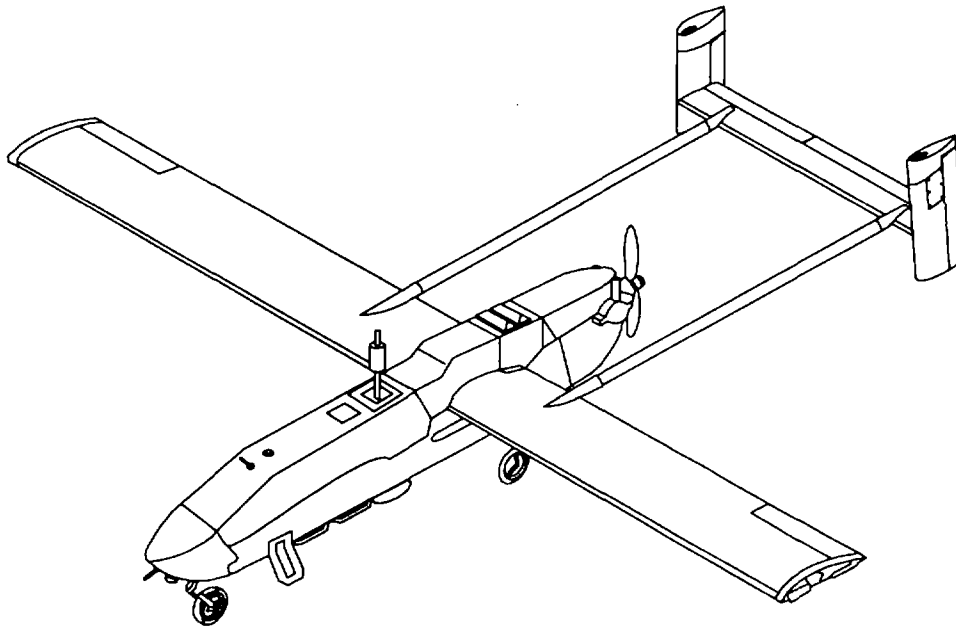


A1-SRRPV-NFM-000



NATOPS FLIGHT MANUAL NAVY MODEL RQ-2A PIONEER UNMANNED AERIAL VEHICLE



PIONEER SYSTEM	1
INDOCTRINATION	2
NORMAL PROCEDURES	3
FLIGHT CHARACTERISTICS	4
EMERGENCY PROCEDURES	5
CONTROL/FLIGHT MODES	6
PERFORMANCE DATA	7

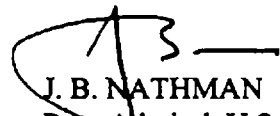


DEPARTMENT OF THE NAVY
CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, D.C. 20350-2000

December, 1999

LETTER OF PROMULGATION

1. The Naval Air Training and Operating Procedures Standardization (NATOPS) Program is a positive approach toward improving combat readiness and achieving a substantial reduction in the aircraft mishap rate. Standardization, based on professional knowledge and experience, provides the basis for development of an efficient and sound operational procedure. The standardization program is not planned to stifle individual initiative, but rather to aid the commanding officer in increasing the unit's combat potential without reducing command prestige or responsibility.
2. This manual standardizes ground and flight procedures but does not include tactical doctrine. Compliance with the stipulated manual requirements and procedures is mandatory except as authorized herein. In order to remain effective, NATOPS must be dynamic and stimulate rather than suppress individual thinking. Since aviation is a continuing, progressive profession, it is both desirable and necessary that new ideas and new techniques be expeditiously evaluated and incorporated if proven to be sound. To this end, commanding officers of aviation units are authorized to modify procedures contained herein, in accordance with the waiver provisions established by OPNAVINST 3710.7, for the purpose of assessing new ideas prior to initiating recommendations for permanent changes. This manual is prepared and kept current by the users in order to achieve maximum readiness and safety in the most efficient and economical manner. Should conflict exist between the training and operating procedures found in this manual and those found in other publications, this manual will govern.
3. Checklists and other pertinent extracts from this publication necessary to normal operations and training should be made and carried for use in naval aircraft.


J. B. NATHMAN
Rear Admiral, U.S. Navy
Director, Air Warfare

NATOPS Flight Manual

Navy Model RQ-2A

CONTENTS

*Page
No.*

PART I — THE PIONEER SYSTEM

CHAPTER 1 — GENERAL DESCRIPTION

1.1	THE UNMANNED AERIAL VEHICLE UAV (PIONEER)	1-1
1.1.1	General	1-1
1.1.2	Crew Required	1-1
1.1.3	Mission Capability	1-1
1.1.4	Principal Dimensions.	1-1
1.1.5	Performance	1-1
1.1.6	Weights.	1-1
1.1.7	Launch and Recovery	1-1

CHAPTER 2 — THE AIR VEHICLE

2.1	UNMANNED AERIAL VEHICLE (UAV)	2-1
2.1.1	UAV Airframe	2-1
2.1.2	UAV Electrical System	2-4
2.1.3	UAV Electronic System.	2-7
2.1.4	Communications	2-10

CHAPTER 3 — THE GROUND CONTROL STATION (GCS) AND THE TRACKING AND COMMUNICATIONS UNIT (TCU)

3.0	GROUND CONTROL SYSTEM	3-1
3.1	GROUND CONTROL STATION (GCS)	3-1
3.1.1	Electrical Power.	3-1
3.1.2	Power Distribution	3-1
3.1.3	System Monitor and Processor (SMP).	3-1
3.1.4	Pilot Control Bay (PBX)	3-2
3.1.5	Tracking Bay (TBY).	3-15
3.1.6	Observer Bay (OBY)	3-19
3.2	TRACKING AND COMMUNICATION UNIT (TCU)	3-28
3.2.1	Communication and Tracking Subsystem (CTS)	3-29
3.2.2	Communications Control Box (CCB)	3-29
3.2.3	Microprocessor Controlled Auto-Tracking Unit (MCAT)	3-29
3.2.4	Encoder/Decoder Unit (EDC)	3-29
3.2.5	C-Band Receiver	3-29
3.2.6	Antenna System.	3-29

CHAPTER 4 — THE PORTABLE CONTROL STATION (PCS)

4.1 PORTABLE CONTROL STATION (PCS) 4-1

4.2 GENERAL DESCRIPTION 4-2

4.2.1 Flight Command/Control Subsystem. 4-2

4.2.2 Communication Subsystem. 4-2

4.2.3 Power Supply Subsystem. 4-2

4.3 PAYLOAD CONTROL 4-2

CHAPTER 5 — THE PAYLOADS

5.1 STABILIZED RECONNAISSANCE PAYLOAD FOR DAYLIGHT
OPERATION (MKD-200) 5-1

5.1.1 General 5-1

5.1.2 Mission Capabilities 5-1

5.1.3 Operational Control Modes. 5-1

5.1.4 Operation Procedures 5-2

5.1.5 Automatic Payload Functions 5-3

5.2 STABILIZED RECONNAISSANCE PAYLOAD FOR DAY/NIGHT
OPERATION (MKD-400) 5-3

5.2.1 General 5-3

5.2.2 Mission Capabilities 5-4

5.2.3 Operational Control Modes 5-5

5.2.4 Operation Procedures 5-6

5.2.5 Displays 5-8

5.2.6 Payload Electronic Box (PEB) 5-8

5.2.7 FLIR Electronic Box (FEB) 5-8

CHAPTER 6 — THE REMOTE RECEIVING STATION (RRS)

6.1 THE REMOTE RECEIVING STATION (RRS) 6-1

6.1.1 Purpose and Use 6-1

6.1.2 General Description 6-1

6.2 SITE SELECTION AND DEPLOYMENT 6-2

6.3 RRS SETUP 6-3

6.3.1 TUA Setup 6-3

6.3.2 Main Unit Setup 6-4

6.3.3 RRS Startup 6-4

6.4 MISSION PROCEDURES. 6-4

6.4.1 Standby Mode 6-4

6.4.2 Operation Mode 6-4

CHAPTER 7 — SYSTEM LIMITATIONS

7.1 OPERATING LIMITATIONS. 7-1

7.1.1 Introduction 7-1

	<i>Page No.</i>
7.1.2	Engine Limitations 7-1
7.1.3	Roll and Pitch and Yaw Limitations 7-1
7.1.4	Airspeed Limitations 7-2
7.1.5	Maneuvering Load Factors. 7-2
7.1.6	Altitude Envelope 7-2
7.1.7	Maximum Weight 7-2
7.1.8	Wind Limitations (Takeoff & Landings). 7-2
7.1.9	Prohibited Maneuvers 7-2
7.1.10	Autopilot Limitations 7-2
7.2	GCS-2000 ELECTRICAL SYSTEM LIMITATIONS 7-3
7.3	COMMUNICATIONS SYSTEMS RANGE LIMITATIONS 7-3
7.4	UPLINK/DOWNLINK FREQUENCY 7-3

PART II — INDOCTRINATION

CHAPTER 8 — INDOCTRINATION PROCEDURES

8.1	INTRODUCTION 8-1
8.2	TRAINING SYLLABUS 8-1
8.2.1	Initial Training (DUTC) 8-1
8.2.2	Unit Training. 8-1
8.3	DESIGNATION AND DESIGNATING AUTHORITY 8-1
8.3.1	Designation. 8-1
8.3.2	Designating Authority 8-1
8.4	QUALIFICATIONS 8-1
8.4.1	External Pilot (EP) 8-1
8.4.2	Internal Pilot (IP). 8-1
8.4.3	Payload Operator (PO). 8-1
8.4.4	Internal Operator (IO) 8-1
8.4.5	Mission Commander (MC). 8-1
8.4.6	Crew Requirements 8-1
8.4.7	Currency 8-2
8.4.8	NATOPS Evaluations 8-2

PART III — NORMAL PROCEDURES

CHAPTER 9 — FLIGHT PREPARATION

9.1	MISSION PLANNING 9-1
9.1.1	Introduction 9-1
9.1.2	Factors Affecting UAV Lift Capability 9-1
9.1.3	Weight and Balance 9-1
9.1.4	Mission Planning. 9-1
9.1.5	Fuel Planning 9-2

	<i>Page No.</i>
9.1.6	Equipment List 9-2
9.2	BRIEFING/DEBRIEFING 9-2
9.2.1	Briefing 9-2
9.2.2	Briefing Guide 9-2
9.2.3	Debriefing 9-3
 CHAPTER 10 — SHORE-BASED PROCEDURES	
10.1	INTRODUCTION 10-1
10.2	SCHEDULING 10-1
10.3	LINE OPERATIONS 10-1
10.3.1	Movement 10-1
10.3.2	Ground Operations 10-1
10.4	SYSTEM ACCEPTANCE 10-3
10.5	PREFLIGHT INSPECTION 10-3
10.5.1	TCU Preflight Inspection 10-3
10.5.2	GCS Preflight Inspection 10-3
10.5.3	PIONEER Preflight Inspection 10-7
10.6	RATO PRESTART CHECKLIST 10-10
10.7	STARTING ENGINE 10-11
10.8	ENGINE SHUTDOWN 10-12
10.9	PRE-TAXI CHECKS 10-12
10.10	PRE-TAKEOFF/LAUNCH PROCEDURES 10-13
10.11	TAKEOFF/LAUNCH CHECKLIST 10-14
10.12	AFTER TAKEOFF 10-15
10.12.1	CLIMB OUT 10-15
10.12.2	Control Checks 10-15
10.13	DISHLOCK 10-15
10.14	CLIMB 10-16
10.15	DESCENT 10-16
10.16	LANDING 10-17
10.17	POST LANDING 10-17
10.18	DUAL UAV OPERATIONS 10-17
10.18.1	Dual Ops Procedures 10-17
10.18.2	Dual OPS / On Station Turn Over 10-18
10.18.3	Dual OPS / Descent & Landing 10-19
10.19	UAV REACQUISITION 10-20

	<i>Page No.</i>
10.20	POST FLIGHT INSPECTION 10-20
10.21	NIGHT OPERATIONS 10-20
10.21.1	Chemlighting Runway 10-20
10.21.2	Hand Signals. 10-20
10.21.3	Recovery - Landing of UAV 10-21
10.22	PRESETS 10-21
10.22.1	Logic and Use of Menus. 10-21
10.22.2	Pilot Bay Presets. 10-21
10.22.3	Pilot Control Table — Other Functions 10-26
10.22.4	Tracking Bay Presets 10-28
10.22.5	Observer Bay Presets 10-29
10.22.6	Other Observer's Control Modes 10-30
10.23	FUNCTIONAL CHECK FLIGHTS. 10-33

CHAPTER 11 — SHIPBOARD PROCEDURES

11.1	INTRODUCTION 11-1
11.2	SYSTEM MODIFICATIONS 11-2
11.2.1	Navigation Data System 11-2
11.2.2	Antenna Elevation 11-5
11.2.3	Antenna Azimuth 11-6
11.2.4	Antenna Switching 11-6
11.2.5	RF System. 11-6
11.2.6	PCS 11-6
11.3	SPARS III. 11-6
11.4	UAV FLIGHT DECK OPERATIONS 11-7
11.4.1	Organization 11-7
11.5	UAV PREFLIGHT PROCEDURES 11-8
11.5.1	TCU PREFLIGHT INSPECTION 11-8
11.5.2	GCS ELECTRICAL PANELS 11-9
11.5.3	INTERCOMMUNICATION SYSTEM 11-9
11.5.4	GCS PBY ELECTRICAL PANELS 11-9
11.5.5	PCS INTEGRITY CHECKLIST. 11-9
11.5.6	PILOT BAY 11-9
11.5.7	OBSERVER BAY. 11-11
11.5.8	TRACKING BAY. 11-11
11.5.9	UAV Preflight/Engine Turn Procedures 11-12
11.5.10	Preflight Briefing 11-12
11.5.11	Recovery Net 11-12
11.5.12	Flight Quarters for UAV Operations 11-13
11.6	UAV FLIGHT DECK LAUNCH PROCEDURES 11-13
11.7	DECK STATUS CRITERIA/AUTHORITY 11-14
11.7.1	GREEN DECK (launch or recovery of UAVs) 11-14

	<i>Page No.</i>
11.7.2	RED DECK 11-14
11.7.3	AMBER DECK 11-14
11.8	UAV INFLIGHT PROCEDURES 11-14
11.8.1	UAV Control 11-14
11.8.2	Securing Flight Quarters. 11-14
11.9	UAV FLIGHT OPERATIONS WITHIN VISUAL RANGE OF SHIP. 11-15
11.9.1	UAV Operation Above 1000 ft MSL. 11-15
11.9.2	UAV Operations Below 1000 ft MSL. 11-15
11.10	PRACTICE/SIMULATED UAV RECOVERY PROCEDURES 11-15
11.11	UAV FLIGHT DECK RECOVERY PROCEDURES 11-15
11.12	FLIGHT DECK CRASH PROCEDURES 11-16
11.12.1	A Problem Exists and a Crash Is Likely. 11-16
11.12.2	A Crash on the Flight Deck 11-16
11.12.3	Crash and Salvage Scene Leader 11-16
11.12.4	UAV Mishap Reporting 11-16
11.13	UAV POST FLIGHT PROCEDURES 11-16
11.14	UAV/AVGAS FUELING AND DEFUELING PROCEDURES 11-17
11.14.1	AVGAS Storage Bladder 11-17
11.14.2	AVGAS Storage Bladder Jettison Procedures. 11-17
11.14.3	UAV Fueling/Defueling. 11-17
11.14.4	AVGAS Bladder Fueling/Defueling 11-18
11.15	OBSERVATION OF UAV OPERATIONS 11-18
11.16	MISSION COMMANDER CHECKLIST (SHIPBOARD). 11-18
11.17	CREW CHIEF PRE-TAKEOFF CHECKLIST (SHIPBOARD) 11-19
11.18	INTERNAL PILOT PRE-TAKEOFF CHECKLIST (SHIPBOARD) 11-19
11.19	PRESETS (SHIPBOARD) 11-20
11.20	OOD CHECKLIST FOR UAV OPERATIONS (SHIPBOARD). 11-22
11.21	PRIFLY CHECKLISTS (SHIPBOARD) 11-23
11.21.1	PRIFLY UAV Pre-launch Checklist 11-23
11.21.2	PRIFLY UAV Launch Checklist 11-24
11.21.3	PRIFLY UAV Pre-Recovery Checklist 11-24
11.21.4	PRIFLY UAV Recovery/Post Recovery Checklist 11-24
11.22	CIC UAV CHECKLIST. 11-25
11.23	RATO MISFIRE PROCEDURES. 11-25
11.24	UAV WATER RECOVERY PROCEDURES 11-25
11.24.1	UAV Mission Commander 11-25
11.24.2	OOD 11-25
11.24.3	Master-At-Arms Division 11-25

	<i>Page No.</i>
11.24.4 UAV Crew Chief	11-25
11.24.5 Boat Crew	11-25
11.24.6 B & A Crane Deck Crew	11-26
11.24.7 Ship Lookouts	11-26

PART IV — FLIGHT CHARACTERISTICS

CHAPTER 12 — FLIGHT CHARACTERISTICS

12.1 TAXIING	12-1
12.2 TAKEOFF	12-1
12.2.1 Rolling Takeoff	12-1
12.2.2 Crosswind Takeoff	12-1
12.3 CLIMB AND CRUISE	12-1
12.3.1 Climb Procedures	12-1
12.3.2 Maneuvering	12-2
12.3.3 Stall Recovery	12-2
12.3.4 Changing Flight Modes	12-2
12.3.5 Autopilot Disconnect (DISCO) Flight	12-2
12.4 LANDING	12-2
12.4.1 Normal Landing	12-2
12.4.2 Crosswind Landing	12-2
12.4.3 Autopilot Disconnect (DISCO) Landing	12-3

PART V — EMERGENCY PROCEDURES

CHAPTER 13 — EMERGENCY PROCEDURES

13.1 GROUND EMERGENCIES	13-1
13.1.1 FIRE ON DECK	13-1
13.1.2 ENG FAILS TO CUT ON COMMAND	13-1
13.1.3 POWER FAILURE (CONTROL STATIONS)	13-2
13.2 LAUNCH AND RECOVERY EMERGENCIES	13-2
13.2.1 RATO MISFIRE	13-2
13.2.2 PNEUMATIC LAUNCHER FAILURE	13-3
13.2.3 ROLLING TAKEOFF ABORT	13-3
13.2.4 HUNG RATO BOTTLE	13-3
13.2.5 LOSS OF VISUAL CONTACT	13-3
13.2.6 ENGINE CUT (EP AT THE CONTROLS)	13-4
13.3 IN-FLIGHT ENGINE EMERGENCIES	13-4
13.3.1 ENGINE CUT (IP AT THE CONTROLS)	13-4
13.3.2 ENGINE TEMP.	13-4
13.3.3 STUCK THROTTLE	13-5
13.3.4 HIGH IDLE (ABOVE 4800 RPM) WITH MIN THROTTLE	13-5
13.3.5 HIGH FUEL CONSUMPTION	13-5

	<i>Page No.</i>
13.4	ELECTRICAL EMERGENCIES 13-6
13.4.1	GENERATOR FAILURE 13-6
13.4.2	BATTERY FAILURE 13-7
13.5.1	NO REPORT 13-8
13.5.2	DUAL UPLINK FAILURE 13-8
13.5.3	SINGLE UPLINK FAILURE 13-9
13.5.4	UAV FAILURE TO RESPOND (GCS LOCKUP) 13-9
13.5.5	EMERGENCY CONTROL STATION TRANSFER 13-9
13.5.6	PROG FAIL LIGHT ILLUMINATED (-30 CONFIGURED NVC) 13-9
13.6	FLIGHT CONTROL EMERGENCIES 13-10
13.6.1	FLIGHT CONTROL MALFUNCTION 13-10
13.6.2	UAV OSCILLATIONS/CNTRL BOX FAILURE (ACFT WITHIN AUTOPILOT LIMITS) 13-11

PART VI — CONTROL/FLIGHT MODES

CHAPTER 14 — CONTROL/FLIGHT MODES

14.1	PILOT CONTROL MODES 14-1
14.1.1	Test Mode 14-1
14.1.2	Preset Mode 14-2
14.1.3	Calibration Mode 14-18
14.1.4	Failure Display Mode 14-18
14.1.5	Multifunction Mode 14-18
14.1.6	Target Altitude Updating Mode 14-21
14.1.7	Camera Guide Updating Mode 14-21
14.1.8	Nav Programmer Updating Mode 14-21
14.1.9	Return Home Updating Mode 14-21
14.1.10	Nav-to-Coordinate Mode 14-21
14.2	FLIGHT MODES 14-22
14.2.1	Position Stick—Manual Flight Mode (“STICKS”) 14-22
14.2.2	Autopilot Disengage (Bypass) — Manual Emergency Flight Control “DISCO” 14-22
14.2.3	Knob Flight Mode 14-22
14.2.4	Combination Flight-Manual (position stick) and Knobs 14-22
14.2.5	Nav to Coordinate Flight Mode 14-22
14.2.6	Camera Guide Flight Mode 14-22
14.2.7	UAV Logic Flight Modes 14-23

PART VII — PERFORMANCE DATA

CHAPTER 15 — PERFORMANCE DATA

15.1	STANDARD DATA 15-1
15.1.1	Crosswind Components 15-1
15.1.2	Ambient Temperature vs. Altitude 15-2
15.1.3	Line-of-sight Altitude Calculations 15-3
15.2	TAKEOFF DATA 15-5
15.2.1	Takeoff Ground Run Distance Charts 15-5

	<i>Page No.</i>
15.3	CLIMB DATA 15-9
15.3.1	Time to Climb. 15-9
15.3.2	Distance Covered in Climb 15-10
15.3.3	Fuel Consumption in Climb 15-11
15.4	CRUISE DATA 15-12
15.4.1	Fuel Consumption in Cruise 173 kg. 15-12
15.4.2	Fuel Consumption in Cruise 191 kg. 15-13
15.4.3	Fuel Consumption in Cruise 200 kg. 15-14
15.5	EMERGENCY DATA 15-15
15.5.1	Stall Speeds 15-15

LIST OF ILLUSTRATIONS

*Page
No.*

CHAPTER 1 — GENERAL DESCRIPTION

Figure 1-1. Pioneer Unmanned Aerial Vehicle 1-2

CHAPTER 2 — THE AIR VEHICLE

Figure 2-1. Nose Landing Gear 2-2

Figure 2-2. Arresting Hook 2-2

Figure 2-3. Wing Section 2-3

Figure 2-4. UAV Electrical System 2-5

Figure 2-5. Flight Control Sensors 2-9

Figure 2-6. UAV Sensor Location 2-9

Figure 2-7. UAV Communications 2-10

Figure 2-8. UAV Communications System 2-11

CHAPTER 3 — THE GROUND CONTROL STATION (GCS) AND THE TRACKING AND COMMUNICATIONS UNIT (TCU)

Figure 3-1. GCS-S280 Shelter 3-1

Figure 3-2. Pilot Control Bay (PBY) 3-2

Figure 3-3. Pilot Display Panel (PDP) 3-2

Figure 3-4. Warning Lights Panel. 3-3

Figure 3-5. Warning Lights Table 3-4

Figure 3-6. Pilot Control Desk (PCD) 3-9

Figure 3-7. Pilot Control Table (PCT). 3-13

Figure 3-8. Tracker Control Desk 3-16

Figure 3-9. Observer Bay (OBY) 3-19

Figure 3-10. Observer Video Control (OVC) 3-20

Figure 3-11. Alphanumeric Information on the OTMP 3-20

Figure 3-12. Graphic Display Field 3-22

Figure 3-13. VTR SONY EVO-9850 3-23

Figure 3-14. Observer Control Desk (OCD). 3-25

	<i>Page No.</i>
Figure 3-15. Observer Control Table	3-27
Figure 3-16. TCU	3-29
Figure 3-17. Communication and Tracking Subsystem, Block Diagram	3-30
CHAPTER 4 — THE PORTABLE CONTROL STATION (PCS)	
Figure 4-1. Portable Control Station (PCS).	4-1
CHAPTER 5 — THE PAYLOADS	
Figure 5-1. MKD-200 Day Payload.	5-2
Figure 5-2. MKD-400 FLIR Payload	5-4
Figure 5-3. FLIR Reticules	5-7
Figure 5-4. FLIR Alphanumeric Data.	5-8
CHAPTER 6 — THE REMOTE RECEIVING STATION (RRS)	
Figure 6-1. Remote Receiving Station	6-1
Figure 6-2. RRS Main Unit Assembly	6-2
Figure 6-3. RRS Tracking Unit Assembly, Setup.	6-3
CHAPTER 7 — SYSTEM LIMITATIONS	
Figure 7-1. Launch Hazard Zones.	7-3
Figure 7-2. Noise Hazard Zones	7-4
CHAPTER 8 — INDOCTRINATION PROCEDURES	
Figure 8-1. External Pilot Currency Chart, 60-day Requirements	8-3
CHAPTER 10 — SHORE-BASED PROCEDURES	
Figure 10-1. Pioneer RPV Exterior Inspection.	10-7
Figure 10-2. Commonly Used Test Points	10-27
Figure 10-3. Pioneer UAV FCF Checklist	10-34
CHAPTER 11 — SHIPBOARD PROCEDURES	
Figure 11-1. LPD-4 Class UAV Installation.	11-1
Figure 11-2. Shipboard Pioneer Arrestment and Recovery System (SPARS) III Installation	11-7
Figure 11-3. CIC UAV Operations Brief Sheet	11-26

CHAPTER 12 — FLIGHT CHARACTERISTICS

Figure 12-1. Typical Landing Pattern 12-3

CHAPTER 15 — PERFORMANCE DATA

Figure 15-1. Crosswind Components 15-1

Figure 15-2. Ambient Temperature vs. Altitude. 15-2

Figure 15-3. Line-of-sight Altitude Calculations 15-3

Figure 15-4. Pioneer Takeoff Distances 15-5

Figure 15-5. Takeoff Ground Run Distance (Weight = 420 lbs) 15-6

Figure 15-6. Takeoff Ground Run Distance (Weight = 440 lbs) 15-7

Figure 15-7. Takeoff Ground Run Distance (Weight = 460 lbs) 15-8

Figure 15-8. Time to Climb 15-9

Figure 15-9. Distance Covered in Climb. 15-10

Figure 15-10. Fuel Consumption in Climb. 15-11

Figure 15-11. Fuel Consumption in Cruise 173 kg. 15-12

Figure 15-12. Fuel Consumption in Cruise 191 kg. 15-13

Figure 15-13. Fuel Consumption in Cruise 200 kg. 15-14

Figure 15-14. Stall Speeds 15-15

RECORD OF CHANGES

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INTERIM CHANGE SUMMARY

The following Interim Changes have been canceled or previously incorporated in this manual:

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ZNR UUUUU

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FM CNO WASHINGTON DC//N789J//

TO ALL UAV COMMANDS

INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//

RHMFIUU/NAVOPMEDINST PENSACOLA FL//06//

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SUBJ/INTERIM CHANGES TO PIONEER RQ-2A UAV NATOPS FLIGHT PUBLICATIONS

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NARR/REF A IS NAVAIR A1-SRRPV-NFM-000 (PIONEER (RQ-2A) UAV NATOPS FLIGHT MANUAL (NFM). REF B IS NAVAIR A1-SRRPV-NFM-500 PIONEER (RQ-2A) UAV NATOPS PILOTS POCKET CHECKLIST (PCL). REF C IS INTERIM CHANGE (IC) 2 TO NA A1-SRRPV-NFM-500 (REF B). REF D IS IC 3 TO A1-SRRPV-NFM-500 (REF B).//

RMKS/1. THIS IS IC NUMBER 3 TO REF A (PIONEER (RQ-2A) UAV NFM), AND IC NUMBER 4 TO REF B (PIONEER (RQ-2A) UAV PCL).

2. SUMMARY. THIS IC MSG CORRECTS TITLE OF FLIGHT IDLE RPM LOW EMERGENCY PROCEDURE IN REF B, AND CHANGES NORMAL OPERATING PROCEDURES IN REFS A AND B TO REDUCE THE EFFECTS OF THERMAL STRESS ON THE ENGINE AND TO MINIMIZE THE OCCURRENCE OF BIG-END-BEARING ENGINE SEIZURES AND LOSS OF THE AIRCRAFT, WHICH HAS USUALLY OCCURRED DURING THE FIRST TEN MINUTES OF A FLIGHT.

3. CHANGE REF A (PIONEER (RQ-2A) UAV NFM), AS FOLLOWS:

A. CHAPTER 9, PAGE 9-3, PARAGRAPH 9.2.2 BRIEFING GUIDE, ITEM 3.D INFLIGHT EMERGENCIES:

(1) DELETE: NA

(2) ADD (INSERT) TWO SUBITEMS:

"(1) ENGINE FAILURE

(2) FLIGHT CONTROL MALFUNCTIONS"

B. CHAPTER 10, PAGE 10-12, PARAGRAPH 10.7 STARTING ENGINE, AFTER STEP 19:

(1) DELETE: N/A

(2) ADD (INSERT):

ENGINE OPERATION AT CONTINUOUS GROUND IDLE RPM SHOULD BE LIMITED TO 5MINUTES, AFTER WHICH ENGINE SPEED SHOULD BE COMMANDED TO APPROX 6000 RPM FOR 10 SECONDS BEFORE GRADUALLY RETARDING THE THROTTLE TO IDLE RPM OVER A 5 TO 10 SECOND PERIOD. IF GROUND IDLE TIME EXCEEDS 5 MINUTES, CYCLE THE ENGINE TO 6000 RPM AS DESCRIBED ABOVE AS SOON AS POSSIBLE. TOTAL GROUND IDLE TIME SHOULD BE MINIMIZED SINCE PROLONGED ENGINE OPERATION AT LOW IDLE SPEEDS PLACES UNDUE THERMAL STRESS ON THE CRANKSHAFT ASSEMBLY.

WARNING

FAILURE TO MAKE GRADUAL (5 TO 10 SECOND DURATION) THROTTLE REDUCTIONS FOLLOWING ENGINE RUN-UPS DURING EXTENDED GROUND IDLE OPERATION CAN RESULT IN BIG-END BEARING FAILURE AND ENGINE SEIZURE. AT NO TIME SHOULD THE ENGINE THROTTLE BE ABRUPTLY REDUCED. ALL ENGINE THROTTLE DECELERATIONS SHOULD BE PERFORMED GRADUALLY.

- C. CHAPTER 10, PAGE 10-14, PARAGRAPH 10.11 TAKEOFF/LAUNCH:
- (1) DELETE: N/A
 - (2) ADD (INSERT) NEW STEPS JUST PRIOR TO STEP 2:
 2. THROTTLE -- 6000 RPM FOR 10 SECONDS (EP)
 3. THROTTLE -- GRADUALLY TO IDLE, RPM 3200-3500 (EP/IP)
 4. CHT -- LESS THAN 190 DEGREES C (IP)
 - (3) RENUMBER OLD STEPS 2 THROUGH 12 AS NEW STEPS 5 THROUGH 15, RESPECTIVELY.
 - (4) ADD (INSERT) AFTER NEW STEP 12, (THROTTLE -- MAX ABOVE 6700):

WARNING

FAILURE TO MAKE GRADUAL THROTTLE REDUCTIONS DURING TAKEOFF/LAUNCH CAN RESULT IN BIG-END BEARING FAILURE AND ENGINE SEIZURE.
- D. CHAPTER 10, PAGE 10-15, PARAGRAPH 10.12.1 CLIMB OUT:
- (1) DELETE: N/A
 - (2) ADD (INSERT) NEW STEPS AFTER STEP 1:
 2. LEVEL AT 70 KIAS -- ESTABLISH (EP)
 3. CHT -- STABLE FOR AT LEAST 2 MINUTES (IP)
 - (3) RENUMBER OLD STEPS 2 THROUGH 9 AS NEW STEPS 4 THROUGH 11, RESPECTIVELY.
 - (4) ADD (INSERT) WARNING AFTER NEW STEP 10 (STATION TRANSFER -- AS REQ):

WARNING

FAILURE TO GRADUALLY REDUCE THROTTLE MAY RESULT IN ENGINE SEIZURE (BIG-END BEARING FAILURE), ESPECIALLY AFTER PROLONGED OPERATION AT GROUND IDLE. MOST OF THESE ENGINE FAILURES HAVE OCCURRED WITHIN THE FIRST 10 MINUTES AFTER TAKEOFF.
4. CHANGE REF B (PIONEER (RQ-2A) UAV PCL), AS FOLLOWS:
- A. PAGE 25, FLIGHT IDLE RPM LOW (ADDED BY IC 3 (REF D)), IN EMERGENCY PROCEDURE TITLE:
- (1) DELETE: "(BELOW 3500 RPM)"
 - (2) ADD "(BELOW 3800 RPM)" SO TITLE READS:
FLIGHT IDLE LOW RPM (BELOW 3800 RPM)
- B. PAGE 90, STARTING ENGINE CHECKLIST:
- (1) DELETE: N/A
 - (2) ADD (INSERT) PRIOR TO STEP 1:

ENGINE OPERATION AT CONTINUOUS GROUND IDLE RPM SHOULD BE LIMITED TO 5 MINUTES, AFTER WHICH ENGINE SPEED SHOULD BE COMMANDED TO APPROX 6000 RPM FOR 10 SECONDS BEFORE GRADUALLY RETARDING THE THROTTLE TO IDLE RPM OVER A 5 TO 10 SECOND PERIOD. IF GROUND IDLE TIME EXCEEDS 5 MINUTES, CYCLE THE ENGINE TO 6000 RPM AS DESCRIBED ABOVE AS SOON AS POSSIBLE.
 - (3) ADD (INSERT) AFTER STEP 19 (THROTTLE -- IDLE):

WARNING

FAILURE TO MAKE GRADUAL (5 TO 10 SECOND DURATION) THROTTLE REDUCTIONS FOLLOWING ENGINE RUN-UPS DURING EXTENDED GROUND IDLE OPERATION CAN RESULT IN BIG-END BEARING FAILURE AND ENGINE SEIZURE. AT NO TIME SHOULD THE ENGINE THROTTLE BE ABRUPTLY REDUCED. ALL ENGINE THROTTLE DECELERATIONS SHOULD BE PERFORMED GRADUALLY.
- C. PAGE 94, TAKEOFF/LAUNCH CHECKLIST, JUST PRIOR TO STEP 2:
- (1) DELETE: NA
 - (2) ADD (INSERT) NEW STEPS:
 2. THROTTLE -- 6000 RPM FOR 10 SECONDS (EP)
 3. IDLE RPM (3200-3500) -- CHECK (EP/IP)

4. CHT (LESS THAN 190 C DEGREES) -- CHECK (IP)
- (3) RENUMBER OLD STEPS 2 THROUGH 12 AS NEW STEPS 5 THROUGH 15, RESPECTIVELY.

- (4) ADD (INSERT) NEW WARNING AFTER NEW STEP 12:

WARNING

FAILURE TO MAKE GRADUAL THROTTLE REDUCTIONS DURING TAKEOFF/LAUNCH CAN RESULT IN BIG-END BEARING FAILURE AND ENGINE SEIZURE.

- D. PAGE 95, CLIMB OUT CHECKLIST (WITH IC 2 (REF C) INCORPORATED), AFTER STEP 1:

- (1) DELETE: N/A

- (2) ADD (INSERT) NEW STEPS AFTER STEP 1:

2. LEVEL AT 70 KIAS -- ESTABLISH (EP)

3. CHT -- STABLE FOR AT LEAST 2 MINUTES (IP)

- (3) RENUMBER OLD STEPS 2 THROUGH 9 AS NEW STEPS 4 THROUGH 11, RESPECTIVELY.

- (4) ADD (INSERT) WARNING AFTER NEW STEP 10 (STATION TRANSFER -- AS REQ):

WARNING

FAILURE TO GRADUALLY REDUCE THROTTLE MAY RESULT IN ENGINE SEIZURE (BIG-END BEARING FAILURE), ESPECIALLY AFTER PROLONGED OPERATION AT GROUND IDLE. MOST OF THESE ENGINE FAILURES HAVE OCCURRED WITHIN THE FIRST 10 MINUTES AFTER TAKEOFF.

5. VC-6 DET PAX POC IS PIONEER (RQ-2A) UAV NATOPS PROGRAM MANAGER LT KENNETH PORTER, DSN 342-8374 OR COMM 301-862-8374, EMAIL PORTERKA@NAVAIR.NAVY.MIL. NAVAIR POC IS LCDR DEAN PETERS, UAV CLASS DESK, DSN 757-5822 OR COMM (301)757-5822, EMAIL PETERSGD@NAVAIR.NAVY.MIL./

//

BT

RAAUZYUW RUENAAA0221 2971718-UUUU--RUENNSN.

ZNR UUUUU

R 231754Z OCT 00 ZYB

FM CNO WASHINGTON DC//N889J//

TO ALL UAV COMMANDS

INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//

BT

UNCLAS

MSGID/GENADMIN/N889J//

SUBJ/INTERIM CHANGES TO PIONEER UAV NATOPS FLIGHT PUBLICATIONS//

REF/A/DOC/NAVAIR/YMD:19991201//

REF/B/DOC/NAVAIR/YMD:19991201//

NARR/REF A IS NAVAIR A1-SRRPV-NFM-000 ((RQ-2A) PIONEER UAV NATOPS

FLIGHT MANUAL (NFM). REF B IS NAVAIR A1-SRRPV-NFM-500 (RQ-2A)

PIONEER UAV NATOPS PILOTS POCKET CHECKLIST (PCL).//

RMKS/1. THIS IS IC NUMBER 2 TO REF A (PIONEER (RQ-2A) UAV NFM), AND
IC NUMBER 3 TO REF B (PIONEER (RQ-2A) UAV PCL).

2. SUMMARY. THIS IC MSG ADDS AN EMERGENCY PROCEDURE FOR A LOW
FLIGHT IDLE RPM CONDITION, TO BE FOLLOWED WHEN ENGINE RPM DROPS
BELOW 3800 RPM AND PRECLUDE TERMINATION OF THE MISSION AND POSSIBLE
LOSS OF THE UAV.

3. CHANGE REF A (PIONEER (RQ-2A) UAV NFM), CHAPTER 13, PAGE 13-6,
AFTER PARAGRAPH 13.3.5:

A. DELETE: N/A

B. ADD (INSERT) NEW EMERGENCY PROCEDURE PARAGRAPH, WITH THE FIRST
FOUR STEPS AS MEMORY ITEMS:

13.3.6 FLIGHT IDLE RPM LOW (BELOW 3800 RPM)

*1. STICK THROTTLE -- SELECT (IP/EP)

*2. THROTTLE -- INCREASE TO WOT (IP/EP)

CAUTION

THROTTLE INCREASE TO WOT SHOULD BE GRADUAL. A SUDDEN
THROTTLE INCREASE WILL MOST LIKELY STALL THE ENGINE.

AVOID ABRUPT THROTTLE MOVEMENTS.

*3. RPM ADJUST -- MAINTAIN ABOVE 5000 RPM (IP/EP)

IF ENGINE DOES NOT RESPOND TO THROTTLE INCREASES:

*4. THROTTLE -- GRADUALLY CYCLE BETWEEN 1/2 THROTTLE AND WOT
(IP/EP)

CAUTION

ABRUPT THROTTLE MOVEMENTS MAY CAUSE ENGINE TO STALL.

5. ELECTRICAL LOAD -- MINIMIZE AS NECESSARY (IP)

NOTE

EXCESSIVE ELECTRICAL LOAD ON THE GENERATOR WILL REDUCE
ENGINE SPEED AND POTENTIALLY CAUSE ENGINE STOPPAGE.

6. LAND AS SOON AS POSSIBLE (ALL).

4. CHANGE REF B (PIONEER (RQ-2A) UAV PCL), PAGE PG 25, AFTER HIGH
FUEL CONSUMPTION EMERGENCY PROCEDURE:

A. DELETE: N/A

B. ADD (INSERT) NEW EMERGENCY PROCEDURE, WITH THE FIRST FOUR STEPS
AS MEMORY ITEMS:

FLIGHT IDLE RPM LOW (BELOW 3500 RPM)

*1. STICK THROTTLE -- SELECT (IP/EP)

*2. THROTTLE -- INCREASE TO WOT (IP/EP)

CAUTION

THROTTLE INCREASE TO WOT SHOULD BE GRADUAL. A SUDDEN
THROTTLE INCREASE WILL MOST LIKELY STALL THE ENGINE.

AVOID ABRUPT THROTTLE MOVEMENTS.

*3. RPM ADJUST -- MAINTAIN ABOVE 5000 RPM (IP/EP)

IF ENGINE DOES NOT RESPOND TO THROTTLE INCREASES:

- *4. THROTTLE -- GRADUALLY CYCLE BETWEEN 1/2 THROTTLE AND WOT (IP/EP)

CAUTION

ABRUPT THROTTLE MOVEMENTS MAY CAUSE ENGINE TO STALL.

- 5. ELECTRICAL LOAD -- MINIMIZE AS NECESSARY (IP)

NOTE

EXCESSIVE ELECTRICAL LOAD ON THE GENERATOR WILL REDUCE ENGINE SPEED AND POTENTIALLY CAUSE ENGINE STOPPAGE.

- 6. LAND AS SOON AS POSSIBLE (ALL)

5. VC-6 DET PAX POC IS PIONEER (RQ-2A) UAV NATOPS PROGRAM LT KENNETH PORTER, DSN 342-8374 OR COMM 301-862-8374, EMAIL PORTERKM@NAVAIR.NAVY.MIL. //

BT

PAAUZYUW RUENAAA4634 1681750-UUUU--RUENNSN.
ZNR UUUUU
P R 161740Z JUN 00 ZYB
FM CNO WASHINGTON DC//N889//
TO ALL UAV COMMANDS
INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
RUDJABF/NAVWARCOL NEWPORT RI//213//
BT
UNCLAS //N03711//
MSGID/GENADMIN/N889//
SUBJ/INTERIM CHANGES TO PIONEER (RQ-2A) UAV NATOPS FLIGHT
/PUBLICATIONS//
REF/A/DOC/NAVAIR/01DEC99//
REF/B/DOC/NAVAIR/01DEC99//
REF/C/LTR/VC-6/14SEP99//
NARR/ REF A IS NAVAIR A1-SRRPV-NFM-000 (PIONEER (RQ-2A) UAV NATOPS
FLIGHT MANUAL (NFM)). REF B IS NAVAIR A1-SRRPV-NFM-500 (PIONEER
(RQ-2A) UAV NATOPS POCKET CHECKLIST (PCL)). REF C IS VC-6 LTR 3711
SER 00/0411 OF 14SEP99; SUBJ:URGENT CHANGE RECOMMENDATION TO PIONEER
NATOPS FLIGHT PUBLICATIONS.//
RMKS/1. THIS IS INTERIM CHANGE NUMBER 1 TO REF A (PIONEER (RQ-2A)
UAV NFM), AND INTERIM CHANGE NUMBER 1 TO REF B (PIONEER (RQ-2A) UAV
PCL).
2. SUMMARY. ADDS 12DS PAYLOAD INFORMATION AND PROCEDURES INTO REF A
NFM AND REF B PCL.
3. CHANGE REF A (PIONEER (RQ-2A) UAV NFM), AS RECOMENDED IN REF C
ENCL (1).
4. CHANGE REF B (PIONEER (RQ-2A) UAV PCL), AS RECOMENDED IN REF C
ENCL (2). THE INTERIM CHANGE SUMMARY PAGE IS MISSING IN REF B, BUT
IS BEING PREPARED AND, WHEN AVAILABLE, WILL BE INSERTED INTO THE COPY
OF REF B POSTED ON THE NATEC SITE FOR LOCAL REPRODUCTION AND
INCORPORATION INTO REF B PAPER COPIES.
5. REFS A AND B ARE POSTED ON THE NATEC WEB SITE, WWW.NATEC.NAVY.MIL.
REF C WAS DISTRIBUTED TO PIONEER (RQ-2A) UAV UNITS AND RELATED NATOPS
ADVISORY GROUP MEMBERS. IF REF C REQUIRED, CONTACT VC-6 NATOPS
PROGRAM MANAGER, LCDR BILL GALLAGHER, AT DSN 342-3512 EXTN 8219, COMM
(301)862-8219, FAX (301)862-8090, OR EMAIL GALLAGHERWP@NAVAIR.NAVY.
MIL.//
BT

LIST OF ACRONYMS AND ABBREVIATIONS

A

A/C. Aircraft.
AAA. Anti-Aircraft Artillery.
AC. Alternating Current.
ADB. Aircraft Discrepancy Book.
AGL. Above Ground Level.
AH. Amp Hours.
APE. Autopilot.
ATA. Airport Traffic Area.
ATU. Airspeed Transducer Unit.
AUX. Auxiliary.

B

BDA. Battle Damage Assessment.
BEU. Battery Emergency Unit.
BITE. Built-in-Test Equipment.
BPU. Barometric Pressure Unit.

C

C3. Command, Control, and Communications.
CAS. Close Air Support.
CBX. Co-pilot Box.
CBY. Communications Bay.
CCB. Configuration Control Board.
CDI. Collateral Duty Inspector.
CFA. Cognizant Field Activity.
CHT. Cylinder Head Temperature.
CO. Commanding Officer.

COHU. Name of camera control manufacturer.

COMNAVAIRLANT. Commander Naval Air Forces, U.S. Atlantic Fleet.

COMNAVAIRPAC. Commander Naval Air Forces, U.S. Pacific Fleet.

CONUS. Continental United States.

CPA. Central Processing Assembly.

CRT. Cathode Ray Tube.

CTS. Communications and Tracking Sub-system.

D

DASC. Direct Air Support Center.

DC. Direct Current.

DNL. Downlink.

DoD. Department of Defense.

DUTC. Department of Defense UAV Training Center

E

EDC. Encoder/Decoder.

EDU. Encoder/Decoder Unit.

EI. Engineering Investigation.

ELOS. Electronic Line-of sight.

EO. Electro Optic.

EOD. Explosive Ordnance Disposal.

EP. External Pilot.

EPS. Electrical Power Supply.

ERC. Engine RPM/Cut-off.

ESS. Essential Bus.

ETC. Engine Thermocouple.

A1-SRRPV-NFM-000

ETH. Engine Thermocouple Harness.

F

FAA. Federal Aviation Administration.

FAC. Forward Air Controller.

FAR. Federal Aviation Regulations.

FCS. Flight Control System.

FEB. FLIR Electronic Box.

FEBA. Forward Edge Battle Area.

FLECOMPRON. Fleet Composite Squadron.

FLIP. Flight Information Publication.

FLIR. Forward Looking Infrared.

FM. Frequency Modulation.

FMC. Full Mission Capable.

FOV. Field of View.

FVU. Flux Valve Unit.

G

GCS. Ground Control Station.

GEN. Generator Electrical Unit.

GHZ. Giga Hertz.

GMT. Greenwich Mean Time.

GPS. Global Positioning System.

H

HAA. Height Above Airport.

HF. High Frequency.

HMMWV. Highly Mobile, Multi-purpose Wheeled Vehicle.

I

IAS Indicated Air Speed.

ICP. Inventory Control Point.

IFF. Identification Friend or Foe.

IMA. Intermediate Maintenance Activity.

IP. Internal Pilot.

IPB. Illustrated Parts Breakdown.

IR. Infrared.

K

KHZ. Kilohertz.

L

LCU. Light Control Unit.

LHA. Amphibious Assault Ship.

LPD. Amphibious Transport Dock.

LRU. Line Replaceable Unit.

LST. Landing Ship Tank.

M

MAF. Maintenance Action Form.

MAGTF. Marine Air Ground Task Force.

MC. Mission Commander.

MCAS. Marine Corps Air Station.

MCAT. Micro Processor Controlled Auto-Tracking Unit.

MDA. Minimum Descent Altitude.

MHZ. Megahertz.

MKD-200. Day Video Camera.

MKD-400. IR Sensor.

MMF. Mobile Maintenance Facility.

MOA. Military Operating Area.

MOCA. Minimum Obstacle Clearance Altitude.

MOS. Military Occupational Specialty.

MRC. Maintenance Requirements Card.

MS. Milliseconds.

MSL. Mean Sea Level.

MUA. Main Unit Assembly.

N

NAF. Naval Air Facility.

NAVAIRSYSCOM. Naval Air Systems Command.

NCC. Navigation Circuit Card.

NESS. Non-Essential Bus.

NGF. Naval Gunfire.

NMC. Not Mission Capable (M)-Maintenance,
(S)-Supply.

NOTAM. Notice to Airmen.

NVC. Navigation Card.

NWS. Nose Wheel Steering.

O

OBY. Observer Bay.

OCD. Observer Control Desk.

OCT. Observer Control Table.

OTMP. Observer Television Monitor Panel.

OVC. Observer Video Control.

P

PBX. Pilot (IP) Control Box.

PBY. Pilot Control Bay.

PCD. Pilot Control Desk.

PCL. Pocket Check List.

PCS. Portable Control Station.

PCT. Pilot Control Table.

PCU. Power Supply Unit.

PDOP. Positional Dilution of Precision.

PDP. Pilot Display Panel.

PEB. Payload Electronic Box.

PLE. Prudent Limit of Endurance.

PLP. Plotter Panel.

PMC. Partial Mission Capable (M)-Maintenance,
(S)-Supply.

PO. Payload Operator.

PSA. Power Supply Assembly.

PSU. Power Supply Unit.

PTMP. Pilot Television Monitor Panel.

Q

QA. Quality Assurance.

QAR. Quality Assurance Representative.

QDR. Quality Deficiency Report.

R

RATO. Rocket Assisted Take Off.

RC. Radio Controlled.

REU. Regulator Electrical Unit.

RF. Radio Frequency.

RFI. Ready For Issue.

RGU. Rate Gyro Unit.

RH. Return Home.

RPV. Remotely Piloted Vehicle.

RRS. Remote Receiving Station.

RSO. Range Safety Officer.

RSTA. Reconnaissance, Surveillance, Target Acquisition.

RTB. Return to Base.

S

SAL. Servo Aileron Left.
SAR. Servo Aileron Right.
SAR. Search and Rescue.
SBX. Student Control Box.
SEP. Shelter Electrical Power.
SEU. Servo Elevator Unit.
SFCP. Shore Fire Control Party.
SMP. System Monitor and Processor.
SNR. Signal-to-Noise Ratio.
SP/SP. Spread Spectrum.
SPARS. Shipboard Pioneer Arresting Recovery System.
SR. Short Range.
SRU. Servo Rudder Assembly.
SSA. Single Step Advance.
SWU. Servo Wheel Unit.
STU. Servo Throttle Unit.

T

TAC(A). Tactical Air Controller (Airborne).
TACAIR. Tactical Aircraft.
TACRON. Tactical Air Traffic Control Squadron.
TBY. Tracking Bay.
TCD. Tracker Control Desk.
TCU. Tracking and Communications Unit.
TM. Telemetry Data.
TPDR. Technical Publication Deficiency Report.
TUA. Tracking Unit Assembly.

U

UAV. Unmanned Aerial Vehicle.
UHF. Ultra-High Frequency.
UPL. Uplink.
UTM. Universal Transverse Mercator.

V

VC. Fleet Composite Squadron.
VFR. Visual Flight Rules.
VGU. Vertical Gyro Unit.
VHF. Very High Frequency.
VIDS/MAF. Visual Information Display System/Maintenance Action Form.
VMC. Visual Meteorological Conditions.
VP.P. Volts Peak to Peak.
VSI. Vertical Speed Indicator.
VTR. Video Tape Recorder.

PREFACE

SCOPE

The NATOPS flight manual is issued by the authority of the Chief of Naval Operations and under the direction of Commander, Naval Air Systems Command in conjunction with the naval air training and operating procedures standardization (NATOPS) program. This manual contains information on all Pioneer systems, performance data, and operating procedures required for safe and effective operations. However, it is not a substitute for sound judgment. Compound emergencies, available facilities, adverse weather or terrain, or considerations affecting the lives and property of others may require modification of the procedures contained herein. Read this manual from cover to cover. It's your responsibility to have a complete knowledge of its contents.

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

A1-RQ2A-NFM-900 Aircrew Pocket Checklist

NAVAIR A1-SRRPV-SDM-000; PIONEER RPV System Description Manual

NAVAIR A1-SRRPV-OPS-100; PIONEER Remotely Piloted Vehicle (RPV) System RPV Operation Manual

NAVAIR A1-SRRPV-MMI-200; PIONEER Remotely Piloted Vehicle (RPV) System RPV Organizational Maintenance with Illustrated Parts Breakdown

NAVAIR A1-SRRPV-EWD-300; PIONEER RPV Electrical Wiring Diagrams

NAVAIR A1-SRRPV-WAB-400; PIONEER RPV Weight and Balance Manual

NAVAIR A1-SRRPV-GCS-500; PIONEER Remotely Piloted Vehicle (RPV) System Ground Control Station (GCS-2000) Operation Manual

NAVAIR A1-SRRPV-GCS-510; PIONEER Remotely Piloted Vehicle (RPV) System Ground Control Station (GCS-2000) Maintenance Manual

NAVAIR A1-SRRPV-GCS-520; PIONEER Remotely Piloted Vehicle (RPV) System Ground Control Station Illustrated Parts Breakdown

NAVAIR A1-SRRPV-PCS-700; PIONEER Remotely Piloted Vehicle (RPV) System Portable Control System (PCS-2000) S-250 Shelter Configuration Operation Manual

NAVAIR A1-SRRPV-PCS-710; PIONEER Remotely Piloted Vehicle (RPV) System Portable Control System (PCS-2000) S-250 Shelter Configuration Organizational Maintenance Manual with Illustrated Parts Breakdown

NAVAIR A1-SRRPV-LAU-800; PIONEER Remotely Piloted Vehicle (RPV) System Launcher Operation and Organizational Maintenance with Illustrated Parts Breakdown

NAVAIR A1-SRRPV-RATO-820; PIONEER Remotely Piloted Vehicle (RPV) Rocket Assisted Takeoff (RATO) Launcher System Operation and Organizational Maintenance Manual with Illustrated Parts Breakdown

NAVAIR A1-SRRPV-SRP-850; Stabilized Reconnaissance Payload (MKD 200) Operation and Maintenance with Illustrated Parts Breakdown

NAVAIR A1-SRRPV-SRP-860; Stabilized Reconnaissance Payload for Day/Night Operation (MKD-400) Operation and Maintenance with Illustrated Parts Breakdown

NAVAIR A1-SRRPV-RRS-900; PIONEER Remotely Piloted Vehicle (RPV) System Remote Receiving Station (RRS) Operation and Organizational Maintenance Manual with Illustrated Parts Breakdown

NAVAIR A1-SRRPV-GSE-960; PIONEER Remotely Piloted Vehicle (RPV) System Ground Support Equipment Catalog

NAVAIR A1-SRRPV-SSM-970; PIONEER Remotely Piloted Vehicle (RPV) System Supplemental Manual for the Shipboard Short Range Remotely Piloted Vehicle (SR-RPV)

HOW TO GET COPIES

One-Time Orders

If this publication is needed on a one-time basis (without future updates), order it from stock by sending an electronic DD 1348 requisition in accordance with NAVSUP Publication 2002 on NAVSUP Publication 600 (Naval Library) CD-ROM disk.

Automatic Distribution (With Updates)

This publication and changes to it are automatically sent of activities that are established on the Automatic Distribution Requirements List (ADRL) maintained by Naval Air Technical Services Facility (NAVAIRTECHSERVRAC), Philadelphia, PA. If there is a continuing need for this publication, each activity's Central Technical Publication Librarian must send a revised ADRL report on floppy disk to NAVAIRTECHSERVRAC. If an activity does not have a library, then send a letter to the Commanding Officer, NAVAIRTECHSERVRAC, Attn: Code 251, 700 Robbins Avenue, Philadelphia, PA 19111 requesting assignment of a distribution account number (if necessary) and automatic mailing of future issues of the publication needed.

Note

The ADRL floppy disk can be used only to place an activity on the mailing list for automatic distribution of future issues of the publications. It cannot be used to make one-time orders of publications from current stock. To get publications from stock, see One-Time Orders above.

Once established on automatic distribution for this or any other NAVAIR technical publication, an activity must submit an ADRL report on floppy disk at least once every 12 months to update or confirm their automatic distribution requirements.

Note

Activities not submitting an ADRL report on floppy disk for more than 12 months may be dropped from distribution of all NAVAIR technical publications.

UPDATING THE MANUAL

To ensure that the manual contains the latest procedures and information, NATOPS review conferences are held in accordance with the current OPNAVINST 3710.7.

CHANGE RECOMMENDATIONS

Recommended changes to this manual or other NATOPS publications may be submitted by anyone in accordance with the current OPNAVINST 3710.7.

Routine change recommendations are submitted directly to the model manager on OPNAV 3710/6 (4-90) shown on the next page. The address of the model manager of this unmanned aerial vehicle is:

COMMANDING OFFICER
FLEET COMPOSITE SQUADRON SIX
1224 POCAHONTAS STREET
NAS NORFOLK, VIRGINIA 23511-2414

Change recommendations of an URGENT nature (safety of flight, etc.) should be submitted directly to the NATOPS advisory group member in the chain of command by priority message.

YOUR RESPONSIBILITY

NATOPS flight manuals are kept current through an active manual change program. Any corrections, additions, or constructive suggestions for improvement of its content should be submitted by routine or urgent change recommendation, as appropriate, at once.

