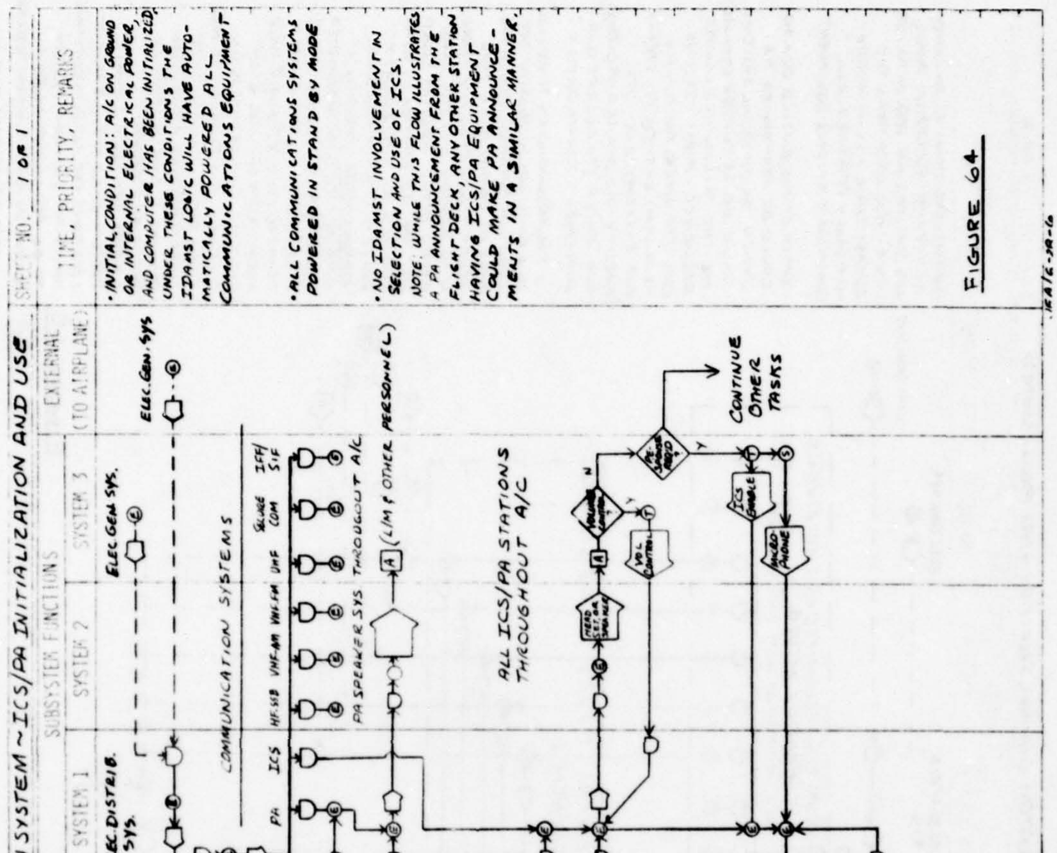


FIGURE 64: Communication System - ICS/PA Initialization and Use

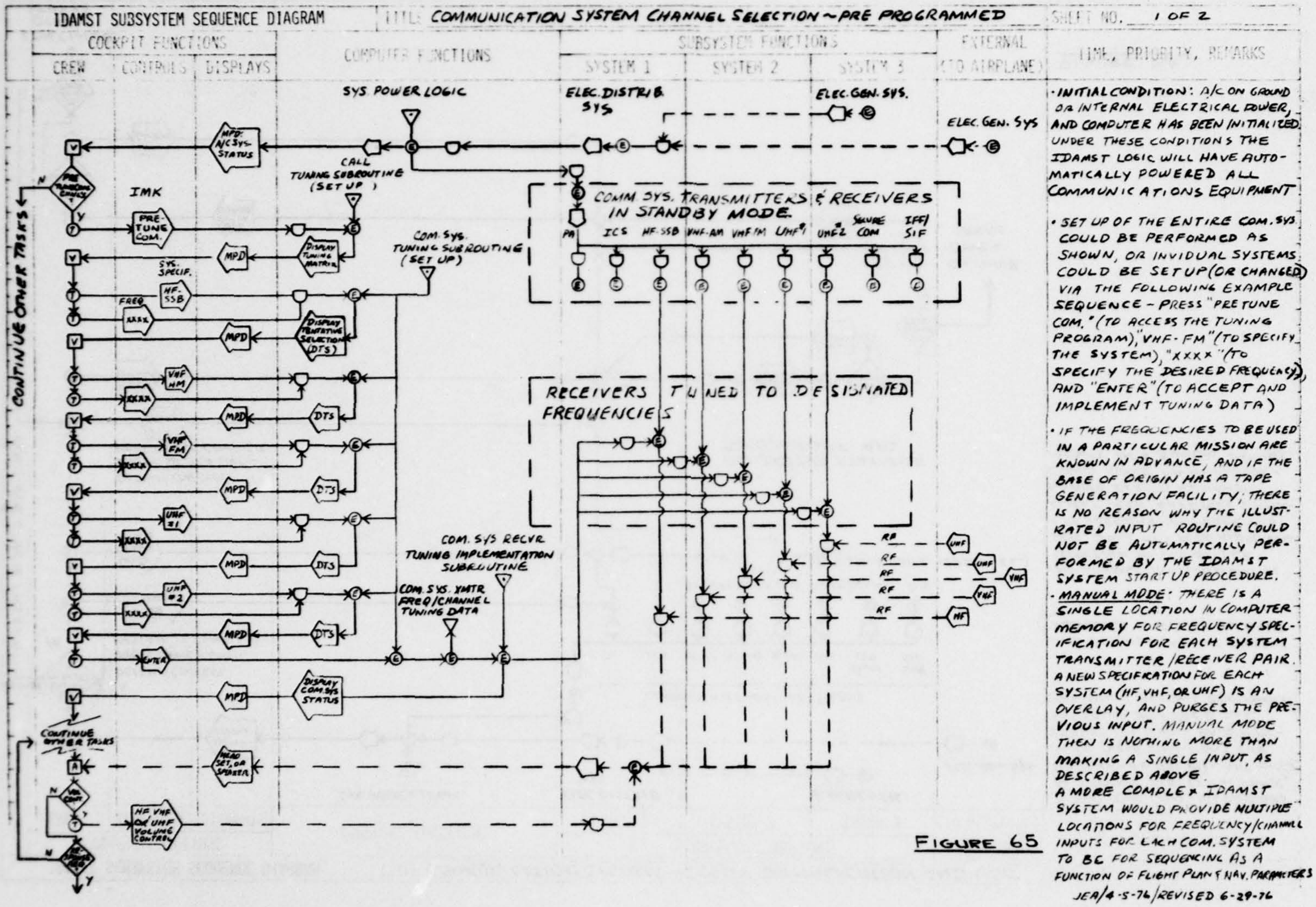


FIGURE 65: Communication System Channel Selection - Preprogrammed

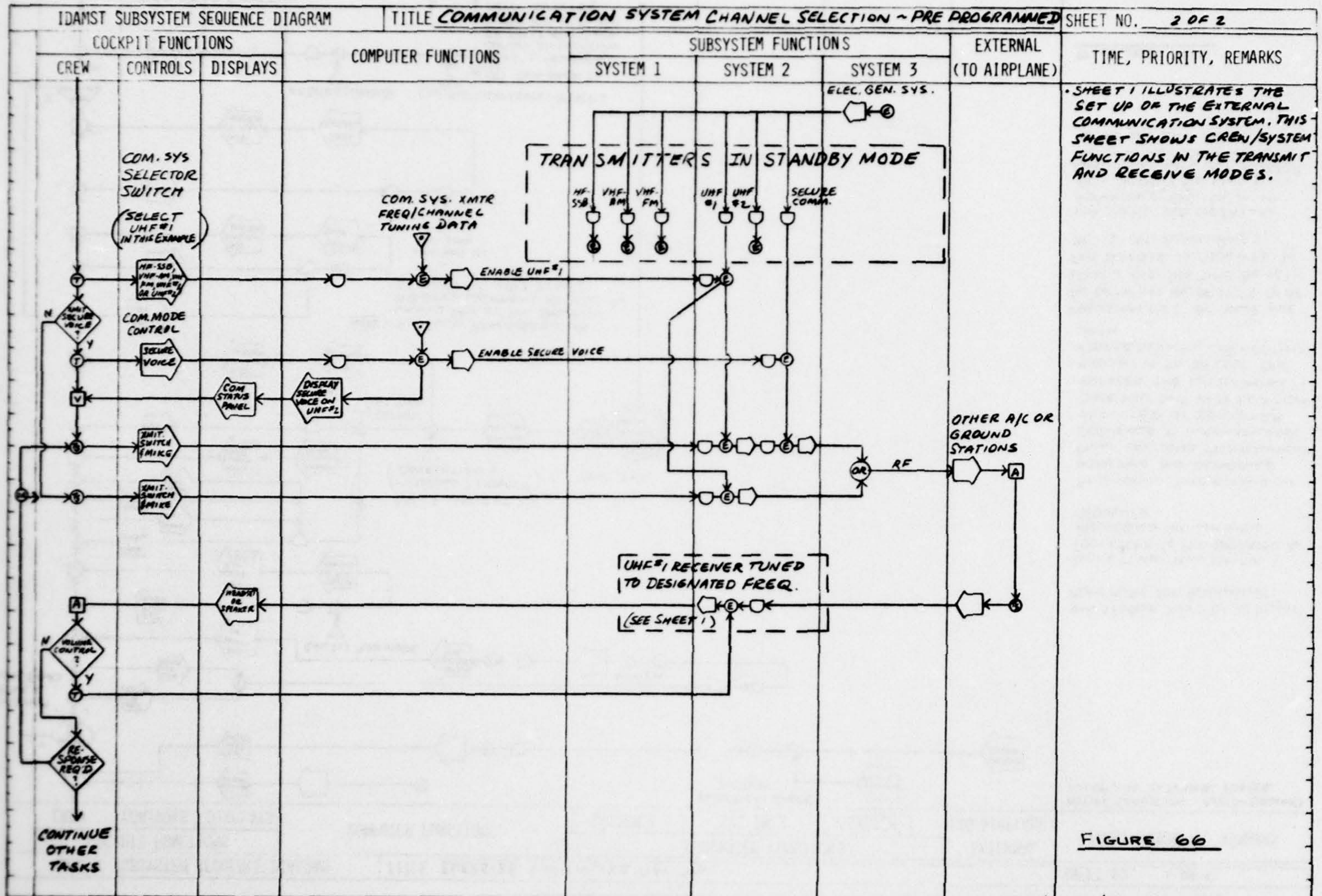


FIGURE 66: Communication System Channel Selection - Preprogrammed

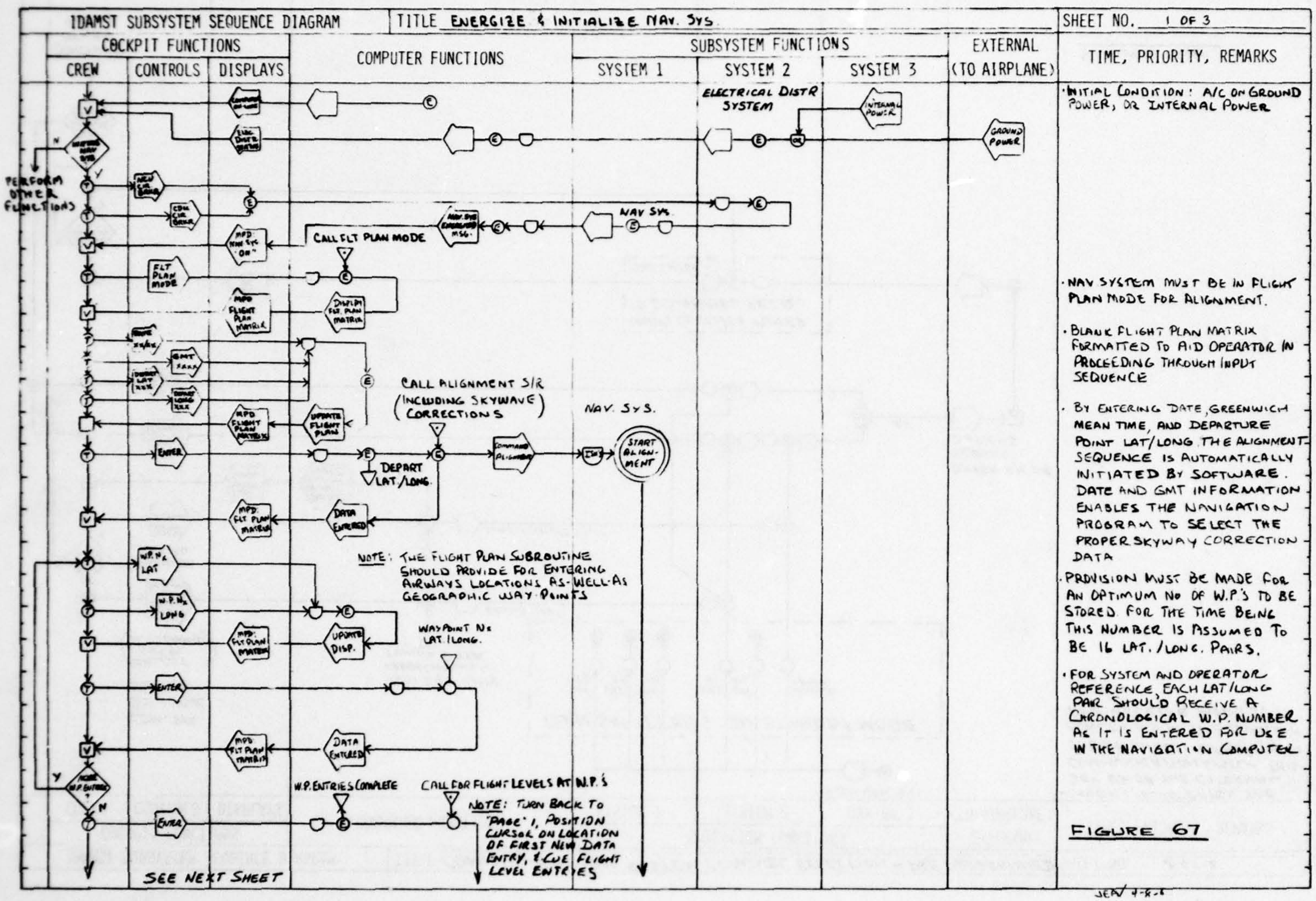


FIGURE 67: Energize & Initialize Nav. Sys.

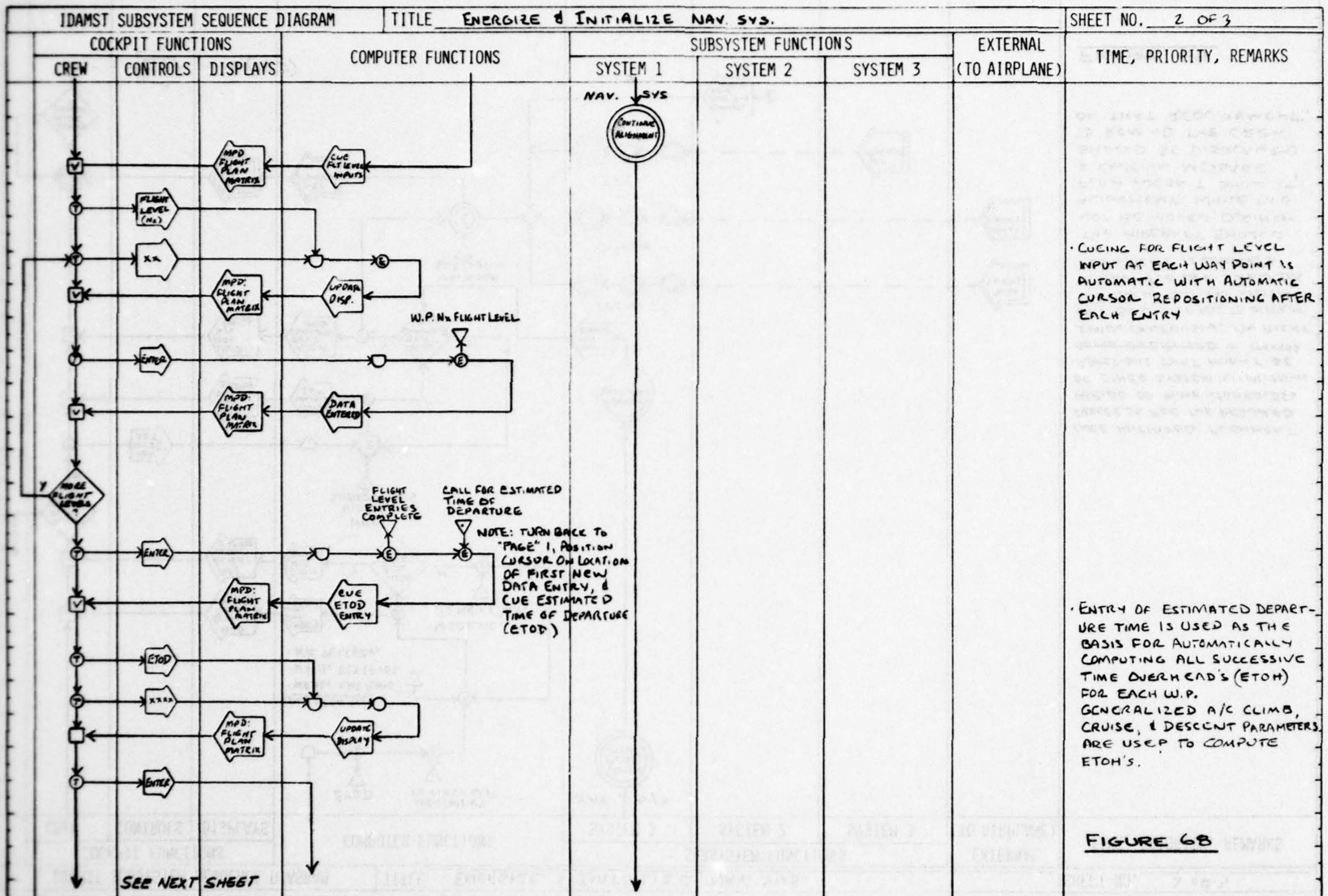


FIGURE 68: Energize & Initialize Nav. Sys.

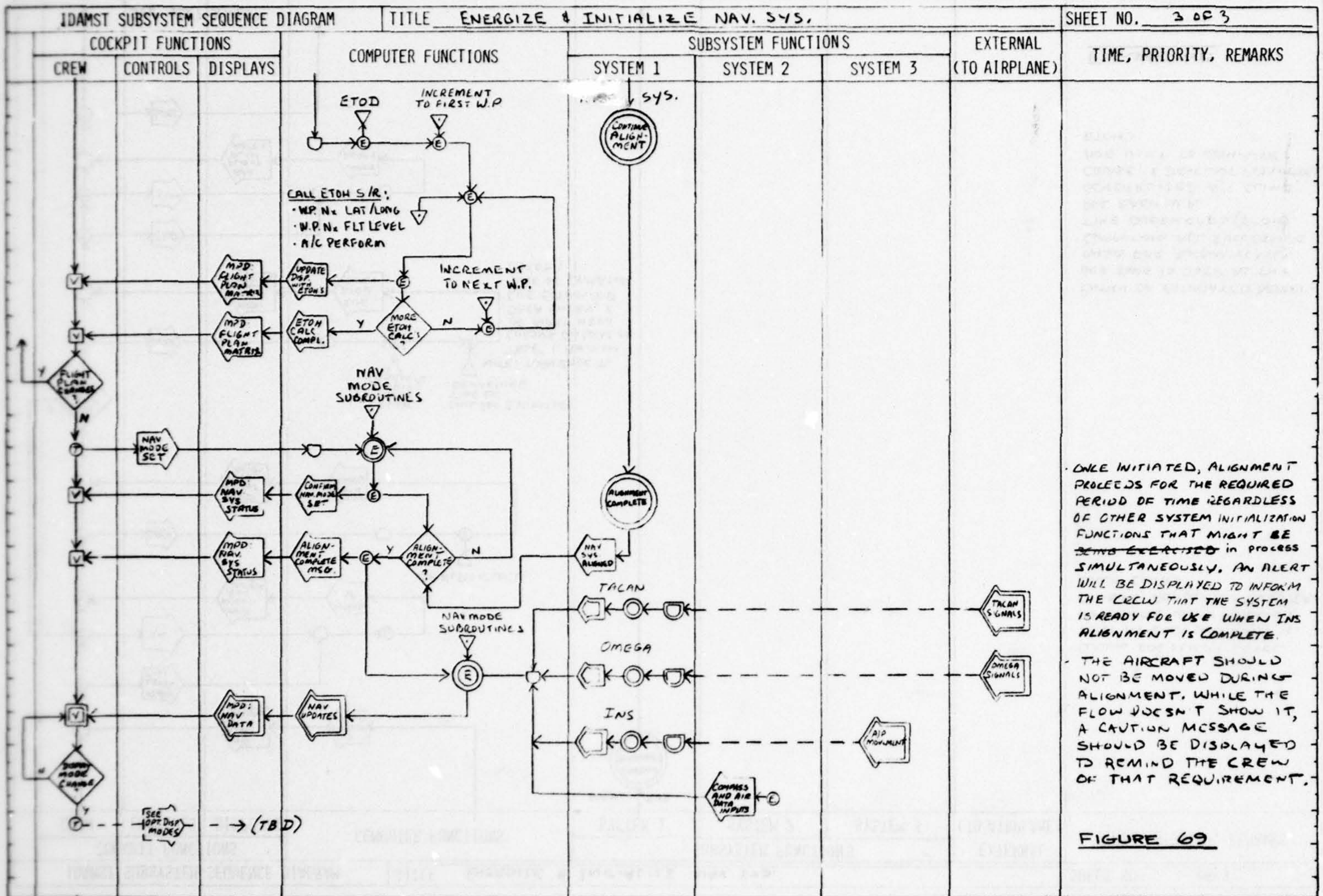


FIGURE 69: Energize & Initialize Nav. Sys.

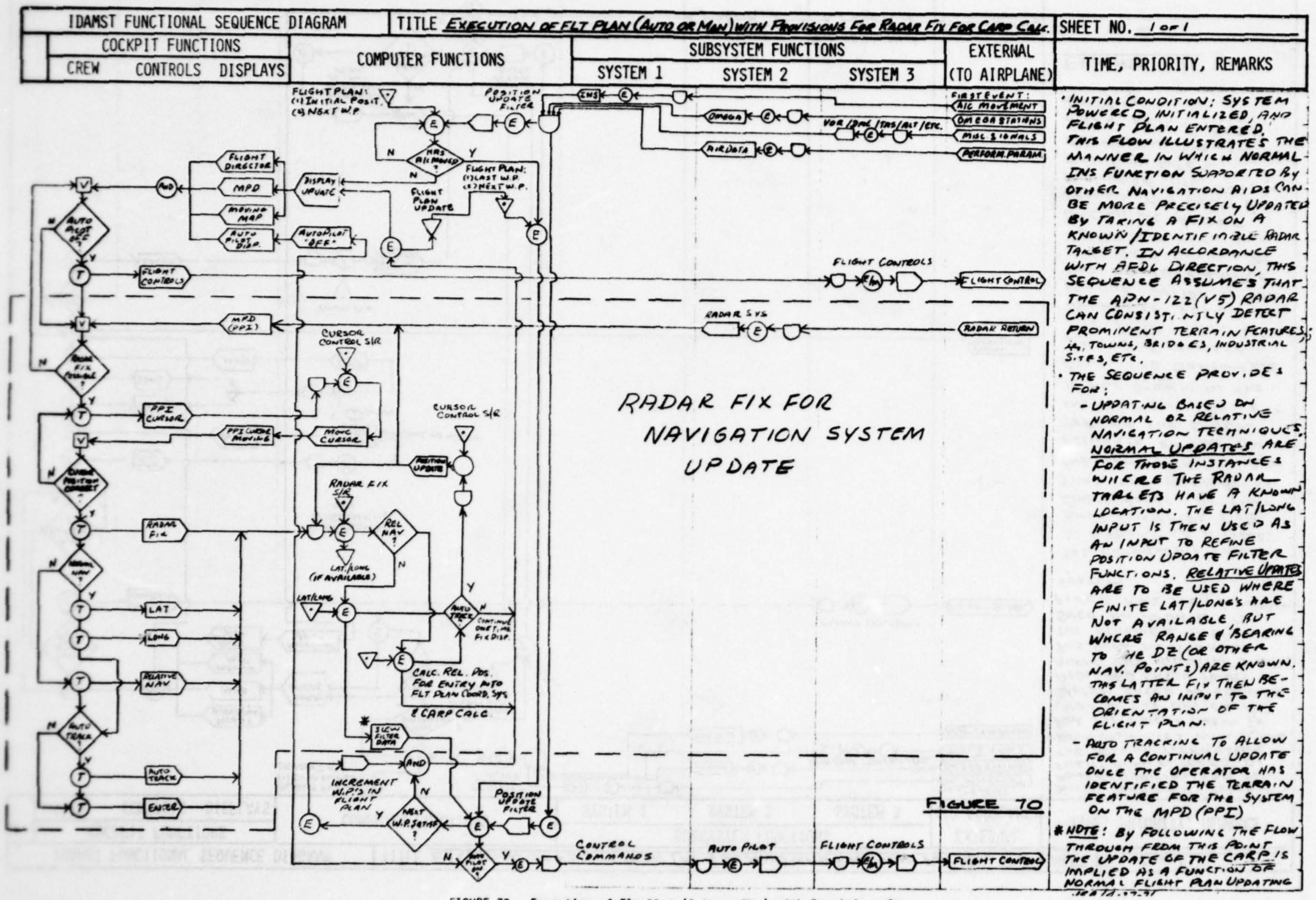


FIGURE 70: Execution of Flt. Plan (Auto or Man) with Provisions for Radar Fix for CARP Calc.

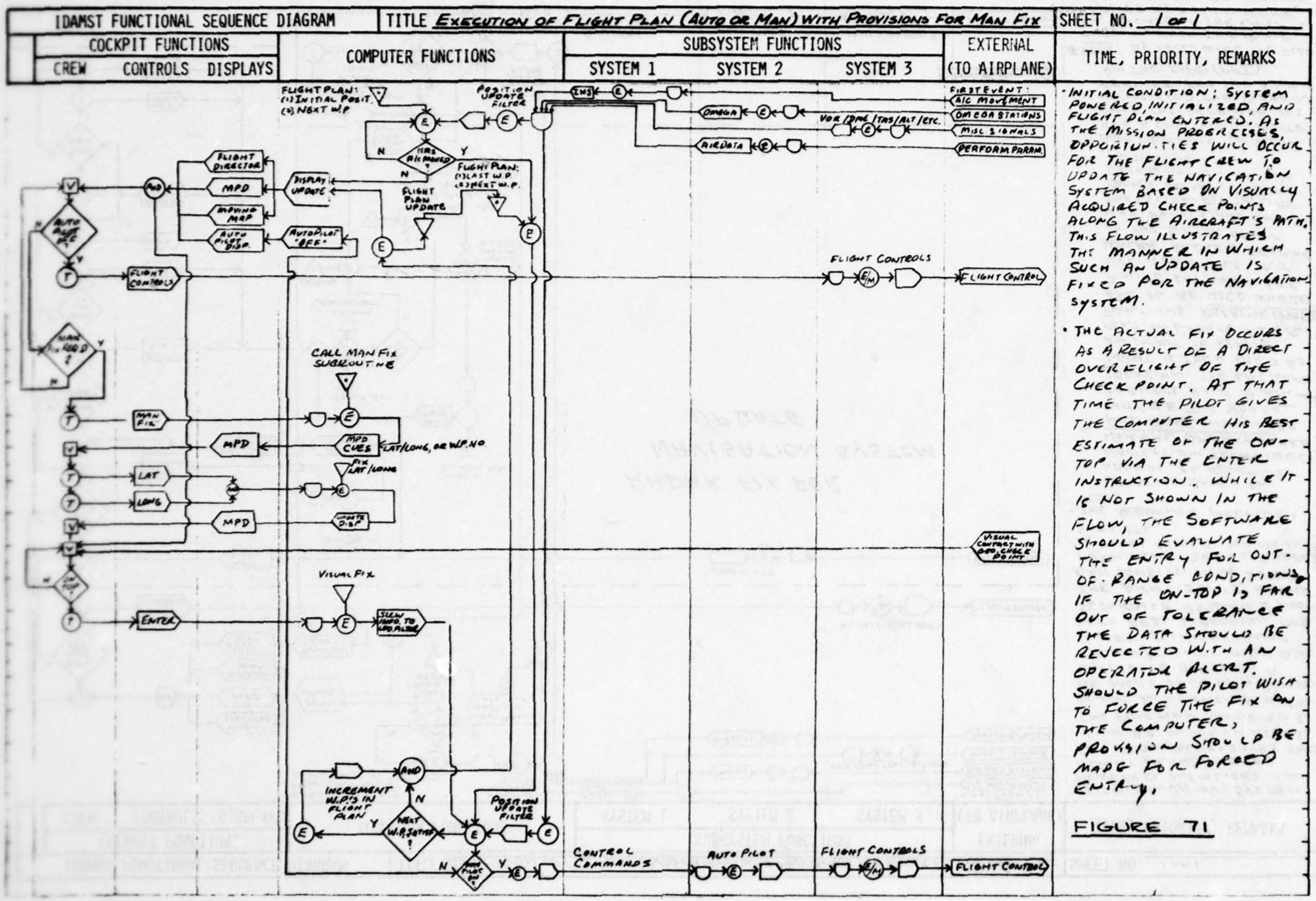


FIGURE 71: Execution of Flight Plan (Auto or Man) with Provisions for Man Fix

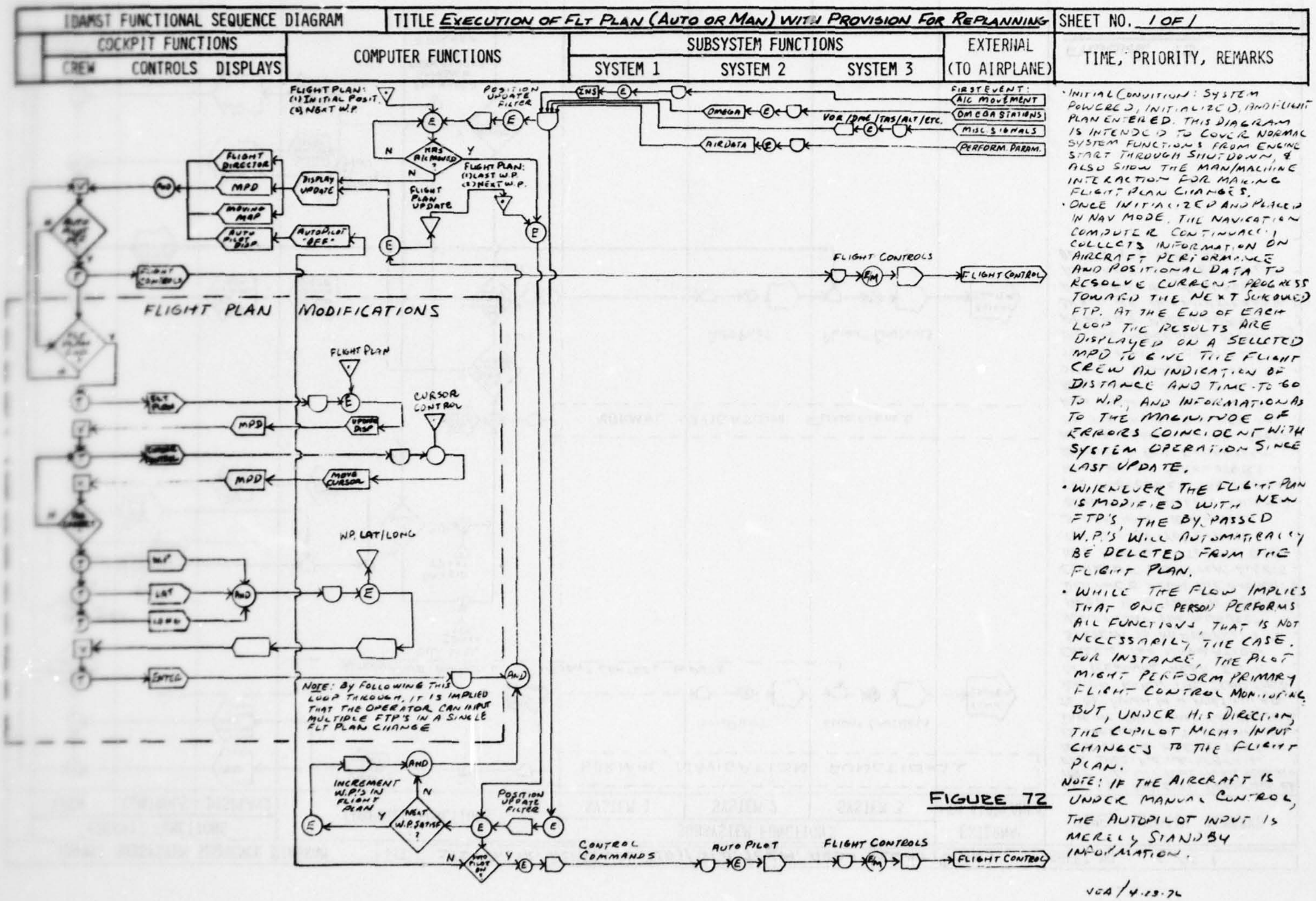


FIGURE 72: Execution of Flt. Plan (Auto or Man) with Provision for Replanning

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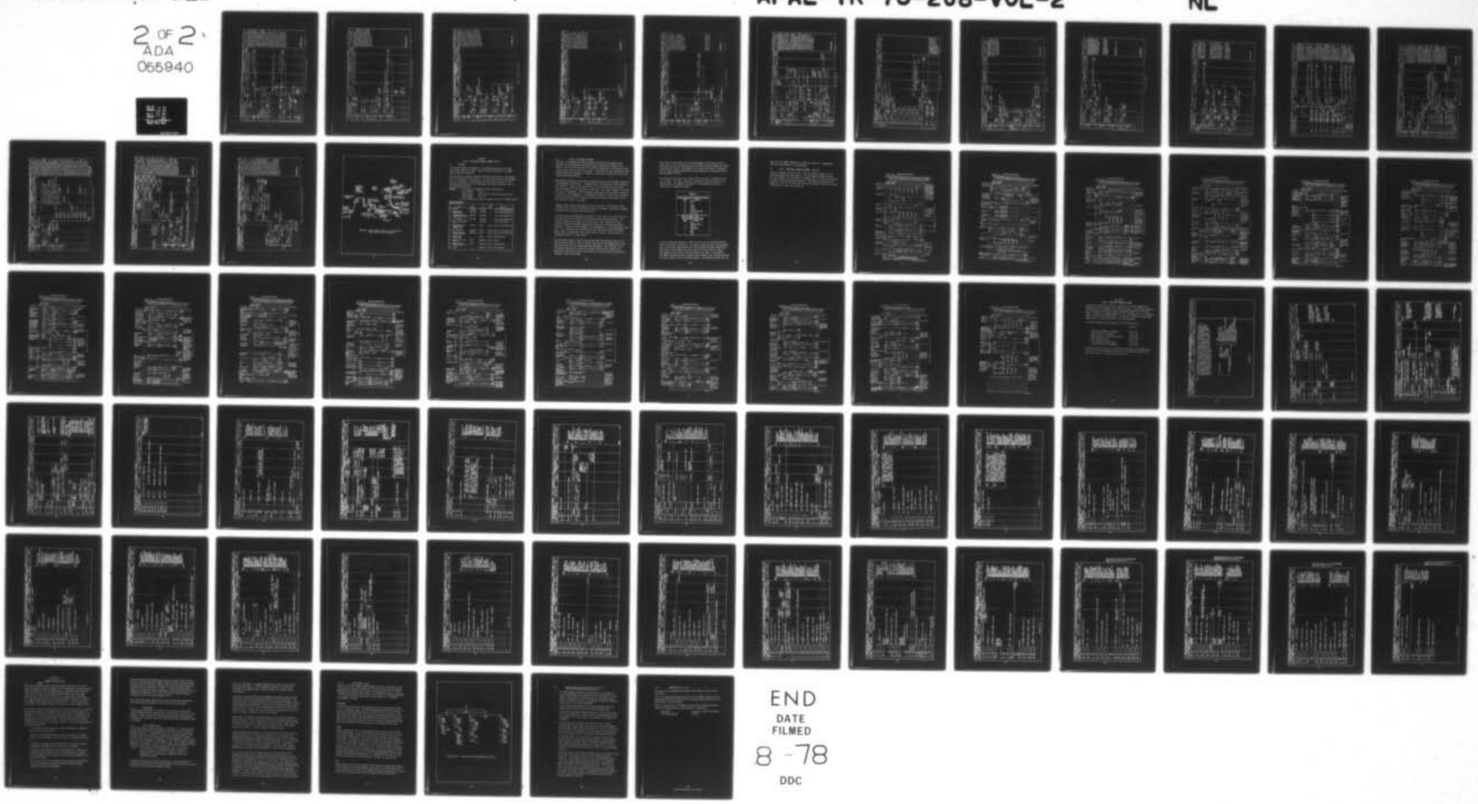

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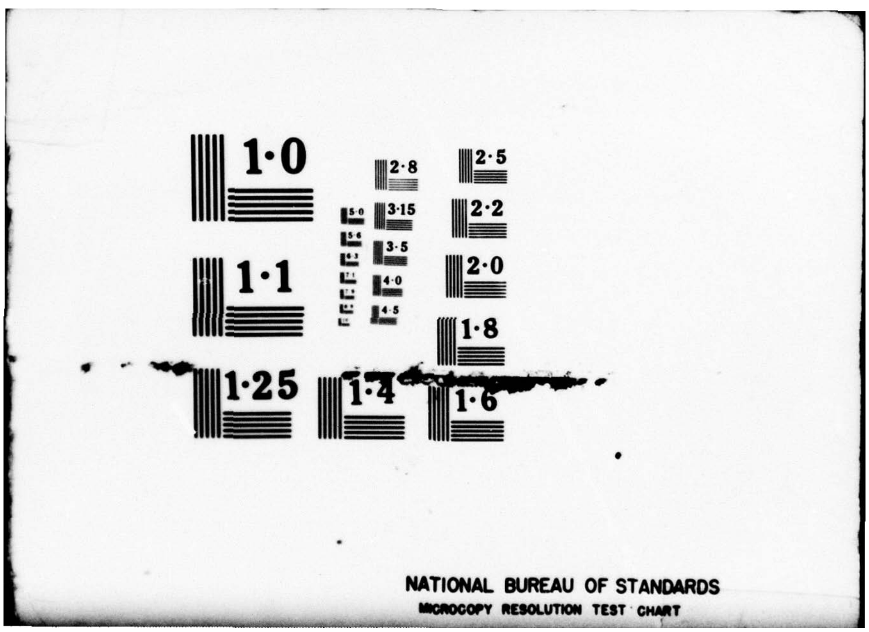
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NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

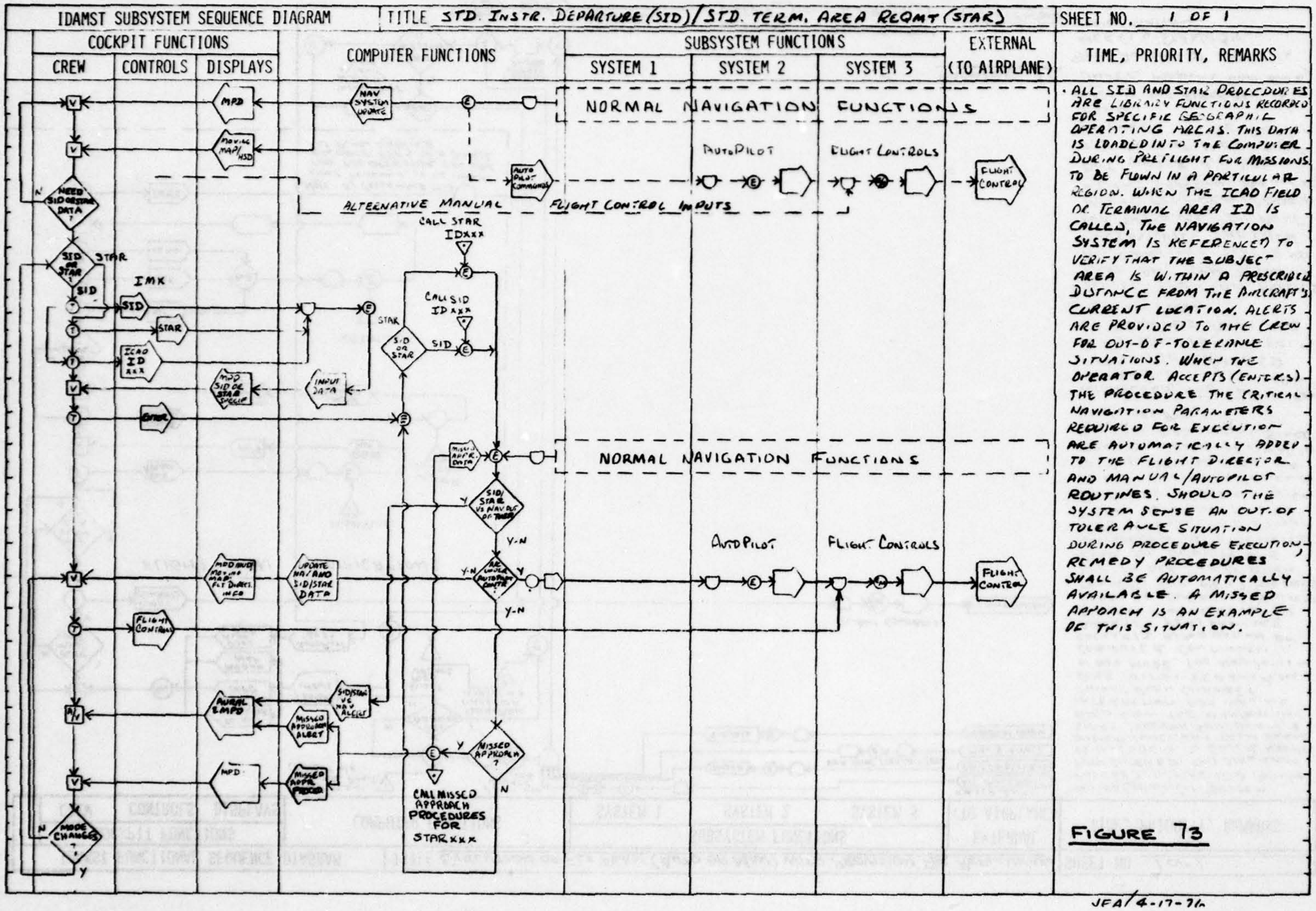


FIGURE 73: Std. Instr. Departure (SID)/Std. Term. Area Reqmt (STAR)

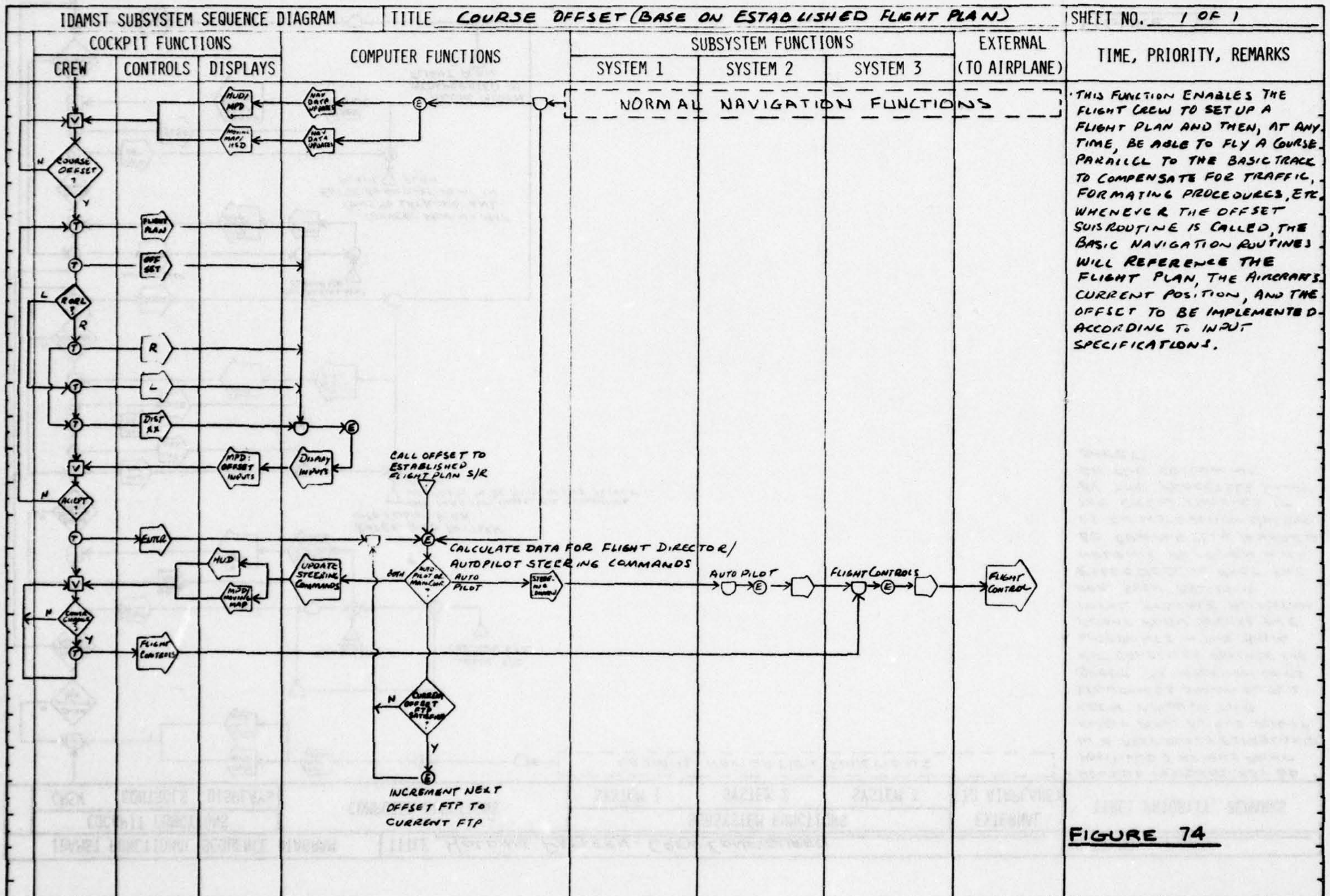


FIGURE 74: Course Offset (Base on Established Flight Plan)