NATOPS FLIGHT MANUAL INTERIM CHANGES

Flight manual interim changes are changes or corrections to the NATOPS flight manuals promulgated by CNO or NAVAIRSYSCOM. Interim changes are issued either as printed pages or as a naval message. The interim change summary page is provided as a record of all interim changes. Upon receipt of a change or revision, the custodian of the manual should check the updated interim change summary to ascertain that all outstanding interim changes have been either incorporated or canceled; those not incorporated shall be recorded as outstanding in the section provided.

CHANGE SYMBOLS

Revised text is indicated by a black vertical line in either margin of the page, adjacent to the affected text, like the one printed next to this paragraph. The change symbol identifies the addition of new information, a changed procedure, the correction of an error, or a rephrasing of material.

WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to “WARNINGS”, “CAUTIONS”, and “Notes” found throughout the manual.



An operating procedure, practice, or condition, etc., which may result in injury or death if not carefully observed or followed.



An operating procedure, practice, or condition, etc., which may result in damage to equipment if not carefully observed or followed.

Note

An operating procedure, practice, or condition, etc., that is essential to emphasize.

WORDING

The concept of word usage and intended meaning which has been adhered to in preparing this Manual is as follows:

“Shall” has been used only when application of a procedure is mandatory.

“Should” has been used only when application of a procedure is recommended.

“May” and “need not” have been used only when application of a procedure is optional.

“Will” has been used only to indicate futurity, never to indicate any degree of requirement for application of a procedure.

NATOPS/TACTICAL CHANGE RECOMMENDATION
 OPNAV 3710/6 (4-90) S/N 0107-LF-009-7900

DATE _____

TO BE FILLED IN BY ORIGINATOR AND FORWARDED TO MODEL MANAGER

FROM (Originator)			Unit		
TO (Model Manager)			Unit		
Complete Name of Manual/Checklist	Revision Date	Change Date	Section/Chapter	Page	Paragraph

Recommendation (be specific)

CHECK IF CONTINUED ON BACK

Justification

Signature	Rank	Title
Address of Unit or Command		

TO BE FILLED IN BY MODEL MANAGER (Return to Originator)

FROM	DATE
------	------

TO _____

REFERENCE

(a) Your Change Recommendation Dated _____

Your change recommendation dated _____ is acknowledged. It will be held for action of

the review conference planned for _____ to be held at _____

Your change recommendation is reclassified URGENT and forwarded for approval to _____

_____ by my DTG _____.

/S/ _____ MODEL MANAGER _____ AIRCRAFT

PART 1

The Pioneer System

Chapter 1—General Description

Chapter 2—The Air Vehicle

Chapter 3—The Ground Control Station (GCS) and Tracking and
Communication Unit (TCU)

Chapter 4—The Portable Control Station

Chapter 5—The Payloads

Chapter 6—The Remote Receiving Station (RRS)

Chapter 7—System Limitations

CHAPTER 1

General Description

1.1 THE UNMANNED AERIAL VEHICLE UAV (PIONEER)

1.1.1 General. The Pioneer UAV surveillance system consists of an Unmanned Aerial Vehicle (UAV) that is either controlled by a control station or is programmed to fly independently under control of its autopilot. The miniature, fixed, high-wing aircraft is used for reconnaissance, surveillance, target acquisition, fire support adjustment, and battle damage assessment. Driven by a pusher propeller, the aircraft relays video and/or telemetry information from its payload to the Ground Control Station (GCS) and/or Portable Control Station (PCS) in real time. More than one control station may be used to either increase the UAV's effective range or to control more than one UAV. The Ground Control Station (GCS-2000) is contained in either an S-250 shelter or an S-280 shelter. When installed aboard ship, the GCS is housed in a mobile maintenance facility (MMF). The PCS, which does not require a shelter, is housed in an S-250 shelter.

1.1.2 Crew Required. The GCS-2000 in the S-250 shelter configuration or the MMF when aboard ship, is manned by a crew of three: a Mission Commander, an Internal Pilot, and a Payload Operator. The GCS-2000 in the S-280 shelter is manned by a crew of four: a Mission Commander, an Internal Pilot, a Payload Operator, and an Intelligence Analyst to operate the Intel Bay. In either configuration an External Pilot is required to fly the aircraft during takeoffs and recoveries.

1.1.3 Mission Capability. The Pioneer UAV system performs a wide variety of reconnaissance, intelligence, and special missions. Strategic or tactically vital data may be obtained cost-effectively by exploiting the UAV's low radar cross section, low IR signature, and remote control versatility.

Typical real time missions performed by Pioneer include:

1. Battlefield Reconnaissance and Observation

2. Artillery Targeting
3. Control of Air Support
4. Battle Damage Assessment
5. Search and Rescue.

1.1.4 Principal Dimensions

Wing Span	16.9 feet
Length	14.0 feet
Height	3.3 feet

1.1.5 Performance

Service ceiling	12,000 ft
Maximum altitude	15,000 ft
Max endurance	5 hrs
Max range	185 km
Engine	26 hpwr
Fuel	AVGAS (94-100 Octane)
Cruise speed	65 kts
Max speed	110 kts

1.1.6 Weights

UAV (empty)	276 lb/125 kg
Payload (max)	75 lb/34 kg
Fuel (full tank)	67 lb/30 kg
Max Takeoff	452 lb/205 kg

1.1.7 Launch and Recovery

Rolling takeoff (min)	210 meters
Pneumatic launch	21 meters
Rocket Assisted Takeoff (RATO)	0
Arrested recovery	130 meters
(short field)	70 meters
Shipboard Net Recovery	0

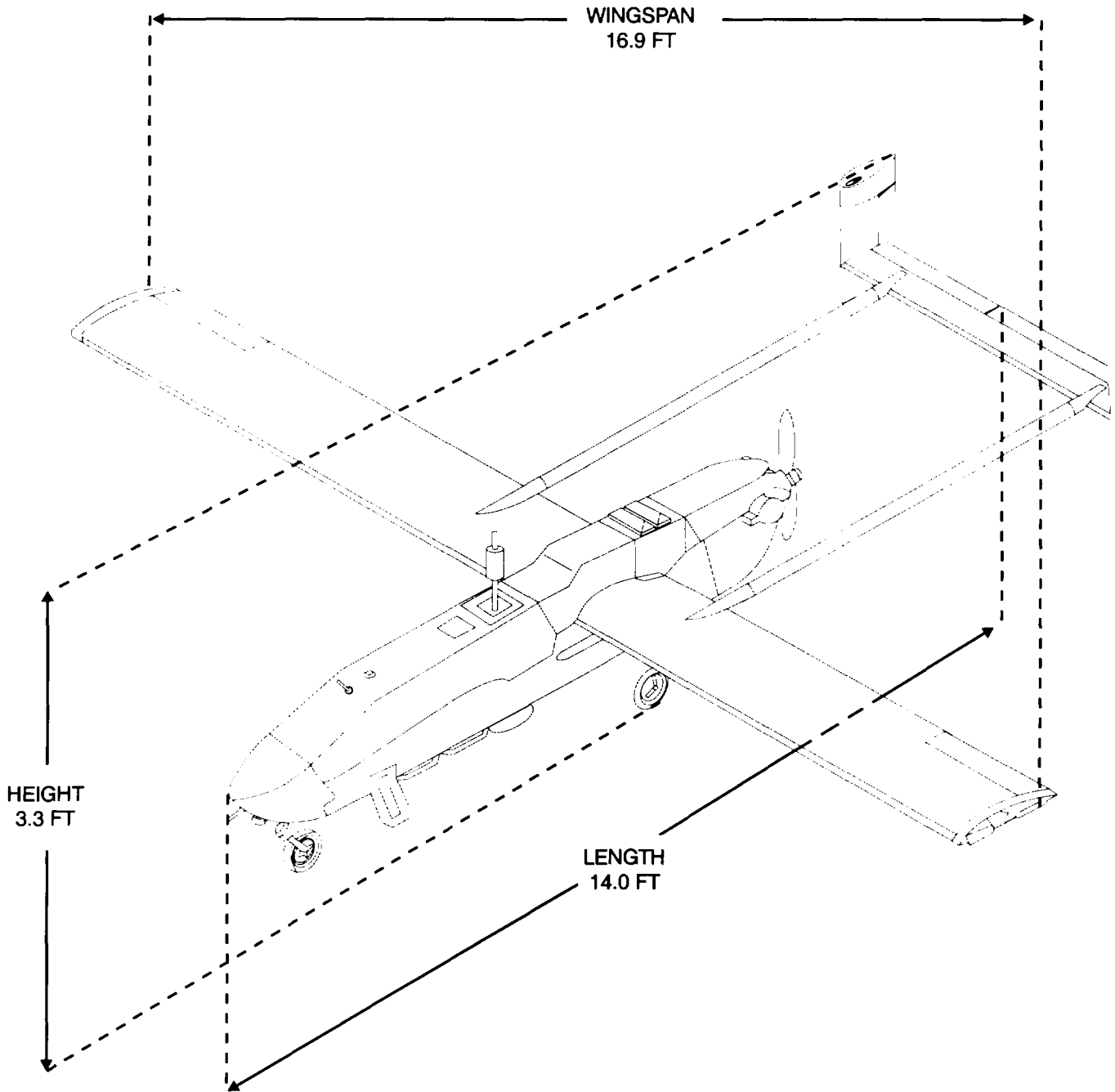


Figure 1-1. Pioneer Unmanned Aerial Vehicle

CHAPTER 2

The Air Vehicle

2.1 UNMANNED AERIAL VEHICLE (UAV)

The UAV is a remote or independently self-controlled high wing light air vehicle. The air vehicle is divided into 5 subsystems:

1. Airframe
2. Electrical System
3. Electronic System
4. Payload
5. Communications.

2.1.1 UAV Airframe

2.1.1.1 Fuselage. The electronic and navigation units, power unit and servos, etc., are housed in various compartments in the fuselage. The payload is housed in the UAV's mid section and is covered with a transparent canopy. The fuselage is of fiberglass construction with four bulkheads located at stations -390, 741, 1142, and 1553. (Stations are identified by distance, in millimeters, fore (minus) and aft (plus) as measured from the center of gravity.) The fuselage skin is made of fiberglass, except for the main access panel, which is made of a composite material (honeycomb/fiberglass), and the nose cover, which is made of KYDEX. The propulsion unit is mounted on the rear fuselage bulkhead (station 1553) and drives a pusher-type propeller. There are two hinged engine cowlings with quick-release fasteners. These are perforated and coated with fiberglass. The fuselage is divided into the following:

1. Fore section
2. Mid section
3. Rear section.

2.1.1.1.1 Fore Section. Nose Compartment (station -390). This compartment houses the nose steering mechanism, the Light Control Unit (LCU), the

Airspeed Transducer Unit (ATU), and the Barometric Pressure Unit (BPU). The white nose position light is installed on the lower side of the nose cover.

Front Compartment (Electronics and Payload Compartments) (stations -390 to 741). This compartment contains the Central Processing Assembly (CPA), Servo Wheel Unit (SWU), the C-band receiver, the RF head, the 28-volt/15-volt converter, the stabilized platform with its control unit(s), the Identification Friend or Foe (IFF) transponder unit and strobe light power supply (installed on the underside of the main access cover), the C-band and IFF transponder antennas (attached to the top side of the main access cover), accelerometers, and a circular opening on the underside of the compartment permitting installation of the payload. A white flashing strobe light, located on the main cover, is used to facilitate tracking the UAV by helicopter or light plane.

2.1.1.1.2 Mid Section. This section consists of one compartment (stations 741 to 1143) occupied by the fuel tank. A fuel drain valve is located at the bottom of the compartment. Four wing-attaching brackets are on the upper part of the compartment. On each side of the compartment, a cable cover protects the wiring path between the fore and after sections.

2.1.1.1.3 Rear Section. Rear Compartment (stations 1141 to 1553). This section houses the vertical gyro unit (VGU), the yaw rate gyro unit (RGU), the electric fuel pump and filter, the electronic power supply (EPS), the C-band diplexer (DCU), the C-band power unit (PCU), and its associated 28V/12V converter, the video transmitter, engine trap counter, and the UHF receiver. The side panels provide access to the units.

Engine Compartment (station 1553). This section and the fire wall house the engine thermocouple and harness (ETC and ETH), the engine RPM cutoff (ERC), the servo throttle unit (STU), and the engine buildup. On the right panel of the engine compartment, access is provided through a spring-loaded cover (door) to input heated air to the engine before startup in cold weather.

2.1.1.2 Landing and Launcher Gear. The landing gear consists of a non-retractable tricycle gear with a steerable nosewheel and an arresting hook. The pneumatic launcher gear is made up of four catapult guides and a belt catch-release mechanism. RATO launching brackets are provided on the arresting hook mounting bracket and on the belly plate in the aft of the aircraft near the fuel vent.

2.1.1.2.1 Nose Landing Gear (Figure 2-1). The Nose Landing Gear consists of a fork, upper arm, and two tension springs and wheel assembly. The wheel is rubber-rimmed and steered by an arm connected to a steering rod and controlled by the wheel servo mechanism housed in the fuselage fore section. The springs allow the landing gear to be retracted and extended and to better absorb landing shocks. Two rubber cushions, installed under the upper arm, stop the foldable part of the landing gear (the lower arm) when the retraction overruns its stroke (172.5 mm maximum).

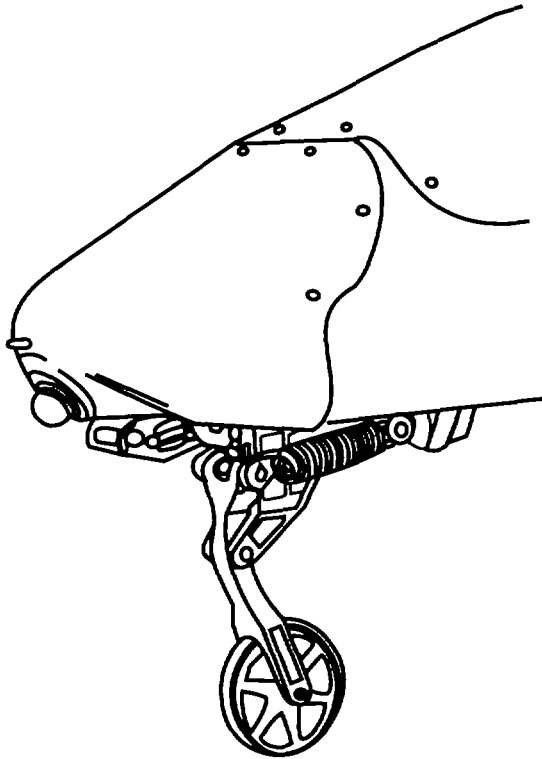


Figure 2-1. Nose Landing Gear

2.1.1.3 UAV Arresting Hook (Figure 2-2). When the UAV lands on a runway, a rear-pointing hook helps bring it to a halt after touchdown by engaging an arresting cable. The hook bracket is attached to the underside of the fuselage and is fastened to the main landing gear beam.

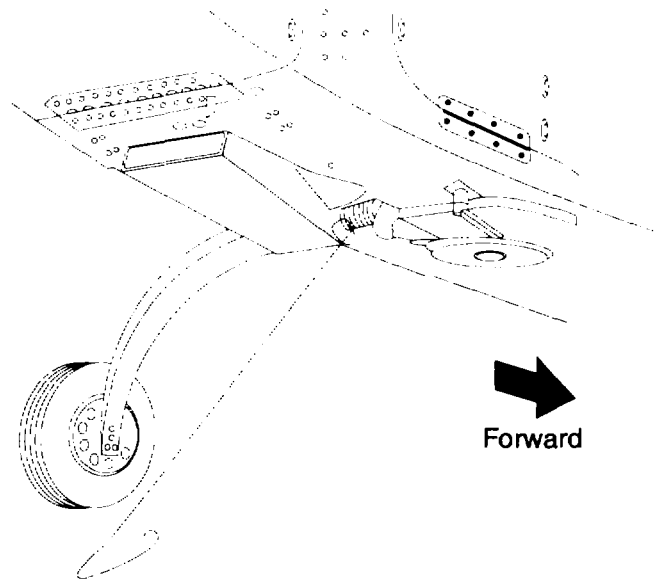


Figure 2-2. Arresting Hook

2.1.1.4 Wings and Tail Section

2.1.1.4.1 Wing Description (Figure 2-3). Each wing has two parts, a right and left half, which are attached to the upper side of the fuselage with four clevis pins passing through four lugs on the wings' underside. The overall wing span is 16.9 ft. Two tubes with clevis assemblies on the ends run the length of each wing. The wings are connected together by pins inserted in the clevis assemblies. Electrical servo actuated ailerons are installed near the wingtip of each wing and are connected to the servo actuators via collapsible linkage. The linkage is designed to collapse whenever a force greater than 34 lb is applied perpendicular to the aileron's normal travel. This design is used to lessen the leverage that can be exerted on the servos during net landings. Access panels are located on the end ribs in each wing to allow access to the aileron actuators and on the underside of the right wing for access to the flux valve.

The aluminum tubes carry all of the load acting on the wings. The fiberglass or KEVLAR ribs maintain the aerodynamic profile of the wings and the skin protects the wing inner parts from humidity and damage. An aluminum bracket, with plug receptacles for the electrical connection from fuselage to wing, is located on the

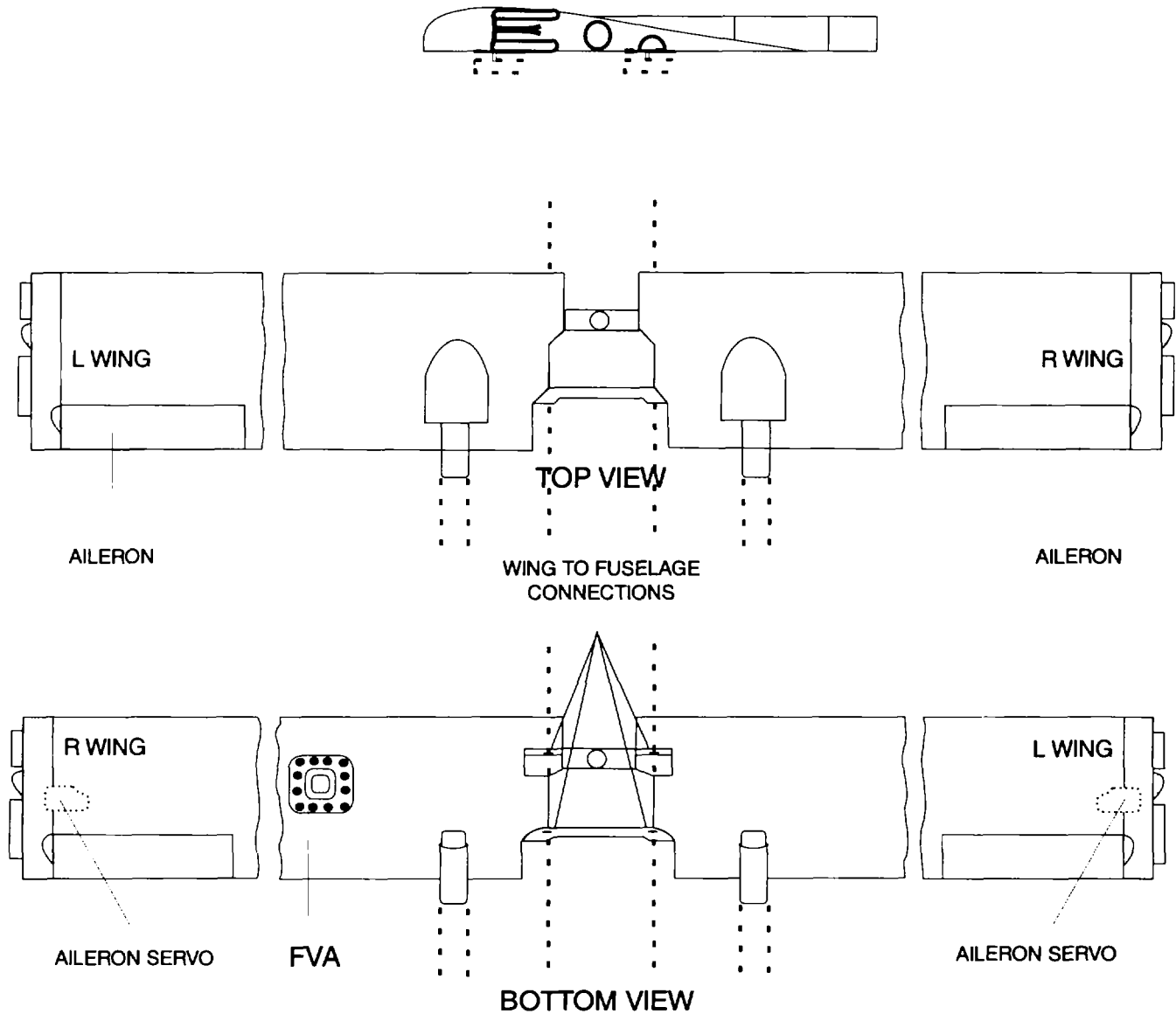


Figure 2-3. Wing Section

trailing edge of the wing. Position lights are located on the wing tips, green on the right wing and red on the left wing. Clear Plexiglas strips in front of each light focus part of the light's energy forward for increased night visibility. The wingtip covers are designed to minimize edge turbulence. Leading edge lights are located on the left and right edges of the wing for use during night operations.

2.1.1.4.2 Tail. The tail section consists of two booms made of 7.62 cm diameter KEVLAR or aluminum tubing 202 cm long, and the vertical/horizontal stabilizers. The right tube houses two electric cables; one controls the right elevator and rudder servo actuators and the other is for the UHF antenna located on the right rudder

surface. The left tube carries a single electrical cable for the left elevator and rudder servo-actuators.

2.1.1.4.3 Horizontal Stabilizer and Elevator.

The tail configuration has dual elevators. The horizontal stabilizer is connected to both vertical stabilizers with lug bolts that fit into brackets on the stabilizers. The horizontal stabilizer is made of fiberglass bonded onto polyurethane foam. Elevators are connected to the stabilizer and are made of balsa wood coated with dope. The elevators are electrically servo actuated and are connected to the servo actuator via collapsible linkage. The linkage is designed to collapse whenever a force greater than 34 lb is applied perpendicular to the elevator's normal travel. This design is used to lessen the

leverage that can be exerted on the servos during net landings. Access panels are located on the top of the horizontal stabilizer to allow access to the elevator servo actuators.

2.1.1.4.4 Vertical Stabilizers and Rudders. The vertical stabilizers are made of fiberglass bonded onto polyurethane foam. The rudders, mounted in the trailing edge of the left and right vertical stabilizers, are made of balsa wood coated with dope. The rudders are electrically servo actuated and connected to servo actuators via collapsible linkage. The linkage is designed to collapse whenever a force greater than 34 lb is applied perpendicular to the rudder's normal travel. This design is used to lessen the leverage that can be exerted on the servo during net landings. An access panel on the outboard side of each vertical stabilizer allows access to the rudder servo actuator.

2.1.1.5 Fuel System. The fuel system consists of a fuel tank, a fuel level sensor, fuel filter, fuel pump, and drain valve fuel tank check valve. The fuel is a 50:1 mixture of 100 octane LoLead AVGAS and natural petroleum-based high quality 2-stroke oil, BIA certified for TC-W. A fuel filling opening to the integral tank is located on the cover of the fuselage at the wing root.

The 42-liter capacity fuel tank is built into the fuselage mid section. It is integrally sealed, includes a fuel level sensor and drain valve, and has connections to vent, supply, and refuel systems.

2.1.1.6 Powerplant. The UAV engine is a horizontally opposed twin-cylinder, crankcase-scavenged, two-stroke engine. Both cylinders are fired simultaneously by a magneto ignition system.

2.1.1.6.1 Carburetors and Fuel Intake System. The fuel intake system consists of two carburetors mounted on the crankcase with the manifold. The carburetor uses a metering diaphragm to control the incoming fuel (rather than a float) for all position operation. The carburetor also has a diaphragm fuel pump operated by the cyclic variation in crankcase pressure. The piston timed port in each cylinder directs the cool incoming charge under the hot exhaust port, improving piston life and reliability.

2.1.1.6.2 Propeller and Generator. A two-blade, 29-inch-diameter pusher propeller is mounted on one end of the engine crankshaft. On the opposite end, an alternator is directly coupled.

2.1.1.6.3 Ignition. The UAV engine has a magneto ignition system that senses a triggering signal from a

magnet that is an integral part of the flywheel. The timing is fixed because there are no wearing parts.

2.1.1.6.4 Engine Build-Up. The engine suspension, alternator coupling, and cooling and exhaust systems are briefly described as follows:

1. **Suspension.** An end-bell mounting adapter is supported on three shock mounts using a dynafocal arrangement that provides center of gravity support. The engine is mounted on an adapter plate, which is also a back cover for the crankcase. On the other side of the adapter plate, an end-bell is provided for the mounting of the alternator.
2. **Generator Coupling.** A flexible coupling, WOODS type, 3JE generator drive is used. It allows quick installation and removal of the generator and protects the generator from shock loads through the crankshaft.
3. **Exhaust.** Diffused type exhaust ducts that improve scavenging of the cylinder are used. This improves clearing of the exhaust gases and helps the fresh air charge enter the combustion chamber.

2.1.2 UAV Electrical System (Figure 2-4)

2.1.2.1 Generator and Regulator. The Generator Electrical Unit (GEU) is the primary source of electrical power. It is installed on the engine and supplies 3-phase ac voltage in delta-configuration. This is rectified by a 3-phase bridge in the EPS and 28 Vdc is fed to the 28V buses. The generator voltage is regulated by the regulator electrical unit (REU). This low-temperature unit monitors the rectified voltage and changes the field current of the generator accordingly. This allows the voltage of the supply bus to remain fixed and be independent of engine speed or changes in the electrical load. The fixed voltage is maintained above 3000 rpm. Below this, the voltage decreases and the battery supplies input to the bus. The maximum power output of the generator is 800 watts.

2.1.2.2 Battery System. The Battery Emergency Unit (BEU) is used as an emergency electrical supply system. When the generator does not supply the correct output (after a fault or drop in engine speed below the minimum value — including engine shutoff), the battery supplies voltage to the essential bus.

Two battery packs connected in parallel are used. Each pack consists of 24 Ni-Cd (SAFT UR126377) cells. The batteries are rated at 2 AH each and do not require special maintenance. The 24-battery pack cells should be kept fully charged at 35V. The battery packs

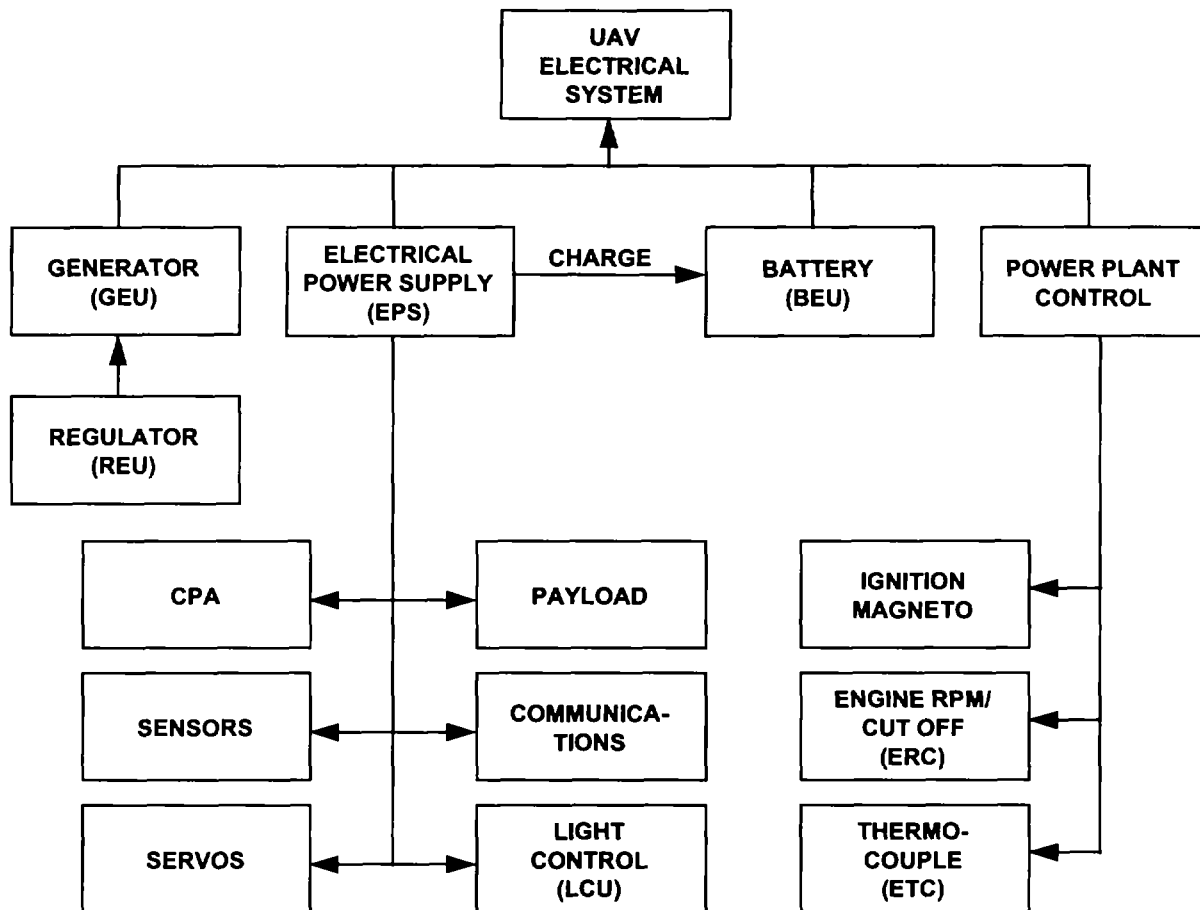


Figure 2-4. UAV Electrical System

are kept charged during flight by the battery charger. The packs are covered with a special insulating winter cover as a protection against extremely low temperatures, or with a summer cover for moderate and high temperatures.

2.1.2.3 Battery Charger. The charger insures that the battery remains fully charged throughout flight, despite regular discharges and leaks. It is a switching type, synchronized with the converters, and supplies a fixed current. It cuts in when battery voltage drops to 32.4 Vdc, and disconnects when voltage reaches 35 Vdc. If the battery is disconnected by placing its switch to OFF, the charger is also disconnected. If the charger is unable to supply the required current (with 28V at the input), it signals a failure through the BITE system with BATT FAIL light. The battery charger is on the non-essential bus.

2.1.2.4 Electrical Power Supply (EPS)

2.1.2.4.1 EPS Description. The EPS is located in the rear section of the UAV fuselage and provides the following functions:

1. Converts voltage received from power supply sources to various voltages required by electrical loads
2. Distributes and divides the supply on the supply buses and protects the output from short-circuits, and inputs from overvoltage/undervoltage.
3. Transfers external commands and reports to CPA
4. Uses self test system to monitor status and internal operations within EPS.

2.1.2.4.2 EPS Components. The EPS is made up of the following main circuits:

1. **Rectification Bridge.** The two 3-phase diode rectification bridges are connected to the 28V ESS and 28V NESS supply buses. They rectify the 3-phase ac voltage from the generator and isolate the ESS from the NESS bus so that the battery cannot feed the NESS bus.
2. **Battery Switching Unit.** When the generator is functional, the battery switching unit enables the battery to be charged to a voltage greater than that of the 28V ESS bus. If the generator fails, the battery switching unit connects the battery to the supply bus without voltage interruption. During the time between the voltage drop and the relay closure, the bus is fed by the battery via the series voltage regulator.
3. **Converters.** The converters change the source voltage (28 Vdc) to other voltages required by the UAV: ± 15 Vdc and +5 Vdc. Each voltage type has two converters connected in parallel. While one converter is operating, the second is on standby. Each converter is isolated and cannot affect the bus. Each converter provides voltage regulation, current limiting, short protection, and overvoltage protection.
4. **Regulator Electrical Unit (REU).** The REU has a 300-ohm resistor connected between the battery and the REU to transfer the starting field current from the battery to the generator.
5. **BITE.** The BITE self-check subsystem monitors test points throughout the power supply system. These points are addressed through coded commands to the BITE exchange in the CPA's AUX module. This arrangement simplifies and shortens troubleshooting procedures controlled from the GCS. Display data is in scaled format and values must be multiplied by eight to determine actual voltages.

2.1.2.5 Engine RPM/Cutoff (ERC) Unit. The ERC unit, located in the engine bay, comprises an engine rpm counter (tachometer), an engine failure warning circuit, and an engine cutoff circuit. The tachometer converts the pulses received from the magneto to a dc voltage using a frequency-to-voltage converter. The ENG CUT failure warning outputs 5 Vdc when the ERC unit receives pulses from the magneto, and 0 Vdc when no pulses are received. The relays that cut off the engine are activated by +28 Vdc. The tachometer circuit and the engine failure circuit outputs are transmitted to the GCS

via separate channels. The engine cutoff circuit operates according to commands received from the ENG CUT bit in the UPL but requires that the aircraft navigation lights be on before the command can operate the ERC engine cut circuitry. The aircraft light command closes a relay in the engine trap and the ENG CUT bit is transferred to the ERC. The engine trap also counts the number of ENG CUT commands received.

2.1.2.6 ENG ON/OFF Safety Switch. This function (ON or OFF) can also be carried out by the ENG ON/OFF safety switch located near the external power connector on the engine bay left panel. When in OFF, the magneto supply is stopped and even if the UPL RUN/CUTOFF bit switch is at RUN, the engine status remains at OFF. This is a safety switch that prevents the accidental startup of the engine when the UAV is undergoing maintenance or ground tests. When the switch is in the ON position, the ignition system is controlled by the UPL.

2.1.2.7 Light Control Unit (LCU). The LCU is located in the fore section of the fuselage behind the ATU and BPU. It is used to control the five position lights. The LCU receives two input commands from the light control circuit in the CPA Buffer card. The first command causes the lights to illuminate with low intensity, and 350 ms later, they are lit with maximum intensity.

2.1.2.7.1 Navigation/Landing Lights. The five navigation/landing lights are positioned as follows: two (amber) on the tail assembly, right and left vertical stabilizers, one (green) on the right wingtip, one (red) on the left wingtip, and one (white) on the nose cover.

2.1.2.7.2 Strobe Light. The strobe light is a flashing white light on top of the UAV main cover. The strobe light is used for tracking of the UAV by sight from helicopter or light plane. The strobe light is turned on and off using a relay located in the rear compartment, which is activated by logic in the EPS. The EPS is commanded via uplink from the GCS or PCS. The strobe/IFF is on the non-essential bus.

2.1.2.8 Engine Thermocouple (ETC). The ETC measures the engine cylinder-head temperature. Its thermocouple probe is located under one of the engine spark plugs. The thermocouple probe consists of two metal strips (nickel and constantin) and is a standard resistance-temperature thermocouple. It is installed on the hotter cylinder from temperature readings made during runup on the test stand. Two signals are sent to the GCS:

1. **UAV Engine Temperature.** An analog signal of range +0.17 Vdc to +5 Vdc, relative to the temperature range 10°C to 320°C.

2. Engine Warning (Low or High Temperature). Control station software monitors DNL to illuminate ENG TEMP light when CHT < 100°C or ≥ 230°C.

2.1.3 UAV Electronic System. The UAV electronic system consists of the Central Processing Assembly (CPA), UAV sensors, and UAV servos. The system provides control of the UAV during flight operations.

2.1.3.1 Central Processing Assembly (CPA).

The CPA supervises the UAV control and communications system. It is located in the fuselage mid-section. The CPA performs the following functions:

1. Decodes command signals received from the GCS on either of the two uplink channels (Primary, Secondary) at one of the UAV receivers, C-Band receiver or UHF receiver. The CPA decodes signals received via the test cable during ground tests or maintenance. The UAV is connected by cable to the GCS TEST connector.
2. Encodes the UAV status reports and data (telemetry) signals for transmission to the GCS on the downlink channel from the UAV C-Band transmitter. It also encodes status signals sent by cable via the test cable during ground tests.
3. Controls and coordinates the UAV flight mode selection and mission.
4. Controls units and subsystems of the UAV including sensors, servos, communication units, Electrical Power Supply (EPS), and Payload Electronic Box (PEB).

The CPA consists of seven modules: EDU, autopilot, navigation, return home & memory, logic, auxiliary, and buffer.

2.1.3.1.1 Encoder/Decoder Unit (EDU) Module.

This comprises a decoder card, an encoder card, and two bit synchronizer cards. All communications to and from the CPA pass through this module via the Decoder and Encoder.

2.1.3.1.2 Autopilot (APE) Module.

The APE comprises three cards: APE1 Card, APE2 Card, and Compass Card. The UAV flight control system is handled by the Autopilot module, which controls the UAV by inputting flight parameters measured by the sensors into control loop circuits. The signals are compared with the input command signals, and the resulting error (difference) signal is used to activate the flight surface and throttle servos accordingly. APE 1 Card contains

circuits for the Altitude and Speed Control (throttle and elevators) Loops, Fuel Sensor Circuit, and Servo test points. APE 2 Card contains circuits for the Direction/Roll and Yaws Rate (ailerons and rudders) Loops, the Autopilot Critical Failure Control circuit, and the regulators for the gyro and sensor supplies. The Compass Card includes circuits used to calibrate the flux valve inclination vector angle, essential to maintain UAV correct heading relative to north after banking or rolling. It also processes and filters all the analog input STICK mode command signals, which input the APE control loops (Aileron, Elevator, Rudder, and Throttle). In addition, the Compass card filters the BYPASS signals to the relevant servos and contains a 9-bit altitude logic circuit.

2.1.3.1.3 Navigation Module.

The Navigation Module consists of one circuit card (NVC) which provides automatic navigation for the UAV. The NVC uses a Global Positioning System (GPS) onboard the UAV to obtain positional fixes from GPS satellites. The NVC is a microprocessor-based design, which is programmable by the pilot to fly to specific waypoints. The NVC basically checks its programmed waypoints to determine where it is ordered to fly to, then checks the GPS for its present location, and then calculates how to fly from its present location to the ordered waypoint. When GPS is not installed or invalid GPS data is received, the NVC uses Dead Reckoning (DR) to calculate how to fly its programmed route of flight.

2.1.3.1.4 Return Home (RH) & Memory Module.

This consists of one card (RH and Logic). The RH circuit includes a memory into which flight parameters are loaded before or during flight, a digital-to-analog converter, and various counters and clocks used to time the UAV return flight legs. RH is used when there is a communications loss in both uplink channels and when the TO-LAND/FLIGHT switch in the GCS is on FLIGHT.

2.1.3.1.5 Logic Module.

The logic circuit supervises the communications and control of the UAV and flight mode selection (RH DELAY, RH, GLIDE, BEACON, TRANSPONDER, and BYPASS modes).

2.1.3.1.6 Auxiliary (AUX) Module.

This consists of one card, AUX. It includes the BITE exchange system and output buffers.

2.1.3.1.7 Buffer Module.

This consists of one card. All input/output signals to and from the CPA that need buffering pass through this card, including all camera, sensor calibration, and compass calibration signals.

2.1.3.2 Flight Control System (FCS) Sensors (Figures 2-5 and 2-6). Five sensors are used in the UAV to measure parameters used in controlling the UAV flight. Signals from the sensors input the FCS control loops and any changes in measurement cause the servo actuators to adjust the flight surfaces or throttle according to commands from the autopilot.

2.1.3.2.1 Barometric Pressure Unit (BPU). The BPU measures the static pressure and sends signals to the altitude control loop of the Autopilot module in the UAV CPA. BPU input is from the static pressure ports in the UAV nose. The range of measurement is from -1,500 to 20,000 ft and a voltage signal of -5 to +5 Vdc is output to the autopilot.

2.1.3.2.2 Airspeed Transducer Unit (ATU). The ATU measures the UAV's indicated airspeed. The ATU is located in the nose compartment of the UAV and mounted on special shock mount rubbers to minimize vibration. It receives signals from the static air pressure ports and the pitot tube located in the center of the UAV nose. Indicated airspeed is calculated by taking the difference between the dynamic and static pressures. A voltage signal in the range of -5 to +5 Vdc, corresponding to an airspeed range of 0 to 150 kt, is sent to the Autopilot module of the CPA.

2.1.3.2.3 Flux Valve Unit (FVU). The FVU indicates the directional heading of the UAV relative to magnetic north. It functions as a magnetic compass and also compensates for movement and changes along the horizontal and longitudinal axes of the UAV during flight. The FVU is located in the mid section of the right wing's undersurface and consists of a compass and electronic unit.

2.1.3.2.4 Vertical Gyro Unit (VGU). The VGU senses the UAV roll and pitch and is used to maintain UAV stability during flight. Roll and pitch signals in the range of -5 to +5 Vdc, corresponding to $\pm 60^\circ$ pitch and $\pm 90^\circ$ roll, are transmitted to the Autopilot module of the CPA. The VGU consists of a gyro, transducers, an ac motor, and amplifiers, and is located in the rear compartment of the UAV. It requires up to 10 minutes (max.) to reach operating RPM.

2.1.3.2.5 Rate Gyro Unit (RGU). The RGU measures the rate of change of yaw (direction) of the UAV and is used to reduce the natural drift of the UAV about its vertical axis. If either the Vertical Gyro Unit or autopilot is damaged, the UAV is controlled manually by the pilot flight box, employing the RGU measurements.

2.1.3.3 Flight Control System (FCS) Servos. The UAV's flight control surfaces, nosewheel, and throttle are controlled by two rudder servos, two elevator servos, two aileron servos, one throttle servo, and one servo wheel unit. The servos form part of the flight control loop. With the exception of the throttle servo, all servos are interchangeable. A command signal and a signal from the sensor(s) are sent to the autopilot control loop. Differences between the desired and the actual flight parameter result in movement of control surface, throttle, or nosewheel.

2.1.3.3.1 R and L Servo Rudder Units. A rudder servo is located in a compartment on the upper portion of each vertical stabilizer. The rudder servo receives signals from the autopilot yaw (heading) control loop and provides a control surface range of movement of $\pm 20^\circ$.

2.1.3.3.2 R and L Servo Elevator Units. An elevator servo is located in a compartment on each side of the tail's horizontal stabilizer. It controls the movement of the elevator on receipt of signals from the autopilot and forms part of the pitch (speed) control loop. The elevator range of movement is $\pm 20^\circ$.

2.1.3.3.3 R and L Servo Aileron. The right and left aileron servos are located in compartments near the right and left wing tips. They are used to control the roll (and heading) of the UAV, and are part of the autopilot roll control loop. The servos are activated by signals received from the autopilot. The aileron range of movement is $\pm 20^\circ$.

2.1.3.3.4 Servo Throttle Unit. The throttle servo is located in the engine bay on the engine dynafocal suspension. Input signals come from the autopilot. The servo throttle regulates the flow of fuel to the carburetors. The Servo Throttle Unit motor is connected to the throttle via the throttle arm, cable and linkage rod. These levers/linkages open or close the throttle according to the autopilot signal, and increase or decrease the fuel flow to the carburetors, affecting the engine speed and climb rate of the UAV. The servo shaft has a range of $\pm 40^\circ$. The servo operates on -5 Vdc (idle speed) to +5 Vdc (wide-open throttle) and is supplied by +28 Vdc.

Autopilot commands to the throttle servo may damage the throttle servo at high throttle settings. The throttle-servo-motors current limits may be exceeded during flights in altitude hold mode whenever the command voltage to the throttle servo exceeds 0.6 volts (test point (TP) 309 equals 0.2). The throttle linearization circuit amplifies the servos command voltage changes at high throttle settings. Flight-testing has shown that throttle servo command voltages vary as much as 2 to 3 volts

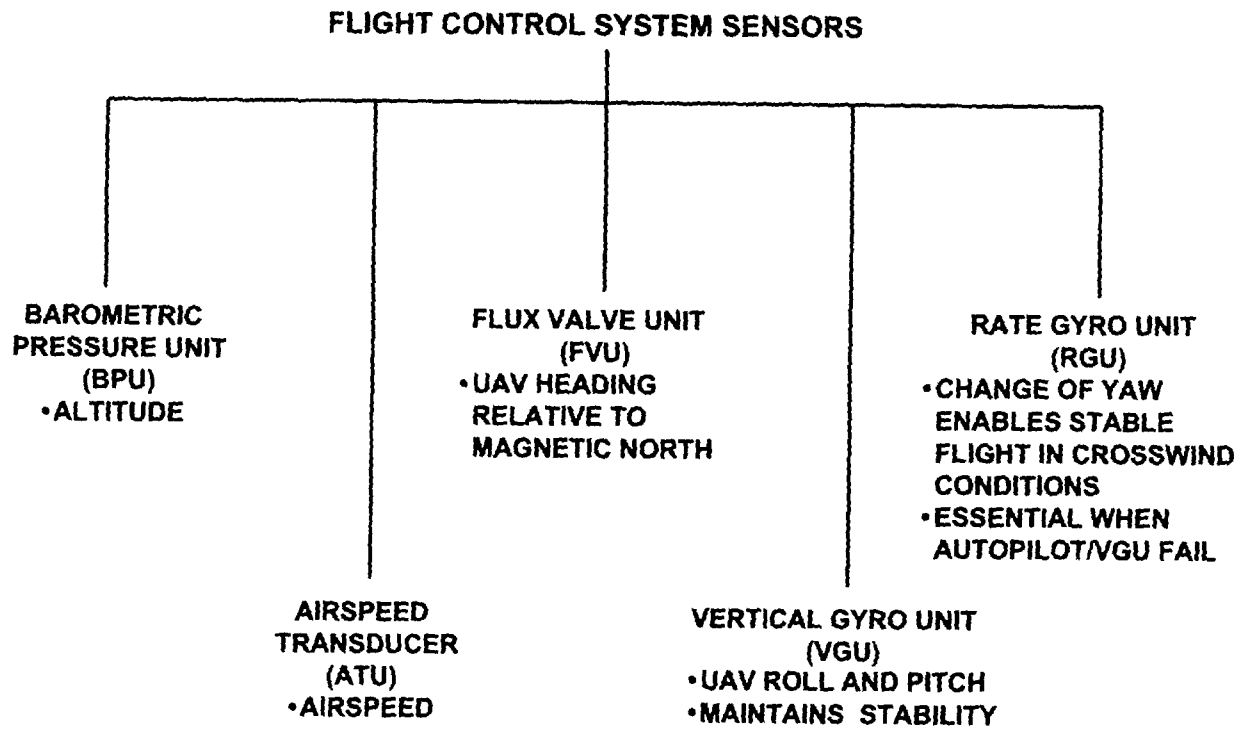


Figure 2-5. Flight Control Sensors

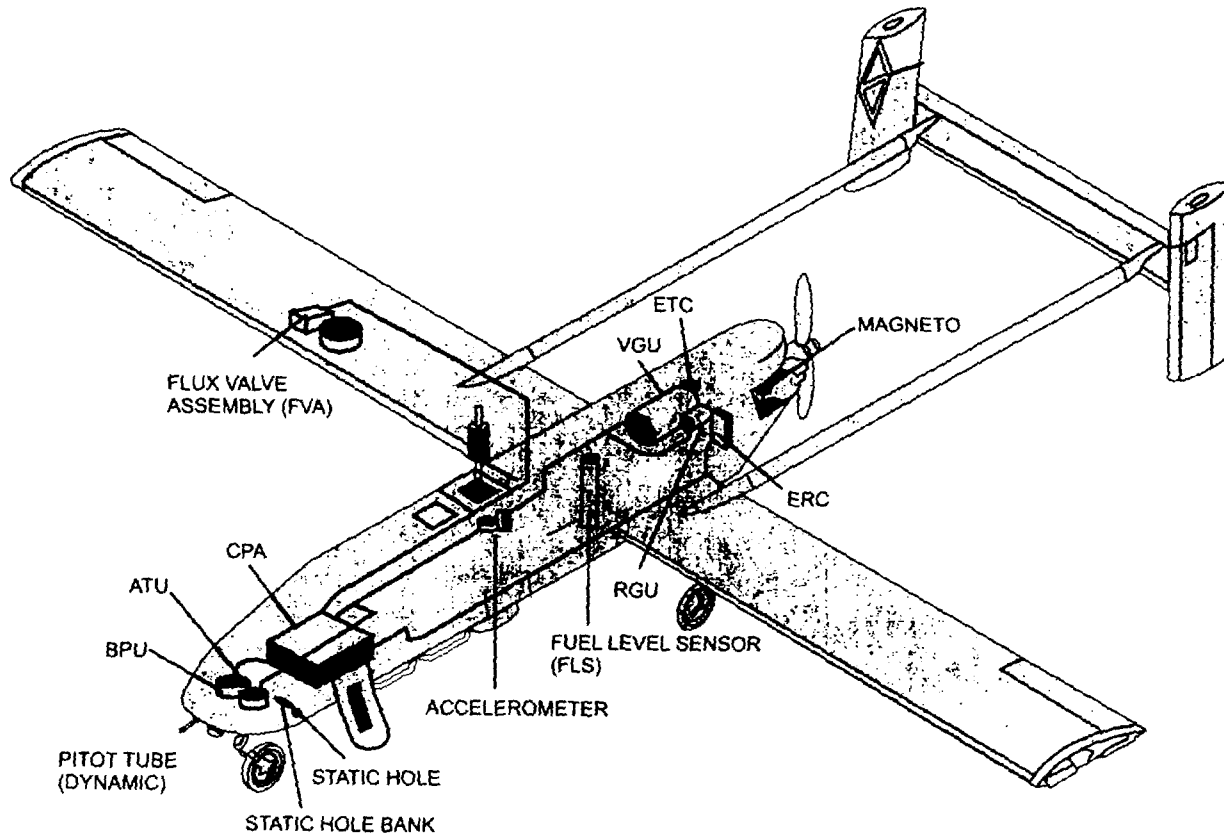


Figure 2-6. UAV Sensor Location

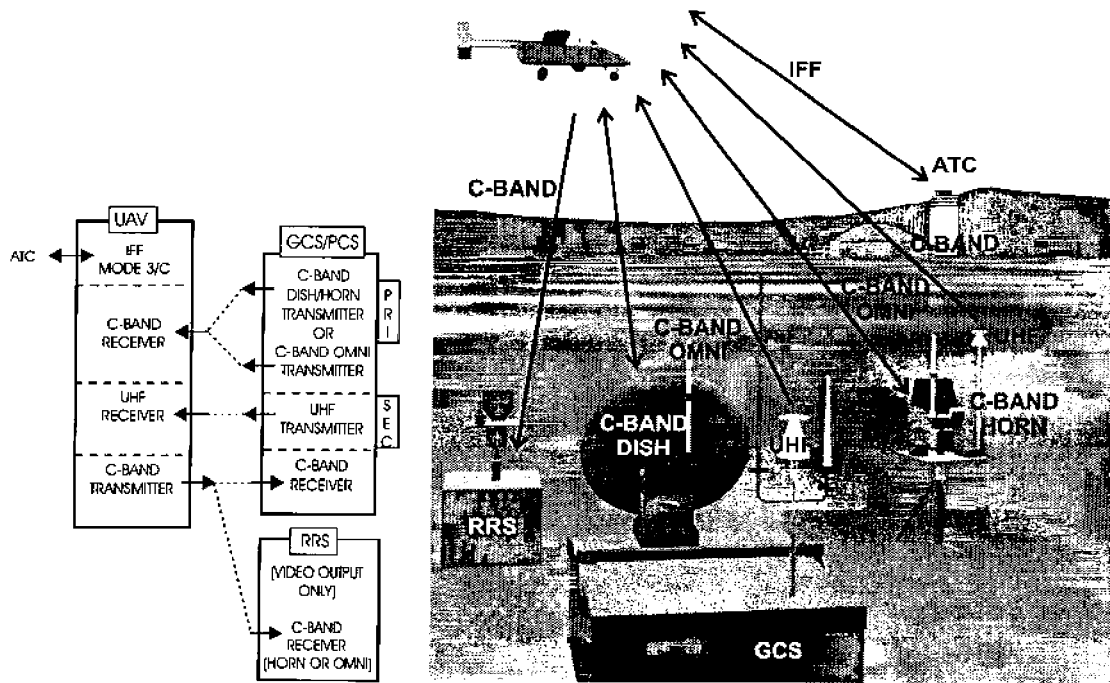


Figure 2-7. UAV Communications

peak-to-peak at up to 7 Hz. This flight condition exceeds the servo-motors current limit.

When altitude hold mode is used, the following procedures shall be followed:

1. TP 309 shall be monitored for 15 seconds during level off for cruise or following airspeed increase.
2. If TP 309 is greater than 0.2, reduce airspeed and/or altitude so that TP is 0.2 or less; or
3. Use stick throttle to continue mission.



Operations in Altitude Hold Mode to include Programmer and Camera Guide Modes when TP 309 is greater than 0.2 may cause damage to servo throttle unit. This condition may lead to a stuck throttle and subsequent loss of air vehicle.

2.1.3.3.5 Servo Wheel Unit. The Servo Wheel Unit is located in the front-end bulkhead in the mid section of the UAV fuselage. Its outputs are +5 Vdc to the nosewheel servo at the same time as the rudder servo is operated. The nosewheel range of movement is $\pm 12^\circ$.

2.1.4 Communications (Figures 2-7 and 2-8). The UAVs communicate with the GCS by radio via the uplink and downlink channels. Downlink communications are in the C-band frequency range. Each UAV sends its subsystem status reports and video and/or telemetry data to the GCS via the downlink channel. Each UAV transmits at a different frequency, which is set on the ground before the flight. Commands to the UAV are sent uplink on two channels, a primary and a secondary. Primary channel (UPL1) communications are in the C-band frequency range. Secondary channel (UPL2) communications are in the UHF range and are used only if the primary channel fails.

One antenna is used for both the uplink and downlink C-band channels, and a diplexer unit is used to separate the UPL reception channel from the DNL transmission

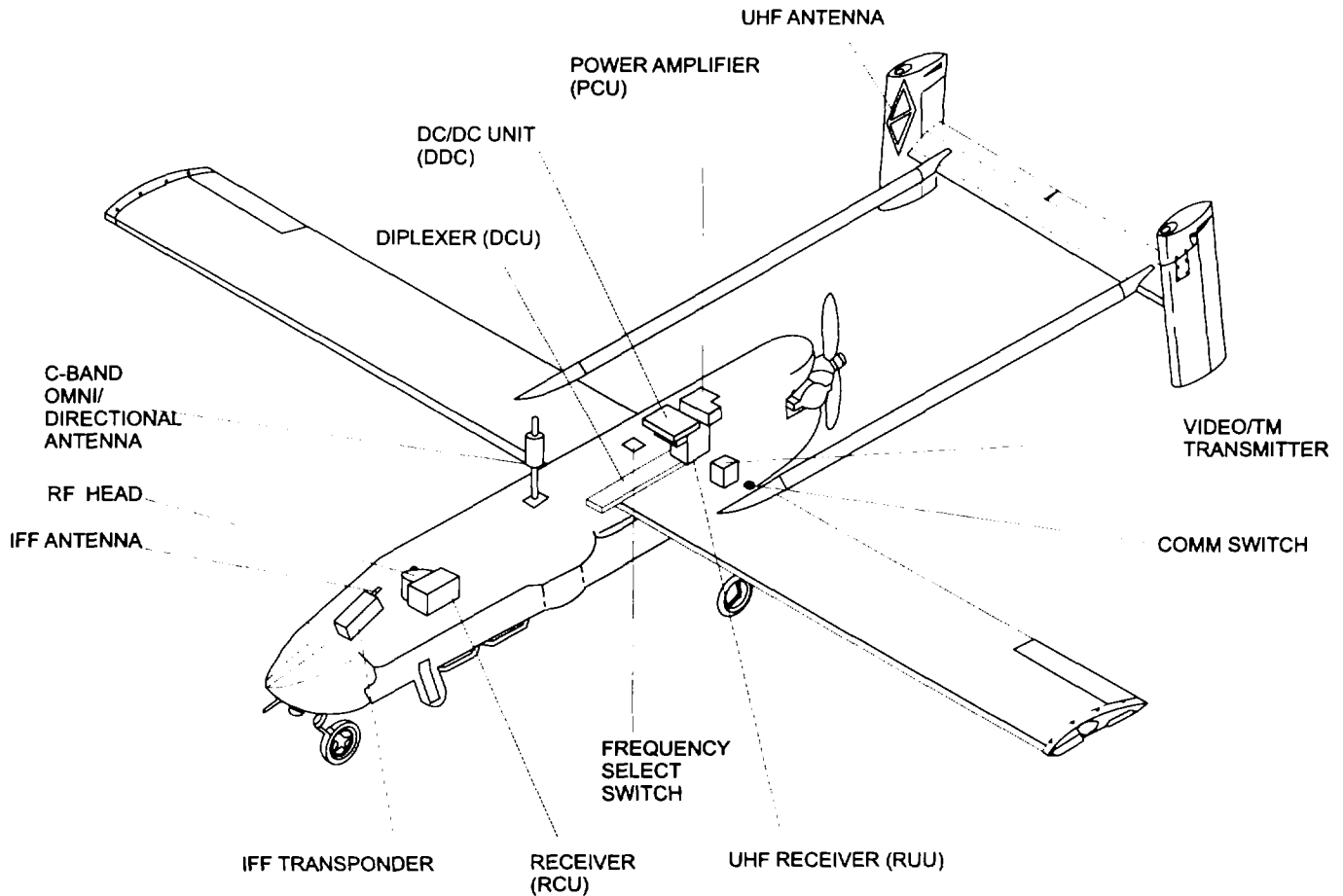


Figure 2-8. UAV Communications System

channel. The diplexer also isolates and protects the receivers from the high power output of the transmitter.

Video and/or telemetry data, as well as UAV status is transmitted on the DNL channel, as well as UAV status reports. The UAV-to-GCS range is calculated by timing the delay between transmitted and received signals from the GCS to the UAV. The range calculation circuits are located in the GCS-2000 Communication Shelter or in the PCS.

The COMM switch, located on the left side of the UAV fuselage, removes all 28 Vdc power from the communication equipment of the UAV. This enables maintenance to be performed on the UAV without the UAV receiving an uplink command or transmitting a

downlink command that might interfere with maintenance actions.

2.1.4.1 IFF Transponder. The IFF transponder is installed on the UAV under the main cover with the antenna mounted on top of the main cover. The IFF transponder, when interrogated by Air Traffic Control ground radar, transmits an identification code. The IFF transmits a four-digit identification code (Mode 3) and altitude information (Mode C).

When interrogated, the IFF transponder responds with a code that is set by using the four numbered (0 through 7) switches on the front of the IFF transponder. This code is set when the IFF is installed before takeoff and cannot be changed in flight. The codes 0000, 1200, 7500, 7600, 7700, and 7777 are not to be used at any time.

Power to the IFF transponder and the strobe light power supply is controlled by a relay mounted in the rear compartment. This relay is energized by an uplink command from the GCS/PCS through the encoder/decoder unit of the CPA. Once through the encoder/decoder, the uplink bit is routed to the EPS logic circuits where the relay is energized to enable 28 Vdc to be supplied to the IFF and the strobe light power supply. The IFF is on the non-essential bus.

2.1.4.2 C-Band Diplexer (DCU). The diplexer allows simultaneous transmission (downlink) and reception (uplink channel 1) on the same antenna. It contains two filters, one to suppress spurious emissions for the transmitter on the receiver frequency and one to suppress signals for the receiver on the transmitter frequency. The diplexer thus prevents mutual interference as well as receiver desensitization due to leakage of energy from the transmitter.

2.1.4.3 C-Band Receiver. The C-Band Receiver is on the non-essential bus. The C-band receiver consists of two modules, the SP/SP receiver and the RF head. The SP/SP receiver is controlled by three signals, which determine the operations/mode of the receiver. The three control signals are:

1. LONG/SHORT, for wide band long or short sequence
2. SECURE/CLEAR, for wide or narrow band frequency
3. COMMAND/LOCK, indicates where the decoder is locked in the uplink channel.

2.1.4.4 UHF Receiver. The UHF receiver receives uplink (secondary) signals from the GCS in parallel with the C-band uplink (primary). The UHF uplink is used if a problem arises with the C-band (primary) uplink.

2.1.4.5 UHF Antenna. This is a wide-band dipole antenna used for UHF reception on the secondary uplink channel. The antenna is located on the outer surface of the right vertical stabilizer.

2.1.4.6 Encoder/Decoder (EDU). The EDU receives data from the UAV receivers and relays commands or reports data to the UAV transmitter. It consists of two main modules: the encoder and decoder. The encoder receives reports from the UAV monitoring systems and flight controls and formats them. The encoder then passes the data to the C-band transmitter for transmission to the control station. The decoder receives uplink data from the C-band receiver and decodes it for the various command flight functions.

Video signals received from the payload are routed to the C-band transmitter. These signals do not pass through the EDU but are piggy-backed on the encoder signals and transmitted. The video signal requires no decoder and can be received by any unit possessing a receiver capable of accepting the frequency of the UAV transmission.

2.1.4.7 C-Band Transmitter. The C-band transmitter receives video from the camera payload and sends it on the main carrier signal. If the transmitter (Item #10) is commanded off during a step, + on in this Item commands the UAV transmitter to beacon mode (8 seconds on, 8 seconds off). If Item #10 is + on, this Item has no effect. If a failure occurs on the UAV with Items #10 and #11 - off, the UAV transmitter will come on in Beacon mode. Telemetry data information is sent on the sub-carrier signal at 7.5 MHz. A frequency select switch (located under the hinged cover holding the PCU assembly) determines the transmitter frequency. The transmitter can be tuned in 5 MHz steps over the band from 4,800 to 4,900 MHz.

2.1.4.8 C-Band Power Amplifier. The amplifier boosts the signal level from +20 to +40 db. A driver boosts the RF input signal to the level required by the power amplifier. The fully amplified signal then passes through a low pass filter and isolator (to absorb the reflected power). The amplifier houses the ON/OFF and LOW/HIGH functions. When in LOW position (LOW POWER), the output is 2.4w for testing on the ground or for short-range testing.

CHAPTER 3

The Ground Control Station (GCS) and The Tracking and Communications Unit (TCU)

3.0 GROUND CONTROL SYSTEM

The Ground Control System (GCS-2000) is a small, modular, highly transportable control station for the PIONEER UAV system. In the land-based configuration, the GCS-2000 is installed in two shelters. The Control Shelter (GCS) is contained in an S-250 or S-280 type shelter and includes the UAV Pilot Control Bay, Tracker Bay, and Observer Bay. The Communications Shelter (TCU) is contained in an S-250 type shelter, and includes the Communication, Tracking, and Antenna systems and the Navigational Data System. The S-280 GCS has additional room for a mission commander, intelligence bay, dual air conditioners, a redesigned AC/DC control panel, and an upgraded intercom system. The use of two shelters provides protection for the PIONEER UAV system operating crew (pilot and observer) without detracting from the system communication range. GCS shipboard operations are conducted from a mobile maintenance facility (MMF) with the TCU antenna mounted on a ship's mast.

3.1 GROUND CONTROL STATION (GCS) (FIGURE 3-1)

3.1.1 Electrical Power. GCS electrical power is supplied by an external power source providing 3-phase/10 kW power (110 Vac/60 Hz). A pack of eight batteries (12 Vdc/100 Amps each) are connected to provide 24Vac/200 Amps emergency power. The shipboard configuration replaces the pack of eight batteries with an uninterruptible power supply (UPS) to provide emergency power.

3.1.2 Power Distribution. 110 Vac from the generator is provided to the pilot and observer bays for monitor operation, air conditioning, illumination system, and the power supply (HPS-2000). The HPS-2000 is a 3-phase voltage rectifier that supplies high current 28 Vdc for distribution to the GCS subsystems. The GCS is

divided into six subsystems: System Monitor and Processor (SMP), pilot's control bay, tracker/plotter bay, payload/observers bay, intelligence bay, and mission

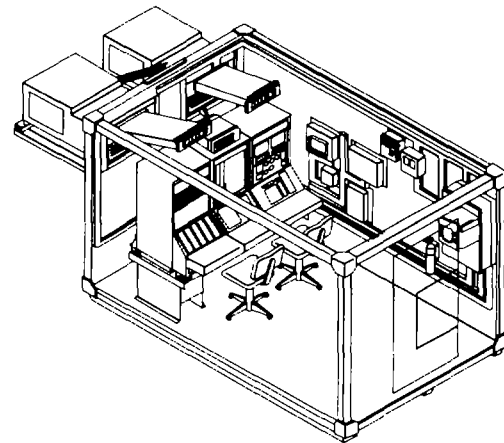


Figure 3-1. GCS-S280 Shelter

commander station, which also contains the electrical power supply and distribution panel.

3.1.3 System Monitor and Processor (SMP). The SMP acts as the central computer for the GCS. It is made up of seven computer cards that provide for the operation of the GCS. The SMP controls communications within the GCS, the GCS operating and application modes, and power supply warning messages. The SMP also performs on-line self tests and diagnostic reports up to card level, system preflight tests on the UAV and GCS, preflight interactive tests, calibration tests of the GCS, set up of the preflight conditions (preset mode), and loading of return home and navigation programs.

3.1.4 Pilot Control Bay (PBX) (Figure 3-2).

This is the station from which the internal pilot controls UAV flight operations. The PBX consists of Pilot Display Panel (PDP), Pilot Control Desk (PCD), Pilot Control Table (PCT), and Pilot's TV Monitor Panel (PTMP).

3.1.4.1 Pilot Display Panel (PDP) (Figure 3-3).

The PDP is a vertical panel that displays UAV flight data, system data, time data, and warnings. It is made up of the following gauges, lights, and caution indicators ("UAV report" indicates signal is transmitted from the UAV).

3.1.4.1.1 UAV Flight Data

1. RANGE KM. Digital readout of UAV-to-Station slant range in kilometers.
2. TRACKING AZIMUTH / RPV HEADING. Indicator 1 indicates the azimuth of the tracking antenna, relative to local grid north. The other indicator indicates the longitudinal axis direction of the UAV, relative to magnetic north (UAV report).

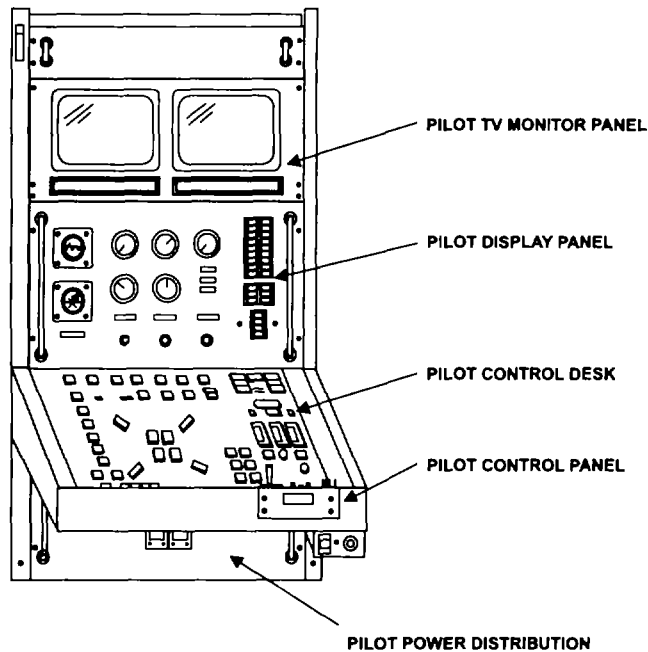


Figure 3-2. Pilot Control Bay (PBX)

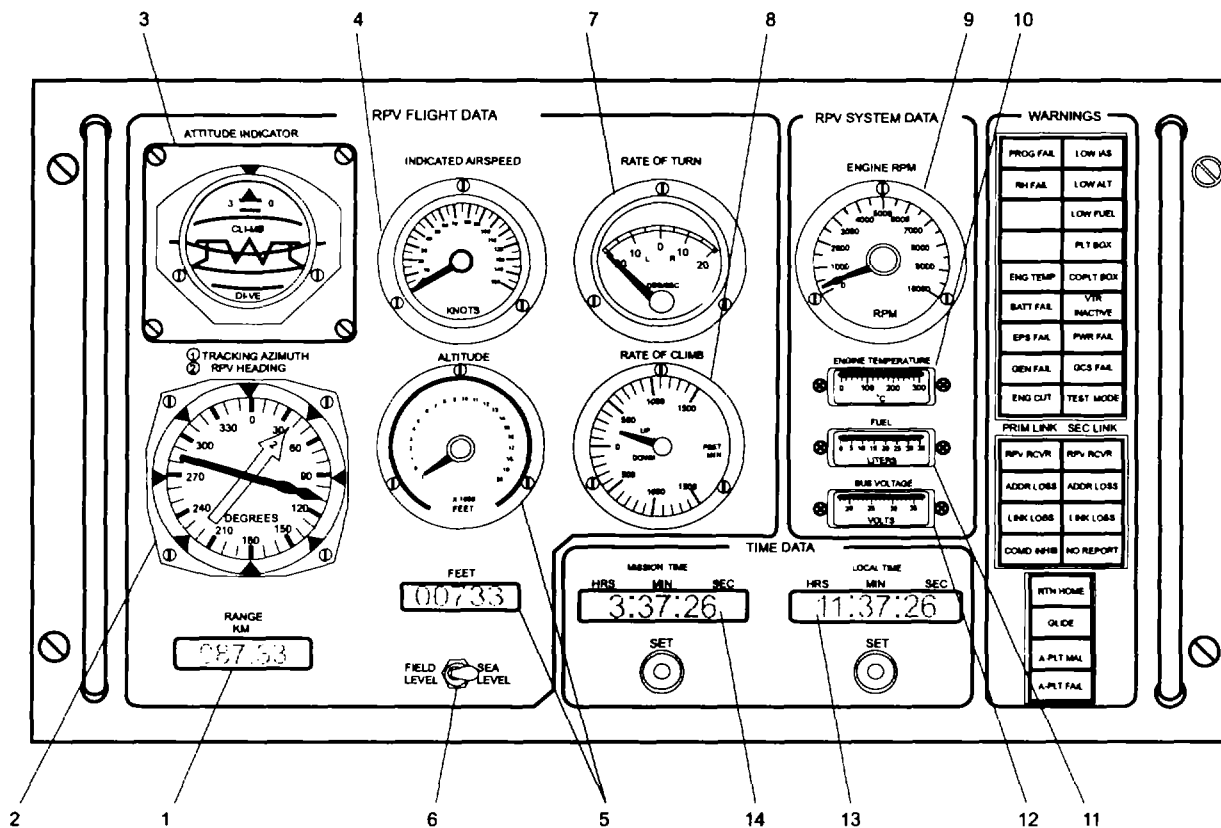


Figure 3-3. Pilot Display Panel (PDP)

3. **ATTITUDE.** Artificial horizon indicates UAV pitch and roll angles (in degrees) from information provided by the UAV Vertical Gyro Unit (VGU) (UAV report).
4. **INDICATED AIRSPEED.** Shows indicated airspeed in knots using information from Airspeed Transducer Unit (ATU). (UAV report).
5. **ALTITUDE** (analog and digital). UAV altitude above sea level or above the field level in accordance with selector position (UAV report, corrected in station).
6. **SEA LEVEL/FIELD LEVEL.** Selects the readout on the analog and digital displays of UAV altitude, either above ground level (AGL) or above mean sea level (MSL).
7. **RATE OF TURN.** Reads reported yaw rate (deg/sec) from UAV rate gyro unit (RGU) (UAV report).
8. **RATE OF CLIMB/VERTICAL SPEED INDICATOR (VSI).** Reads UAV rate of climb/descent in feet per minute (UAV report).

3.1.4.1.2 UAV System Data

9. **ENGINE RPM.** Reads engine speed in revolutions per minute (UAV report).
10. **ENGINE TEMPERATURE.** Engine cylinder head temperature (°C) (UAV report from the engine thermocouple unit).
11. **FUEL.** Indicates fuel quantity in liters (UAV report).
12. **BUS VOLTAGE.** Shows Essential Bus (ESS) voltage (UAV report).

3.1.4.1.3 Time Data

13. **LOCAL TIME SET.** Digital readout for local time. Push-button to set local time.
14. **MISSION TIME SET.** Digital readout for mission time. Push-button to reset and start mission time.

3.1.4.1.4 Warnings (Figures 3-4 and 3-5)

1. **PROG FAIL.** Indicates memory circuit malfunction in flight programmer. Illuminates when power supply to the system is interrupted (may erase program), when program is loaded incor-

rectly, or when no program is loaded after the UAV is switched on (UAV report).

2. **RH FAIL.** (Return Home Failure)

WARNINGS	
PROG FAIL	LOW IAS
RH FAIL	LOW ALT
	LOW FUEL
	PLT BOX
ENG TEMP	CO-PLT BOX
BATT FAIL	VTR INACTIVE
EPS FAIL	PWR FAIL
GEN FAIL	GCS FAIL
ENG CUT	TEST MODE
PRIM LINK	SEC LINK
RPV RCVR	RPV RCVR
ADDR LOSS	ADDR LOSS
LINK LOSS	LINK LOSS
COMD INHIB	NO REPORT
RTN HOME	
GLIDE	
A-PLT MAL	
A-PLT FAIL	

Figure 3-4. Warning Lights Panel

- a. **Lamp Blinking:** Failure detected in the station calculations and RH updating.
 - (1) RH calculated time is greater than 2:39H (max RH time).
 - (2) RH calculated distance is greater than 200 km. (max RH distance).
 - (3) UAV cannot return home due to available flight/meteorological data.
 - (4) Wind calculation has not been updated during last 30 min.

LIGHT	PROBABLE CAUSES	ACTION
PROG FAIL	1. INCORRECTLY LOADED DATA OR NO DATA IN RPV PROGRAMMER. 2. MISSION COMPUTER SET TO - NO.	1. MISSION COMPUTER.....+ YES. 2. NVC BYPASS...CYCLE YES - NO. 3. CHECK/RELOAD RPV PROGRAMMER.
RH FAIL (FLASHING)	FAILURE DETECTED IN STATION CALCULATIONS AND RH UPDATING.	PRESS FAIL CHECK.
RH FAIL (STEADY)	1. PWR SUPPLY INTERRUPTED. 2. INCORRECTLY LOADED RH DATA. 3. NO RH LOADED.	CHECK PWR SUPPLY, RELOAD RH DATA.
ENG TEMP	CYLINDER HEAD TEMP <100°C OR ≥ 230°C.	CONTROL ENG. TEMP IAW ENGINE LIMITATIONS (7.1.2).
BATT FAIL	1. BATT. VOLTAGE <32V WITH NO GEN FAIL. 2. GEN FAIL & BATT <25V. 3. BATT VOLTAGE UNBALANCED.	1. EXECUTE BATTERY FAILURE EMERGENCY PROCEDURE. 2. WITH A GEN FAIL LIGHT, EXECUTE GENERATOR FAIL EMERGENCY PROCEDURE.
EPS FAIL	1. INOPERATIVE BATTERY CHARGER. 2. INOPERATIVE CONVERTER. 3. BATTERY SWITCHING CIRCUIT, +15 VDC / + 5 VDC BUSES OUT OF TOLERANCE. 4. CENTRAL CLOCK INOPERATIVE.	LAND AS SOON AS PRACTICAL.
GEN FAIL	1. MECHANICAL FAILURE. 2. PHASE IMBALANCE. 3. OVER VOLTAGE/UNDER VOLTAGE. 4. ENGINE FAILURE.	EXECUTE GENERATOR FAIL EMERGENCY PROCEDURE.
ENG CUT	1. ERC FAILURE. 2. UAV ENGINE OFF.	1. CHECK ENGINE RPM INDICATOR. 2. EXECUTE ENGINE CUT EMERGENCY PROCEDURE.
LOW IAS	AIRSPEED IS BELOW PRESET.	1. INCREASE IAS. 2. CHECK IAS GAUGE/EDC DNL. 3. ADJUST PRESET.
LOW ALT	ALTITUDE IS BELOW PRESET.	1. CHECK ALTIMETERS/EDC DNL. 2. CLIMB AS DESIRED. 3. ADJUST PRESET.
LOW FUEL	LOW FUEL FUEL IS BELOW PRESET.	1. CHECK FUEL GAUGE/EDC DNL 2. RTB AS NECESSARY. 3. ADJUST PRESET.
PLT BOX	PILOT BOX DISCONNECTED OR INOPERATIVE.	CHECK IF BOX IS CONNECTED.
CO-PLT BOX	CO-PILOT BOX DISCONNECTED OR INOPERATIVE.	CHECK IF BOX IS CONNECTED.
VTR INACTIVE	VTR NOT IN RECORD MODE	INITIATE RECORD MODE, IF DESIRED.
PWR FAIL	FAILURE IN POWER SUPPLY.	PRESS FAIL CHECK ON PCT TO DETERMINE MAL-FUNCTION.
GCS FAIL	FAILURE IN ANY UNIT OF GCS-2000.	PRESS FAIL CHECK ON PCT TO DETERMINE MAL-FUNCTION.
TEST MODE	GCS-2000 IS IN TEST MODE.	DESELECT TEST MODE.

Figure 3-5. Warning Lights Table (Sheet 1 of 3)

LIGHT	PROBABLE CAUSES	ACTION
PRI LINK RPV RCVR	UPLINK ON UAV PRI RCVR LOW OR NO RECEPTION	<ol style="list-style-type: none"> 1. WAIT TO ENSURE TRUE EMERGENCY. 2. PRI XMTR ON HIGH. 3. ATTEMPT CLIMB OR HEADING CHANGE AND VERIFY. 4. IF WARNING PERSISTS LAND ASAP.
PRIM LINK ADDR LOSS	ADDR RECEIVED BY PRIMARY RCVR INCORRECT OR NOT RECEIVED.	<ol style="list-style-type: none"> 1. ENSURE PRIM XMTR ON HIGH. 2. GCS FAIL, PWR FAIL AND LOW PWR LAMPS OFF. 3. ANT TRACKING AND ELEVATION LOCKED. 4. CORRECT UAV ADDRESS. 5. IF WARNING PERSISTS LAND ASAP.
PRIM LINK LINK LOSS	UAV REPORTS LOSS OF PRIM UPLINK COMMANDS.	<ol style="list-style-type: none"> 1. ENSURE PRIM XMTR ON HIGH. 2. GCS FAIL, PWR FAIL AND LOW PWR LAMPS OFF. 3. ATTEMPT CLIMB OR HEADING CHANGE AND VERIFY. 4. IF WARNING PERSISTS LAND ASAP.
COMD INHIB	NONFUNCTIONAL.	N/A.
SEC LINK RPV RCVR	UPLINK ON UAV SEC RCVR LOW OR NO RECEPTION.	<ol style="list-style-type: none"> 1. WAIT TO ENSURE TRUE EMERGENCY. 2. SEC XMTR ON HIGH. 3. ATTEMPT CLIMB OR HEADING CHANGE AND VERIFY. 4. IF WARNING PERSISTS LAND ASAP.
SEC LINK ADDR LOSS	ADDR RECEIVED BY SECONDARY RECEIVER INCORRECT OR NOT RECEIVED.	<ol style="list-style-type: none"> 1. ENSURE PRIM XMTR ON HIGH. 2. GCS FAIL, PWR FAIL AND LOW PWR LAMPS OFF. 3. CORRECT UAV ADDRESS. 4. IF WARNING PERSISTS LAND ASAP.
SEC LINK LINK LOSS	UAV REPORTS LOSS OF SEC UPLINK COMMANDS.	<ol style="list-style-type: none"> 1. ENSURE SEC XMTR ON HIGH. 2. GCS FAIL, PWR FAIL AND LOW PWR LAMPS OFF. 3. ATTEMPT CLIMB OR HEADING CHANGE AND VERIFY. 4. IF WARNING PERSISTS LAND ASAP.
NO REPORT	<ol style="list-style-type: none"> 1. LOSS OF RECEPTION FROM UAV TRANSMITTER. 2. FAULT IN TCU RECEIVER ANTENNA. 	<ol style="list-style-type: none"> 1. VERIFY NVC BYPASS +YES. 2. UAV XMTR PUSH-BUTTON ON AND HIGH PWR. 3. ANT TRACKING AND ELEVATION LOCKED. 4. RECYCLE, CORRECT ADDRESS. 5. RPV ANT - OMNI. 6. RCVR FAIL LAMP OFF. 7. CHECK TCU FOR CBY FAIL. 8. RECORD LAST UAV POSIT., ALT., RANGE, HDG.
RTN HOME	1. UAV FLYING WITH LOSS OF BOTH UPLINKS.	<ol style="list-style-type: none"> 1. ENSURE PRIM & SEC XMTRS ON HIGH. 2. GCS FAIL, PWR FAIL & LOW PWR LAMPS OFF. 3. CHECK ADDRESS AND ANTENNA LOCK. 4. FOLLOW UAV TO RH COORDINATES.
GLIDE	1. UAV FLYING WITH LOSS OF BOTH UPLINKS.	<ol style="list-style-type: none"> 1. PRIM & SEC. XMTRS ON HIGH. 2. GCS FAIL, PWR FAIL & LOW PWR LAMPS OFF. 3. ENSURE CORRECT ADDRESS. 4. RECORD LAST UAV POSIT., ALT., RANGE, AND HDG.

Figure 3-5. Warning Lights Table (Sheet 2 of 3)

LIGHT	PROBABLE CAUSES	ACTION
<p>A-PLT MAL</p>	<p>ALTITUDE, AIRSPEED, HEADING UPLINK AND DOWNLINK DIFFER IN VALUE.</p>	<p>ENSURE ENGINE RPM IS ABOVE 3500 RPM. IF ABOVE 3500 RPM ENTER STICK MODES ONE AT A TIME IN THE FOLLOWING ORDER:</p> <p><u>AIRSPEED ABNORMAL</u> IAS READY PUSH-BUTTON OUT. PITCH ANGLE: 2°-3° LEVEL 5°-10° CLIMB -5°-0° DESCENT. LAND ASAP.</p> <p><u>ALTITUDE ABNORMAL</u> ALT-READY OUT. ENGINE RPM SET TO 6000 RPM. CHECK ALTITUDE ON TV MONITOR. START DESCENT. LAND ASAP.</p> <p><u>HEADING ABNORMAL</u> ROLL-READY PRESS. ROLL ANGLE 0°. IF NEEDED, ROLL-READY OFF TO MAINTAIN CONTROL. CAMERA TO PILOT'S WINDOW. USE PLOTTER TO NAVIGATE. LAND ASAP.</p>
<p>A-PLT FAIL</p>	<ol style="list-style-type: none"> 1. RATE OF ROLL GREATER THAN 120 DEGREES / SECOND, OR RATE OF PITCH GREATER THAN 45 DEGREES / SECOND. 2. POWER INTERRUPTION TO AUTOPILOT. 	<ol style="list-style-type: none"> 1. CHECK THE FOLLOWING INSTRUMENTS FOR ABNORMAL INDICATIONS. <ol style="list-style-type: none"> A. ATTITUDE INDICATOR B. RATE OF TURN C. RATE OF CLIMB 2. IF INDICATIONS ARE ABNORMAL, EXECUTE FLIGHT CONTROL MALFUNCTION EMERGENCY PROCEDURE. 3. IF INDICATIONS ARE NORMAL, VERIFY A-PLT FAIL LIGHT EXTINGUISHES WITHIN 15 SECONDS. <p>Note: It is normal for the A-PLT Fail light to illuminate for 15 seconds when the payload platform is selected "ON."</p>

Figure 3-5. Warning Lights Table (Sheet 3 of 3)

- (5) RH calculation has not been performed during last 3 min.
- (6) RH data has not been updated during the first minute of flight in Programmed Mode.
- b. Lamp remains lit: UAV reports malfunction in Return Home data memory. It lights when electrical power to the memory is lost (might erase RH data), when there is malfunction in RH data loading process, or when electrical power is applied to UAV and no data is loaded.
3. ENG TEMP. Lights when cylinder-head temperature (CHT) is $< 100^{\circ}\text{C}$ or $\geq 230^{\circ}\text{C}$ (UAV report). When RPV TX commanded off, light will illuminate if CHT $> 260^{\circ}\text{C}$.
- Note**
- Comply with Engine Limitations section 7.1.2.
4. BATT FAIL. Lights when one of the following occurs (UAV report):
- Battery voltages lower than 32v without generator failure
 - Battery voltages lower than 25v with a generator failure
 - Battery voltage unbalance of 0.5v between battery packs.
5. EPS FAIL. All circuits in the EPS are redundant and the system will automatically switch to a backup circuit if an output voltage is too high or low. Switching causes the EPS FAIL light to illuminate. Lights when one of the following occurs (UAV report):
- Inoperative charger
 - Inoperative converter
 - The supply circuit that should operate when generator malfunction occurs is inoperative
 - Converter protection circuit failure.
6. GEN FAIL. Lights when UAV generator is unable to provide adequate power or one of three phases drops below 24v (UAV report).
7. ENG CUT. Lights when engine RPM drops below approximately 500 rpm (UAV report).
8. LOW IAS. Lights when UAV reported airspeed is below the LOW IAS level preset by the pilot. The warning is triggered by station logic. The LOW IAS preset limits the lowest airspeed that can be set by the AIRSPEED knob.
9. LOW ALT. Lights when UAV reported altitude above sea level is lower than the LOW ALT level preset by the pilot. The warning is triggered by station logic. The LOW ALT preset does not limit the ALTITUDE knob.
10. LOW FUEL. Lights when UAV reported fuel level is lower than the LOW FUEL level preset by the pilot. The warning is triggered by station logic.
11. PLT BOX. Lights when PBX failure is detected or PBX is disconnected.
12. COPLT BOX. Lights when CBX failure is detected or CBX is disconnected.
13. VTR INACTIVE. Lights when the VTR is not recording.
14. PWR FAIL. Lights when failure is detected in any unit of the station power supply system.
15. GCS FAIL. Lights when a failure is detected in GCS.
16. TEST MODE. Lights when the test push-button is selected (TEST MODE push-button lights). While executing TEST MODE the station can not control the UAV.
17. RPV RCVR/PRIM LINK. Lights when the primary uplink receiver on the UAV reaches low reception level or loses reception (UAV report).
18. ADDR MODE/PRIM LINK. UAV reports the address received in the primary uplink is wrong or no uplink is being received (UAV report).
19. LINK LOSS/PRIM LINK. UAV reports loss of primary uplink commands (decoder is not locked) (UAV report).
20. RPV RCVR/SEC LINK. Lights when the secondary uplink receiver on UAV encounters low reception level or loses reception (UAV report).

21. **ADDR MODE/SEC LINK.** UAV reports that the address received in the secondary uplink is wrong or when no address is received (UAV report).
22. **LINK LOSS/SEC LINK.** UAV reports loss of secondary uplink commands (decoder is not locked) (UAV report).
23. **COMD INHIB.** Lights to indicate that the uplink is being disregarded by the UAV due to the programmer mode of flight programming. This function is no longer used.
24. **NO REPORT.** Indicates TCU loss of reception from the UAV C-Band transmitter or a fault in the TCU antenna.
25. **RTN HOME.** UAV reports flying with both uplinks lost while FLT-TO/LD switch is in FLT position. RETURN HOME is performed according to the last data updated by the station.
26. **GLIDE.** UAV reports flying with both uplinks lost while FLT-TO/LD switch is in TO/LD position. UAV autopilot maintains 0° pitch, 0° roll, and engine idle.
27. **A-PLT MAL.** UAV reports malfunction during “Hold” modes of one or more of the following circuits: altitude, airspeed, and heading. UAV compares uplink commands with sensor reports. A-PLT MAL illuminates if one of the following conditions exists:
 - a. Difference between altitude commanded and altitude reported is greater than 500 feet and the rate of climb/descent is less than 100 feet/minute for more than 10 seconds (UAV report).
 - b. Difference between airspeed commanded and airspeed reported is greater than 5 knots for more than 16 seconds (UAV report).
 - c. Difference between heading commanded and heading reported is greater than 11.5 degrees for more than 40 seconds (UAV report).
28. **A-PLT FAIL.** Lights to indicate severe failure of the control flight system when the autopilot senses higher than permitted pitch and roll rates (rate of roll is greater than 120 degrees/second, rate of pitch is greater than 45 degrees/second). The warning also lights when electrical power to autopilot is interrupted. Warning stays on for 15 seconds (UAV report).

3.1.4.2 Pilot Control Desk (PCD) (Figure 3-6).

The PCD is the canted panel located at the pilot control bay. The controls that are used to control the UAV during missions are primarily located here. The UAV communications control and display are also located here. The switches, buttons, and indicators are as follows:

1. **DISENG/AUTOPLT.** Emergency autopilot disengagement. Pressing push-button lights AUTOPILOT only. When UAV reports that autopilot has been disengaged, DISENG also lights. Press again to cancel the command. DISENG/AUTOPLT passes control to the control box in command. The STICKCONTR push-button illuminates to indicate STICK (RATE) control mode.

2. **MASTER CAUTION.** Illuminated push-button. Lights when one or more warning lamps in the PCD-2000 or PDP-2000 light except REPORT INHIBIT.

Pressing and holding the push-button causes the last illuminated warning lamp to flash.

Releasing the push-button turns the lamp (in the MASTER CAUTION push-button) off.

When the warning lamp that triggered MASTER CAUTION turns off, MASTER CAUTION also turns off.

3. **FLT-TO/LD.** This push-button predetermines the resulting flight mode during loss of both uplinks and address.

When TO/LD mode is selected and both uplinks are lost, UAV goes into Glide mode. UAV APE is pre-programmed to 0° pitch and 0° roll, and engine idle. This prevents Return Home from being performed when communication is lost during taxi, takeoff, and landing phases.

When in FLT mode and both uplinks are lost, the UAV performs Return Home according to the last RH data sent to it. FLT is lit with UAV report after the push-button is pressed. TO/LD flashes when the UAV is in the air and exceeds preset minimum IAS. This reminds the pilot to switch to FLT mode. Entering programmed flight automatically switches to FLT mode. Disengagement of DISENG/AUTOPLT switch automatically switches to TO/LD mode.

4. **GEN RESET.** Used to reconnect generator to EPS after overvoltage disconnection. Pressing the push-button lights it for 5 seconds and GEN FAIL

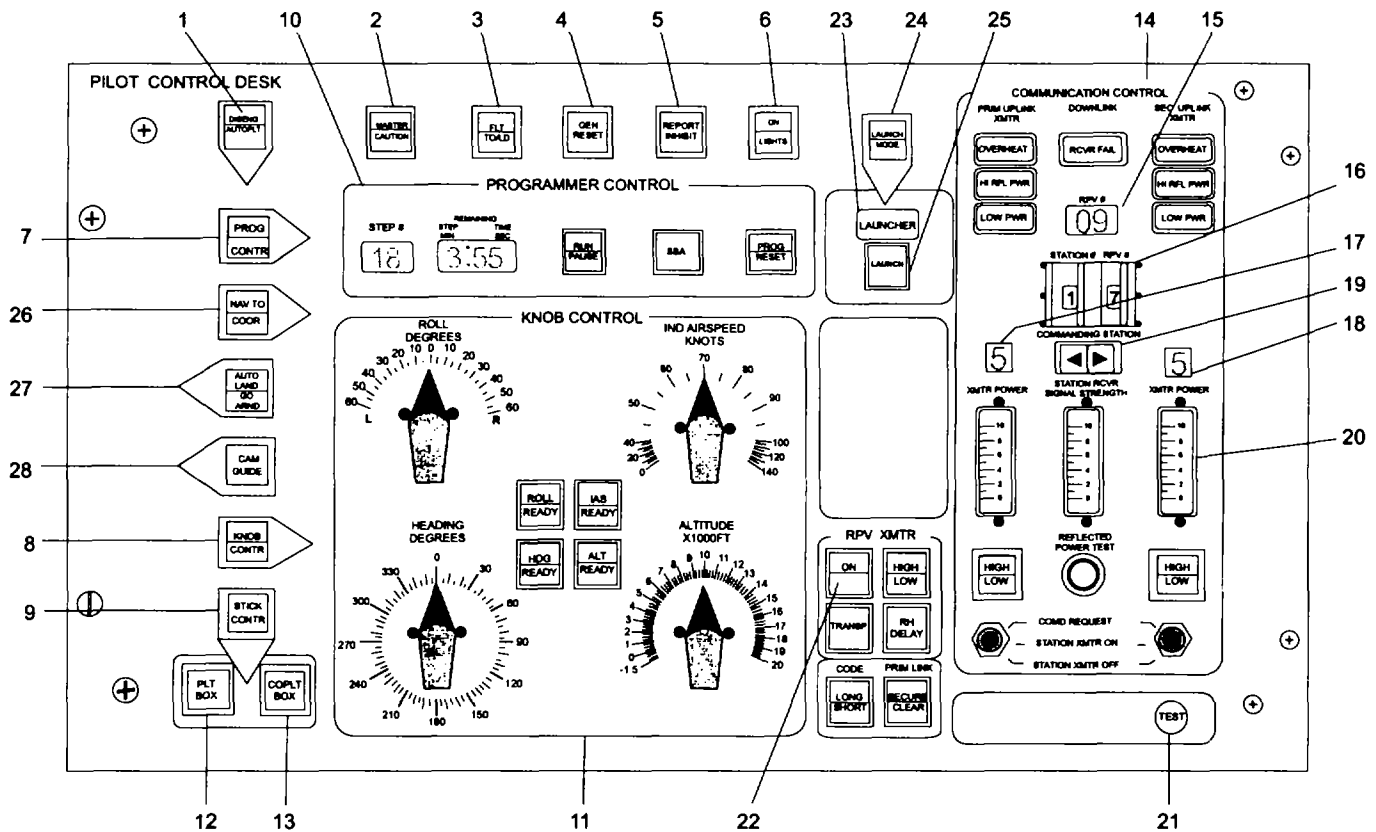


Figure 3-6. Pilot Control Desk (PCD)

warning light goes off 5 seconds later if reset was successful.

5. **REPORT INHIBIT.** Pressing this push-button blocks UAV reports during flight except when A-PLT FAIL or A-PLT MAL warnings are reported. Pressing REPORT INHIBIT at time of malfunction lights the push-button as a reminder of the block. Pressing the REPORT INHIBIT push-button a second time providing UAV "listens", releases the block and extinguishes the light. Any new malfunction activates the UAV transmitter. When UAV transmitter is on, all warnings, including blocked ones, are reported to station. Verifying a malfunction by pressing the push-button a second time releases all blocked warnings.
6. **ON/LIGHTS.** Two-section illuminated push-button used to switch on the UAV lights. When selected at CBX, top half of light illuminates inside GCS.

7, 8, & 9. **PROG/CONTR, KNOB/CONTR, STICK CONTR.** One of these three push-buttons is pressed to select mode of flight, canceling other modes. Pressing KNOB/CONTR switches the UAV to autopilot control with control circuits (AIRSPEED, ALTITUDE, ROLL, and HEADING) prepared in advance. If one or more of the circuits is not ready, the flight is not fully automatic and STICK/CONTR push-button lights together with KNOB CONTR. The lower half of the push-button lights when pressed. The upper half lights (by UAV report) when one or more circuits have been connected in the UAV. Pressing STICK CONTR lights the push-button and switches UAV to manual/position control. The control box is switched on at this time and the PROG CONTR or KNOB CONTR push-buttons are extinguished. PROG CONTR mode switches the UAV to programmed flight. The bottom half illuminates when the push-button is pressed. It is necessary to keep the push-button pressed until UAV reports that the mode has been engaged (until the upper half is illuminated). At end of program UAV switches to KNOB/CONTR if circuit

is at READY position. If the KNOB/CONTR circuit is not at the READY position, UAV switches to manual/position control. Pressing DISENG AUTOPLT also transfers UAV to STICK CONTR.

10. PROGRAMMER CONTROL

- a. STEP #. Display of the current programmer step.
- b. REMAINING STEP TIME. Display of Estimated Time of Arrival (ETA) at the point to which the aircraft is flying, once in Programmer mode. After arriving at waypoint, step time displays remaining holding time.
- c. RUN/PAUSE. Deactivated. (RUN light is always on and PAUSE is nonfunctional.)
- d. SSA (Single Step Advance). Pressing this push-button advances the RPV programmer (NAV Card) one active step. It is used when it is necessary to shorten the current flight step. The push-button remains illuminated only when pressed. This action also switches the RUN/PAUSE push-button to PAUSE mode.
- e. PROG RESET. Pressing this push-button will "back step" the RPV programmer (Nav Card) one active step.

11. KNOB CONTROL

- a. IAS/READY, ALT/READY. These push-buttons are used to set airspeed and altitude in KNOB CONTR flight mode. When either of these switches is pressed, only the READY light is illuminated. To illuminate the other half, KNOB/CONTR is pressed, engaging the circuit. When the UAV reports that a circuit has been engaged, the upper halves of IAS ALT/READY and KNOB/CONTR are illuminated and control is passed to the appropriate PCD KNOB controller. Pressing an illuminated IAS ALT/READY push-button causes it to revert to manual (position) control. ALT/READY off causes manual throttle control and IAS/READY off causes manual elevator control.
- b. ROLL/READY, HDG/READY. These push-buttons cannot be operated simultaneously. Pressing one push-button lights the READY half in one and cancels the READY half on the other push-button (if it was on). The

other half lights when KNOB/CONTR is pressed and the UAV reports that the circuit has been engaged. Pressing a lit push-button again causes it to revert to manual (position control of the circuit, manual aileron and rudder control).

- c. ALTITUDE, IND AIRSPEED, HEADING, ROLL. These four knobs determine the respective function data for KNOB/CONTR mode. They are operational when the adjacent push-button is in READY position and KNOB/CONTR push-button is pressed.

12 & 13. PLT BOX, COPLT BOX. Only one of these push-buttons can be illuminated at a time. Pressing the extinguished push-button causes the illuminated push-button to extinguish and the selected push-button to illuminate. When the STICK CONTR push-button is pressed, the box whose push-button is illuminated controls the UAV. Failure or disconnection of a box prevents its push-button from being illuminated from the GCS.

14. COMMUNICATION CONTROL

- a. PRIM UPLINK XMTR/OVERHEAT. Indicates that primary uplink transmitter is overheating in the TCU.
- b. SEC UPLINK XMTR/OVERHEAT. Indicates that secondary uplink transmitter is overheating in the TCU.
- c. RCVR FAIL. Indicates a failure in the station C-Band receiver.
- d. PRIM UPLINK XMTR/HI RFL PWR. Indicates that reflected power in the primary uplink transmitter is too high.
- e. SEC UPLINK XMTR/HI RFL PWR. Indicates that reflected power in the secondary uplink transmitter is too high.
- f. PRIM UPLINK XMTR/LOW PWR. Indicates that transmission power in the primary uplink is too low.
- g. SEC UPLINK XMTR/LOW PWR. Indicates that transmission power in the secondary uplink is too low.

15. **RPV # (display).** Digital read-out of the number (address) of the UAV whose downlink the station is receiving.
16. **STATION #/RPV # (thumbwheels).** Left thumbwheels switch used to set the station address (eight addresses possible, 0 to 7). Right thumbwheels switch used to set the address of the UAV to which the GCS transmits commands (16 addresses possible, 0 to 15).
17. **PRIMARY UPLINK STATION NUMBER DISPLAY.** LED display that indicates the station number of the station transmitting the C-Band uplink on which the UAV C-Band receiver is locked (UAV report).
18. **SECONDARY UPLINK STATION NUMBER DISPLAY.** LED display that indicates the station number of the station transmitting the UHF uplink on which the UAV UHF receiver is locked (UAV report).
19. **COMMANDING STATION.** Split indicator. Left arrow illuminates when the primary (C-band) uplink (from the station whose number is displayed in the primary uplink station number display) controls the UAV. Right arrow illuminates when the secondary (UHF) uplink (from the station whose number is displayed in the secondary uplink station number display) controls the UAV.
20. **COMMUNICATION DISPLAY AND CONTROL AREA**
- PRIM UPLINK XMTR POWER/SEC UPLINK XMTR POWER.** Two analog meters (one for each uplink XMTR) read transmission power.
 - STATION RCVR/SIGNAL STRENGTH.** Analog meter reads the strength of the signal at station receiver.
 - PRIM UPLINK XMTR HIGH/LOW.** Used to switch the primary uplink transmitter to high or low transmission power.
 - SEC UPLINK XMTR HIGH/LOW.** Used to switch the secondary uplink transmitter to high or low transmission power. Each press switches between positions (only low transmission power is available from the PCS UHF uplink transmitter).
- e. **REFLECTED POWER TEST.** When pressed, two XMTR PWR meters read reflected power of each transmitter.
- f. **TRANSMITTER CONTROL SWITCHES.** Two switches, one for each transmitter. Each has the following positions:
- STATION XMTR OFF** — Transmitter off
 - STATION XMTR ON** — Transmitter in operation.
 - COMD REQUEST** — Transmitter operates and requests command of UAV.
- Transferring GCS command from one link to the other requires that both switches be placed (and held) in the COMD REQUEST position; the switch of the commanding link must be released first (back to XMTR ON) and then the switch of the link to which control is to be transferred is released.
21. **TEST.** Pressing TEST lights all PCD, PCT, and PDP push-buttons and annunciators and moves all analog indicators to the full-scale position. TEST is continuously lit to indicate that electrical power is reaching the bulbs.
22. **RPV XMTR**
- ON.** Pressing this push-button commands the UAV to operate its transmitter and lights the lower half of the push-button. The upper half (ON) is illuminated when the UAV transmitter is activated and reported via DNL to the GCS. Pressing again switches transmitter off.
 - HIGH/LOW.** Switches between high and low UAV transmitter power for C-band transmitter only.

WARNING

Do not switch the UAV transmitter to high power when the UAV is on the ground, except for a few seconds during preflight checks and on takeoff roll, due to RF HAZARD.

- c. TRANSP. Commands the UAV transmitter to operate in the TRANSPONDER mode. The UAV transmits only when correctly addressed by the uplink. Pressing this push-button switches off the UAV XMTR push-button. TRANSP is automatically switched off when UAV XMTR push-button is switched on. Warnings and failures are transmitted in this mode.
- d. RH DELAY. Pressing this push-button causes alternating time delays of 2 seconds (push-button not illuminated) and of approximately 30 seconds (push-button illuminated) before UAV commences Return Home mode (after both uplink channels lost). During the time delay, UAV maintains last commanded flight data. With NVC bypass +YES, the RH delay is 2 seconds.
- e. LONG/SHORT. Pressing this two-position push-button selects the long or short frequency span in C-band. Used to lock the SP/SP aircraft receiver.
- f. SECURE/CLEAR. Pressing this two-position push-button engages/disengages the protected transmission system.

23. LAUNCHER. Green illuminated indicator. Light indicates success of series checks of the launch system mounted on the vehicle.

24 & 25. LAUNCH. Illuminated push-button for launching the UAV. This feature is no longer utilized; however, the software is still functional. Once activated, pushing this button a second time will deselect LAUNCH mode.



Pressing this button will immediately run the throttle servo to max and lock out all other UPL commands including remote engine cut.

26. NAV TO COOR. Illuminated push-button for entering the navigation-to-coordinates mode.



Use of Nav-to-Coordinate mode not authorized.

27. AUTOLAND/GO AROUND. Two-section illuminated push-button for entering the automatic landing procedure. When pressed, the upper section lights. Pressing again sets UAV to go-around mode.



Use of AUTOLAND mode not authorized.

28. CAM GUIDE. Illuminated push-button for entering the camera guide flight mode.

3.1.4.3 Pilot Control Table (PCT) (Figure 3-7).

The PCT is the horizontal control panel where the keypad and stick controls are located. The keypad is used to enter and change the menu data for the UAV and the stick controls are used to control the UAV in manual mode. The functions of the various keys, push-buttons, and sticks are as follows:

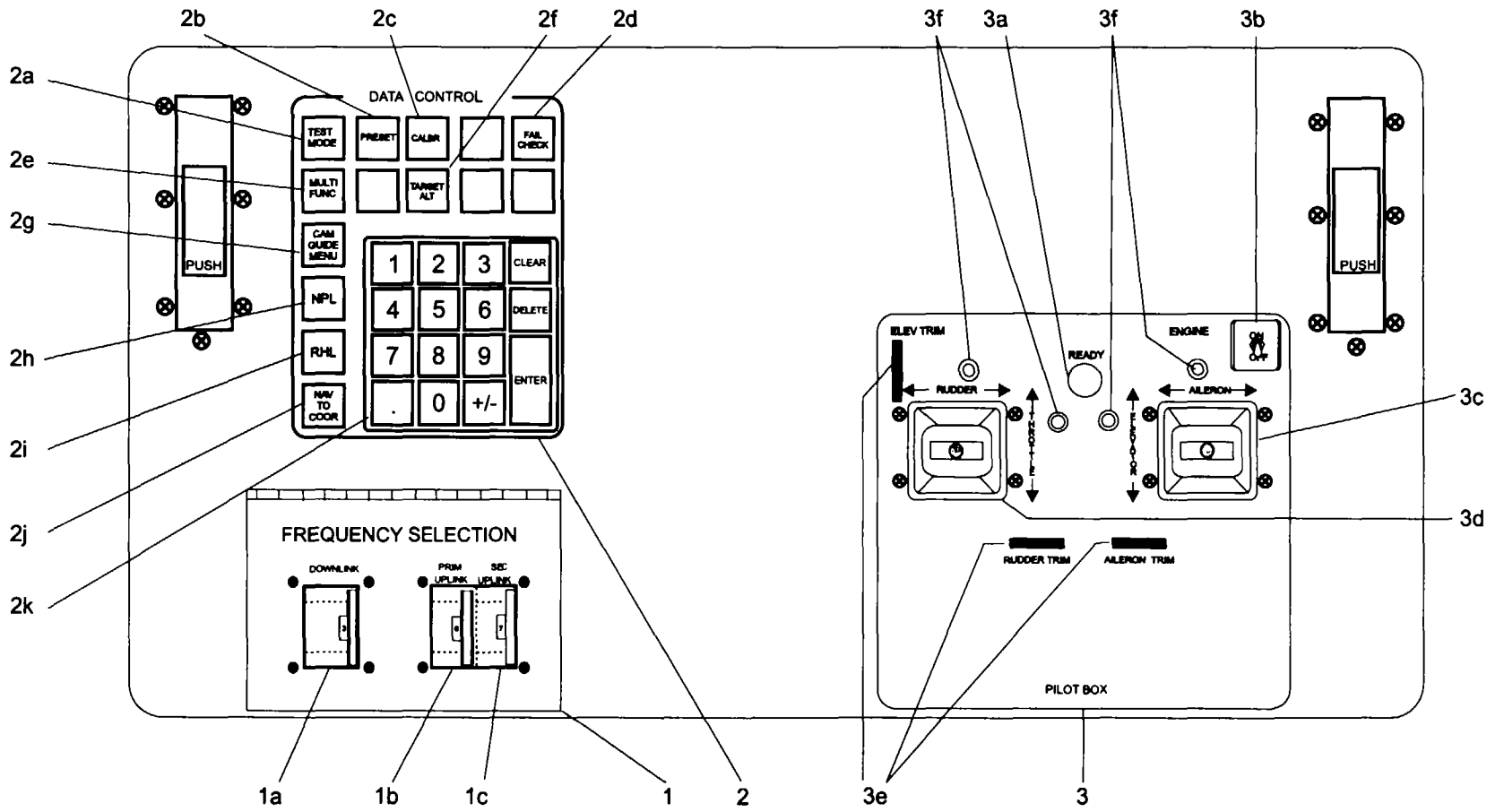
1. FREQUENCY SELECTION.

- a. DOWNLINK. Thumbwheels. Selects the station receiving frequency.
- b. PRIM UPLINK. Thumbwheels. Selects the station primary transmitting frequency.
- c. SEC UPLINK. Thumbwheels. Selects the station secondary transmitting frequency.

2. DATA CONTROL. The following functional push-buttons are lit when their control mode is selected. They must be pressed again to get out of one mode before another mode can be selected.

- a. TEST MODE. Functional push-button. Selects the TEST control mode.

Figure 3-7. Pilot Control Table (PCT)





When the station is in TEST mode, the UAV cannot be controlled by the pilot. This push-button is covered to prevent inadvertent selection of this mode.

- b. PRESET. Functional push-button. Selects the PRESET control mode. 13 menus on screen.
- c. CALBR. Functional push-button. Selects the CALIBRATION control mode. Used mainly during inflight calibration of altitude and warning limits. #1 menu in presets.
- d. FAIL CHECK. Functional push-button. Allows display of malfunction warning message when the PWR FAIL, GCS FAIL, or RH FAIL warning lamps indicate a malfunction.
- e. MULTIFUNCTION. Functional push-button. Selects the Multifunction control modes.
- f. TARGET ALT. Functional push-button. Allows inflight updating of the target altitude data.
- g. CAM GUIDE. Functional push-button. Allows selection of the Camera Guide flight mode and establish holding parameters.
- h. NPL. Functional push-button. Selects the NavProgrammer updating control mode. Used mainly during inflight updating of the navigation program data.
- i. RHL. Functional push-button. Selects the Return Home Updating control mode. Used mainly during inflight viewing or updating of the RH parameters.
- j. NAV TO COOR. Functional push-button. Allows selection and updating of the navigation to coordinate mode.



Use of Nav-to-Coordinate mode not authorized.

- k. DATA INPUT KEYBOARD. Numeric keyboard. Used to enter numerical data and to select control functions.

3. PILOT BOX CONTROL (PBX).

- a. READY. Command annunciator that illuminates when the PBX has been selected on the PCD (PLT BOX push-button is illuminated). When illuminated, the PBX is used to control the UAV if STICK CONTR is selected. If the autopilot is disengaged, STICK CONTR is automatically selected. The annunciator stays lit in any flight mode if PBX is selected on the PCD.
- b. ENGINE ON/OFF. This switch operates only in STICK CONTR mode. It is used to cut the engine. UAV lights must be on for engine to cut.
- c. AILERON/ELEVATOR STICK. Controls pitch and roll axes of UAV with following modes:
 - (1) STICK CONTR/Autopilot Engaged — movement of stick commands angles of pitch and roll. Keeping stick in position maintains the required angle. Angle limits are: Pitch: -17° to $+20^{\circ}$; Roll: 60° left and right.
 - (2) STICK CONTROL/Autopilot Disengaged (emergency) — movement of stick commands angles of UAV control surfaces and results in rate of pitch/bank proportional to the movement. The stick is spring-loaded and returns to neutral when released.
- d. RUDDER/THROTTLE STICK. A sideways movement of this stick commands rudder and nosewheel movement throughout their travel. Fore/aft movement changes throttle position accordingly. Rudder is spring-loaded and centers itself. Throttle position stays at last setting.
- e. ELEV. TRIM, RUDDER TRIM, AILERON TRIM. Three trim wheels, one for each control axis, are used to change PBX commands by up to 10% for a given stick position.
- f. CIRCUIT ANNUNCIATORS. Four lights indicate circuit mode.

3.1.4.4 Pilot's TV Monitor Panel (PTMP). Consists of two 9" video monitors each with its associated picture adjustment controls. The left monitor displays pilot's data as selected from the PCT. The right hand monitor displays payload video or digital information as selected on the observer's left-hand video monitor. In the shipboard GCS configuration, the right-hand monitor can display GPS/Antenna Interface Box (IBX) digital information as selected on the PCT.

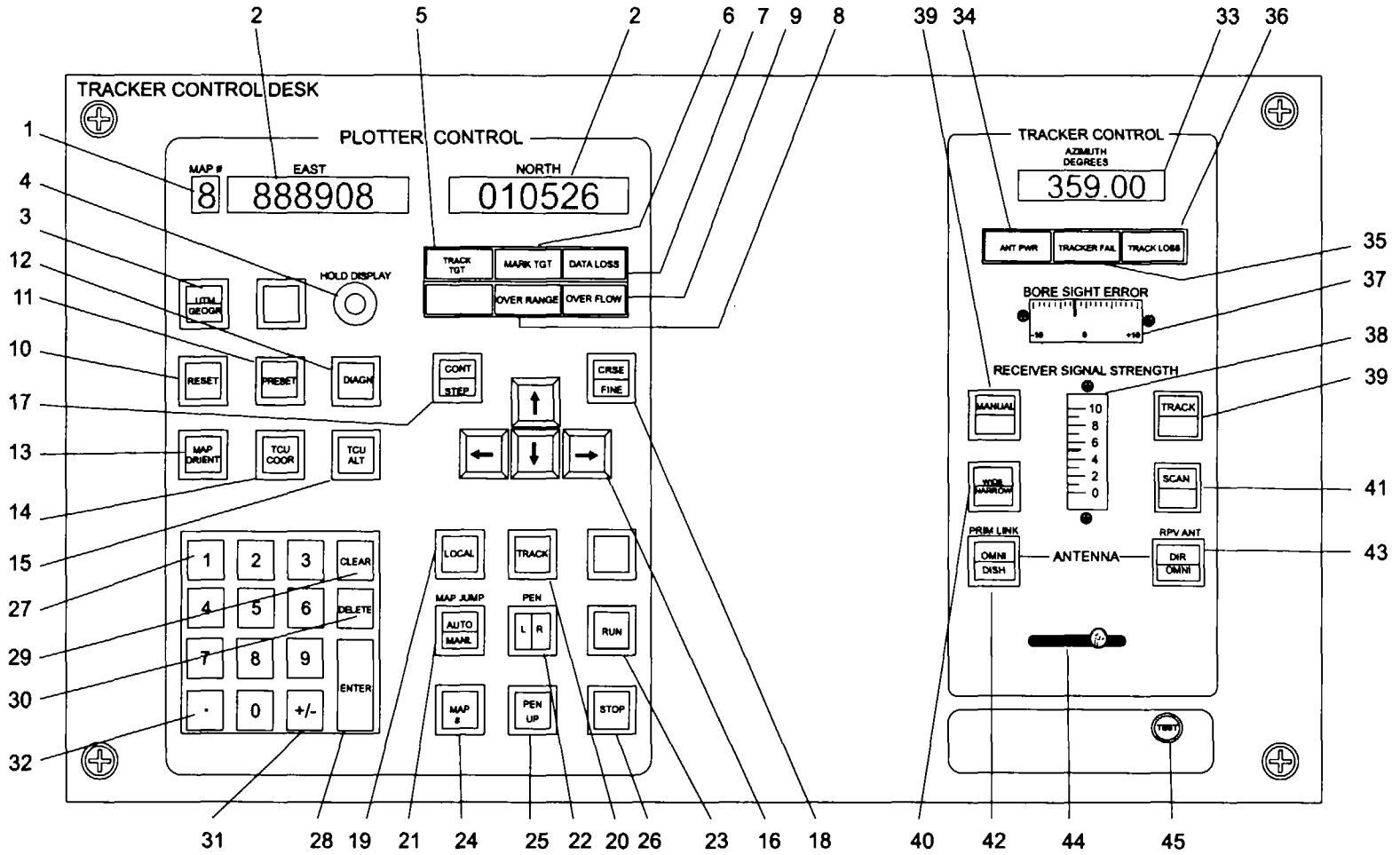
3.1.5 Tracking Bay (TBY). The TBY performs both the navigation data display and tracking control functions. The TBY consists of the Plotter Panel (PLP) and the Tracker Control Desk (TCD) (Figure 3-8). The PLP houses the plotter mechanical units (the plotting area, the arm, and the pen) and electronic units and is used to plot the path of the UAV flight. The TCD handles the tracking logic, the bay preflight and diagnostics test, and the real-time plotter calculations. The TCD is divided into two sections; the Plotter Control Area and the Tracking Control Area.