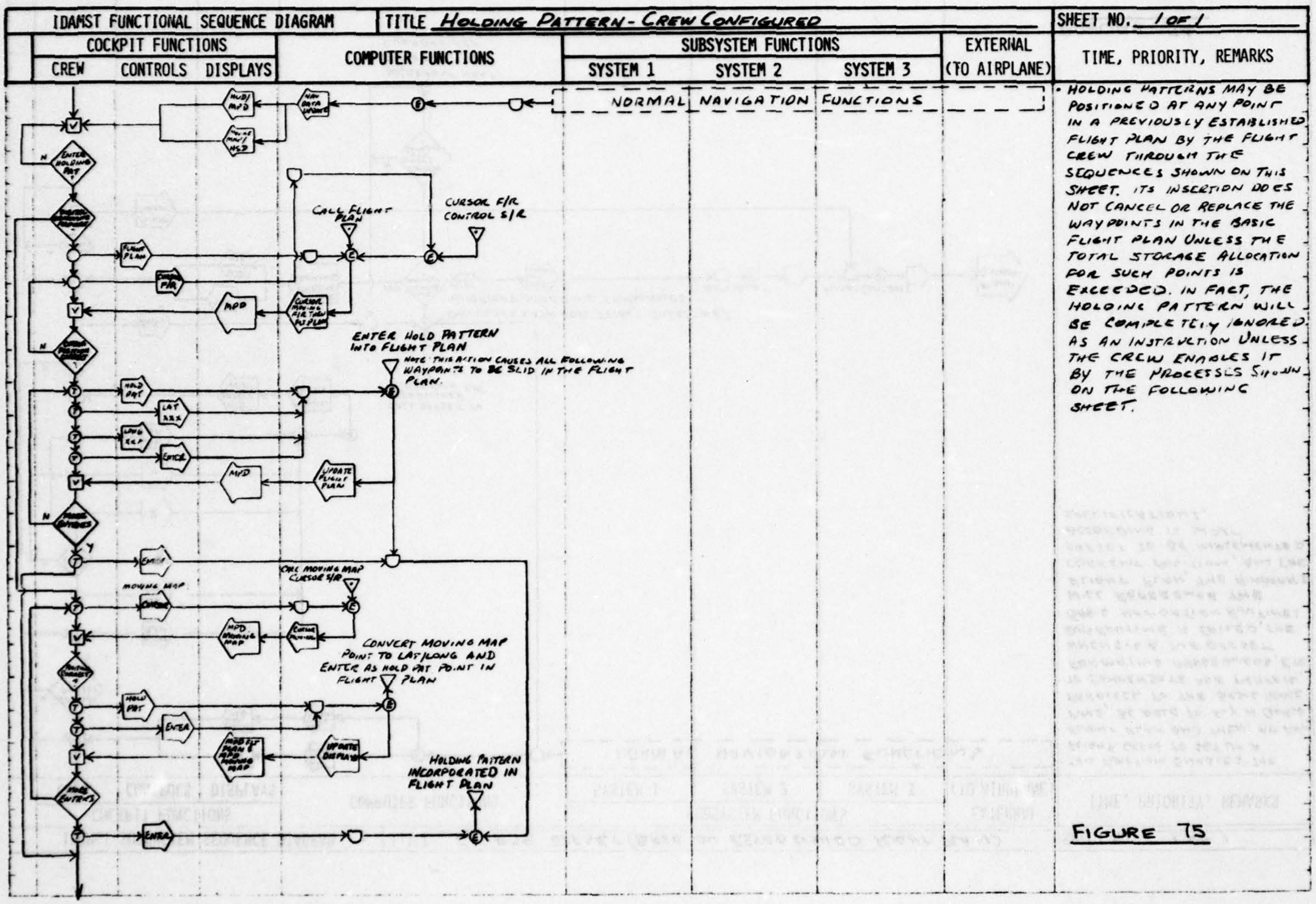


FIGURE 75: Holding Pattern - Crew Configured

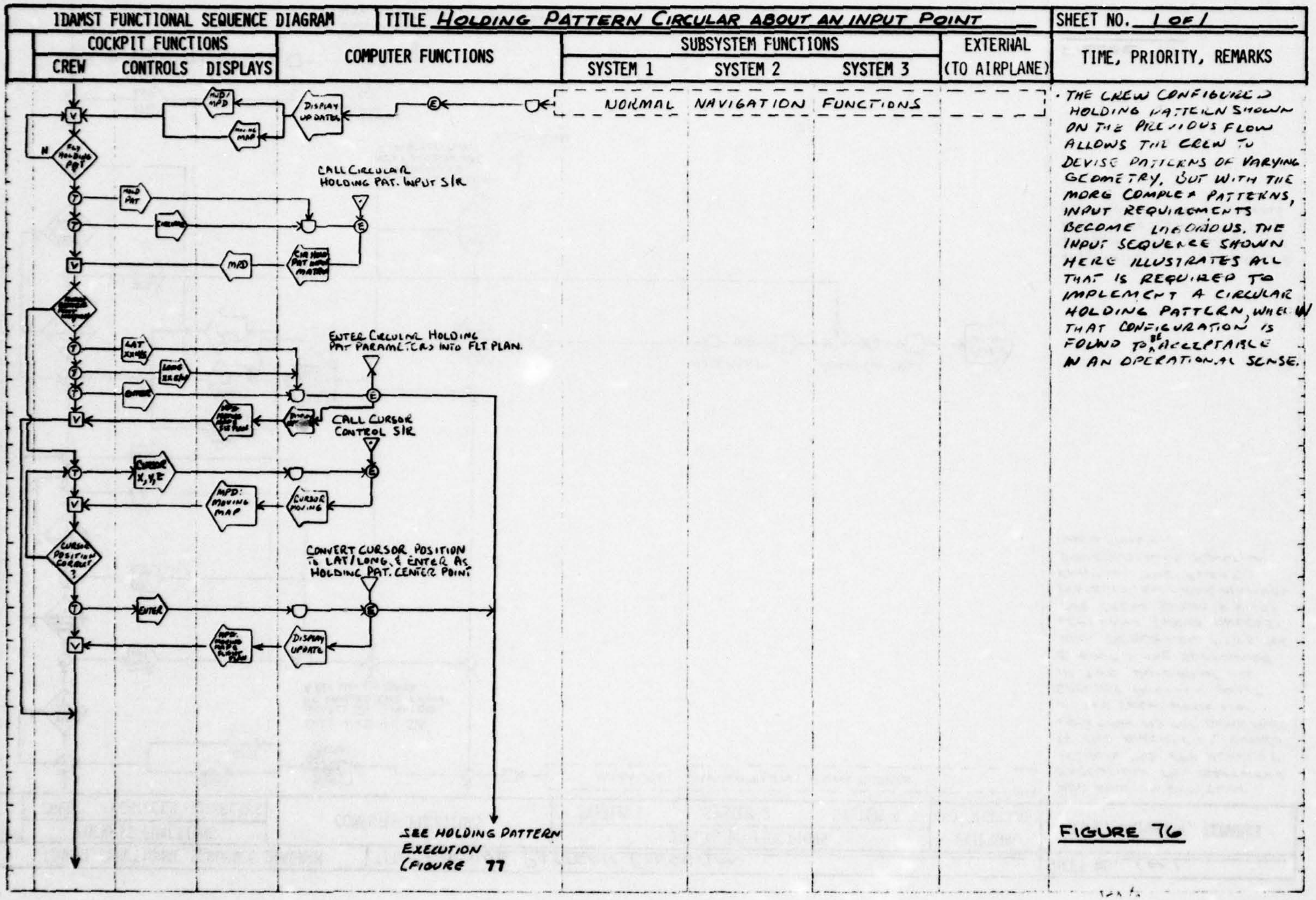


FIGURE 76: Holding Pattern Circular About an Input Point

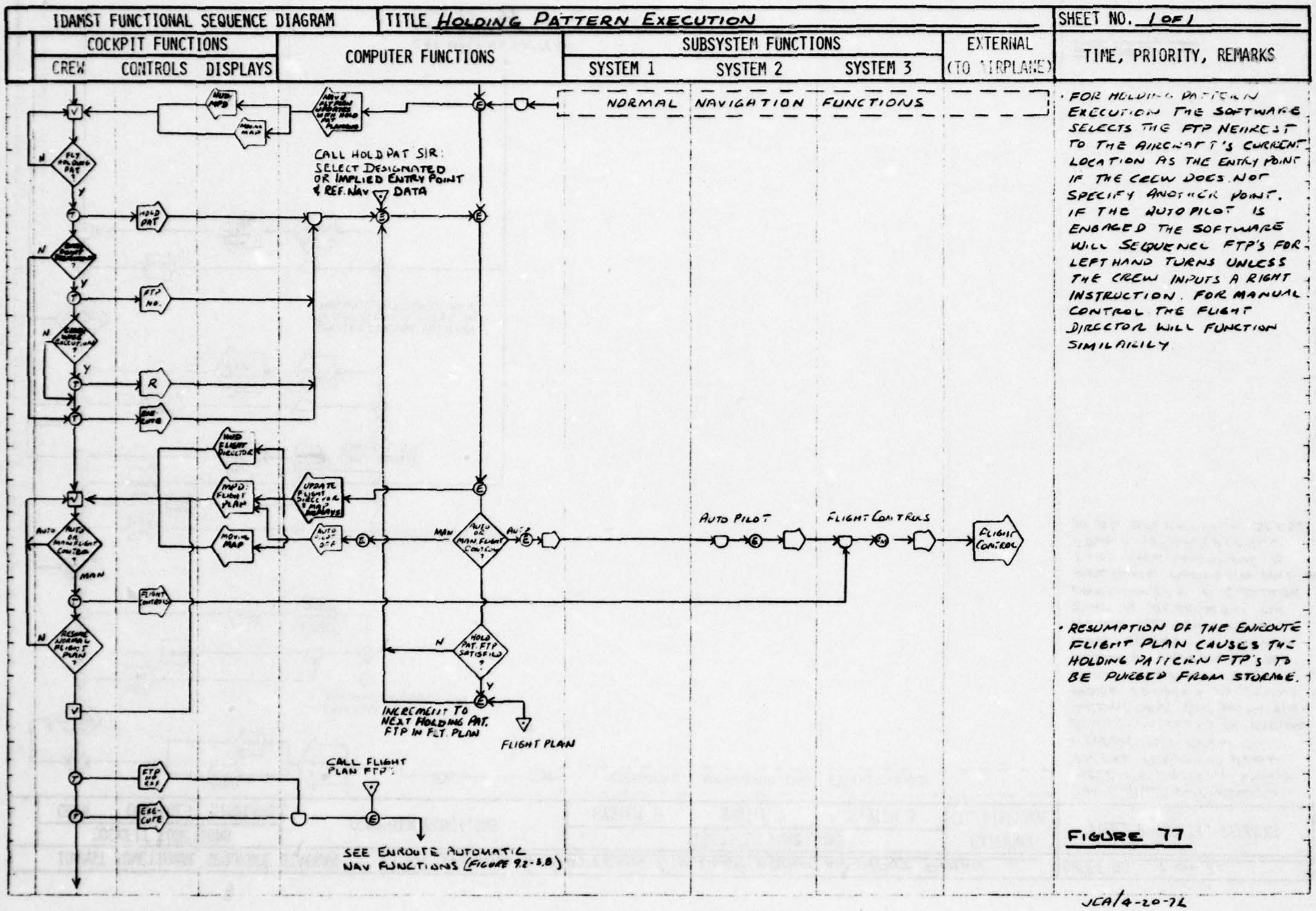


FIGURE 77: Holding Pattern Execution

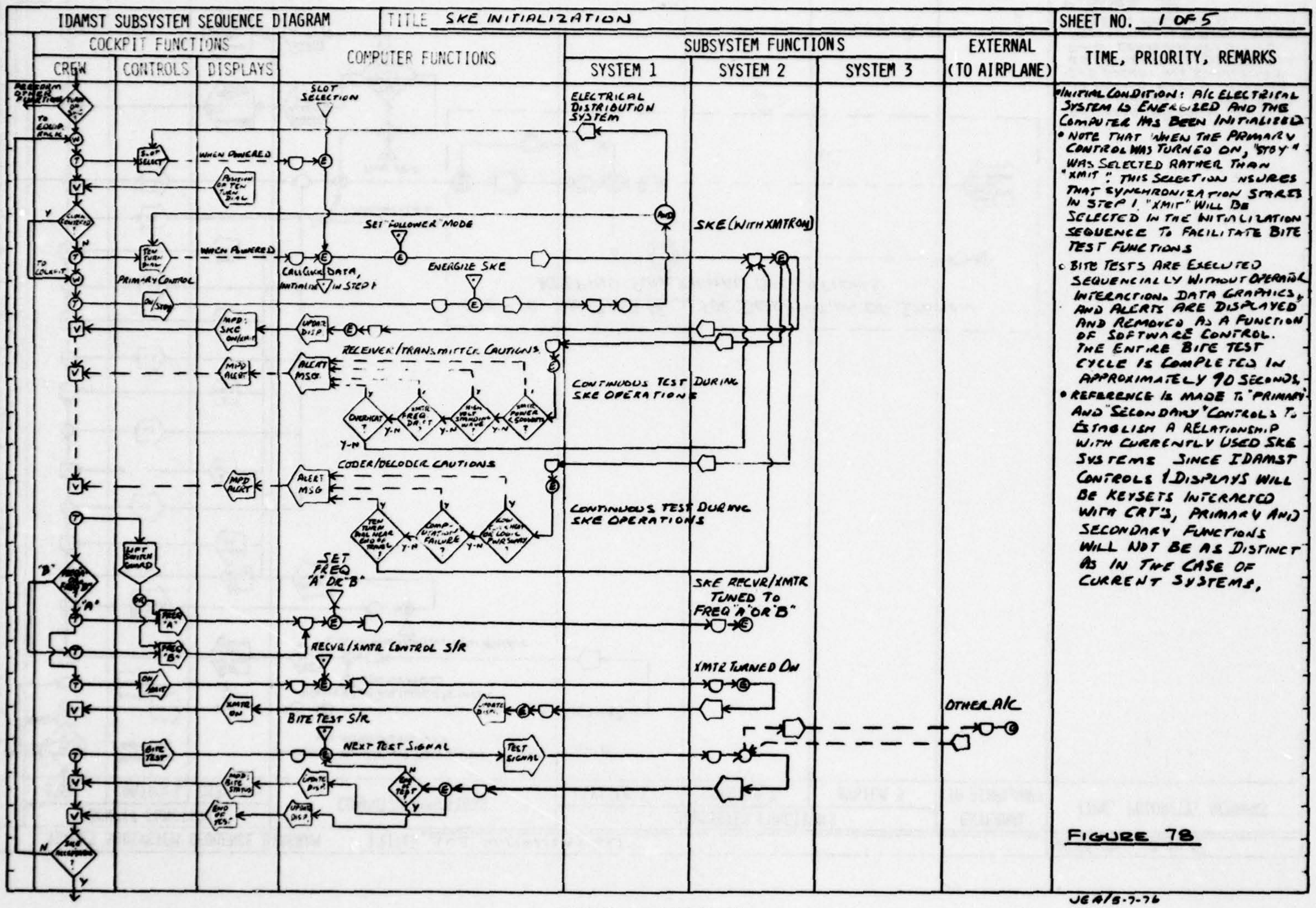


FIGURE 78: SKE Initialization

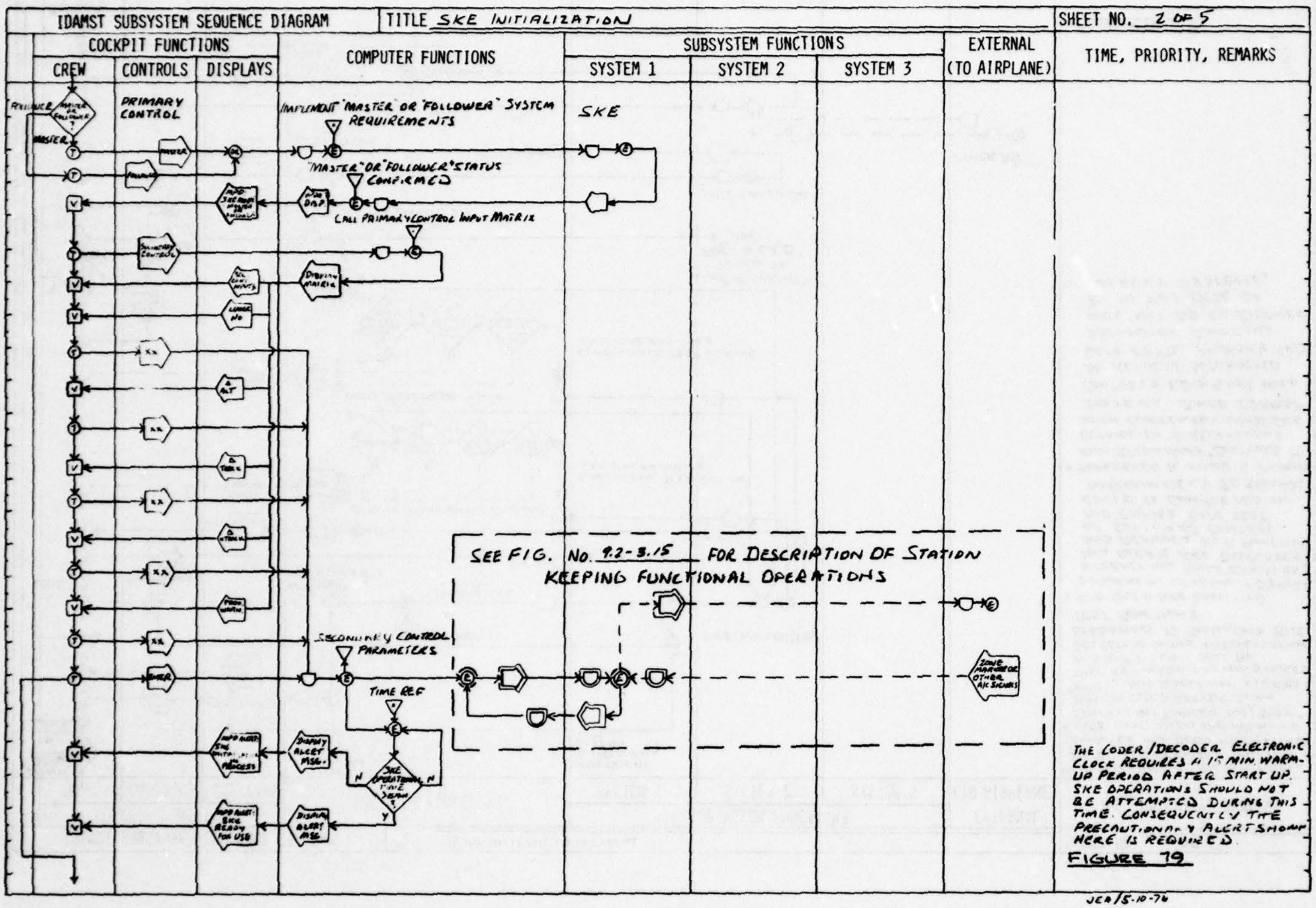


FIGURE 79: SKE Initialization

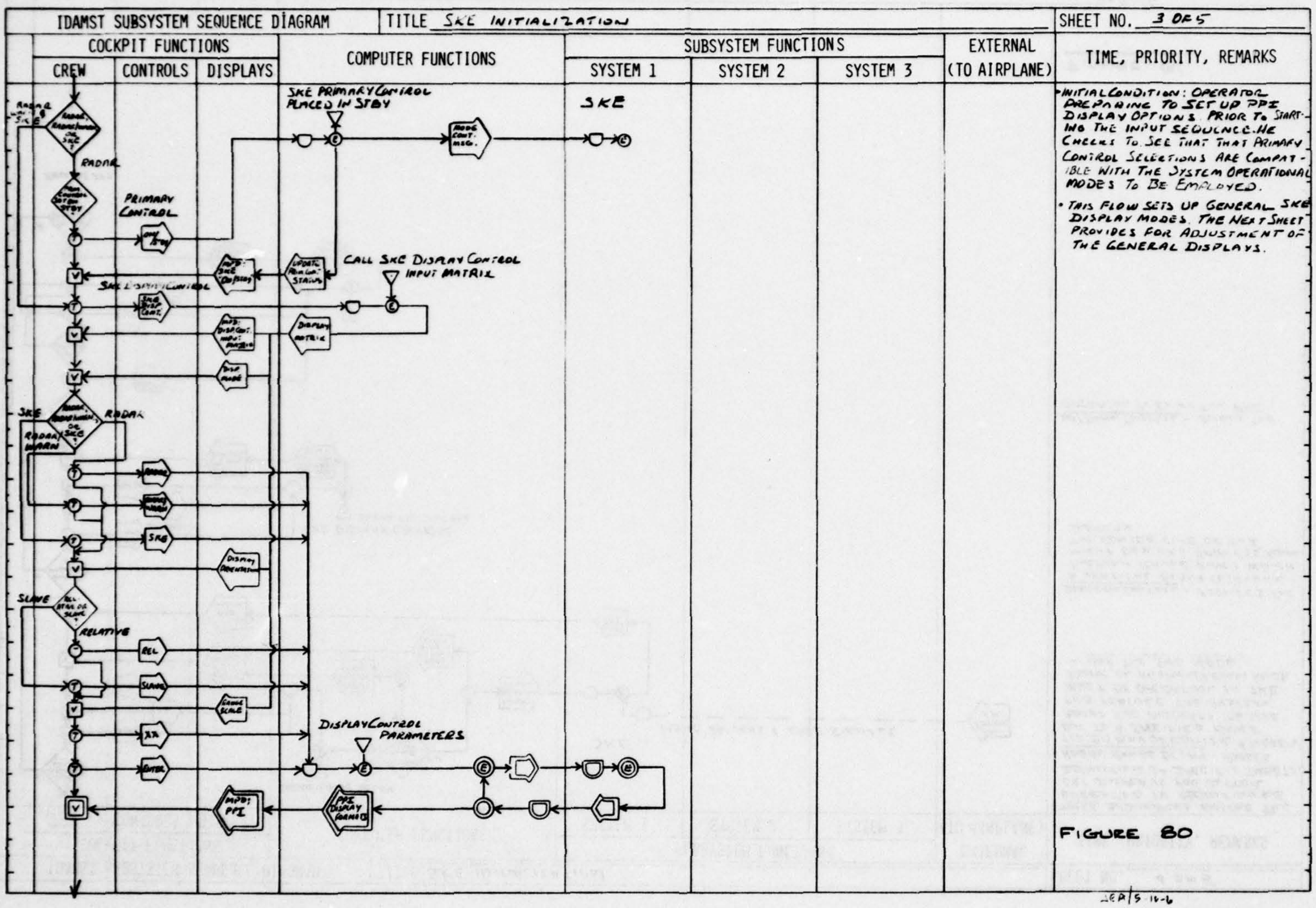


FIGURE 80: SKE Initialization

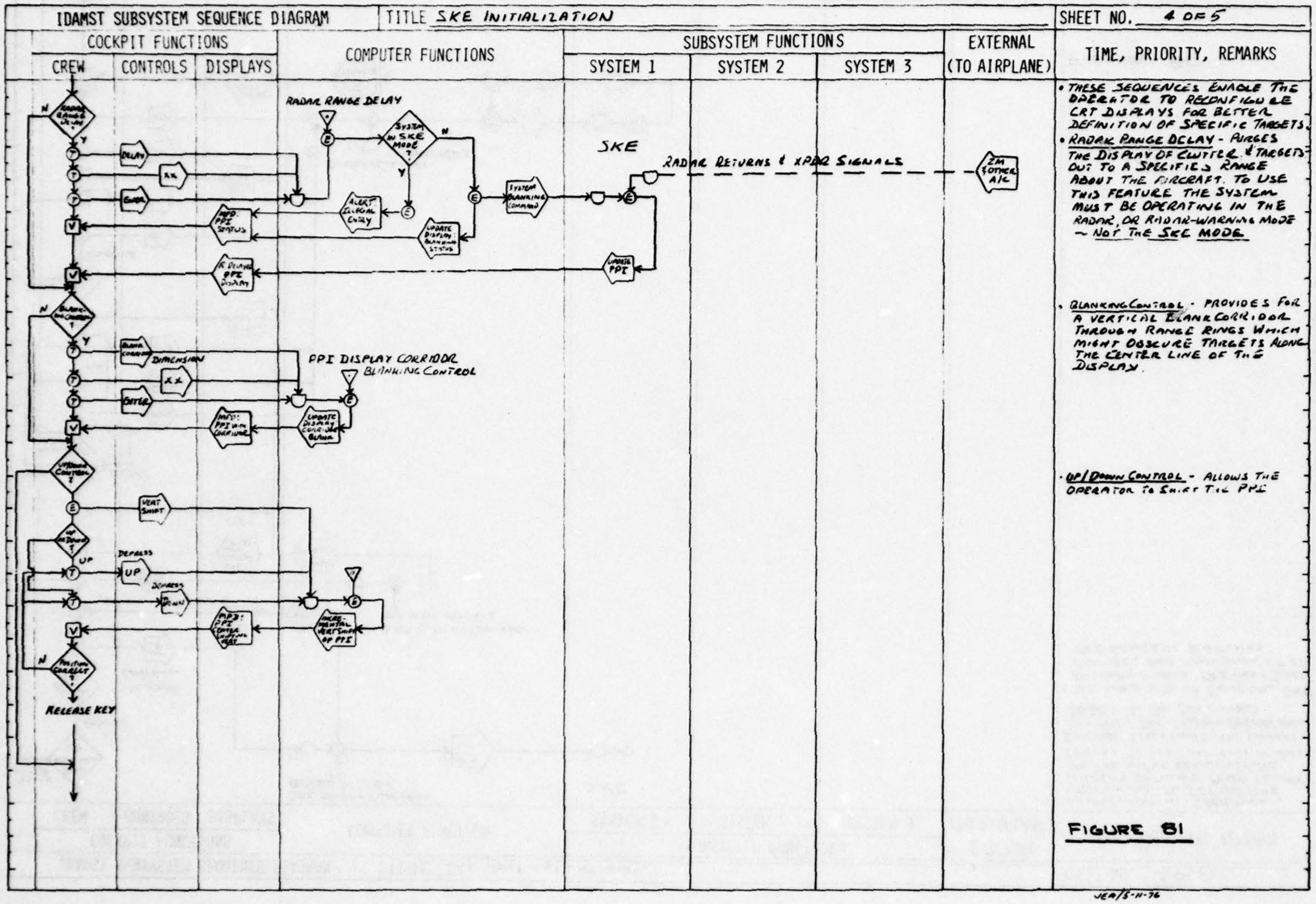


FIGURE 81: SKE Initialization

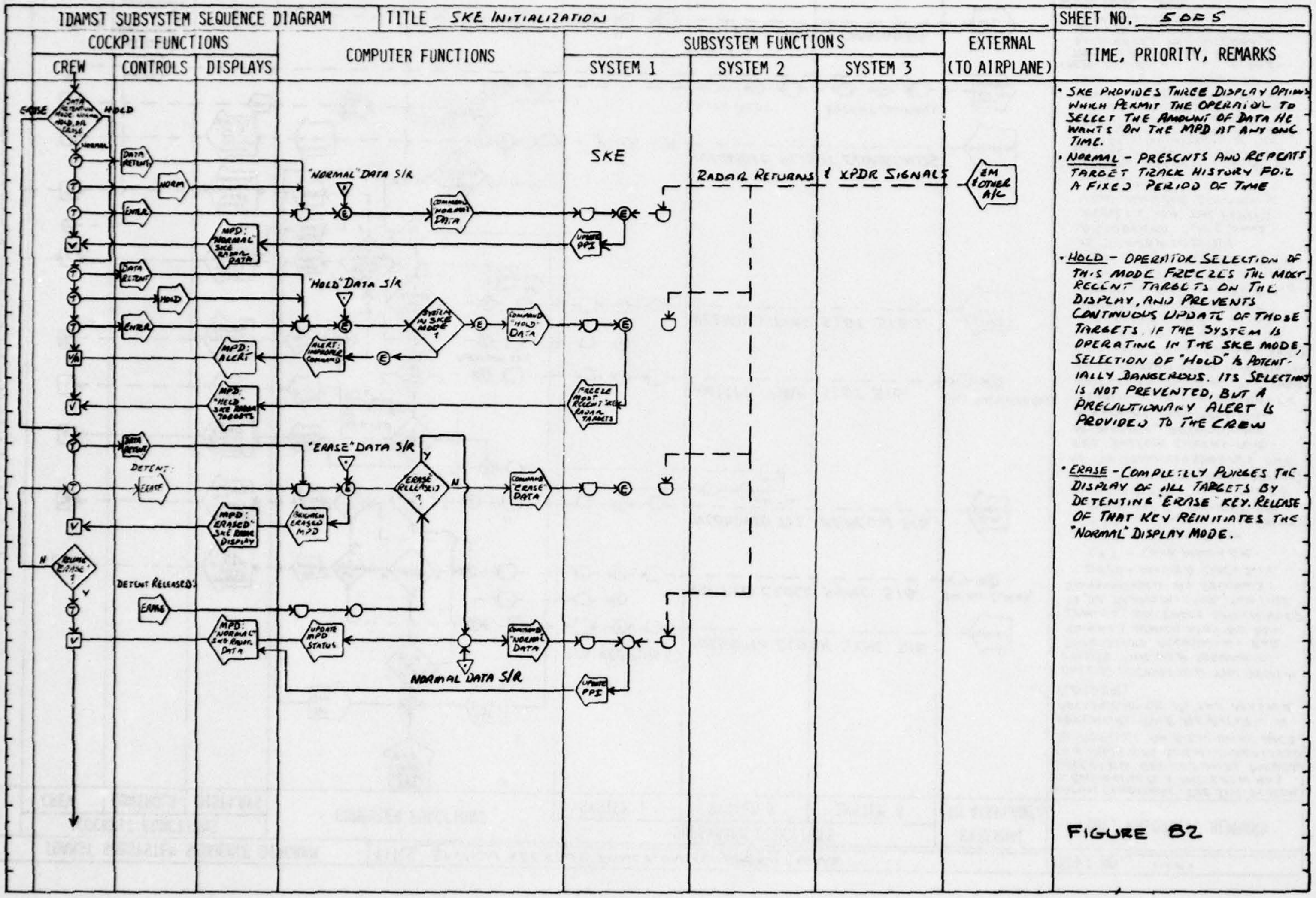


FIGURE 82: SKE Initialization

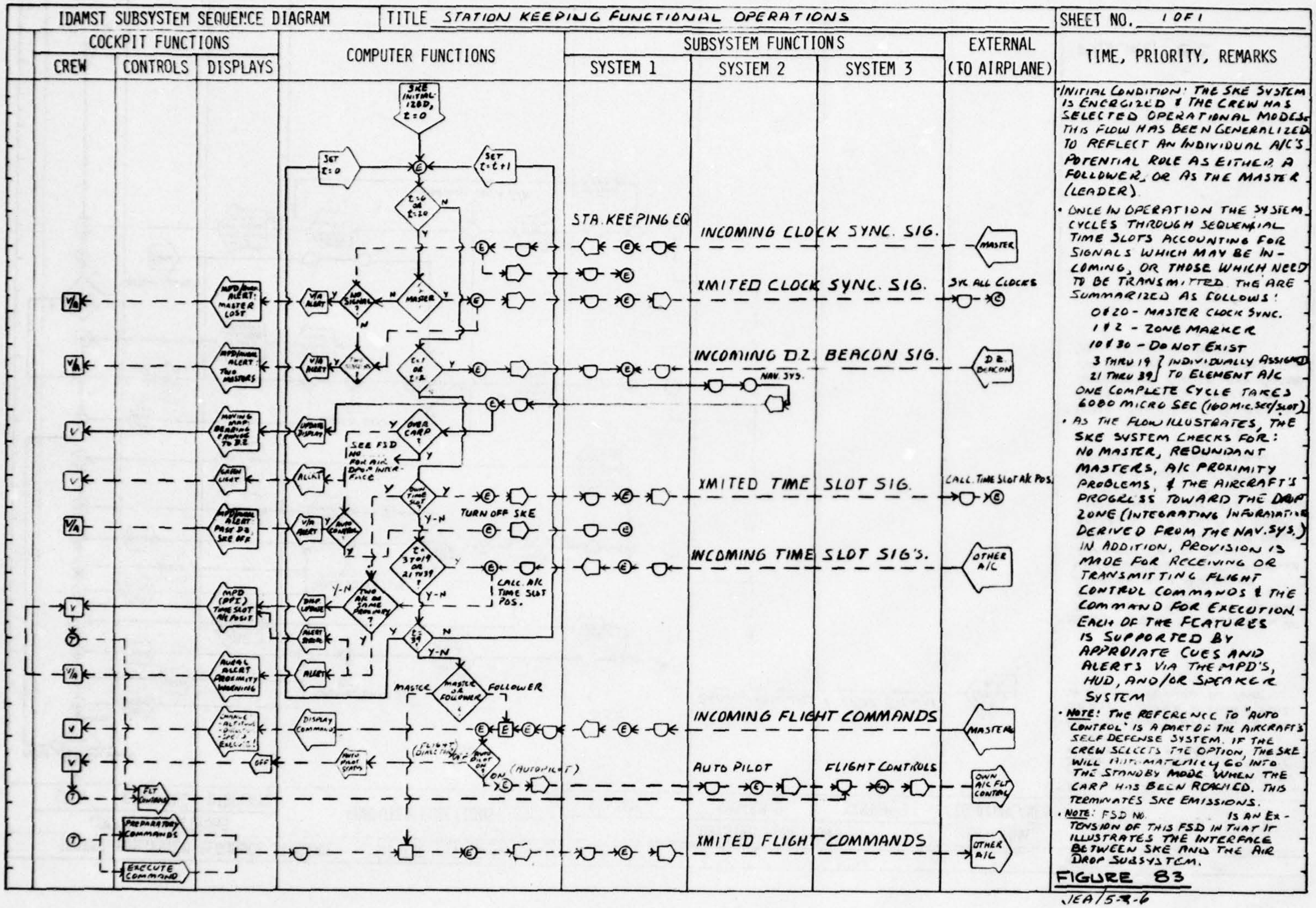


FIGURE 83: Station Keeping Functional Operations

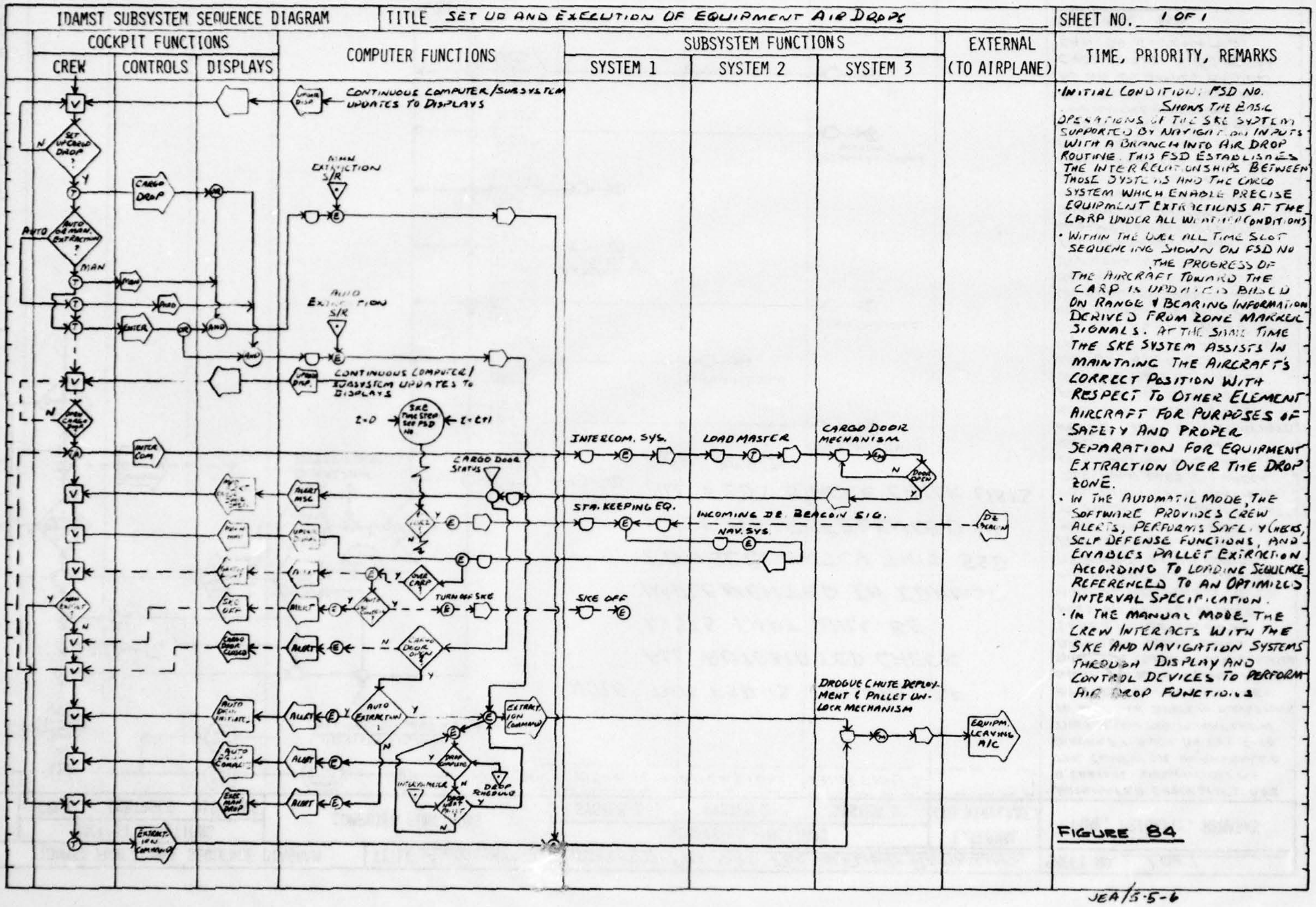


FIGURE 84: Set Up and Execution of Equipment Air Drops

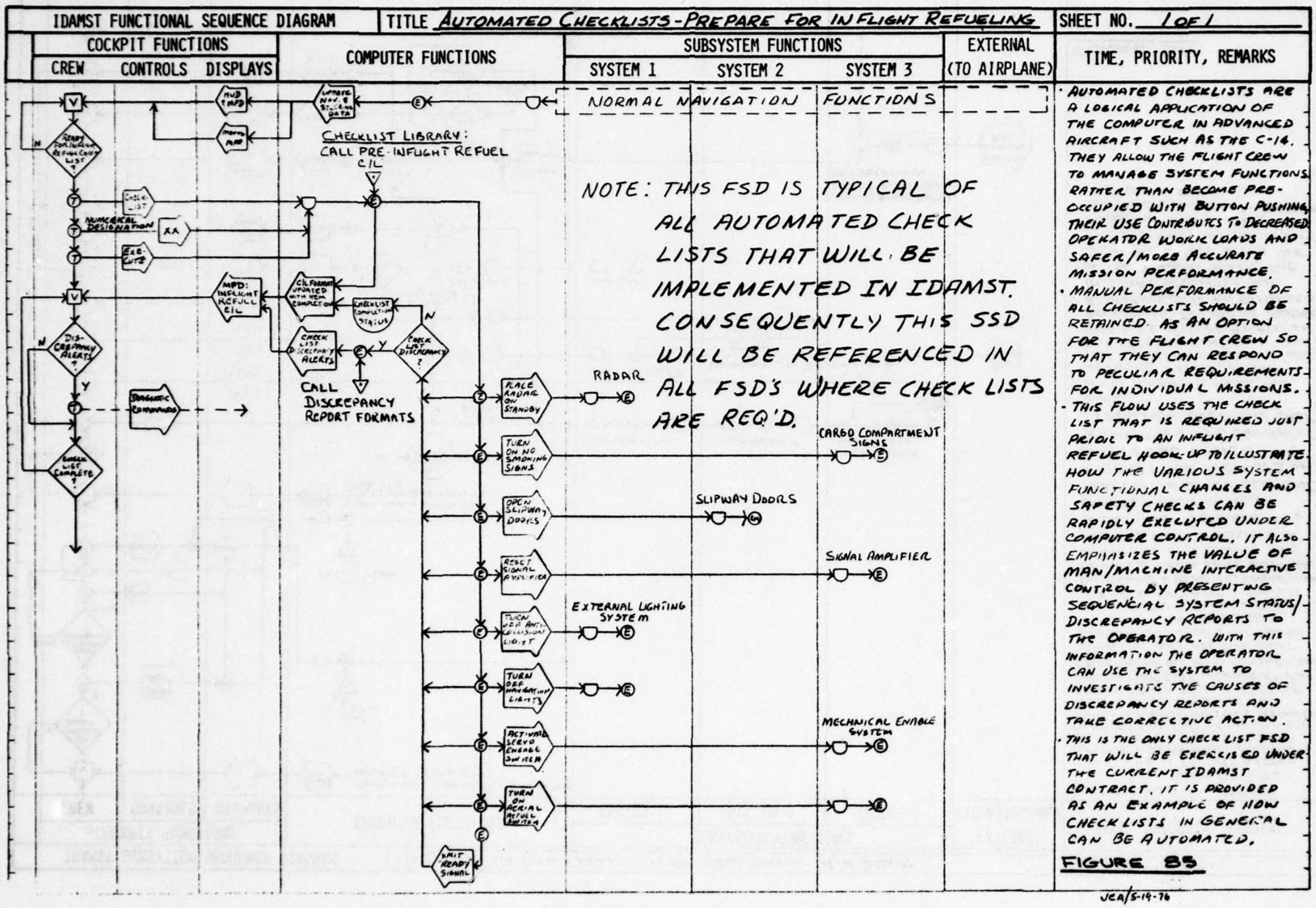


FIGURE 85: Automated Checklists - Prepare for Inflight Refueling

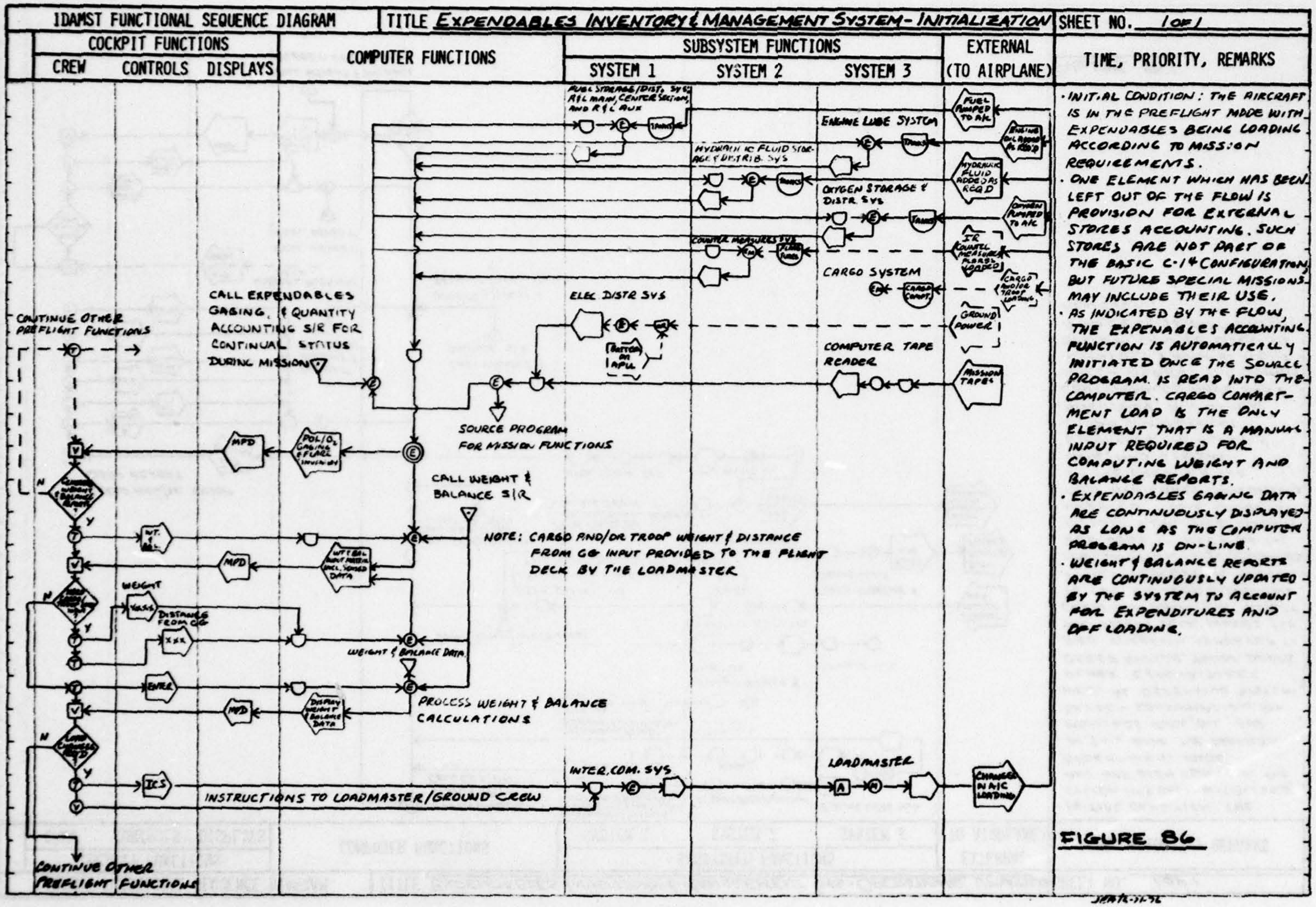


FIGURE 86: Expendables Inventory & Management System - Initialization

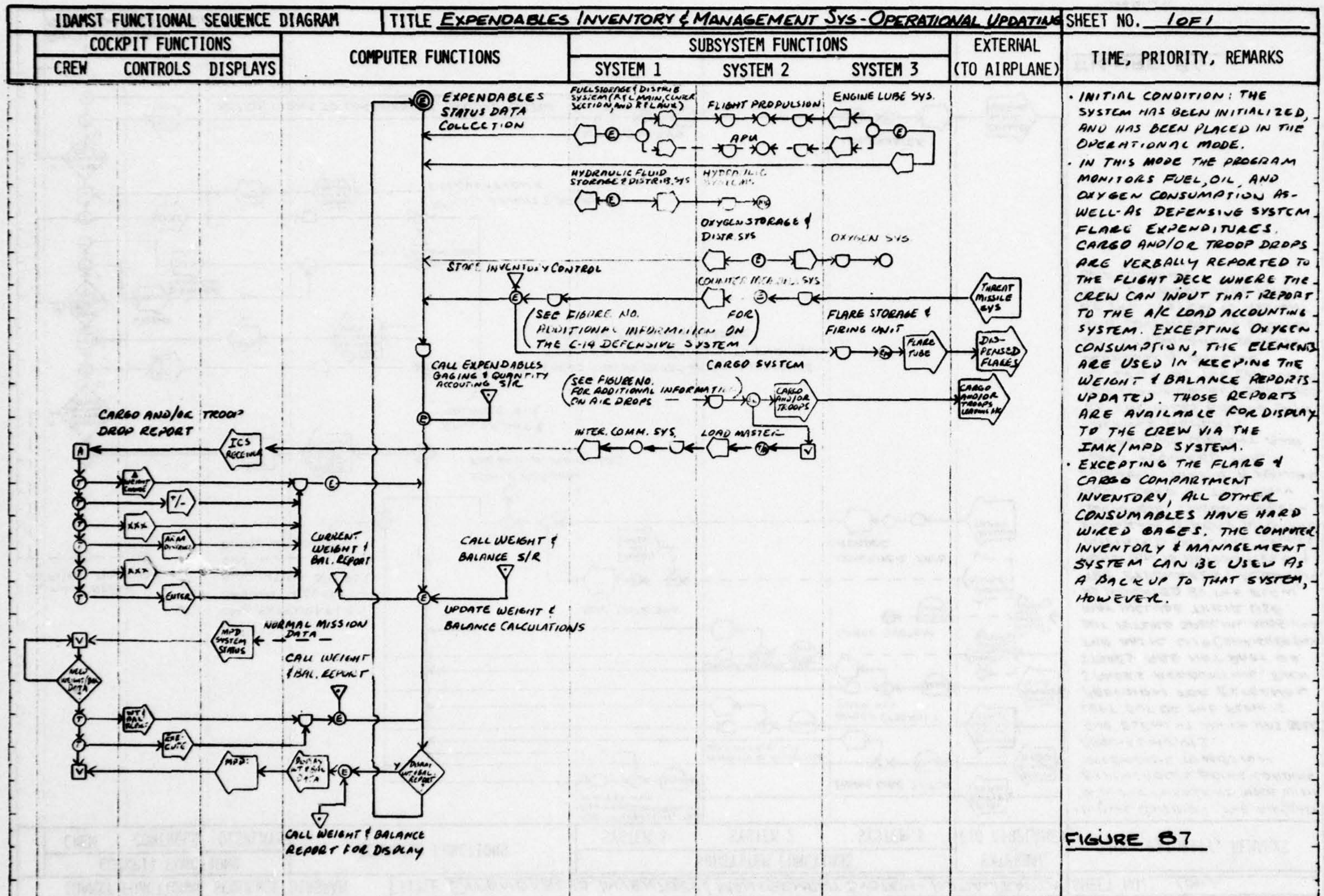


FIGURE 87: Expendables Inventory & Management Sys - Operational Updating

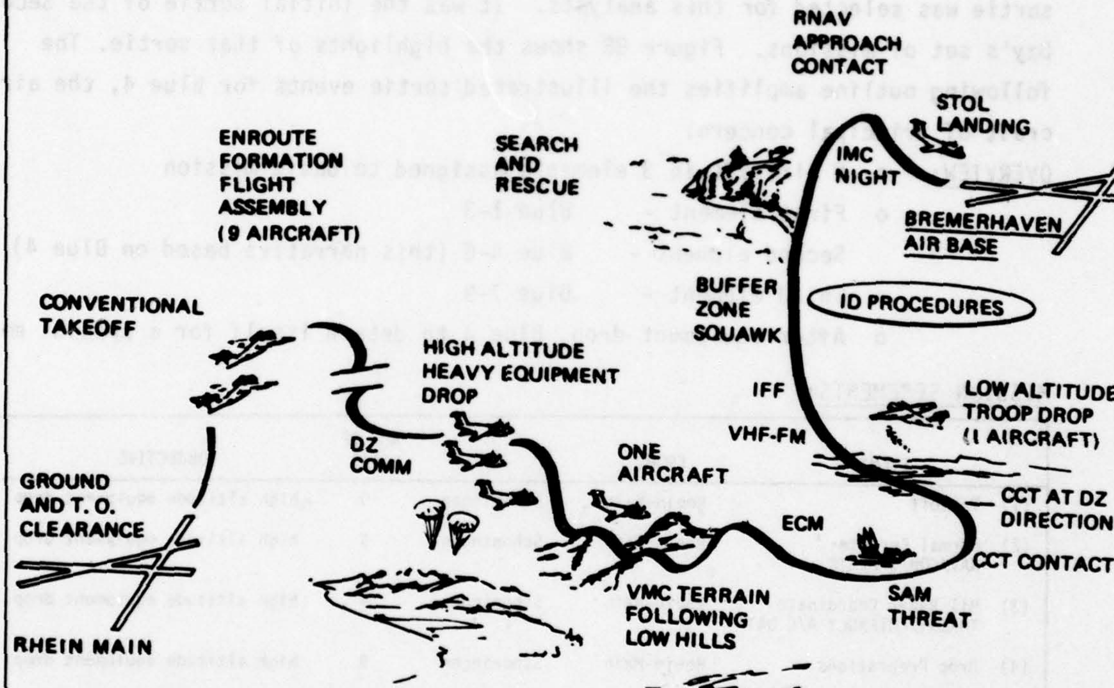


FIGURE 88: Mission Events Covered by Level One FSD's
(First Sortie of the Second Day)

SECTION V

LEVEL 1 FUNCTIONAL SEQUENCE DIAGRAMS (FSD'S)

5.1 OVERVIEW

The Technical Approach, Paragraph 2.1, introduced and defined Level 1 FSD's. This section contains the Level 1 FSD's which were developed for the IDAMST study, Figures 89 through 104.

From the Sorties included in the AFAL three day mission scenario, one complete sortie was selected for this analysis. It was the initial sortie of the Second Day's set of missions. Figure 88 shows the highlights of that sortie. The following outline amplifies the illustrated sortie events for Blue 4, the aircraft of principal concern:

<u>OVERVIEW:</u>
- o 9 aircraft in 3 elements assigned to basic mission
- o First element - Blue 1-3
  Second element - Blue 4-6 (this narrative based on Blue 4)
  Third element - Blue 7-9
- o After equipment drop, Blue 4 to detach itself for a special mission.

<u>MISSION SEGEMENTS:</u>

	EVENT	FROM	TO	NO. OF A/C	OBJECTIVE
(1)	Takeoff	Rhein-Main	Schoningen	9	high altitude equipment drop
(2)	Normal Enroute NAV/COM/IFF/ATC	Rhein-Main	Schoningen	9	high altitude equipment drop
(3)	Mil Radar Coordinate THREAT/FRIENDLY A/C DATA	Rhein-Main	Schoningen	9	high altitude equipment drop
(4)	Drop Prepratioms	Rhein-Main	Schoningen	9	high altitude equipment drop
(5)	High Altitude Equipment Drop	--	Schoningen	9	ground force re-supply
(6)	Low Altitude (1500') Penetration of E. German Air Space	Schoningen	Klotze	1(Blue 4)	Special Forces personnel drop
(7)	Drop Preparations	Schoningen	Klotze	1(Blue 4)	Special Forces personnel drop
(8)	Request and Receive Airborne ECM Support	Schoningen	Klotze	1(Blue 4)	Special Forces personnel drop
(9)	Special Forces Personnel Drop	--	Klotze	1(Blue 4)	Covert operations
(10)	Enroute Transit, and Repeat (2)	Klotze	Bremerhaven	1(Blue 4)	Recovery
(11)	Search and Rescue Related to Downed F16	Klotze	Bremerhaven	1(Blue 4)	Search and Rescue
(12)	Landing	--	Bremerhaven	1(Blue 4)	Sortie completion

5.2 LEVEL 1 FSD FORMAT ELEMENTS

The level 1 FSD formats have been configured to show to the largest extent possible, the simultaneous crew/system functions occurring in scenario time blocks. Provision has been made to illustrate interactions of the two-man flight crew with the various aircraft subsystems. As appropriate, the flow defines which system commands are hardwired as opposed to those whose interface is facilitated through the software medium.

The dedicated headings on the format allow the analyst to call the most frequently used subsystems, specifically - "Communications", "Navigation", "Flight Controls", and "Sensors". Notes on each application give the specification as to which type of equipment in the subsystem is being used. The "other" heading is included to allow for references to less frequently used systems and functions in addition to actions of the loadmaster. For reference to events or signals which influence Blue 4's mission activities, and which have their origins outside the aircraft, the "External" column is included.

"Operator Notes" amplify the crew activities called for in the scenario, while "Software Notes" provide information pertaining to computer interface of hardware subsystems with the display and control suit.

For each scenario event depicted on the level 1 FSD, flow lines briefly outline the systems which are involved in accomplishing the required functions. The "Figure" numbers, which appear on the horizontal lines, reference the more detailed man/machine/software relationships defined by the Subsystem Sequence Diagrams. A number of Figure numbers are accompanied by a "To Be Determined (TBD)" note. This indicates that the FSD analysis has identified an SSD requirement which remains unsatisfied as this study comes to a close. That work must be completed as part of a future effort.

The time blocks shown in the left hand column index FSD events to those of the AFAL narrative scenario. Only a rigorous simulation of the IDAMST system could provide the basis for an accurate workload assessment. But reference to FSD time-blocks together with cooperative two-man crew functions linked to the magnitude of SSD processing gives the analyst an intuitive feel for man/machine loadings in each mission mode.

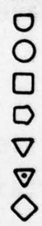
Definitions for the symbols used in FSD development are provided by Table 3. Since Level 1 FSD's are merely an outline of mission events intended to provide only superficial detail, some symbols are used more than others. Storage and recall of data along with the decision logic notation are infrequently used in the development of FSD's.

The direction of activity flow on both the FSD's and SSD's is generally from top to bottom. But where a repetitive man/machine interaction occurs (as in communications, for example), the device of illustrating the flow with a closed loop is frequently employed.

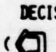
TABLE 3
FSD/SSD Symbology

THE FOLLOWING SYMBOLS ARE USED IN DEVELOPING FSD'S AND SSD'S:

SYMBOL — MEANING



- RECEIVE
- ACT
- MONITOR
- TRANSMIT
- STORE DATA
- RECALL DATA FROM STORAGE
- DECISION LOGIC

NOTE: A DOUBLE SYMBOL ( , FOR EXAMPLE) MEANS THAT THE FUNCTION IS CONTINUOUSLY PERFORMED

AMPLIFYING INFORMATION USED WITH SYMBOLS:

LEGEND	MEANING
A	AURAL
E	ELECTRONIC/ELECTRICAL
M	MECHANICAL
RF	RADIO FREQUENCY
S	SPEECH
T	TOUCH
V	VISUAL

It will be noted that the Level 1 FSD's do not call all of the SSD Functions which are included in Section IV. This occurs because the SSD's were generated with a narrow view toward defining aircraft multimode functional capabilities. While most of these capabilities were called for in the scenarios, not all were because the aircraft was never operated in that mode. As an example, the IDAMST navigation system is based on R-NAV concepts which include provisions for course offsets as well as holding patterns. The scenarios did not call for these, but the IDAMST software must provide the capability. Consequently, they were both addressed in SSD development.

5.3 LEVEL 1 FUNCTIONAL SEQUENCE DIAGRAMS - ANALYSIS

Figures 39 through 104 are the Level 1 FSD's for selected segments of the second day AMST mission (See Figure 3). The SSD reference numbers noted on the flow, together with the operator and software notes, constitute the analysis provided to software Engineering personnel. The remaining selected mission segments for the first and third days mission (see Figures 2 and 4) are provided in Section VI by Figures 105 through 135.

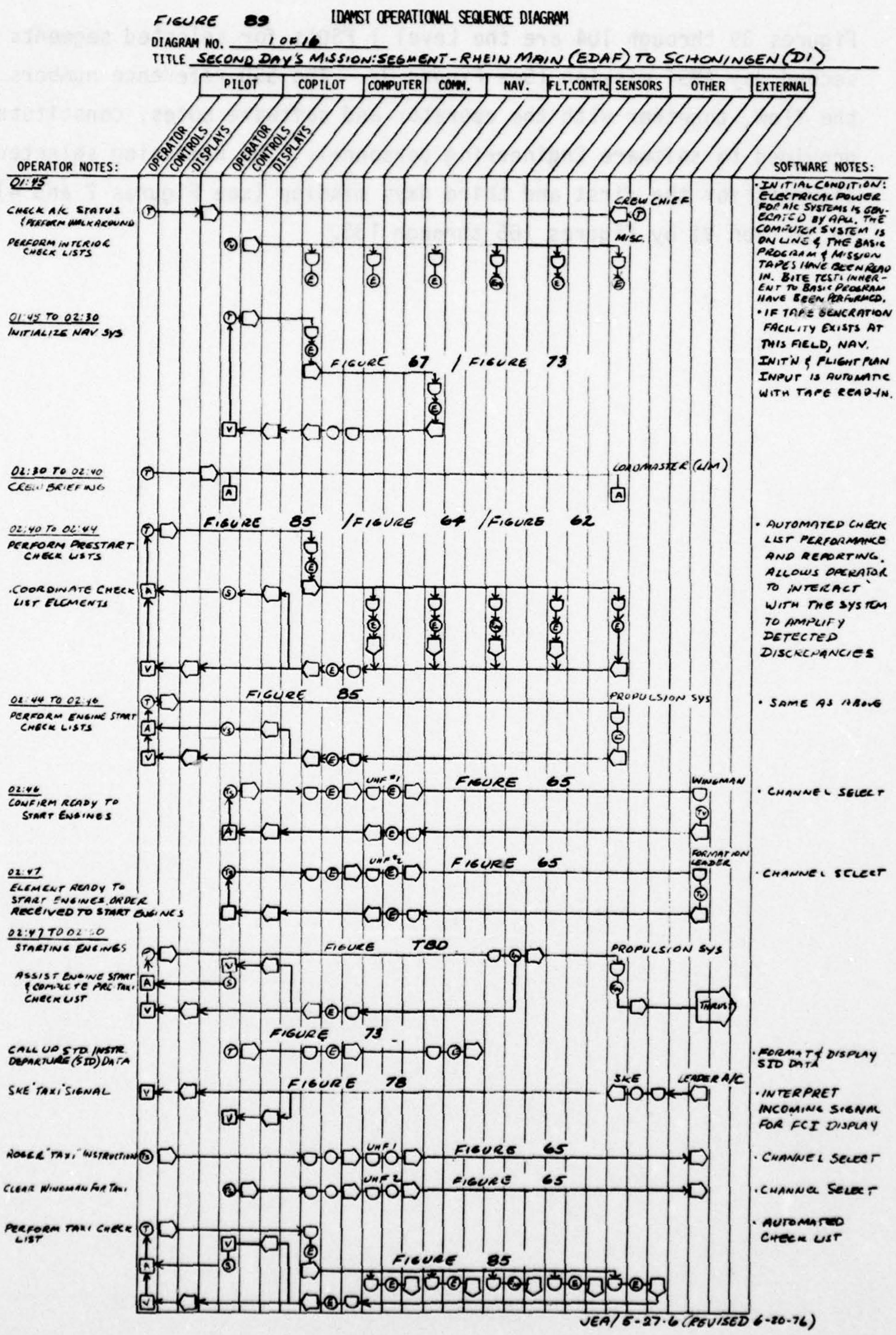


FIGURE 89: Second Day's Mission: Segment - Rhein Main (EDAF) to Schoningen (DI)

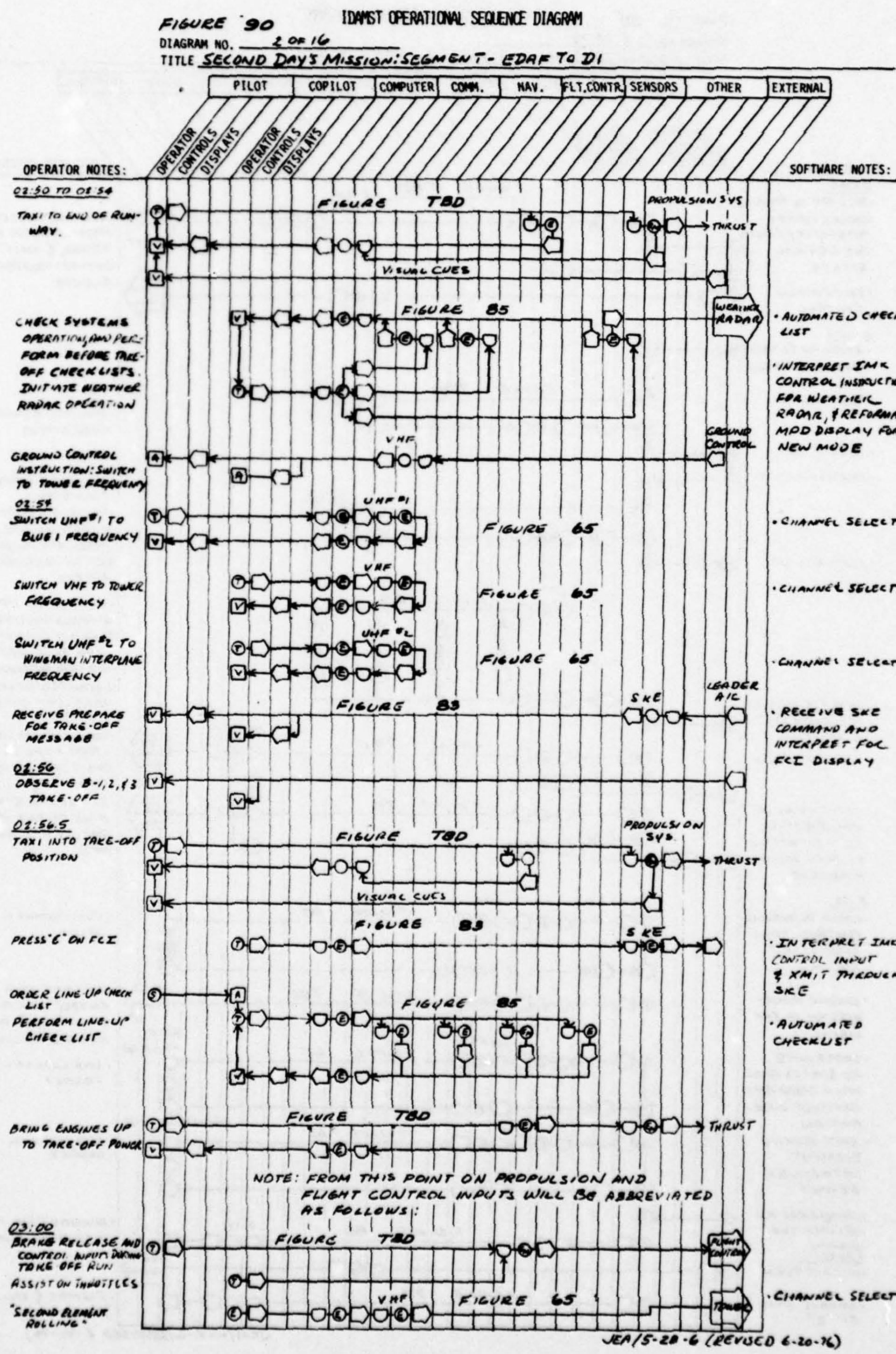


FIGURE 90: Second Day's Mission: Segment - EDAF to DI

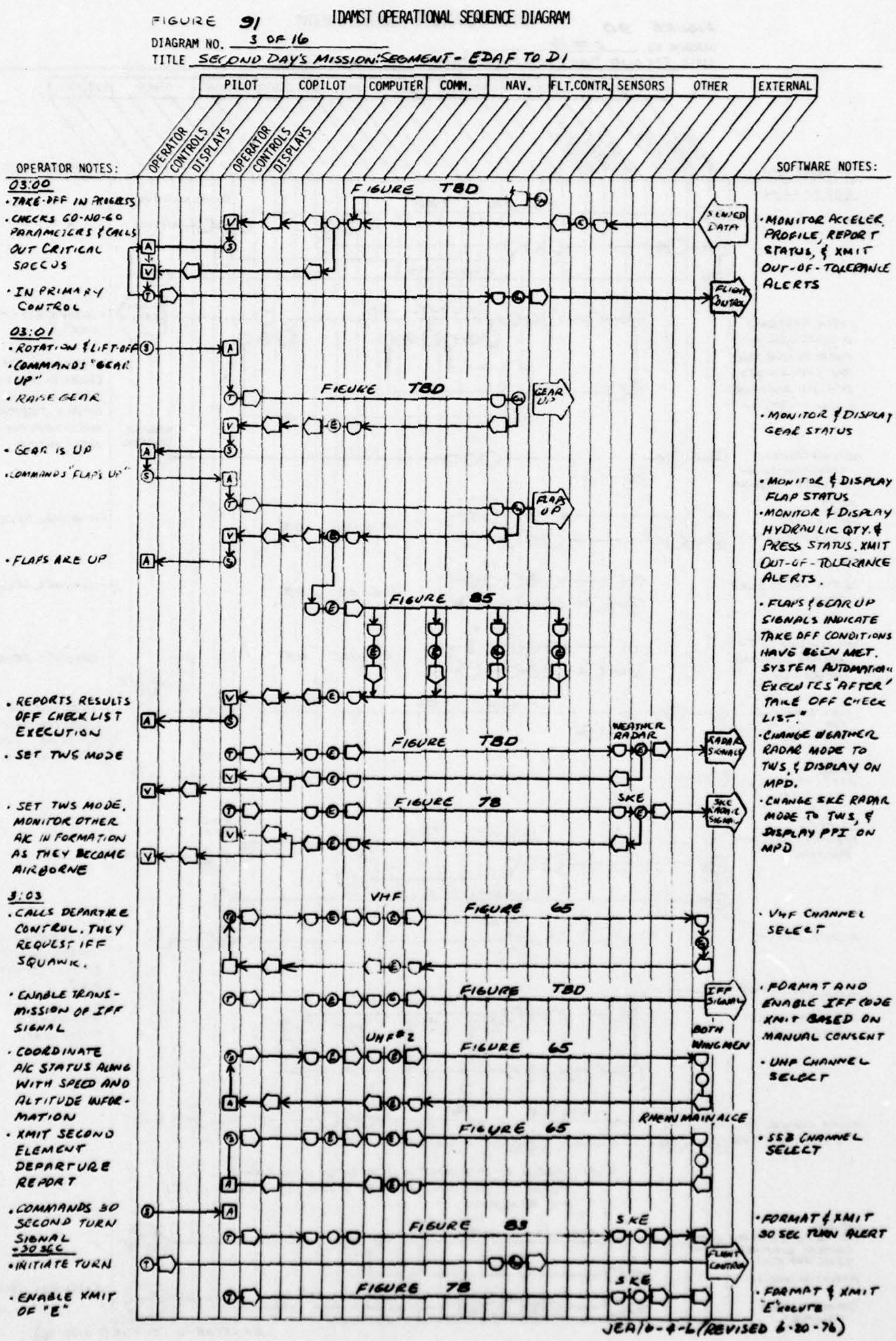


FIGURE 91: Second Day's Mission: Segment - EDAF to DI

FIGURE 92 IDAMST OPERATIONAL SEQUENCE DIAGRAM

DIAGRAM NO. 4 OF 16

TITLE SECOND DAY'S MISSION: SEGMENT - EDAF TO DI

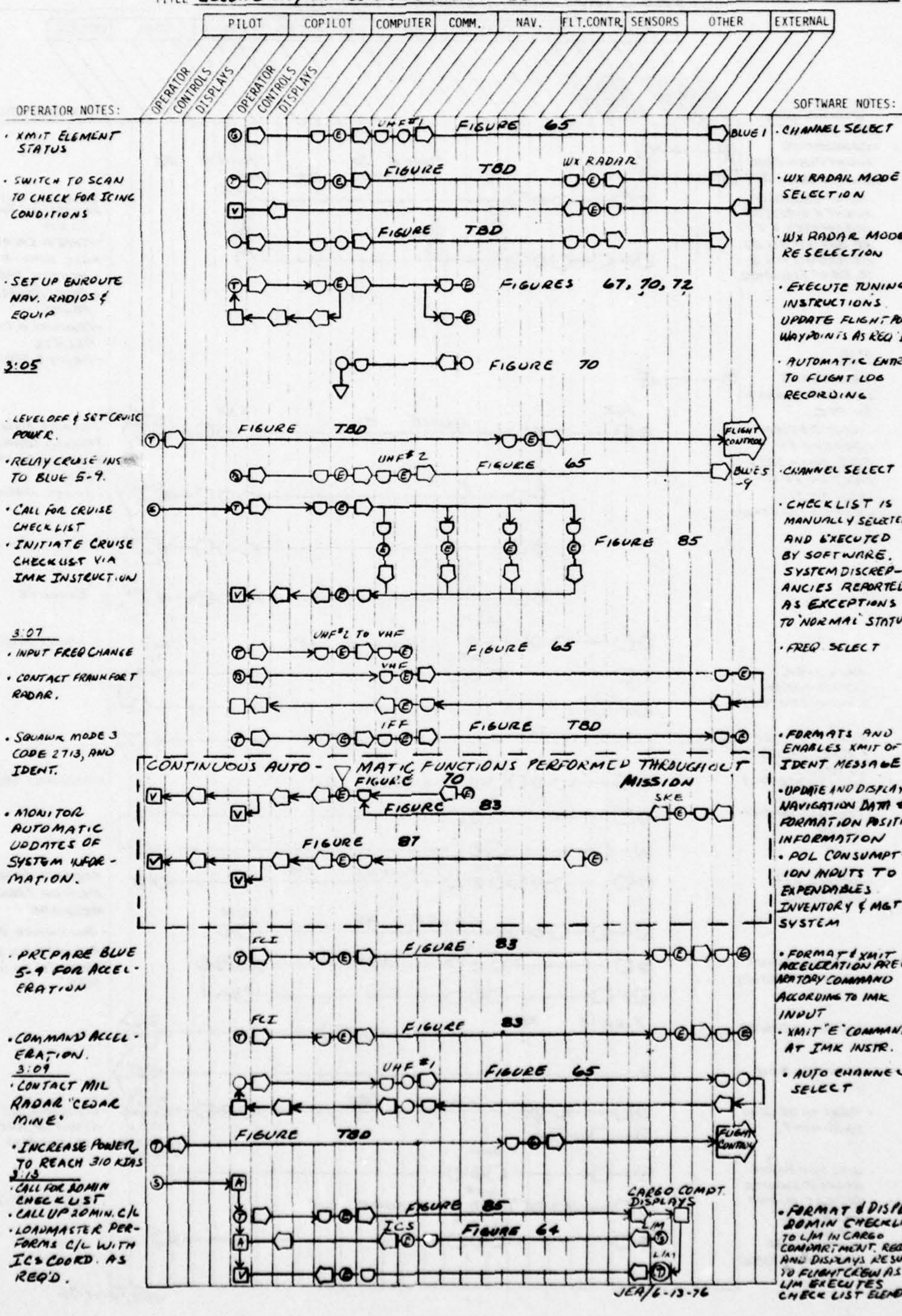


FIGURE 92: Second Day's Mission: Segment - EDAF to DI

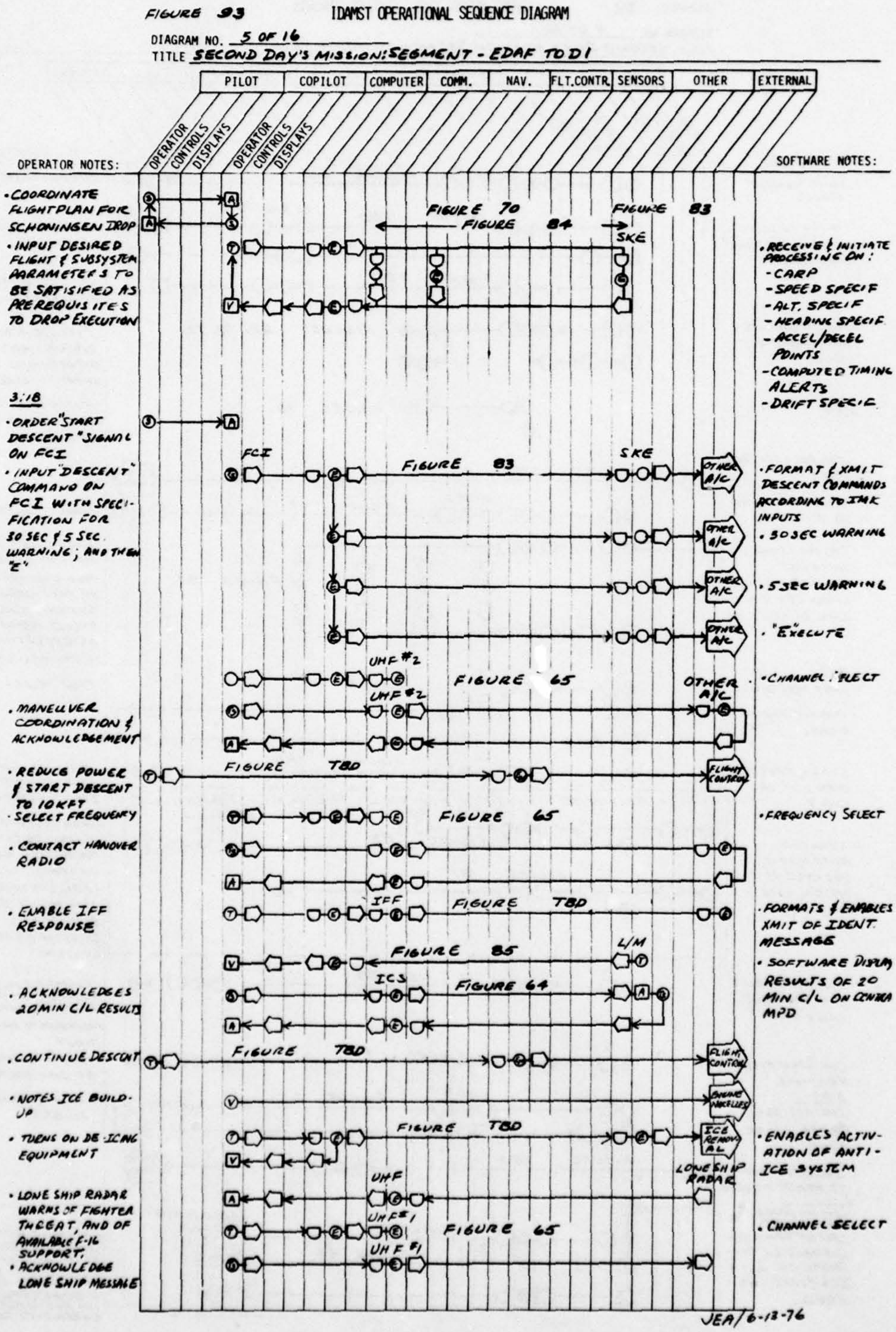


FIGURE 93: Second Day's Mission: Segment - EDAF to DI

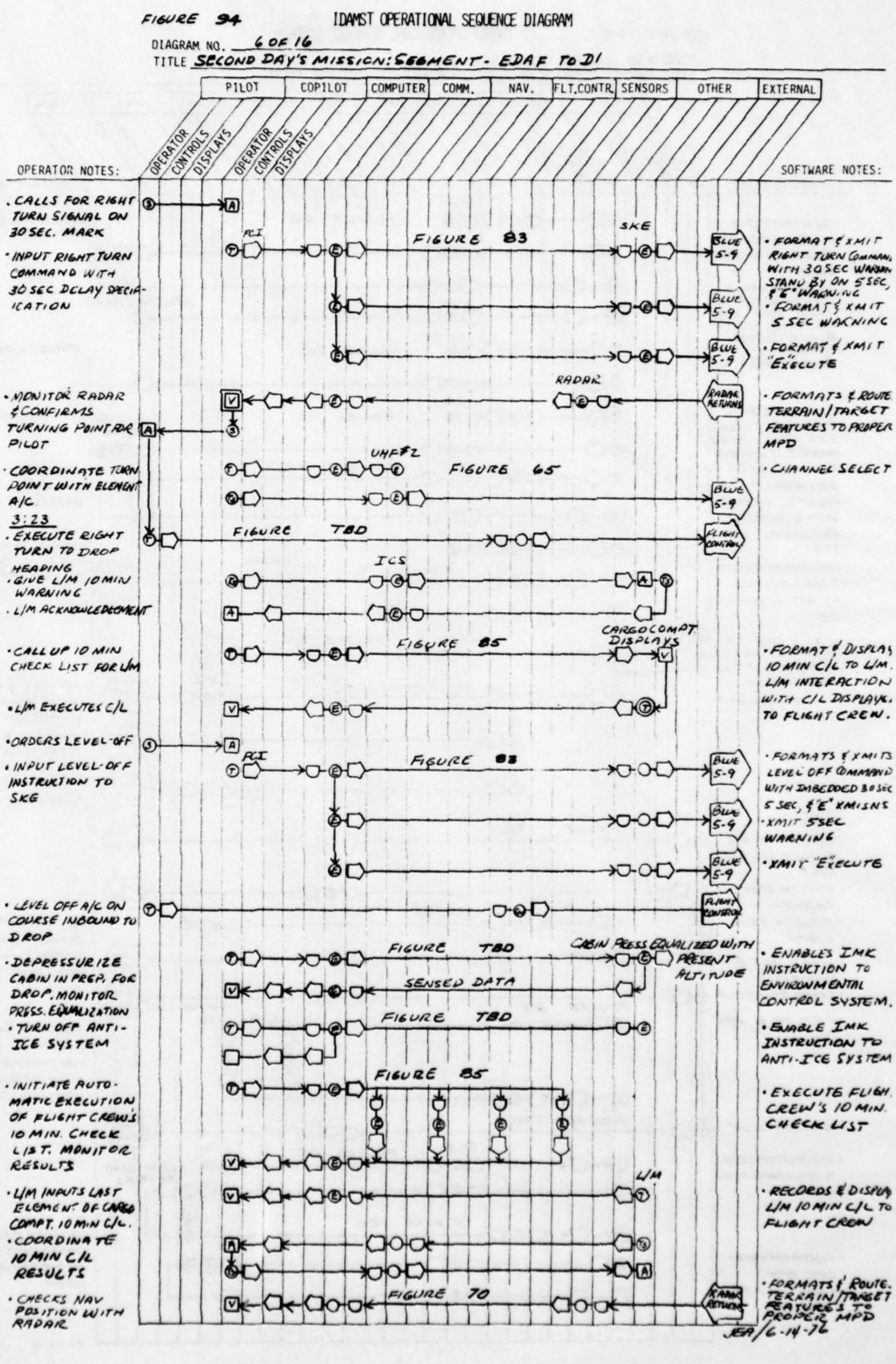


FIGURE 94: Second Day's Mission: Segment - EDAF to DI

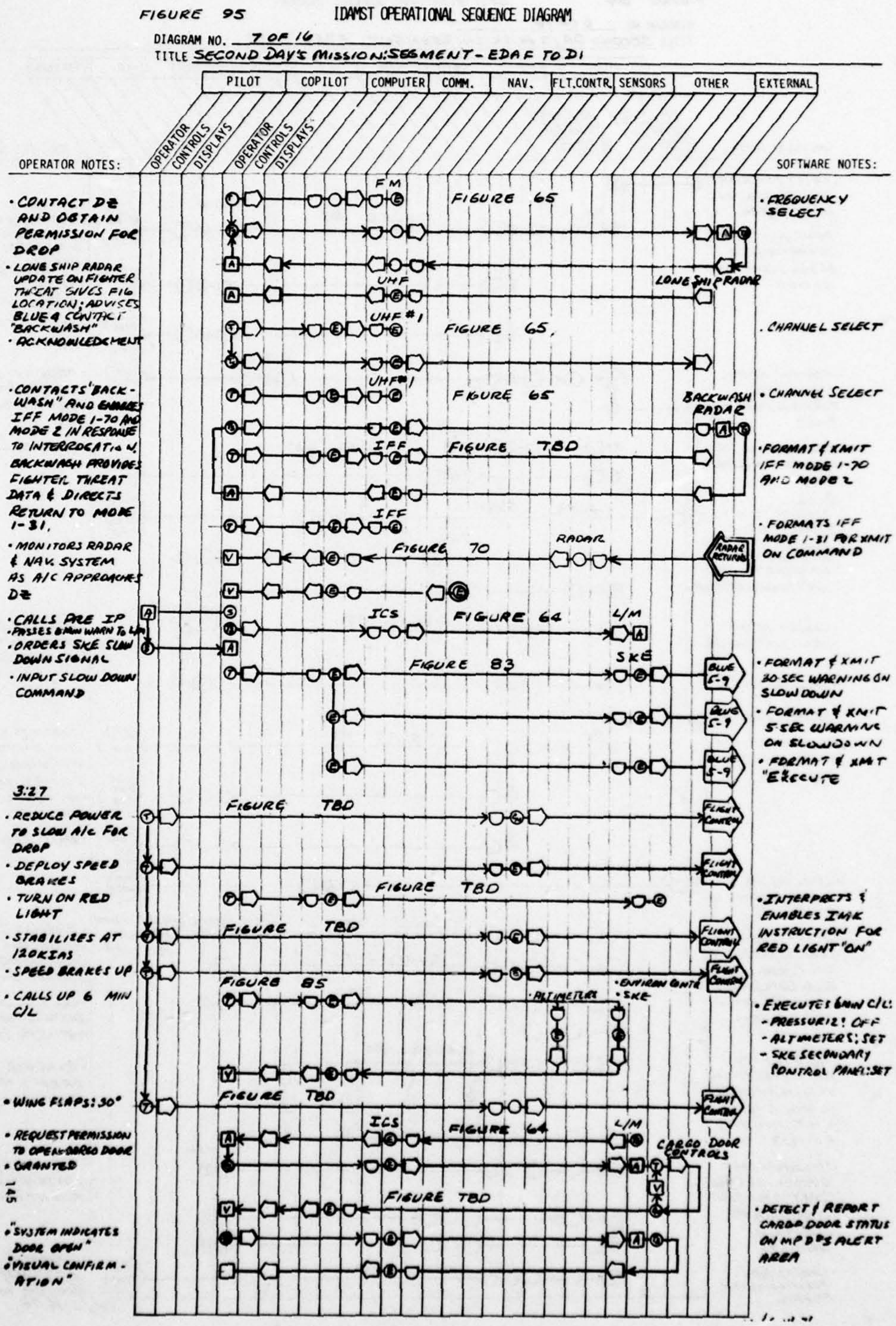


FIGURE 95: Second Day's Mission: Segment - EDAF to DI

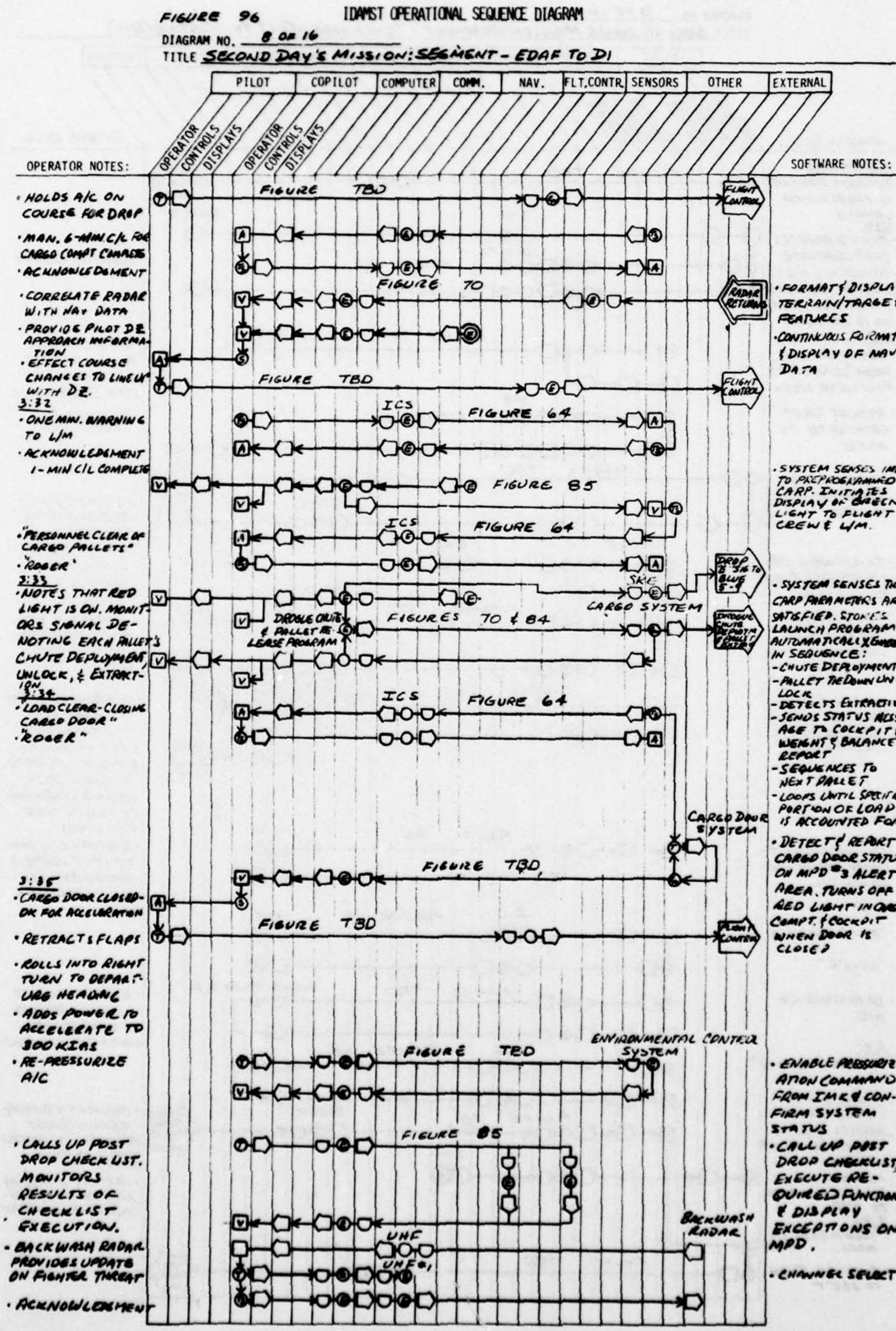


FIGURE 96: Second Day's Mission: Segment - EDAF to DI

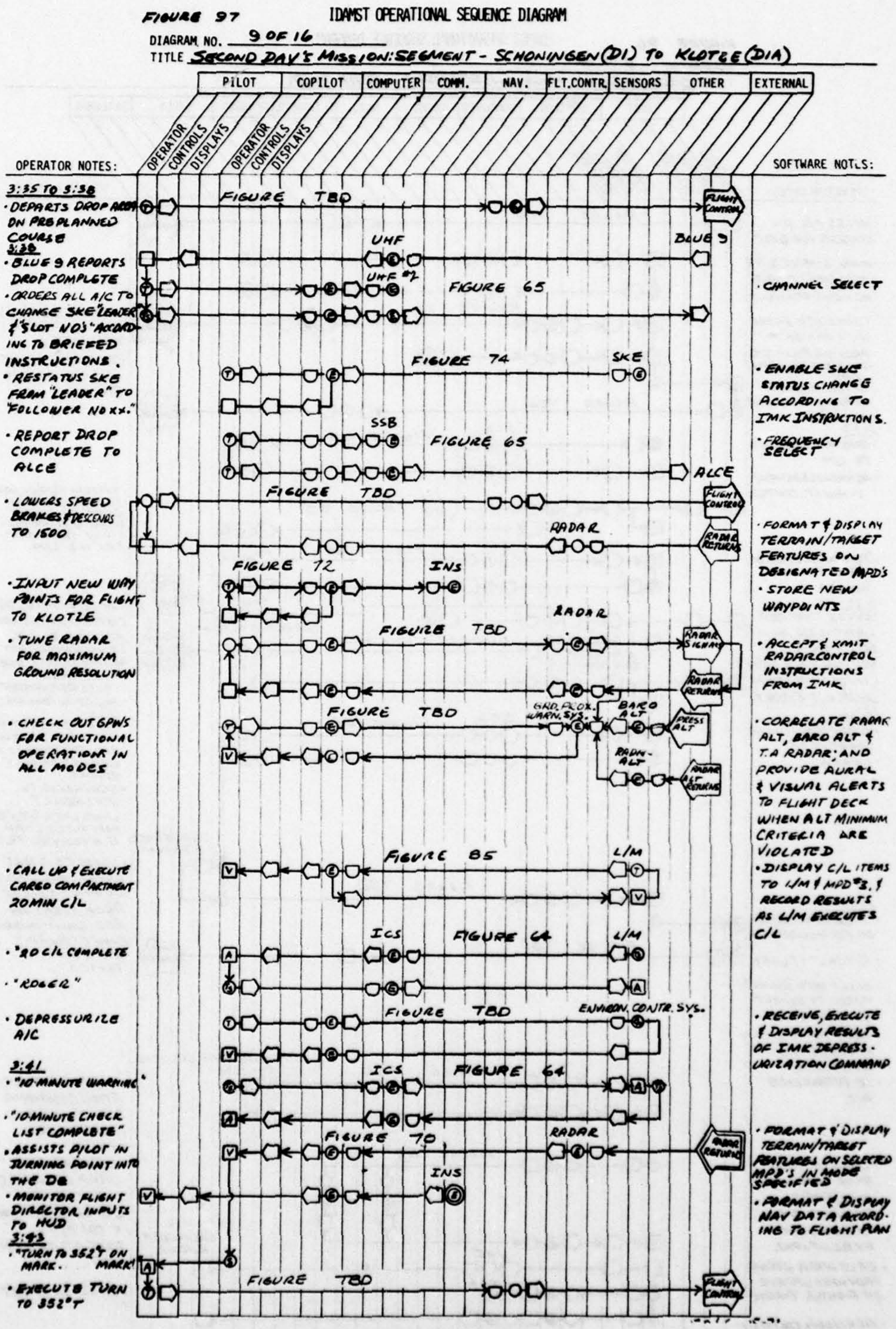


FIGURE 97: Second Day's Mission: Segment - Schoningen (DI) to Klotze (DIA)

FIGURE 98 IDAMST OPERATIONAL SEQUENCE DIAGRAM

DIAGRAM NO. 10 OF 16

TITLE SECOND DAY'S MISSION: SEGMENT - DI TO DIA

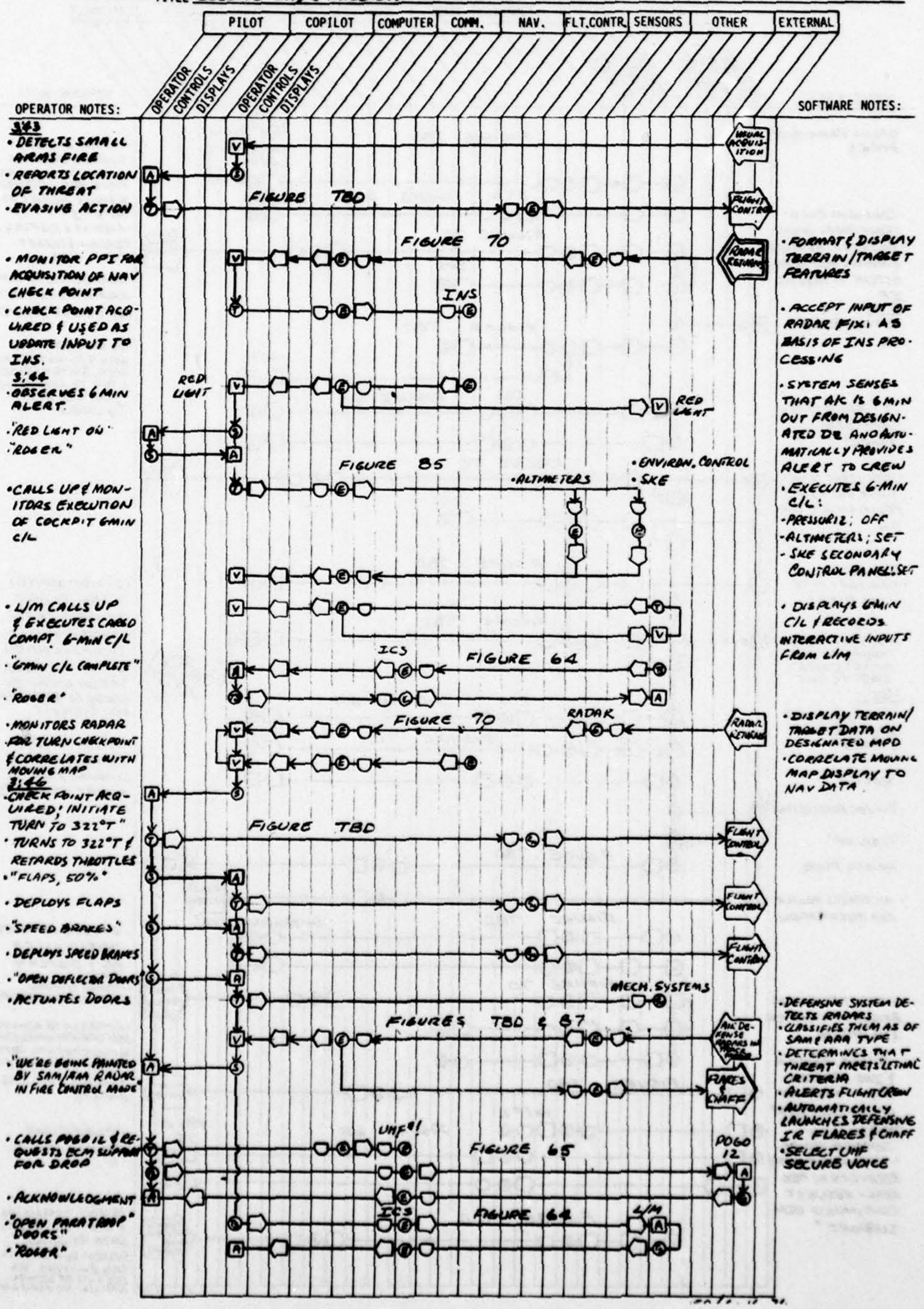


FIGURE 98: Second Day's Mission: Segment - DI to DIA

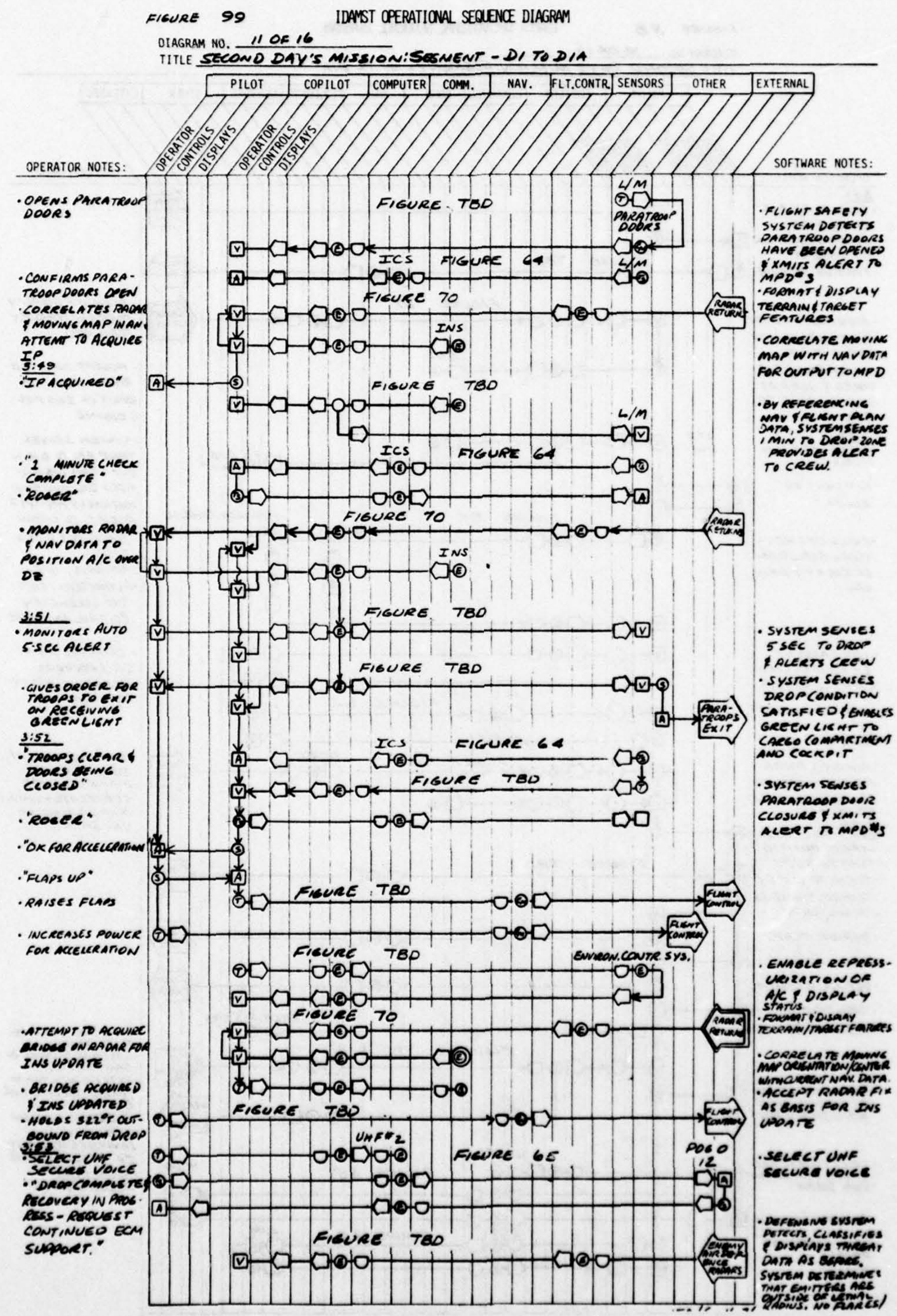


FIGURE 99: Second Day's Mission: Segment - DI to DIA

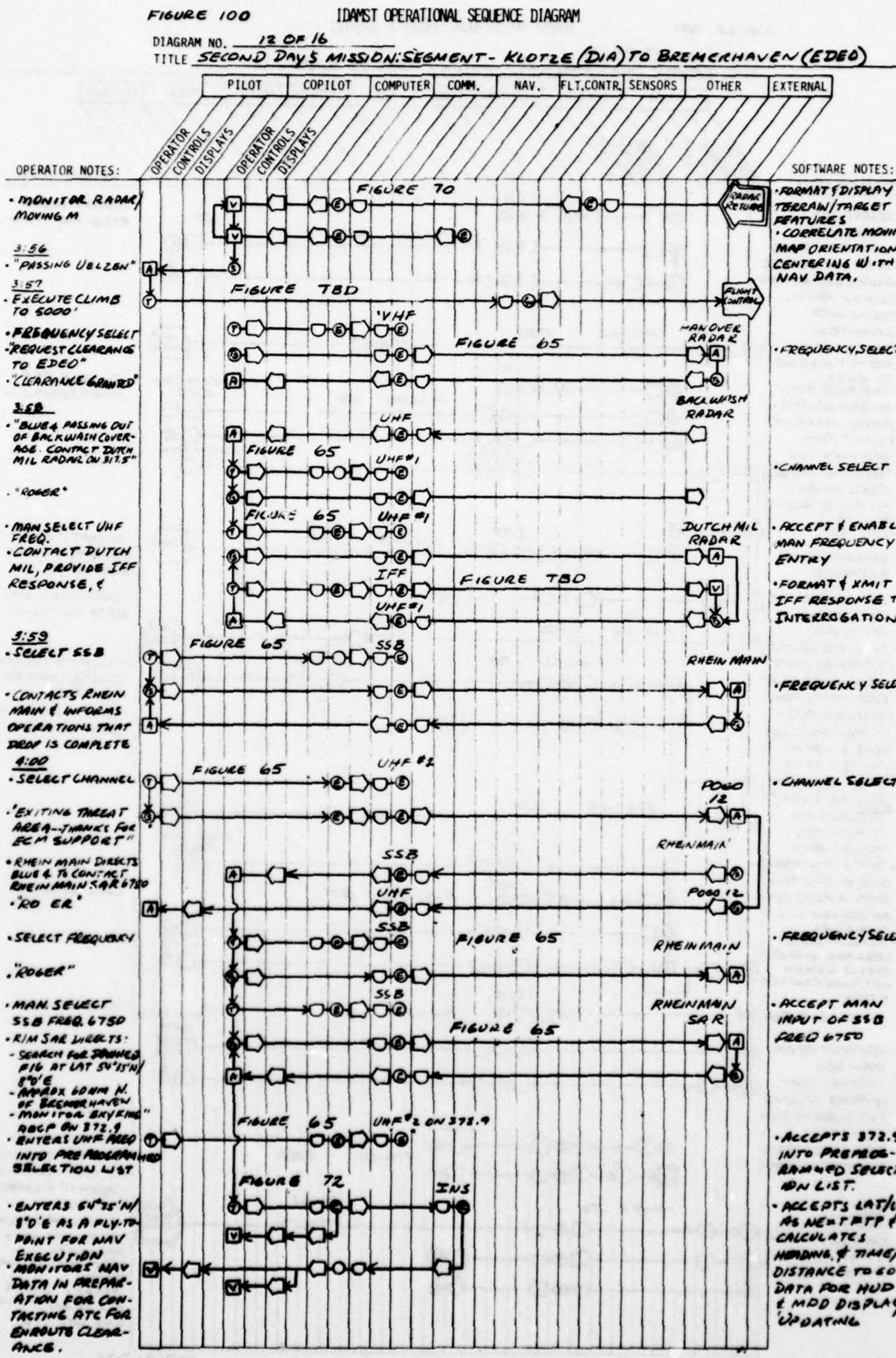


FIGURE 100: Second Day's Mission: Segment - Klotze (DIA) to Bremerhaven (EDEO)

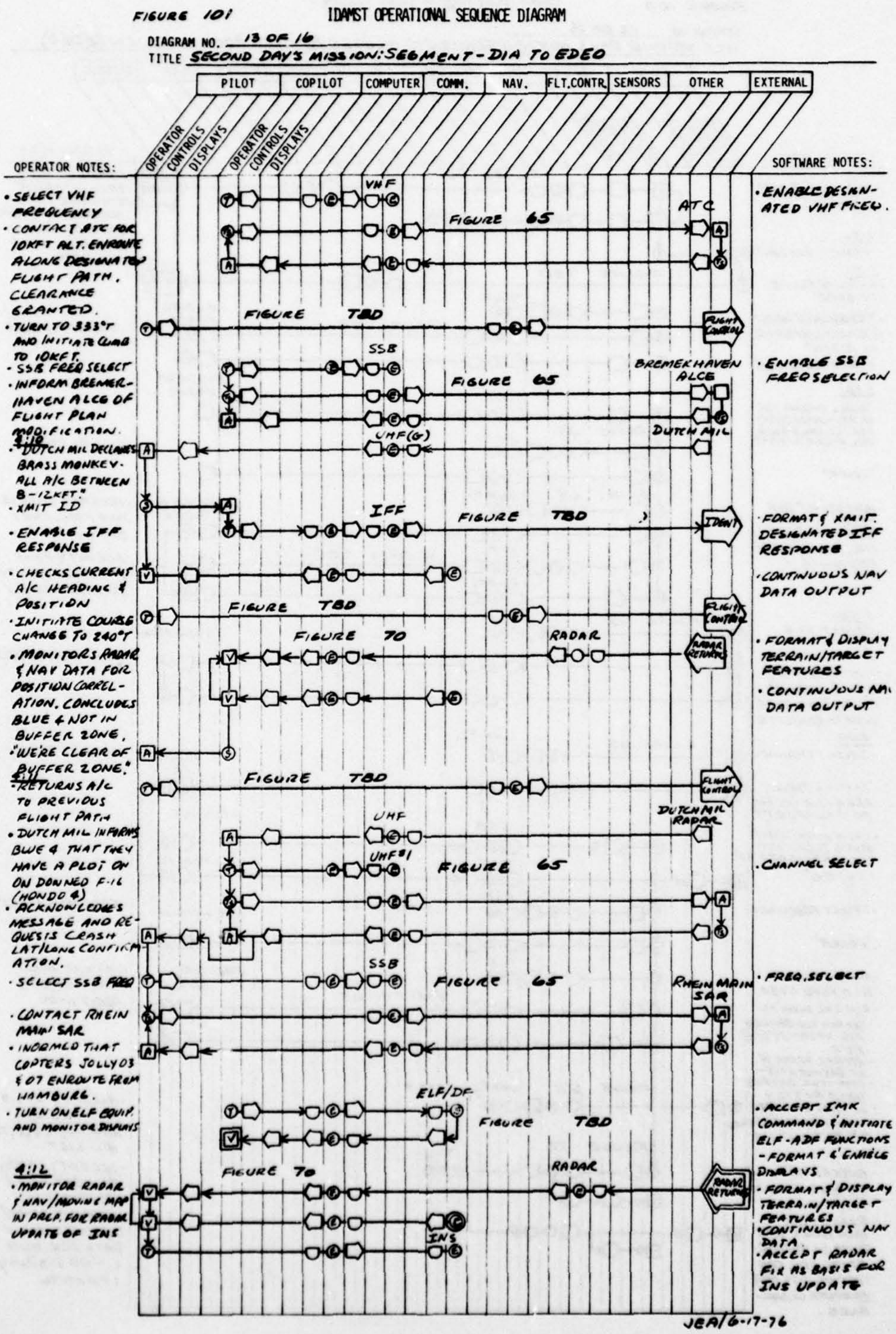


FIGURE 101: Second Day's Mission: Segment - DIA to EDEO

IDAMST OPERATIONAL SEQUENCE DIAGRAM

FIGURE 102

DIAGRAM NO. 14 OF 16

TITLE SECOND DAY'S MISSION: SEGMENT - DIA TO EDEO

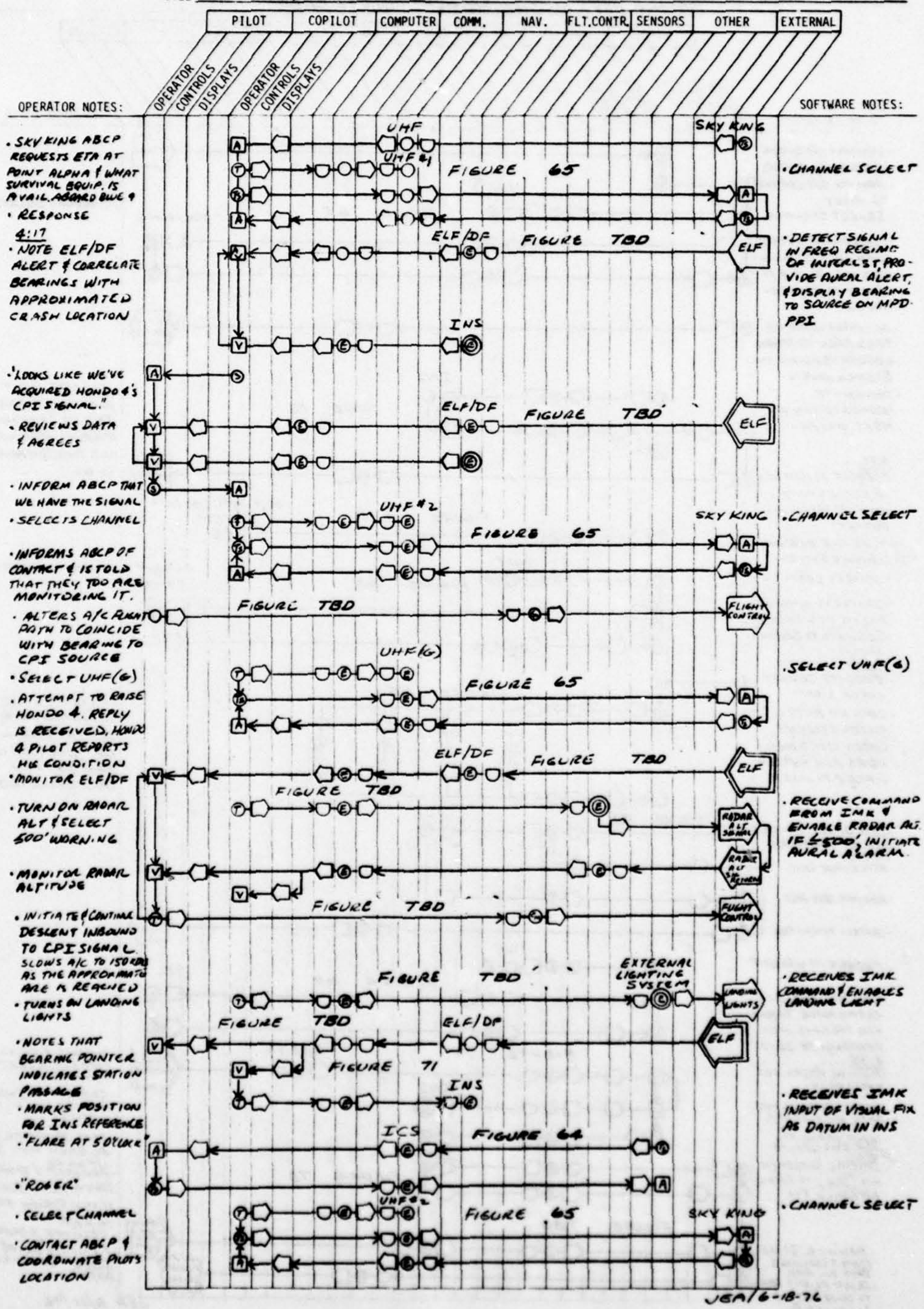


FIGURE 102: Second Day's Mission: Segment - DIA to EDEO

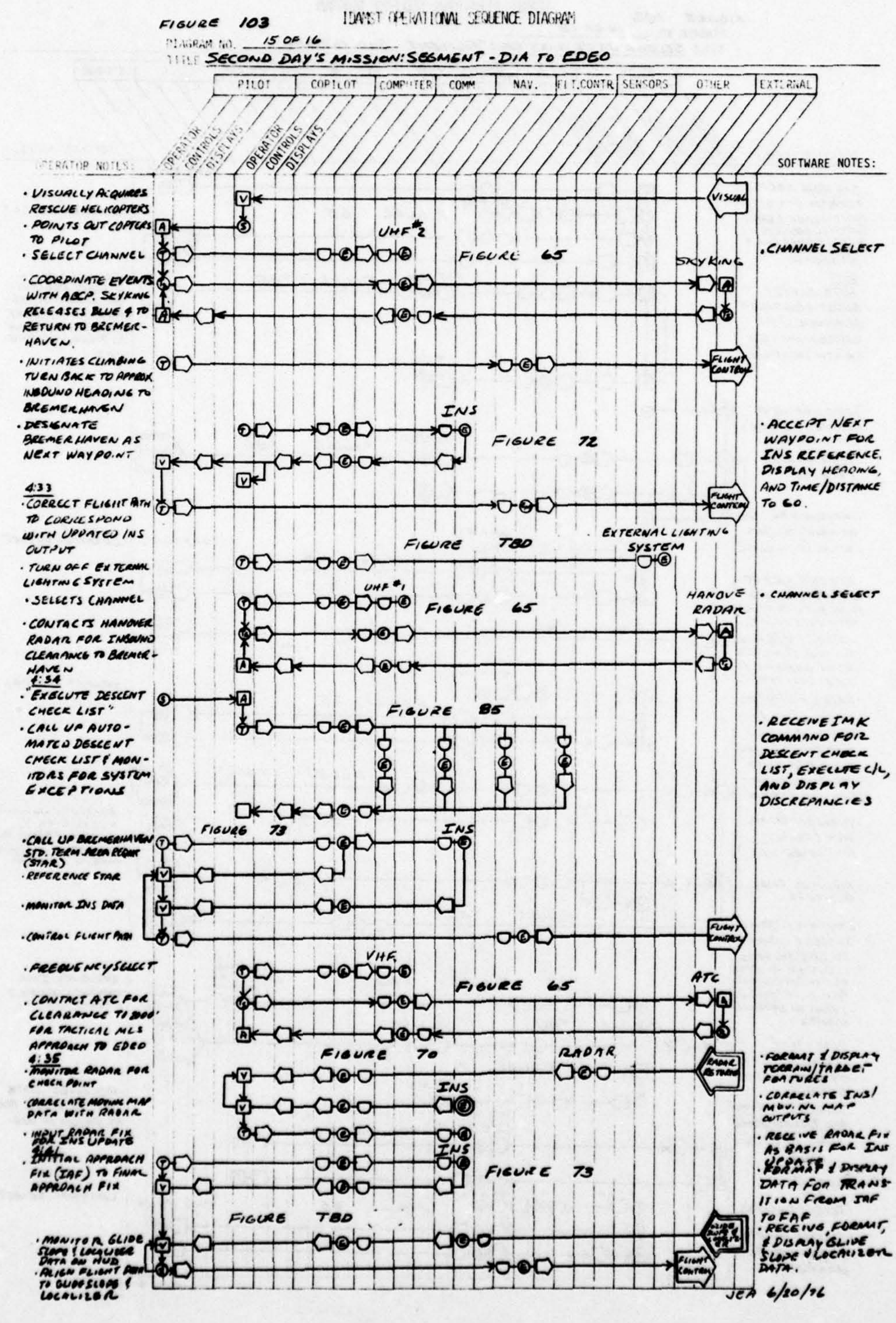


FIGURE 103: Second Day's Mission: Segment - DIA to EDEO

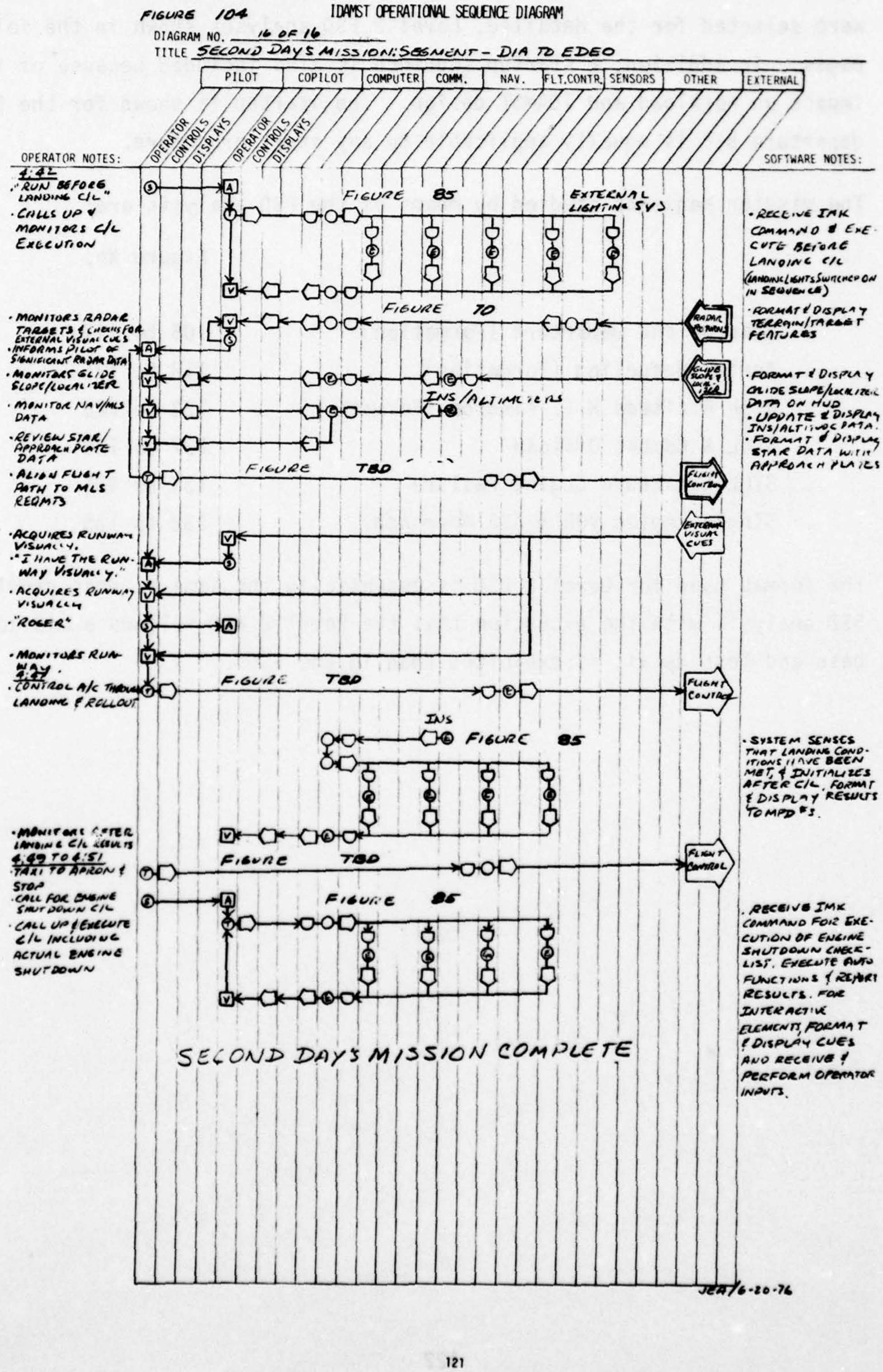


FIGURE 104: Second Day's Mission: Segment - DIA to EDEO

SECTION VI

LEVEL 2 FUNCTIONAL SEQUENCE DIAGRAMS

The time line analyses of Section III pointed to six mission segments that appeared to have the potential for excessive workloads. These mission segments were selected for the detailed, Level 2 FSD analyses shown in the following pages. In addition, a startup sequence is also included because of its potential impact on workload and IDAMST design. The startup is shown for the Dover AFB departure but is equally applicable to any start procedure.