3.1.5.1 Plotter Control Area. This area on the left side of the TCD has the following indicators and functional push-buttons:

1. **MAP#.** A single-digit display of the map number (1-9) for which data is inserted or checked (in PRESET or DIAGN mode, respectively), or of the map being used for navigation.
2. **EAST, NORTH.** These displays express pen coordinates in UTM. Both displays exhibit six digits without decimal points.
3. **UTM/GEOGR.** Pressing this push-button shifts between UTM and geographic method of coordinates display, and controls the UTM/GEOGR indicator accordingly. In PRESET mode, only UTM position is possible in this configuration.
4. **HOLD DISPLAY.** Pressing this push-button freezes EAST and NORTH displays for 5 seconds or as long as push-button is pressed. Releasing results in display of actual position.
5. **TRACK TARGET.** Lights up when the TRACK TARGET push-button in the OCT has been pressed. The plotter traces the target's course of travel instead of tracing the trajectory of the UAV.
6. **MARK TARGET.** Illuminates to indicate the MARK TARGET function has been initiated.
7. **DATA LOSS.** Lights if range or azimuth data is lost.
8. **OVER RANGE.** Lights to indicate that pen tracking position is outside the grid coordinates entered during map orientation and pen continues to plot in UP position. OVER RANGE is extinguished if the pen returns to the grid coordinates entered during map orientation.
9. **OVERFLOW WARNING.** Lights to indicate that tracking data memory is full. Oldest data coordinates will be lost from memory first.
10. **RESET.** Pressing this push-button shifts between PRESET and DIAGN modes, to bring the pen to "park pen" (lower left corner of map) and to reinitialize the plotter.
11. **PRESET.** PRESET enters the initialization data for the plotter. That data includes:
 - MAP # (number),
 - Four-map reference points (corners),
 - TCU coordinates, and
 - TCU altitude.
12. **DIAGN.** This push-button is operative only in RESET mode. DIAGN allows the following checks:
 - a. **Map Orientation.** The pen goes over the four map reference points and the coordinates are displayed in EAST and NORTH displays.
 - b. **TCU Coordinates.** The pen marks TCU location (if within plotter table dimensions), and TCU coordinates are displayed in EAST and NORTH displays.
 - c. **TCU Altitude.** The altitude is displayed in NORTH display.
 - d. **Plotter memory.**
 - e. **Plotter hardware.**

DIAGN is extinguished only at the end of a successful check or when another mode is selected. If a check is unsuccessful, both DIAGN and the appropriate function push-button stay lit.
13. **MAP ORIENT.** MAP ORIENTATION push-button is operative only in PRESET or DIAGN modes. After PRESET is engaged, map reference points are entered clockwise starting from lower left corner. Pen movement is controlled for each direction (+Y, -X, -Y, +X) with the four arrowed push-buttons. Coordinates of each reference point are keyed in local grid when the

Figure 3-8. Tracker Control Desk



pen is located at the respective point. These coordinates are displayed at time of entry. When map orientation is completed, automatic check (diagnostic) is performed.

14. TCU COOR. This push-button is operative only in PRESET or DIAGN mode. When PRESET is engaged and TCU COOR is pressed the station local grid coordinates are entered in ± 1 meter resolution. In DIAGN mode, the station coordinates are displayed for 5 seconds and the pen marks the station location. The push-button lamp extinguishes after a successful check.
15. TCU ALT. Engaging TCU ALT push-button in PRESET mode allows entry of the station (TCU) altitude (in meters) into plotter memory. In DIAGN mode, push-button displays TCU altitude in North LED.
16. PEN-MOVING PUSH-BUTTONS. Pressing any of these push-buttons (only with LOCAL push-button engaged) moves the plotter pen in the marked direction. To move the pen 45° , press two push-buttons at a time (these push-buttons must not oppose each other).
17. CONT/STEP. Determines the type of pen movement. In CONT setting, the pen moves as long as a pen-moving push-button remains pressed. In STEP setting, only a single, predetermined movement (determined by COARSE/FINE push-button) is made regardless of how long a pen-moving push-button is pressed.
18. COARSE/FINE. Each press of this push-button switches between its settings. In STEP mode, plotter pen moves in increments of 0.3 mm in COARSE setting and 0.1 mm in FINE setting.
19. LOCAL. Pen-moving push-buttons can be operated only when LOCAL push-button is lit. This mode is operative in RESET, PRESET, and DIAGN modes. LOCAL is extinguished if RUN is engaged (or when RUN associated TRACK push-button is engaged).
20. TRACK. Pressing TRACK push-button shifts plotter to communicate with the GCS software. Navigation data and other control commands are sent to the plotter for plotting.
21. MAP JUMP AUTO/MAN. Each press of this push-button switches the method of shifting between maps in plotter memory. Manual shift is done by entering map number. In AUTO setting, the pen chooses the smallest possible map scale. AUTO/MAN is operative only in RUN mode. MAP # display reads the currently referenced map when shifting either manually or automatically.
22. PEN L/R. Used to select and interchange the right and left pens. The lamp inside the push-button indicates which pen is in use. In extreme locations, the changeover between the two pens is automatic, according to which pen can trace in that position.
23. RUN. This mode is the normal, working mode of the plotter. RUN is operative in TRACK mode and extinguished by pressing LOCAL, STOP, or RESET push-button.
24. MAP #. A map number between one and nine can be entered following a press on MAP # display. The push-button is operative in PRESET, DIAG, and MAN (Jump) modes.
25. PEN UP. When it is unnecessary or undesirable to plot a course on the map, press the PEN UP push-button to lift the pen off the map. In case of DATA LOSS to the plotter, the pen stays down; with resumption of data supply, the pen draws a straight line from last known point to newly reported point.
26. STOP. Halts plotting of the course on maps but reception of data continues. Re-engaging RUN mode causes plotting to resume at a fast pace to compensate for the delay.
27. NUMERICAL KEYBOARD. Use of the keyboard is possible in the following modes: PRESET, DIAGN, LOCAL, and MAN (JUMP). After the desired push-button is pressed, MAP #, MAP ORNT, TCU COOR, or TCU ALT and a check program number may be entered in numerical form. After keying a number, the ENTER push-button lights to indicate that the information has to be stored.
28. ENTER. Transfers information from the keyboard into plotter memory. ENTER is also used to record plotter pen coordinates in PRESET mode. The ENTER push-button lamp is lit by pressing any of the keyboard keys, and is extinguished when ENTER is pressed.
29. CLEAR. Used to clear (zero) inserted numerical data.
30. DELETE. Not used.

- 31. +/- . Not used.
- 32. Decimal Point.

3.1.5.2 Tracking Control Area. This area on the right side of the TCD has the following indicators and functional push-buttons:

- 33. **AZIMUTH DEGREES.** Digital readout of azimuth (in relation to grid north) from station to UAV in degrees, tenths of a degree, and hundredths of a degree. This readout summarizes antenna axis angle and tracking error and is used for antenna north alignment process.
- 34. **ANT PWR.** Comes on whenever antenna motor is not receiving power either because switch outside station is off or there is a malfunction in antenna power supply.
- 35. **TRACKER FAIL.** Warning lamp lights to indicate a failure in the tracking system.
- 36. **TRACK LOSS.** Indicator lamp that notifies of a loss of tracking. It is operative only when the system is in TRACK mode.

When the SCAN push-button is not lit and loss of tracking occurs, the antenna stops at that point and the TRACK LOSS indicator lamp starts blinking. The system tries to retrack the UAV for 5 seconds, the antenna remains in the same position, and the TRACK LOSS lamp remains lit. In this situation, the operator must track the UAV and perform a RESET to extinguish the lamp.

When the SCAN push-button is lit and a loss of tracking occurs, the TRACK LOSS indicator lamp starts blinking and the system begins an angular scan around the point where the tracking was lost. The SCAN push-button starts blinking. If the system is able to retrack, the TRACK LOSS lamp extinguishes and the SCAN push-button emits a steady light. If the system fails to retrack the UAV after 5 seconds, the antenna stops at the point tracking was lost. TRACK LOSS indicator lamps light and SCAN push-button stays lit. In this situation, the operator must intervene.

- 37. **BORE SIGHT ERROR.** Indicator used to read tracking antenna angular error and to lock tracking antenna on UAV.
- 38. **RECEIVER SIGNAL STRENGTH.** Indicates received signal strength in ground station receiver.

- 39. **MANUAL/TRACK.** When the MANUAL push-button is lit, the antenna is manually controlled. Deflection of the joystick controls the sideways movement of the antenna at an angular velocity relative to the rate of deflection of the joystick. When the joystick is in the center position and the MANUAL push-button is lit, the antenna remains stationary with no drift. When the TRACK push-button is lit, the antenna is in AUTOMATIC TRACK mode and tracks the UAV. Moving the joystick manually while the system is in TRACK mode causes a momentary changeover to the MANUAL mode; the MANUAL push-button lights and the TRACK push-button extinguishes. Releasing the joystick causes the system to revert to TRACK mode.
- 40. **WIDE/NARROW.** Functions only in TRACK mode. The halves of this push-button determine the bandwidth sensitivity of the antenna control system. When the MANUAL push-button is lit, the WIDE/NARROW push-button is extinguished completely. Moving to the TRACK mode causes the system to begin at the WIDE mode, which lights. Subsequent depressions of the WIDE/NARROW push-button cause the modes to interchange.
- 41. **SCAN.** Determines the action taken by the system when a loss of tracking occurs.
- 42. **PRIM LINK OMNI/DISH.** Switches the transmission and reception of the primary UPL and DNL channels between the dish and the omnidirectional antennas. Moving the push-button from DISH to OMNI position engages the MANUAL mode. The MANUAL push-button lights and the TRACK push-button is extinguished (if it was lit). When the push-button is in OMNI position, the ATC-2000 cannot be moved to the TRACK mode. To move to the TRACK mode, this push-button must be in or moved to the DISH mode. The OMNI position compels the BORE SIGHT ERROR meter to read 0 (the middle position).
- 43. **UAV ANT DIR/OMNI.** Command to UAV allowing directional or omnidirectional control of C-Band antenna. The UAV directional antenna only works when the GCS/TCU is in the TRACK mode. UAV antenna defaults to OMNI when the TCU omni antenna is selected.
- 44. **CONTROL STICK.** Single axis stick used for manual control of tracking antenna angle. In middle position, antenna is stationary. Tilting side-

ways commands angular velocity proportional to stick deflection. Stick can be operated in MANUAL or TRACK mode. Tilting stick in TRACK switches mode to MANUAL until stick is released.

45. TEST. Pressing TEST lights all TCD-2000 push-buttons and annunciators and moves the pointers in all analog indicators to their full-scale reading. TEST is continuously lit to indicate that electrical power is reaching the bulbs.

3.1.6 Observer Bay (OBY) (Figure 3-9). The OBY consists of an observer television monitor panel (OTMP), an observer video control (OVC), a Video Tape Recorder (VTR), an observer control desk (OCD), and an observer control table (OCT).

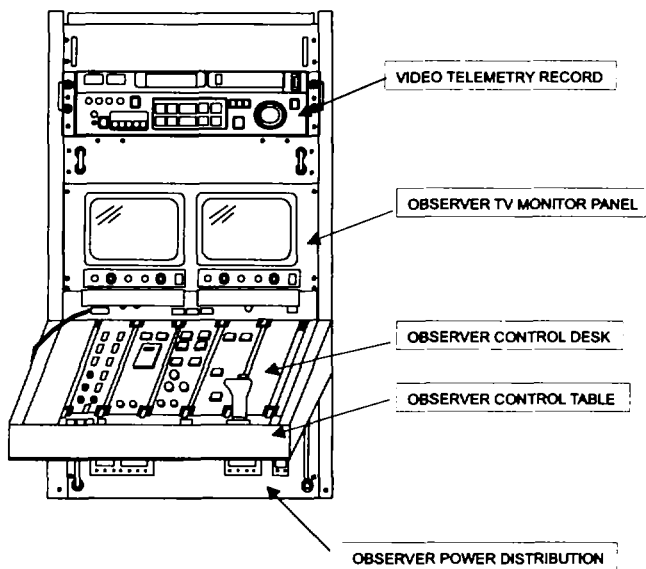


Figure 3-9. Observer Bay (OBY)

3.1.6.1 Observer Television Monitor Panel (OTMP). The OTMP is the vertical panel mounted in front of the observer that is used to display video data on two 9-inch monitors. Each monitor has video adjustment controls under the screen. Monitor presentations are controlled by the observer from the OVC. The video presentation should be maintained on the left observer monitor because it is hard wired to the pilot bay right side monitor, which is used for flight. A video hard copy unit is located over the TBV and can be used to provide hard copy image of the video displayed on the monitor. Above the monitors is a VTR used to tape video reception from the payload. The observer's video monitors are identical to those of the pilot. Both 9-inch video monitors can display video signals received from the UAV, OBY-2000 messages, or Playback of VCR data.

3.1.6.2 Observer Video Control (OVC) (Figure 3-10). The OVC is used to select and control video graphics. It also includes provisions for auxiliary video hookups, VCR activation, and the light pen used during artillery spotting missions.

1. LIGHT PEN. Connector used to engage light pen for artillery adjustment purposes.
2. AUX VIDEO. Connector used for the input of an external video signal for display.
3. DIMMER. Two knobs used to control the light intensity (DARK to BRIGHT) of the alphanumeric displays that appear on the monitors. It may be necessary to adjust the dimmer controls slightly up or down if flashing white lines appear on the CRT displays. Also used in optical alignment procedures.
4. VIDEO GRAPHIC ON. Used to switch alpha-graphic displays on and off. When in off position, all alpha-graphic data is turned off, except the line-of-sight vector (18), north vector (20), and picture center (cross) (17).
5. VIDEO GRAPHIC ALL/PART. Use of this push-button is possible only when VIDEO GRAPHIC ON push-button is engaged. At this stage, ALL is lit, indicating that all alphanumeric information is displayed. Pressing the push-button switches to PART (partial display of information). Figure 3-11 shows the alphanumeric information displayed on the OTMP, and the table below describes the graphics. An asterisk (*) denotes information displayed in PART position.
6. SPARE. Not used.
7. VTR RECORD/INACTIVE. RECORD lights when VTR is recording. INACTIVE lights when VTR is not recording.

3.1.6.2.1 Graphic Display Field. The graphic display field displays graphic information concerning the airborne payload. This field is not used in the pilot's display screen. Figure 3-12 shows the information displayed in the graphic display field.

1. ANALOG HEADING AND BEARING INDICATOR. A dual pointer analog indicator for display of TV camera (narrow pointer) and UAV (wide pointer) bearings relative to magnetic north.
2. DIGITAL HEADING DISPLAY. Displays the UAV heading.

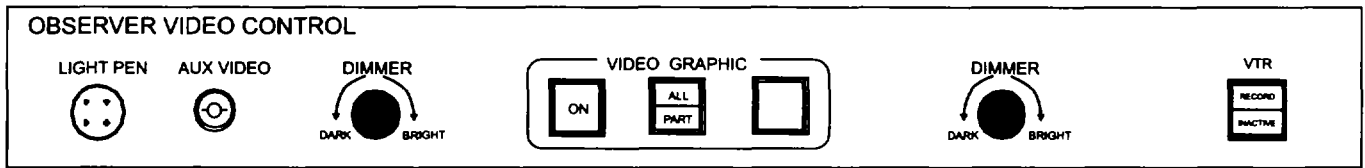


Figure 3-10. Observer Video Control (OVC)

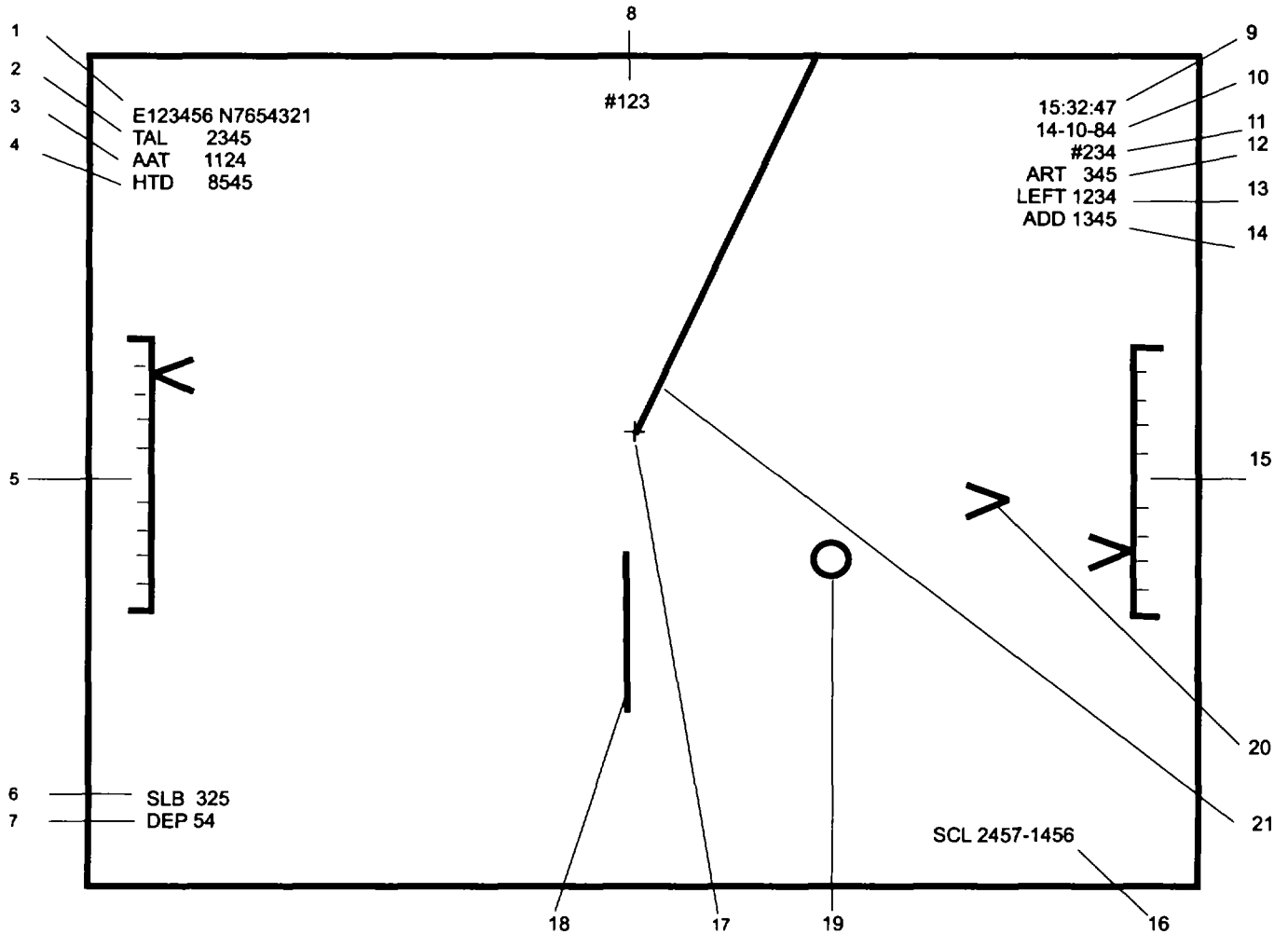


Figure 3-11. Alphanumeric Information on the OTMP (Sheet 1 of 2)

1.	*Target coordinates - on the camera optical axis - east/north coordinates
2.	Target altitude above sea level (TAL = Target Altitude) = meters
3.	UAV altitude above the target (AAT = Altitude Above Target) = meters
4.	Horizontal distance from UAV to target (HTD = Horizontal Target Distance) = meters
5.	Graphic display of HTD. Each line equals 1000m. Lowest line=0m/highest line=10,000m
6.	Line-of-sight bearing relative to grid north 9 SLB = Sight Line Bearing) = degrees
7.	Line-of-sight depression relative to horizon (DEP - Depression) = degrees
8.	*Sequential number of event, appearing for a few seconds during target designation
9.	*Time (local time) - hours: minutes: seconds
10.	Date - day-month-year
11.	Mission serial number, entered by the operator - 3-digit number. The artillery adjustment information (steps 12-14) appears only during the artillery adjustment procedures.
12.	Artillery adjustment identification number consisting of: (1) ART: Artillery (2) 3-digit number: target designation number, defined by the operator (3) 2-digit number: shell sequential number
13.	Artillery east/west adjustment data (RIGHT = east/LEFT = west) = meters
14.	Artillery north/south data (ADD = north/DROP = south) = meters
15.	Graphic display of the camera field-of-view (FOV) : (1) Pointer at lowest line = widest FOV - MKD 200 and 12DS DLTV camera = super narrow FOV - MKD 400 (2) Pointer at highest line = narrowest FOV - MKD 200 and 12DS DLTV camera = super wide - MKD 400
16.	Picture scale at the screen center, consisting of: (1) SCL: Scale (2) 4-digit number: picture scale parallel to the line-of-sight axis (3) 4-digit number: picture scale perpendicular to the line-of-sight axis. Scale ratio is given in meters (on ground) to centimeters (on screen).
17.	*Graphic display of the picture center (cross)
18.	*Graphic display of the ground projection of the line-of-sight on the displayed picture (vector). Vector direction is toward the center of the picture.
19.	Graphic display of where the light pen was pressed. Appears for several seconds.
20.	Graphic display of the north on the picture axes (vector) (20). Vector direction is from the center of the picture outside.
21.	Graphic display of the gun to target (vector). The gun to target vector is enabled/ disabled by the PRESET/GUNFIRE menu on the observer bay. The geographic coordinates of the gun are also entered via the menu.

Figure 3-11. Alphanumeric Information on the OTMP (Sheet 2 of 2)

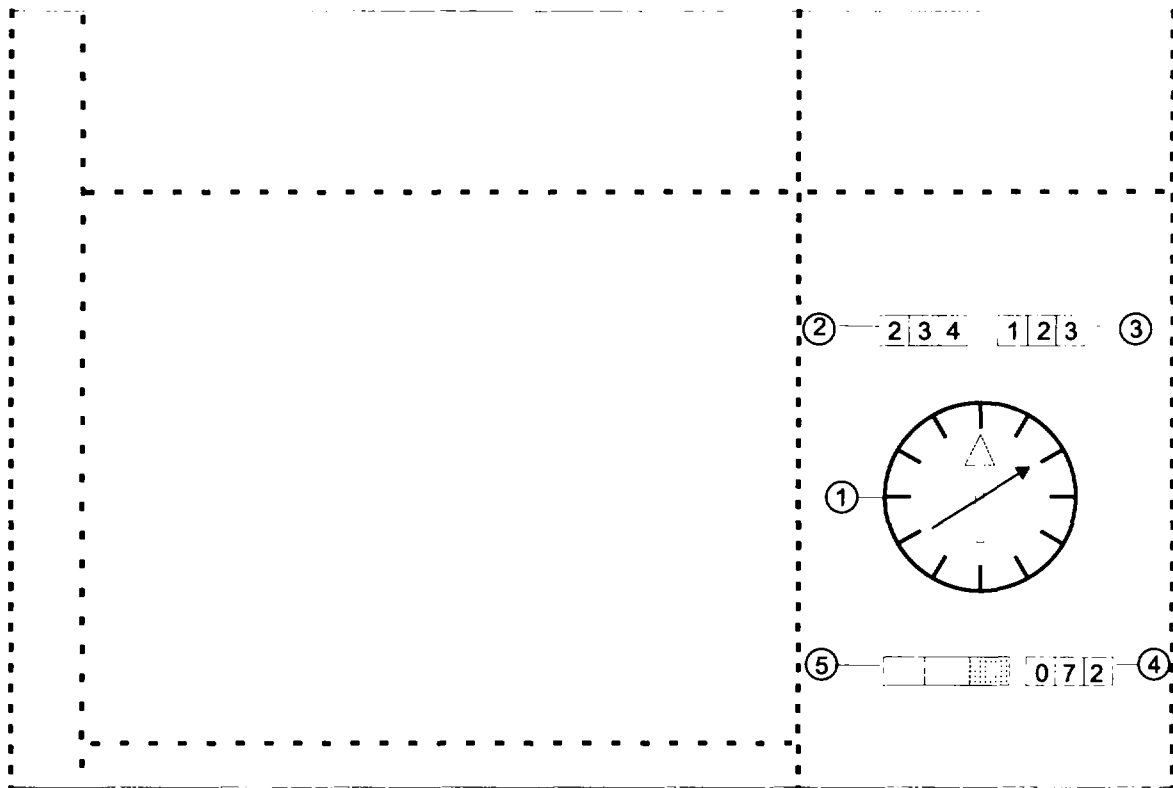


Figure 3-12. Graphic Display Field

- 3. **DIGITAL BEARING DISPLAY.** Displays the TV camera bearing relative to the UAV nose.
 - 4. **DIGITAL DEPRESSION DISPLAY.** Displays the TV camera depression angle relative to UAV horizontal axis.
 - 5. **ANALOG DEPRESSION INDICATOR.** Pointer indicating TV camera depression angle. The dotted area indicates a depression angle at which the camera is not stabilized.
- 3.1.6.3 VTR.** The VTR is a Sony model EVO-9850. The VTR records uplink and downlink data, downlink video, and intercom audio. See Figure 3-13.
- 1. **POWER ON/OFF.** Two-position switch used to activate and deactivate unit.
 - 2. **TIME COUNTER DISPLAY SWITCH.** Selects what is displayed in time counter display as follows:
 - a. **COUNTER:** Displays the amount of tape travel in hours, minutes, seconds and frames.
 - b. **TC:** The item to be displayed depends on the setting of the U BIT/TIME switch on the sub panel. When the U BIT/TIME SWITCH is set to TIME: Displays the 8 mm time code. When the U BIT/TIME switch is set to U BIT: Displays the user bit.
 - c. **DIAL MENU:** The unit enters the dial menu operation mode. The dial menu is displayed. In this mode, any other functions are deactivated.
 - 3. **TIME COUNTER DISPLAY.** Displays the item selected by time counter display switch.
 - 4. **RESET BUTTON.** When the time counter display switch (2) is set to COUNTER and the time counter display (3) indicates the amount of tape travel, press this button to reset time counter display and display on the time counter display.

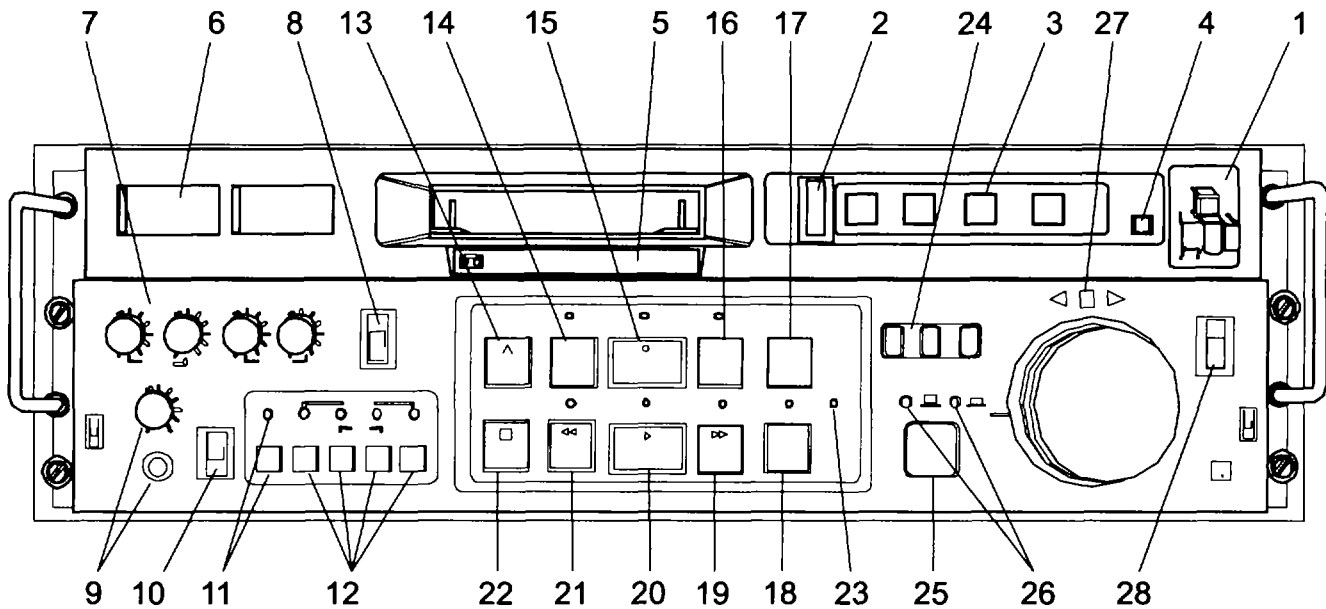


Figure 3-13. VTR SONY EVO-9850

5. **STATUS INDICATORS.** These indicators are located in the window below the cassette compartment opening, and light to provide operational status information about the unit.
6. **AUDIO LEVEL METERS.** These meters indicate the audio recording level in record or Electric-to-Electric (EE) mode. They indicate playback level in playback mode.
7. **PCM/AFM AUDIO LEVEL CONTROLS.** These controls allow independent adjustment of audio record levels.
8. **METER SELECT SWITCH.** Selects the audio whose level is to be displayed on the audio level meter.
 - a. **PCM:** Displays the recording level while the audio input signal is being recorded onto the PCM track. The meter displays playback level during playback.
 - b. **AFM:** Displays the recording level while the audio input signal is being recorded onto the AFM track. The meter displays playback level during playback.
9. **PHONES JACK and VOLUME CONTROL.** Jack accepts 8 ohm stereo headphones to monitor the signal selected with the MONITOR SELECT switch. Volume is adjustable with the volume level control.
10. **MODE SELECT SWITCH.** Set the switch to EDIT to perform editing. The unit is always synchronized with the input video signal regardless of the operation mode (record, playback, etc.). Set the switch to NORMAL in the playback mode. The unit is synchronized with the internally generated reference signal.
11. **ASSEMBLE BUTTON and INDICATOR.** Press this button to select ASSEMBLE edit mode. The indicator above the button will light. Press again to cancel ASSEMBLE edit mode.
12. **INSERT BUTTONS and INDICATORS.** In INSERT edit mode, press the VIDEO, PCM CH-1, PCM CH-2 or TIME CODE buttons to select the desired input signal (the indicator above the selected button lights). To cancel, press the button again. The light will go off.
13. **EJECT BUTTON.** Ejects the cassette.
14. **PREROLL BUTTON AND INDICATOR.** When this button is pressed, the tape rewinds for 5 seconds and stops in the pause mode.
15. **REC (Record) BUTTON and INDICATOR.** Press this button together with the PLAY button to start recording. Pressing the REC button allows you to monitor the picture and sound in EE mode, as long as you keep the button held down.

16. **EDIT BUTTON and INDICATOR.** Press this button together with the **PLAY** button to start editing. Pressing the **EDIT** button allows monitoring of the picture and sound of the input signals selected with the **ASSEMBLE** or **INSERT** buttons in **EE** mode, as long as the button is held down.
17. **CUT OUT BUTTON.** Press this button to finish **ASSEMBLE** or **INSERT** editing. Edit mode is canceled, but the tape continues to run in playback mode. When this button is pressed in record mode, record mode is canceled. When this button is pressed in pause mode following preroll, edit mode is canceled.
18. **PAUSE BUTTON and INDICATOR.** Press this button to stop the tape momentarily. To restart tape, press this button again. When **PAUSE** is pressed during recording, the **EE** picture is displayed. When **PAUSE** is pressed during playback, a still picture is displayed. When **PLAY**, **F FWD**, **REW** or **SEARCH** buttons are pressed during pause mode, pause mode will be released and the tape will run in the mode corresponding to the pressed button.
19. **F FWD (Fast Forward) BUTTON and INDICATOR.** Press this button to fast forward the tape. The picture and sound can be monitored in **EE** mode during fast forwarding.
20. **PLAY BUTTON and INDICATOR.** Press this button to start playback. Press the **PLAY** button together with **REC** or **EDIT** button to begin recording or editing.
21. **REW (Rewind) BUTTON and INDICATOR.** Press this button to rewind the tape. The picture and sound can be monitored in **EE** mode during rewinding.
22. **STOP BUTTON.** Press this button to stop the tape transport completely. The picture and sound can be monitored in **EE** mode during stop mode.
23. **SERVO INDICATOR.** Lights when drum and servo and capstan servo lock during playback.
24. **DIAL MENU BUTTONS.**
 - a. **MENU** button: While holding down this button, turn the search dial in **JOG** mode to select the menu item.
 - b. **DATA** button: While holding down this button, turn the search dial in **JOG** mode to set the data.
 - c. **SET** button: Press this button after changing one or more items in menu to save the changes.
25. **SEARCH BUTTON.** Press this button to place the unit in search mode. Searching with the search dial in **JOG** or **SHUTTLE** mode will then be possible.
26. **SHUTTLE/JOG INDICATORS.** The **SHUTTLE** indicator lights when the unit is in **SHUTTLE** mode. The **JOG** indicator lights when the unit is in **JOG** mode. To change the mode, press the search dial.
27. **SEARCH DIAL and DIRECTION INDICATORS.** Functions as a search dial menu operation, according to the setting of the time counter display switch.
28. **REMOTE/LOCAL SWITCH.** Set this switch to control the unit either locally or from the equipment connected to the **REMOTE 1** connector on the rear panel.
 - a. **REMOTE:** The unit is controlled from an external unit connected to the 9-pin **REMOTE 1** connector on the rear panel. Setting this switch to **REMOTE** disables all the tape transport buttons on the control panel, except for the **STOP** and **EJECT** buttons.
 - b. **LOCAL:** The unit is controlled from the front control panel.

3.1.6.4 Observer Control Desk (OCD) (Figure 3-14). The **OCD** is a five-module desk that provides selection and control of the **UAV** payload. Each of the five module bays are interchangeable and location of each module is left to the discretion of the local unit.

1. MKD 200 PAYLOAD CONTROL MODULE

- a. **VIDEO ON.** Two-position push-button used to activate the **TV** camera. Upper half of push-button lights when pressed. **ON** lights when video transmissions are received from **UAV**.
- b. **IRIS AUTO/MAN.** Two-position push-button used to control the camera iris. When **AUTO** is lit, the iris opening is controlled automatically by the camera electronics. When **MAN** is lit,

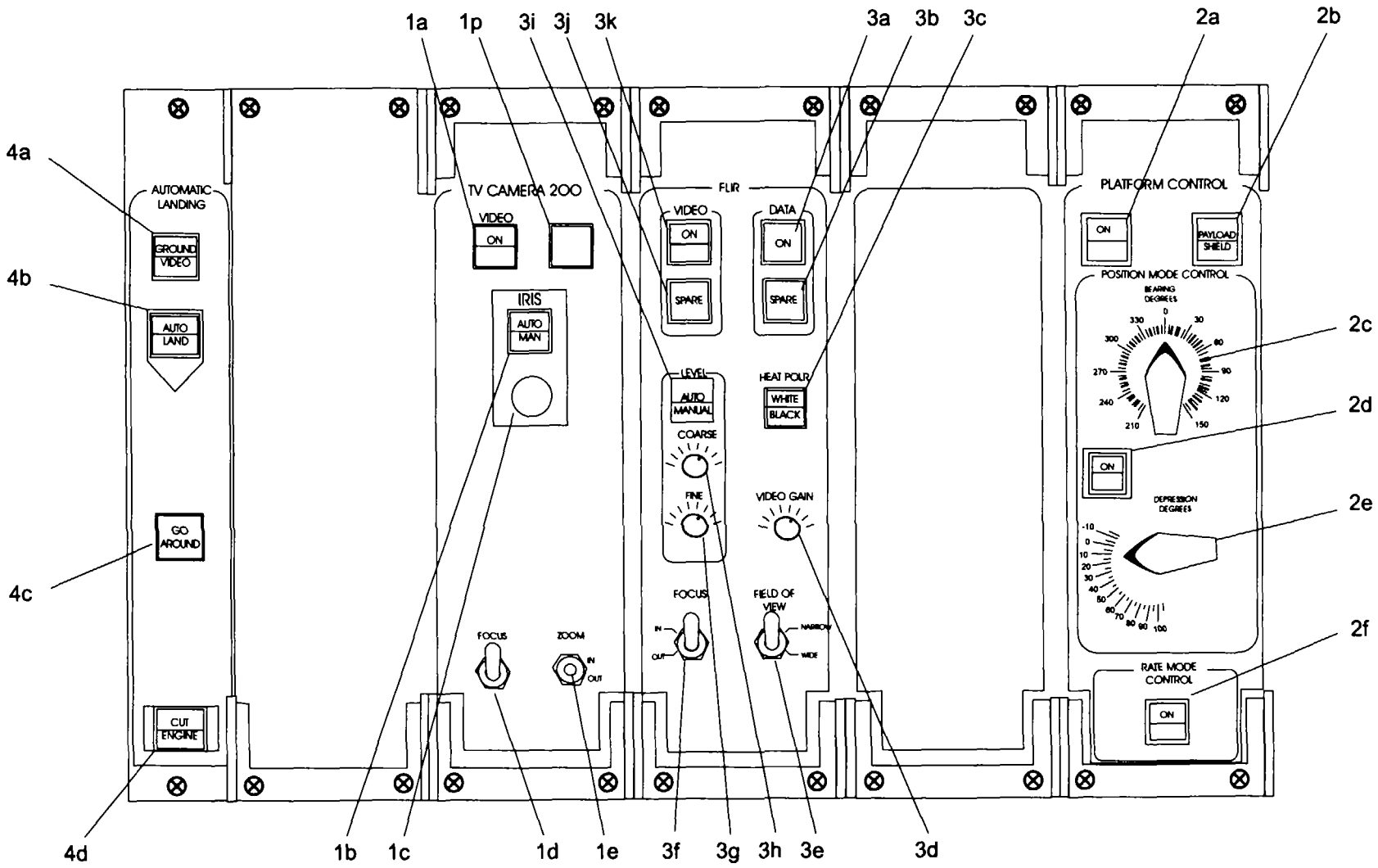


Figure 3-14. Observer Control Desk (OCD)

the iris opening is controlled manually by the iris potentiometer.

- c. IRIS. Manually controls the Payload iris.
- d. FOCUS. Momentary switch used to control the camera focus in the up/down position, the focus lens moves and the Middle position is fixed focus.
- e. ZOOM. Momentary switch used to control the camera focal length (field-of-view angle). The IN position (UP) provides narrower field-of-view and the OUT position (down) provides wider field-of-view.
- f. SPARE. Not used.

2. PLATFORM CONTROL MODULE

- a. For the MKD-200 and MKD-400 payloads, this push-button is pressed to uncage the platform and provide electrical power to the platform gimbals. The bottom half illuminates when pressed indicating a command was sent to the UAV to turn on the platform. The top half illuminates when the UAV reports the platform is activated. When deselected, the MKD-200 or MKD-400 payload moves to pilot's window position and mechanically cages.

Note

Because of the electrical drain on the system, activation of this button will normally cause momentary illumination of the A-PLT FAIL warning lamp.

- b. PAYLOAD SHIELD. Causes the payload shield to move into down position for payload protection during landing or net retrieval. The payload shield can only be deployed when the FLT-TO/LD push-button on the PCD is in the TO/LD mode.
- c. BEARING DEGREES SELECTOR KNOB. Payload sensor platform bearing (in relation to UAV's longitudinal axis) selector. Operates when payload is in POSITION control mode.
- d. POSITION MODE CONTROL ON. This push-button is pressed to select the POSITION control mode for the payload sensor platform (controlled by the BEARING DEGREES and DEPRESSION DEGREES selector knobs).

- e. DEPRESSION DEGREES SELECTOR KNOB. Payload sensor platform depression angle (in relation to UAV horizontal axis) selector. Operates when payload is in POSITION control mode.
- f. RATE MODE CONTROL ON. This push-button is pressed to select the RATE control mode for the active payload sensor (controlled by the camera control stick on the OCT-2000).

3. MKD 400 FLIR CONTROL MODULE

- a. DATA ON. Push-button (green). When illuminated, inserts alphanumeric status of the FLIR sensor display on the OBY video monitor.
- b. SPARE. Spare illuminating push-button (yellow).
- c. HEAT POLAR WHITE/BLACK. Two-position illuminating push-button (green). When WHITE is illuminated, hot objects are represented as white on the monitor. When BLACK is illuminated, hot objects are represented as black on the monitor.
- d. VIDEO GAIN. Rotary knob used to control the gain command for FLIR. The control is active under VIDEO ON (item No. 3k).
- e. FIELD OF VIEW NARROW/WIDE. Three-position momentary switch used to select camera field of view (super narrow, narrow, wide, super wide). Each switch deflection (narrow or wide) changes the camera field of view one step in the corresponding direction (toward super narrow or super wide, respectively).
- f. FOCUS IN/OUT. Three-position momentary switch. IN position moves the camera focus lens in. OUT position moves the camera focus lens out.
- g. LEVEL FINE. Rotary knob used for fine tuning of the screen background level. Active only when the AUTO/MANUAL push-button (item No. 3i) is in the MANUAL position.
- h. LEVEL COARSE. Rotary knob used for coarse tuning of the screen background level. Active only when the AUTO/MANUAL

push-button (item No. 3i) is in the MANUAL position.

- i. AUTO/MANUAL. Two-position illuminating push-button (AUTO - green, MANUAL - yellow). When AUTO is illuminated, the screen background gray level is automatically controlled by the system. When MANUAL is illuminated, the screen background gray level is controlled manually by the observer using the FINE (item No. 3j) and COARSE (item No. 3h) knobs.
- j. VIDEO SPARE. Spare illuminating push-button (yellow).
- k. VIDEO ON. Two-position illuminating push-button (green) used to activate the FLIR system.

4. AUTOMATIC LANDING

- a. GROUND VIDEO. No longer used.
- b. AUTO/LAND. No longer used.
- c. GO AROUND. No longer used.
- d. CUT/ENGINE. No longer used.

3.1.6.5 Observer Control Table (OCT) (Figure 3-15). The OCT provides control of payload when operating in rate mode, a keypad for data input, and control menus for the OBY. It also provides for OBY functional tests and calibration. In the preset mode the observer uses the keypad to define parameters, input data, align the camera and confirm payload installation.

1. CAMERA CONTROL STICK. Joystick used to control the payload line-of-sight when in RATE control mode. Tilting the stick in the desired direction moves the camera line-of-sight. The push-button located on top of the joystick performs different functions for each type of payload. Toggling the push-button with an MKD-200 payload selects between velocity and acceleration modes. When the joystick is in velocity position, the rate of change is linear to joystick angle of deflection. Releasing the joystick will stop movement of the payload. When it is in acceleration position, the rate of change increases with time. Releasing the joystick allows the payload to continue movement at the same rate until the operator provides an opposite and equal movement of the joystick or selecting velocity position. The push-button selects between two constant speeds for the MKD-400 payloads. The selections are $4^{\circ}/\text{sec}$ and $40^{\circ}/\text{sec}$ movement.

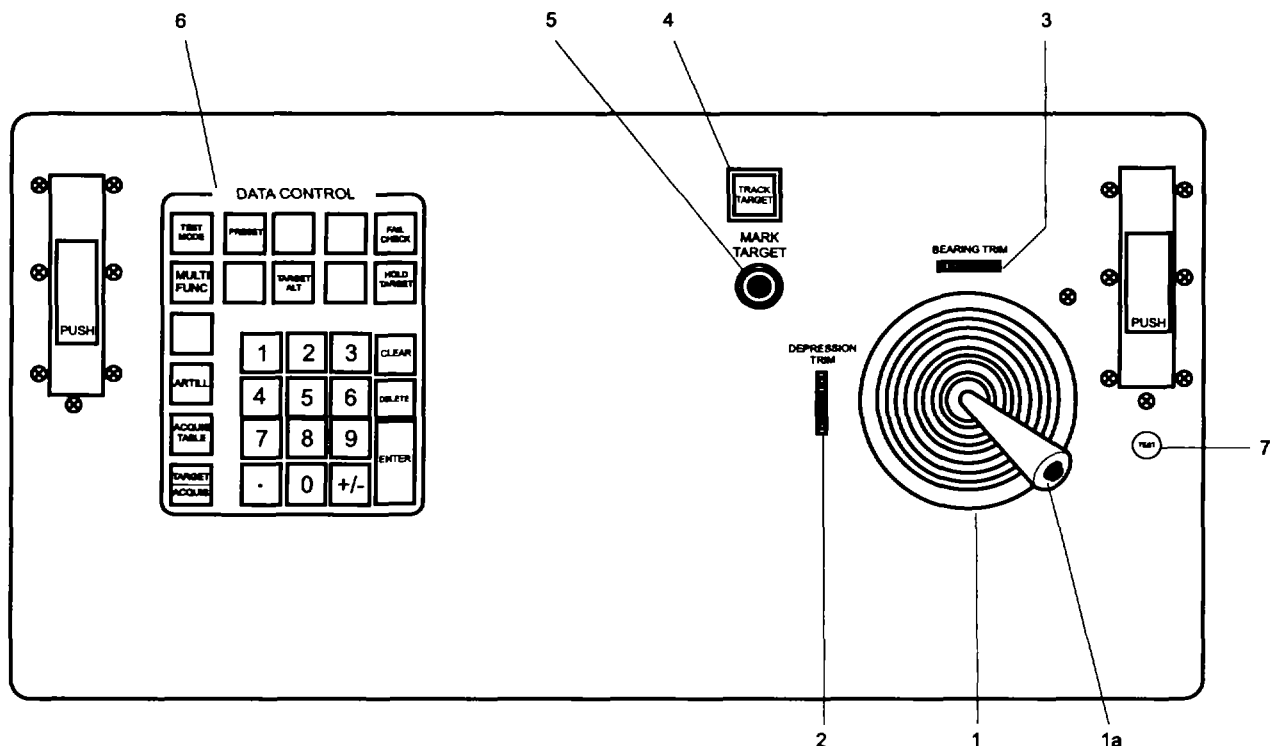


Figure 3-15. Observer Control Table

2. **DEPRESSION TRIM.** Used to trim drifts and/or inaccuracies of stick in depression axis.
3. **BEARING TRIM.** Used to trim drifts and/or inaccuracies of stick in bearing axis.
4. **TRACK TARGET.** Momentary push-button. When pressed, causes plotter to trace the movement of the camera optical axis on the ground (instead of tracing UAV trajectory), which helps the payload operator obtain better orientation. When pressed, TRACK TARGET indicator lamp illuminates on PLOTTER CONTROL AREA in TCD-2000. When released, plotter returns to its regular function.
5. **MARK TARGET.** When pressed, the position of the UAV is marked on the plotter and identified by a sequential number. The target altitude iteration is begun and the IP is prompted to update TAL. RPV tracking data is being stored when this function is selected. After IP updates and exits TAL menu the GCS updates target coordinates and marks target location on the map with corresponding sequential event number.
6. **DATA CONTROL PANEL.** The following functional push-buttons are lit when their control modes are selected:
 - a. **TEST MODE.** Functional push-button used to select the TEST control mode. When the OBY-2000 is in Test mode, the airborne payload cannot be controlled by the payload operator. The push-button is covered to prevent unwanted operation of this mode.
 - b. **PRESET.** Functional push-button used to select the Preset control mode.
 - c. **FAIL CHECK.** Functional push-button that allows the display of a malfunction warning message when the OTMP-2000 indicates malfunction detection.
 - d. **MULTI FUNCTION.** Functional push-button used to select the Multifunctional control mode.
 - e. **TARGET ALT.** Not functional.
 - f. **TARGET HOLD.** Functional push-button that allows payload to lock on targets.
 - g. **ARTILL.** Functional push-button that allows artillery adjustment procedure to start.
 - h. **TARGET ACQUISITION TABLE.** Functional push-button that allows the user to enter the target acquisition menu directly.
 - i. **TARGET ACQUISITION.** Functional push-button used to start the Target Acquisition mode.
 - j. **DATA INPUT KEYBOARD.** Numeric keyboard used to enter numerical data and to select control functions.
7. **TEST PUSH-BUTTON.** Used to perform lamp test on OCT.

3.2 TRACKING AND COMMUNICATION UNIT (TCU) (FIGURE 3-16)

The TCU-2000 controls all UAV-to-station tracking and communication functions, manages the UPL/DNL messages, and performs the preflight and diagnostic tests. The GCS-2000 Antenna System is part of the Communication and Tracking subsystem. It is modular and is installed on the communication shelter. It consists of one C-band omnidirectional transmitting/receiving antenna, one UHF omnidirectional transmitting/receiving antenna, and one C-Band directional/tracking antenna mounted on a pedestal. The antenna system enables tracking of and communication with the UAV up to 185 km. The shipboard configuration consists of two sets of C-band and UHF antennas installed on foundations remotely located from the TCU. Antenna tracking and switching is controlled by an RF switching box located in the TCU.

The TCU is powered by an external generator which provides single-phase 110 Vac/60-Hz power. In addition a pack of eight batteries (12 Vdc/100 AH each) combines to provide 28 Vdc/200 AH emergency power. The shipboard configuration replaces the pack of eight batteries with an uninterruptible power supply (UPS) to provide emergency power. The electrical power supply and distribution subsystem and the communication and tracking subsystem constitute the major components of the TCU.

The electrical power supply and distribution subsystem consists of five components that provide the required electrical requirements of the TCU and provide power failure warnings to the internal pilot. The power supply unit (PSU) is a single phase rectifier that supplies high-current 28 Vdc power and charges the backup battery pack. The communication power distribution (CPD) and the shelter electric power (SEP) box provide, monitor, and distribute DC voltages to the communications bay and to the antenna. The pilot display panel

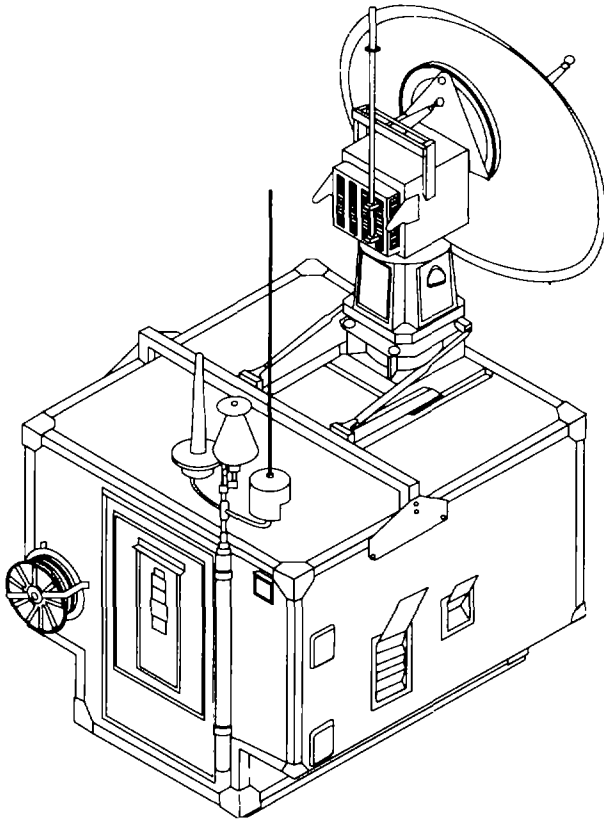


Figure 3-16. TCU

(PDP) provides a power failure warning light and provides a failure message on the data screen in the event of a power interruption.

3.2.1 Communication and Tracking Subsystem (CTS) (Figure 3-17) provides for communication with the UAV and operates the tracking unit. It transmits uplink data to the UAV in C-band and UHF and receives C-band downlink at ranges up to 185 km. UAV communications are encoded before transmission. The CTS decodes downlink and encodes uplink commands. Video downlink is piggybacked on the coded

transmissions and processed for the TV monitors. The tracking subsystem provides tracking azimuth and UAV slant range to station. The CTS is made of five major components.

3.2.2 Communications Control Box (CCB) performs the subsystem calculations and control functions as well as controls interbay communication for the SMP.

3.2.3 Microprocessor Controlled Auto-Tracking Unit (MCAT) controls RF communications and tracking of the UAV. The MCAT performs the tracking calculation and control functions of the auto-tracking system including tracking antenna control, UAV azimuth calculation, and communications bay power control and status reports.

3.2.4 Encoder/Decoder Unit (EDC) encodes uplink transmissions and decodes downlink receptions and routes them to the transmitters and CCB respectively. The EDC is also responsible for UAV to TCU range calculations.

3.2.5 C-Band Receiver receives downlink from the UAV, strips the non-coded video signals and sends it to the GCS, and forwards encoded receptions to the EDC. It also provides the MCAT with AM data for UAV tracking.

3.2.6 Antenna System is installed on top of the S-250 shelter and consists of two omnidirectional transmission/receiving antennas, a direction tracking dish antenna, an RF box, and a pedestal unit. The omnidirectional antennas are for UHF and C-band while the directional dish antenna is used for C-band only. The RF box routes power to the pedestal unit and RF signals to the communications bay. The pedestal unit rotates the dish antenna to maintain reception with the UAV with a continuous, multi-turn 360° range of motion.

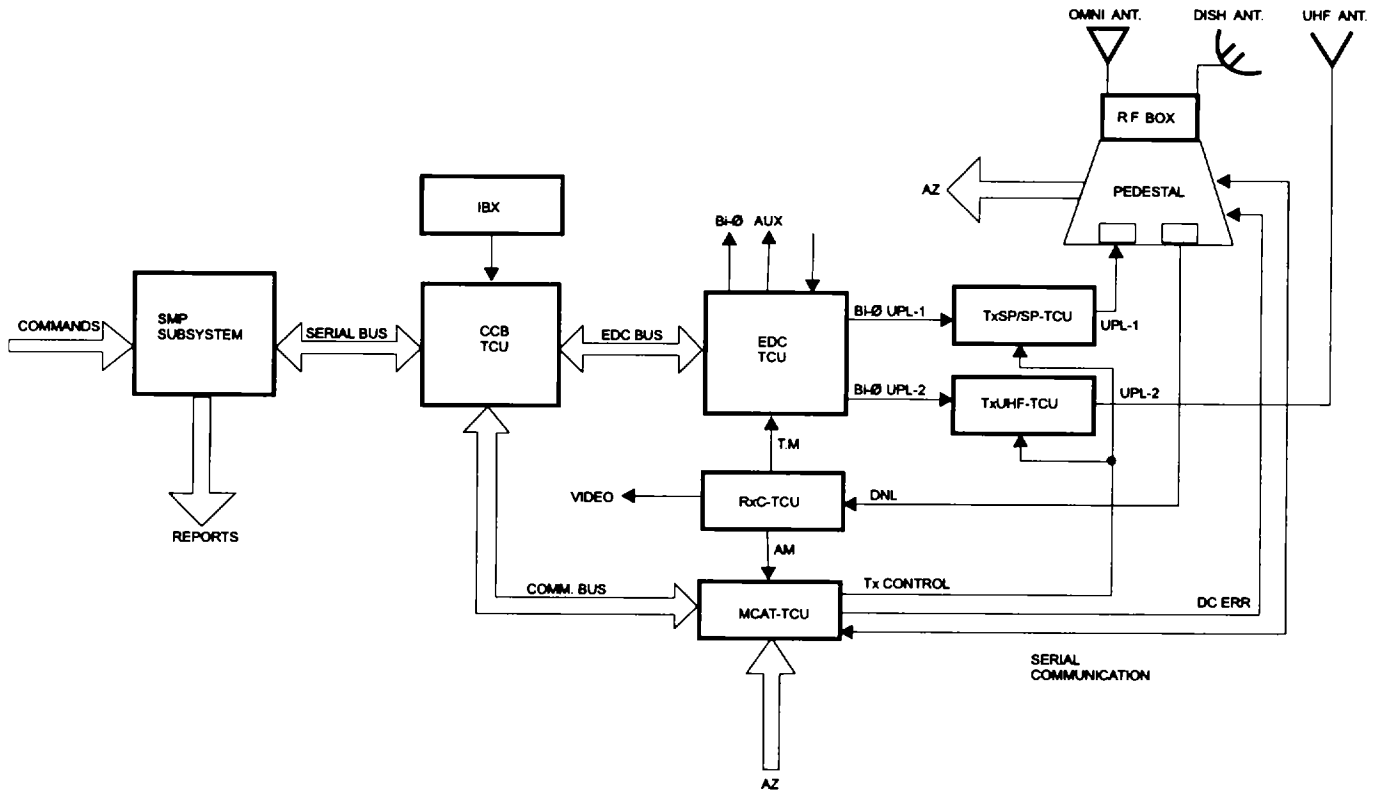


Figure 3-17. Communication and Tracking Subsystem, Block Diagram

CHAPTER 4

The Portable Control Station (PCS)

4.1 PORTABLE CONTROL STATION (PCS)

The PCS is a compact and modular station installed in three cases. The display case houses the TV monitors and flight instruments, the Flight/command case houses the pilot control desk and pilot control table, and the communications case houses the communications control unit and power distribution panel. The PCS is typically housed in an S-250 shelter and mounted on an M-1042 HMMWV. For shipboard configuration, the PCS is mounted in a standard 19-inch rack installed in a

compartment directly below Primary Flight Control (PRIFLY). By design it is a mobile/transportable system manned by one pilot and is used to control the UAV during take-off and landings. It has an effective control range of 40 km. When used for split site operations the PCS will typically be manned by a crew of three: one internal and one external pilot and a payload operator. The PCS can extend the maximum range of the UAV by up to 40 km and can also help overcome terrain masking and electronic line-of-sight problems.