The mission segments studied by means of the FSD analysis are:

	Figure No.
. Startup and Departure (Formation)	105 to 117
. Aerial Refueling (Formation)	118 to 121
. High Altitude H.E. Airdrop (Formation)	122 to 126
. STOL & Combat Offload	127 to 129
. STOL Departure Engine Failure	130 to 131
. Single Engine VOR & ASA Approach	132 to 135

The format used for Level 2 FSD is essentially the same as that developed for SSD analysis with the exception that the Level 2 FSD follows a mission time base and less detail is exhibited than in the SSDs.

IDAMST FUNCTIONAL SEQUENCE DIAGRAM			TITLE [1] CONTINUAL FLIGHT FUNCTIONS					SHEET NO.
COCKPIT FUNCTIONS			COMPUTER FUNCTIONS	SUBSYSTEM FUNCTIONS			EXTERNAL (TO AIRPLANE)	TIME, PRIORITY, REMARKS
CREW	CONTROLS	DISPLAYS		SYSTEM 1	SYSTEM 2	SYSTEM 3		

[1] The following FSD's show the discrete crew actions which occur during selected periods of high workloads. These discrete actions are only a portion of the total flight crew workload operating throughout flight. Not shown are the continual visual checks of many flight variables and the corresponding control(s) response to any undesired divergence of these variables. These continual tasks operate from prior to take-off to after landing. They are listed here to provide a more complete picture of the actual flight tasks during flight.

Determine:
- Actual value
- Required value
- Error
- Required correction
- Best method

Make correction

For:
- Time
- Pitch angle & rate
- Roll angle & rate
- Heading angle & rate
- Speed & rate
- Altitude & rate (Baro & Radio)
- Angle of Attack
- Flight path angle
- Propulsion parameters
- Airplane configuration
- Navigation system readouts
- Navigation position adjustments
- Airplane systems

FIGURE 105

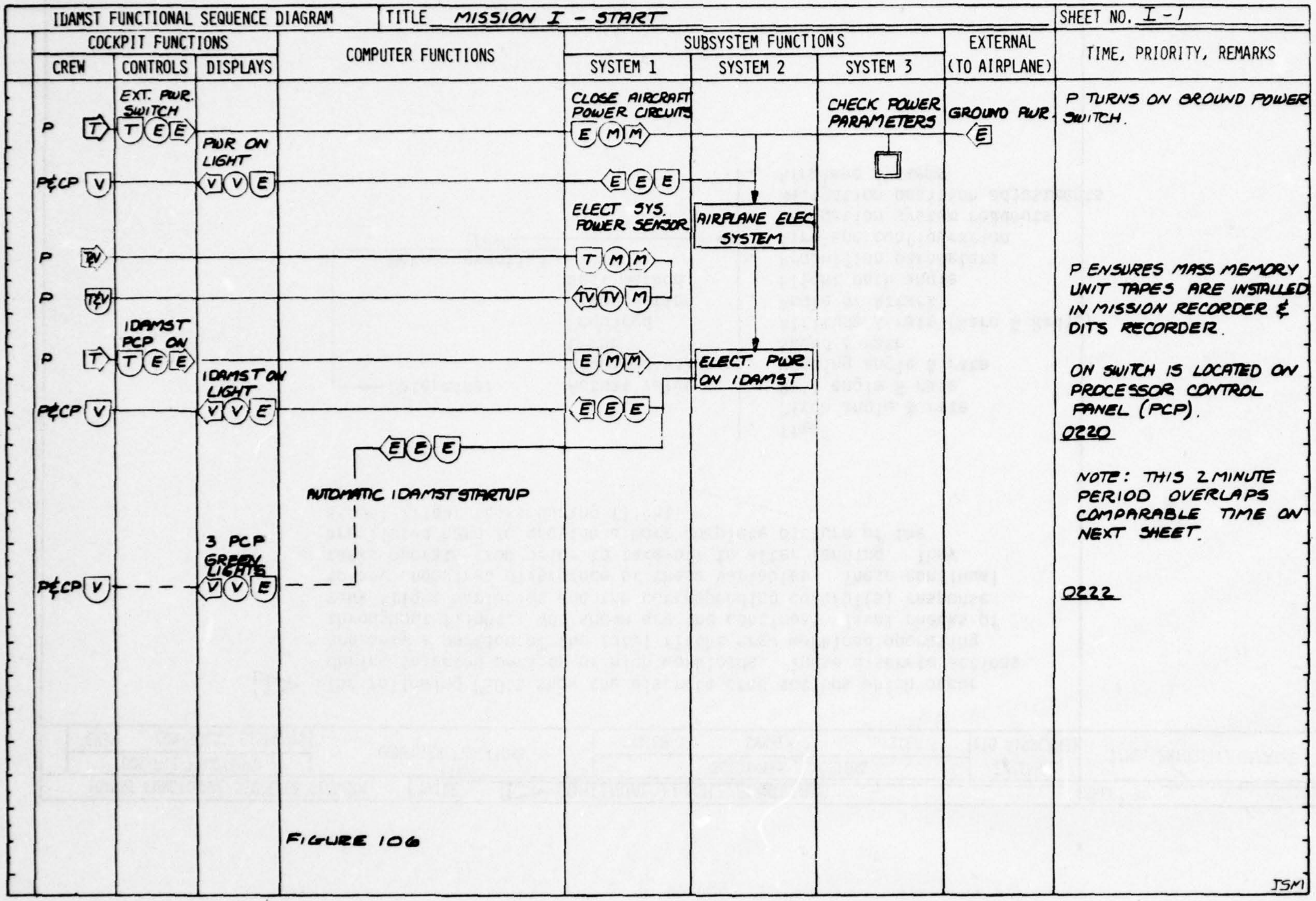

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - START
SHEET NO. I - 1
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
EXT. PWR. SWITCH
PWR ON LIGHT
CLOSE AIRCRAFT POWER CIRCUITS
CHECK POWER PARAMETERS
GROUND PWR.
P TURNS ON GROUND POWER SWITCH.
ELECT SYS. POWER SENSOR
AIRPLANE ELEC SYSTEM
P ENSURES MASS MEMORY UNIT TAPES ARE INSTALLED IN MISSION RECORDER & DITS RECORDER.
IDAMST PCP ON
IDAMST ON LIGHT
ELECT. PWR. ON IDAMST
ON SWITCH IS LOCATED ON PROCESSOR CONTROL PANEL (PCP).
0220
AUTOMATIC IDAMST STARTUP
NOTE: THIS 2 MINUTE PERIOD OVERLAPS COMPARABLE TIME ON NEXT SHEET.
3 PCP GREEN LIGHTS
0222
JSM

FIGURE 106

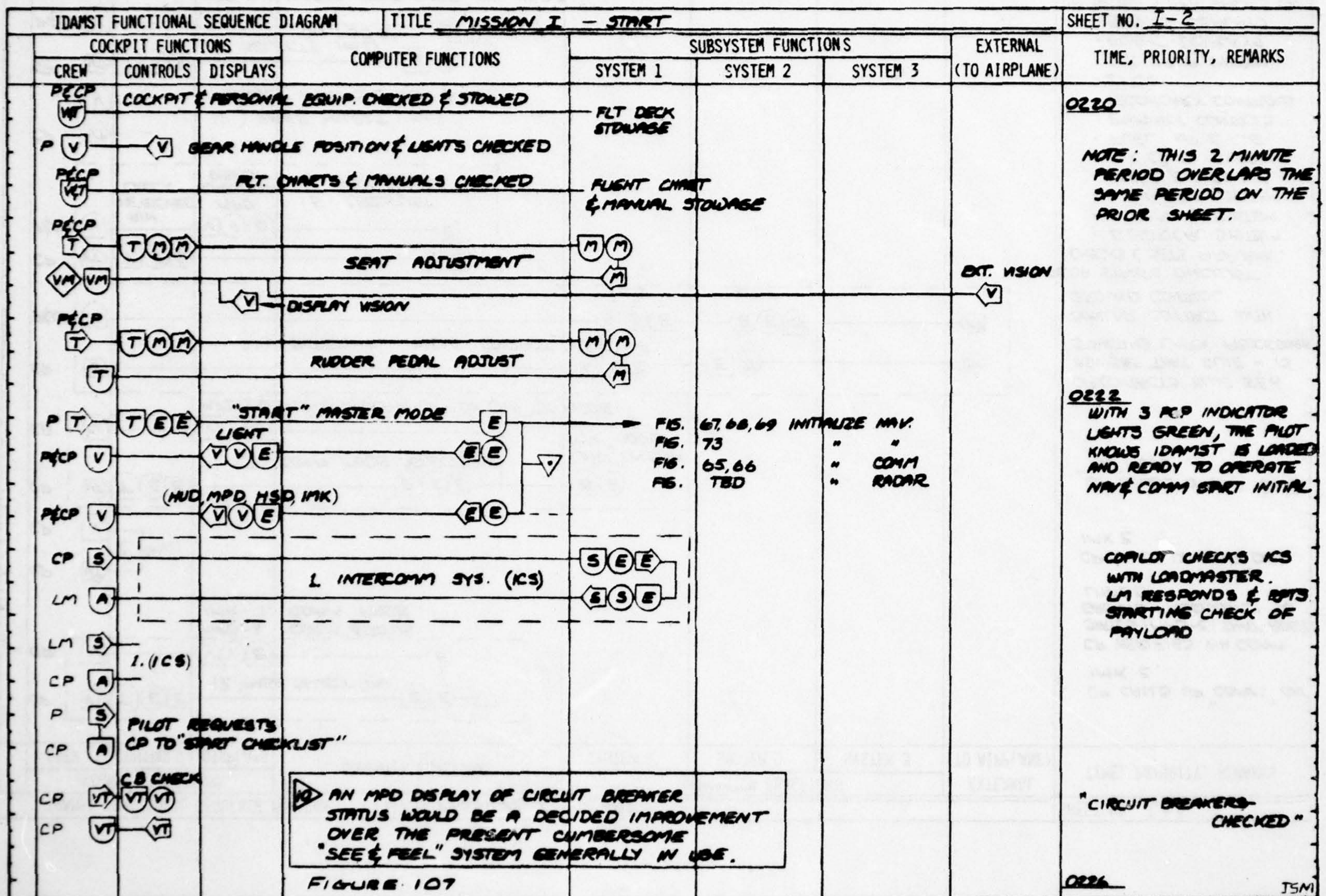

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - START
SHEET NO. I-2
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
COCKPIT & PERSONAL EQUIP. CHECKED & STOWED
FLT DECK STOWAGE
GEAR HANDLE POSITION & LIGHTS CHECKED
FLT. CHARTS & MANUALS CHECKED
FLIGHT CHART & MANUAL STOWAGE
SEAT ADJUSTMENT
DISPLAY VISION
EXT. VISION
RUDDER PEDAL ADJUST
"START" MASTER MODE
LIGHT
(HUD, MPD, HSD, IMK)
FIG. 67, 68, 69 INITIALIZE NAV.
FIG. 73 " "
FIG. 65, 66 " COMM
FIG. TBD " RADAR
1. INTERCOMM SYS. (ICS)
1. (ICS)
PILOT REQUESTS CP TO "START CHECKLIST"
C.B CHECK
AN MPD DISPLAY OF CIRCUIT BREAKER STATUS WOULD BE A DECIDED IMPROVEMENT OVER THE PRESENT CUMBERSOME "SEE & FEEL" SYSTEM GENERALLY IN USE.
0220
NOTE: THIS 2 MINUTE PERIOD OVERLAPS THE SAME PERIOD ON THE PRIOR SHEET.
0222
WITH 3 FCP INDICATOR LIGHTS GREEN, THE PILOT KNOWS IDAMST IS LOADED AND READY TO OPERATE NAV & COMM START INITIAL
COPILOT CHECKS ICS WITH LOADMASTER. LM RESPONDS & RPTS STARTING CHECK OF PAYLOAD
"CIRCUIT BREAKERS-CHECKED"
0226
JSM

FIGURE 107

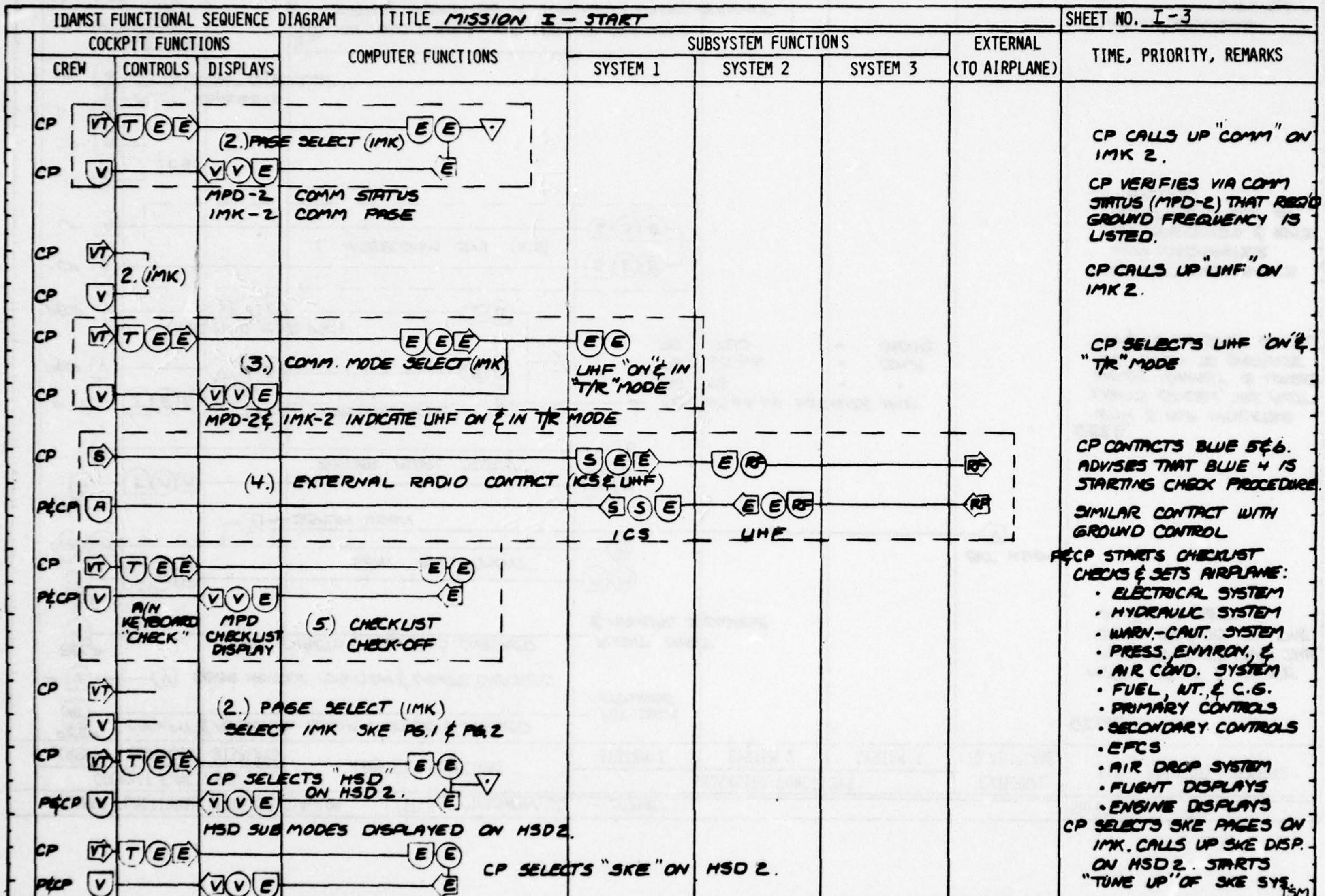

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - START
SHEET NO. I-3
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
CP
CP
(2.) PAGE SELECT (IMK)
MPD-2
IMK-2
COMM STATUS
COMM PAGE
CP CALLS UP "COMM" ON IMK 2.
CP VERIFIES VIA COMM STATUS (MPD-2) THAT REQ'D GROUND FREQUENCY IS LISTED.
CP
CP
2. (IMK)
CP CALLS UP "UHF" ON IMK 2.
CP
CP
(3.) COMM. MODE SELECT (IMK)
UHF "ON" & IN "T/R" MODE
MPD-2 & IMK-2 INDICATE UHF ON & IN T/R MODE
CP SELECTS UHF "ON" & "T/R" MODE
CP
P&CP
(4.) EXTERNAL RADIO CONTACT (ICS & UHF)
ICS
UHF
RF
CP CONTACTS BLUE 5 & 6. ADVISES THAT BLUE 4 IS STARTING CHECK PROCEDURE.
SIMILAR CONTACT WITH GROUND CONTROL
CP
P&CP
A/N KEYBOARD "CHECK"
MPD CHECKLIST DISPLAY
(5.) CHECKLIST CHECK-OFF
P&CP STARTS CHECKLIST CHECKS & SETS AIRPLANE:
· ELECTRICAL SYSTEM
· HYDRAULIC SYSTEM
· WARN.-CAUT. SYSTEM
· PRESS. ENVIRON. &
· AIR COND. SYSTEM
· FUEL, WT. & C.G.
· PRIMARY CONTROLS
· SECONDARY CONTROLS
· EFCS
· AIR DROP SYSTEM
· FLIGHT DISPLAYS
· ENGINE DISPLAYS
CP
(2.) PAGE SELECT (IMK)
SELECT IMK SKE PG.1 & PG.2
CP
P&CP
CP SELECTS "HSD" ON HSD 2.
HSD SUB MODES DISPLAYED ON HSD 2.
CP
P&CP
CP SELECTS "SKE" ON HSD 2.
CP SELECTS SKE PAGES ON IMK. CALLS UP SKE DISP. ON HSD 2. STARTS "TUNE UP" OF SKE SYS.
JSM

FIGURE 108

IDAMST FUNCTIONAL SEQUENCE DIAGRAM — TITLE MISSION I - START — SHEET NO. I -4

COCKPIT FUNCTIONS: CREW	CONTROLS	DISPLAYS	COMPUTER FUNCTIONS	SUBSYSTEM FUNCTIONS: SYSTEM 1	SYSTEM 2	SYSTEM 3	EXTERNAL (TO AIRPLANE)	TIME, PRIORITY, REMARKS
P&CP (T)			FIG. 78 THRU 82 (SKE INITIALIZATION)					0226 P&CP CONTINUE CHECKOUT OF IDAMST CONTROLS, DISPLAYS, & SYSTEMS
P&CP (AV)								
P&CP (T)			FIG. 86 (EXPENDABLES INVENTORY & MANAGEMENT - INITIALIZATION)					
P&CP (V)								
P&CP (T)			FIG. 61 (GENERAL DATA INPUT)					
P&CP (V)								
P&CP (T)			FIG. 72 (EXECUTION OF FLIGHT PLAN WITH PROVIS. FOR REPLAN.)					
P&CP (AV)								
P&CP (T)			FIG. 85 (AUTOMATED CHECKLISTS)					
P&CP (V)								
								0226

FIGURE 109

JSM

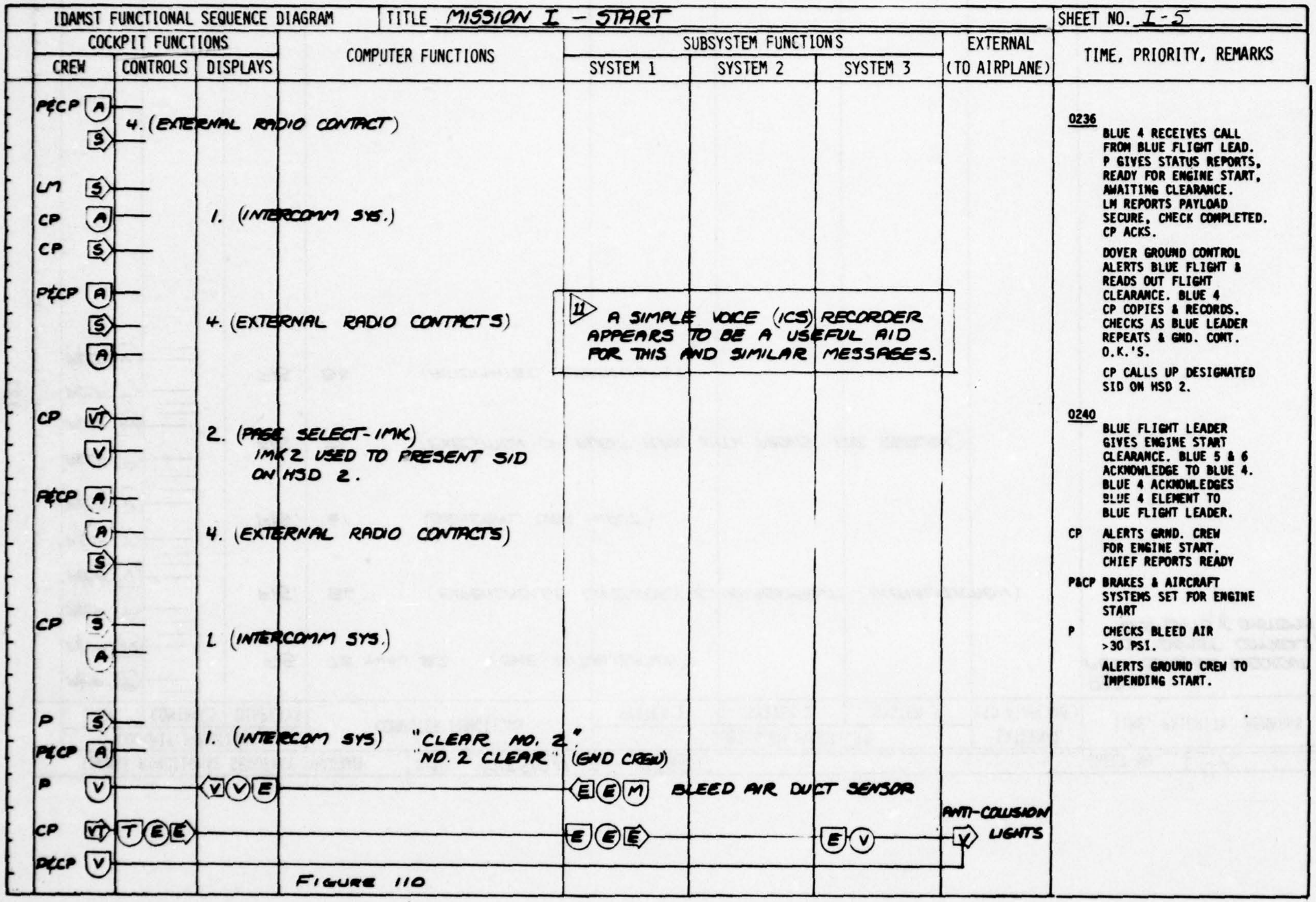

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - START
SHEET NO. I-5
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
P&CP
4. (EXTERNAL RADIO CONTACT)
LM
CP
1. (INTERCOMM SYS.)
CP
P&CP
4. (EXTERNAL RADIO CONTACTS)
11 A SIMPLE VOICE (ICS) RECORDER APPEARS TO BE A USEFUL AID FOR THIS AND SIMILAR MESSAGES.
CP
2. (PAGE SELECT-IMK)
IMK 2 USED TO PRESENT SID ON HSD 2.
P&CP
4. (EXTERNAL RADIO CONTACTS)
CP
1. (INTERCOMM SYS.)
P
P&CP
1. (INTERCOM SYS)
"CLEAR NO. 2"
"NO. 2 CLEAR" (GND CREW)
P
BLEED AIR DUCT SENSOR
CP
ANTI-COLLISION LIGHTS
P&CP
0236
BLUE 4 RECEIVES CALL FROM BLUE FLIGHT LEAD.
P GIVES STATUS REPORTS, READY FOR ENGINE START, AWAITING CLEARANCE.
LM REPORTS PAYLOAD SECURE, CHECK COMPLETED.
CP ACKS.
DOVER GROUND CONTROL ALERTS BLUE FLIGHT & READS OUT FLIGHT CLEARANCE. BLUE 4 CP COPIES & RECORDS. CHECKS AS BLUE LEADER REPEATS & GND. CONT. O.K.'S.
CP CALLS UP DESIGNATED SID ON HSD 2.
0240
BLUE FLIGHT LEADER GIVES ENGINE START CLEARANCE. BLUE 5 & 6 ACKNOWLEDGE TO BLUE 4.
BLUE 4 ACKNOWLEDGES BLUE 4 ELEMENT TO BLUE FLIGHT LEADER.
CP ALERTS GRND. CREW FOR ENGINE START. CHIEF REPORTS READY
P&CP BRAKES & AIRCRAFT SYSTEMS SET FOR ENGINE START
P CHECKS BLEED AIR >30 PSI.
ALERTS GROUND CREW TO IMPENDING START.

FIGURE 110

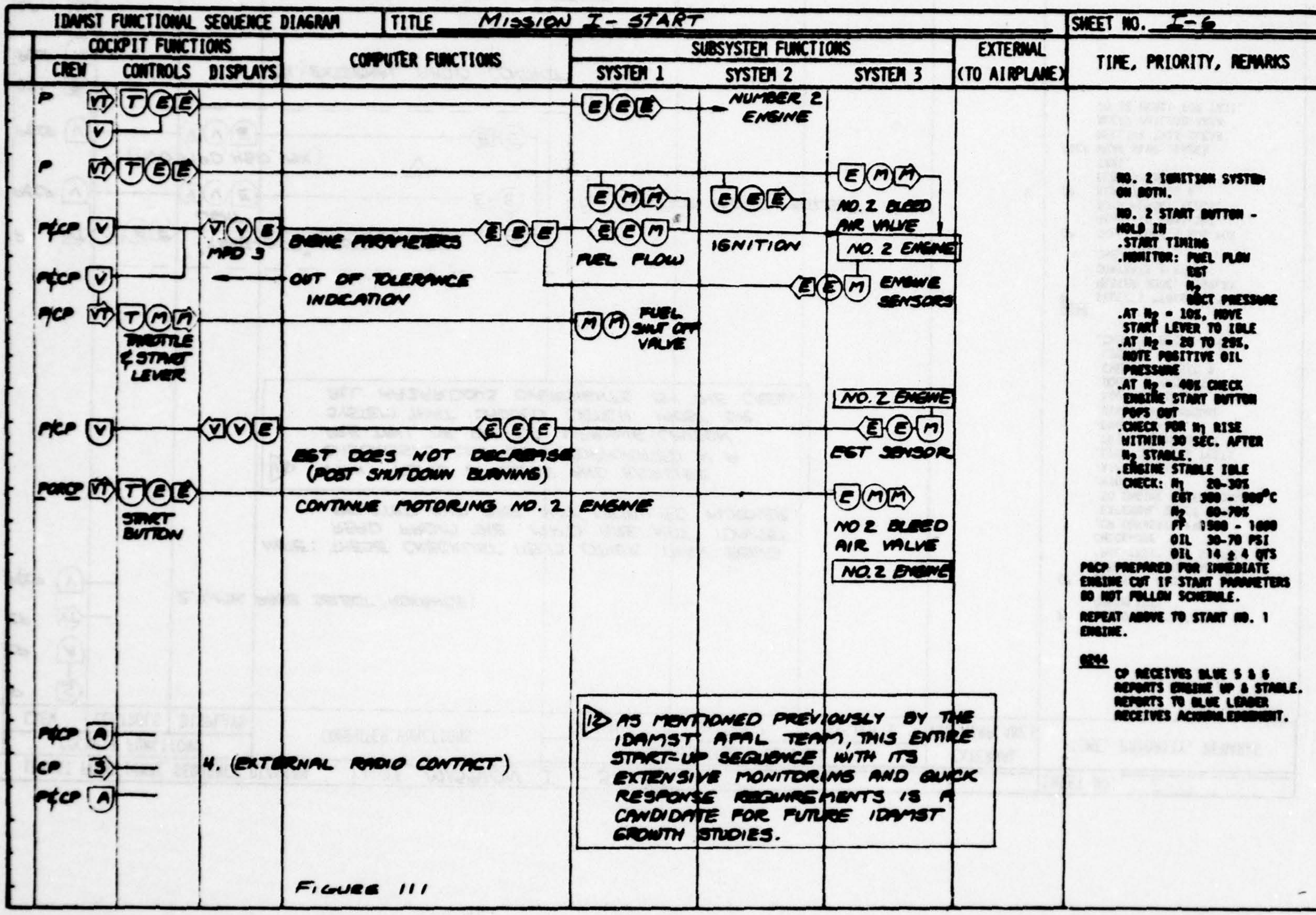
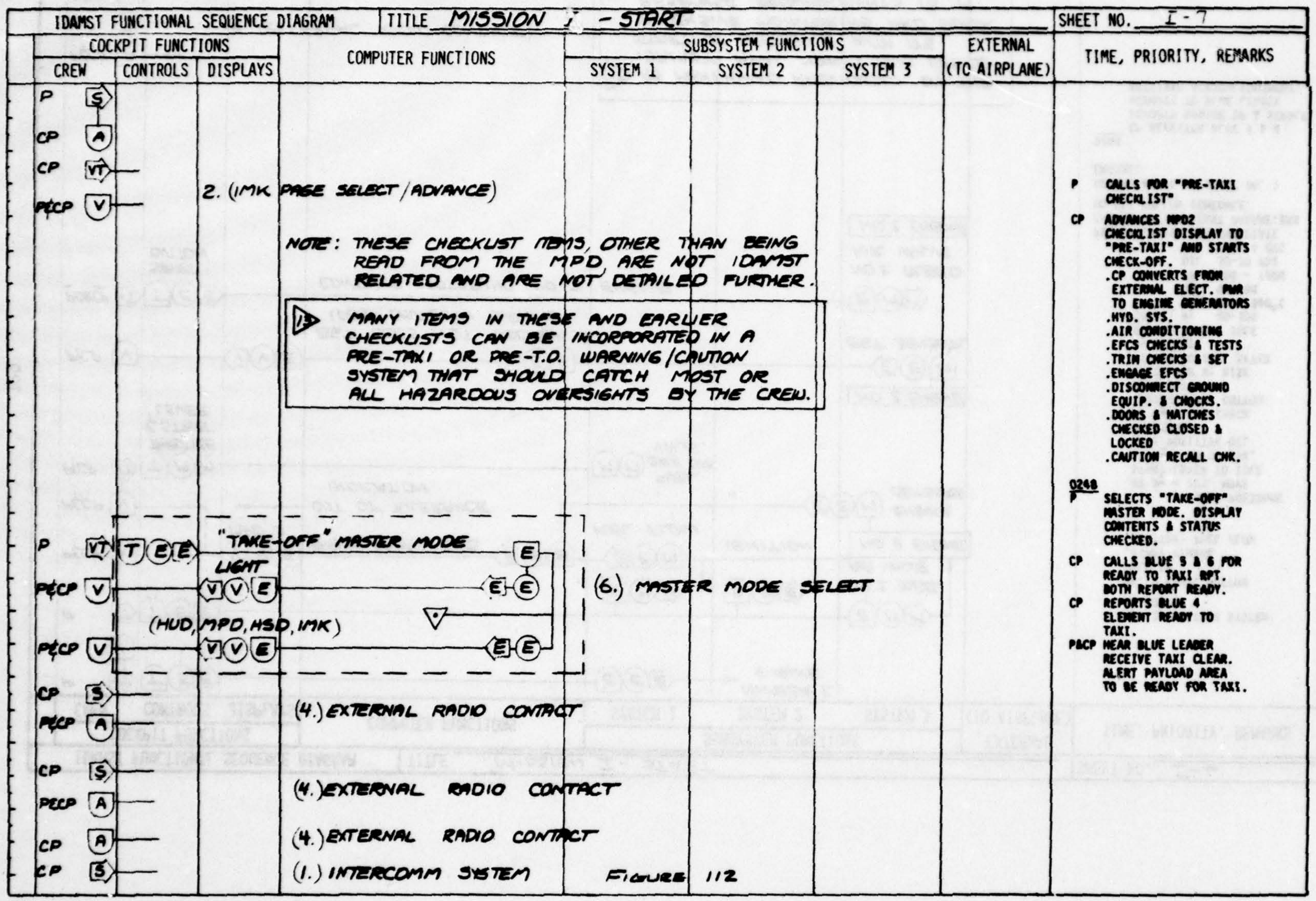

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - START
SHEET NO. I-6
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
P
P&CP
P/CP
P or CP
CP
NUMBER 2 ENGINE
NO. 2 BLEED AIR VALVE
NO. 2 ENGINE
ENGINE PARAMETERS
MPD 3
FUEL FLOW
IGNITION
ENGINE SENSORS
OUT OF TOLERANCE INDICATION
THROTTLE & START LEVER
FUEL SHUT OFF VALVE
EGT DOES NOT DECREASE (POST SHUTDOWN BURNING)
EGT SENSOR
CONTINUE MOTORING NO. 2 ENGINE
START BUTTON
4. (EXTERNAL RADIO CONTACT)
12 AS MENTIONED PREVIOUSLY BY THE IDAMST AFAL TEAM, THIS ENTIRE START-UP SEQUENCE WITH ITS EXTENSIVE MONITORING AND QUICK RESPONSE REQUIREMENTS IS A CANDIDATE FOR FUTURE IDAMST GROWTH STUDIES.
NO. 2 IGNITION SYSTEM ON BOTH.
NO. 2 START BUTTON - HOLD IN
.START TIMING
.MONITOR: FUEL FLOW
EGT
N2
DUCT PRESSURE
.AT N2 = 10%, MOVE START LEVER TO IDLE
.AT N2 = 20 TO 25%, NOTE POSITIVE OIL PRESSURE
.AT N2 = 40% CHECK ENGINE START BUTTON POPS OUT
.CHECK FOR N1 RISE WITHIN 30 SEC. AFTER N2 STABLE.
.ENGINE STABLE IDLE CHECK: N1 20-30%
EGT 300 - 500°C
N2 60-70%
FF 1500 - 1000
OIL 30-70 PSI
OIL 14 ± 4 QTS
P&CP PREPARED FOR IMMEDIATE ENGINE CUT IF START PARAMETERS DO NOT FOLLOW SCHEDULE.
REPEAT ABOVE TO START NO. 1 ENGINE.
0244
CP RECEIVES BLUE 5 & 6 REPORTS ENGINE UP & STABLE.
REPORTS TO BLUE LEADER
RECEIVES ACKNOWLEDGEMENT.

FIGURE 111


IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - START
SHEET NO. I-7
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TC AIRPLANE)
TIME, PRIORITY, REMARKS
2. (IMK PAGE SELECT/ADVANCE)
NOTE: THESE CHECKLIST ITEMS, OTHER THAN BEING READ FROM THE MPD ARE NOT IDAMST RELATED AND ARE NOT DETAILED FURTHER.
MANY ITEMS IN THESE AND EARLIER CHECKLISTS CAN BE INCORPORATED IN A PRE-TAXI OR PRE-T.O. WARNING/CAUTION SYSTEM THAT SHOULD CATCH MOST OR ALL HAZARDOUS OVERSIGHTS BY THE CREW.
"TAKE-OFF" MASTER MODE LIGHT
(HUD, MPD, HSD, IMK)
(6.) MASTER MODE SELECT
(4.) EXTERNAL RADIO CONTACT
(4.) EXTERNAL RADIO CONTACT
(4.) EXTERNAL RADIO CONTACT
(1.) INTERCOMM SYSTEM
P CALLS FOR "PRE-TAXI CHECKLIST"
CP ADVANCES MPD2 CHECKLIST DISPLAY TO "PRE-TAXI" AND STARTS CHECK-OFF.
.CP CONVERTS FROM EXTERNAL ELECT. PWR TO ENGINE GENERATORS
.HYD. SYS.
.AIR CONDITIONING
.EFCS CHECKS & TESTS
.TRIM CHECKS & SET
.ENGAGE EFCS
.DISCONNECT GROUND EQUIP. & CHOCKS.
.DOORS & HATCHES CHECKED CLOSED & LOCKED
.CAUTION RECALL CHK.
0248
P SELECTS "TAKE-OFF" MASTER MODE. DISPLAY CONTENTS & STATUS CHECKED.
CP CALLS BLUE 5 & 6 FOR READY TO TAXI RPT. BOTH REPORT READY.
CP REPORTS BLUE 4 ELEMENT READY TO TAXI.
P&CP HEAR BLUE LEADER RECEIVE TAXI CLEAR. ALERT PAYLOAD AREA TO BE READY FOR TAXI.
Figure 112

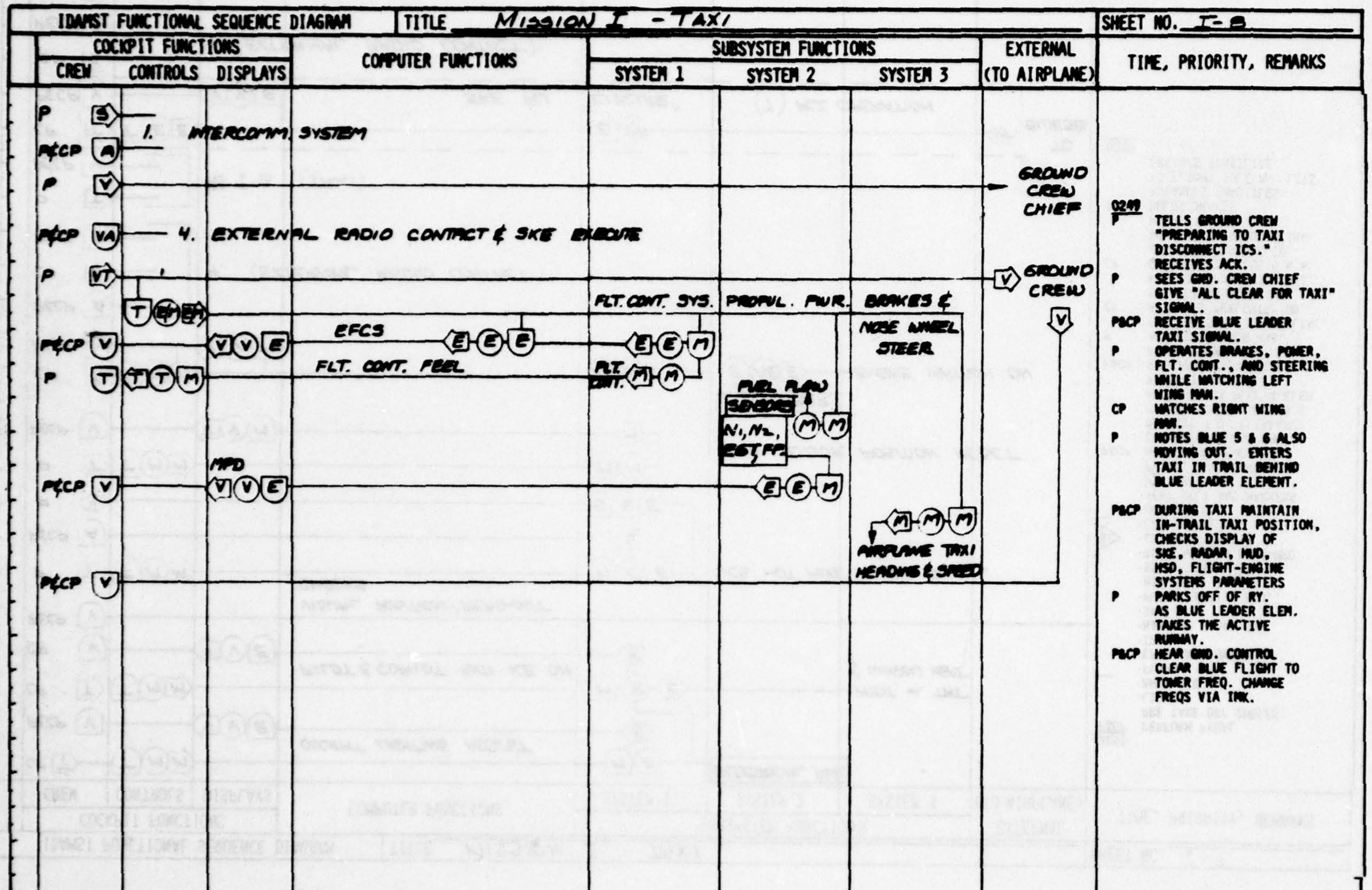
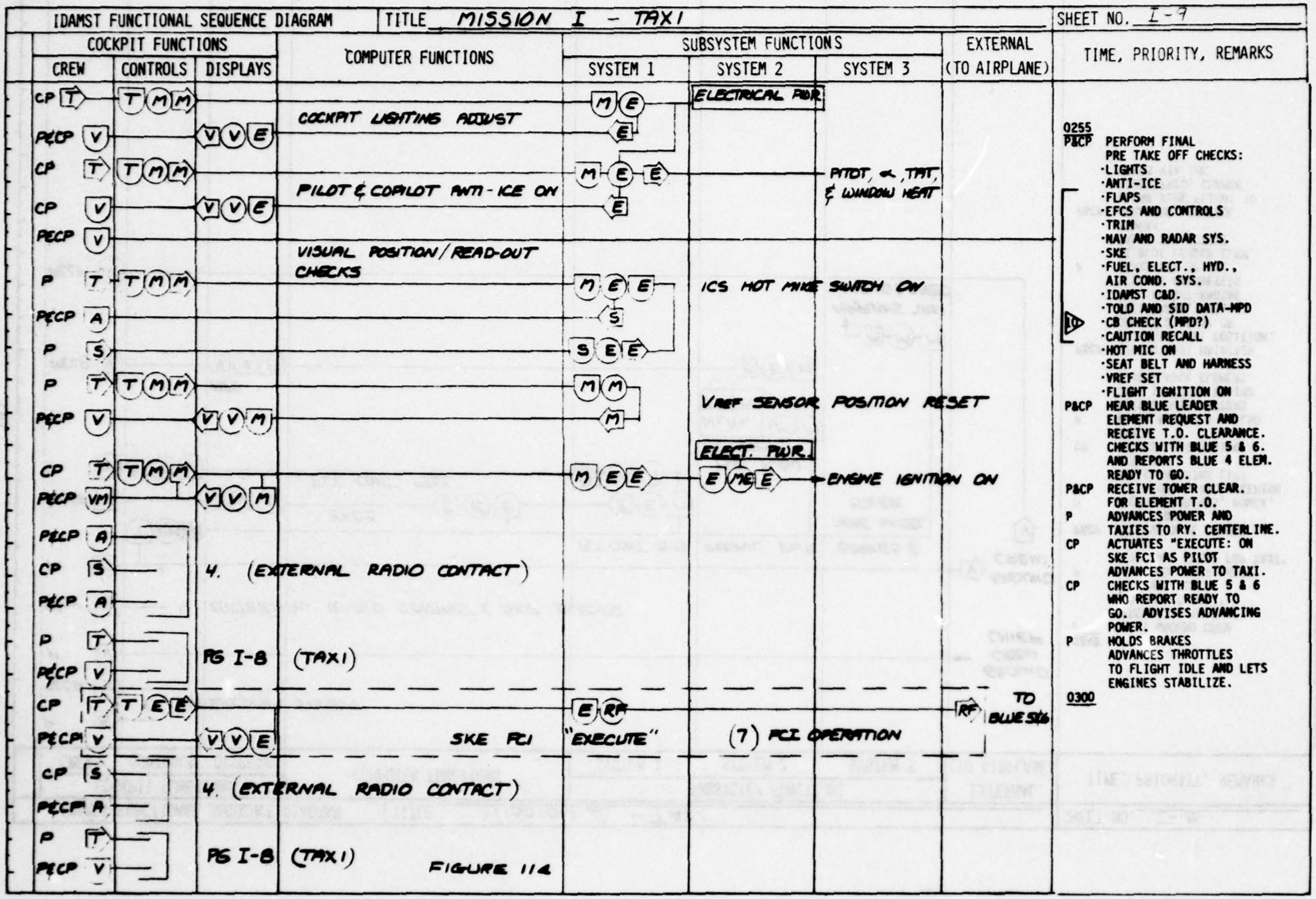

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - TAXI
SHEET NO. I-8
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
1. INTERCOMM SYSTEM
4. EXTERNAL RADIO CONTACT & SKE EXECUTE
GROUND CREW CHIEF
GROUND CREW
FLT. CONT. SYS.
PROPUL. PWR.
BRAKES & NOSE WHEEL STEER
EFCS
FLT. CONT. FEEL
FLT. CONT.
FUEL FLOW SENSORS
N1, N2, EGT, FF
MPD
AIRPLANE TAXI HEADING & SPEED
0249
P TELLS GROUND CREW "PREPARING TO TAXI DISCONNECT ICS." RECEIVES ACK.
P SEES GND. CREW CHIEF GIVE "ALL CLEAR FOR TAXI" SIGNAL.
P&CP RECEIVE BLUE LEADER TAXI SIGNAL.
P OPERATES BRAKES, POWER, FLT. CONT., AND STEERING WHILE WATCHING LEFT WING MAN.
CP WATCHES RIGHT WING MAN.
P NOTES BLUE 5 & 6 ALSO MOVING OUT. ENTERS TAXI IN TRAIL BEHIND BLUE LEADER ELEMENT.
P&CP DURING TAXI MAINTAIN IN-TRAIL TAXI POSITION, CHECKS DISPLAY OF SKE, RADAR, HUD, HSD, FLIGHT-ENGINE SYSTEMS PARAMETERS
P PARKS OFF OF RY. AS BLUE LEADER ELEM. TAKES THE ACTIVE RUNWAY.
P&CP HEAR GND. CONTROL CLEAR BLUE FLIGHT TO TOWER FREQ. CHANGE FREQS VIA INK.
0255
JSM

FIGURE 113



IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - TAXI
SHEET NO. I-9
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
ELECTRICAL PWR
COCKPIT LIGHTING ADJUST
PILOT & COPILOT ANTI-ICE ON
PITOT, α, TAT, & WINDOW HEAT
VISUAL POSITION/READ-OUT CHECKS
ICS HOT MIKE SWITCH ON
VREF SENSOR POSITION RESET
ELECT. PWR.
ENGINE IGNITION ON
4. (EXTERNAL RADIO CONTACT)
FG I-8 (TAXI)
SKE FCI
"EXECUTE"
(7) FCI OPERATION
TO BLUE 5&6
4. (EXTERNAL RADIO CONTACT)
FG I-8 (TAXI)
0255
P&CP PERFORM FINAL PRE TAKE OFF CHECKS:
·LIGHTS
·ANTI-ICE
·FLAPS
·EFCS AND CONTROLS
·TRIM
·NAV AND RADAR SYS.
·SKE
·FUEL, ELECT., HYD., AIR COND. SYS.
·IDAMST C&D.
·TOLD AND SID DATA-MPD
·CB CHECK (MPD?)
·CAUTION RECALL
·HOT MIC ON
·SEAT BELT AND HARNESS
·VREF SET
·FLIGHT IGNITION ON
P&CP HEAR BLUE LEADER ELEMENT REQUEST AND RECEIVE T.O. CLEARANCE. CHECKS WITH BLUE 5 & 6. AND REPORTS BLUE 4 ELEM. READY TO GO.
P&CP RECEIVE TOWER CLEAR. FOR ELEMENT T.O.
P ADVANCES POWER AND TAXIES TO RY. CENTERLINE.
CP ACTUATES "EXECUTE: ON SKE FCI AS PILOT ADVANCES POWER TO TAXI.
CP CHECKS WITH BLUE 5 & 6 WHO REPORT READY TO GO. ADVISES ADVANCING POWER.
P HOLDS BRAKES ADVANCES THROTTLES TO FLIGHT IDLE AND LETS ENGINES STABILIZE.
0300

FIGURE 114

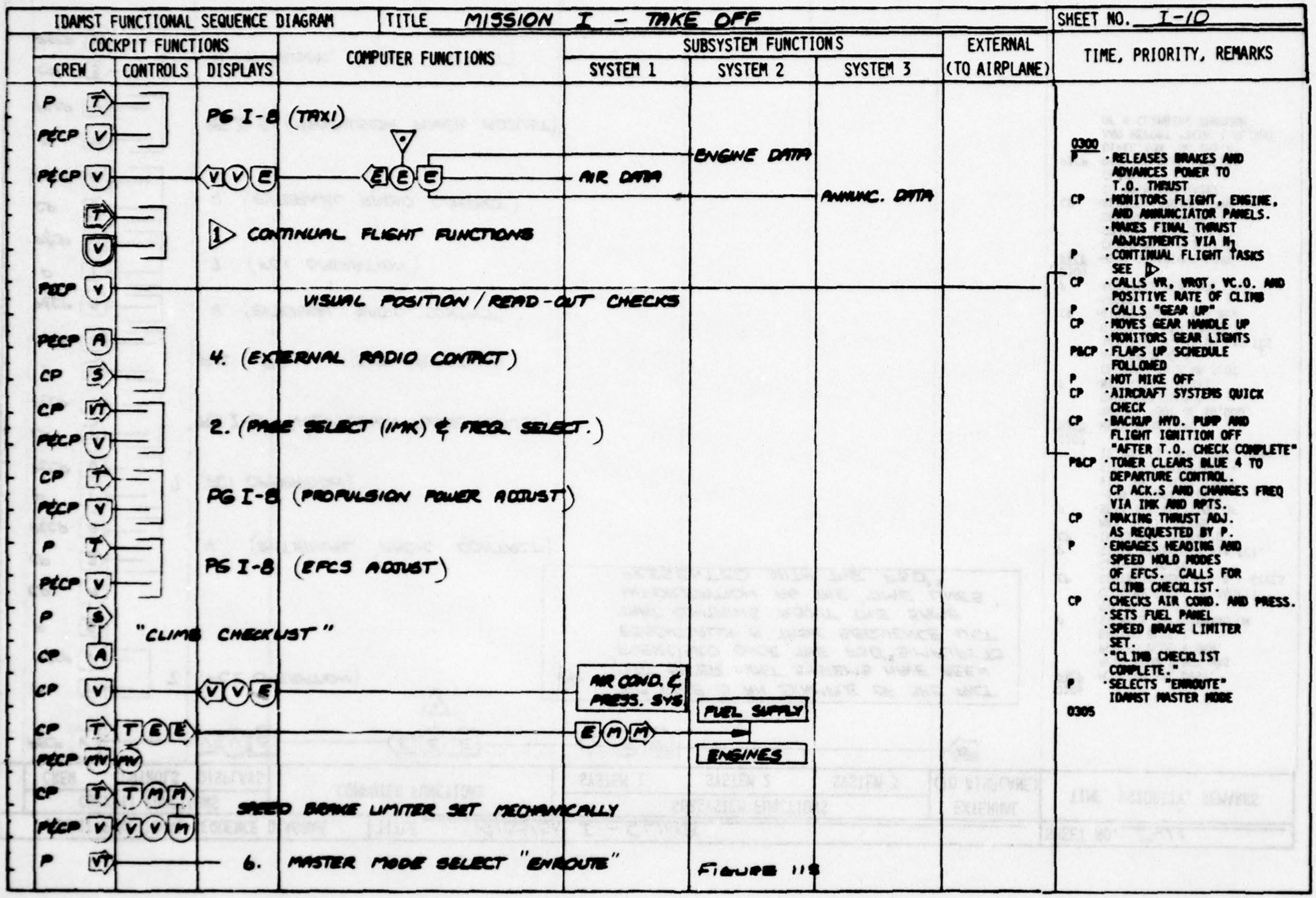

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - TAKE OFF
SHEET NO. I-10
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
PG I-8 (TAXI)
ENGINE DATA
AIR DATA
ANNUNC. DATA
CONTINUAL FLIGHT FUNCTIONS
VISUAL POSITION / READ-OUT CHECKS
4. (EXTERNAL RADIO CONTACT)
2. (PAGE SELECT (IMK) & FREQ. SELECT.)
PG I-8 (PROPULSION POWER ADJUST)
PG I-8 (EFCS ADJUST)
"CLIMB CHECKLIST"
AIR COND. & PRESS. SYS
FUEL SUPPLY
ENGINES
SPEED BRAKE LIMITER SET MECHANICALLY
6. MASTER MODE SELECT "ENROUTE"
0300
P · RELEASES BRAKES AND ADVANCES POWER TO T.O. THRUST
CP · MONITORS FLIGHT, ENGINE, AND ANNUNCIATOR PANELS.
· MAKES FINAL THRUST ADJUSTMENTS VIA N_1
P · CONTINUAL FLIGHT TASKS SEE 1
CP · CALLS VR, VROT, VC.O. AND POSITIVE RATE OF CLIMB
P · CALLS "GEAR UP"
CP · MOVES GEAR HANDLE UP · MONITORS GEAR LIGHTS
P&CP · FLAPS UP SCHEDULE FOLLOWED
P · HOT MIKE OFF
CP · AIRCRAFT SYSTEMS QUICK CHECK
CP · BACKUP HYD. PUMP AND FLIGHT IGNITION OFF "AFTER T.O. CHECK COMPLETE"
P&CP · TOWER CLEARS BLUE 4 TO DEPARTURE CONTROL. CP ACK.S AND CHANGES FREQ VIA IMK AND RPTS.
CP · MAKING THRUST ADJ. AS REQUESTED BY P.
P · ENGAGES HEADING AND SPEED HOLD MODES OF EFCS. CALLS FOR CLIMB CHECKLIST.
CP · CHECKS AIR COND. AND PRESS. · SETS FUEL PANEL · SPEED BRAKE LIMITER SET. · "CLIMB CHECKLIST COMPLETE."
P · SELECTS "ENROUTE" IDAMST MASTER MODE
0305

Figure 118

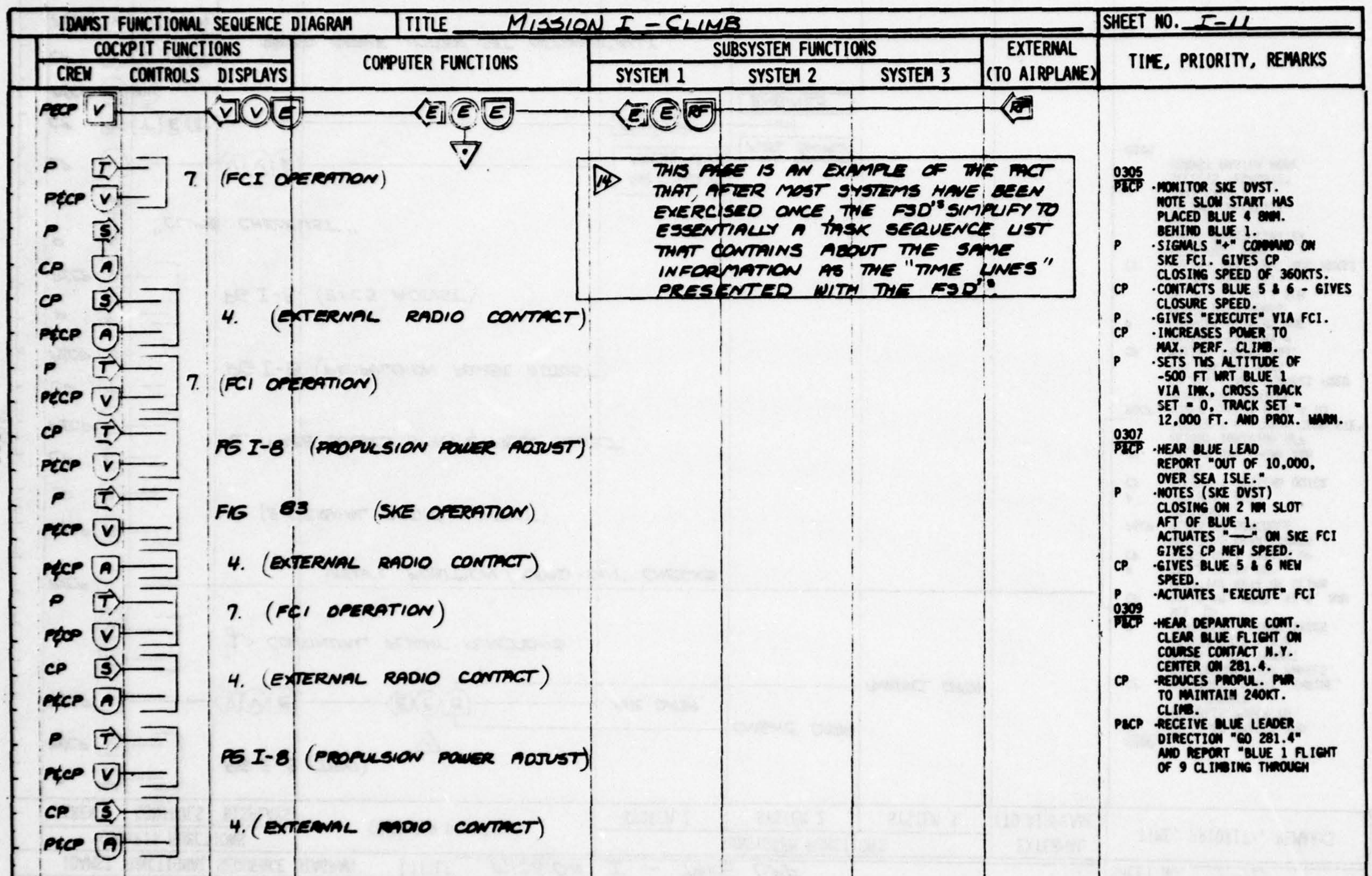

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - CLIMB
SHEET NO. I-11
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
P&CP V
P T
P&CP V
P S
CP A
CP S
P&CP A
P T
P&CP V
CP T
P&CP V
P T
P&CP V
P&CP A
P T
P&CP V
CP S
P&CP A
P T
P&CP V
CP S
P&CP A
7. (FCI OPERATION)
4. (EXTERNAL RADIO CONTACT)
7. (FCI OPERATION)
FS I-8 (PROPULSION POWER ADJUST)
FIG 83 (SKE OPERATION)
4. (EXTERNAL RADIO CONTACT)
7. (FCI OPERATION)
4. (EXTERNAL RADIO CONTACT)
FS I-8 (PROPULSION POWER ADJUST)
4. (EXTERNAL RADIO CONTACT)
14 THIS PAGE IS AN EXAMPLE OF THE FACT THAT, AFTER MOST SYSTEMS HAVE BEEN EXERCISED ONCE, THE FSD'S SIMPLIFY TO ESSENTIALLY A TASK SEQUENCE LIST THAT CONTAINS ABOUT THE SAME INFORMATION AS THE "TIME LINES" PRESENTED WITH THE FSD'S.
0305
P&CP ·MONITOR SKE DVST. NOTE SLOW START HAS PLACED BLUE 4 8NM. BEHIND BLUE 1.
P ·SIGNALS "+" COMMAND ON SKE FCI. GIVES CP CLOSING SPEED OF 360KTS.
CP ·CONTACTS BLUE 5 & 6 - GIVES CLOSURE SPEED.
P ·GIVES "EXECUTE" VIA FCI.
CP ·INCREASES POWER TO MAX. PERF. CLIMB.
P ·SETS TWS ALTITUDE OF -500 FT WRT BLUE 1 VIA IMK, CROSS TRACK SET = 0, TRACK SET = 12,000 FT. AND PROX. WARN.
0307
P&CP ·HEAR BLUE LEAD REPORT "OUT OF 10,000, OVER SEA ISLE."
P ·NOTES (SKE DVST) CLOSING ON 2 NM SLOT AFT OF BLUE 1. ACTUATES "—" ON SKE FCI GIVES CP NEW SPEED.
CP ·GIVES BLUE 5 & 6 NEW SPEED.
P ·ACTUATES "EXECUTE" FCI
0309
P&CP ·HEAR DEPARTURE CONT. CLEAR BLUE FLIGHT ON COURSE CONTACT N.Y. CENTER ON 281.4.
CP ·REDUCES PROPUL. PWR TO MAINTAIN 240KT. CLIMB.
P&CP ·RECEIVE BLUE LEADER DIRECTION "GO 281.4" AND REPORT "BLUE 1 FLIGHT OF 9 CLIMBING THROUGH

FIGURE 116

IDAMST FUNCTIONAL SEQUENCE DIAGRAM | TITLE Mission I - CLIMB | SHEET NO. I-12

COCKPIT FUNCTIONS: CREW	CONTROLS	DISPLAYS	COMPUTER FUNCTIONS	SUBSYSTEM FUNCTIONS: SYSTEM 1	SYSTEM 2	SYSTEM 3	EXTERNAL (TO AIRPLANE)	TIME, PRIORITY, REMARKS

Cockpit functions (crew):

P&CP (ST)
P&CP (A)
P&CP (T)
P&CP (V)
ETC.

Computer functions:

11. (EXTERNAL RADIO CONTACTS)

7. (FCI OPERATION)

Notes:

(Note 16) DURING THE CLIMB PERIOD THE CP CAN MONITOR THE NAVIGATION OUTPUTS AND ESTABLISH EARLY SYSTEM CREDULITY BY CROSS CHECKS WITH OTHER AIRCRAFT IN THE FORMATION.

(Note 17) EXPECTED GPS ACCURACIES PROVIDE A BACKUP REPLACEMENT POSSIBILITY FOR THE COMPLEX SKE (APN-169) SYSTEM. WITH ALL AIRCRAFT & GPS 3/4° ON A COMMON GRID PERFORMANCE SHOULD BE EQUIVALENT TO OR BETTER THAN THE PRESENT SKE SYSTEM. A DETAILED STUDY IS STRONGLY RECOMMENDED.

Time, priority, remarks:

P&CP ·HEAR N.Y. CENTER, "ROGER SQUAWK 3426 IDENT."
CP ·IDENT
P&CP ·HEAR N.Y. CENTER "BLUE 1 RADAR CONTACT CLIMB TO FL 370. SQUAWK 2400 OUT OF FL 230." AND BLUE 1 RESPONSE.
0312 P&CP ·HEAR N. Y. CENTER TO BLUE 1 "RECEIVED YOUR SQUAWK OUT OF 230, CLEARED ON COURSE. CONTACT ANDREWS AIRWAYS ON ___ OR 6756. RPT N.Y. CENTER OVER SHAD AND WHEN ANDREWS CONTACTED"
P&CP ·HEAR BLUE LEADER "ROGER COPIED. BLUE FLIGHT MONITOR ___."
CP ·CHANGES FREQ. TO ___ VIA INK AND HEARS BLUE 1 CALLING ANDREWS.
P&CP ·HEAR "BLUE 1 THIS IS ANDREWS."
P&CP ·HEAR BLUE 1 "ROGER ANDREWS BLUE 1 FLIGHT OF 9 CLIMBING TO FL 370. ESTIMATE SHAD AT 0173Z 39.13N - 74.14W NEXT."
P&CP ·HEAR ANDREWS ROGER BLUE 1. ANDREWS TAKING PRIMARY GUARD AT THIS TIME. MAINTAIN 13 PRIMARY, 67 SECONDARY. REPORT SHAD WITH YOUR ESTIMATE FOR 39.13N 74.14W.
0315 ·P&CP NOTE FORMATION IN POSITION AND FLIGHT APPROACHING 37,000 FT.

FIGURE 117

IDAMST FUNCTIONAL SEQUENCE DIAGRAM | TITLE MISSION I-RENDEZVOUS & AERIAL REFUEL | SHEET NO. I-13

COCKPIT FUNCTIONS: CREW	CONTROLS	DISPLAYS	COMPUTER FUNCTIONS	SUBSYSTEM FUNCTIONS: SYSTEM 1	SYSTEM 2	SYSTEM 3	EXTERNAL (TO AIRPLANE)
P&CP	V	FIG. 83	(SKE OPERATION)				
CP	T	FIG. "TBD"	(RADAR CONTROL SUBSYSTEM)				
P&CP	V						
CP	ST	4.	(EXTERNAL RADIO CONTACT)				
P&CP	A						
P	S						
CP	A						
CP	VT	6.	(MASTER MODE SELECT) "AIR REFUEL"				
P&CP	V						
CP	V	FIG. TBD	(RADAR CONTROL SUBSYSTEM)				
P&CP	A	4.	(EXTERNAL RADIO CONTACT)				
P&CP	V	7.	(FCI OPERATION)				
CP	T	FIG. I-8	(PROPULSION POWER ADJUST)				
P&CP	V						
CP	V	FIG. TBD	(RADAR CONTROL SUBSYSTEM)	RECOGNIZES TANKER BEACONS			
CP	S	1.	(INTERCOMM SYS)	REPORTING TANKER BEARING & DISTANCE			
P&CP	A	4.	(EXTERNAL RADIO CONTACT)				

TIME, PRIORITY, REMARKS

0640
P&CP ·MONITORING FORMATION STATUS ON SKE DVST
·CONTINUAL P&CP
CP ·READJUSTS RADAR (IN BCN. MODE) AT MAX. RANGE. LOOKS FOR TANKER IDENT. SIGNAL.
CP ·ATTEMPTS UHF CONTACT WITH DESIGNATED TANKER. (ESSO 67)
P ·REQUESTS AIR REFUELING CHECKLIST.
CP ·SELECTS "AIR REFUEL" MASTER MODE
CP ·NOTES POSSIBLE TANKER SIGNAL
CP ·IDENTS. AND VERIFIES TANKER
P&CP ·HEAR TANKER LEAD REQUESTED TO CONTINUE PRESENT COURSE.
CP ·STARTS AIR REFUEL CHECKLIST

0646
P&CP ·RECEIVE DESCENT COMMAND ON FCI
CP ·EXECUTE SIGNAL-FCI. ADJUSTS POWER FOR CRUISE DESCENT
P&CP ·MONITORING SKE AND RADAR DISPLAYS - CP REPORTS TANKERS 12 O'CLOCK-100 MILES.

0651
CP ·"TANKERS 12 O'CLOCK - 90 MILES."
CP ·"AIR REFUEL CHECKLIST COMPLETED"
P&CP ·RECEIVE "LEVEL OFF ON EXECUTE SIGNAL." INSTRUCTION.

FIGURE 118

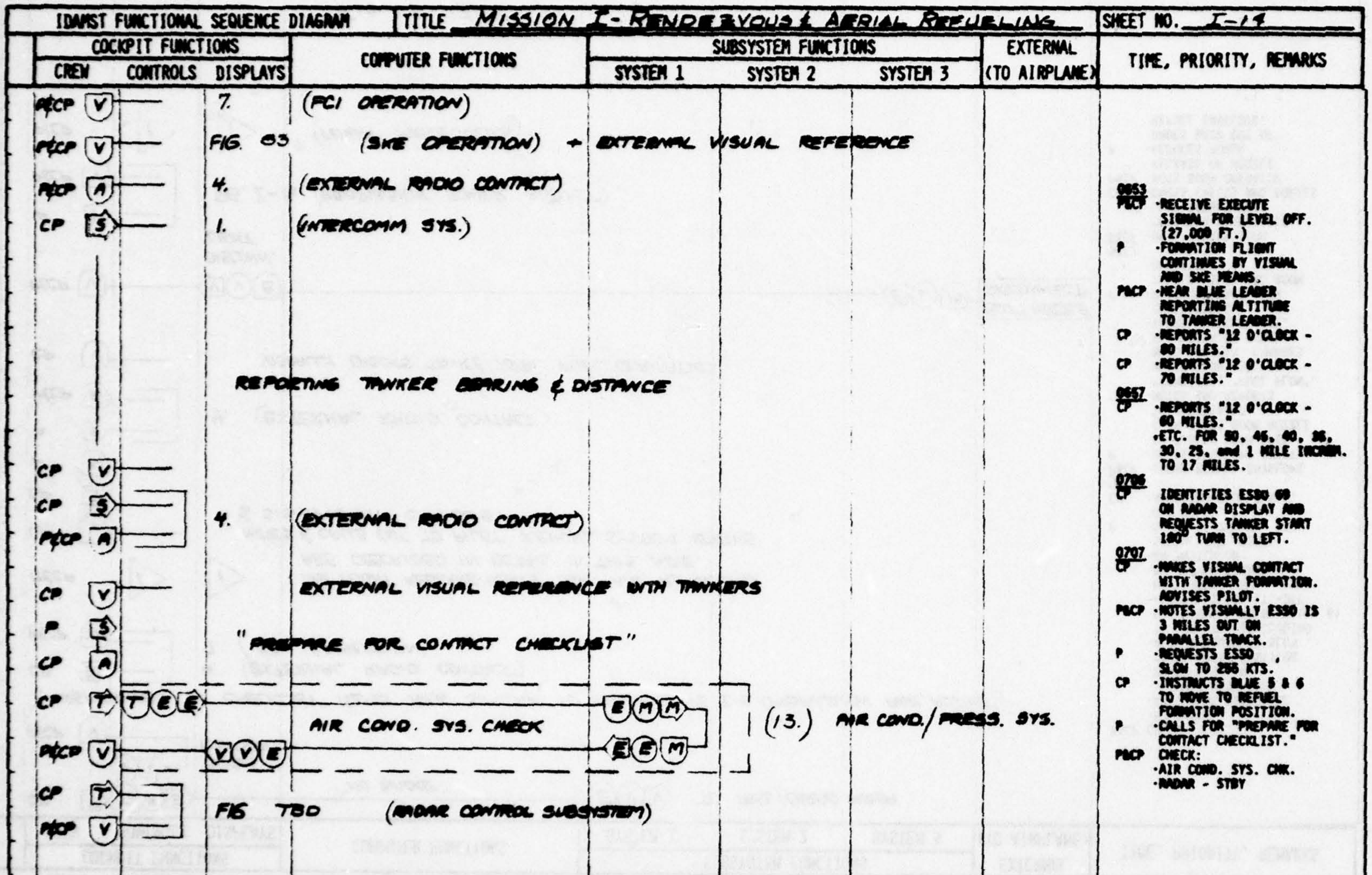

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I-RENDEZVOUS & AERIAL REFUELING
SHEET NO. I-14
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
P&CP
7.
(FCI OPERATION)
P&CP
FIG. 63
(SKE OPERATION) + EXTERNAL VISUAL REFERENCE
P&CP
4.
(EXTERNAL RADIO CONTACT)
CP
1.
(INTERCOMM SYS.)
REPORTING TANKER BEARING & DISTANCE
CP
CP
P&CP
4.
(EXTERNAL RADIO CONTACT)
CP
EXTERNAL VISUAL REFERENCE WITH TANKERS
P
CP
"PREPARE FOR CONTACT CHECKLIST"
CP
AIR COND. SYS. CHECK
P&CP
(13.) AIR COND./PRESS. SYS.
CP
P&CP
FIG TBD
(RADAR CONTROL SUBSYSTEM)
0653 P&CP ·RECEIVE EXECUTE SIGNAL FOR LEVEL OFF. (27,000 FT.)
P ·FORMATION FLIGHT CONTINUES BY VISUAL AND SKE MEANS.
P&CP ·HEAR BLUE LEADER REPORTING ALTITUDE TO TANKER LEADER.
CP ·REPORTS "12 O'CLOCK - 80 MILES."
CP ·REPORTS "12 O'CLOCK - 70 MILES."
0657 CP ·REPORTS "12 O'CLOCK - 60 MILES."
·ETC. FOR 50, 45, 40, 35, 30, 25, and 1 MILE INCREM. TO 17 MILES.
0706 CP IDENTIFIES ESSO 60 ON RADAR DISPLAY AND REQUESTS TANKER START 180° TURN TO LEFT.
0707 CP ·MAKES VISUAL CONTACT WITH TANKER FORMATION. ADVISES PILOT.
P&CP ·NOTES VISUALLY ESSO IS 3 MILES OUT ON PARALLEL TRACK.
P ·REQUESTS ESSO SLOW TO 255 KTS.
CP ·INSTRUCTS BLUE 5 & 6 TO MOVE TO REFUEL FORMATION POSITION.
P ·CALLS FOR "PREPARE FOR CONTACT CHECKLIST."
P&CP CHECK:
·AIR COND. SYS. CHK.
·RADAR - STBY

FIGURE 119

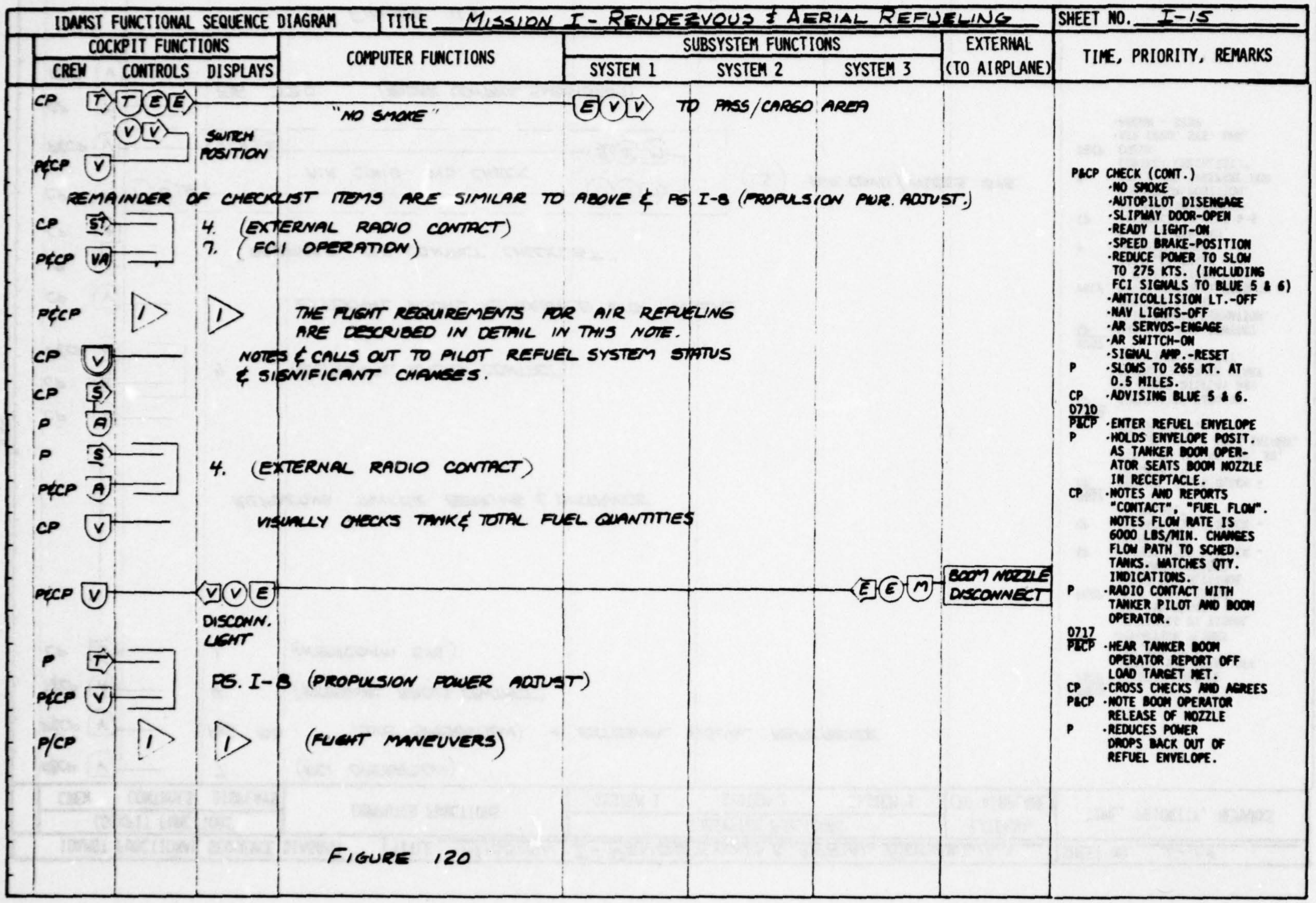

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - RENDEZVOUS & AERIAL REFUELING
SHEET NO. I-15
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
CP
"NO SMOKE"
TO PASS/CARGO AREA
SWITCH POSITION
P&CP
REMAINDER OF CHECKLIST ITEMS ARE SIMILAR TO ABOVE & PS I-B (PROPULSION PWR. ADJUST.)
CP
4. (EXTERNAL RADIO CONTACT)
P&CP
7. (FCI OPERATION)
P&CP
THE FLIGHT REQUIREMENTS FOR AIR REFUELING ARE DESCRIBED IN DETAIL IN THIS NOTE.
CP
NOTES & CALLS OUT TO PILOT REFUEL SYSTEM STATUS & SIGNIFICANT CHANGES.
CP
P
P
P&CP
4. (EXTERNAL RADIO CONTACT)
CP
VISUALLY CHECKS TANK & TOTAL FUEL QUANTITIES
P&CP
DISCONN. LIGHT
BOOM NOZZLE DISCONNECT
P
P&CP
PS. I-B (PROPULSION POWER ADJUST)
P/CP
(FLIGHT MANEUVERS)
P&CP CHECK (CONT.)
·NO SMOKE
·AUTOPILOT DISENGAGE
·SLIPWAY DOOR-OPEN
·READY LIGHT-ON
·SPEED BRAKE-POSITION
·REDUCE POWER TO SLOW TO 275 KTS. (INCLUDING FCI SIGNALS TO BLUE 5 & 6)
·ANTICOLLISION LT.-OFF
·NAV LIGHTS-OFF
·AR SERVOS-ENGAGE
·AR SWITCH-ON
·SIGNAL AMP.-RESET
P ·SLOWS TO 265 KT. AT 0.5 MILES.
CP ·ADVISING BLUE 5 & 6.
0710
P&CP ·ENTER REFUEL ENVELOPE
P ·HOLDS ENVELOPE POSIT. AS TANKER BOOM OPERATOR SEATS BOOM NOZZLE IN RECEPTACLE.
CP ·NOTES AND REPORTS "CONTACT", "FUEL FLOW". NOTES FLOW RATE IS 6000 LBS/MIN. CHANGES FLOW PATH TO SCHED. TANKS. WATCHES QTY. INDICATIONS.
P ·RADIO CONTACT WITH TANKER PILOT AND BOOM OPERATOR.
0717
P&CP ·HEAR TANKER BOOM OPERATOR REPORT OFF LOAD TARGET MET.
CP ·CROSS CHECKS AND AGREES
P&CP ·NOTE BOOM OPERATOR RELEASE OF NOZZLE
P ·REDUCES POWER DROPS BACK OUT OF REFUEL ENVELOPE.