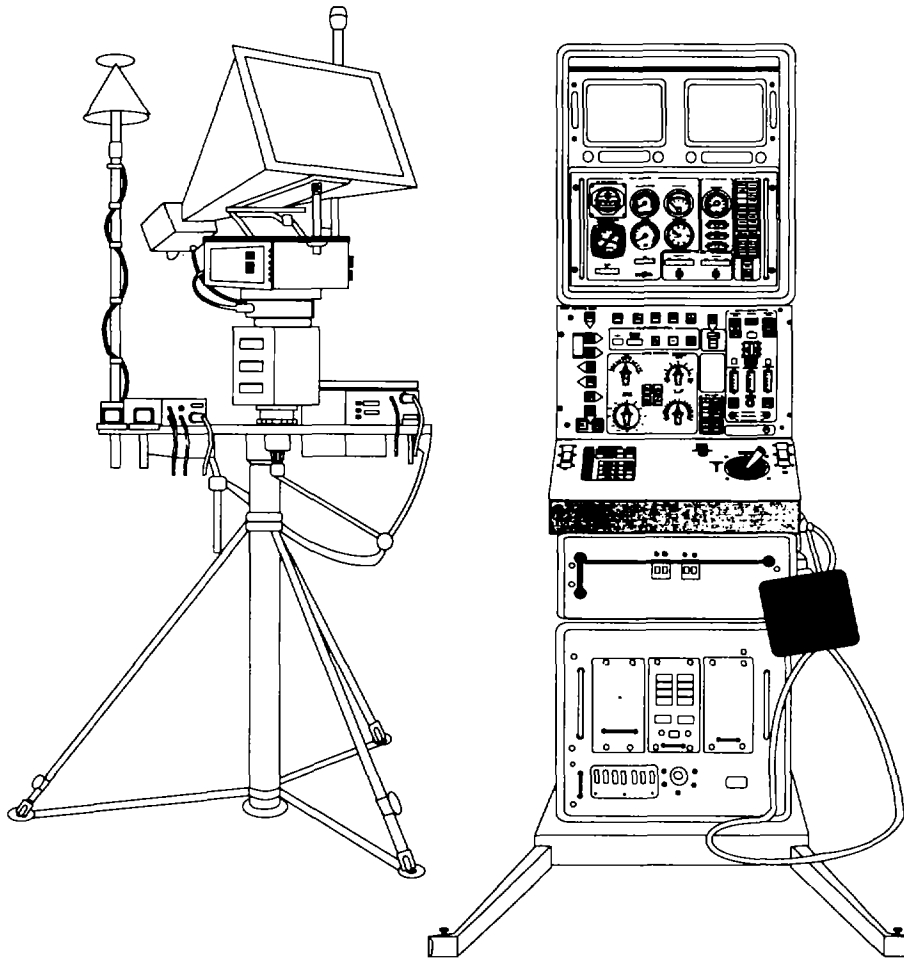


Figure 4-1. Portable Control Station (PCS)

4.2 GENERAL DESCRIPTION

The PCS contains three main subsystems: the flight command/control subsystem, communication subsystem, and power supply subsystem.

4.2.1 Flight Command/Control Subsystem. The flight command/control subsystem allows the pilot to perform takeoff/landing and flight control until command of the UAV is transferred to the GCS. This subsystem also allows computerized preflight tests on the UAV and system diagnostic test on the PCS down to unit level, using the preflight Interactive Test Mode. It contains a TV monitor panel (PTMP), a pilot display panel (PDP), a pilot control desk (PCD), a pilot control table (PCT), and two flight control boxes.

4.2.2 Communication Subsystem. The communication subsystem allows data communication with the UAV. The subsystem performs the following main functions: Transmits/receives data to/from the UAV, encodes/decodes data to/from the UAV, calculates the range to the UAV, and loads Return Home data to the UAV. The communication subsystem contains antennas, receivers/transmitters, and a communication control unit.

1. **Antennas.** There are two omnidirectional transmitting/receiving antennas (one C-band and one UHF), and a directional C-Band horn antenna. The horn antenna rotates 359° with a mechanical stop.
2. **Receivers/Transmitters.** There are two transmitters, one for C-Band and one for UHF, and one C-Band receiver.
3. **Communication control unit.** Encodes/decodes the message to/from the UAV and controls the receiver and transmitters. High power is not available with the PCS UHF transmitter. (Selection of high power for the secondary link will cause low power warning lamp to illuminate.)

4.2.3 Power Supply Subsystem. The PCS is powered by a 110 Vac 60-Hz external generator and has two 12-volt batteries for emergency power. The shipboard configuration replaces the two 12-volt batteries with an uninterruptible power supply (UPS) to provide emergency power. Electrical supply distribution to the bays consists of 28 Vdc (for TV monitors), +5 Vdc and ±15 Vdc. The distribution is controlled by two power distribution units, one for the piloting subsystems and one for the communications.

4.3 PAYLOAD CONTROL

Control of the payload (MKD-200/400, 12DS) can be accomplished using the PCS and the Student Box. To accomplish this, the payload type and payload control bay must be set using the PRESET/RPV DATA menu (Item #10 on the PRESET menu) on the PCS. After control of the payload is set to PBY, the payload functions are controlled by the Student Box and multifunction menu option, PAYLOAD CONTROL (Item #6). Each of the control levers on the student box controls an axis for the camera.

The aileron stick controls camera bearing. Pushing the stick to the left/right turns the camera left/right.

The elevator stick controls camera depression. Pulling back on the stick raises the camera and pushing forward on the stick lowers the camera.

The zoom for the MKD-200 payload video camera is controlled by the throttle stick where idle is zoom out and max throttle is zoom in. For the MKD-400 FLIR camera, the throttle controls the field of view where idle is widest FOV and max throttle is narrowest FOV.

Camera focus is controlled by the rudder stick. Right rudder causes payload to focus out, left rudder causes payload to focus in.

CHAPTER 5

The Payloads

5.1 STABILIZED RECONNAISSANCE PAYLOAD FOR DAYLIGHT OPERATION (MKD-200) (FIGURE 5-1)

5.1.1 General. The MKD-200 payload consists of a TV camera mounted on a stabilized platform. The stabilized platform, controlled by the Payload Electronic Box (PEB), enables setting and stabilization of camera line-of-sight. The MKD-200 payload is installed in the special payload compartment provided in the UAV. It receives electrical power from the UAV electrical system. Commands to the payload subassemblies (modes of operation, control of gimbals, camera azimuth, elevation, camera on/off, zoom, etc.) are received through the UAV radio uplink (UPL), while payload telemetry and video data are transmitted to ground control through the UAV video and telemetry downlink (DNL).

The MKD-200 payload is a delicate optical system. It requires a special, clean environment for removal and installation of optical/mechanical assemblies. The LRUs (Line Replaceable Units) of the MKD-200 are the stabilized platform assembly, the electronic assembly, the bubble dome, and the cables. Troubleshooting at the LRU level is performed by automatic/interactive tests carried out by the pilot/observer in the control station (GCS-2000 or PCS). Preventive maintenance required for the MKD-200 consists of bubble dome cleaning and preflight checks performed from the control station.

The MKD-200A is an improved day payload. It is enclosed in the same opaque protective bubble as the MKD-400. Operating procedures are the same for both MKD-200 and MKD-200A payloads, but video quality of the MKD-200A is reportedly better than the MKD-200.

5.1.2 Mission Capabilities. The MKD-200 payload has the following mission capabilities:

1. Illumination Range
 - a. Effective picture 0.5 to 10,000 lux

- b. Full performance from 2 to 10,000 lux.

2. Line-of-sight Coverage

- a. Pitch: from $-88^\circ (\pm 3)$ to $5 (\pm 3)$, continuous
- b. Yaw: 360° multiturn, continuous
- c. Stabilization: 100 μ rad (peak max), in both axes.

3. Target Detection: up to 18 km

4. Target Recognition: 3 km.

5.1.3 Operational Control Modes. The MKD-200 payload operates in the following modes:

1. Manual Control mode
2. Caging Control mode.

5.1.3.1 Manual Control Mode. In this mode, the observer controls the TV camera line-of-sight to view the area and to perform reconnaissance missions. The MKD-200 payload can be manually controlled in two submodes:

1. Rate Control
2. Position Control.

5.1.3.2 Rate Control. The observer controls the rate of change in the TV camera line-of-sight by means of a joystick, located on the Observer Control Table (OCT) at the control station. Moving the joystick (back, forward, left, or right) moves the line-of-sight (up, down, left, or right) accordingly. The rate of change is determined by the angle of the joystick from the vertical (mid) position in two modes, selected by a velocity/acceleration (VEL/ACCEL) switch. When the joystick is in velocity position, the rate of change is linear to the joystick angle. When it is in acceleration position, the rate of change increases with time.

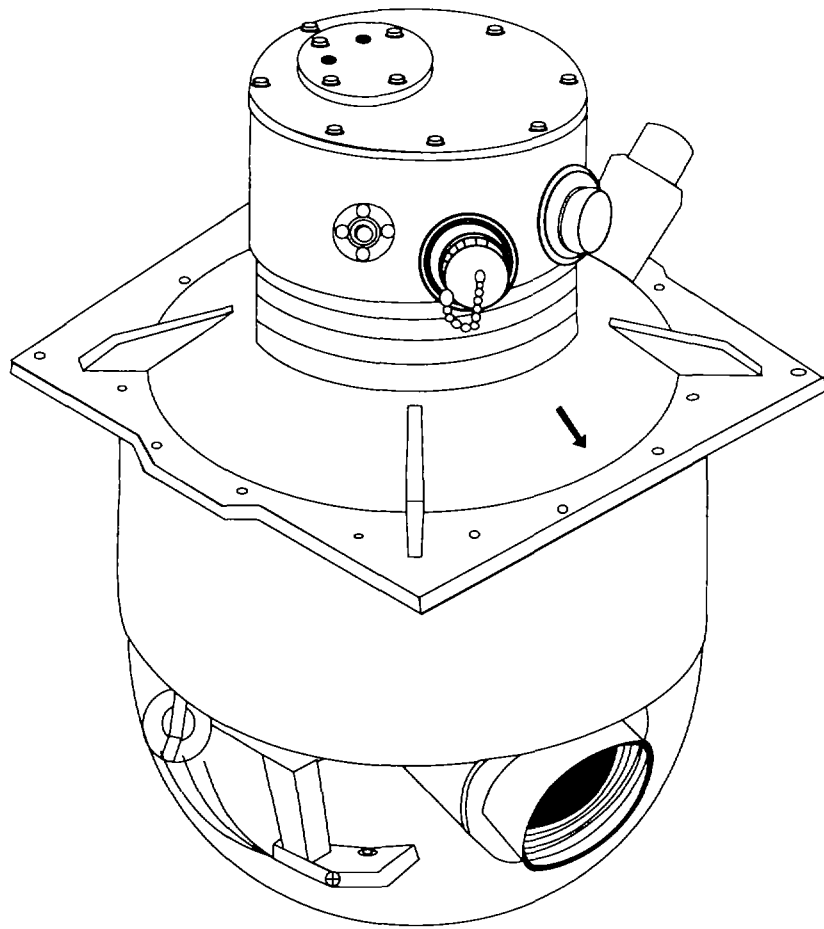


Figure 5-1. MKD-200 Day Payload

5.1.3.3 Position Control. The observer controls the TV camera line-of-sight by means of two control knobs (one for each axis) located on the payload control panel at the control station. The position control has pitch angle authority of $-88^\circ (\pm 3^\circ)$ through $\pm 5^\circ (\pm 3^\circ)$.

5.1.3.4 Caging Control Mode. In this mode, the gimbals of the mechanical assembly are locked to the UAV axes. The MKD-200 can be caged in two submodes. Both submodes are automatically performed by the MKD-200 control logic. The MKD-200 operator cannot select these modes nor turn them ON/OFF.

5.1.3.5 Mechanical Caging Mode (MECH CAGE). The gimbals are mechanically locked to the UAV axes by means of an electromechanical device, thus setting the TV camera line-of-sight at -6° pitch and 0° yaw, relative to the UAV axes.

This mode is automatically selected by the MKD-200 logic when a failure in the UAV's generator is detected (GEN FAIL signal). The MECH. CAGE mode has a fixed pitch angle of -6° and a fixed yaw angle of 0° . Caging time should be no greater than 10 seconds.

5.1.3.6 Electrical Caging Mode (ELEC. CAGE). The gimbals are electrically caged to the UAV axes, thus setting the TV camera line-of-sight at a preset pitch angle (0° to 30°) and 0° yaw angle, relative to the UAV axes. This mode is automatically selected by the MKD-200 logic when the communication link to the control station is lost (LOST CARRIER warning).

5.1.4 Operation Procedures

5.1.4.1 Turn-On Procedure. After receiving the turn-on command from the operator, the MKD-200 payload performs the following:

1. Activates the rate gyro unit
 2. Disconnects power to the yaw and pitch gimbal motors until there is complete stabilization of the rate gyro output signals, and then powers the gimbals motors
 3. Releases the mechanical caging of the gimbals
 4. Sets the zoom lens to maximum field of view
 5. Sets the MKD-200 payload to Manual Control mode
 6. Performs functional tests.
2. After 3 seconds (required by the MKD-200 to confirm the LOST CARRIER mode), the following procedures are performed:
 - a. The MKD-200 payload is set to Electrical Caging mode
 - b. TV camera operates continuously
 - c. Iris is set to automatic mode
 - d. Focus freezes in its last position
 - e. Zoom lens is set to maximum field of view.
 3. The MKD-200 payload returns to normal operation 3 seconds after the emergency termination command is received from the UAV.

5.1.4.2 Turn-off Procedure. After receiving the turn-off command from the operator, the MKD-200 payload performs the following:

1. Switches the MKD-200 payload to Mechanical Caging mode
2. At the end of the MECH. CAGE mode, disconnects the MKD-200 payload from the power supply with the exception of the TV camera, which operates continuously
3. Sets the zoom lens to maximum field of view.

5.1.4.3 Optimizing Target Coordinate Accuracy. Target coordinate accuracy is optimized with steeper camera depression angles. This is because, at a steeper depression, any movement of the camera in elevation results in less linear movement on the ground than it would at a shallower depression. Therefore, there is less target coordinate fluctuation and potential linear coordinate error. Errors can also be introduced by incorrect target altitude (Preset 7 — TAL), barometric pressure (Preset 5 — Pressure Table), or altimeter cal (Preset 1) entries, all of which will result in erroneous altitude above target (AAT) values. The effect of these errors is also reduced at the steeper depression angles.

5.1.5 Automatic Payload Functions

5.1.5.1 UAV Automatic Functions. The UAV automatic payload functions are performed when a failure is detected in the uplink communication system (LOST CARRIER warning). Should the MKD-200 payload receive a LOST CARRIER signal, it proceeds according to the following steps:

1. The mechanical and electro-optical assemblies (i.e., the line-of-sight) freeze in their last positions

5.1.5.2 MKD-200 Automatic Functions. The MKD-200 automatic payload functions are performed when voltages out of the designated range are detected in the MKD-200 payload. In this case, the MKD-200 is shut off without performing the turn-off procedure, and the turn-on procedure is inhibited.

5.2 STABILIZED RECONNAISSANCE PAYLOAD FOR DAY/NIGHT OPERATION (MKD-400) (FIGURE 5-2)

5.2.1 General. The MKD-400 payload consists of a lightweight FLIR system mounted on a stabilized platform. The platform is stabilized in two axes by a pitch-over-yaw type gimbals system. Thus, the platform enables the FLIR to sustain a fixed line-of-sight (relative to ground) that can be set for various angles by controlling the gimbals system. The platform is controlled by the Platform Electronic Box (PEB), which receives control commands and sends status reports via the UAV CPA cable. The FLIR is a real-time thermal-imaging system, based on the principle of detecting thermal energy radiated by objects encountered in its field of view. The received energy is then converted to a standard TV image by the FLIR Electronic Box (FEB). The MKD-400 Payload is installed in the special payload compartment provided in the UAV. It receives electrical power from the UAV electrical system. Commands to the payload subassemblies (modes of operation, control of gimbals, camera azimuth, elevation, camera on/off, zoom, etc.) are received through the UAV radio uplink (UPL), while payload telemetry and video data are transmitted to ground control through the UAV video and telemetry downlink (DNL).

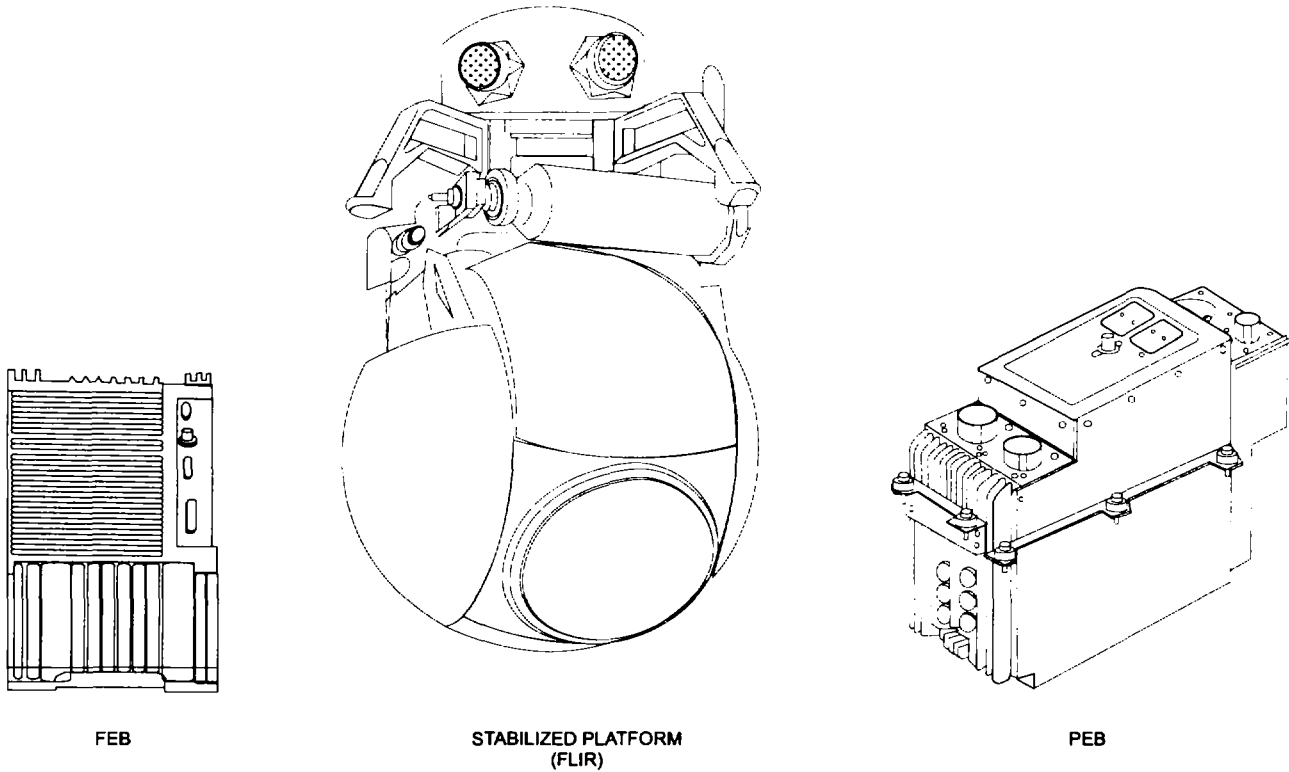


Figure 5-2. MKD-400 FLIR Payload

5.2.2 Mission Capabilities. The MKD-400 Payload system has:

1. Calculated detection and recognition ranges (50% probability) for NATO standard target (2.3 x 2.3 x 4.6 m)
 - a. Super-wide FOV — Detection: 1.6 km
 - b. Wide FOV
 - Detection: 3.1 km
 - Recognition: 1.4 km.
 - c. Narrow FOV
 - Detection: 7.7 km
 - Recognition: 3.7 km.
2. Line-of-sight coverage
 - a. Pitch: -85° through 0° (±3°), continuous
 - b. Yaw: 360° multiturn, continuous.

The MKD-400 Payload is a delicate optical system. It requires a special, clean environment or removal and installation of optical/mechanical assemblies. The FLIR uses a germanium window instead of a bubble dome since the bubble dome is not transparent to IR rays. The FLIR germanium window should be covered by a protective cover during all inoperative time to avoid damage to the window. The components of the MKD-400 are the stabilized platform assembly (including the FLIR unit), the PEB, the FEB, the two cooling nitrogen bottles, and the system harnesses. Troubleshooting at the component level is performed by automatic/interactive tests carried out by the pilot/observer in the ground control station (GCS-2000). In addition, the payload system is tested during the UAV automatic test. When the control station is the PCS-2000, the payload system can be tested only during the UAV automatic test. Preventive maintenance and ready-to-service operations consist of cleaning; preflight actions, nitrogen bottle replacement, and window protective cover removal/installation. Payload calibration procedures can be performed while the payload is installed in the UAV and operated in conjunction with the GCS-2000 only. System calibration is performed by the observer from the observer bay (OBY-200) in the station.

The MKD-400C is an improved IR sensor that incorporates a closed-loop cooling system, eliminating the need for nitrogen. The closed-loop system has a built-in compressor that provides high-pressure air for cooling of the IR sensor. The operating procedures and characteristics listed in this section are the same for both payloads except that the MKD-400C does not have the time limits that the nitrogen-cooled MKD-400 has.

5.2.3 Operational Control Modes. In order to perform reconnaissance missions, the observer may use several control modes. In these modes the observer is able to control the line-of-sight as well as the focus and the FOV of the MKD-400 system.

5.2.3.1 Rate Mode. This mode is selected by pressing the RATE push-button on the PLATFORM CONTROL module located on the OCD. In this mode the observer controls the rate of change in the platform/FLIR line-of-sight by means of the push-button on the Observer Stick. There are two fixed velocities, 40°/sec (high) and 4°/sec (low), selected by pressing the push-button on the observer joystick (OCT).

The manual rate mode has the following specifications:

1. Yaw angle: 360°, multi-turn
2. Pitch angle: 0° through -85° ($\pm 3^\circ$)
3. Slewing rate: 0° through 30°/sec
4. Acceleration rate: At least 60°/sec² on both axes
5. Line-of-sight: Stabilized (35 μ rad).

5.2.3.2 Position Mode. This mode is selected by pressing the POSITION push-button on the PLATFORM CONTROL module. The observer controls the position of the platform/FLIR line-of-sight by setting the payload position control knobs located on the PLATFORM CONTROL module.

The manual rate mode has the following specifications:

1. Yaw angle: 360°, multi-turn
2. Pitch angle: 0° through 85° ($\pm 3^\circ$)
3. Accuracy: $\pm 3^\circ$
4. Line-of-sight: Stabilized.

5.2.3.3 Semi-Automatic Control Modes. The semi-automatic control modes are GCS-controlled modes. In these only the platform pitch and yaw commands (line-of-sight) are station-computer controlled; the remaining payload commands (FOV, focus, video gain, and heat polarity) are manually controlled.

The semi-automatic/station computer line-of-sight control modes perform “lock” on a preselected ground location (“target”) or the current line-of-sight. Since the UAV is moving, the line-of-sight parameters must be constantly updated. The update of parameters is done by station computer commands sent to the UAV via the uplinks according to station computer calculations. There are two semi-automatic control modes: fast target acquisition mode and target acquisition mode.

5.2.3.4 Target Hold Mode. In this mode the payload line-of-sight is “locked” on a manually set ground point (using one of the manual modes). The station calculates the platform pitch and yaw compensation command. The FLIR will be looking at the ground point as long as this mode remains selected. This mode is selected by the observer by pressing the TARGET HOLD push-button in the DATA CONTROL section on the OCT.

5.2.3.5 Target Acquisition Mode. In this mode the payload line-of-sight is set to a preselected ground point (coordinates). The observer selects the coordinates through the TARGET ACQUISITION MENU using the SELECT screen.

The mode becomes active upon pressing the TARGET ACQUIS push-button in the DATA CONTROL section on the OCT. Upon selecting this mode, the platform line-of-sight will be automatically set to the selected coordinates and will remain set until the mode is canceled.

Note

This mode is not possible in flight control modes that do not enable the station to receive the slant or other flight parameters of the UAV in order to calculate the UAV location.

5.2.3.6 Caging Mode. In this mode the platform gimbals (mechanical assembly) are locked to the UAV axes. The MKD-400 can be caged in two modes. Both caging modes are automatically performed by the MKD-400 control logic. The observer cannot select or intervene in these modes of operation.

5.2.3.7 Mechanical Caging Mode. The platform gimbals are mechanically locked to the UAV axes by means of an electro-mechanical device, setting the FLIR line-of-sight at 0° pitch and 0° yaw, relative to the UAV axes. This mode is automatically selected by the MKD-400 logic during turn on/turn-off procedures. During turn-off the elevation and azimuth motors are disconnected.

The mechanical cage mode has the following specifications:

1. Fixed pitch angle: 0°
2. Fixed yaw angle: 0°
3. Accuracy on both axes: ±0.5°
4. Line-of-sight: Not stabilized
5. Caging time: 15 sec (max).

5.2.3.8 Electrical Caging Mode. The platform gimbals are electrically caged to the UAV axes. This is done by compensation commands to the gimbal motors, setting the FLIR line-of-sight at a preset pitch angle (depression) of 0° to -30° and yaw angle to 0°, relative to UAV. This mode is automatically selected by MKD-400 logic upon a UAV report of communication loss for at least 3 seconds.

The electrical cage mode has the following specifications:

1. Fixed pitch angle: 0° to -30° (laboratory preset)
2. Fixed yaw angle: 0°
3. Accuracy on both axes: Stabilized.

5.2.4 Operation Procedures

5.2.4.1 Turn-On Procedure. The MKD-400 logic performs the turn-on procedure in response to the observer pressing the ON push-button on the PLATFORM CONTROL module (on the OCD). The MKD-400 payload turn-on procedures include the following items detectable by payload operator:

1. Sets the field of view to WIDE FOV
2. Sets the control mode to manual rate mode.

5.2.4.2 Turn-Off Procedure. The MKD-400 logic performs the turn-off procedure in response to the observer pressing the ON (setting to OFF) push-button on

the PLATFORM CONTROL module (on the OCD). The MKD-400 payload performs the following:

1. Switches the platform to mechanical caging mode
2. At the end of mechanical caging, disconnects the power from the platform and maintains power to the FLIR
3. Sets the field of view to WIDE FOV.

5.2.4.3 Functional Test Procedures. The payload functional test should be performed after installation or replacement of an MKD-400 system. This test is also carried out as a performance check of the Payload MKD-400 System.

5.2.4.4 Preflight Procedures. The MKD-400 preflight tests are performed within the UAV preflight test. There are functional tests that may be performed instead of the preflight test. Before starting the preflight test ensure nitrogen bottles are on the platform and the germanium window protective cover has been removed.

5.2.4.5 In-flight Procedures. Before turning on the MKD-400, get mission commander approval and announce "Platform ON." Turning ON the MKD-400 system could cause the "A PLT FAIL" warning lamp to light due to overloading of the power bus and a momentary power loss identified by the AUTO PILOT system.

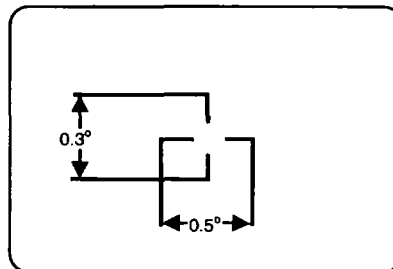
Note

Every time the FLIR is turned on, it uses an amount of nitrogen equivalent to approximately 20 minutes of flight time.

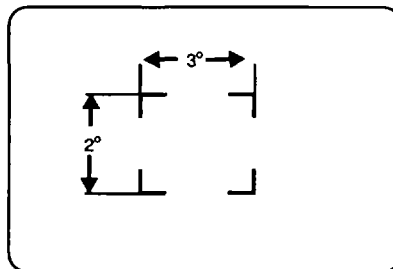
1. During launch/recovery, platform should be set in POSITION mode and oriented aft (bearing 180° and depressed 45°) to minimize potential damage to the germanium window. For RATO launch camera should be caged to minimize damage from the RATO bottle.
2. After recovery, when the UAV has stopped, turn OFF the PAYLOAD CONTROL and wait 25 seconds until the platform is mechanically caged.

5.2.4.6 Optimizing Target Coordinate Accuracy. Target coordinate accuracy is optimized with steeper camera depression angles. This is because, at a steeper depression, any movement of the camera in elevation results in less linear movement on the ground than it would at a shallower depression. Therefore, there is less target coordinate fluctuation and potential linear coordinate error. Errors can also be introduced by incorrect

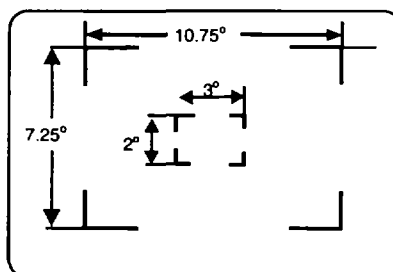
1.	Gray Levels	Display of the available gray levels (7 levels).
2.	"SCAN" (Flashing)	Occurs when scanner initially comes up to speed or when scanner has lost synchronization.
3.	"COOL" (Flashing)	Occurs when detector is initially cooling down or when system has run out of N ² gas.
4.	"HOT - B" "HOT - W"	Indicates that hot objects are represented as black images. Indicates that hot objects are represented as white images.
5.	"FOV-N/FOV-W/FOV-SW/FOV-SN"	Indicates the current FOV.
6.	"AUT" "MAN"	Indicates automatic gain and level adjustment. Indicates manual gain and level adjustment.
7.	"FCS" (Flashing)	Indicates focus drive at limits of travel. When "FCS" is displayed, back off FOCUS slightly.



SUPER NARROW/NARROW FOV



WIDE FOV



SUPER WIDE FOV

Figure 5-3. FLIR Reticules

FUNCTION NO. 1

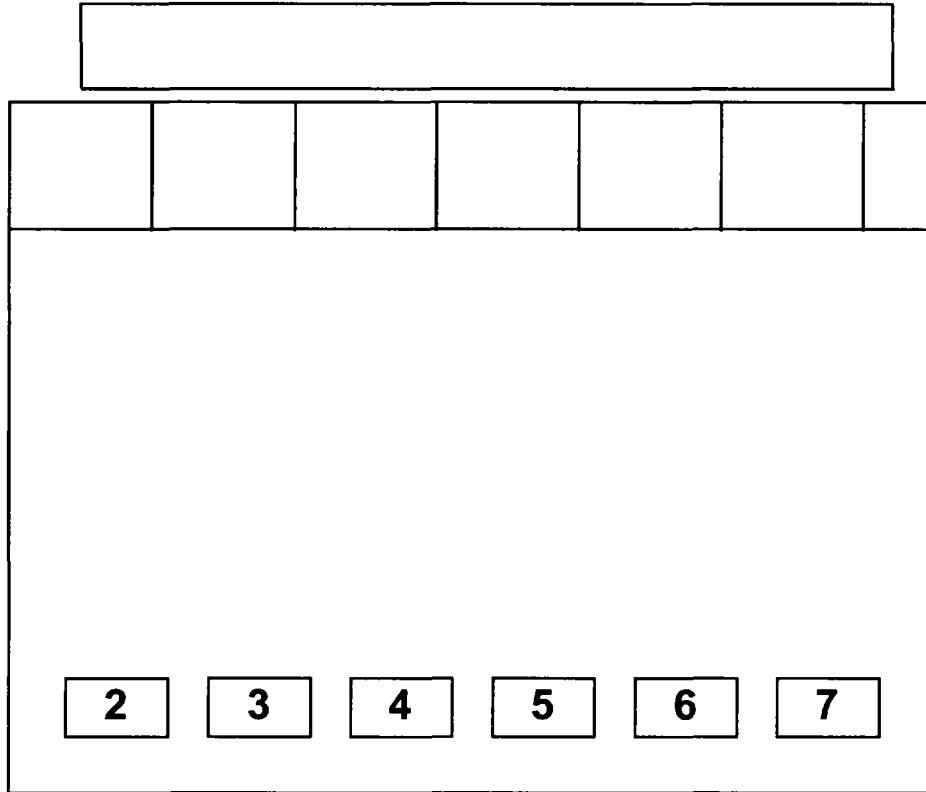


Figure 5-4. FLIR Alphanumeric Data

target altitude (Preset 7 — TAL), barometric pressure (Preset 5 — Pressure Table), or altimeter cal (Preset 1) entries, all of which will result in erroneous altitude above target (AAT) values. The effect of these errors is also reduced at the steeper depression angles.

5.2.5 Displays. The FLIR displays the following information on a TV screen:

1. IR scene image
2. Gray Scale (operator selectable)
3. Reticule (Figure 5-3) (operator selectable)
4. BIT/Status information.

5.2.5.1 Alphanumeric Data (Figure 5-4). The screen provides alphanumeric data to be displayed at the top and bottom of the display

5.2.6 Payload Electronic Box (PEB). The PEB incorporates all the electronic circuitry required for operation and control of the payload and its components. The PEB serves as the control-processing unit for positioning and operating the platform. It interfaces the command, data and power signals with the other UAV systems.

5.2.7 FLIR Electronic Box (FEB). The FEB provides power conditioning, video synchronization waveform, video processing, and scan mirror drives needed for FLIR operation. The FEB processes sensor data into video format for transmission via the UAV communication system.

CHAPTER 6

The Remote Receiving Station (RRS)

6.1 THE REMOTE RECEIVING STATION (RRS) (FIGURE 6-1)

6.1.1 Purpose and Use. The Remote Receiving Station (RRS) is designed to receive and display real-time data transmitted from the UAV. The data received by the RRS consists of a video picture from the day camera/IR sensor payload in the UAV. The payload, which is remotely controlled from the control stations, continuously transmits a picture of the surveyed area, which is displayed on the RRS monitor. This video contains no graphic or any other parametric data.

6.1.2 General Description. The RRS consists of two main subsystems: the Tracking Unit Assembly (TUA) and the Main Unit Assembly (MUA).

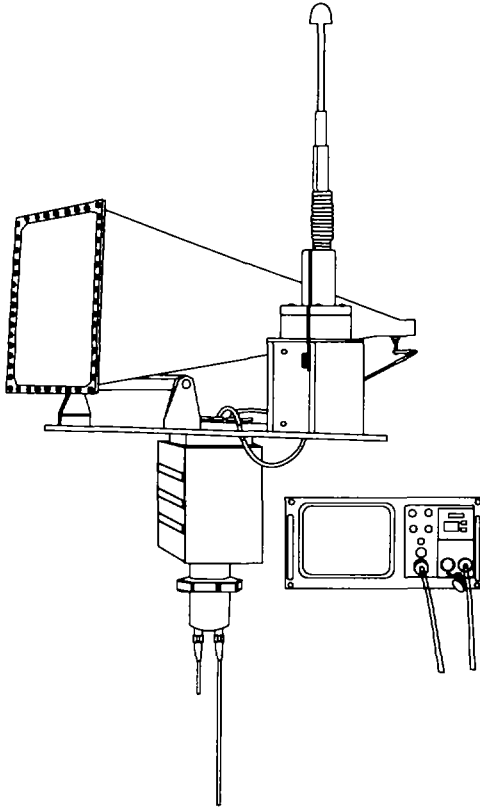


Figure 6-1. Remote Receiving Station

6.1.2.1 Tracking Unit Assembly (TUA). The TUA consists of the Pedestal Assembly, which receives downlink (DNL) signals through a directional (HORN) antenna or an OMNI Assembly. The antennas are mounted on a manually controlled tracking plate that allows tracking of the UAV. The TUA is designed to fit an MT-60 standard antenna mounting. If the UAV is transmitting via the directional antenna, the RRS must be located within the beam width for downlink reception. If the UAV is transmitting in OMNI, only distance limitations apply.

6.1.2.1.1 Directional Antenna (HORN). The HORN provides directional 359° azimuth coverage and elevation coverage of $\pm 12^\circ$. It operates in the frequency range of 4.5 to 5.5 GHz with a gain of 24 dB. The HORN receives with a horizontal beam width of 9° and a vertical beam width of 12°.

6.1.2.1.2 Omnidirectional Antenna (OMNI). The OMNI Antenna provides 360° azimuth coverage for the frequency range 4.8 to 4.99 GHz with a gain of 4 dB. The OMNI antenna receives within a horizontal beam width of 360° and a vertical beam width of 30°.

6.1.2.1.3 Pedestal Assembly. The Pedestal Assembly consists of a moving part on which the Tracking Plate Assembly is installed and a static part (Pedestal Assembly base). The Pedestal Assembly includes a DC motor, a transmission gear, and a central axis. The DC motor receives its power from the command panel via a control cable. The motor revolutions are transmitted to the central axis through the transmission gear. The Tracking Plate Assembly is mounted on the central axis and is able to rotate bi-directionally 359°. The two antennas are mounted on the antenna base and their output is applied to the down converter, which selects the receiving antenna according to control signals from the main unit. The down converter receives the OMNI/HORN selection signal and DC power from the Main Unit through the antenna control cable. The down converter output is provided to the receiver through an RF cable.

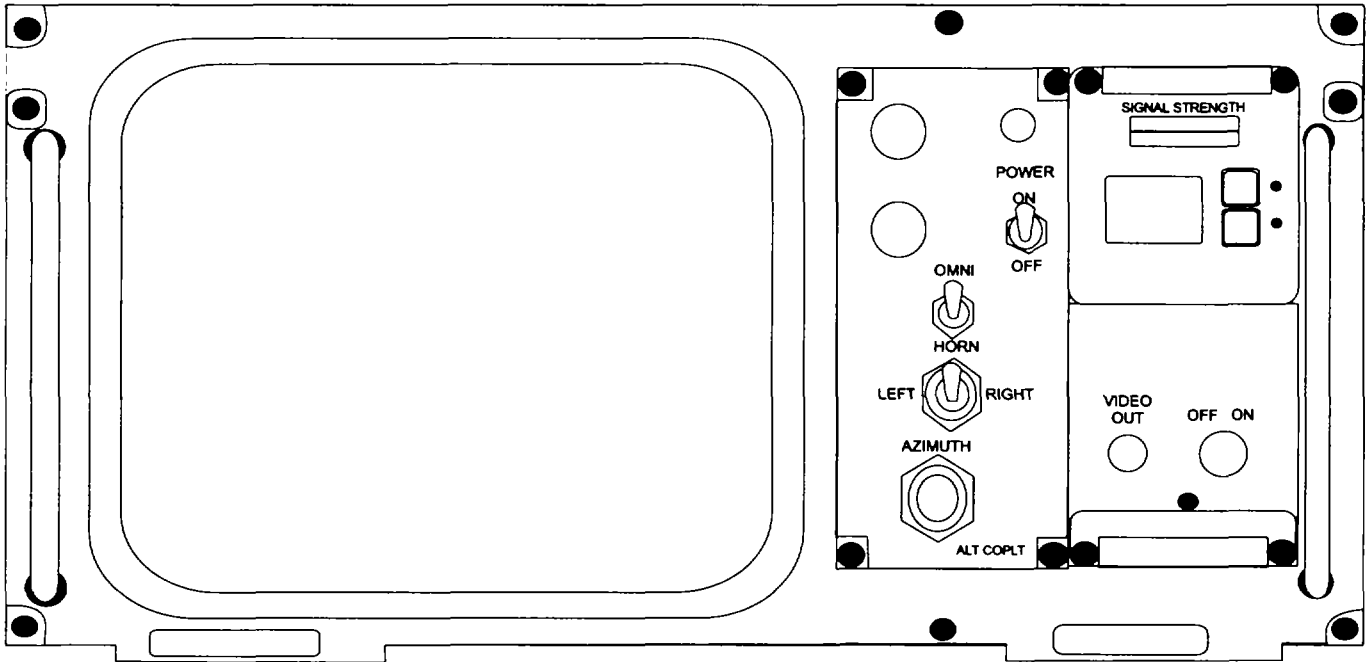


Figure 6-2. RRS Main Unit Assembly

6.1.2.1.4 OMNI Assembly. The OMNI Assembly provides the first amplification stage for the C-band RF signal and selects the receiving antenna. The OMNI Assembly consists of a coaxial switch, which receives the two RF signals from the OMNI and HORN antennas and a control signal from the command panel.

6.1.2.2 Main Unit Assembly (MUA). The MUA consists of four main subsystems.

6.1.2.2.1 Receiver Unit. The RF signal enters the receiver and is delivered to the mixer through a filter. The video signal detected is amplified and delivered to the Main Unit monitor and to the VIDEO OUT output. The operating frequency is determined by push-buttons on the receiver front panel, which permit selection of one of ten preset channels, in 2-MHz steps.

6.1.2.2.2 Command Panel. The command panel is a three-toggle, two-knob (up, down) panel for turning the system on and off and controlling monitor brightness and contrast. The panel also allows the selection of HORN or OMNI antennas, and controls the pedestal rotation.

6.1.2.2.3 Monitor Assembly displays the video picture.

6.1.2.2.4 Power Supply Assembly (PSA) includes the Power Supply Box Assembly and a motor for

cooling fan operation. The PSA receives 24Vdc from an external source and supplies the voltages for system operation. A cooling fan motor is located on the PSA and rotates a fan to decrease the MUA internal temperature. The motor is activated by a relay in the monitor assembly.

6.2 SITE SELECTION AND DEPLOYMENT

Select an appropriate deployment site considering the following:

1. Altitude. Find the highest site in the area to afford maximum reception.
2. Concealment. Find a site affording minimal exposure.
3. Free Line-of-Sight. Find a site free of obstacles (buildings, trees, etc.) that may interfere with direct RRS-UAV communication.
4. Easy access to communication with controlling station and supported unit.
5. UAV flight profile that assures video reception.

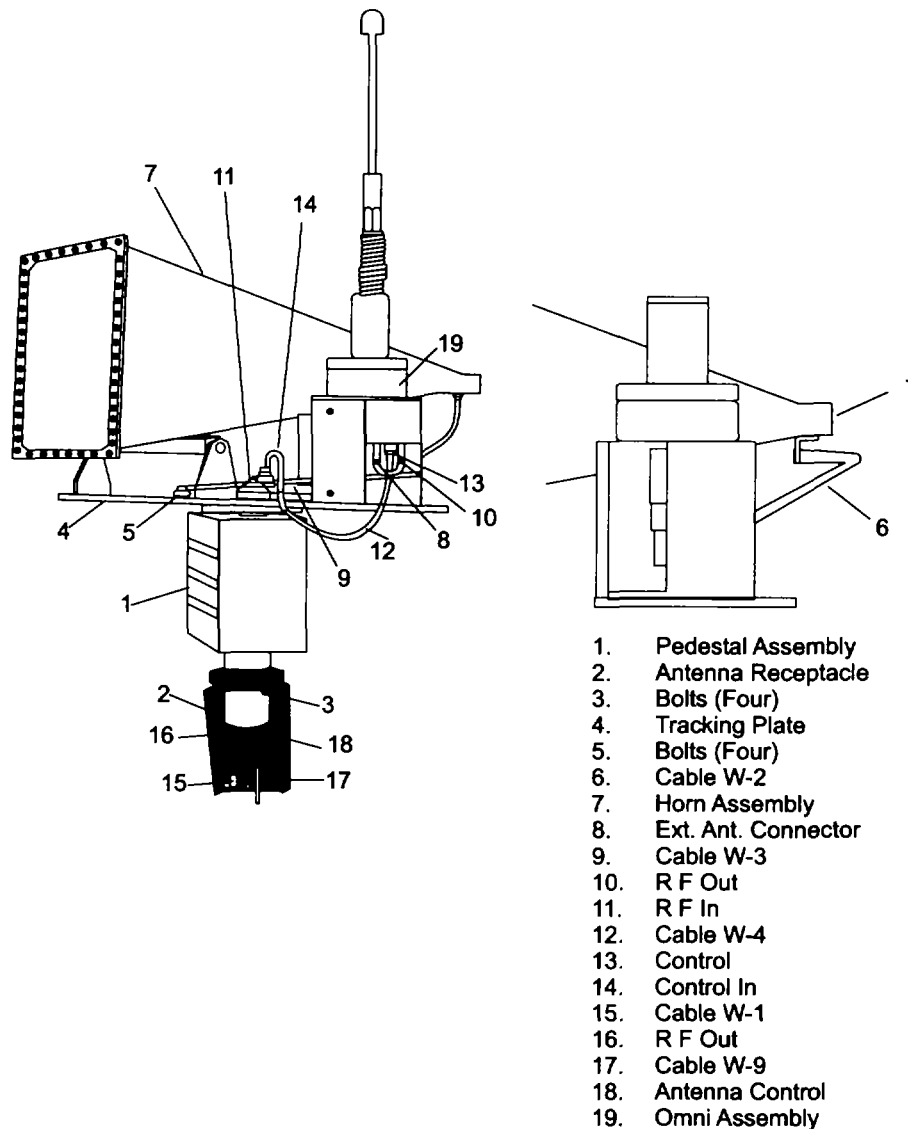


Figure 6-3. RRS Tracking Unit Assembly, Setup

6.3 RRS SETUP

6.3.1 TUA Setup (Figure 6-3)

Note

The numbers in parentheses refer to those in Figure 6-3.

1. Remove TUA from containers.
2. Place the pedestal assembly (1) on the antenna receptacle (2) as high as possible, and secure using four bolts (3).
3. Place the tracking plate (4) on the pedestal assembly, and secure using four bolts (5).
4. Connect coaxial cable W-2 (6), which connects the HORN antenna (7) to the EXT. ANT. connector (8) on the OMNI assembly (19). Tighten connectors.
5. Connect coaxial cable W-3 (9) to connectors RF OUT (10) on the OMNI assembly and RF IN (11) on the pedestal. Tighten connectors.
6. Connect control cable W-4 (12) to connectors CONTROL (13) on the OMNI assembly and CONTROL IN (14) on the pedestal. Tighten connectors.
7. Connect coaxial cable W-1 (15) to connector RF OUT (16) on the pedestal assembly. Tighten connector.

8. Connect control cable W9 (17) to connector ANTENNA CONTROL (18) on the pedestal assembly. Tighten connector.
9. Adjust the elevation of the HORN antenna according to the expected direction of the UAV. Elevation of HORN antenna is adjusted by loosening adjustment knob on rear horn mounting bracket, positioning antenna as required, and tightening adjustment knob.

6.3.2 Main Unit Setup

1. Slide the MUA onto the base, ensuring that alignment pins are matched, and secure using two locking wing bolts.
2. Connect cable W-9 to the ANT CONT connector on the control panel. Tighten connector.
3. Connect coaxial cable W-1 to the RF IN connector on the receiver unit panel. Tighten connector.
4. Ensure that power is supplied to the RRS main unit assembly (24Vdc) with cabling provided.

6.3.3 RRS Startup

1. Turn POWER switch to ON. Ensure that the power lamp illuminates.
2. Select the operation frequency channel by means of the up and down push-buttons.

Note

Under current configuration, Channel 16 or 1 is used for operation.

3. Set the OMNI/HORN switch to the OMNI position. Check that the SIGNAL STRENGTH indicator on the receiver unit indicates a reading above 1/14 of its length (i.e., a signal is received).
4. If the signal is too weak (less than 1/2 of the meter length), set the OMNI/HORN switch to the HORN position.
5. Rotate the HORN antenna by means of the AZIMUTH switch on the command panel to reach a

maximal reading on the SIGNAL STRENGTH meter.



Do not electrically drive antenna past mechanical stops.

6. Ensure that a clear video picture is displayed on the monitor whenever a signal is received from the UAV. Adjust BRIGHT and CONTR knobs on command panel as necessary.

Note

At very low environmental temperatures, the main unit requires a warm-up period. During this period, the video picture may be blurred.

6.4 MISSION PROCEDURES

6.4.1 Standby Mode. Before receiving the UAV transmissions, verify the following:

1. POWER ON/OFF switch is in ON position.
2. POWER indication light is illuminated.
3. Antenna selector is in HORN position.
4. HORN antenna is pointed in the direction of the expected appearance of the UAV.
5. Receiver channel corresponds to the UAV downlink signal frequency.
6. None of the LEDs illuminate (no reception) on the SIGNAL STRENGTH meter.
7. Monitor operates properly; white noise (snow) appears (no reception).

6.4.2 Operation Mode. After the UAV downlink signal is received, the TUA should be rotated using the AZIMUTH switch on the command panel, until a maximal reading on the SIGNAL STRENGTH meter and a clear video picture on the monitor are attained.

CHAPTER 7

System Limitations

7.1 OPERATING LIMITATIONS

7.1.1 Introduction. The limitations set forth in this section are the result of flight test & operational experience. Close attention must be given to the text since it represents limitations that are not necessarily repeated on the instrument markings. If limitations are exceeded, report it immediately. Further flight should not be attempted until the air vehicle is inspected by qualified maintenance personnel.

7.1.2 Engine Limitations

Static Idle RPM
(Payload & Lights Off)3200-3500 rpm

Minimum Static Full throttle rpm.....6700 rpm

Cylinder Head Temperature.....110°C (Min.)
231°C to 260°C (Max. 4 minutes)



- Continuous engine operation at idle for more than 30 seconds in flight, while not within glide range to landing site, should be avoided.
- If engine temp exceeds 260°C at any time, or the temp is held at or above 231°C for more than 4 mins. duration per occurrence, the mission shall be aborted.
- The engine temp should not exceed 240°C for a period of one hour after the engine has operated in the 231°C to 260°C temperature range. If the engine temp exceeds 240°C, immediately initiate cooling procedures.

Note

While engine temps above 230°C and below 260°C are authorized, the GCS and PCS software will illuminate the ENG TEMP warning light at or above 230°C. Refer to section 13.3.2, ENGINE TEMP emergency procedures, for appropriate response to an ENG TEMP warning light.

7.1.3 Roll and Pitch and Yaw Limitations

Autopilot Engaged

Roll: Knob control30° AOB
Stick control60° AOB



Bank angles in excess of 30° should be avoided when UAV is not in sight.

Pitch: Knob control+18°, -14°
Stick control+20°, -17°

Yaw: Knob control±10°
Stick control±20°

Autopilot Disengaged

Roll:90° AOB
Pitch:±60°
Yaw:±20°

7.1.4 Airspeed Limitations

Maximum

Knob control.....	95 KIAS
Stick control	110 KIAS
Nav programmer	80 KIAS

Minimum

Still air.....	55 KIAS
Rough air.....	60 KIAS

7.1.5 Maneuvering Load Factors

“G” limits.....+3g/-1.5g

7.1.6 Altitude Envelope

Min altitude.....	ELOS
Service ceiling	12,000 ft
Absolute ceiling.....	15,000 ft

7.1.7 Maximum Weight

Options II and II+:

Rolling Takeoff.....	205 kg
RATO or Pneumatic Takeoff.....	203 kg

7.1.8 Wind Limitations (Takeoff & Landings)

Maximum headwind	25 kts, gusts to 30 kts
Maximum crosswind.....	15 kts, gusts to 20 kts
Maximum tailwind	5 kts (RATO/Pneumatic)
Maximum tailwind.....	5 kts (Rolling T/O)

7.1.9 Prohibited Maneuvers

1. Intentional spins
2. Inverted flight, rolls, or loops
3. Intentional stalls below 1200 ft. AGL
4. Rates of descent greater than 480 ft/min on landing

5. Negative “g” for more than 3 sec
6. Flight in known icy conditions.



- Flight in rainy conditions should be avoided.
- Avoid flying in winds over 60 knots at altitude.
- Avoid flying in areas in which downdrafts are expected.

7.1.10 Autopilot Limitations. When altitude hold mode is used, the following procedures shall be followed:

1. TP 309 shall be monitored for 15 seconds during level off for cruise or following airspeed increase.
2. If TP 309 is greater than 0.2, reduce airspeed and/or altitude so that TP is 0.2 or less; or
3. Use stick throttle to continue mission.



Operations in Altitude Hold Mode to include Programmer and Camera Guide Modes when TP 309 is greater than 0.2 may cause damage to servo throttle unit. This condition may lead to a stuck throttle and subsequent loss of air vehicle.

7.2 GCS-2000 ELECTRICAL SYSTEM LIMITATIONS

Control shelter

DC28 (± 4) Vdc
 AC110 (± 10) Vac
 60 (± 2) Hz (3-phase)

Communications shelter

DC28 (± 4) Vdc
 AC110 (± 10) Vac
 60 (± 2) Hz (single phase)

7.3 COMMUNICATIONS SYSTEMS RANGE LIMITATIONS

Primary uplink (C-band)185 km
 Secondary uplink (UHF)185 km
 Downlink185 km

WARNING

Do not switch UAV transmitter to high power on ground until insuring all ground personnel are clear of UAV nose area.

7.4 UPLINK/DOWNLINK FREQUENCY

Primary uplink (C-band)

Frequency4.55 GHz
 Bandwidth12.5 MHz
 Power30 Watts

Secondary uplink (UHF)

Frequency range420-470 MHz
 Bandwidth600 KHz
 Power (50 watt XMTR)45.7 dBm at antenna

Downlink (C-band)

Frequency range4.8-4.9 GHz
 Bandwidth10 MHz
 Power30 Watts

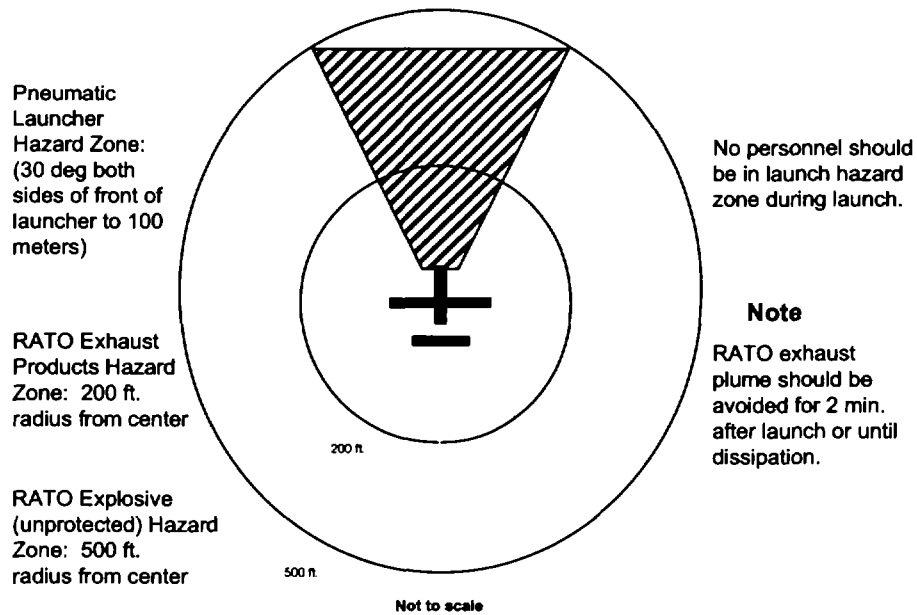
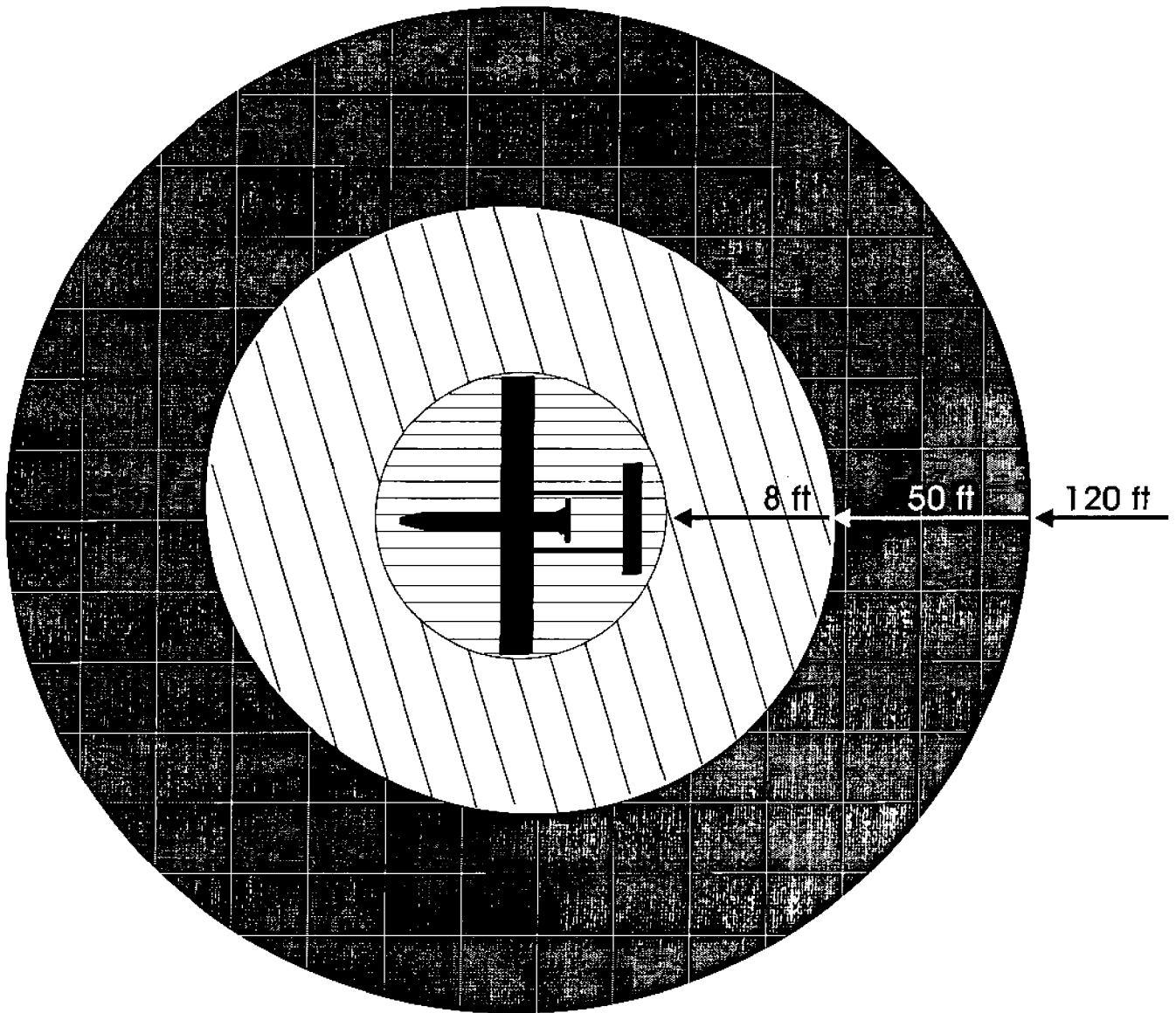


Figure 7-1. Launch Hazard Zones






-  DOUBLE HEARING PROTECTION REQUIRED AT ALL TIMES
-  DOUBLE HEARING PROTECTION REQUIRED DURING HIGH POWER
-  SINGLE HEARING PROTECTION REQUIRED AT ALL TIMES



Figure 7-2. Noise Hazard Zones

PART II

Indoctrination

Chapter 8 — Indoctrination Procedures

CHAPTER 8

Indoctrination Procedures

8.1 INTRODUCTION

This section describes the minimum training and refresher training required for achieving and maintaining qualifications in key UAV operating billets.