FIGURE 120

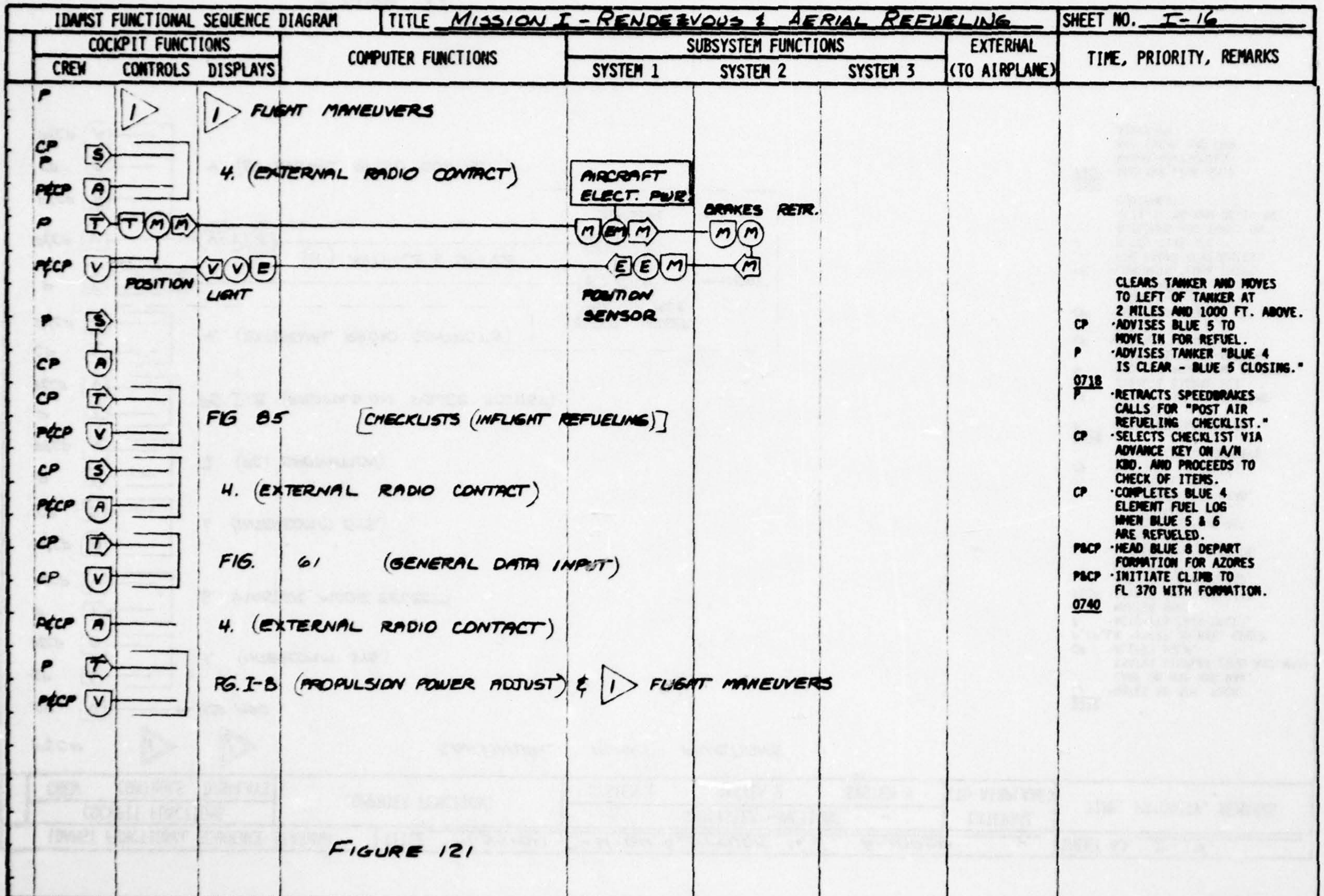

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - RENDEZVOUS & AERIAL REFUELING
SHEET NO. I-16
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
P
1 FLIGHT MANEUVERS
CP
P
P&CP
4. (EXTERNAL RADIO CONTACT)
AIRCRAFT ELECT. PWR.
P
BRAKES RETR.
P&CP
POSITION
LIGHT
POSITION SENSOR
P
CP
CP
FIG 85 [CHECKLISTS (INFLIGHT REFUELING)]
P&CP
CP
4. (EXTERNAL RADIO CONTACT)
P&CP
CP
FIG. 61 (GENERAL DATA INPUT)
CP
P&CP
4. (EXTERNAL RADIO CONTACT)
P
FG. I-8 (PROPULSION POWER ADJUST) & 1 FLIGHT MANEUVERS
P&CP
CLEARS TANKER AND MOVES TO LEFT OF TANKER AT 2 MILES AND 1000 FT. ABOVE.
CP ·ADVISES BLUE 5 TO MOVE IN FOR REFUEL.
P ·ADVISES TANKER "BLUE 4 IS CLEAR - BLUE 5 CLOSING."
0718
P ·RETRACTS SPEEDBRAKES CALLS FOR "POST AIR REFUELING CHECKLIST."
CP ·SELECTS CHECKLIST VIA ADVANCE KEY ON A/N KBD. AND PROCEEDS TO CHECK OF ITEMS.
CP ·COMPLETES BLUE 4 ELEMENT FUEL LOG WHEN BLUE 5 & 6 ARE REFUELED.
P&CP ·HEAD BLUE 8 DEPART FORMATION FOR AZORES
P&CP ·INITIATE CLIMB TO FL 370 WITH FORMATION.
0740

FIGURE 121

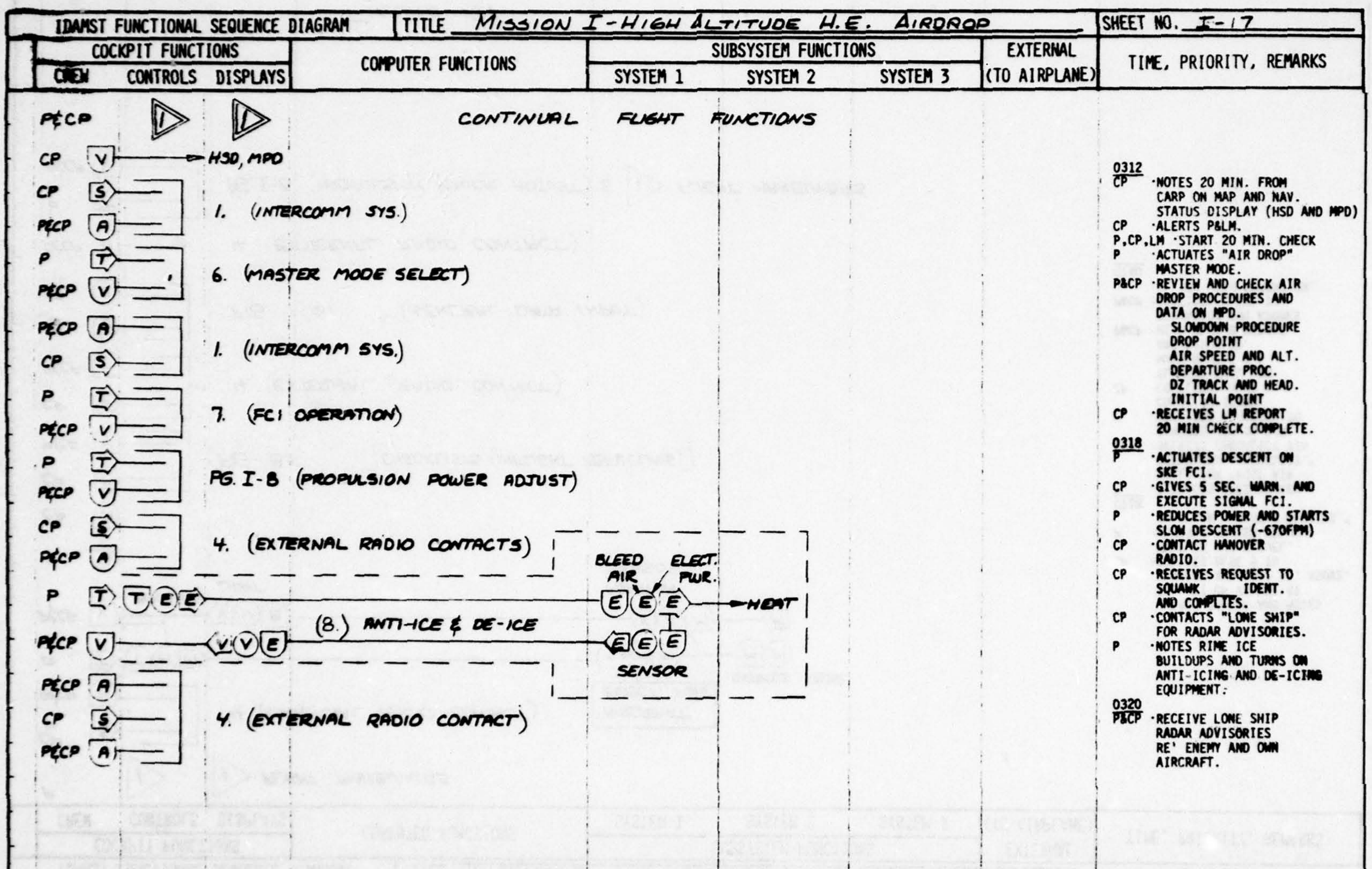
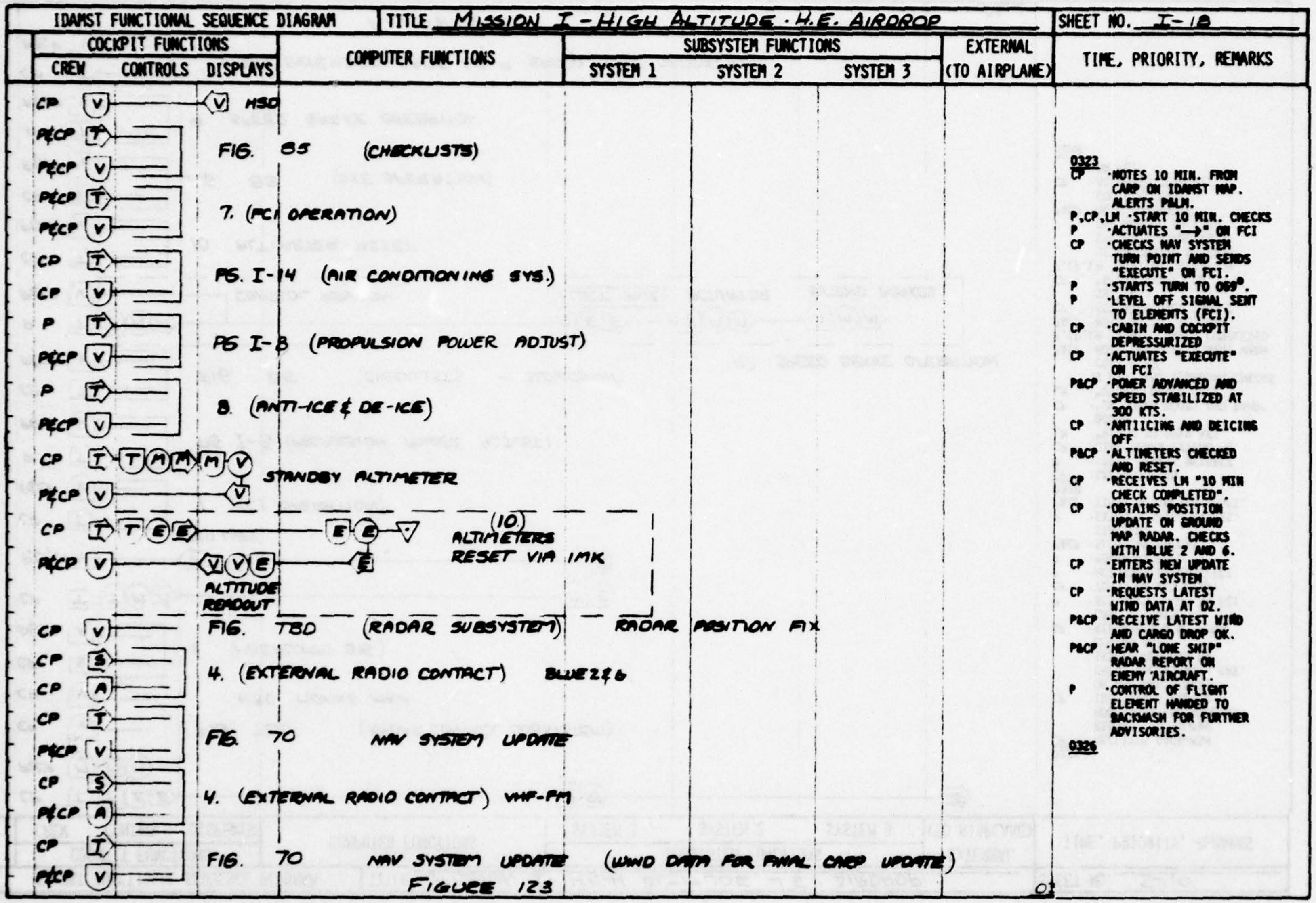
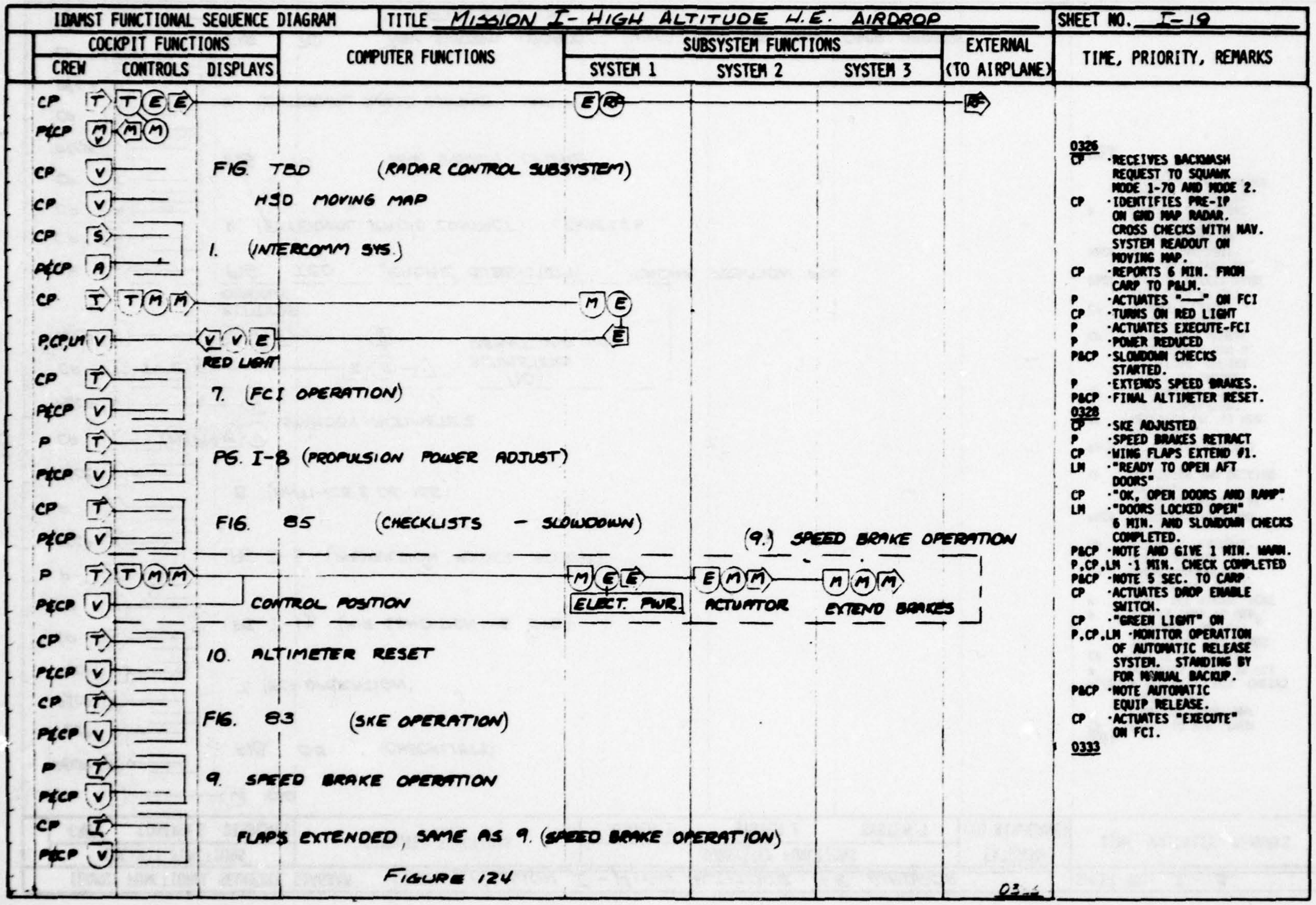

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - HIGH ALTITUDE H.E. AIRDROP
SHEET NO. I-17
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
P&CP
CONTINUAL FLIGHT FUNCTIONS
CP
HSD, MPD
CP
1. (INTERCOMM SYS.)
P&CP
P
6. (MASTER MODE SELECT)
P&CP
P&CP
1. (INTERCOMM SYS.)
CP
P
7. (FCI OPERATION)
P&CP
P
PG. I-8 (PROPULSION POWER ADJUST)
P&CP
CP
4. (EXTERNAL RADIO CONTACTS)
P&CP
BLEED AIR
ELECT. PWR.
P
HEAT
(8.) ANTI-ICE & DE-ICE
P&CP
SENSOR
P&CP
CP
4. (EXTERNAL RADIO CONTACT)
P&CP
0312
CP ·NOTES 20 MIN. FROM CARP ON MAP AND NAV. STATUS DISPLAY (HSD AND MPD)
CP ·ALERTS P&LM.
P,CP,LM ·START 20 MIN. CHECK
P ·ACTUATES "AIR DROP" MASTER MODE.
P&CP ·REVIEW AND CHECK AIR DROP PROCEDURES AND DATA ON MPD.
SLOWDOWN PROCEDURE
DROP POINT
AIR SPEED AND ALT.
DEPARTURE PROC.
DZ TRACK AND HEAD.
INITIAL POINT
CP ·RECEIVES LM REPORT 20 MIN CHECK COMPLETE.
0318
P ·ACTUATES DESCENT ON SKE FCI.
CP ·GIVES 5 SEC. WARN. AND EXECUTE SIGNAL FCI.
P ·REDUCES POWER AND STARTS SLOW DESCENT (-670FPM)
CP ·CONTACT HANOVER RADIO.
CP ·RECEIVES REQUEST TO SQUAWK IDENT. AND COMPLIES.
CP ·CONTACTS "LONE SHIP" FOR RADAR ADVISORIES.
P ·NOTES RIME ICE BUILDUPS AND TURNS ON ANTI-ICING AND DE-ICING EQUIPMENT:
0320
P&CP ·RECEIVE LONE SHIP RADAR ADVISORIES RE' ENEMY AND OWN AIRCRAFT.

FIGURE 122


IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I - HIGH ALTITUDE - H.E. AIRDROP
SHEET NO. I-18
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
CP
P&CP
P
MSD
FIG. 85 (CHECKLISTS)
7. (FCI OPERATION)
PS. I-14 (AIR CONDITIONING SYS.)
PS I-8 (PROPULSION POWER ADJUST)
8. (ANTI-ICE & DE-ICE)
STANDBY ALTIMETER
(10)
ALTIMETERS RESET VIA IMK
ALTITUDE READOUT
FIG. TBD (RADAR SUBSYSTEM)
RADAR POSITION FIX
4. (EXTERNAL RADIO CONTACT) BLUE 2 & 6
FIG. 70 NAV SYSTEM UPDATE
4. (EXTERNAL RADIO CONTACT) VHF-FM
FIG. 70 NAV SYSTEM UPDATE (WIND DATA FOR FINAL CARP UPDATE)
0323
CP ·NOTES 10 MIN. FROM CARP ON IDAMST MAP. ALERTS P&LM.
P,CP,LM ·START 10 MIN. CHECKS
P ·ACTUATES "→" ON FCI
CP ·CHECKS NAV SYSTEM TURN POINT AND SENDS "EXECUTE" ON FCI.
P ·STARTS TURN TO 069°.
P ·LEVEL OFF SIGNAL SENT TO ELEMENTS (FCI).
CP ·CABIN AND COCKPIT DEPRESSURIZED
CP ·ACTUATES "EXECUTE" ON FCI
P&CP ·POWER ADVANCED AND SPEED STABILIZED AT 300 KTS.
CP ·ANTIICING AND DEICING OFF
P&CP ·ALTIMETERS CHECKED AND RESET.
CP ·RECEIVES LM "10 MIN CHECK COMPLETED".
CP ·OBTAINS POSITION UPDATE ON GROUND MAP RADAR. CHECKS WITH BLUE 2 AND 6.
CP ·ENTERS NEW UPDATE IN NAV SYSTEM
CP ·REQUESTS LATEST WIND DATA AT DZ.
P&CP ·RECEIVE LATEST WIND AND CARGO DROP OK.
P&CP ·HEAR "LONE SHIP" RADAR REPORT ON ENEMY AIRCRAFT.
P ·CONTROL OF FLIGHT ELEMENT HANDED TO BACKWASH FOR FURTHER ADVISORIES.
0326
FIGURE 123


IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I- HIGH ALTITUDE H.E. AIRDROP
SHEET NO. I-19
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
FIG. TBD (RADAR CONTROL SUBSYSTEM)
HSD MOVING MAP
1. (INTERCOMM SYS.)
RED LIGHT
7. (FCI OPERATION)
PG. I-8 (PROPULSION POWER ADJUST)
FIG. 85 (CHECKLISTS - SLOWDOWN)
(9.) SPEED BRAKE OPERATION
CONTROL POSITION
ELECT. PWR.
ACTUATOR
EXTEND BRAKES
10. ALTIMETER RESET
FIG. 83 (SKE OPERATION)
9. SPEED BRAKE OPERATION
FLAPS EXTENDED, SAME AS 9. (SPEED BRAKE OPERATION)
0326
CP ·RECEIVES BACKWASH REQUEST TO SQUAWK MODE 1-70 AND MODE 2.
CP ·IDENTIFIES PRE-IP ON GND MAP RADAR. CROSS CHECKS WITH NAV. SYSTEM READOUT ON MOVING MAP.
CP ·REPORTS 6 MIN. FROM CARP TO P&LM.
P ·ACTUATES "—" ON FCI
CP ·TURNS ON RED LIGHT
P ·ACTUATES EXECUTE-FCI
P ·POWER REDUCED
P&CP ·SLOWDOWN CHECKS STARTED.
P ·EXTENDS SPEED BRAKES.
P&CP ·FINAL ALTIMETER RESET.
0328
CP ·SKE ADJUSTED
P ·SPEED BRAKES RETRACT
CP ·WING FLAPS EXTEND #1.
LM ·"READY TO OPEN AFT DOORS"
CP ·"OK, OPEN DOORS AND RAMP"
LM ·"DOORS LOCKED OPEN" 6 MIN. AND SLOWDOWN CHECKS COMPLETED.
P&CP ·NOTE AND GIVE 1 MIN. WARN.
P,CP,LM ·1 MIN. CHECK COMPLETED
P&CP ·NOTE 5 SEC. TO CARP
CP ·ACTUATES DROP ENABLE SWITCH.
CP ·"GREEN LIGHT" ON
P,CP,LM ·MONITOR OPERATION OF AUTOMATIC RELEASE SYSTEM. STANDING BY FOR MANUAL BACKUP.
P&CP ·NOTE AUTOMATIC EQUIP RELEASE.
CP ·ACTUATES "EXECUTE" ON FCI.
0333
FIGURE 124

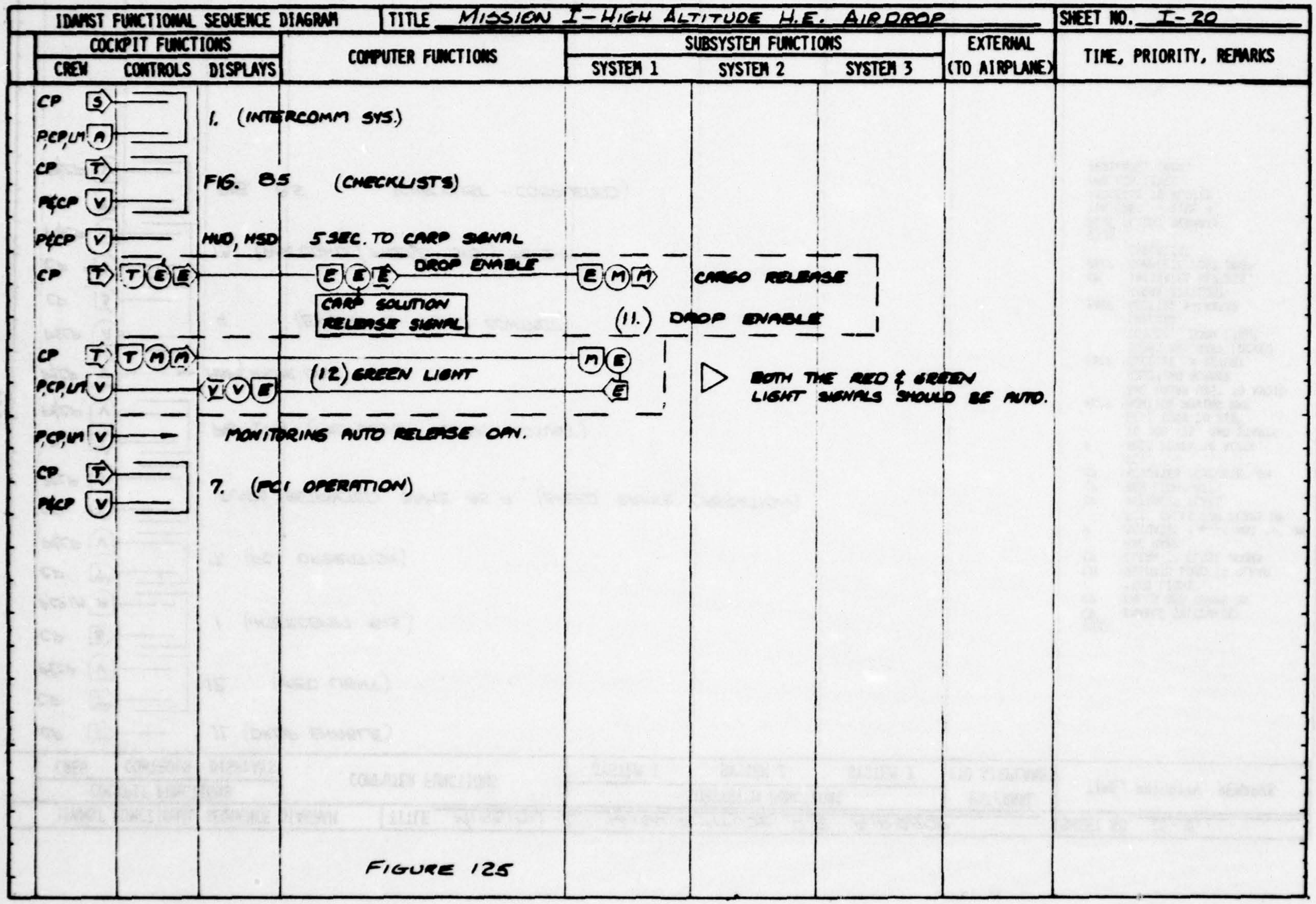

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION I–HIGH ALTITUDE H.E. AIRDROP
SHEET NO. I-20
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
CP
P,CP,LM
P&CP
1. (INTERCOMM SYS.)
FIG. 85 (CHECKLISTS)
HUD, HSD
5 SEC. TO CARP SIGNAL
DROP ENABLE
CARP SOLUTION RELEASE SIGNAL
CARGO RELEASE
(11.) DROP ENABLE
(12) GREEN LIGHT
BOTH THE RED & GREEN LIGHT SIGNALS SHOULD BE AUTO.
MONITORING AUTO RELEASE OPN.
7. (PCI OPERATION)

FIGURE 125

IDAMST FUNCTIONAL SEQUENCE DIAGRAM | TITLE MISSION I - HIGH ALTITUDE H.E. AIRDROP | SHEET NO. I-21

Cockpit Functions: Crew	Cockpit Functions: Controls	Cockpit Functions: Displays / Computer Functions	Subsystem Functions: System 1	Subsystem Functions: System 2	Subsystem Functions: System 3	External (To Airplane)
CP	T	11. (DROP ENABLE)				
CP	T	12. (RED LIGHT)				
P&CP	V					
CP	S	1. (INTERCOMM SYS.)				
P,CP,LM	A					
CP	T	7. (FCI OPERATION)				
P&CP	V					
CP	T	FLAPS RETRACTED, SAME AS 9. (SPEED BRAKE OPERATION)				
P&CP	V					
P	T	FG I-8 (PROPULSION POWER ADJUST)				
P&CP	V					
P&CP	V	→ MAP & RADAR DIST				
P&CP	A	4. (EXTERNAL RADIO CONTACT)				
CP	S					
CP	T	13. (AIR COND./PRESS. SYS.) FG. I-14				
P&CP	V					
CP	T	FIG. 85 (CHECKLIST - COMPLETED)				
P&CP	V					

TIME, PRIORITY, REMARKS

0333
- CP ·ENABLE SWITCH-OFF
- CP ·CALLS AND TURNS ON "RED LIGHT".
- LM ·REPORTS LOAD IS CLEAR
- CP ·CLEAR TO CLOSE DOORS AND RAMP.
- P ·ACTUATES "←" AND "+" ON FCI. CALLS FOR FLAPS UP.
- CP ·RETRACTS FLAPS.
- CP ·RED LIGHT-OFF.
- CP ·ACTUATES "EXECUTE" ON FCI.
- P ·ADDS POWER TO ACCEL. TO 300 KTS. AND STARTS LEFT TURN TO 312°
- P&CP ·MONITOR MOVING MAP AND RADAR DIST TO AVOID CROSSING BORDER.
- P&CP ·RECEIVE LM REPORT DOORS AND RAMP LOCKED CLOSED. DOOR LIGHT CHECKED.
- P&CP ·RECEIVE BACKWASH RADAR ADVISORY.
- CP ·INITIATES REPRESS.
- P&CP ·COMPLETE POST DROP CHECKLIST

0336
BLUE FLIGHT DEPARTS FOR EDEO -- BLUE 4 PROCEEDS TO KLOTZE FOR LOW LEVEL PERSONNEL DROP.

FIGURE 126

IDAMST FUNCTIONAL SEQUENCE DIAGRAM | TITLE MISSION III - SHORT LANDING WOLFSBURG | SHEET NO. III-1

CREW	CONTROLS / DISPLAYS	COMPUTER FUNCTIONS	SYSTEM 1	SYSTEM 2	SYSTEM 3	EXTERNAL (TO AIRPLANE)
P&CP	A	4. (EXTERNAL RADIO CONTACT, FIG. I-5)				
CP	S					
CP	S					
P&CP	A	1. (INTERCOMM SYSTEM FIG I-2)				
CP	T					
P&CP	V	FIG. 70 (NAV. SYSTEM UPDATE)				
CP	T					
P&CP	V	FIG 72 (NEW WAYPOINTS)				
P	T					
P&CP	V	FIG. I-8 (EFCS ADJUST)				
P&CP	A	1. (INTERCOMM SYSTEM, FIG. I-2)				
CP	S					
P&CP	V					V UELZEN
P	◇ NO UPDATE					
P&CP	V — MPD-MAP					
P	T	FIG I-8 (EFCS ADJUST)				
P&CP	V					
CP	S	4 (EXTERNAL RADIO CONTACT)				
P&CP	A					
P	S REQUESTS CHECKLIST					
CP	A					
CP	T					
P&CP	V	FIG. 86 (CHECKLISTS)				

TIME, PRIORITY, REMARKS

1030

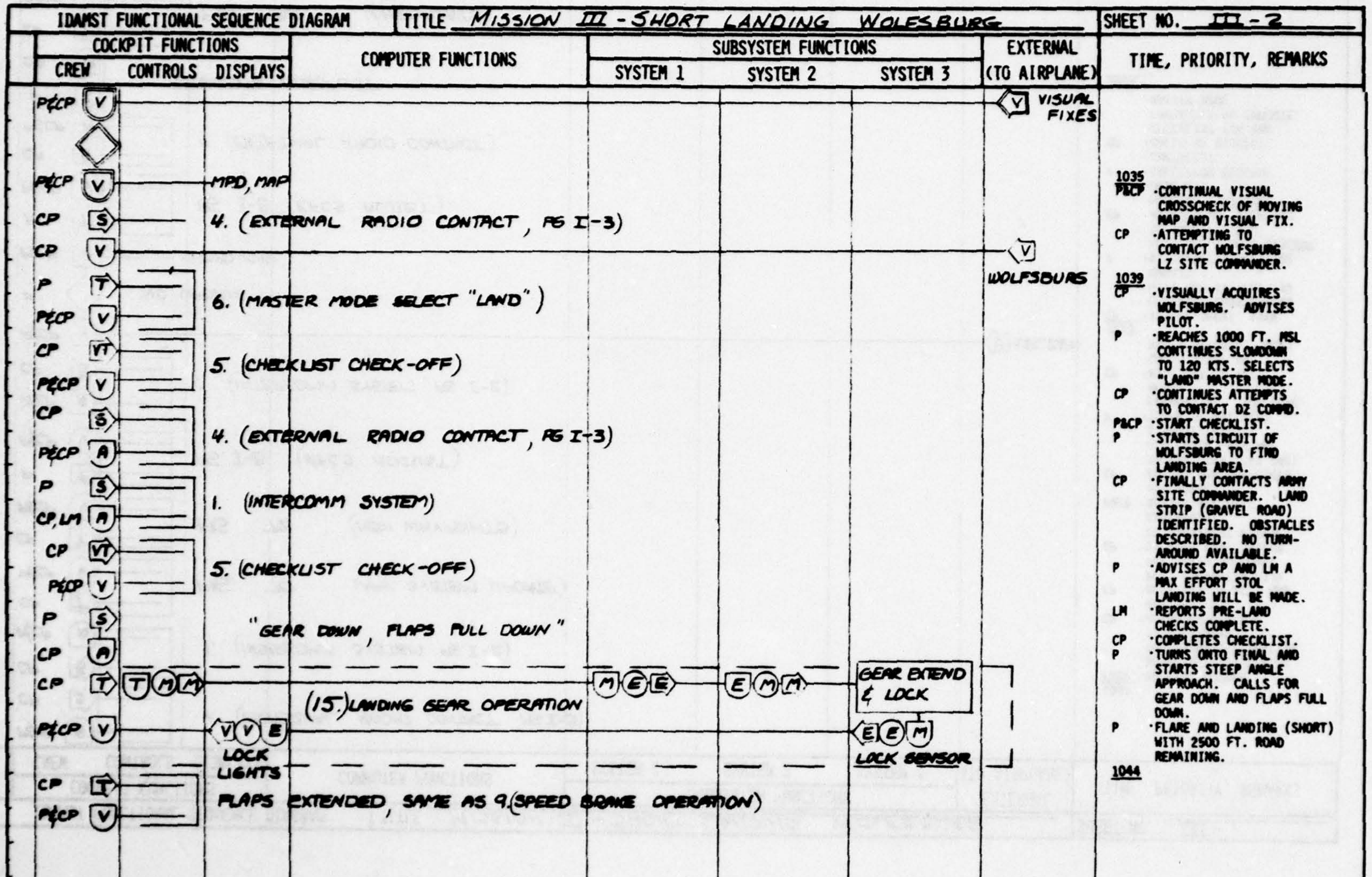
- P&CP · RECEIVE BREMERHAVEN ALCE DIRECTION TO CHANGE DESTINATION TO WOLFSBURG.
- CP · ACKNOWLEDGES AND ADVISES LM.
- CP · RECEIVES LM ACT. AND RPT. PREPARING LOAD FOR RAPID OFFLOAD.
- CP · UPDATES NAV. SYSTEM ON PROMINENT VISUAL CHECKPOINT.
- P&CP · REVIEW NEW DEST. AND ROUTE.
- CP · ENTERS NEW WAYPOINTS IN NAV. SYS. (BY IMK) AND CHECKS NEW MAP DISPLAY (HSD).
- P · TURNS TO NEW HEAD. ENGAGES ALT. AND HEAD. HOLD.
- CP · RECEIVES LM RPT. CARGO READY FOR RAPID OFFLOAD. ACKS.

1033

- CP · VISUAL IDENT. OVER UELZEN. CROSSCHECKS WITH NAV SYSTEM. NO UPDATE.
- P · DISCONNECTS ALTITUDE HOLD AND STARTS DESCENT TO 1000 FT. MSL.
- CP · ADVISES BACKWASH AND HANOVER STARTING DESCENT.
- P · CALLS FOR DESCENT CHECKLIST.
- CP · CALLS UP DESCENT CHECKLIST VIA IMK. PRESENTLY IN ENROUTE MASTER MODE.