8.2 TRAINING SYLLABUS

Standard training for each aircrew position involves initial training at the Department of Defense UAV Training Center (DUTC), with follow-on training at the tactical unit.

8.2.1 Initial Training (DUTC). All personnel with UAV-specific MOSs and NECs must have successfully completed the appropriate course of instruction at the DUTC at Ft. Huachuca, AZ.

8.2.2 Unit Training. Upon completion of the appropriate initial training syllabus the trainee will complete tactical training at the local command in accordance with the current training manual and local directives.

8.3 DESIGNATION AND DESIGNATING AUTHORITY

8.3.1 Designation. Personnel will be designated to a specific position only after successfully completing the prescribed courses of instruction for the position, and receiving certification thereof by the designating authority. The certificate shall state the position in which the individual is qualified and shall be placed in his/her aircrew qualification jacket.

8.3.2 Designating Authority. Commanding officers or officers in charge of Pioneer units are authorized to issue certificates for specific crew positions in their units.

8.4 QUALIFICATIONS

8.4.1 External Pilot (EP). The EP shall complete the course of instruction outlined in the current CNET trainee guide. In addition, the EP shall satisfactorily

complete the local unit EP check flight before qualification is certified.

8.4.2 Internal Pilot (IP). The IP shall complete the course of instruction outlined in the current CNET trainee guide. In addition, the IP shall satisfactorily complete the local unit IP check flight before qualification is certified.

8.4.3 Payload Operator (PO). The PO shall complete the course of instruction outlined in the current CNET trainee guide. In addition, the PO shall satisfactorily complete the local unit PO check flight before qualification is certified.

8.4.4 Internal Operator (IO). The IO shall complete the course of instruction outlined in the current CNET trainee guide. In addition, the IO shall satisfactorily complete the local unit IO check flight before qualification is certified.

8.4.5 Mission Commander (MC). The Pioneer Mission Commander is a specific UAV flight crew position responsible for Mission Commander and Pilot In Command responsibilities as delineated in OPNAVINST 3710.7 series. The MC shall possess advanced knowledge of UAV capabilities, limitations, employment considerations, and airspace coordination requirements. The MC must be fully familiar with all stations and major components of the UAV system. The ultimate responsibility for safety of flight rests with the Mission Commander. The MC shall complete the local unit MC check flight before qualification is certified.

8.4.6 Crew Requirements

1. The minimum crew required to conduct range flight is MC, IP, IO, and EP.
2. The minimum crew required to conduct local touch-and-go training without a payload is EP and IP. In this case, the Pilot at Controls (PAC) fulfills the PIC responsibility as delineated in OPNAVINST 3710.7 series.

3. All instructional flights will be under the supervision of a certified instructor for the crew position receiving instruction.
4. Split site operations shall require a certified IP to man the PCS whenever the UAV can be controlled by that station.
5. A certified crew chief will be present for all engine starts.
6. Ground personnel and wing walkers will receive appropriate training at unit level prior to taxiing an operating UAV.

8.4.7 Currency

8.4.7.1 External Pilots. EP currency will be based on Figure 8-1. The requirements must be met within a 60-day period to maintain currency. A training device for EPs can be a ½ scale Pioneer, MiG RC aircraft, or the PC-based EP simulator. To regain currency, a recurrency flight will be flown with an EP instructor consisting of: 1 takeoff, 5 touch and go’s (T&G) or low approaches (LA), and 1 landing. Also, before a recurrency flight, the EP shall conduct 1 hr of training device with an EP instructor.

If the EP has not flown in one week, the EP shall utilize a training device for 1 hour, prior to a Pioneer flight. A day flight must be flown within 5 days prior to a night flight. An EP instructor may accumulate training device time during an instruction period. Actual flight hours may be substituted for training device hours on a 1-for-1 basis. Commanders of units without available training devices may waive training device requirements.

8.4.7.2 Internal Pilot, Mission Commanders, and Payload Operators. IP, MC, and PO that have not operated Pioneer in their respective positions within

the past 90 days shall be given a refresher flight under the supervision of a certified instructor.

8.4.8 NATOPS Evaluations. Each crew position shall complete a written examination and a flight evaluation annually.

8.4.8.1 Written Examination. The written examination shall consist of open and closed book sections and test practical knowledge of equipment employment and emergency procedures. The exams shall consist of a minimum of 40 and 20 questions respectively. Minimum acceptable scores are 3.5 and 3.3, respectively. The written examination shall be administered not more than 30 days prior to the flight evaluation.

8.4.8.2 Flight Evaluation. The flight evaluation may be conducted on any flight and should test practical knowledge of equipment employment and emergency procedures.

8.4.8.3 Definitions

Qualified — that degree of competence demonstrated by a crewmember who has good knowledge of standard operating procedures and thorough understanding of their area of the UAV system.

Unqualified — that degree of competence demonstrated by a crewmember who fails to meet the minimum acceptable standards. The individual should receive individual, supervised instruction until qualified or until permanently unqualified.

8.4.8.4 Waivers. Unit commanders are authorized to waive, in writing, minimum flight and training requirements where recent experience and knowledge of UAV operations warrant.

EP Currency	Takeoff/Launch	T&G or LA	Landings	Training Device
Shore Day	2	10	2	6 hrs
Shore Night	1	5	1	2 hrs
Sea Day	2	10	2	6 hrs
Sea Night	1	5	1	2 hrs

Figure 8-1. External Pilot Currency Chart, 60-day Requirements

Part III

Normal Procedures

Chapter 9 — Flight Preparation

Chapter 10 — Shore-Based Procedures

Chapter 11 — Shipboard Procedures

CHAPTER 9

Flight Preparation

9.1 MISSION PLANNING

9.1.1 Introduction. Adequate and thorough planning of the flight is necessary to assure the successful completion of any mission.

9.1.2 Factors Affecting UAV Lift Capability

9.1.2.1 Humidity. The performance charts contained in Part VII of this manual presume the aircraft to be operating in air of “standard” composition. “Standard” air is perfectly dry; consequently, the density altitude computed from the appropriate chart in the NATOPS will be less than the actual density altitude if operating in humid air.

Air saturated with water vapor (100 percent relative humidity) will be approximately 97 percent as dense as standard air. Therefore, when operating under saturated conditions, density altitude computations from NATOPS should be adjusted upward by 1,000 feet (adjust proportionately if relative humidity is less than 100 percent).

In cases where performance is depicted in terms of pressure altitude rather than density altitude, the effects of humidity may be considered by:

1. Determining “dry” density altitude by taking pressure altitude and outside air temperature into the density altitude chart.
2. Adding the humidity correction to the determined dry density altitude.
3. Working the density altitude chart backward to find the effective pressure altitude corresponding to the “wet” density altitude.
4. Using effective pressure altitude in those performance charts requiring pressure altitude input (and “wet” density altitude in those requiring density altitude input).

9.1.3 Weight and Balance

1. Basic weight of a UAV includes all fixed operating equipment and trapped fuel and oil.
2. Operating weight is the basic weight of a UAV plus payload, fuel, oil, and all special equipment required for the mission.
3. Maximum gross weight is the total weight (UAV plus all contents) at which the UAV may take off. This weight takes into consideration performance and structural limitations of the UAV and must not be exceeded.
4. Useful load is the difference between operating weight and maximum gross weight.

9.1.4 Mission Planning. Mission planning has two requirements. The first requirement is for pilots and operations personnel to calculate normal and emergency air vehicle operating capabilities concurrent with existing ambient conditions and mission requirements prior to every flight on a daily basis. The second requirement is preparation of planning documents for a future support mission. The planning is normally prepared from weather summaries and consideration of predicted weather in the area. Weather summaries suitable for preparation of such estimates can be prepared or obtained by any authorized weather facility with a forecasting ability. UAV operations should be conducted in VFR conditions to the maximum extent possible.

9.1.4.1 Frequency Deconfliction. Embarked UAV operations require planning consideration of possible electromagnetic interference (EMI) from various emitters currently onboard LPD-class ships. EMI studies concluded that the Pioneer UAV’s UHF uplink is susceptible to AN/SPS-40 (Air Search Radar) interference. A 15-MHz separation between UHF secondary uplink and the SPS-40 Air Search Radar should reduce any degradation experienced.

Prior to any land or ship operations at locations other than homeguard, considerations should be given to

frequency management. As a guide, when operating the UAV in an environment containing potential EMI interference from ship radar, air defense radar, microwaves as well as UAV operations involving another UAV unit, frequency separations of 0.05 GHz (downlink) and 15 MHz (uplink) are recommended. Coordination between unit commanders is highly recommended to mitigate the possibility of one unit's uplink commands interfering with another unit's UAV.

9.1.5 Fuel Planning. Fuel planning should be performed before flight using fuel performance charts in Chapter 16. Consideration should be given to winds aloft to arrive overhead the landing site with at least 8 liters of fuel remaining.

9.1.6 Equipment List. The below listed equipment is considered the minimum essential equipment for UAV operations.

1. One operable control station with operational primary and secondary control links.
2. Operable lights and IFF transponder equipment to comply with FAA requirements.
3. Backup electrical supply.
4. Operational return home mode of flight.
5. Two-way communication between the UAV control station and appropriate airspace authority.

9.2 BRIEFING/DEBRIEFING

9.2.1 Briefing. Proper and thorough briefing of flight crews is as crucial to mission success as thorough planning. As such, it should be conducted in the most logical, least time consuming, most organized manner possible. Every effort should be made to have all flight crewmembers available at each brief.

The person delivering the brief should orchestrate the proceedings to achieve maximum effectiveness. Some methods to achieve this are as follows:

1. Have everyone in place and begin the brief on time.
2. Seat crew positions together. By doing this, you save the time lost by people moving to their next briefing positions.
3. All administrative information should be reproduced and passed to all aircrewmen initially.

4. Have crews prepare their respective documents prior to the brief (gross weight limitations, load computation card, and any locally required documents).
5. Use appropriate briefing guides for the type mission being performed.

A briefing shall be conducted using a briefing guide. On training flights, the appropriate syllabus guide will be used stressing learning objectives, maneuvers to be demonstrated, maneuvers to be introduced, and common errors and causes.

9.2.2 Briefing Guide

1. Administrative information should be reproduced for handout at the beginning of the briefing and is not covered verbally.
 - a. Roll call, flight assignments
 - b. WX
 - (1) local
 - (2) enroute
 - (3) forecast.
 - c. Time hack
 - d. General
 - (1) air vehicle number
 - (2) call sign
 - (3) event number
 - (4) mission number.
 - e. Mission
 - (1) configuration
 - (2) fuel
 - (3) payload
 - (4) weight.
 - f. Times
 - (1) start
 - (2) take-off
 - (3) time on target
 - (4) landing.
 - g. Type launch/recovery

- h. Controlling agencies
 - i. Operation area
 - j. Hazards to flight
 - k. VTR
 - l. Special considerations
 - (1) split ops
 - (2) night
 - (3) RATO
 - (4) others.
2. Mission profile
- a. Intelligence brief
 - (1) enemy situation
 - (2) friendly situation.
 - b. Supported units
 - c. Mission statement / commander's intent
 - d. Concept of operations
 - (1) departure
 - (2) enroute
 - (3) target area
 - (4) RTB.
 - e. Coordinating instructions
 - (1) restricted areas
 - (2) maps/charts, declination, inclination
 - (3) return home
 - (4) bingo fuel
 - (5) intelligence/authentication
 - (6) elevation/dish antenna.
3. Emergencies
- a. Ground emergencies

- b. Aborts
 - (1) ground
 - (2) takeoff
 - (3) downrange.
- c. Lost communications
 - (1) UAV
 - (2) flight crew
 - (3) control agencies.
- d. Inflight emergencies
- e. Crew coordination
- f. Safety.

9.2.3 Debriefing. A proper debriefing shall be conducted after all training and operational flights. This is a very important phase of the flight in that a vast majority of our learning comes from the consolidation of constructive criticisms from all crewmembers. Mistakes can be discussed in an atmosphere free from distractions. The types of information derived from debriefs are threefold and are as follows:

1. Note how well a pilot/payload operator performed maneuvers/duties on a training flight. Good points can be brought out as well as the reasons for and corrective actions for problem areas.
2. On operational flights, discuss how well the mission was accomplished. Also discuss tactics used, effectiveness, improvements to tactics, and any new item that may affect future operations.
3. Obtain first-hand intelligence information from flight crews. Essential elements of information plus any new or unusual circumstances that could influence future operations should be discussed.

A debriefing guide shall be used for debriefing. For training operational flights, the syllabus guide or appropriate briefing guide should be used. This allows you to examine systematically each maneuver and its accomplishment, all mission goals, all tactics involved, and any other items that had a bearing on the mission.

CHAPTER 10

Shore-Based Procedures

10.1 INTRODUCTION

Shore-based procedures discussed in this chapter cover many operational situations.

10.2 SCHEDULING

The commanding officer/officer in charge or his designated representative is responsible for the promulgation of the flight schedule. The flight schedule, when published, becomes an order of the commanding officer/officer in charge. The flight schedule will contain sufficient information to assure that all preparations relative to flight can be accomplished in a smooth and timely manner. The following items are listed as a minimal guide:

1. Mission number and/or flight code
2. Time of takeoff
3. Time of return
4. Crew assignment
5. Remarks.

10.3 LINE OPERATIONS

10.3.1 Movement. The UAV should be guided from the rear provided adequate clearance is available. Unless being steered, elevate nosewheel when changing UAV ground direction. Special care should be taken especially when propeller is spinning.

10.3.2 Ground Operations

10.3.2.1 Preflight Inspection. The MC shall ensure that a complete system inspection has been accomplished prior to flight.

10.3.2.2 Fire Guard. Prior to starting the engine, a qualified fire guard shall be stationed near the engine and remain in readiness with a fire bottle until the engine is operating.

WARNING

The fire guard shall remain clear of the propeller area.

10.3.2.3 Starting Engine. A qualified person designated by the commanding officer shall be present whenever the engine is started. Starting personnel will receive and acknowledge the crew chief's signals before starting the engine. The UAV engine shall not be started until the UAV is properly secured with chocks. Chocks and tiedowns will be removed with caution when engine is operating and only upon the proper signal.

10.3.2.4 Control Box Transfers. Prior to executing a control box transfer between pilot stations, the following switches shall be confirmed in the correct positions: Lights, Autopilot, STICKS/KNOBS, ENG Switch, and Throttle.

10.3.2.5 Control Station Transfer Procedures

10.3.2.5.1 Preparation for Control Station Transfer. The following procedures prepare the receiving station to take command of the UAV. These steps should be completed as far in advance of control station transfer as possible.

1. FLT-TO/LDAS REQD (IP)
2. Nav LightsAS REQD (IP)
3. Flight/Control Mode.....AS REQD (IP)
4. Station Xmtrs.....HIGH/OFF (IP)
5. Station AddressSET (IP)
6. RPV Address.....SET (IP)
7. RPV Xmtr.....ON/HIGH (IP)



RPV transmitter should not be placed on HIGH on deck unless personnel are beyond 3 ft of the antenna and only for brief periods of time to prevent PCU overheating.

- 8. DNL Frequency Thumbwheel SET (IP)
- 9. UHF UPL FrequencySET (IP)
- 10. Primary UPL/CodeSHORT/SECURE (IP)
- 11. Presets
 - a. Cal & Warnings
 - b. Range Cal
 - c. RPV Data
 - d. RH Settings.

10.3.2.5.2 Control Station Transfer. The following procedures should not be conducted until command of the vehicle is to be transferred. Once commenced, this checklist should not be interrupted. Although voice communication is encouraged, tactical situations may dictate a no communication transfer. Detailed briefing and training are required for no communication transfers. For split site operations, pre-transfer coordination can be conducted via radio, phone, e-mail or message.

- 1. Control Box/
Flight ModeVERIFY (RCV IP)
- 2. Non-commanding UPLOFF (XFER IP)

Note

Both stations should observe the RPV RCVR, ADDR LOSS and LINK LOSS warning lights illuminate for the non-commanding link.

- 3. Non-commanding UPLON/REQD (RCV IP)

Note

Both stations should observe the RPV RCVR, ADDR LOSS and LINK LOSS warning lights extinguish for the non-commanding link. Additionally, the station address for the requesting station should begin flashing.

- 4. Commanding UPLREQD/OFF (XFER IP)

Note

Once both station addresses begin to flash, the transferring IP should release his UPL transmitter switch first. This action places the receiving station in command of the RPV and automatically reverts the transferring station transmitter to the non-commanding mode. Once the transmitter is secured by the transferring IP, both stations should observe the RPV RCVR, ADDR LOSS, and LINK LOSS warning lights illuminate for what is now the non-commanding link.

- 5. Commanding UPLON (RCV IP)
- 6. Non-commanding UPLON (RCV IP)

Note

Both stations should observe the RPV RCVR, ADDR LOSS and LINK LOSS warning lights extinguish for the non-commanding link.

- 7. Preferred
Commanding UPLSELECT (RCV IP)

Note

The selection for preferred uplink is based on which freq band is likely to be more stable. The decision should be based on EMI, atmospheric conditions, etc.

- 8. Return Home DataLOAD/VERIFY (RCV IP)
- 9. Primary UPL CodeAS REQD (RCV IP)

10.3.2.6 Engine Shutdown. This checklist is provided for shutting down the engine in a non-emergency situation. The intent is to preserve all preset data and battery life in order to effect a quick turnaround for subsequent launch.

- 1. WheelsPINNED/CHOCKED (CC)
- 2. External PowerOFF (IP/CC)
- 3. External Power CableCONNECTED (CC)
- 4. External PowerON (IP/CC)
- 5. Battery SwitchOFF (CC)

6. ERC Switch.....OFF/CUT (CC)

10.4 SYSTEM ACCEPTANCE

The Mission Commander should not accept the UAV System for flight until he is assured that the UAV System is satisfactory for safe flight and accomplishment of the assigned mission. The two major steps to be taken prior to acceptance of the UAV are careful examination of the recent discrepancies and a thorough preflight inspection.

10.5 PREFLIGHT INSPECTION

10.5.1 TCU Preflight Inspection

1. AC Entrance Panel

Generator selected1 or 2
 Corresponding light
 (Gen 1 or Gen 2).....ILLUMINATED

2. AC Distribution Panel

115 Vac light.....ILLUMINATED
 Circuit BreakersCHECKED
 (ON AS REQD)

3. DC Distribution Panel

Battery Warning LightOFF
 PS Fail LightOFF
 DC Main Light.....ILLUMINATED
 DC Main Indicator.....28 Vdc (±2)
 Circuit BreakersON
 RADIOAS REQD
 DC main selector switch.....1
 BuzzerENABLED

4. Auxiliary Control Unit

Elevation actuator breaker.....ON
 Dish angle, based on Mission.....AS REQD
 Radio power sourceAS REQD
 Actuator direction.....OFF

5. Horizon power supply (CPS 253A)

DC ampere meter.....25 AMP (±2)
 DC voltage meter.....28 Vdc (±2)
 Power indication lightsON
 Power circuit breaker.....ON

6. UHF Transmitter

Channel Selector2

PowerH
 XMTGON (If Transmitting)
 Power Failure.....OFF
 VSWR FailureOFF
 XMTG/STBYXMTG
 Channel 2 Frequency SelectorAS REQD
 Main power lightON
 Remote lightON
 ON/OFF switchON
 Local/remote switchREMOTE

7. CCB - Communication Panel

All warning lightsOFF
 ON/OFF switchON
 Test push-button light.....ON

8. MX 1105B-GPS (As Required)

PowerON
 SetupCOMPLETED

9. Battery box circuit breakerIN

10.5.2 GCS Preflight Inspection. Maintenance daily inspections and interactives establish operational readiness for a given system configuration. Operator preflight inspection ensures the integrity and operation for the given system configuration. The external pilot (EP) shall ensure that control box cannon plugs are locked into their detents.

10.5.2.1 GCS Electrical Panels

1. Generator selector SwitchGEN1 or GEN2

2. Three-phase indicator lampsILLUMINATED

3. Voltage meter (in all 3 phases).....115VAC (±10 VAC)
 Current meter (in all 3 phases).....CHECKED
 Frequency meter60 Hz (±2)

4. Circuit breakers onCHECKED

5. GCS lightingAS REQUIRED

6. Warning panelALL LIGHTS
 EXTINGUISHED

7. Battery

Voltage28V (±4)
 Current.....0 AMP

A1-SRRPV-NFM-000

- 8. Supply power
 - Voltage.....28 Vdc (±2)
 - Current25 AMP (±5)
- 9. Electrical Power applied to UAVVERIFY

10.5.2.2 Air Conditioner

- 1. MODE SelectorAS REQD
- 2. TEMP levelAS REQD

10.5.2.3 Intercommunication System

- All stations activated.....CHECK

10.5.2.4 Pilot Bay

- 1. Communication warning lampsOUT
- 2. TV monitors on/adjustedVERIFY
- 3. Pilot and Observer’s PresetsCOMPLETED

Note

Refer to PRESETS section of this checklist for details.

4. Pilot Display Panel

a. Warnings

- LOW IAS.....ON
- LOW ALTON
- LOW FUEL.....OFF
- PLT BOXOFF
- COPLT BOX.....OFF
- VTR INACTIVEON
- PWR FAILOFF
- GCS FAILOFF
- TEST MODEOFF
- PROG FAILOFF
- RH FAILOFF
- ENG TEMPON
- BATT FAIL.....ON
- EPS FAILOFF
- GEN FAILON
- ENG CUTON
- SEC LINK: RPV RCVR,
ADDR VAC, LINK LOSSOFF
- NO REPORT.....OFF
- RTN HOME.....OFF
- GLIDEOFF

- A-PLT MALOFF
- A-PLT FAILOFF
- PRIM LINK: RPV RCVR,
ADDR MODE, LINK LOSSOFF
- COMD INHIB.....OFF

b. RPV System Data

- ENGINE RPM.....0
- ENGINE TEMP.....INDICATES OAT
- FUEL.....CHECKED
- BUS VOLTAGE.....28 Vdc (±2)

c. RPV Flight Data

- ATTITUDE INDICATOR~0° PITCH/ROLL

Note

The attitude indicator shall be confirmed for correct launch attitude as follows:

- For RATO Launch+14°±2° pitch
- For Pneumatic Launch.....+10.5°+6° or -2° pitch
- IAS.....0-20 KTS
- RATE OF TURN0°
- TRACKING AZIMUTHREFLECTS TCD
AZIMUTH DISPLAY
- RPV HEADINGREFLECTS
UAV HEADING
- ALTITUDE (METER/
NUMERICAL DATA).....VERIFIED AT
SEA/FIELD LEVEL
- RATE OF CLIMB0
- RANGE.....REFLECTS UAV RANGE
FIELD LEVEL/SEA
- LEVEL SWITCHFIELD LEVEL

d. Time Data

- MISSION TIME.....0
- LOCAL TIMEREFLECTS
CURRENT TIME

5. Pilot Control Desk

- DISENG/AUTOPLT.....OFF
- MASTER CAUTIONOFF
- FLT-TO/LDTO/LD
- GEN RESET.....OFF
- REPORT INHIBITOFF
- ON/LIGHTS.....OFF

LAUNCH MODE,
 LAUNCHER, LAUNCH.....OFF
 PROG CONTR.....OFF
 NAV TO COOR.....OFF
 AUTO LAND/GO AROUND.....OFF
 CAMERA GUIDE.....OFF
 KNOB CONTR.....OFF
 STICK CONTR.....ON
 PLT BOX.....ON
 COPLT BOX.....OFF

XMTR POWER and
 STATION RCVR SIGNAL
 STRENGTH (meters).....6
 HIGH/LOW.....AS DESIRED
 PRIM UPL and SEC UPL
 (toggle switches).....STATION XMTR ON
 TEST Push-button.....PRESSED
 ALL PBYP lamps, push-buttons, annunciators,
 meters and digital displays.....CHECKED

Note

All meters should be pegged except for the fuel meter, which will read 30 liters. All digital displays should read eight (8) except for the altitude, mission time and local time readouts. All lights and pushbuttons should be lit.

a. PROGRAMMER CONTROL.....OFF
 STEP #.....SET
 REMAINING STEP/TIME.....VERIFIED
 RUN/PAUSE.....BOTH ON
 SSA.....OFF
 PROG/RESET.....OFF

b. KNOB CONTROL

ROLL.....0°
 ROLL READY.....ILLUMINATED
 IND AIRSPEED.....70 KTS
 IAS READY.....ILLUMINATED
 HEADING.....AS REQD
 ALTITUDE.....1000 FT. AGL
 ALT READY.....ILLUMINATED

c. RPV XMTR

ON/OFF.....ON
 HIGH/LOW.....LOW
 TRANSP.....OFF
 RH DELAY.....OFF
 SECURE/CLEAR.....SECURE
 LONG/SHORT.....AS REQD

d. COMMUNICATION CONTROL

PRIM UPLINK:
 OVERHEAT,
 HI RFL PWR, LOW PWR.....OFF
 DOWNLINK:
 RCVR FAIL.....OFF
 SEC UPLINK:
 OVERHEAT,
 HI RFL PWR, LOW PWR.....OFF
 RPV# (display).....VERIFIED
 STATION#/RPV#
 (Thumbwheel).....VERIFIED
 COMMANDING
 STATION (arrow).....SEC UPL
 STATION# (displays).....VERIFIED

6. Pilot Control Table

READY light.....ON
 RUDDER, AILERON,
 THROTTLE, ELEVATOR lights.....ON
 ENGINE ON/OFF Switch.....ON
 ELEV TRIM.....MAXIMUM UP
 RUDDER TRIM.....CENTERED
 POSITION
 AILERON TRIM.....CENTERED
 POSITION
 THROTTLE STICK.....IDLE

10.5.2.4.1 PCS Integrity Checklist

External Power Supply:

Voltage Meter.....28 Vdc
 ICS / Radio.....CHECK
 PPD:

+15 Vdc Supply Circuit Breakers.....OFF
 28 Vdc Systems Circuit Breakers.....ON

CPD:

All Circuit Breakers.....AS REQD
 P.S. Lamp.....OUT
 BATT Lamp.....ON
 BATT Warning Lamp.....OUT

CCB — Communication Panel:

All Warning Lamps.....OUT
 ON / OFF Switch.....ON
 Lamp Test Switch.....CHECK

10.5.2.5 Tracking Bay

1. Plotter panel maps.....POSITIONED

- 2. PRESET Maps to PlotterCOMPLETED

Note

Refer to Tracking Bay PRESETS in the PRESET Section of this checklist.

- 3. Tracker Control Desk

- a. Plotter control

MAP#VERIFIED
 EAST/NORTH/SOUTHVERIFIED
 UTM/GEOGRUTM
 RESETON
 PRESET, DIAGN,
 MAP ORIENT,
 TCU COVR, TCU ALTOFF
 DATA LOSSOFF
 OVER RANGEOFF
 TRACK TARGETOFF
 MARK TARGETOFF
 OVER FLOWOFF
 CONT/STEPAS REQD
 COARSE/FINEOFF
 LOCALON
 TRACKOFF
 AUTO/MANUALASREQ
 L/R pen selectionLEFT PEN

Note

Verify left pen light illuminates on tracker arm.

RUNOFF
 MAP#OFF
 PEN UPOFF

Note

Verify pen in up position on tracker arm.

STOPOFF

- b. Tracker Control

Azimuth DegreesAS REQD
 ANT PWROFF
 TRACKER FAILOFF
 TRACK LOSSOFF
 MANUALON
 TRACKOFF
 WIDE/NARROWOFF
 SCANOFF

DISH/OMNIOMNI
 RPV ANTOMNI
 TEST (push-button)PRESS
 LAMPS/METERSCHECKED

10.5.2.6 Observer Bay (Observer)

- 1. Observer Control Table

PRESET MenuCOMPLETED
 Multifunction MenuCOMPLETED
 Target Acquisition MenuCOMPLETED

- 2. Video Telemetry Recorder

POWERON
 TAPELOADED/REWOUND
 TIME COUNTER
 DISPLAY SWCOUNTER
 TIME COUNTER DISPLAYRESET
 LOCAL/REMOTELOCAL
 AUDIO LEVELS0 DB
 (EXCEPT PCM CH3 (VOICE)
 ADJUST TO LEVEL 2)
 PHONE LEVELMIDRANGE
 MODE SELECTNORMAL
 METER SELECTAS REQD
 ASSEMBLEOFF
 INSERT INDICATIONSOFF
 TAPE TRANSPORT INDICATORSOUT

- 3. OTMPON

Note

Both adjusted (do not change size of screen w/video).

- 4. Observer Video Control

LIGHT PENCONNECTED
 AUX VIDEOEXTERNAL VIDEO
 CONNECTED AS REQD
 DIMMERSADJUSTED
 VIDEO GRAPHIC BUTTONSAS DESIRED
 VTR RECORD / INACTIVEINACTIVE

- 5. Observer Control Desk

- a. AUTOMATIC LANDINGALL PUSH-BUTTONS OFF

- b. MKD-200 Payload (Used for both MKD-200 and MKD-200A)

VIDEOON

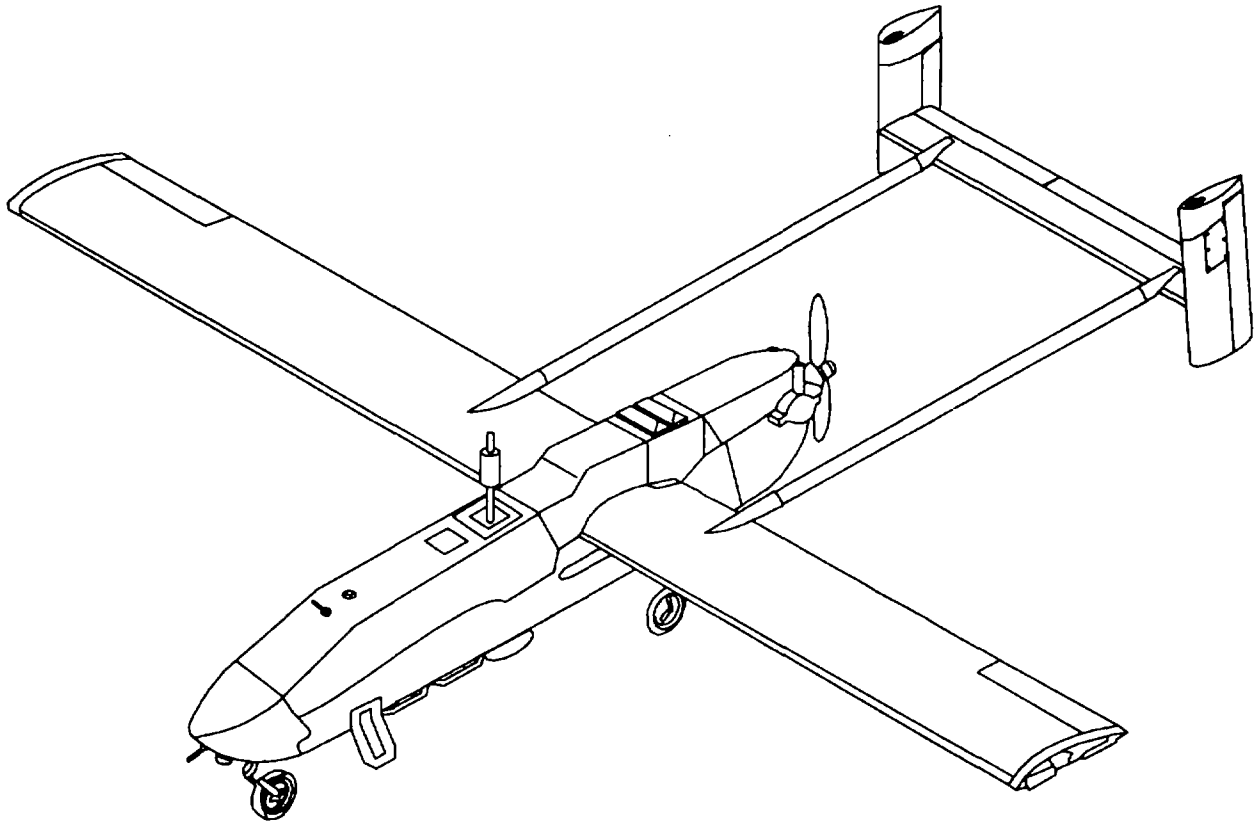


Figure 10-1. Pioneer RPV Exterior Inspection

IRIS.....AUTO
 IRIS MANUAL KNOB.....CENTERED
 FOCUS.....SET
 ZOOM.....MAX OUT

BEARING TRIM and
 DEPRESSION TRIM.....AS REQD

c. MKD-400 Payload

VIDEO.....AS REQD
 LEVEL.....AUTO
 DATA.....ON
 HEAT POLR.....AS REQD
 FIELD OF VIEW.....SUPER WIDE
 FOCUS.....SET

d. PLATFORM CONTROL

ON push-button.....ON
 POSITION/RATE
 CONTROL push-buttons.....POSITION
 BEARING DEGREES.....180
 DEPRESSION DEGREES.....0
 PAYLOAD SHIELD.....OFF

6. Observer Control Table

All push-buttons.....OFF

10.5.3 PIONEER Preflight Inspection

10.5.3.1 Exterior Inspection (Figure 10-1). The exterior inspection (preflight) should be conducted to detect possible discrepancies, which could result in the unsafe flight operation of the Pioneer Air Vehicle.

1. NOSE COWLING:

- a. Nose Cowling Fasteners: Check for security, and missing fasteners.
- b. BPU Static Ports: Check for security and for obstructions.
- c. Pitot Tube: Check for security and obstructions.
- d. Nose Light Unit: Check for security of components.

2. FUSELAGE NOSE SECTION (LOWER NLG AREA):

- a. Nose Wheel Stops: Inspect mechanical stops for nose wheel travel limits.
- b. Servo Arm Fastener: Check for security and proper assembly of components.
- c. Nose Landing Gear Strut: Check for structural integrity to include mechanical components. Ensure proper alignment of nose wheel in Autopilot Disconnect.
- d. Wheel and Tire Assembly: Check for freedom of movement (should not have excessive play on axle assembly) and wear of rubber tire compound.
- e. Pneumatic Launch (Strap) Catch Release Mechanism: Check for function if utilizing pneumatic launcher for flight operation.

3. FUSELAGE (LEFT SIDE):

- a. Main Upper Hood: Check for security of fasteners to include those missing, and associated fasteners to include the Directional Antennae, IFF Strobe assembly, and GPS package.
- b. Forward Left Rail Launch Guide: Check for security and inclusion of fairing.
- c. Upper Main Wing Mounting Points: Check for mounting pin(s)/safety clips and for security to include possible cracks or other structural anomalies.
- d. Lower Main Wing Area: Check for possible fuel leaks around wing mounting points to lower fuselage area and cabling conduit.
- e. Access Panels and Hatches: Check for security of fasteners, to include missing fasteners.
- f. Rear Left Rail Launch Guide: Check for security and inclusion of fairings.
- g. Toggle Switches to include: Battery, ERC, Comm, and VGU. Check for preset positions and security of switches.
- h. Upper Cowling (Engine): Check for security of fasteners to include missing fasteners and structural cracking.
- i. Lower Cowling (Engine): Check for security of fasteners to include missing fasteners and structural cracking.

4. PAYLOAD PACKAGE MKD-200, MKD-400, A AND C MODELS:

- a. MKD-200: Check for integrity of payload bubble to include check for cracks, moisture.
- b. MKD-400: Check for security of unit.

5. MAIN WING (LEFT SIDE PANEL):

- a. Wing Tip (Left): Check for security and absence of fasteners. Check for security of navigation lighting.
- b. Aileron Unit (Left): Check for binding of unit against adjacent areas. Inspect aileron surface for signs of structural failure and/or excess wear of hinge point pivots. Lift up and down on wing to note proper autopilot functioning.

Note

Some Pioneer models may incorporate breakaway damage resistant surfaces. Inspect for integrity of components.

- c. Servo Aileron Left (SAL): Check for mechanical integrity of linkages and associated hardware including left aileron surface.
- d. Left Wing Panel: Inspect for signs of structural failure (i.e. cracks around mounting point, excessive drooping of wing panel, excessive wear of mounting point pin holes, cracks in the wing panel, or wing covering deterioration).
- e. Wing Strut Mounting Point: Inspect for security of pin through wing and associated hardware.
- f. Tail Boom Mounting Point (Left Side): Check for signs of cracking and inspect for security of tail boom mounting bolts (3).

6. TAIL BOOMS (LEFT AND RIGHT SIDES): Inspect for security and damage to boom structure.

Note

Some UAV models are equipped with aluminum boom structures while others are constructed of composite materials.

7. HORIZONTAL STABILIZER:

- a. Horizontal Stabilizer: Inspect structure for cracks or other visible signs of damage. Inspect attachments to tail boom assembly for security. Inspect attachment to vertical stabilizer assembly and associated hardware.
 - b. Elevator Surfaces: Check for integrity of units including hinge pivot points for wear, and potential binding against adjacent areas.
 - c. Servo Elevator Units (SEU): Inspect for mechanical integrity to include linkages, safety wiring, and associated hardware.
8. VERTICAL STABILIZER (LEFT AND RIGHT):
- a. Vertical Stabilizer: Inspect for structural cracks or other visible signs of damage. Check and inspect attachment points to horizontal stabilizer to assure security.
 - b. Vertical Stabilizer Tips: Check for security of fasteners to include navigation lighting fixtures.
 - c. Rudder Units: Inspect for integrity of unit to include hinge pivot points for wear, and potential binding against adjacent areas.
 - d. Servo Rudder Unit (SRU): Inspect for mechanical integrity to include linkages, safety wiring, and associated hardware.
 - e. Vertical Stabilizer Skid Plates: Inspect for binding against rudder assembly due to tail strikes.
9. FUSELAGE (RIGHT SIDE):
- a. Forward Right Rail Launch Guide: Check for security and inclusion of fairings.
 - b. Upper Main Wing Mounting Points: Check for mounting pin(s)/safety clips, and for security to include possible cracks or other structural anomalies.
 - c. Lower Main Wing Area: Check for possible fuel leaks around wing mounting points to lower fuselage area and cabling conduit.
 - d. Access Panels and Hatches: Check for security of fasteners, to include missing fasteners.
 - e. Rear Right Rail Launch Guide: Check for security and inclusion of fairings.
 - f. Upper Cowling (Engine): Check for security of fasteners, to include missing fasteners and structural cracking.
 - g. Lower Cowling (Engine): Check for security of fasteners to include missing fasteners and structural cracking. Check for excessive fuel leakage or oily deposits.
10. MAIN WING (RIGHT SIDE PANEL):
- a. Wing Tip (Right): Check for security and absence of fasteners. Check for security of navigation lighting.
 - b. Aileron Unit (Right): Check for binding of unit, and against adjacent areas. Inspect aileron surface for signs of structural failure and/or excess wear of hinge points pivots.
 - c. Servo Aileron Right (SAR): Check for mechanical integrity of linkages, and associated hardware to include right aileron surface.
 - d. Right Wing Panel: Inspect for signs of structural failure (i.e., cracks around mounting points, excessive drooping of wing panels, excessive wear of mounting point pin holes, cracks in the wing panel, or wing covering deterioration).
 - e. Wing Strut Mounting Point: Inspect for security of pin through wing and associated hardware.
 - f. Tail Boom Mounting Point (Right Side): Check for signs of cracking, and inspect for security of tail boom mounting bolts. (3)
 - g. Flux Valve Unit (FVU): Inspect for secure mounting.
11. FUSELAGE (AFT UPPER SECTION):
- a. BEU Access Hatch: Check for security of fasteners and associated bolts and hardware. Check for structural cracks and signs of fatigue.
 - b. Main Wing Fairing: Check for security of fasteners to include missing fasteners or mounting bolt hardware.

12. MAIN LANDING GEAR (MLG) UNIT:

- a. Landing Gear Strut: Check for possible delamination of fiberglass components including structural cracking.
- b. Main Landing Gear Attachment Points: Check for loose or missing bolts and associated safety wiring.
- c. Arresting Gear Attachment Point: Check for security of Arresting Gear and condition of skid pad.

Note

During preflight procedure Arresting Gear secure pin may be installed and should be removed before launch.

- d. Main Landing Gear Wheel and Tire Assembly: Check for wear of the tire unit.

13. POWERPLANT:

- a. Spark Plug Wiring: Check for security and safety wiring.
- b. Cylinder Head Cowling: Check for security, and possible cracking.
- c. Exhaust Stacks: Inspect for cracks, excessive carbon build-up, and visible scarring of cylinder wall and piston ring assembly.
- d. Engine Thermocouple Harness (ETH): Check for security of attachment (one cylinder only).
- e. Flywheel Unit: Check for structural integrity, scarring, or corrosion on magnets.
- f. Magneto Wiring: Check for security and abrasion of wiring by lower engine cowling.
- g. Propeller Unit: Check for security of mounting hub and associated hardware and safety wiring. Insure correct mounting direction of propeller (i.e., leading edge of prop forward). Check prop for nicks and cracks which could result in prop failure.
- h. Binding of Reciprocating Components: Check by rotating propeller through several cycles to determine possible bearing malfunction or other associated problem.

Note

There should be freedom of movement until encountering of compression stroke (visual inspection through exhaust stack).

14. EXTERNAL IDLE ADJUSTMENT:

Check for security (if UAV is so equipped).

10.5.3.2 Generator Inspection (When Required for Operation)

- 1. Identify specific generators providing power to system.
- 2. Visually inspect power cables and connectors/fittings.
- 3. Check cycles at 60 Hz \pm 2 Hz.
- 4. Check voltage at 110 V \pm 10 V.

Note

Both gauges (one on generator, one in control shelter) should be inspected. Gauge in shelter should be considered primary indicator.

- 5. Check percent of rated power at approximately 75%.
- 6. Check fuel level to ensure adequate supply for mission.

10.6 RATO PRESTART CHECKLIST

Note

Shipboard ops require FLIGHT QUARTERS and AMBER DECK for RATO upload.

- 1. RATO Upload ClearanceREQUESTED (MC)

Note

If external power is not used or is unavailable, start engine from battery power and complete presets after engine start.

- 2. External PowerOFF (CC)
- 3. RATO UploadCOMPLETE (CC)

- 4. RATO Final ChecksCOMPLETE (CC)
- 5. External PowerON (CC)
- 6. Update Presets.....COMPLETE (IP)
 After power has been interrupted to the UAV, the following PRESETS must be reset:
 - a. Return Home Data(PRESET 2)
 - b. Mission Computer(PRESET 13)
 - 1. GeneralUPDATE 1-6
 - 2. Mask (if GPS)DEFAULT
 - c. Navigation Programmer/
 Mission Computer(PRESET 3)
 - 1. (2) GeneralAS REQD
 - 2. (1) Current ReportVERIFY
 - 3. (5) RPV Programmer.....AS REQD
 - 4. (7) Command, Item 3
 (if GPS).....AUTO/2D
 - d. Range Cal.....(PRESET 4)
- 7. Engine Start Clearance.....REQUESTED/
 APPROVED (MC)
- 8. Control Transfer to PCSCOMPLETE

10.7 STARTING ENGINE

A qualified person designated by the commanding officer shall be in control of the pilot box whenever the UAV engine is started. Starting personnel shall receive and acknowledge the plane captain's and fireguard's all clear signals before engaging starter. The UAV engine shall not be started until the UAV is properly chocked. Chocks shall be removed with caution when the propeller is turning and only upon proper signal from the plane captain.

- 1. ICSCHECKED (ALL)
- 2. VTR RECORD/INACTIVE.....RECORD (PO)
- 3. StarterREADY (CC)

Crew Chief (CC) ensures starter and all start personnel are in position.

- 4. Fire ext. and fire guardPRESENT (CC)
- 5. CBX.....SELECTED (EP)
 Control of UAV is transferred to EP and EP READY light is illuminated.
- 6. Nav LightsAS REQD (EP)
- 7. IFF/StrobeAS REQD (IP)
- 8. ERC SwitchON (CC)
- 9. VGU SwitchON (CC)
- 10. Comm SwitchON (CC)
- 11. Battery SwitchON (CC)
- 12. EXT POWER.....OFF (IP)



Ensure the external power source is properly identified (GCS, PCS, or PP7333) and power is secured prior to removing external power cable from UAV.

- 13. Ext Power CableDISCONNECTED (CC)
- 14. TP-53 (monitor 20 seconds).....>3.4 (IP)

Note

Monitor TP-53 for at least 20 secs. If reading is less than 3.4, battery replacement is required. In this case, immediately reconnect external power to preserve presets and interactives.

- 15. Engine startCLEARED (MC)



CC shall determine that personnel are clear of the UAV prior to engine start. EP shall request clearance for engine start from the MC after the CC reports ready.

- 16. EngineSTART (CC)



Engine should be started without delay, as battery usage of more than 1.5 min requires battery replacement.

- 17. Throttle.....APPROX 5000 RPM (EP)
- 18. Eng TempVERIFY (IP)

Note

RPM shall be maintained between 4800-5200 until CHT indicates above 150°C. Verify ENG TEMP light is extinguished above 100°C.

- 19. ThrottleIDLE (EP)
- 20. ENG CUT, BATT FAIL, GEN FAIL
Warning lamps.....OUT (IP)

Note

If TP-53 is increasing and at least 3.62 Vdc, takeoff with the BATT FAIL light illuminated is permitted.

10.8 ENGINE SHUTDOWN

This checklist is provided for shutting down the engine in a non-emergency situation. The intent is to preserve all preset data and battery life in order to effect a quick turnaround for subsequent launch.

- 1. WheelsPINNED/CHOCKED (CC)
- 2. External PowerOFF (IP/CC)
- 3. External Power CableCONNECTED (CC)
- 4. External Power.....ON (IP/CC)
- 5. Battery Switch.....OFF (CC)
- 6. ERC Switch.....OFF/CUT (CC)

10.9 PRE-TAXI CHECKS



To prevent tension link failure during RATO operations, all throttle accelerations shall be conducted gradually.

- 1. Flight Controls.....CHECK (EP)

Note

Check AILERONS, ELEVATORS, RUD-
DERS, and NWS for correct response. The
CC/EP shall check correct response by com-
paring the stick input to the control surface
deflection.

Examples:

- Back StickElevators UP
- Forward Stick.....Elevators DOWN
- Left Stick (Roll)Lt Aileron UP,
Rt Aileron DOWN
- Right Stick (Roll).....Lt Aileron DOWN,
Rt Aileron UP
- Left Stick (Yaw)Rudders/NWS Left
(UAV perspective)
- Right Stick (Yaw).....Rudders/NWS Right
(UAV perspective)



To prevent damage to the SWU, do not con-
duct rudder checks during RATO operations
unless the NWS linkage has been
disconnected.

- 2. Idle RPM (3200-3500).....CHECK (IP)
- 3. Bus VoltageCHECK (IP)
- EP accelerates throttle to MAX then returns to idle
three times and verifies steady bus voltage (28 ±2 V).
- 4. Throttle.....MAX RPM ABOVE 6700 (EP)



Wide-open throttle shall not be maintained
for more than 10 seconds.

- 5. Throttle.....APPROX 5000 RPM (EP)
- 6. ENG Switch.....OFF (EP)
- Confirm no effect for at least 3 seconds.
- 7. ENG Switch.....ON (EP)

- 8. Nav Lights.....ON (EP)
- 9. ENG SwitchCYCLE (EP)
Verify engine cut reaction.
- 10. Throttle.....IDLE (EP)
- 11. Nav Lights.....AS REQD (EP)
- 12. Autopilot.....DISENG (EP)
- 13. IDLE RPM (3200-3500).....CHECK (IP)
- 14. Throttle.....MAX RPM ABOVE 6700 (EP)



Wide-open throttle shall not be maintained for more than 10 seconds.

- 15. Throttle.....IDLE (EP)
- 16. Flight Controls.....CHECK (EP)

Note

Check AILERONS, ELEVATORS, RUDERS, and NWS for correct response.

- 17. AutopilotENGAGE (EP)
- 18. Additional box checksAS REQD (EP)

Note

Panel interactive tests ensure correct operation of each control box. The above checks ensure proper functioning of the uplink command path and air vehicle components.

- 19. Walkaround.....COMPLETE (CC)
- 20. Eng Trap CountCOMPLETE (CC)

Note

During RATO or pneumatic launches the CC may be required to man his position in an alternate location. If applicable implement Step 22.

- 21. Ready for Taxi.....CLEARED (MC)



CC shall not taxi the UAV until permission has been granted by the mission commander.

- 22. CC off headset.....ADVISE WHEN ON HEADSET (IP/MC)

10.10 PRE-TAKEOFF/LAUNCH PROCEDURES

- 1. CBX selectedCONFIRM (EP)
- 2. Video/PlatformCHECK/POSITION AS REQD (PO)



Set for type of Takeoff/Launch. For RATO: Caged as applicable. For Rolling/Pneumatic Launch: MKD 200 caged, 180° bearing and 0° depression for all other MKDs.

- 3. Lamp TestCOMPLETE (IP)
- 4. PRIM/SEC Uplink Xmtrs.....HIGH (IP)
- 5. Gauges/Instruments.....CHECK (IP)



The ATTITUDE indicator shall be confirmed for correct launch attitude as follows:

RATO	+14° ±2°
Pneumatic	+10.5° +6°/-2°
Rolling	Level

Note

At a minimum, the following shall be checked: RPM, ENG TEMP, and FAIL CHECK, Bus voltage and warning lamps. Perform an Altitude Calibration as necessary.

Note

Maximum time for VGU to erect is up to 10 minutes.

- 6. Range Cal.....CONFIRM (IP)
ADJUST IF NECESSARY
- 7. CC Back on headset.....CONFIRM (CC) (IP/MC)
- 8. **(RATO)** Shorting Jack J1REMOVED (CC)
- 9. **(RATO)** Fire line
(cable W1).....CONNECTED (CC)
(Pneum.) V6 valve closed.....CONFIRM (CC)
- 10. Altimeter Cal.....CONFIRM (IP)

Note

If the Altimeter Calibrations are updated, then the PRESET/MISSION COMPUTER/GENERAL must be updated and loaded. Failure to do so will result in improper flight altitudes during NPL flight.

- 11. **(Dual OPS)** NVC Bypass.....-NO (IP)
- 12. **(Dual OPS)** NPL / Current Report ...SELECT (IP)
- 13. **(Dual OPS)** Step #CONFIRM (IP)

Note

All information displayed within "STEP #" is acquired from the Ground Programmer only. The RPV Programmer should be verified for accuracy of all NPL steps.

- 14. **(Dual OPS)** PRSNT POS.....CONFIRM (IP)
- 15. **(Dual OPS)** Range / ETA.....CONFIRM (IP)
- 16. **(Dual OPS)** Operation Mode.....AS REQD (IP)
- 17. **(RATO)** Remote Safe/Arm Switch.....SAFE (CC)
(Pneum.) Launcher S2 SwitchOFF (CC)
- 18. Takeoff Trim.....SET (EP)

10.11 TAKEOFF/LAUNCH CHECKLIST

WARNING

Execution of the TAKEOFF/LAUNCH checklist shall not commence until all personnel are clear of the nose of the vehicle. At any time during the takeoff/launch sequence any member of the crew may announce "ABORT, ABORT, ABORT" in the event of any safety of flight emergency.

- 1. Pins.....REMOVED (CC)
Remove tailhook and/or launch pins.

WARNING

Verify tension link integrity prior to removing pins.

- 2. FLT-TO/LDFLT (IP)
- 3. Manual Rtn
Home DataLOAD & VERIFY (IP)
- 4. Takeoff/Launch clearance.....CLEARED (MC)
- 5. **(RATO)** Firing BoxREADY LIGHT (CC)
(Pneum.) V6 Valve.....OPEN (CC)
- 6. **(RATO)** Remote Safe/
Arm SwitchARMED (CC)
(Pneum.) Launcher S2 SwitchARMED (CC)
- 7. All Stations ReportREADY (ALL)
- 8. Nav LightsAS REQD (EP)
- 9. ThrottleMAX ABOVE 6700 (EP)
- 10. UAVRELEASE/LAUNCH (EP)
 - a. Rolling Takeoff: EP will call "ROTATE" and "LIFT OFF."

b. RATO: EP counts down, "5-4-3-2-1 LAUNCH." RATO crew press ARM & FIRE switches simultaneously. After rocket fires, release ARM & FIRE switches; verify switches have returned to their secure positions. A total of three (3) attempts to fire are authorized prior to initiating MISFIRE procedures.

c. Pneumatic Launch: EP counts down "5-4-3-2-1 LAUNCH."

Launcher Command
Module Switch.....CLOSED

A total of three (3) attempts to fire are authorized prior to initiating MISFIRE procedures.

- 11. Mission Clock.....START (IP)
- 12. RPV XmtrHIGH (IP)

10.12 AFTER TAKEOFF

10.12.1 Climb Out

- 1. Climb.....ABOVE 500 FT AGL (EP)
- 2. Controllability ChecksCOMPLETE (EP)

Note

These checks are conducted to determine if the UAV meets the below listed criteria. The IP shall verify pitch and bank angles for each maneuver.

Pitch UP	18° ±3°
Pitch DN	14° ±3°
Bank LT	57° ±3°
Bank RT	57° ±3°

- 3. Nav LightsAS REQD (EP)
- 4. IFF/StrobeAS REQD (IP)
- 5. ALT/IAS/HDG KnobsAS REQD (IP)

Note

Must be in full knobs "heading" in order to transition into programmer mode. Use of programmer is subject to the TP 309 limitations.

- 6. (Dual OPS) PROG CONTR
Push ButtonSELECT (IP)
- 7. (Dual OPS) UAV Enters
Correct NPL Flight.....CONFIRM (IP)
- 8. Station TransferAS REQD (IP)
- 9. CBX to PBX XFERAS REQD (IP)

10.12.2 Control Checks. Whenever control and/or flight modes are modified, a control check should be conducted to confirm proper UAV response to the new mode. E.g., when transferring control from the CBX to the PBX, the IP should schedule a turn or climb opposite to a CBX input and verify proper response.

Similar verifications should be done when switching between STICKS, KNOBS, and PROGRAMMED flight modes.

10.13 DISHLOCK

A dishlock can be conducted regardless of whether or not you currently have command of the UAV. If not in command, the first four items on the checklist are performed to match the controlling station's uplink commands. While not required to perform a successful dishlock, these steps are required to increase the margin of safety.

The dishlock procedure may have to be performed in conjunction with a CBX to PBX control transfer. In this case, close crew coordination is required to avoid skipping required steps.

- 1. RPV AntOMNI (IP)
- 2. ALT/IAS/HDG
KnobsSET AS REQD (IP)
- 3. ALT/IAS/HDG
LightsREADY/SELECT AS REQD (IP)
- 4. UAV HeadingESTABLISH (IP/EP)

- 5. Dish Azimuth/Elevation.....SET (IP)
- 6. Primary Link.....DISH (IP)



Note

Dishlock procedures should not be attempted until the UAV is beyond 1 km due to the high slew rates in close. During dishlock, a NO REPORT condition may exist until the dish azimuth and elevations are properly adjusted.

- 7. Antenna Track.....ADJUST (IP)

Note

Adjust the antenna track for maximum signal strength and 0° boresight error. This will help ensure the receiver main lobe (vice side lobe) is used for tracking.

- 8. Tracker ControlTRACK (IP)
- 9. Plotter Control.....AS REQD (PO)

10.14 CLIMB

- 1. Mission Altitude.....SET (IP/EP)
- 2. Altimeter SettingSEA LEVEL (IP)
- 3. Plotter Control.....AS REQD (PO)
- 4. RPV AntAS REQD (IP)
- 5. Commanding Link.....AS REQD (IP)
- 6. UPL Code.....LONG (IP)
- 7. Low Altitude Warning.....ADJUST (IP)
- 8. RH First Climbing SpiralYES (IP)
- 9. RH UpdateVERIFY (IP)
- 10. CBX to PBXVERIFY (IP)

10.15 DESCENT

Standard rates of descent are made at 400-600 feet per minute. Full idle position will allow maximum descent, with airspeed set at 60-62 knots. Other techniques can increase the available descent rate (i.e. spiral from altitude, “S” turns, slipping) to expedite UAV recovery in an emergency.

- Final descent should be commenced to arrive overhead the landing site with at least 8 liters (indicated) of fuel remaining. Abrupt pitch or bank maneuvers can cause fuel starvation with low fuel, and should be avoided when the UAV is returning with low fuel (5-7 liters). Fuel starvation may occur in level flight when fuel quantity is 4 liters or less.
- Monitor CHT during descents. If the CHT approaches minimum limits (110°C), level off. Set RPM for level flight and monitor CHT until it reaches a level acceptable for continued descent.

- 1. Altimeter Setting.....FIELD (IP)
- 2. Low Altitude Warning.....ADJUST (IP)
- 3. Commanding Link.....AS REQD (IP)
- 4. IFF/StrobeAS REQD (IP)
- 5. UPL CodeAS REQD (IP)
- 6. Nav LightsAS REQD (IP)
- 7. FLT-TO/LDTO/LD (IP)
- 8. Payload Shield.....DEPLOY (IP/PO)
- 9. FLT-TO/LDFLT (IP)
- 10. RH Auto.....VERIFY (IP)
- 11. RPV AntOMNI (IP)
- Once the EP has visual:
- 12. CBX SELECTAS REQD (IP)
- 13. Full Sticks / Mixed ModeAS REQD (IP)
- 14. Primary Link.....OMNI (IP)
- 15. Manual RHLOAD/VERIFY (IP)

10.16 LANDING



The landing checklist should be commenced to be on deck with at least 7 liters (indicated) of fuel remaining. Abrupt pitch or bank maneuvers can cause fuel starvation with low fuel and should be avoided when the UAV is returning with low fuel (5-7 liters). Fuel starvation may occur in level flight when fuel quantity is 4 liters or less.

- 1. Station TransferAS REQD (IP)
- 2. PlatformSET (IP/PO)



Set for Landing. For Net: MKD 200/400, Caged. For Rolling; MKD 200 caged; 180° for all other MKDs.

Once established on Downwind leg:

- 3. Nav LightsON (EP)

Once established on Final for a Full Stop:

- 4. FLT-TO/LDTO/LD (IP)

After runway touchdown/net impact:

- 5. EngineOFF (EP)

10.17 POST LANDING

- 1. Nav LightsOFF (EP)
- 2. RPV XmtrLOW (IP)
- 3. UPL Xmtrs.....LOW/OFF (IP)
- 4. Mission ClockSTOP (IP)
- 5. PlotterRESET (PO)
- 6. VTR RECORD/
INACTIVEINACTIVE (PO)

- 7. Video/PlatformOFF (PO/IP)
- 8. ERC SwitchOFF (CC)
- 9. Comm, VGU, BattAS REQD (CC)



To prevent damage to the VGU, the UAV should not be moved for at least 10 minutes once power to the VGU has been secured.

10.18 DUAL UAV OPERATIONS

Operation of the Pioneer UAV in an intelligence gathering scenario may require on-station times in excess of single UAV endurance limitations. One Pioneer UAV is limited to a total flight endurance time of about four hours (including enroute time from home base to target and return). Dual Ops procedures are intended to provide an on-station relief using a second UAV launched and guided by the same UAV unit. This procedure will increase UAV on-station time in proportion to the number of follow-on launches, and with regard to the distance between home base and target. To ensure unbroken coverage and maximum on-station time, follow-on launch times must be carefully planned and coordinated.

10.18.1 Dual Ops Procedures

- 1. Two (or more) UAVs, with proper frequency separation, are preflighted and all programmed routes are entered into the GCS and PCS. All procedures and UAV frequencies and channels are carefully briefed. The two UAVs should have different addresses, UHF frequencies, and C-band downlink frequencies.
- 2. The first UAV is launched by the GCS or by the PCS and transferred to the GCS upon completion of in-flight checks. It is flown to the on-station entry point to begin the mission. Enroute navigation programs are loaded into and checked in the UAV.
- 3. Prior to the first UAV reaching Prudent Limit of Endurance (PLE), and allowing for enroute time for the second UAV, the second UAV is launched by the PCS and controllability checks are conducted.

4. The first UAV is put into a programmed holding pattern on station by the GCS. The GCS then tunes to the second UAV, takes control from the PCS, conducts controllability checks, and programs it to fly a route to the on-station entry point, hold, and return to home base, ensuring that altitude separation of at least 1000 feet is maintained between UAVs. At this time, the PCS continues to track the second UAV to station, or to the limit of its line-of-sight coverage. The GCS tunes back to the first UAV, resumes control, and continues with the mission.



Dual UAV operations shall select NVC Bypass -NO. With NVC Bypass selected +YES and UAV in programmed mode, when the controlling station changes address, the UAV (incorrectly) executes return home. A power fluctuation on the UAV with NVC Bypass -NO may cause an unrecoverable NVC hang.

Note

While this step causes a break in mission coverage, it ensures that both the first and second UAVs can be programmed and controlled by the GCS, and all programs are recorded on the Video Telemetry Recorder (VTR).

5. When the second UAV arrives on station, the first UAV is commanded to fly its programmed return route to a holding point near home base. When the first UAV is enroute home in programmer mode, the GCS tunes to the second UAV, takes control, and continues with the mission.

Note

Radar assistance may be necessary to acquire UAVs returning from distant targets. Use of Strobe/IFF should be considered prior to entering programmer mode.

6. The PCS tunes to the first UAV, and when acquired, takes control and lands it.

Note

Acquisition of a returning UAV by a ship-board PCS may require turning the ship to eliminate antenna masking.

7. Upon completion of mission, the second UAV is flown home by GCS. Landing is accomplished from either GCS or PCS.

10.18.2 Dual OPS / On-Station Turn Over

Note

This checklist covers the basic procedures for returning an off-going UAV to a recovery/PCS area and receiving an oncoming UAV for mission purposes.

1. RPV Programmer set for RTBCONFIRM (IP)
2. NVC Bypass.....-NO (IP)
3. UPL Code.....SHORT/SECURE (IP)
4. NPL/Current ReportSELECT (IP)
5. Step#CONFIRM (IP)

Note

All information displayed within "STEP #" is acquired from the Ground Programmer only. The RPV Programmer should be verified for accuracy of all NPL steps.

6. PRSNT POS.....CONFIRM (IP)
7. Range/ETA.....CONFIRM (IP)
8. Operation Mode.....AS REQD (IP)
9. Return Home.....VERIFY/CHANGE (IP)
If Changed.....VERIFY LAST
UPDATE MENU (IP)
10. PROG CONTR Push-button.....SELECT (IP)
11. UAV Enters Correct
NPL FlightCONFIRM (IP)
12. GCS XMTRS.....OFF (IP)

Note

Verify off going UAV executing Programmer Mode.

- 13. RPV ANT.....DIRECTIONAL (IP)
- 14. Oncoming UAV DNL
Frequency.....SELECT (IP)
- 15. Oncoming UAV UHF
Frequency.....SELECT (IP)
- 16. Oncoming UAV Address.....SELECT (IP)
- 17. Dishlock (oncoming UAV).....EXECUTE (IP)
- 18. Station XMTRS.....ON/HIGH (IP)
- 19. Communications
Warning Lamps.....OUT (IP)
- 20. Verify Positive Control
of UAVCONFIRM (IP)

Note

A possibility exists that the indicated altitude does not match the oncoming UAV's actual altitude. NPL will maintain the altitude that is commanded by the UAV Programmer.

- 21. QNH / QFE
(Recorded at Takeoff).....ENTER (IP)
- 22. Oncoming PRI / SEC
Range Cal. Offsets.....ENTER (IP)
- 23. NVC Bypass (-20 ONLY).....+YES (IP)
- 24. Perform Climb
Checklist.....COMPLETE (IP)

10.18.3 Dual OPS / Descent & Landing



Final descent should be commenced to arrive overhead the landing site with at least 8 liters (indicated) of fuel remaining. Abrupt pitch or bank maneuvers can cause fuel starvation with low fuel, and should be avoided when the UAV is returning with low fuel (5-7 liters). Fuel starvation may occur in level flight when fuel quantity is 4 liters or less.



Monitor CHT during descents. If the CHT approaches minimum limits (110°C) level off. Set RPM for level flight and monitor CHT until it reaches a level acceptable for continued descent.

- 1. Station Transmitters.....OFF (IP)
- 2. RTB UAV DNL FrequencySELECT (IP)
- 3. RTB UAV UHF FrequencySELECT (IP)
- 4. RTB UAV Address.....SELECT (IP)
- 5. QNH/QFEVERIFY/ENTER (IP)
- 6. Range Cal. Offsets.....ENTER (IP)
- 7. UPL Code.....SHORT (IP)
- 8. NPL Step #VERIFY (IP)

- 9. Programmer Mode.....SELECT (IP)
- 10. Station TransmittersON/HIGH (IP)
- 11. Communications
Warning Lamps.....OUT (IP)
- 12. Altimeter Setting.....FIELD (IP)
- 13. LOW Altitude Warning.....ADJUST (IP)
- 14. Commanding Link.....AS REQD (IP)
- 15. IFF/StrobeAS REQD (IP)
- 16. NAV LightsAS REQD (IP)
- 17. UAV in SightYES (EP)
- 18. Knobs/SticksSELECT (IP)
- 19. Verify Positive
Control of UAVCONFIRM (IP/EP)
- 20. NVC BypassYES (IP)
- 21. FLT/TO-LDTO-LD (IP)
- 22. Payload Shield.....DEPLOY (IP)
- 23. FLT/TO-LDFLT (IP)
- 24. PlatformSET (IP)



Payload set for Landing. For Net MKD 200/400, Caged. For Rolling: MKD 200 caged; 180° for all other MKDs.

- 25. Manual RHUPDATE/LOAD (IP)
- 26. NAV LightsON (EP)
- 27. FLT/TO-LDTO-LD (IP)
- 28. EngineOFF (EP)

10.19 UAV REACQUISITION

The EP should be in position prior to the arrival of the UAV. After establishing communication with the flight crew the EP may be asked to verify CBX switch positions. Acquiring the UAV is done by looking in the general direction of the dish antenna azimuth.

Information from the IP may assist in reacquisition. Heading, altitude, and range should be utilized. When the UAV is spotted, the CBX may be selected, and the EP can assist the internal operator in negotiating heading changes to enhance the position of the UAV.

When ready the EP will announce “Ready For Heading.” The EP may also request altitude (throttle control) and airspeed (elevator control). Refer to normal landing procedures at this time, utilizing good flight and ground crew coordination, or as mission profile demands.

10.20 POST FLIGHT INSPECTION

Once cable arrestment has occurred, the UAV should be inspected for signs of debris, impact, damage, and propeller deterioration. In the event of mission turn-around, EP will conduct entire pre-flight inspection procedures prior to second flight.

10.21 NIGHT OPERATIONS

10.21.1 Chemlighting Runway

1. Chemlights for centerline should be spaced approximately 50 feet apart.
2. The runway edges should be illuminated with chemlights, spaced in between the centerline lighting.

Note

The actual amount of chemlights required may be determined by operational profile.

10.21.2 Hand Signals

1. Taxi of the UAV is performed — “LIGHTS ON” to end of the runway.
2. When the UAV is positioned for take-off, and the crew chief/ground crew has performed the final walk-around, the crew chief/ground crewmember will indicate with one cycle, “OFF-ON-OFF” of a flashlight. (Amber tipped recommended).

3. The EP (if ready) will acknowledge the crew chief's signal with one "ON-OFF-ON" cycle of the navigation lights.
4. The crew chief/ground crew will confirm signaling, with two cycles "OFF-ON-OFF," "OFF-ON-OFF" of the amber tipped flashlight.
5. At this time, if the EP is "READY FOR TAKE-OFF" Maximum RPM is applied.
6. EP checks and confirms RPM, completes two cycles "ON-OFF-ON," "ON-OFF-ON" of the navigation lights, indicating to ground crew to release the UAV for takeoff roll.

10.21.3 Recovery - Landing of UAV

1. Ensure that the runway chemlights are still illuminated and in position.
2. Depending on possible terrain features of the approach end of the runway, it may be necessary to position signal personnel to indicate to the EP when the UAV has cleared the obstruction.
3. Ensure all chemlights are collected after recovery complete.

10.22 PRESETS

10.22.1 Logic and Use of Menus

10.22.1.1 Menu Logic. The GCS-2000 operational system was built using a top-down design method; i.e., to reach a specific operating function, the user pages his way through a top-down menu system. The menus are fixed, and selecting an item from a higher level menu prompts the selected lower level menu. Main menus of the operational system are selected by functional push-buttons and can be viewed as roots of the system. Each main menu is divided into a group of selecting menus, and each group into submenus, until a specific function is reached. Each selecting menu, submenu, and function can be viewed as a major or minor branch of a main root, thus building a menu tree.

10.22.1.2 Working With a Menu Tree

1. Selecting a Main Menu. Select the main menu root by pressing the specific functional push-button on the user's keyboard. A menu tree can be selected only if all other menu trees (functional push-buttons) except the FAIL CHECK menu tree are turned off. The operational program is built sequentially and the system leads the operator

through the menu items in logical order. After all functions in the submenu are performed, the system continues directly to the next menu or returns to the original selecting menu. A default option, usually the next submenu, appears in the item number field. The default option is selected by pressing the ENTER key.

2. Operational function selection is similar to submenu selection. If no default option is selected, the cursor is displayed in the item number field. If the system requests an input, the cursor appears on the data entry field and the user enters the required data.
3. Exiting From a Menu Tree. Operation in a main menu is terminated by pressing the specific functional push-button on the user's keyboard. When the push-button key is pressed the system acknowledges the termination by turning off the push-button internal lamp. The numeric keyboard and all control keys are disengaged.
4. The system evaluates data only after the ENTER key is pressed, or in some cases when the submenu is exited. If the data is acceptable, it is entered into the system for use. This data appears on the appropriate item line in the menu field. If the data is unacceptable, the data entry field flashes until the DELETE key is pressed and acceptable data is entered.

10.22.2 Pilot Bay Presets

1. PRESET push-buttonSELECT
2. PRESET Menu is displayedCHECK
3. Press keyboard #1 and "ENTER"PRESS

10.22.2.1 Altimeter Cal & Warning Set (Item #1)

1. CASE-1: UAV on ground, in preflight, near the control station.
 - a. Altitude above Sea Level

FIELD LEVEL/SEA LEVEL
 Switch on PDPSEA LEVEL
 Accurate altitude (in feet) of UAV
 above sea levelENTER
 Verify proper entry of QNH on PDP
 digital displayVERIFIED
 Document numerical
 display of item #3RECORDED

- b. Altitude above field level
 FIELD LEVEL/SEA LEVEL
 switch on PDPFIELD LEVEL
 Altitude of UAV above field
 levelENTER
 (normally, for runway takeoff equals 1 foot;
 RATO & Pneumatic equals 3 feet)
 Verify proper entry of QFE
 on PDP digital displayVERIFY
 Document numerical
 display of item #4RECORDED

Note

Compare barometric measures (items #3 and #4) with local meteorological data (if available). If deviation exists, record for possible future use.

Note

Digital Altimeter readout may decrease 50-100 feet after engine start. Re-calibrate altimeter on both sea level and field level if required. Compare to EDC downlink altimeter readout prior to takeoff.

- c. LOW Airspeed Limitations and WarningSET
 (58-70 knots)



Do not set Low Airspeed Limit below stall speed.

- d. Low Altitude WarningSET
 (-1,500 to 21,500 ft)
- e. Low Fuel Warning Minimum
 fuel level between 0-20.0 ltrsSET
- 2. CASE-2: UAV in flight, control transfer from launch site, altitude unknown.
 - a. Altitude above SEA LEVEL
 FIELD LEVEL/SEA LEVEL
 switch on PDPSEA LEVEL
 Enter pressure at sea level:(QNH) received from local meteorological station or from control station passing UAV controlENTERED
 Verify proper display of QNH altitude on digital

display on PDPVERIFY
 (Must have UPL established)

- b. FIELD LEVEL/SEA LEVEL
 switch on PDPFIELD LEVEL
 Enter pressure at field level (QFE)
 received from local meteorological
 station or from station passing
 control of UAVENTERED
- c. LOW Airspeed Limitations and Warning —
 Minimum airspeedSET
 (58-70 knots)

Note

During locking process, it is possible to lose UAV downlink (no report).

- d. Low Altitude Warning
 Minimum AltitudeSET
 (-1,500 to 21,500 ft)
- e. Low Fuel Warning Minimum
 Fuel level between 0-20.0 ltrsSET

10.22.2.2 Return Home Data (Item #2). Return Home data menu displayed after completion of Altimeter Calibration and Warning Set menu or by pressing #2 and “enter” from PRESET menu.

- a. Cruise Altitude 3, 6, 9, or
 12 thousand feetSET
- b. Cruise Airspeed 60, 70,
 or 80 knotsSET
- c. Final Holding Altitude -1, 1, 3,
 or 5 thousand feetSET
- d. First Climbing Spiral
 (+) YES (-) NOSELECTED
- e. Coordinates/Home 13 digit UTM grid
 coordinate of RETURN
 HOME LOCATIONSET
- f. Coordinates/Nav Program endSET

Note

Coord/Nav Prg end is not functional. However, the last active step of any program should be entered as a valid RH location.

10.22.2.3 Navigation Programmer (Item #3)

Note

On RPV Data Menu (Press #10) Mission Computer must be set to + YES.

The following Navigation Programmer MISSION COMPUTER Menu is displayed after completion of Return Home data menu or by selecting PRESET #3. It provides the following data/functions:

1. Current Report.
2. General: Used to specify UAV critical fuel level and NVC operations mode.
3. Ground Programmer: Used to specify and load Navigation Programmer step parameters. The following Navigation Programmer parameter options are available:
 - a. ADVANCE STEP
 - b. STEP#1 TO 96
 - c. ACTIVE + ACTIVE or - INACTIVE
 - d. COORDINATESUTM COORDINATES OF WAYPOINT
 - e. GRID ZONE.....GRID ZONE OF OPERATING AREA
 - f. HOLDING TIME0:00:00 HRS:MIN: SEC (0:00:01 THROUGH 8:31:00)
 - g. ALTITUDE.....00.0 KFT (0.1 KFT THROUGH 20.0 KFT)
 - h. AIRSPEED00 kt (60 KT THROUGH 80 KT)
 - i. COMMAND.....+(RECEIVE) OR -(INHIBIT)
(- INHIBIT option has been deactivated)
 - j. TRANSMITTER.....+(ON) OR -(OFF)
 - k. BEACON.....+(ON) OR -(OFF)
 - l. FILM CAMERA
(IFF/Strobe)+(ON) OR -(OFF)
 - m. VIDEO CAMERA+(ON) OR -(OFF)

n. PROGRAM.....+(CONTINUE)
OR -(END)

4. Query: Used to query the NVC for the status of various navigational and GPS data.
5. RPV Programmer: This submenu is similar to submenu #3 (Ground Programmer). Values appearing in this submenu are taken directly from the RPV programmer (NVC) - not from the GCS/PCS programmer.
6. Mask: Used to specify GPS sensor operation parameters.
7. Command: Used to access waypoint #00, define GPS position fixes as 2-D or 3-D, and to access GPS/NVC reset and test functions.
8. Load programmer: Used to load groups of Ground Programmer steps to the NVC. Option not required if single step loading (option, 0 {Load Step} of Ground Prog. or UAV Prog) was used. If 'LOAD ALL STEPS' is selected, loading will take up to 20 minutes or more.
9. Clear RPV Programmer: Clears the RPV programmers; i.e. all parameters set to 0 and all steps, except step #1, set to - inactive.
10. Reset Programmers: Clears both the RPV and GCS/PCS programmers; all steps, except step #1, will be set to - inactive.

10.22.2.4 Range Calibration (Item #4). Range calibration menu is displayed after completion of Navigation Programmer data menu or by selecting #4 and "enter" from PRESET menu.

1. PCD controls and indicators:
 - a. PRIM UPLINK and SEC UPLINK Toggle SwitchesSTATION TRANSMITTER ON
 - b. PRIM XMTR and SEC XMTR push-button high/low.....LOW
 - c. RPV XMTR push-buttonON
 - d. RPV XMTR HIGH/LOW push-buttonLOW
 - e. RPV # (ADDRESS) thumbwheel.....SET TO CURRENT UAV #

- f. PRIM UPL SECURE/
CLEAR push-buttonSECURE
 - g. CODE LONG/SHORT
push-buttonSHORT
 - h. COMMANDING STATION
arrow LINKPOINTING TO PRIMARY
2. PDP warning lamps:
 - a. RPV RCVR ADDRESS
LOSS (PRIM) LINK LOSSOFF
 - b. RPV RCVR ADDRESS
LOSS (SEC) LINK LOSSOFF
 - c. NO REPORT.....OFF
 3. PRIM LINK OMNI/DISH
push-button switchOMNI
 4. TCD RECEIVER
SIGNAL STRENGTH
meter strengthINDICATES 6 OR MORE
 5. Range between TCU
and UAV.....ENTERED

Note

Allow range to count down before switching to SEC Link.

6. UAV RANGE display
on PDPVERIFIED
7. Offset/correction factors.....RECORDED
8. COMMANDING
STATION arrow.....TRANSFER
(transfer command from PRIM to SEC uplink)
9. Repeat steps 5 and 7.....COMPLETED

10.22.2.5 Meteorological Data (Item #5). Meteorological data menu is displayed after completion of range calibration menu or by entering #5 and “enter” in the PRESET menu.

1. Mode Selection Updates:
 - a. Alt/pressure table+(Yes) - (No)
 - b. Automatic Wind Update+(Yes) - (No)

2. Data Entry/Pressure Table
 - a. Update table with altitudes/
pressure in millibars —
received from local
meteorological stationENTER
3. Data Entry/Wind Table
 - a. Update table with winds
at altitude — received from
local meteorological stationENTER
4. Data Entry/Temperature Table
 - a. Update table with temperature
at altitude in degrees CelsiusENTER

Note

Each table has 15 entries for altitudes from 2,000 to 16,000 feet.

Partial update of the table is acceptable and the various types of data are marked as follows:

In — input data entered

Est — estimated data (based on input data)

Time (hour:min) — calculated data (wind table only)

10.22.2.6 Camera Guidance (Item #6). Camera guidance menu is displayed after completion of Meteorological data menu or by pressing #6 and “enter” in the PRESET menu.

1. Circling Radius - Radius, in km, of UAV orbit. Set from 1.0 to 9.9 km.
2. Circ - Target Distance - Distance, in km, from the center of the UAV orbit to the target. Set from 0 to 15 km.
3. Circ - Target Azimuth - Azimuth, in degrees, from the center of the UAV orbit to the target.
4. Default parameters - Radius = 1.0 km, Distance = 0.0 km, Azimuth = 0°.

10.22.2.7 Geographical Data (Item #7). Geographical data menu is displayed after completion of Camera Guidance menu or by pressing #7 and “enter” in the PRESET menu.

1. Target Altitude — Set target altitude above sea level, in meters.
2. Station Data/Coordinates — Set the 13 digit UTM grid coordinates for the TCU location.

Note

Auto Position Update (step #4) must be disabled to allow entry of Station Data/Coordinates.

3. Station Data/Altitude — Set the TCU altitude above sea level in meters.
4. Auto Position Update — (YES or NO).

Note

Yes — indicates that the station coordinates are obtained from the GPS, and the values in preset #2 are not valid. No — indicates there is no autoposition source available for the TCU, and values loaded in preset #2 are used.

5. Grid Zone Input — (YES or NO). Enables (+ yes) or disables (- no) the alternate grid zone entered in Item #6 below. When the grid zone input is - no, the GCS obtains coordinate data from either the PRESET/GEOGRAPHIC coordinates or the Navigational Data System. When the grid zone input is + yes and the GCS is receiving coordinate information from the Navigational Data System, the grid zone provided in Item #6 below is used by the GCS instead of the calculated grid zone from the Navigational Data System.

Note

The IP has the option of selecting the grid zone for GPS computations between 1 and 60. When the GRID ZONE INPUT is NO, the system will compute and display a GRID ZONE NUMBER.

6. Grid Zone — This item is provided so the operator can alter the station grid zone by one (1) in either direction from the grid zone calculated by the Navigational Data System. The grid zone is enabled/disabled by the grid zone input. This function is used when the UAV is to be flown into a grid zone different from the one in which the GCS is located.

7. Magn. Declin — Set angle, in degrees and minutes (grid to magnetic) (+, east, right).

10.22.2.8 Tracker Calibration (Item #8). Tracker calibration menu is displayed after completion of Geographical data menu or by pressing #8 and “enter” in the PRESET menu.

1. Azimuth. Allows the user to enter the known direction between the station and the beacon unit, during the azimuth calibration procedure.
2. Correction Offset. Displays the difference between the measured direction to the beacon unit and the direction read by the tracking unit, and is used to calibrate the direction read by the tracking unit relative to the map grid. Set to 0° for ship-board operations.
3. Masked Zone A (Item #3). Defines a blind area of the directional antenna caused by an obstruction. The zone is defined by entering the degrees at which the blind zone starts (F-from) and ends (T-to). The From value entered must be less than the To value entered and values must be less than 360 degrees.
4. Masked Zone B. Defines a second blind area of the directional antenna.
5. Auto Ship Heading Update. Enables/-disables the automatic heading update mode. If + yes, all related controls and indicators read true bearings. If - no, all related controls and indicators read relative bearings.
6. Own Ship True Heading. The default value used for ship’s heading if the auto ship heading update is disabled or inoperative. This value should be set to 0° for ground based operations.

10.22.2.9 Retrieval Net Data (Item #9)

Note

This function is for shipboard Autoland system and is no longer used. All values should be set to zero.

Retrieval net data is displayed after completion of Tracker calibration menu or by pressing #9 and “enter” in the PRESET menu.

1. Station-glide path distance meters

- 2. Station-net distancemeters
+ net behind station
- net in front of station
- 3. Eng cut point-net distance.....meters
- 4. Net altitudemeters

10.22.2.10 RPV Data (Item #10). The RPV data menu is displayed after completion of the Retrieval Net data menu or by pressing #10 and “enter” in the PRESET menu.

- 1. Weight (Empty fuel tanks) in Kg
- 2. RPV model850 (Option I)
907 (Option II)
910 (Option II+)
- 3. Payload
 - 0 — NONE
 - 1 — MKD 200
 - 2 — MKD 400
 - 3 — RADIO RELAY (Not available)
 - 4 — EO/FLIR
- 6. Camera Control Bay
 - 1 — OBY
 - 2 — PBY
- 7. Mission Computer+(YES)

Note

Mission computer must be set to + YES to access preset menu #13 (MISSION COMPUTER Menu), and to access valid Navigation Programmer menu (Preset #3).

10.22.2.11 Point Navigation Data (Item #11). The Point Navigation data menu is displayed after completion of RPV data menu or by entering #11 on PRESET menu.

- 1. NAVIGATION/UPDATE the 13 digit UTM coordinates for each target. For use in Navigation Coordinate mode.
- 2. Mode Continue (+) - go to next target. Hold (-) - circle over the target at the parameters defined in the Camera Guidance Menu.

10.22.2.12 GPS Initialization (Item #12). Not used.

10.22.2.13 Mission Computer (Item #13)

Note

PRESET Menu 13 can only be accessed if Mission Computer (Preset Menu #10) is set to (+) YES.

The Mission Computer menu can only be displayed by selecting preset #13.

- 1. General: will initialize UAV position, critical fuel, date, and time. This data will be initialized during Preflight for Nav Programmer use.
- 2. Mask: will initialize the UAV’s GPS sensor control parameters.
- 3. Ground programmer: accesses the programmer card resident in the GCS/PCS only (Preset #3).
- 4. Datum: allows the operator to select the appropriate ellipsoid model (8 options).
- 5. The Load Programmer: menu is used for loading groups of Navigation Program steps to the NVC. (Loading steps 1 through 96 can take up to 20 min or more.)
- 6. Clear RPV Programmer: will render all RPV Navigation Programmer steps inactive except for step 1, which is left active. This menu also erases all parameters within the RPV programmer and sets them to zero.
- 7. Reset Programmers: clears all steps in both the RPV and ground programmer programs, and renders all steps inactive except step 1, which is left active.

10.22.3 Pilot Control Table — Other Functions

10.22.3.1 Calibration (CALBR). Same as Pilot Bay PRESET #1.

10.22.3.2 Fail Check. This push-button may be used at any time as part of troubleshooting or emergency procedures. “FAILURE DISPLAY” will display warning message(s) relating to: PWR FAIL (steady), GCS FAIL (steady), RH FAIL (flashing), CAMERA GUIDE push-button (flashing), and NAV to COORD pushbutton (flashing).

10.22.3.3 Multifunction

1. Uplink Command

- a. IFF/Strobe Cmd — (ON/OFF)
- b. Payload Shield — (ON/OFF)

2. GPS data (TCU IBX)

- a. Station Coordinates Exxxxxx Nxxxxxx
- b. Velocity X0 m/s Y0 m/s
- c. Area number
- d. Status Code
- e. Error Code
- f. Ship True Hdg
- g. Ship Pitch
- h. Ship Roll

3. Current Navigation Data — provides data on UAV for navigation including speeds, heading, track, winds, and fuel.

4. RPV test point check allows selection of five test points to be monitored by system. (See Figure 10-2.)

5. EDC Panel — allows IP to select and monitor: Uplink analog, Uplink digital, Downlink analog, and Downlink digital information.

6. Payload Control — IP selects control parameters for payload selected. Menu is only available when Preset #10 RPV DATA, ITEM #6, CAMERA CONTROL BAY is selected to PBY. Menu in this field will reflect payload selected in preset #10 RPV DATA, ITEM #3, PAYLOAD.

MULT FACTOR	TEST POINT	DESCRIPTION	FAIL	PASS
8	0	Fuse 28 V NESS	0	3.5 ± 0.5
8	1	28 REU (regulator)	0	3.5 ± 0.5
8	2	Fuse Strobe/IFF	0	3.5 ± 0.5
8	3	C-Band receiver	0	3.5 ± 0.5
8	4	UHF receiver	0	3.5 ± 0.5
8	5	DC-DC conv, PCU	0	3.5 ± 0.5
8	15	Exterior lights	0	3.5 ± 0.5
8	20	Fuse, Directional Antenna	0	3.5 ± 0.5
8	21	Fuse, Servo-NW	0	3.5 ± 0.5
8	22	Fuse, Vertical Gyro	0	3.5 ± 0.5
2	44	Engine Cut (EPS)	cut = 2.5 V	Run - 0V
8	51	Battery (after switch)	40 = 32 V	(charged)
8	52	Battery balance	1/2 test point	53 ± .04
8	53	Battery (before switch)	4.0 = 32 V	(charged)
2	56	Battery Charger good Fail	= 2.5 ± .3	Fail = 0± .3V

Figure 10-2. Commonly Used Test Points

MKD-400

- 1. Payload — determines if platform is on or off.
- 2. FLIR — determines if sensor is on or off.
- 3. DATA — provides data about sensor status.
- 4. POLARITY — determines if sensor signal is black hot or white hot.
- 5. LEVEL MODE — rotary knobs used for fine or coarse adjust background level.
- 6. LEVEL SET — push-button used to select auto or manual IRIS control.
- 7. GAIN SET — rotary knob used to control the gain command for FLIR.
- 8. MODE CONTROL — choose rate position for payload operation.

MKD-200

1. PAYLOAD — determines if platform is on or off.
2. RATE — select high or low rate for platform.
3. CAMERA — select camera on or off.
4. IRIS MODE — determine if iris setting is determined automatically or manually.
5. IRIS SET — allows for manual manipulation of iris on camera.
6. MODE CONTROL — choose rate or position for payload operation.

10.22.3.4 Target Altitude (TARGET ALT). IP enters altitude of target above sea level in meters. Same as Pilot Bay PRESET #7.

10.22.3.5 Camera Guide Menu. Same as Pilot Bay PRESET #6.

10.22.3.6 Navigation Programmer (NPL). Same as Pilot Bay PRESET #3.

10.22.3.7 Return Home Loading (RHL)

1. RPV last update. Displays the last updated return home parameters.
2. Data change. Enables updating of the return home parameters. Same as Item #2 in Preset.
3. LOAD Nav Program Return Home data. Loads RH update data when a programmed flight is planned.
4. Auto loading. Enables/disables automatic loading of predefined return home parameters.
5. Man Return Home. Enables entering manual return home parameters and loading them.

10.22.3.8 Navigation To Coordinates (NAV TO COOR)

1. NAVIGATION/SELECT or NAVIGATION/UPDATE menus will interchange at each push of the ENTER key.
2. NAVIGATION/SELECT allows the operator to select one of up to 10 targets displayed and activate it as the next target for this mode.

3. NAVIGATION/UPDATE allows the operator to enter and change data in the navigation coordinate program.

10.22.4 Tracking Bay Presets

1. PLOTTER SETUP

- a. Pen Up push-button.....PRESS
- b. Reset push-buttonPRESS
- c. Pen should go to Park Pen VERIFIED
- d. Place Map(s)
on plotter.....COMPLETED

2. MAP NUMBER

- a. Preset push-buttonPRESS
- b. Map # push-buttonPRESS
- c. 1 (on the TBY keyboard).....ENTER

3. MAP ORIENTATION

- a. Map Orient push-buttonPRESS
- b. Map OrientILLUMINATED
- c. LocalILLUMINATED
- d. Using Cont/Step and Coarse/Fine push-buttons place pen over grid intersection in Lower Left corner of map.
- e. Key in Easting; 3 digits
(you drop the ones, tens, and hundreds zeros of the coordinate).....ENTER
- f. Key in Northing; 4 digitsENTER
- g. Repeat steps d-f for each corner of the map working clockwise.
- h. Diagn Push-buttonILLUMINATES
- i. Plotter should go to each Point and the Pen should go down on each corner.
- j. Check Digital Display for Corner Coord.
- k. Pen returns to Pen Park.....VERIFIED

4. TCU COORDINATES

- a. TCU COORD Push-buttonPRESS
 - b. TCUILLUMINATED
 - c. Key in Easting; 6 Digits
for TCU coordinatesENTER
 - d. Key in Northing; 7 Digits
for TCU coordinatesENTER
 - e. Plotter should go to the TCU Coord and
the pen should go downVERIFIED
5. TCU ALTITUDE
- a. TCU Alt Push-buttonPRESS
 - b. TCU AltILLUMINATED
 - c. Key in Alt (meters) of TCUENTER
 - d. Will display in Easting Screen
while being keyed and will
display briefly in northing
screen after entryVERIFIED
6. REPEAT FOR MAPS #2 through #9 as Req. Subsequent maps must be within the boundaries of Map #1.

10.22.5 Observer Bay Presets

PRESET Push-button.....PRESS

10.22.5.1 General Data. Select item #1 General data.

- 1. First Event (number)ENTER
- 2. Date (dd-mm-yy)ENTER
- 3. Mission (number).....ENTER

10.22.5.2 Payload. Select item #2. Payload Definition. Select appropriate Payload.

10.22.5.3 Optical Axis Alignment Procedure. To align the optical axis of a payload with the screen on the OTMP, perform the following steps. The UAV must be on the ground and stationary before performing this procedure.

- 1. Place the target 10 to 15 feet from the payload, making sure that points B and C remain on the screen with the graphics cross (center of screen)

- on point A when the zoom is maximum in (narrow FOV).
- 2. Press the PRESET push-button on the Observer's Control Table (OCT). The PRESET menu appears on the OTMP screen.
- 3. Select Item #3 (Alignment Procedures).
 - a. PRESET/ALIGNMENT menu appears on the OTMP screen.
 - b. Note the alignment correction number (in pix) on Item #1 of the PRESET/ALIGNMENT menu.
- 4. Select Item #2 (Optical Alignment).
 - a. PRESET/ALIGNMENT/OPTICAL appears on the OTMP screen.
 - b. A second graphics cross appears on the screen. The position of the second cross can be controlled by the dimmer knobs on the OVC.
- 5. Select Item #1 (Line #1) of the PRESET/ALIGNMENT/OPTICAL menu. At the bottom of the screen, "1 first * second -" appears.
- 6. Place payload in Position Control mode (where the payload is controlled by the bearing and depression knobs) by pressing the ON push-button in the POSITION MODE CONTROL area of the PLATFORM CONTROL module on the OCD. The bottom half (unmarked) of the POSITION MODE CONTROL ON push-button illuminates when pressed and the top half (ON) illuminates when the RPV reports that the platform is in position control mode.
- 7. Locate the target by moving the BEARING DEGREES and DEPRESSION DEGREES knobs on the OCD until the target appears on the screen.
- 8. Move the zoom to 75% of maximum zoom in (narrow FOV). The graphic zoom indicator on the right side of the screen should be 2.5 lines from the top of the zoom scale.
- 9. Using the BEARING DEGREES AND DEPRESSION DEGREES knobs on the OCD, place the original graphics cross (not the one controlled by the dimmer knobs) on point A of the target.
- 10. Move the second graphics cross, using the dimmer knobs on the OVC, to point B of the target and

press ENTER. At the bottom of the screen, the “1 first * second -” will change to “1 first + second *.”

11. Move the zoom to 75% of maximum zoom out (wide FOV). The graphic zoom indicator on the right side of the screen should be 2.5 lines from the bottom of the zoom scale.
12. Place the original graphics cross on point A of the target using the BEARING DEGREES and DEPRESSION DEGREES knobs on the OCT.
13. Place the second graphics cross on point B of the target using the dimmer knobs on the OVC and press ENTER. The “-” signs in Item #1 (Line #1) of the menu will change to “+” signs. At the bottom of the screen “2 first * second -” appears.
14. Repeat steps 8 to 13 using points A and C on the target. The “-” signs in Item #2 (Line #2) on the menu will change to “+” signs.
15. After the “-” signs in Item #2 (Line #2) of the menu have changed to “+” signs, press ENTER again. This completes the procedure and returns you to the PRESET/ALIGNMENT menu.

ENTER may have to be pressed a second time to return to the PRESET/ALIGNMENT menu. If CLEAR is pressed instead of ENTER, the adjustments are not performed by the system.

16. Record the payload number and the alignment correction (pix) number as it appears in Item #1 of the PRESET/ALIGNMENT menu. Anytime this payload is utilized for a mission, the recorded alignment correction (pix) number can be entered in Item #1 of the PRESET/ALIGNMENT menu and the alignment procedure does not have to be repeated.

10.22.5.4 Timers and Counters

1. VCR TimerSET AS DESIRED
set to display time tape has remaining (MP)
Select item #4 Timers and Counters.
2. Camera Timer — Disregard, Not used.

10.22.5.5 Gunfire

Select item #5 Gunfire.

1. Gun/Target display.....(+ENABLE,-DISABLE)
Displays gun target line on video screen.

2. Gun On Ship.....(+YES, -NO)
Yes indicates gun is on ship with TCU.
3. Gun Location EntryE123456 N1234567
If yes selected above this grid will be same as TCU.
4. HEIGHTXXXXM
Gun location’s elevation in meters (MSL).
5. Ship LocationE123456 N1234567
Grid for firing battery or ship.
6. Delete Gun Entry.

10.22.6 Other Observer Control Modes

10.22.6.1 Multifunction

1. Screen selection
Left screen (normal by UAV sensor)
Right screen (normal by DATA)
2. Multifunction/Screens
 1. Data
 2. UAV Sensor
 3. VCR #1
 4. VCR #2
 5. Auxiliary
 6. Default parameters.

10.22.6.2 Artillery — Light Pen (Article)

1. Target Number
Average _____
2. Adjustment
_____ ADD RIGHT _____
(DROP) LEFT _____
DIST _____ AZIMUTH _____

Operator should ensure that accurate barometric pressure, declination angle, and target altitude are already entered. The direction in which the impact of the rounds must be corrected is as follows:

ADD — impact corrected to the North

DROP — impact corrected to the South

RIGHT — impact corrected to the East

LEFT — impact corrected to the West

Artillery light pen adjustments are based on 6400 mils (360° grid).

10.22.6.3 Target Acquisition Table. On OCT select Target Acquisition Table.

1. TGT ACQ/SelectDISPLAYED
2. Press ENTERPRESSED
3. TGT ACQ/UpdateDISPLAYED
4. Enter up to 9 target locations in 13 digit UTM grid coordinates and altitudesENTERED
5. Press ENTERPRESSED
6. Select the number of the target desired for TGT ACQ functionSELECTED

10.22.6.3.1 Artillery Adjustment Procedures. The Artillery Adjustment application program provides the parameters for artillery adjustment using the real-time picture seen on the TV screen at the exact moment the shell explodes. The program calculates the actual distance between the intersection of the optical axis with the ground and the shell impact point indicated by the operator.

To perform the calculations, the system receives:

1. Parameters fed in by the operator before flight:
 - a. Barometric correction parameters for correction of UAV barometric pressure
 - b. The angle between the map local grid north and magnetic north
 - c. Estimated target altitude above sea level
 - d. The optical axis parameters on the screen axes
 - e. Camera type (volt-angles, table, focal length).
2. Parameters received from the system:
 - a. UAV pitch, roll, and heading angles

b. Camera bearing and depression in relation to UAV and field of view (in angles)

c. UAV barometric pressure.

3. Parameters fed in by the operator at shell impact:

a. The parameters of the shell impact point.

The program does not require information on the UAV location to perform calculations. Therefore, the GCS/UAV range and azimuth and GCS location parameters are not important for the artillery adjustment procedure.

The adjustment results are displayed on the data monitor and, for a few seconds, on the UAV video monitor. The information is displayed on the local map axes as a number/word pair for each shell.

1. The number represents the distance, in meters, between the shell impact point and the target location.
2. The words represent the direction in which the shellfire must be corrected (add, drop, left, right).

To begin the artillery adjustment procedure, the ARTILL push-button on the OCT is pressed and Item #2 is selected from the display menu. The adjustment procedure is performed using a light pen.

After starting the adjustment procedure, the observer should track the target on the monitor as accurately as possible. The camera field-of-view must be at maximum. When the shell impact appears on the screen, the pen should be pressed accurately against this point. This will cause a second cross hair to momentarily appear.

The light pen is activated by pressing it against the screen.

With the pen touch, the correction parameters are superimposed for a few seconds on the video picture, indicating the shell number to which the information relates. Every press of the pen starts the process again.

When touching the impact point with the light pen, it is essential that the optical axis cross be accurately positioned on the target.

At the same time, the data monitor (on the OTMP) displays the following information:

1. The shell number

2. The average correction in meters for all shells entered, given as RIGHT/LEFT (East/West) and ADD/DROP (North/South)
3. The adjustment required in meters for the shell, given as RIGHT/LEFT and ADD/DROP.

Because the Artillery Adjustment function (Artill Menu) calculates the distance and azimuth between the target and the shell impact point, this function is also useful in the measurements of large objects on the ground, i.e., check points in convoy paths, bridge or air-field lengths, etc.

1. Holding the optical axis on one end of an object to be measured and applying a light pen press to the other end will provide a distance and azimuth between the two points. This information is then displayed on the Observers Graphic Display field.

Artillery Call For Fire Format

1. OBSERVER IDENTIFICATION: _____ de _____
2. WARNING ORDER: _____ K
(Immediate Suppression; Fire for Effect; Adjust Fire; Suppress)
3. TARGET LOCATION:
 - a. (GRID) _____ K
(6 digit grid coordinate)
 - b. (POLAR) Direction _____, Distance _____ K
Unit firing must know observer's location.
 - c. (SHIFT FROM KNOWN POINT)
Direction _____,
L/R _____, ADD/DROP _____
UP/DN _____ K
4. TARGET DESCRIPTION: _____ K
Include type of equipment, number of troops, etc.

5. METHOD OF ENGAGEMENT

- a. Type of adjustment:
 - (1) Area (standard)
 - (2) Precision (registration OR destruction).
- b. Danger Close (The term "Danger Close" must be included if rounds will fall within 600 meters of friendly troops.)

c. Ammunition:

- (1) Shell
 - (a) HE is standard.
 - (b) ICM, ILLUM, FASCAM, SMOKE, etc. must be requested.
- (2) Fuse
 - (a) Quick is standard.
 - (b) VT, TIME, etc. must be requested.

d. Distribution of rounds:

- (1) Parallel sheaf is standard.
- (2) Converged sheaf (all rounds impact near same point).
- (3) Open sheaf (rounds impact at max effective bursting radius).

6. METHOD OF FIRE AND CONTROL

- a. Method of Fire: Battery is standard. (Observer may request L/R Plt; All available, etc.)
- b. Method of Control: Fire When Ready Is Standard
 - (1) At My Command
 - (2) Time On Target
 - (3) Cannot Observe
 - (4) Fire When Ready
 - (5) Continuous Illumination
 - (6) Coordinated Illumination
 - (7) Continuous Fire
 - (a) Cease Loading
 - (b) Check Firing
 - (8) Repeat.

Naval Gunfire Call For Fire Format

1. SPOTTER IDENTIFICATION: _____ de _____

2. WARNING ORDER: [FIRE MISSION (target number if known)]

3. Target Location: (omit if target number is used)

- a. GRID _____ K
(6 digit altitude, direction)
- b. SHIFT FROM KNOWN POINT _____ DIR,
_____ L/R, _____ ADD/DROP, _____ UP/DN
- c. POLAR: _____ DIR,
DIS, _____ ALT CORR, _____

4. TARGET DESCRIPTION: _____ K

5. METHOD OF ENGAGEMENT

- a. Type of engagement (choose one): destruction, neutralization, harass, mark, screen, obscure, coordinated illum, continuous illum *Danger Close is 750m for 5" guns and 1000m for 16" guns with the exception of 16" ICM which is 2000m*.
- b. Trajectory (Full Charge is standard) request reduced charge for low trajectory.
- c. Ammunition (Shell/Fuse combination) HE/PD is standard.

6. METHOD OF FIRE AND CONTROL

- a. Method of Fire: main armaments, secondary armament, number of guns, special instructions, interval, sustained fire, TOT.
- b. Method of Control: spotter adjusts, ship adjust, fire for effect.

SHELL FUSE COMBINATIONS AVAILABLE FOR NAVAL GUNS

WPN SYSTEM	SHELL/FUSE COMBINATIONS
5"/38	HC/PD, BD; HE/MT, BD; WP/PD, MT; ILL/MT; COM/BD; RAP/CVT
5"/54	SAME AS 5"/38
16"/50	HC/PD, MT, BD; AP/BD; ICM/MT

10.23 FUNCTIONAL CHECK FLIGHTS

Functional check flights (FCFs) are required under the following conditions (after the necessary ground check and prior to the release of the aircraft for operational use):

- A. Receipt of an air vehicle from another reporting custodian or rework facility. When an air vehicle has not flown in more than 30 days and is returned to flight status. Minimum checks required are prefixed by the letter "A."
- B. After installation of engine, engine rigging has been performed, fuel control or any other components that cannot be checked in ground operation. Minimum checks required are prefixed by the letter "B."
- C. When fixed or movable flight surfaces or flight control system components have been installed, reinstalled, adjusted or rerigged, and improper adjustment or replacement of such components could cause an unsafe operating condition. Minimum checks required are prefixed by the letter "C."
- D. After major avionics repair or replacement that cannot be checked during ground operation. Minimum checks required are prefixed by the letter "D."

Use the checklist below for FCFs.

**NATOPS
PIONEER UAV
FUNCTIONAL CHECK FLIGHT CHECKLIST**

Date of Check Flight _____ Check Flight Number _____

Aircraft Bureau Number _____ Reason for FCF _____

BRIEF:

Mission Commander: _____

Quality Assurance Rep: _____

DEBRIEF:

Mission Commander: _____

Quality Assurance Rep: _____

PROFILE

PREFLIGHT

A B C D 1. EXTERIOR INSPECTION _____

STARTING ENGINE

A B C D 1. Perform Starting Engine checklist.

Figure 10-3. Pioneer UAV FCF Checklist (Sheet 1 of 4)

GROUND CONTROL CHECKS

- | | | |
|-----|--|--|
| A C | | <p>FLIGHT CONTROLS (AUTOPILOT ENGAGED)</p> <ol style="list-style-type: none"> 1. ELEVATORS FULL UP _____ 2. ELEVATORS FULL DOWN..... _____ 3. AILERONS LEFT ROLL _____ 4. AILERONS RIGHT ROLL _____ 5. RUDDERS LEFT YAW _____ 6. NOSE WHEEL STEERING LEFT..... _____ 7. RUDDERS RIGHT YAW _____ 8. NOSE WHEEL STEERING RIGHT _____ |
| A B | | <p>ENGINE CHECKS (AUTOPILOT ENGAGED)</p> <ol style="list-style-type: none"> 1. IDLE RPM (3200-3500)..... _____ 2. BUS VOLTAGE (28 ±2 Vdc)..... _____ 3. MAX RPM (6700 MIN)..... _____ 4. ENGINE CUT (LIGHTS OFF)..... _____ 5. ENGINE CUT (LIGHTS ON)..... _____ 6. THROTTLE DETENT CHECK (CBX, 1-8 CLICKS FROM IDLE POSITION TO FIRST NOTED RPM CHANGE) _____ |
| A C | | <p>FLIGHT CONTROLS (AUTOPILOT DISENGAGED)</p> <ol style="list-style-type: none"> 1. ELEVATORS FULL UP _____ 2. ELEVATORS FULL DOWN..... _____ 3. AILERONS LEFT ROLL _____ 4. AILERONS RIGHT ROLL _____ 5. RUDDERS LEFT YAW _____ 6. NOSE WHEEL STEERING LEFT..... _____ 7. RUDDERS RIGHT YAW _____ 8. NOSE WHEEL STEERING RIGHT _____ |
| A B | | <p>ENGINE CHECKS (AUTOPILOT DISENGAGED)</p> <ol style="list-style-type: none"> 1. IDLE RPM (3200-3500)..... _____ 2. BUS VOLTAGE (28 ±2 Vdc)..... _____ 3. MAX RPM (6700 MIN)..... _____ 4. ENGINE CUT (LIGHTS OFF)..... _____ 5. ENGINE CUT (LIGHTS ON)..... _____ 6. THROTTLE DETENT CHECK (CBX, 1-5 CLICKS FROM IDLE POSITION TO FIRST NOTED RPM CHANGE) _____ |

Figure 10-3. Pioneer UAV FCF Checklist (Sheet 2 of 4)

INFLIGHT CHECKS (EXTERNAL PILOT)

- A C CONTROLLABILITY CHECKS
 - 1. PITCH UP (18 ±3 DEG)....._____
 - 2. PITCH DOWN (14 ±3 DEG)_____
 - 3. LEFT ROLL (57 ±3 DEG)_____
 - 4. RIGHT ROLL (57 ±3 DEG)....._____
 - 5. LEFT YAW (20 DEG)....._____
 - 6. RIGHT YAW (20 DEG)....._____
 - 7. STRAIGHT & LEVEL FLIGHT_____
 - 8. AUTOPILOT DISENGAGE FLIGHT CHECKS_____

- A B ENGINE CHECKS
 - 1. SELECTED RPM (INDICATE SELECTED RPM)....._____
 - 2. INCREASE/DECREASE THROTTLE_____
 - 3. DC BUS VOLTAGE STEADY_____

- A D HEADING CHECKS
 - 1. HEADING INDICATOR STEADY_____
 - 2. ACCURACY WITH RUNWAY/SHIP_____
 - 3. FOUR CARDINAL HEADINGS....._____

Figure 10-3. Pioneer UAV FCF Checklist (Sheet 3 of 4)

INFLIGHT CHECKS (INTERNAL PILOT)

- A INFLIGHT CHECK
 - 1. PERFORM DISHLOCK_____
 - 2. IP CONTROL CONFIRMCONFIRM

- A D CONTROLLABILITY CHECKS
 - 1. KNOB CONTROLSELECTED
 - 2. HEADING (STEADY)_____
 - 3. ALTITUDE (STEADY)....._____
 - 4. AIRSPEED (STEADY)....._____
 - 5. SELECT ROLL.....CONFIRM
 - 6. ROLL (STEADY)....._____

- A D CAMERA GUIDE CHECKS
 - 1. CAMERA GUIDE MODESELECTED
 - 2. VERIFY SET PARAMETERS_____

- A D PROGRAMMER CHECKS
 - 1. PROGRAMMER MODESELECTED
 - 2. VERIFY SET PARAMETERS_____

- A D RETURN HOME CHECKS
 - 1. RPV ADDRESSCHANGED
 - 2. RETURN HOME MODE (ACTIVATED)....._____
 - 3. VERIFY PARAMETERS_____

Remarks: _____

Figure 10-3. Pioneer RPV FCF Checklist (Sheet 4 of 4)

CHAPTER 11

Shipboard Procedures

11.1 INTRODUCTION

The shipboard version of the Pioneer UAV system incorporates a number of modifications to provide an operational capability in an at-sea environment. These changes include an enhanced Navigation Data System, the addition of a second TCU antenna to provide full 360-degree communications and tracking coverage

around the ship, a switching system for the dual antennas, an antenna stabilization system, a more powerful antenna azimuth drive, and modifications to the RF system. A net recovery system is provided to net arrest the UAV for retrieval aboard ship. The net recovery system is referred to as the Shipboard Pioneer Arresting and Recovery System Three (SPARS III).

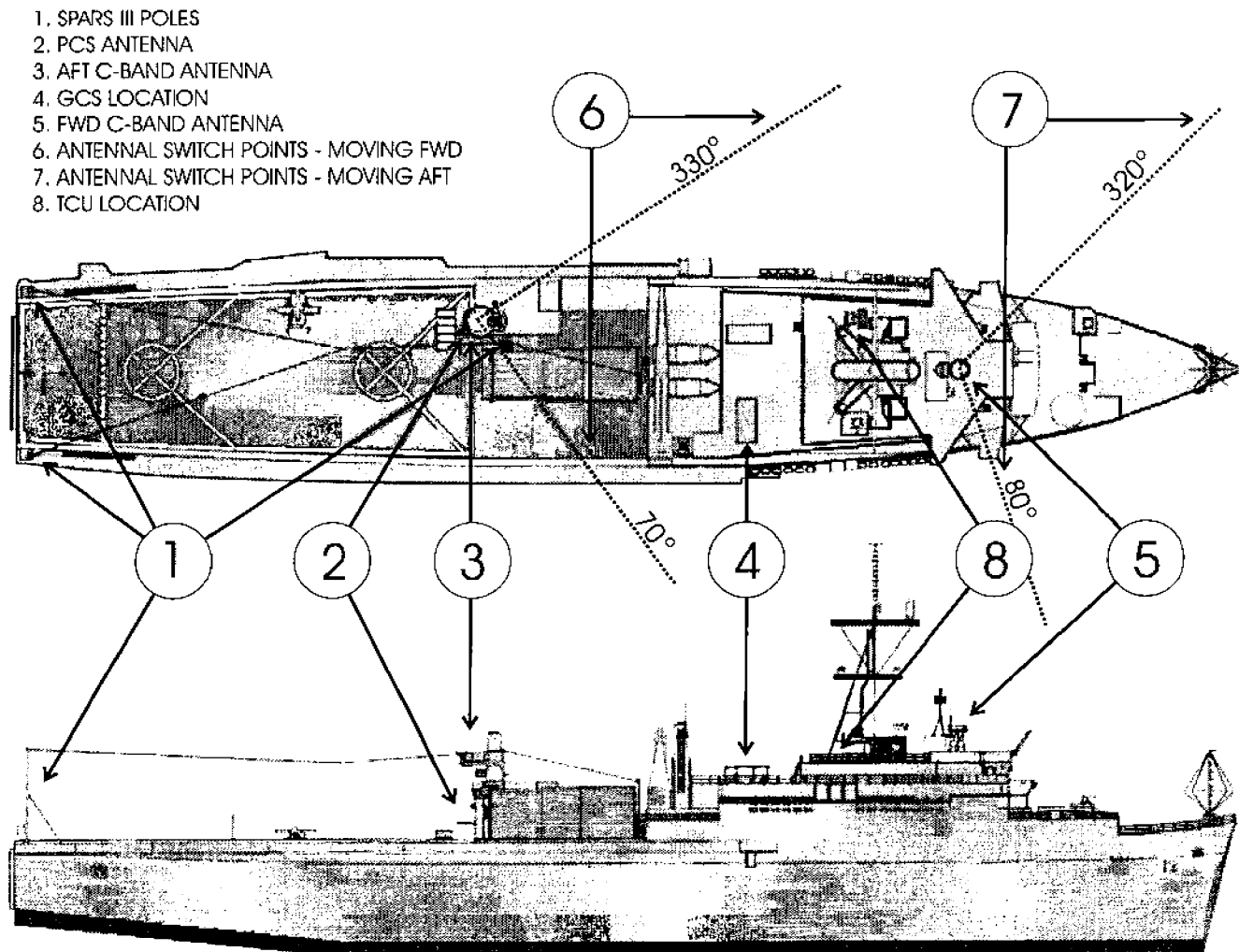


Figure 11-1. LPD-4 Class UAV Installation

11.2 SYSTEM MODIFICATIONS

The LPD configured Pioneer GCS is housed in a modified MF shelter mounted on the aft Gun Deck. The TCU is housed in an S-250 shelter located one deck below the Signal Bridge. The TCU antennas are housed in shipboard radomes installed on platforms remotely located from the shelter. The forward platform is located on the same level as the TCU shelter with the antenna itself located approximately two levels higher. The aft antenna platform is attached to the aft side of the port stack at approximately the 03 level. The PCS is installed inside the skin of the ship in the compartment directly below Primary Flight Control (PRIFLY). The PCS antenna is housed in a radome with the supporting platform installed on the port stack at about the 01 level. Uninterruptible Power Supply (UPS) units are installed in the GCS, TCU, and PCS in place of the land-based systems' backup batteries to provide emergency power in the event of a ship's power failure (Figure 11-1).