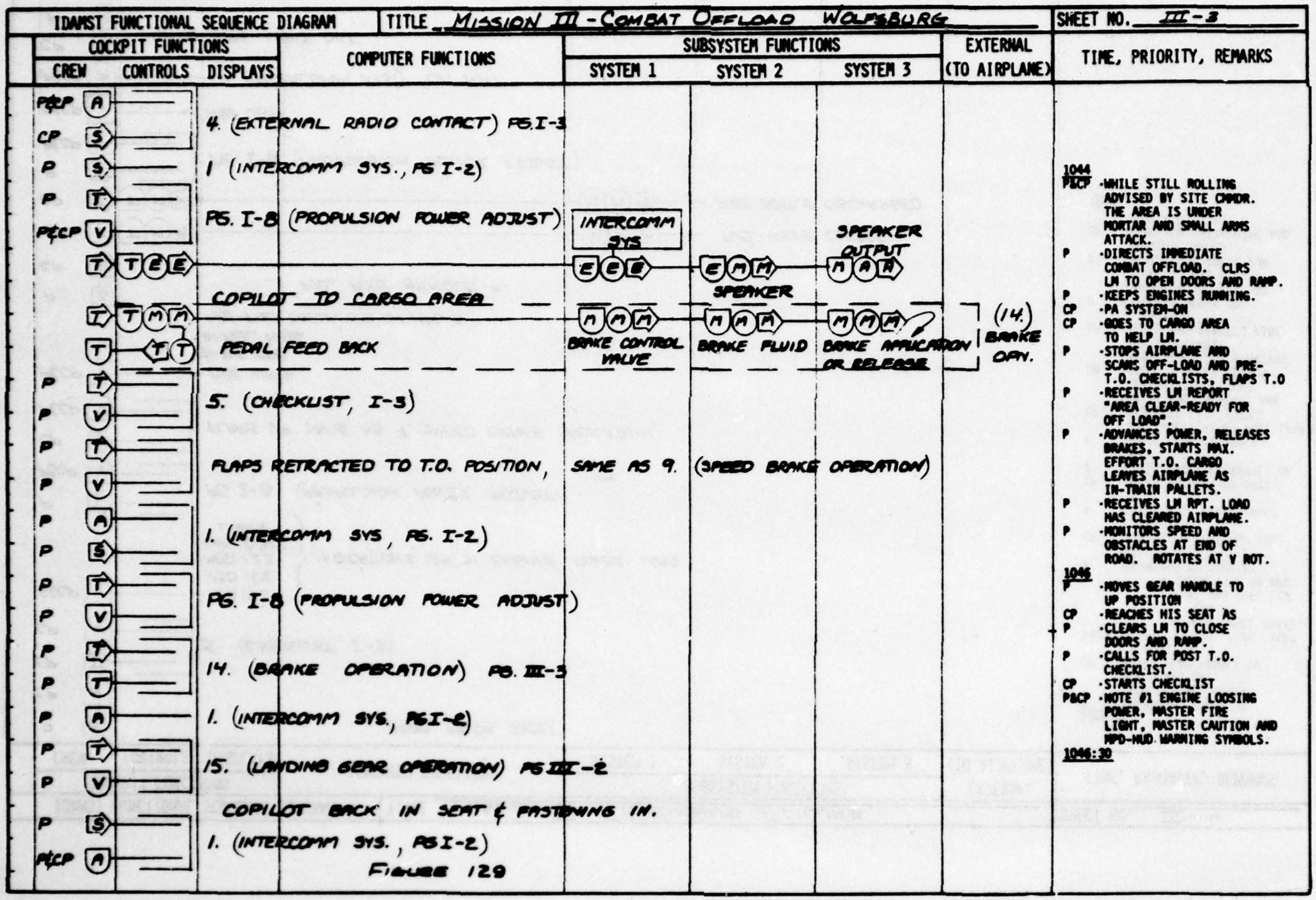
1035

FIGURE 127



IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION III - SHORT LANDING WOLFSBURG
SHEET NO. III - 2
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
VISUAL FIXES
MPD, MAP
4. (EXTERNAL RADIO CONTACT, FG I-3)
WOLFSBURG
6. (MASTER MODE SELECT "LAND")
5. (CHECKLIST CHECK-OFF)
4. (EXTERNAL RADIO CONTACT, FG I-3)
1. (INTERCOMM SYSTEM)
5. (CHECKLIST CHECK-OFF)
"GEAR DOWN, FLAPS FULL DOWN"
(15.) LANDING GEAR OPERATION
GEAR EXTEND & LOCK
LOCK LIGHTS
LOCK SENSOR
FLAPS EXTENDED, SAME AS 9.(SPEED BRAKE OPERATION)
P&CP
CP
P
CP,LM
1035 P&CP ·CONTINUAL VISUAL CROSSCHECK OF MOVING MAP AND VISUAL FIX.
CP ·ATTEMPTING TO CONTACT WOLFSBURG LZ SITE COMMANDER.
1039 CP ·VISUALLY ACQUIRES WOLFSBURG. ADVISES PILOT.
P ·REACHES 1000 FT. MSL CONTINUES SLOWDOWN TO 120 KTS. SELECTS "LAND" MASTER MODE.
CP ·CONTINUES ATTEMPTS TO CONTACT DZ COMMD.
P&CP ·START CHECKLIST.
P ·STARTS CIRCUIT OF WOLFSBURG TO FIND LANDING AREA.
CP ·FINALLY CONTACTS ARMY SITE COMMANDER. LAND STRIP (GRAVEL ROAD) IDENTIFIED. OBSTACLES DESCRIBED. NO TURN-AROUND AVAILABLE.
P ·ADVISES CP AND LM A MAX EFFORT STOL LANDING WILL BE MADE.
LM ·REPORTS PRE-LAND CHECKS COMPLETE.
CP ·COMPLETES CHECKLIST.
P ·TURNS ONTO FINAL AND STARTS STEEP ANGLE APPROACH. CALLS FOR GEAR DOWN AND FLAPS FULL DOWN.
P ·FLARE AND LANDING (SHORT) WITH 2500 FT. ROAD REMAINING.
1044

FIGURE 128


IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION III - COMBAT OFFLOAD WOLFSBURG
SHEET NO. III-3
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
P&CP A
CP S
P S
P T
P&CP V
T T E E
T T M M
T T T
P T
P V
P T
P V
P A
P S
P T
P V
P T
P T
P A
P T
P V
P S
P&CP A
4. (EXTERNAL RADIO CONTACT) PG. I-3
1 (INTERCOMM SYS., PG I-2)
PG. I-8 (PROPULSION POWER ADJUST)
INTERCOMM SYS
E E E
E M M
SPEAKER
M A M
SPEAKER OUTPUT
COPILOT TO CARGO AREA
M M M
BRAKE CONTROL VALVE
BRAKE FLUID
BRAKE APPLICATION OR RELEASE
(14.) BRAKE OPN.
PEDAL FEED BACK
5. (CHECKLIST, I-3)
FLAPS RETRACTED TO T.O. POSITION, SAME AS 9. (SPEED BRAKE OPERATION)
1. (INTERCOMM SYS, PG. I-2)
PG. I-8 (PROPULSION POWER ADJUST)
14. (BRAKE OPERATION) PG. III-3
1. (INTERCOMM SYS., PG I-2)
15. (LANDING GEAR OPERATION) PG III-2
COPILOT BACK IN SEAT & FASTENING IN.
1. (INTERCOMM SYS., PG I-2)
1044
P&CP ·WHILE STILL ROLLING ADVISED BY SITE CMDR. THE AREA IS UNDER MORTAR AND SMALL ARMS ATTACK.
P ·DIRECTS IMMEDIATE COMBAT OFFLOAD. CLRS LM TO OPEN DOORS AND RAMP.
P ·KEEPS ENGINES RUNNING.
CP ·PA SYSTEM-ON
CP ·GOES TO CARGO AREA TO HELP LM.
P ·STOPS AIRPLANE AND SCANS OFF-LOAD AND PRE-T.O. CHECKLISTS, FLAPS T.O
P ·RECEIVES LM REPORT "AREA CLEAR-READY FOR OFF LOAD".
P ·ADVANCES POWER, RELEASES BRAKES, STARTS MAX. EFFORT T.O. CARGO LEAVES AIRPLANE AS IN-TRAIN PALLETS.
P ·RECEIVES LM RPT. LOAD HAS CLEARED AIRPLANE.
P ·MONITORS SPEED AND OBSTACLES AT END OF ROAD. ROTATES AT V ROT.
1046
P ·MOVES GEAR HANDLE TO UP POSITION
CP ·REACHES HIS SEAT AS
P ·CLEARS LM TO CLOSE DOORS AND RAMP.
P ·CALLS FOR POST T.O. CHECKLIST.
CP ·STARTS CHECKLIST
P&CP ·NOTE #1 ENGINE LOOSING POWER, MASTER FIRE LIGHT, MASTER CAUTION AND MPD-HUD WARNING SYMBOLS.
1046:30
Figure 129

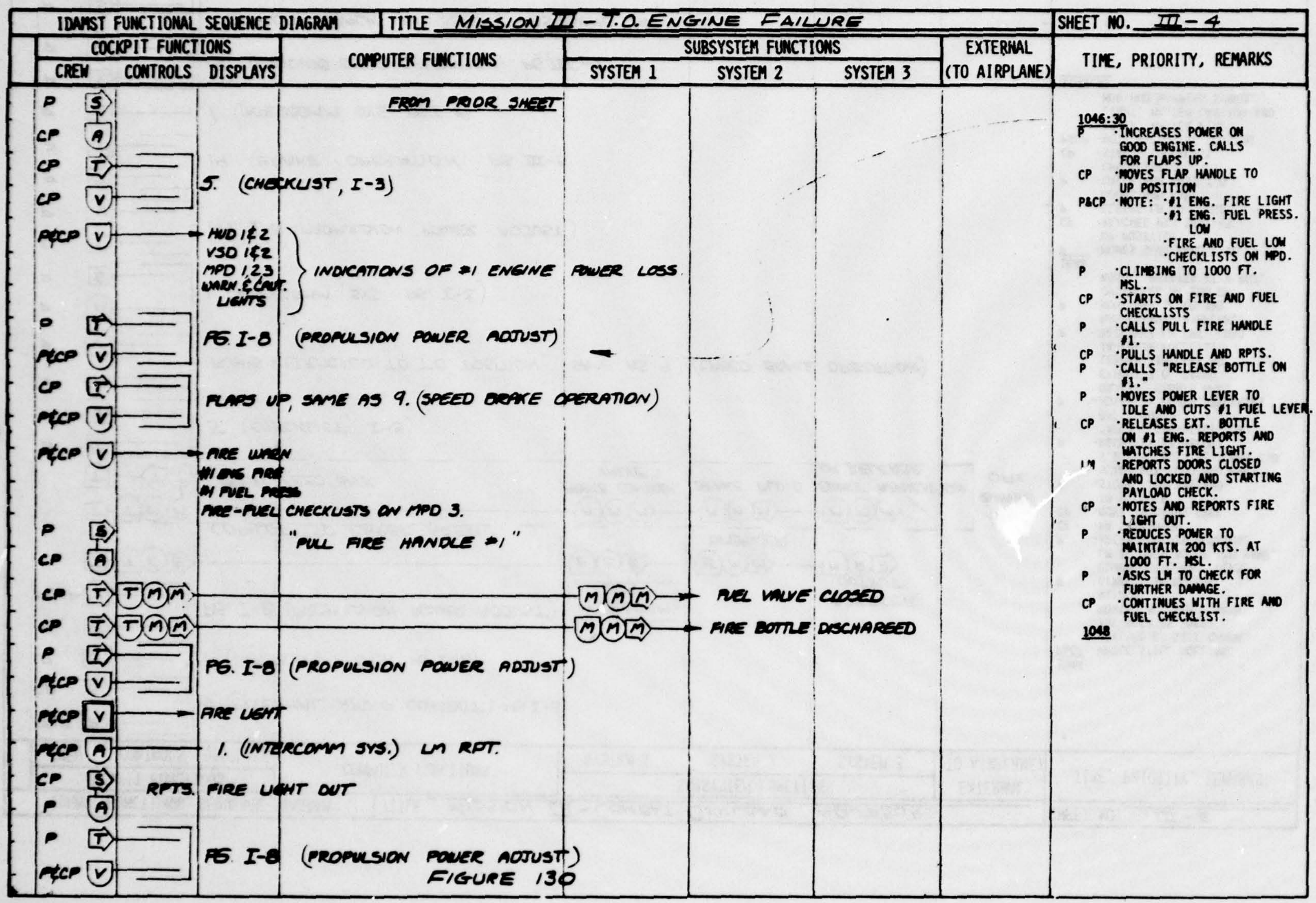

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION III - T.O. ENGINE FAILURE
SHEET NO. III - 4
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
FROM PRIOR SHEET
5. (CHECKLIST, I-3)
HUD 1 & 2
VSD 1 & 2
MPD 1,2,3
WARN. & CAUT. LIGHTS
INDICATIONS OF #1 ENGINE POWER LOSS
FG. I-8 (PROPULSION POWER ADJUST)
FLAPS UP, SAME AS 9. (SPEED BRAKE OPERATION)
FIRE WARN
#1 ENG FIRE
#1 FUEL PRESS
FIRE-FUEL CHECKLISTS ON MPD 3.
"PULL FIRE HANDLE #1"
FUEL VALVE CLOSED
FIRE BOTTLE DISCHARGED
FG. I-8 (PROPULSION POWER ADJUST)
FIRE LIGHT
1. (INTERCOMM SYS.) LM RPT.
RPTS. FIRE LIGHT OUT
FG. I-8 (PROPULSION POWER ADJUST)
1046:30
P ·INCREASES POWER ON GOOD ENGINE. CALLS FOR FLAPS UP.
CP ·MOVES FLAP HANDLE TO UP POSITION
P&CP ·NOTE: ·#1 ENG. FIRE LIGHT
·#1 ENG. FUEL PRESS. LOW
·FIRE AND FUEL LOW
·CHECKLISTS ON MPD.
P ·CLIMBING TO 1000 FT. MSL.
CP ·STARTS ON FIRE AND FUEL CHECKLISTS
P ·CALLS PULL FIRE HANDLE #1.
CP ·PULLS HANDLE AND RPTS.
P ·CALLS "RELEASE BOTTLE ON #1."
P ·MOVES POWER LEVER TO IDLE AND CUTS #1 FUEL LEVER.
CP ·RELEASES EXT. BOTTLE ON #1 ENG. REPORTS AND WATCHES FIRE LIGHT.
LM ·REPORTS DOORS CLOSED AND LOCKED AND STARTING PAYLOAD CHECK.
CP ·NOTES AND REPORTS FIRE LIGHT OUT.
P ·REDUCES POWER TO MAINTAIN 200 KTS. AT 1000 FT. MSL.
P ·ASKS LM TO CHECK FOR FURTHER DAMAGE.
CP ·CONTINUES WITH FIRE AND FUEL CHECKLIST.
1048

FIGURE 130

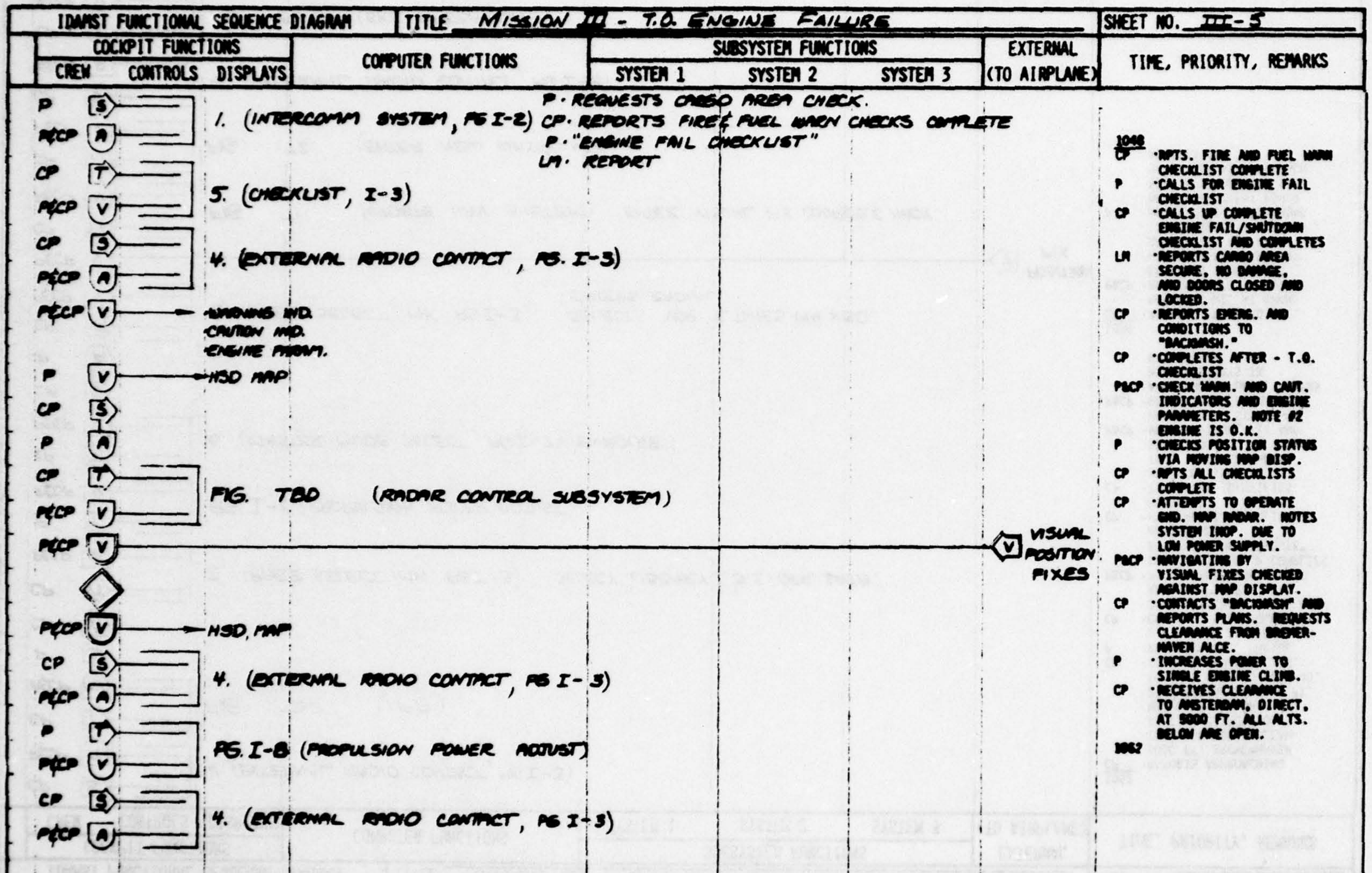

IDAMST FUNCTIONAL SEQUENCE DIAGRAM
TITLE MISSION III - T.O. ENGINE FAILURE
SHEET NO. III-5
COCKPIT FUNCTIONS
CREW
CONTROLS
DISPLAYS
COMPUTER FUNCTIONS
SUBSYSTEM FUNCTIONS
SYSTEM 1
SYSTEM 2
SYSTEM 3
EXTERNAL (TO AIRPLANE)
TIME, PRIORITY, REMARKS
P
P&CP
CP
1. (INTERCOMM SYSTEM, FS I-2)
P · REQUESTS CARGO AREA CHECK.
CP · REPORTS FIRE & FUEL WARN CHECKS COMPLETE
P · "ENGINE FAIL CHECKLIST"
LM · REPORT
5. (CHECKLIST, I-3)
4. (EXTERNAL RADIO CONTACT, FS. I-3)
WARNING IND.
CAUTION IND.
ENGINE PARAM.
HSD MAP
FIG. TBD (RADAR CONTROL SUBSYSTEM)
VISUAL POSITION FIXES
HSD, MAP
4. (EXTERNAL RADIO CONTACT, FS I-3)
FS. I-8 (PROPULSION POWER ADJUST)
4. (EXTERNAL RADIO CONTACT, FS I-3)
1048
CP ·RPTS. FIRE AND FUEL WARN CHECKLIST COMPLETE
P ·CALLS FOR ENGINE FAIL CHECKLIST
CP ·CALLS UP COMPLETE ENGINE FAIL/SHUTDOWN CHECKLIST AND COMPLETES
LM ·REPORTS CARGO AREA SECURE, NO DAMAGE, AND DOORS CLOSED AND LOCKED.
CP ·REPORTS EMERG. AND CONDITIONS TO "BACKWASH."
CP ·COMPLETES AFTER - T.O. CHECKLIST
P&CP ·CHECK WARN. AND CAUT. INDICATORS AND ENGINE PARAMETERS. NOTE #2 ENGINE IS O.K.
P ·CHECKS POSITION STATUS VIA MOVING MAP DISP.
CP ·RPTS ALL CHECKLISTS COMPLETE
CP ·ATTEMPTS TO OPERATE GND. MAP RADAR. NOTES SYSTEM INOP. DUE TO LOW POWER SUPPLY.
P&CP ·NAVIGATING BY VISUAL FIXES CHECKED AGAINST MAP DISPLAY.
CP ·CONTACTS "BACKWASH" AND REPORTS PLANS. REQUESTS CLEARANCE FROM BREMERHAVEN ALCE.
P ·INCREASES POWER TO SINGLE ENGINE CLIMB.
CP ·RECEIVES CLEARANCE TO AMSTERDAM, DIRECT, AT 9000 FT. ALL ALTS. BELOW ARE OPEN.
1052

FIGURE 131

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IDAMST FUNCTIONAL SEQUENCE DIAGRAM — TITLE: MISSION III - SINGLE ENGINE VOR & ASA APPROACH — SHEET NO. III-6

Crew	Controls / Displays	Computer Functions	Subsystem Functions: System 1	System 2	System 3	External (to Airplane)
CP	S	4. (EXTERNAL RADIO CONTACT, PG I-3)				
P&CP	A					
CP	T	FIG. TBD (IFF)				
P&CP	NV					
P	S					
CP	A					
CP	VT	2. (PAGE SELECT IMK, PG I-3)	SELECT "LIBRARY" & "S.E. OPNL. DATA."			
P&CP	V					
P	T	PG. I-8 (PROPULSION POWER ADJUST)				
P&CP	V					
CP	T	6. (MASTER MODE SELECT, PG I-7) "ENROUTE"				
P&CP	V					
CP	S					
P	A					
CP	VT	2. (PAGE SELECT IMK, PG I-3)	SELECTS VOR & TUNES VIA KBD. ENTERS RADIAL			
P&CP	V					
P&CP	V					Y POSITION FIX
CP	TV	FIG. 71 (UPDATE NAV SYSTEM)	ENTER VISUAL FIX COORDS & HACK.			
P&CP	V					
CP	VT	FIG. 72 (ENTER NEW WAYPOINTS)				
P&CP	V					
CP	S	4. (EXTERNAL RADIO CONTACT, PG I-3)				
P&CP	A					
CP	T	FIG 83 (SKE OPERATION)				
P&CP	V					

Time, Priority, Remarks

1052
- CP · REPORTS APPROACHING 5000 FT. BREMERHAVEN CENTER CHANGES CLEARANCE TO DIRECT TO NEUNKOOP VOR ON 270° RADIAL AT 5000 FT. SQUAWK. MODE 3, CODE 40.
- CP · REPEATS AND COMPLIES.
- P · REQUESTS OPT. CRUISE S.E. SPEED AND POWER.
- CP · CALLS UP S.E. POWER DATA VIA IMK. READS AND ADJUSTS POWER.
- P&CP · PILOT CALLS FOR CRUISE CHECKLIST AND CP COMPLIES. BY SELECTING "ENROUTE" MASTER MODE.
- CP · CP REPORTS CHECKLIST COMPLETE.
- CP · TUNES AND IDENTIFIES NEUNKOOP VOR VIA IMK. DESIRED RADIAL SELECTED.
- P&CP · VERIFY VISUAL FIX AND UPDATE NAV. SYSTEM.
- P&CP · REVIEW AMSTERDAM AND ENROUTE DATA. ENTER NEW WAYPOINTS IN NAV SYSTEM.

1054
- CP · REPORTS ENTERING IMC. REQUESTS WX. AT EHAM.
- P&CP · RECEIVES RPT. 4000IR LOC & GS INOP. SKE EQUIPPED AIRCRAFT ON GROUND FOR ASA APP. IF DESIRED.
- P · NOTES THAT, WITH RADAR OFF, SUFFICIENT POWER EXISTS TO OPERATE SKE, OPTS. FOR ASA APPROACH ADVISES CP.

FIGURE 132

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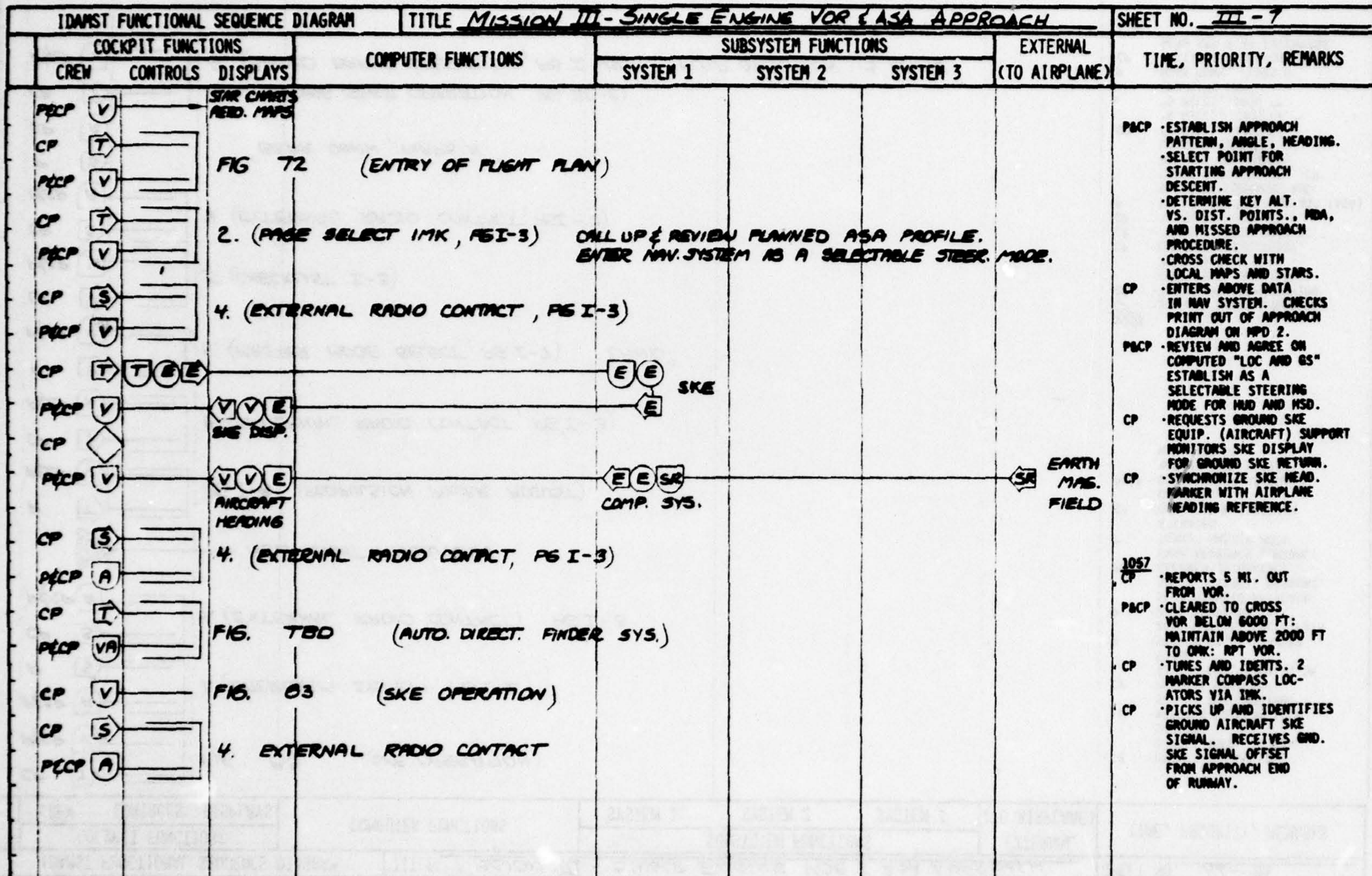

FIGURE 133

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IDAMST FUNCTIONAL SEQUENCE DIAGRAM | TITLE MISSION III - SINGLE ENGINE VOR & ASA APPROACH | SHEET NO. III-B

COCKPIT FUNCTIONS (CREW, CONTROLS, DISPLAYS) | COMPUTER FUNCTIONS | SUBSYSTEM FUNCTIONS (SYSTEM 1, SYSTEM 2, SYSTEM 3) | EXTERNAL (TO AIRPLANE) | TIME, PRIORITY, REMARKS

CP (T), P&CP (V) — FIG. 83 (SKE OPERATION)

P&CP (A), P (S) — 1. (INTERCOMM SYSTEM, PG.I-2)

CP (S), P&CP (A) — 4. (EXTERNAL RADIO CONTACT) PG.I-3

(D) — ALL FLIGHT MANEUVERS

P (T), P&CP (V) — PG I-8 (PROPULSION POWER ADJUST)

CP (S), P&CP (A) — 4. (EXTERNAL RADIO CONTACT, PG.I-3)

P (T), P&CP (V) — 6. (MASTER MODE SELECT, PG.I-7) "LAND"

CP (T), P&CP (V) — 5. (CHECKLIST, I-3)

CP (S), P&CP (A) — 4. (EXTERNAL RADIO CONTACT, PG.I-3)

P (S), CP (A) — "GEAR DOWN, FLAPS N."

CP (T) — 15. (LANDING GEAR OPERATION, PG. III-2)

P&CP (V) — 9. (SPEED BRAKE OPERATION, PG I-19) FLAP OPERATION IS SAME.

TIME, PRIORITY, REMARKS:

CP ·ENTERS GROUND SKE OFFSET INFO. IN NAV. SYSTEM.
LM ·REPORTS PAYLOAD AREA SECURE FOR LANDING.
CP ·REPORTS OVER VOR 15 MI. OUT, TURNING ON FINAL.
P ·STARTS RIGHT TURN TO ROLL OUT ON "LOC". PATH
P ·REDUCES POWER TO SLOW DOWN TO APPROACH SPEED. STARTS DESCENT.
P&CP ·CLEARED TO CONTACT EHAM APPROACH CONTROL.
P ·"LAND" MASTER MODE ACTUATED.
CP ·CALLS EHAM APPROACH CONTROL.
P&CP ·CLEARED FOR APPROACH, REPORT OMK, LATEST WIND AND WX.

1059
CP ·STARTS "LAND" CHECKLIST.
CP ·"10 MILES, APPROACHING GATE (9MI. GATE) AT 3500 FT."
CP ·COMPLETES CHECKLIST.
CP ·"9 MILE GATE, 3500 FT."
CP ·"8 MILES, 3100 FT."
P FOLLOWING "LOC AND GS" (ASA) STEERING COMMANDS AND CROSS CHECKING VS. CP REPORTS AND MARKER LOCATOR SIGNALS.
CP ·"7 MILES, 2700 FT."
"6 MILES, 2300 FT."
"5 MILES, 1900 FT. CROSSING OMK".
P ·GEAR DOWN, FLAPS N.
CP ·INITIATES AND MONITORS GEAR AND FLAP EXTENSION.
1101

FIGURE 134

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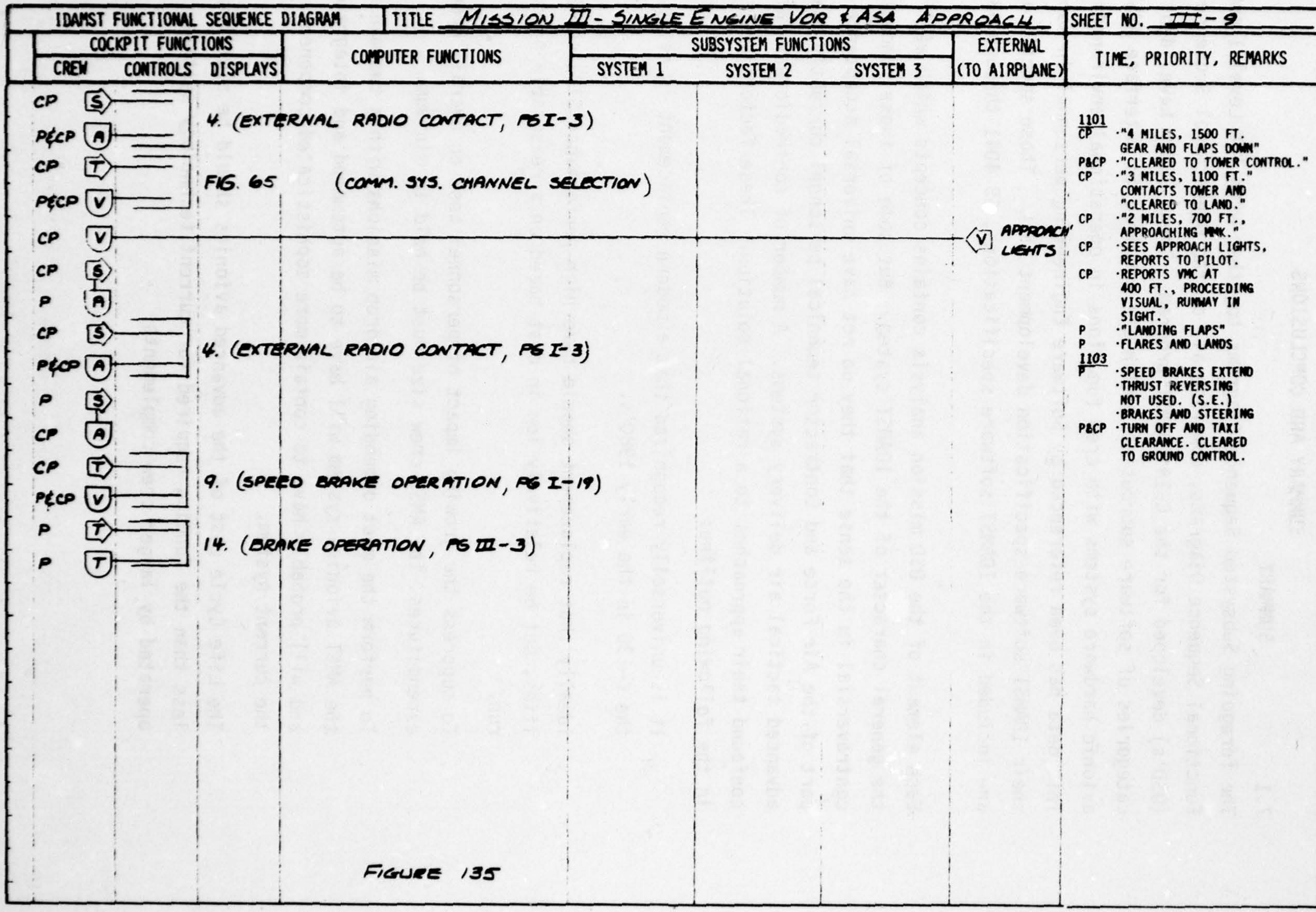

FIGURE 135

SECTION VII

SUMMARY AND CONCLUSIONS

7.1 SUMMARY

The foregoing Subsystem Sequence Diagrams together with the Level 1 and 2 Functional Sequence Diagrams, comprise all of the Operational Sequence Diagrams (OSD's) developed for the C-14 IDAMST program. These OSD's have identified categories of software subroutines which are required to interface AMST avionic hardware systems with crew functions in operational environments. This data has been referenced by Software Engineering personnel in support of their IDAMST software specification development task. Those specifications are included in the IDAMST software specifications, SB 4041 through SB 4044.

Each element of the OSD mission analysis contains concepts which will formulate the general character of the IDAMST system. But some of those concepts are controversial in the sense that they do not have universal acceptance on the part of the Air Force and Contractor technical personnel currently planning advanced tactical air delivery systems. A number of contradictory factors confound their approaches to a rational solution. These factors are summarized in the following outline:

- It is universally recognized that a modern replacement is needed for the C-130 in the early 1980's.
- Ideally that replacement should have high performance STOL capabilities, but be relatively low in cost based on a reasonable production run.
- To suppress the growing impact of personnel cost on overall program expenditures, the AMST crew size must be held to minimum.
- To perform the most demanding air drop missions with a two-man crew, the AMST avionics system will have to be automated and integrated, and will probably have to contain more sophisticated components than the current system.
- The Life Cycle cost of the advanced avionics should be significantly less than the funding required for current technology systems operated by larger crew complements.

Personnel conducting the IDAMST mission analysis have been mindful of these factors as they performed work elements during the study. Wherever possible they have sought to incorporate concepts which tend to alleviate rather than aggravate these considerations. By that, it is meant that the technical approach has emphasized software enhancement of existing systems which can be automated and integrated; this in lieu of specifying advanced technology systems which carry with them unacceptable costs.

The following paragraphs summarize the conclusions which have evolved from the mission analysis performed in light of the factors noted above.

7.2 CONCLUSIONS

The most severe requirement for the AMST is the precision air drop under Instrument Meteorological Conditions (IMC) with a two-man flight crew. With respect to avionics systems, the possible solutions to the requirement may be accomplished in several steps, each involving progressive technology levels of indenture.

7.2.1 Initial IDAMST System

To facilitate two-man flight crew control of the AMST, it is obvious that all navigation functions need to be automated so that they require a minimum of operator interaction. Coincident with that task, the basic components (INS and Omega) need to be functionally integrated with complementary systems which can amplify positional information. These complementary systems include radio aids, Drop Zone Marker, Search/Weather radar, station keeping equipment, compasses, and altimeters. Data from these systems, when integrated with basic system data significantly enhance geographic and tactical navigation.

NOTE: The performance of the proposed AMST radar is not going to provide exceptionally good terrain mapping information. Consequently, its contribution to navigation tasks is not expected to be great.

To enhance survivability in hostile environments, it may be desirable to integrate passive ECM data into navigation outputs to assist the crew in rapidly fixing the relative bearings of potential threats.

The use of the computer to automate communications tasks will make flight deck tasks less complex. The most immediate objective is to provide for pretuning of the separate radios so that selection is by channel rather than frequency.

In the area of system monitoring and management, the software subroutines can be used to directly input sensed data to check lists and calculations. The sensed data would include both qualitative and quantitative information related to subsystem status and operation. Records such as weight and balance reports could be updated on a real time basis providing accurate data to the crew at a moment's notice. Likewise, the on-off and moding of subsystems would be available for automatic accounting in check list execution.

Manual check lists demand an inordinate amount of crew time and attention in the current system. Many of those check lists can be automated to the extent that they perform, as well as display, the sequencial items. Where input data is required, the check list subroutine can alternatively call sensed data where it is available, or cue for operator interactive inputs.

Flight procedures may be handled in much the same way as check lists with the exception that they are not likely to be interactive. For instance, the system generated display of Standard Instrument Procedures (SID's), Standard Terminal Area Requirements (STAR's), Missed Approach plates, etc., may be cued as a function of sensed aircraft position and flight mode. The automatic calling of SID's and STAR's could be expanded to include software tuning of communications equipment to the prescribed air traffic control frequencies.

Most of the features which have been identified to enhance AMST mission performance have been solely concerned with improving flight deck tasks but some of these same features can be used to refine cargo compartment functions. Employment of automated check lists is a case in point. This suggests the possibility of providing the Load/Jumpmaster with an abbreviated IMK/MPD panel for operator interaction and that facility provides the means by which Mission/System Visibility can be expanded to refine and expedite cargo compartment management. Closed circuit TV coverage of that area from the flight deck can be used to facilitate remote control of aircraft systems, and the extraction of cargo. That kind of visual coverage supports safety and emergency functions.

7.2.2 Growth IDAMST System

Elements of the basic IDAMST system are described above. Performance of the system could be significantly improved with the incorporation of an advanced Mapping/Terrain Avoidance (M/TA) radar; and alternatively the Joint Tactical Information Distribution System (JTIDS), or the Global Positioning System (GPS). It is presumed that one or the other of JTIDS and GPS will ultimately be incorporated in the AMST.

M/TA Radar

The M/TA radar together with the integrated navigation system makes the AMST a truly all weather system. The INS with Omega supported by the various navigation aids provides worldwide means of transiting to tactical areas. M/TA radar operations together with the navigation subsystems provide the basis for continual position fixing and CARP updating during penetration into the drop area. While zone marker support will still be needed for some operations, the M/TA radar eliminates the absolute reliance on that system for IMC drops.

JTIDS

Figure 136 summarizes all of the operational features that are being planned for the JTIDS system. As the figure indicates, the system is basically a real time tactical command and control system providing the user aircraft with a large volume of information. Threat data in addition to own force information is included. Coincident with that data, the system also provides the receiving aircraft with the means of determining its relative position along with the positions of other units in the tactical area. Regional information on weather and the status of facilities at recovery bases is included. Because of JTIDS system design characteristics, all of the transmitted messages are immune from jamming or unintentional interference. As a consequence, the system is highly reliable and meets all of the requirements of the AMST for tactical data.

GPS

While JTIDS provides relative navigation (with respect to transmitting stations), the GPS enables very accurate geographic navigation for worldwide applications. In most instances, this system in the IDAMST system would become the prime source of positional information with the INS and Omega furnishing backup data.

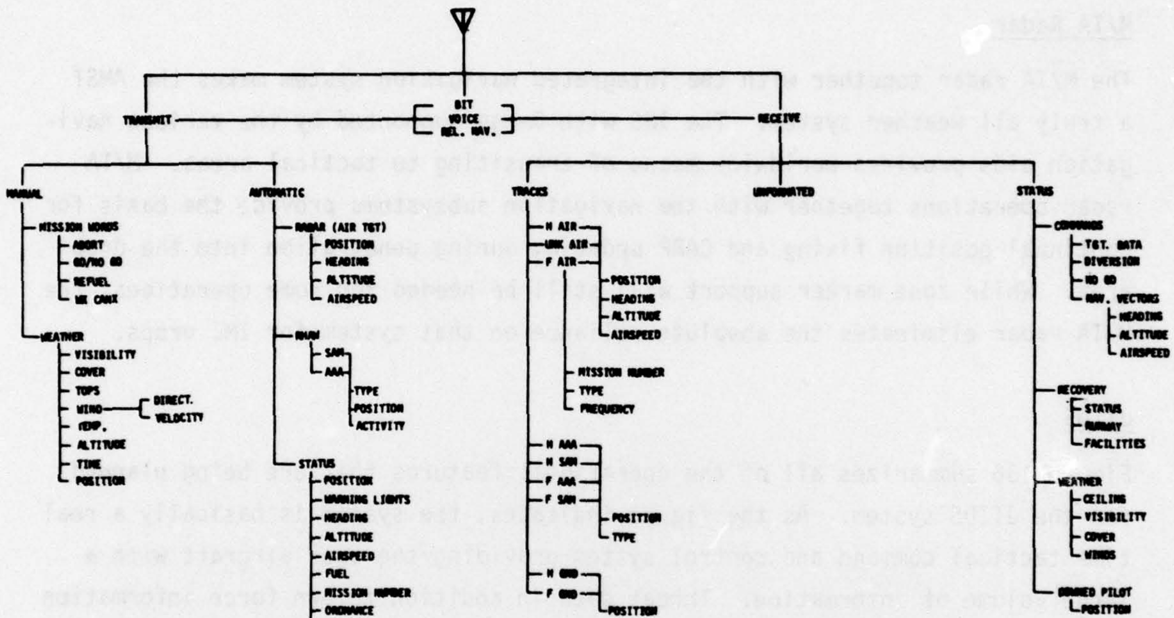

FIGURE NO. 136 Baseline JTIDS Transmit/Receive Functions

7.2.3 General Comments Derived from Time Line and Operational Sequence Diagram Analysis

- o The IDAMST concept provides an excellent means of improving the present cumbersome (and too often inaccurate) "See and Feel" circuit breaker status system. An MPD display of circuit breaker status based on reliable CB sensors is an excellent candidate for workload reduction and flight safety improvement.
- o A time-indexed voice recorder with in-flight playback capability appears to be a useful aid in 2-man flight deck operations.
- o The complex engine start sequences which still include a requirement for fast pilot reactions to rapid changes in engine parameters should be the subject of a study leading to an automatic start program for the IDAMST.
- o The near future availability of GPS hardware and its expected precision makes this equipment the basis for a possible replacement of the present, complex, SKE system (APN-169). With all aircraft and GPS zone markers on a common grid, station keeping performance using GPS should be equivalent to or better than the present SKE system.
- o The detailed manual activity required to establish and execute an airborne radar or station keeping approach makes it almost mandatory that, beyond several manual inputs, the IDAMST concept be able to present complete approach diagrams which include aircraft position. In addition, steering signals should be available for manual/automatic operation.
- o During the analysis it was noted that under some circumstances reliance on the HUD as the primary source of flight information could be dangerous. As an example, consider a C-14 formation employing SKE. If any two aircraft penetrate the same time slot, and a proximity warning is sounded, the pilots must transfer their attention from HUD's to SKE PPI's prior to taking evasive action. It is possible that a collision could occur before the proper break left or right, or climb/dive decision is made. The proper solution to the problem, of course, is to further integrate the system to provide evasive steering commands to the HUD.

7.2.4 IDAMST Benefits to C-14

The exercise of the IDAMST mission analysis tasks leads to several overall conclusions:

First - An automated/integrated system built around IDAMST concepts promises to decrease C-14 flight crew workloads to enhance efficient performance of all AMST missions, and flight safety.

Second - The character of the IDAMST system provides a compatible building block for C-14 application to special missions. Examples are:

- EMI/ELINT
- RPV Launch/Recovery
- Delivery of Sensors and Ordnance
- Gunship

*U.S.Government Printing Office: 1978 — 757-080/604