11.2.1 Navigation Data System. Because the ship is continuously changing position, an effective means of updating the ground station position and true antenna azimuth must be employed. The main navigation unit for the LPD installation is the MX-1105B located in the TCU. The MX-1105B contains a Trimble ACE II GPS receiver, CPU, synchronization circuit card, and a display with keypad on the front panel. Ship's heading information is passed to the CPU from the ship's gyro via the synchronization card. The CPU packages positional information from the GPS and heading information from the ship's gyro for display on the Navigation Interface Status menu in the PBX via the IBX. The display and keypad on the MX-1105B provides access to several menus that display navigational information, satellite information, and user input menus. The IBX assembles the navigation data in a CBY-compatible format. The data is sent through the IBX Stargate ACL card via the ACL-4 Distribution Box to the CBY, where it is interfaced to the Pioneer system. A Graphics Adapter PCB (not installed in the land-based version of the IBX) allows raw IBX navigation data to be displayed on the right-hand PBX monitor as the Navigation Interface Status menu (see paragraph 11.2.1.2). The menu is selected with the A/B switch attached to the right-hand side of the PCD.

11.2.1.1 MX-1105B Menus. The unit contains several status and user input menus:

- 100 — Navigation
- 200 — Satellite
- 15 — Heading Mode
- 24 — Speed
- 25 — Heading
- 35 — Gyro Error
- 36 — Gyro Ratio
- Main Menu

INT	LAT N	38° 09.044'	01/11/99
3D	LON W	76° 26.234'	GMT 16 57 09
	Heading	62.1° (A)	ALT =33 m
100	Speed	15.00 kts	DRT=0

100 — NAVIGATION

1. INT, SEQ, NAV: INT is displayed upon power up of the system. SEQ indicates the GPS receiver is searching for satellite data. NAV indicates the unit is performing positional fixes.
2. 2D, 3D: Indicates the receiver is performing a 2-dimensional or 3-dimensional fix. This relates to the number of satellites available.
3. 100: Identifies this display as menu 100.
4. LAT/LON: Provides GPS location in degrees, minutes, and thousandths of a minute.
5. Heading: (A) indicates heading in degrees from the ship's gyro. This is selected using menu 15 Heading Mode. (M) indicates heading input was manually input using menu 25 Heading.
6. Speed: This information is entered manually from menu 24 Speed and is not used for any calculations.
7. Date: Current date—from GPS.
8. GMT: Indicates current Greenwich Mean Time. If time is incrementing, the system is performing positional fixes.

- 9. ALT: Altitude of GPS receiver relative to spheroid level and indicated in meters.
- 10. DRT: A timer that activates when satellite signals are lost. NAV will change to SEQ, GMT time will freeze, and after ten seconds the PBY monitor will prompt pilot for manual update of ship's location.

# SATS = 8	COG = 36
HDOP = 8	SOG = 36
200	MAG VAR = 9.9 W

200 — SATELLITES

- 1. # SATS: Number of satellites used to calculate position. The Trimble receiver uses a maximum of 8 satellites.
- 2. HDOP: Horizontal Dilution of Precision. A measurement of accuracy for geometric GPS calculations. Values less than 8 are considered good (1 = best).
- 3. 200: Identifies this display as menu 200.
- 4. COG: Indicates ship's course over the ground in degrees. This parameter is derived by the MX-1105B from a series of GPS position fixes, and may differ from the ship's heading due to current set and drift.
- 5. SOG: Indicates ship's speed over the ground in knots. This parameter is derived by the MX-1105B from a series of GPS position fixes, and may differ from the ship's speed through the water due to current set and drift.
- 6. MAG VAR: Magnetic variation for the current position. This information is stored within the GPS receiver and is not updated.

Heading Mode
Heading Mode = (A) or (M)
15

15 — HEADING MODE

- 1. Heading Mode: Selects between Automatic or Manual heading input. If Automatic, the ship's heading is obtained from the ship's gyro via the synchronization card. If manual is selected, menu

25 Heading is automatically displayed for heading input.

- 2. 15: Identifies this display as menu 15.

Speed
Speed = 36
Enter Speed =
24

24 — SPEED

- 1. Speed: Indicates speed entered previously in this menu.
- 2. Enter Speed: Allows user to enter current ship's speed. User may enter values from -100 kts to +100 kts. After entering value, menu 100 is displayed.
- 3. 24: Identifies this display as menu 24.

Heading
Heading = 109.2°
Enter Heading =
25

25 — HEADING

- 1. Heading: Indicates heading entered previously in this menu.
- 2. Enter Heading: Allows user to manually enter current ship's heading. An invalid value will display 00.
- 3. 25: Identifies this display as menu 25.

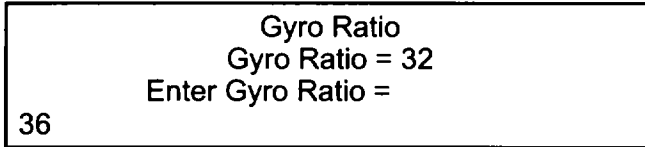
Gyro Error
Gyro Error = 15.2
Enter Gyro Error =
Use (-) for West
35

35 — GYRO ERROR

- 1. Gyro Error: Indicates gyro error entered previously in this menu.
- 2. Enter Gyro Error: Allows user to enter ship's gyro error. Error value is obtained from the ship's

bridge. An east error (+) is added to current heading. A west error (-) is subtracted from current heading. Heading entered manually (using menu 25 Heading) will not be adjusted for gyro error input.

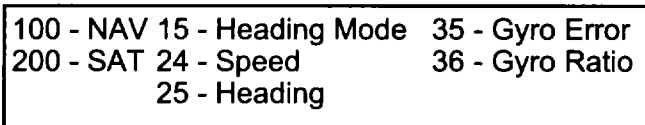
- 3. 35: Identifies this display as menu 35.



36 — GYRO RATIO

- 1. Gyro Ratio: Indicates gyro ratio entered previously in this menu.
- 2. Enter Gyro Ratio: Allows user to enter the ratio between the course and fine synchros in the ship's gyrocompass. Value is obtained from ship's bridge. This menu is required when Heading is selected to Automatic.

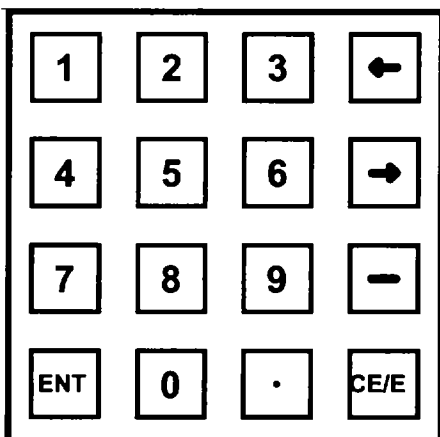
- 3. 36: Identifies this display as menu 36.



MAIN MENU

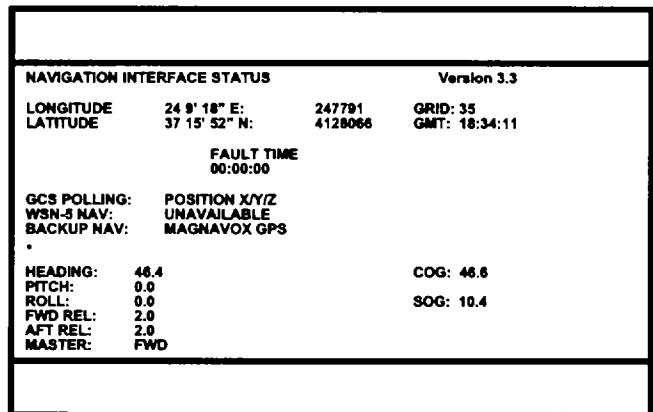
- 1. This menu is displayed when the user has entered an incorrect menu number or when ENT key is pressed.

KEYPAD



- 1. 0-9: Provides numeric entry and decimal point.
- 2. •: Decimal point.
- 3. ENT: Typing menu number and pressing enter will display that menu. Pressing enter by itself displays the main menu.
- 4. ←: This key operates as a backspace.
- 5. →: This key is not operational.
- 6. -: This represents a negative sign when entering numeric values. In menu 15 Heading Mode, selects between Automatic and Manual.
- 7. CE/E: This key is not operational.

11.2.1.2 Navigation Interface Status Menu. This menu provides the operator with station coordinate information as well as the status of the navigation equipment.



- 1. LONGITUDE/LATITUDE: Represents the most recent coordinate update (degrees, minutes, seconds) from the MX-1105b. The coordinates are updated once every 2 seconds. If communication is lost with the navigation unit, the coordinates remain at the most recently updated coordinates until the link is restored and new coordinates are received from the navigation unit.
- 2. E, N, and GRID: Represents the easting, northing, and grid zone for the UTM coordinate system, respectively. The grid zone displayed is the preferred grid zone for the current position and is unaffected by the GRID ZONE INPUT item on the PBY GEOGRAPHIC DATA menu (PRESET #7). The grid coordinates correspond to the LONGITUDE and LATITUDE displayed on the menu.
- 3. GMT: Indicates current Greenwich Mean Time.

4. **FAULT TIME:** Indicates when the most recent fault occurred due to lost communications with the GCS or MX-1105b. The time is indicated in GMT.
5. **GCS POLLING:** Indicates the current information being requested by the CBY. The codes are listed below.
 - a. **HEADING/P/R:** Request for ship's heading, pitch, and roll. Note: ship's heading is the only parameter in this group currently used by the system.
 - b. **POSITION X/Y/Z:** Request for ship's position in 3 axes.
 - c. **-blank-:** No request. This should appear for brief intervals only.
 - d. **OFF:** Communication with the CBY has been interrupted. The time of the fault is displayed in the FAULT TIME column. If communications are restored, the time of the fault remains, indicating when the interruption occurred.
6. **WSN-5:** Displays the status of the WSN-5 navigation unit. This unit is not installed on LPDs, and the display reads UNAVAILABLE in this application.
7. **BACKUP NAV:** Displays the status codes of the MX-1105B navigation units. The codes are as follows:
8. **MX-1105B:**
 - a. **GPS:** Indicates that the MX-1105B has a GPS fix. This code indicates normal operation.
 - b. **DR:** Indicates the MX-1105B is in dead reckoning mode. This generates degraded position coordinates and does not update the displayed coordinates.
 - c. **XX:** An error has occurred in communication with the MX-1105B.
 - d. **FAIL:** No communication with the MX-1105B.
 - e. **LOSS:** No communication with the MX-1105B.
9. *****: Flashes alternately to indicate the IBX is operational.
10. **HEADING:** Indicates ship's true heading (in degrees).
11. **COG:** Indicates ship's course over the ground (in degrees). This parameter is derived by the MX-1105B from a series of GPS position fixes, and may differ from the ship's heading due to current set and drift.
12. **PITCH:** Indicates ship's pitch (in degrees) when this data is supplied from a WSN-5 unit. Remains at 0.0 for MX-1105B.
13. **ROLL:** Indicates ship's roll (in degrees) when this data is supplied from a WSN-5 unit. Remains at 0.0 for MX-1105B.
14. **SPEED:** Indicates ship's speed (in knots) when this data is supplied from a WSN-5 unit. The MX-1105B is not provided with a ship's speed input, but the speed may be entered manually into the MX-1105B via its keyboard. If this is done, the manually entered speed will be displayed on this line.
15. **SOG:** Indicates ship's speed over the ground (in knots). This parameter is derived by the MX-1105B from a series of GPS position fixes, and may differ from the ship's speed through the water due to current set and drift.
16. **FWD REL:** Forward antenna relative azimuth (0—360 degrees).
17. **AFT REL:** Aft antenna relative azimuth (0—360 degrees).
18. **MASTER:** Indicates the antenna currently selected as active in the auto-switching mode.

Note

In manual switching mode, the active antenna is displayed by the LEDs on the COHU Camera Control Panel. The MASTER display will always indicate the antenna that would be selected if the system was switched to auto mode.

11.2.2 Antenna Elevation. Both TCU dish antennas are stabilized in the vertical plane of the feed horn to negate the effects of ship's pitch and roll on communication and tracking. A gyro on each antenna senses ship's motion and sends a signal to an Elevation Servo Amplifier (ESA), which drives a heavy-duty linear

actuator attached to the dish. The elevation angle (relative to true level) is manually controlled by a knob on the COHU Camera Control Panel, which is mounted just above the Observer's TV Monitor Panel (the COHU camera is no longer used but the control panel is still installed in the OBY). The system automatically maintains the selected angle, which is indicated by a meter on the panel. The stabilization system may be bypassed if desired by means of a switch on the panel.

11.2.3 Antenna Azimuth. Dual Triac Power Amplifiers are installed in the 221 Integrator. These allow driving the antenna pedestal motors at up to 5 degrees/sec, which is a higher rotation speed than that possible with the standard azimuth drive. This may be required if the ship changes course rapidly while the system is tracking. In a land-based system, the antenna drive amplifiers are installed in the MCAT (Microprocessor Controlled Auto Tracker). The shipboard MCAT is modified to be compatible with the external amplifiers.

11.2.4 Antenna Switching. Only one antenna at a time is transmitting to and receiving from the UAV. Antenna selection is controlled by the Antenna Resolver PCB (not installed in land-based systems) in the IBX. The card receives antenna azimuth data and controls the switching points based on parameters coded on the IBX floppy disk. On the LPD installation, the switching points are 080 and 330 degrees relative when rotating clockwise, and 070 and 320 degrees relative when rotating counterclockwise. The switching commands are sent to the 221 Integrator (which performs the actual switching of the power and signal lines) and to the RF Switch Box (where the RF paths are switched). When placed in auto mode (via a switch on the COHU Camera Control Panel), the slave (deselected) antenna is driven so that it is always pointing in the same direction as the master (selected) antenna, and is thus ready to assume communications when the UAV enters its coverage area. When the switch is placed in MANUAL mode only the selected antenna is driven, which will result in the two antennas coming to rest at different azimuths. Before selecting auto mode, the antennas should be aligned manually as closely as possible to the same azimuth.

11.2.5 RF System. The primary shipboard change to the RF system is the addition of the RF Switch Box in the TCU. This unit contains the coax relays that route the RF signals to the forward or aft antenna. It also contains amplifiers to boost the uplink and downlink signals. These boosters are required because of losses in the shipboard antenna cables, which are much longer than a land-based system's due to the remotely mounted antennas. Additionally, external amplifiers are installed on each TCU RF Plate to further boost the downlink signal. The TCU C-band uplink transmitter is hard-wired

for a constant high output in order to supply sufficient power to the PCUs in the antennas. Hi and low PCU output power is still manually selectable on the PCD. A shipboard-only DC/DC converter is installed in each antenna RF Box to provide ± 15 volt power to the RF Plate in order to avoid the voltage drop inherent in the long cable runs.

11.2.6 PCS. The shipboard PCS is installed in a drip-proof cabinet instead of the three EDAK cases used on a land-based system. PCS horn antenna coverage on the LPD is currently limited due to obstruction by the aft stack and the telescoping helo hangar. With the hangar fully retracted the coverage is approximately from 103 to 282 degrees relative. With the hangar fully extended the coverage is from 090 to 282 degrees relative. 360-degree rotation pedestals are available for shipboard use, but these are not required since the PCS antenna does not have 360-degree coverage.

11.3 SPARS III

The SPARS III net recovery system consists of three vertical poles used to support a 29-ft high by 39-ft wide recovery net. The net traverses on a V-shaped slipper cable with two energy-absorbing water twisters dampening the force applied by the UAV on net impact. Slipper cable tension is applied by way of a tensioning cable running from a winch located at the base of the forward pole, through a boat block at the top of the forward pole and attached to the apex of the V-shaped slipper cable. When fully rigged, the system is tensioned to 4000 pounds with the net located 40 ft forward of the aft pole at its static (rigged) position. During UAV recovery the net will travel forward a maximum of 30 ft (Figure 11-2).

The aft poles are approximately 69 ft apart and located in the catwalks at the after corners of the flight deck approximately 204 ft from the forward pole. The forward pole is mounted at the aft port corner of the hangar. All poles are raised by means of electric motor-driven hydraulic systems. The aft poles use sliding forward braces and pivoting inboard braces for support when fully rigged. The forward pole is supported against slipper cable tension by means of guy wires attached to the top forward edge of the hangar and on the inboard side of the port stack. When not in use the poles are lowered into horizontal resting positions so as not to interfere with helicopter flight operations.

In addition to the main recovery net, a barricade net is installed between the aft poles to prevent a UAV from "undershooting" the main recovery net and causing damage or injury to helos, vehicles, or personnel on deck. The barricade extends up from the deck to a height

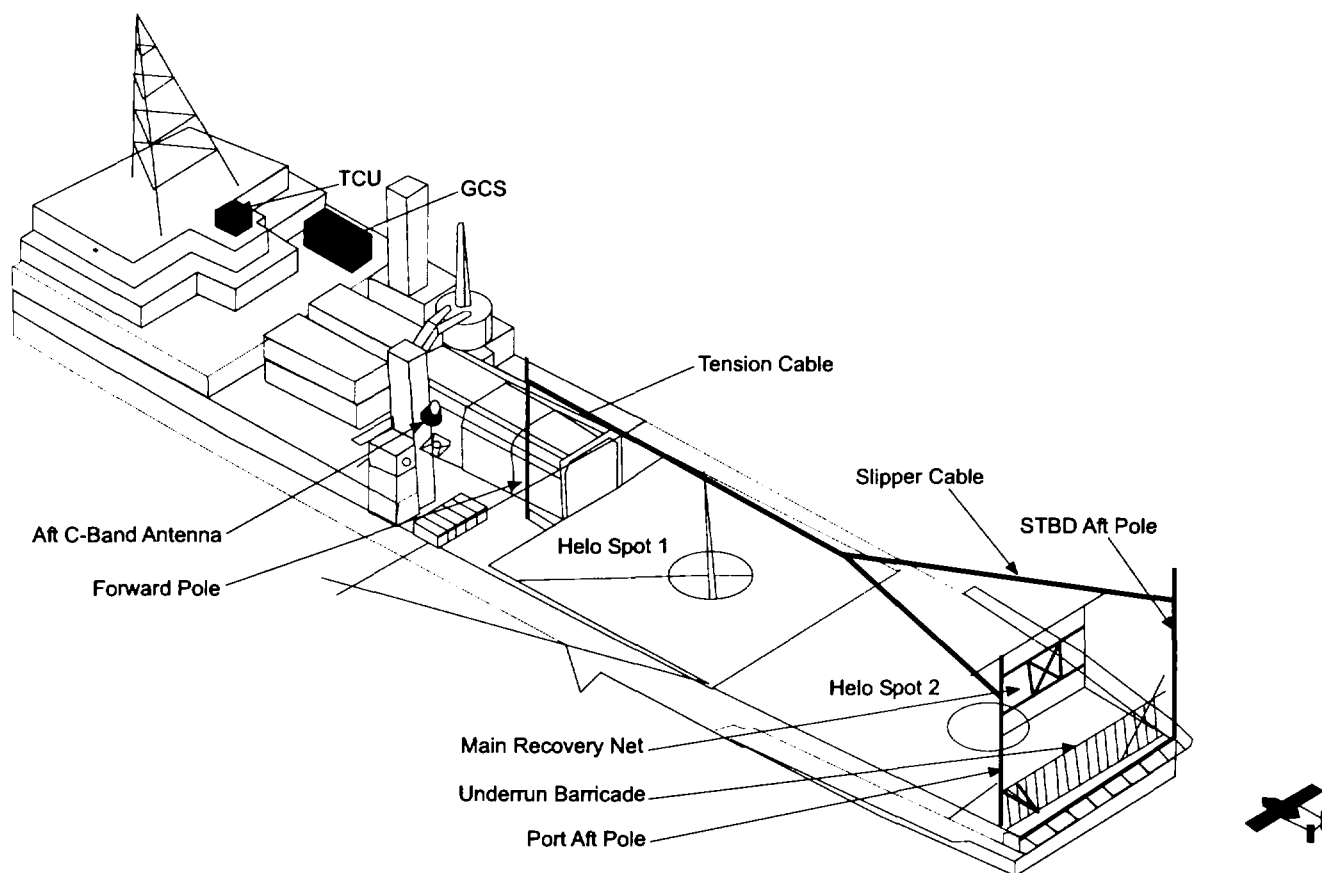


Figure 11-2. Shipboard Pioneer Arrestment and Recovery System (SPARS) III Installation

approximately four feet below the bottom of the main net. Due to its rigid attachment to the aft poles there is no provision for energy absorption other than net stretch on UAV impact.

Note

Upon impacting the barricade net, there is a good chance the UAV will either land in the deck edge netting or fall off the fantail into the water.

During SPARS III operations, the upper corners of the main recovery net are attached to the slipper cable via nylon ropes attached to energy-absorbing straps. The straps are wound on drums axially mounted within the energy-absorbing water twisters. The lower corners of the main net are then attached to gathering lines. Upon UAV impact the recovery net slides forward on the slipper cables applying tension to the attaching strap allowing the UAV's forward energy to be absorbed by the water twisters. As the net slides forward on the slipper cables the lower corners are drawn up into a "U" shape around the UAV. Once coming to rest the UAV is suspended in the recovery net over the deck. The recovery

net is then lowered to the flight deck by easing tension on the slipper cable. Once on the deck the UAV is removed from the net and a post flight inspection is completed.

11.4 UAV FLIGHT DECK OPERATIONS

11.4.1 Organization. When operating UAVs aboard LPD class ships, a UAV detachment will be embarked with an Officer in Charge (OIC). Additionally, various test personnel and technical representatives may also be embarked. Duties and responsibilities are assigned as follows:

11.4.1.1 UAV Detachment Officer in Charge. When embarked, the UAV Detachment Officer in Charge reports to the Executive Officer and Commanding Officer for all matters involving UAV operations and UAV Detachment personnel. Specifically, the UAV Detachment OIC will be responsible for the following (when embarked):

1. Maintenance and operation of UAVs, UAV storage containers, recovery net and associated equipment, AVGAS bladder and fuel fittings, hoses, and pumps, Ground Control System (GCS), Porta-

ble Control System (PCS), and associated UAV control equipment

2. For all UAV fueling operations
3. For rigging and breakdown of the UAV recovery net and launch platforms
4. For safe and proper handling of Rocket Assisted Take Off (RATO) bottles
5. For maintenance and cleanliness of assigned compartments while embarked.

11.4.1.2 Air Officer. The ship's Air Officer is responsible for overall flight deck operation and safety. He reports directly to the Commanding Officer for operations involving the flight deck. In addition, he is responsible for the maintenance and operation of all flight deck equipment and for the direction of all flight deck personnel. He will provide the following support for UAV operations:

1. Man all designated flight quarters stations as amended for UAV operations.
2. Provide designated spaces to the embarked UAV detachment for their maintenance and administrative support, and maintain those spaces when detachment personnel are not embarked.
3. Maintain, with ship's force technical assistance as required, the recovery system, UAV control stations, UAV fueling station, and all associated equipment when UAV detachment personnel are not embarked.

11.4.1.3 Operations Officer. The ship's Operations Officer will oversee contractor maintenance of UAV electronic control systems and designated maintenance functions when the UAV detachment personnel and technical representatives are not embarked.

11.4.1.4 Engineering Officer. The ship's Engineering Officer is responsible for providing maintenance and technical support for the proper upkeep of installed UAV mechanical, hydraulic, and electrical systems.

11.4.1.5 Damage Control Assistant (DCA). The ship's DCA is responsible for fire safety and firefighting equipment in support of flight operations per NWP-42 and NAVAIR 00-80R-19, and for training of fire and crash crews.

11.4.1.6 Weapons Officer. The ship's Weapons Officer is responsible for the maintenance of the

RATO bottle storage magazine, ready service locker, and the security of the magazine. When the UAV detachment is not embarked, the Weapons Officer is also responsible for the safe handling and storage of RATO bottles.

11.4.1.7 Navigator. The ship's Navigator will provide an appropriate flight weather briefing 2 1/2 hours prior to the scheduled launch time. Information will be provided on the ship's intended movement and navigation information in preparation for UAV missions.

11.4.1.8 TAO/CIC Watch Officer. The TAO or CIC Watch Officer will provide a tactical mission brief to the UAV Mission Commander approximately two hours prior to a scheduled UAV launch.

11.5 UAV PREFLIGHT PROCEDURES

Chapter 10 provides detailed preflight procedures for UAV systems. The following are supplemental procedures for operating UAVs from LPD class ship flight decks:

11.5.1 TCU PREFLIGHT INSPECTION

1. UPS PANEL

Battery Voltage96 Vdc (±10)
 Output Voltage110 Vac (±10)
 Charge CurrentFLOAT
 AC utility power on lightILLUMINATED
 Inverter bypassed light.....ILLUMINATED
 Inverter on light.....OFF

2. AC DISTRIBUTION PANEL

115 Vac light.....ILLUMINATED
 Circuit BreakersON

3. DC DISTRIBUTION PANEL

Battery Warning LightOFF
 PS Fail LightOFF
 DC Main Light.....ILLUMINATED
 DC Main Indicator.....28 Vdc (±2)
 Circuit BreakersON
 DC Main Selector SwitchON
 BuzzerENABLED

4. IBX POWER SWITCH.....ON

5. UHF TRANSMITTER

Channel Selector Switch2
 Power SwitchH

XMTG LightON (IF XMTG)
 Power Failure LightOFF
 VSWR Failure LightOFF
 XMTG/STBY SwitchXMTG
 Channel 2 Frequency SelectorAS REQD
 Main Power LightILLUMINATED
 Remote LightILLUMINATED
 ON/OFF SwitchON
 Local/Remote SwitchREMOTE

6. 221 INTEGRATOR

Fwd and Aft ANT. SwitchON
 Local/Remote SwitchREMOTE

7. HORIZON POWER SUPPLY (CPS 253A)

Dc Ampere Meter25 AMP (±2)
 Dc Voltage Meter28 Vdc (±2)
 Power Indication LightsILLUMINATED
 Power Circuit BreakerON

8. CCB – COMMUNICATION PANEL

All Warning LightsOFF
 Power ON/OFF SwitchON
 Test Push-button LightILLUMINATED

9. MX 1105B-GPS (As Required)

PowerON
 SetupCOMPLETED

11.5.2 GCS ELECTRICAL PANELS

1. Shelter Circuit BreakersAS REQD

2. Power Supply Panel SwitchON

Frequency Meter60 Hz (±2)
 Voltage Meter (in all
 3 phases)115 Vac (±10)

3. UPS SwitchON

Input Present LightILLUMINATED
 Inverter On LightILLUMINATED
 Output Present LightILLUMINATED

11.5.3 INTERCOMMUNICATION SYSTEM

1. Mode Select SwitchINT

2. VolumeAS REQD

3. Impedance SelectAS REQD

4. All Stations ActivatedCHECK

11.5.4 GCS PBY ELECTRICAL PANELS

1. DC CONTROL PANEL

Warning Panel
 Main LightON
 All Other LightsOFF
 28 Vdc SwitchUP
 RDC Power
 Current< 30 AMPS
 Voltage28 Vdc (± 2)
 Video Retrans. SwitchOFF
 Bay SwitchesON

2. AC CONTROL PANEL

Current Meter (all 3 phases)CHECKED
 Voltage Meter
 (all 3 phases)115 Vac (± 10)
 Frequency Meter60 Hz (± 2)
 Circuit BreakersAS REQD

3. MAIN AC PANEL

Generator Selector SwitchGEN 1
 Three-Phase
 Indicator LampsILLUMINATED

11.5.5 PCS INTEGRITY CHECKLIST. See 10.5.2.4.1.

11.5.6 PILOT BAY

1. TV MonitorsON/Adjusted

2. Pilot Display Panel

a. Warnings

LOW IASON
 LOW ALTON
 LOW FUELOFF
 PLT BOXOFF
 COPLT BOXOFF
 VTR INACTIVEON
 PWR FAILOFF
 GCS FAILOFF
 TEST MODEOFF
 PROG FAILOFF
 RH FAILOFF
 ENG TEMPON
 BATT FAILON
 EPS FAILOFF
 GEN FAILON

ENG CUTON
 SEC LINK: RPV RCVR,
 ADDR MODE, LINK LOSSOFF
 NO REPORTOFF
 RTN HOMEOFF
 GLIDEOFF
 A-PLT MALOFF
 A-PLT FAILOFF
 PRIM LINK: RPV RCVR,
 ADDR MODE, LINK LOSSOFF
 COMD INHIBOFF

b. RPV System Data

ENGINE RPM0
 ENGINE TEMPINDICATES OAT
 FUELCHECKED
 BUS VOLTAGE28 Vdc (±2)

c. RPV Flight Data

ATTITUDE
 INDICATOR~0° PITCH/ROLL



The attitude indicator shall be confirmed for correct launch attitude as follows:

For RATO Launch+14°±2° pitch
 For Pneumatic Launch ...+10.5°+6° or -2° pitch

IAS0-20 KTS
 RATE OF TURN0°
 TRACKING
 AZIMUTHREFLECTS TCD
 AZIMUTH DISPLAY
 RPV HEADINGREFLECTS
 UAV HEADING
 ALTITUDE (METER/
 NUMERICAL DATA)VERIFIED AT
 SEA/FIELD LEVEL
 RATE OF CLIMB0
 RANGEREFLECTS UAV RANGE
 FIELD LEVEL/
 SEA LEVEL SWITCHFIELD LEVEL

d. Time Data

MISSION TIME0
 LOCAL TIMEREFLECTS
 CURRENT TIME

3. PILOT CONTROL DESK

DISENG / AUTOPLTOFF
 MASTER CAUTIONOFF
 FLT-TO/LDTO/LD
 GEN RESETOFF
 REPORT INHIBITOFF
 ON / LIGHTSOFF
 LAUNCH MODEOFF
 PROG CONTROLOFF
 NAV TO COOROFF
 AUTO LAND / GO AROUNDOFF
 CAMERA GUIDEOFF
 KNOB CONTROLOFF
 STICK CONTROLON
 PLT BOXON
 COPLT BOXOFF

a. PROGRAMMER CONTROLOFF
 STEP #SET
 REMAINING STEP/TIMEVERIFIED
 RUN/PAUSEBOTH ON
 SSAOFF
 PROG/RESETOFF

b. KNOB CONTROL

ROLL0°
 ROLL READYILLUMINATED
 IND AIRSPEED70 KTS
 IAS READYILLUMINATED
 HEADINGAS REQD
 ALTITUDE1000 FT
 ALT READYILLUMINATED

c. RPV XMTR

ON/OFFON
 HIGH/LOWLOW
 TRANSPOFF
 RH DELAYOFF
 SECURE/CLEARSECURE
 LONG/SHORTAS REQD

d. COMMUNICATIONS CONTROL

PRIME UPLINK: OVERHEAT,
 HI RFL PWR, LOW PWROFF
 DOWNLINK: RCVR FAILOFF
 SEC UPLINK: OVERHEAT
 HI RFL PWR, LOW PWROFF
 RPV# (display)VERIFIED
 STATION#/RPV#
 (thumbwheel)VERIFIED
 COMMANDING
 STATION (arrow)SEC UPL

STATION# (displays)..... VERIFIED
 XMTR POWER
 and STATION RCVR
 SIGNAL STRENGTH (meters).....>6
 HIGH/LOWLOW
 PRIM UPL and
 SEC UPLSTATION XMTR ON
 TEST Push-button.....PRESSED
 ALL PBYP lamps,
 push-buttons,
 enunciators, meters,
 and digital displaysCHECKED

Note

All meters should be pegged except for the fuel meter, which will read 30 liters. All digital displays should read 8 except for mission time and local time readouts. All light and push buttons should be lit.

e. PILOT CONTROL TABLE

READY LIGHTON
 RUDDER, AILERON,
 THROTTLE, ELEVATOR LIGHTS.....ON
 ENGINE ON/OFF SWITCHON
 RUDDER TRIM.....CENTERED
 ELEV TRIM.....MAX UP
 AILERON TRIM.....CENTERED
 THROTTLE.....IDLE

11.5.7 OBSERVER BAY

1. OBSERVER CONTROL TABLE

PRESET MENUCOMPLETED
 MULTIFUNCTION MENU.....COMPLETED
 TARGET ACQUISITION
 MENUCOMPLETED

2. Video Telemetry Recorder

POWERON
 TAPELOADED/REWOUND
 TIME COUNTER
 DISPLAY SW.....COUNTER
 TIME COUNTER DISPLAYRESET
 LOCAL/REMOTE.....LOCAL
 AUDIO LEVELS0 DB (EXCEPT PCM CH-3
 (VOICE) ADJUST TO LEVEL 2)
 PHONE LEVELMIDRANGE
 MODE SELECT.....NORMAL
 METER SELECT.....AS REQD
 ASSEMBLE.....OFF
 INSERT INDICATIONSOFF

TAPE TRANSPORT INDICATORSOUT

3. ANTENNA CONTROL

AUTO/MANUAL SWITCHAUTO
 AUTO LIGHT.....ON
 FWD/AFT LIGHTFWD or AFT
 FWD/AFT SwitchAS REQD
 GCS CONTROL LIGHTON
 ELEVATION CONTROL Switch.....NORMAL
 DISH ELEVATIONAS REQD

4. OTMPON

5. OBSERVER VIDEO CONTROL

LIGHT PEN.....CONNECTED
 DIMMERSADJUSTED
 VIDEO GRAPHIC
 PUSHBUTTONS.....AS DESIRED
 VTR RECORD / INACTIVEINACTIVE

6. OBSERVER CONTROL DESK

AUTOMATIC
 LANDING.....ALL PUSH-BUTTONS OFF

MKD 200 PAYLOAD

VIDEOON
 IRISAUTO
 IRIS MANUAL KNOB.....CENTERED
 FOCUSSET
 ZOOMMAX OUT

MKD 400 PAYLOAD

VIDEOAS REQD
 LEVELAUTO
 DATAON
 HEAT POLRAS REQD
 FIELD OF VIEWSUPER WIDE
 FOCUSSET

PLATFORM CONTROL

ON PUSH-BUTTONON
 POSITION/RATE
 CONTROLPOSITION
 BEARING DEGREES.....0
 DEPRESSION DEGREES0
 PAYLOAD SHIELD.....OFF

7. OBSERVER CONTROL TABLE

All Push-buttonsOFF
 BEARING TRIM and
 DEPRESSION TRIM.....AS REQD

11.5.8 TRACKING BAY

- 1. PLOTTER PANEL
MAPS.....POSITIONED
- 2. PRESET MAPS
TO PLOTTER.....COMPLETED

Note

Refer to Tracking Bay PRESETS in the PRESET Section of this checklist.

- 3. TRACKER CONTROL DESK
PLOTTER CONTROL
- MAP #.....VERIFIED
- EAST/NORTH.....VERIFIED
- UTM/GEOGR.....UTM
- RESET.....ON
- PRESET, DIAGN, MAP ORIENT
- TCU COVR, TCU ALT.....OFF
- DATA LOSS.....OFF
- OVER RANGE.....OFF
- TRACK TARGET.....OFF
- MARK TARGET.....OFF
- OVER FLOW.....OFF
- CONT/STEP.....AS REQD
- COARSE/FINE.....OFF
- LOCAL.....ON
- TRACK.....OFF
- AUTO/MANUAL.....AS REQD
- L/R PEN SELECTION.....LEFT

Note

Verify left pen light illuminates on tracker arm.

- RUN.....OFF
- MAP #.....OFF
- PEN UP.....OFF

Note

Verify pen in up position on tracker.

- STOP.....OFF

4. TRACKER CONTROL

- AZIMUTH DEGREES.....AS REQD
- ANT PWR.....OFF
- TRACKER FAIL.....OFF
- TRACK LOSS.....OFF
- MANUAL.....ON

- TRACK.....OFF
- WIDE/NARROW.....OFF
- SCAN.....OFF
- DISH/OMNI.....OMNI
- RPV ANT.....OMNI
- TEST (push-button).....PRESS
- LAMPS/METERS.....CHECKED

11.5.9 UAV Preflight/Engine Turn Procedures.

Approximately two hours prior to a scheduled launch (or any time a UAV engine will be operated), the UAV Crew Chief will muster the UAV Launch/Recovery Detail to conduct preflight system checks. At this time, communications will be established on the (ICS) circuit between the Ground Control Station (GCS), the Crew Chief located on the flight deck, and the Portable Control Station (PCS). The following are UAV Launch/Recovery Detail Stations:

1. The ship's Helicopter Control Officer, Flight Deck Officer/CPO, and Flight Deck LPO will oversee all flight deck evolutions.
2. UAV Crew Chief on the flight deck is responsible for UAV launch preparations on the flight deck.
3. GCS/PCS station personnel as required for preflight checks.
4. The Flight Deck Officer/CPO will ensure a FOD walkdown is completed in the immediate vicinity prior to turning up the UAV. He will also ensure that a 15-lb CO₂ bottle and one PKP bottle are present and manned prior to starting a UAV engine.
5. The Crew Chief will obtain permission from the Tactical Action Officer (TAO) or CIC prior to activating transmitters and from the Officer of the Deck (OOD) prior to conducting engine turns (requires an AMBER DECK).

11.5.10 Preflight Briefing. Whenever practical and operational considerations permit, a UAV preflight briefing should be held at least 2 hours in advance of the scheduled launch time.

11.5.11 Recovery Net. If flight deck operations allow, the UAV detachment should commence rigging the recovery net one half hour prior to the setting of UAV flight quarters or one and one half hours prior to the scheduled launch. The latest the net should be raised is 45 minutes prior to the scheduled launch. Prior to commencing rigging:

1. The UAV Crew Chief will obtain permission from the OOD and inform him that the flight deck will be fouled for all helicopter operations at least 15 minutes after the net is fully rigged.
2. The OOD will ensure relative winds are less than 30 knots from any direction and that weather conditions are safe for men working on the flight deck.
3. The OOD will minimize ship's maneuvering consistent with operational and safety considerations.
- b. Fire and Crash Crew manned per NAVAIR 00-80R-19. When UAVs are the only aircraft operating, LPD crash crew minimum requirements may be amended at the ship's Commanding Officer's discretion to delete the requirement for a Twin-Agent Unit (TAU) operator and Hotsuit men.
5. Portable Control Station (PCS). Manned by one UAV detachment Internal Pilot.
6. Ground Control Station (GCS). Manned by UAV detachment personnel to include the Mission Commander, Internal Pilot, and Payload Operator. The Mission Commander is responsible for all UAV operations.

11.5.12 Flight Quarters for UAV Operations.

If not already set, approximately one hour prior to the scheduled UAV launch the ship will set flight quarters for UAV operations. The following flight quarters stations will normally be manned for UAV operations:

1. Bridge: In addition to the normal watch standers, a sound-powered phone talker will augment the bridge team to provide communications between the bridge, Combat Information Center (CIC), Primary Flight Control (PRIFLY), and the GCS.
2. Combat Information Center: The CIC watch section will be augmented as necessary by a sound-powered phone talker and an Air Controller.

Note

The Tactical Action Officer (TAO) retains the authority and responsibility for overall ship's operations and employment of shipboard systems. He will be fully informed of all UAV operational requirements, including communications, EMCON, area clearance, flight plan, flight profiles, and test procedures.

3. Primary Flight Control (PRIFLY): Manned by the ship's Air Officer and, as required by the ship's Watch, Quarter and Station Bill, a sound-powered phone talker. The Air Officer will ensure all items on the UAV Tower Operator Checklists (paragraph 11.21) are completed for all launch and recovery operations. The Air Officer is responsible for all flight deck activity.
4. Flight Deck Crew. The flight deck crew consists of the following:
 - a. Flight Deck Officer/CPO and Flight Deck LPO to ensure the safe conduct of all flight deck operations.

11.6 UAV FLIGHT DECK LAUNCH PROCEDURES

The following step-by-step procedures will be followed during UAV launches:

1. If not already set, the OOD will have the word passed to set flight quarters for UAV operations and for all unauthorized personnel to remain clear of the flight deck while conducting UAV flight operations.
2. Upon the setting of flight quarters UAV detachment and flight deck personnel will conduct a full FOD walkdown of the flight deck.
3. The Mission Commander will complete the UAV flight operations checklist up to "Request for AMBER DECK" no later than 40 minutes prior to scheduled launch time. When all stations are manned and ready, and the UAV flight operations checklist has been completed, the Mission Commander will request an "AMBER DECK for RATO upload" from the Air Officer.
4. Upon setting "AMBER DECK," a hose team will man their hose on the side from which the UAV is to be launched, and the ordnance-man will draw a RATO bottle from the magazine or ready service locker and connect it to the UAV for final launch preparations. The hose team will remain stationed at their hose until the UAV engine has been started.
5. Following final RATO checks and engine start, only the Flight Deck Officer/CPO and UAV launch crew will remain on the flight deck. Fire and crash crew personnel will take cover.

6. Upon successful completion of the UAV Automatic Test Sequence, the Crew Chief and the External Pilot (EP) will make a final check to ensure no unauthorized persons are on the flight deck and report to the Mission Commander (MC) that the flight deck is ready for a "GREEN DECK."
7. The OOD should turn to FOXTROT CORPEN no later than five minutes prior to launch and will complete the OOD Checklist for UAV Operations (paragraph 11.20).
8. The Mission Commander will request a "GREEN DECK for UAV launch" from the OOD via the Air Officer approximately two minutes prior to launch.
9. Upon meeting all launch preparations the OOD will authorize a "GREEN DECK for UAV launch."
10. The EP will position himself for UAV launch.
11. When directed by Mission Commander, the EP will countdown the UAV launch on the UAV ICS system. The EP countdown will be relayed to the OOD via the primary sound-powered circuit. The Crew Chief will direct the ordnance-man to fire the RATO bottle when the EP commands launch.
12. Upon gaining normal flight, the EP will control the UAV, maintaining its position aft of the ship in sight until ready to pass control to either PCS or GCS Internal Pilot (IP). In the event of RATO misfire, the procedures contained in paragraph 11.23 will be executed.

11.7 DECK STATUS CRITERIA/AUTHORITY

The following is the criteria and authority for granting a GREEN, AMBER, or RED DECK:

11.7.1 GREEN DECK (launch or recovery of UAVs). The OOD will set "GREEN DECK" only after the following criteria are met:

1. Mission Commander has reported all stations for UAV operations are manned and ready for UAV launch and that the sound-powered telephone communications have been established.
2. The ship is on FOX CORPEN and wind over deck is within approved parameters. "GREEN DECK" will be maintained until UAV inflight control checks are reported complete and satisfactory by the Mission Commander.

11.7.2 RED DECK. The OOD, TAO, HCO/UAV Tower Operator, FDO, MC, IP, EP, or Flight Deck Crew Chief may all direct a "RED DECK" if any unsafe condition exists with regard to UAV flight operations. A "RED DECK" will be ordered if all criteria for either "GREEN" or "AMBER DECK" are not met. The OOD is the only person with authority to grant a "GREEN" or "AMBER DECK" after a "RED DECK" has been ordered. Any station directing a "RED DECK" will immediately report it to the OOD via the sound-powered phone circuit with the reason for a "RED DECK." The following are possible reasons for directing a "RED DECK":

1. The ship must maneuver outside of the wind envelope for launch or recovery of UAVs after a "GREEN DECK" is ordered.
2. The TAO or OOD reports another aircraft or shipping in the area that may interfere with, or be endangered by, UAV flight operations.
3. Unauthorized personnel are observed on the flight deck or other unsafe location.
4. Failure of UAV control functions or equipment at either PCS, GCS, or by location.
5. Loss of phone communications at any station.
6. Loss of radio communications with any external stations required for UAV operations.
7. Electromagnetic interference observed by the CIC, PCS, EP, or GCS that would preclude positive control of the UAV during launch, recovery, or in flight.

11.7.3 AMBER DECK. "AMBER DECK" will be requested by the Mission Commander for uploading or downloading RATO bottles to the UAV, and whenever operating the UAV engine.

11.8 UAV INFLIGHT PROCEDURES

After a successful UAV launch, the following procedures and general guidelines for UAV operations apply:

11.8.1 UAV Control. After the EP has positive control of the UAV in flight and is maintaining the aircraft in visual sight, control may be passed to the IP as required by the MC. The TAO in CIC retains responsibility for employment of the ship and its systems, and is therefore responsible for UAV operations when under the control of any of the shipboard stations (PCS or GCS), or until operational control is assumed by

another controlling authority. He is authorized to direct the operations of inflight UAVs when under ship's control, but will immediately inform the Commanding Officer and the UAV Detachment OIC if he directs any UAV operations that deviate from the flight plan or mission. The Mission Commander will advise the TAO on aircraft limitations or capabilities that will inhibit/prevent successful completion of the assigned mission.

11.8.2 Securing Flight Quarters. Flight Quarters for UAV operations will be secured by the OOD only after the Mission Commander reports successful completion of UAV inflight checks.

11.9 UAV FLIGHT OPERATIONS WITHIN VISUAL RANGE OF SHIP

Minimum criteria for UAV flight operations within visual range of the ship are as follows:

11.9.1 UAV Operation Above 1000 ft MSL. The ship's UAV directional tracking antenna is unable to maintain track of the UAV within 0.5 NM of the ship. Additionally, the ship's UAV antenna has blind zones directly above the ship. Therefore, no UAV will be flown above 1000 ft MSL within 0.5 NM (0.93 km) of the ship.

11.9.2 UAV Operations Below 1000 ft MSL

1. PCS Control. No UAV flight operations will be conducted below 1000 MSL under PCS control without the specific permission of the Mission Commander. Requests to operate the UAV below 1000 ft MSL should only be for emergency recovery situations.
2. External Pilot UAV Control. External Pilot (EP) control of the UAV is done only for launching and recovering the UAV. Maneuvers of any type other than those required to launch, recover, conduct controllability checks, and maintain currency are strictly prohibited. Additionally, the following restrictions shall be applied:
 - a. No overflights of the ship for any purpose.
 - b. All UAVs shall remain beyond 0.5 NM (0.93 km) of the ship when conducting control checks.
 - c. Any flight profile that points the UAV directly at the ship while the UAV is within 0.5 NM (0.93 km) of the ship is prohibited, unless performing recovery maneuvers.

- d. Any flight profile that brings the UAV closer than 0.3 km to the ship during recovery maneuvers, unless an actual recovery is to be conducted, is prohibited.
- e. All wave-off maneuvers shall be conducted so that the UAV makes its wave-off turn in a direction away from the ship and proceeds outbound on a 180-degree relative bearing.

11.10 PRACTICE/SIMULATED UAV RECOVERY PROCEDURES

Both day and night practice approaches are required to train new EPs and to maintain EP proficiency. Prior to conducting practice approaches, the MC will inform the OOD and TAO of the number of approaches required and the expected duration of the evolution.

1. The OOD will pass the word that the flight deck is closed to all unauthorized personnel and, if possible, will maneuver the ship to provide suitable recovery winds. Flight quarters need not be set until time for the final net recovery.
2. UAV launch and recovery personnel shall ensure that the flight deck remains clear of all unauthorized personnel during practice approaches.
3. The Crew Chief shall verify the recovery net is rigged and ready and report such to the Mission Commander.
4. The Mission Commander shall ensure all approaches are waved off outside 0.3 km and that proper wave-off procedures are followed.

11.11 UAV FLIGHT DECK RECOVERY PROCEDURES

At least 30 minutes prior to the scheduled recovery of a UAV, the OOD will station flight quarters for UAV recovery operations. All stations will be manned as for UAV launch with the single exception that an ordnance-man will not be required. The following procedures for recovering a UAV apply:

1. The Crew Chief will verify the recovery net is rigged and ready and report such to the Mission Commander. Both the main net and the under-run net are required for all UAV recoveries.
2. The Mission Commander will complete applicable portions of the UAV recovery checklist.

3. The Air Officer will complete the UAV recovery checklist (paragraph 11.21.3) and, following concurrence with the Mission Commander, will request a "GREEN DECK" from the OOD.
4. When within visual range, control of the UAV will be passed to the EP. The EP will report positive control to the Mission Commander prior to closing the ship with the UAV.
5. The OOD will complete applicable portions of the OOD UAV recovery checklist, and will order a "GREEN DECK" for UAV recovery when appropriate.
6. After the UAV has landed in the recovery net, the Air Officer will notify all stations that the UAV has been recovered and announce on the 5MC "UAV IN THE RECOVERY NET, ENGINE STOPPED. UAV RECOVERY PERSONNEL MAN THE NET."
7. The Fire and Crash Crew will man their hoses during the UAV lowering operation.
8. When lowering the net and UAV, the Air Officer will announce on the 5MC "ATTENTION ON THE FLIGHT DECK, ALL UNAUTHORIZED PERSONNEL REMAIN CLEAR OF THE FLIGHT DECK WHILE LOWERING UAV AND RECOVERY NET SYSTEM." At this time, the UAV Detachment will man the net and lower the UAV to the deck.
9. When the UAV recovery net is stowed and the UAV has been refueled, the UAV Crew Chief will request permission from the OOD (via the Air Officer) to secure from UAV flight quarters.

11.12 FLIGHT DECK CRASH PROCEDURES

If a UAV crash on the flight deck is possible or has already occurred, the following procedures shall be followed:

11.12.1 A Problem Exists and a Crash Is Likely

1. The Mission Commander shall notify the CO, OOD, Air Officer, and TAO (CIC Watch Officer) that control problems exist and that a crash is possible.
2. Air Officer shall declare an emergency on the flight deck and clear the deck of all personnel.

3. The OOD shall be prepared to maneuver the ship as required.

11.12.2 A Crash on the Flight Deck

1. Air Officer shall announce "CRASH ON THE FLIGHT DECK," over the 5MC, and report the emergency to the OOD.
2. Fire and Crash Crew shall respond to the emergency per NAVAIR 00-80-R-14. Additional hose teams and assistance shall be brought to the scene as required by the Crash and Salvage Scene Leader.
3. In the event of fire, the OOD shall maneuver the ship per ship's doctrine to minimize the winds and the spread of fire.
4. Corpsman shall immediately respond to any on-scene injuries.
5. Master-At-Arms personnel shall be summoned to keep the flight deck clear of non-essential personnel.

11.12.3 Crash and Salvage Scene Leader. When a crash occurs, the overall supervision and direction of salvage operations is the responsibility of the Crash and Salvage Scene Leader. In the event of a crash mishap, the UAV Detachment Maintenance Officer should be available to provide technical assistance to the Crash and Salvage Scene Leader.

Note

Only the Commanding Officer may authorize jettisoning of aircraft.

1. Ship's photographer shall be tasked with photographing the crash scene and the remaining wreckage.
2. No actions shall be taken to move or tamper with the wreckage without the Crash and Salvage Scene Leader's approval.
3. Before removal, all wreckage should be inspected to determine possible cause of mishap.

11.12.4 UAV Mishap Reporting. UAV Mishap Reporting Procedures contained in OPNAVINST 3750.6 shall be followed to report safety investigation findings. In the event that the UAV enters the water near the ship, UAV water recovery procedures contained in this chapter shall be followed.

11.13 UAV POST FLIGHT PROCEDURES

Upon successful recovery of the UAV, the following procedures will be followed:

1. The UAV recovery net and equipment will be thoroughly inspected for damage by the net repair personnel.
2. Unless otherwise directed, the Crew Chief will have the net system disassembled and stored for sea. It is important to note this should be expedited to provide a clear deck for helicopter operations and should normally be completed within 30 minutes of recovery for full disassembly, and within ten minutes if only partial disassembly is needed to clear the flight deck in the shortest time possible.
3. All UAVs should be fully fueled immediately upon recovery and cleared from the flight deck forward of the foul line for helicopter operations within 15 minutes of recovery.
4. The Fire and Crash Crew will remain on station for fueling and will be secured by the Air Officer when all UAVs have been fueled.
5. If any UAVs are required to be left on deck and not stowed in their container, the OOD will be notified for approval. The OOD will be notified when all UAVs are stowed.

11.14 UAV/AVGAS FUELING AND DEFUELING PROCEDURES

The fuel used by UAVs is 100-octane low-lead AVGAS, a gasoline that is highly flammable and explosive in the light fuel-to-air mixture. Special procedures and safety precautions are required when working with UAVs or AVGAS. Permission to conduct AVGAS fuel transfer will always be obtained from the OOD while underway, and the Command Duty Officer (CDO) in port. The following procedures apply to all AVGAS transfer operations:

11.14.1 AVGAS Storage Bladder. This rubber bladder is located forward on either the starboard or the port catwalk, semi-fixed to a jettisonable trolley. An emergency jettison lever is located on the catwalk across from the accommodation ladder winch. A wire strap retaining pendant is provided to prevent inadvertent jettisoning during bladder fueling or PMS on the quick release system. This pendant WILL ALWAYS BE DISCONNECTED when the bladder has fuel in it. When not in use, the rubber fueling hoses for refueling

the bladder and the UAV will be disconnected from the pump and the AVGAS bladder, drained of all fuel, and stored in their brackets. Valves on two sample lines on either side of the hand pump will be closed when not drawing samples and will be checked closed prior to connecting rubber hoses to the AVGAS Bladder and pump.

WARNING

Smoking is prohibited within 50 feet of the fuel bladder at all times.

11.14.2 AVGAS Storage Bladder Jettison Procedures. In the event of a fire within 50 feet of the AVGAS bladder, it will be jettisoned. The jettison procedures should normally be conducted by the Fire and Crash Crew, but this does not preclude its jettison by any crewmember if the situation dictates.

11.14.3 UAV Fueling/Defueling. All UAV fuel tanks will be maintained filled to capacity at all times (on deck or stowed) unless delivered to the ship with the fuel tank emptied and certified gas free. If a UAV with an empty tank cannot be certified gas free, it will be immediately fueled to capacity. The following procedures will be followed when fueling UAVs:

1. The flight deck will be secured and the SMOKING LAMP out in all topside spaces during all UAV fueling/defueling operations.
2. Hotwork, grinding, or the use of spark-producing or electrical tools within 50 feet of AVGAS shall be prohibited.
3. Immediately upon removing a UAV from its storage container, the fuel tank will be inspected to ensure it is full. If it is not full, it will be refueled to capacity without delay, provided there is no evidence of a fuel tank leak.
4. Immediately upon recovering a UAV it will be fueled to capacity.
5. Prior to fueling, UAV Detachment personnel will connect the rubber transfer hoses to the AVGAS bladder and hand pump. They will ensure the fuel sample line valves are closed.
6. When the above is accomplished, they will fill the UAV fuel tank to capacity.

7. Prior to UAV defueling, permission will be obtained from the OOD to ensure the ship is outside 50 NM from land.
8. The UAV will be positioned at the port or starboard aft deck draining and two fire extinguishers (CO₂ and PKP) will be readily available.
9. A hose approximately six feet in length will be routed overboard in combination with a funnel and will be used to drain the fuel from the UAV.
10. Upon completion of UAV defueling, the entire area will be thoroughly flushed.
11. The UAV fuel tank will then be purged using LP air.
12. After being purged, the fuel tank will be inspected and certified gas free.

11.14.4 AVGAS Bladder Fueling/Defueling.

Fueling or defueling of the AVGAS bladder will generally be accomplished in port and is the responsibility of the Air Officer. The following procedures shall be followed:

1. At least one hour prior, permission will be obtained to commence AVGAS fueling or defueling operations from the Naval Base Fire Marshall on the pier and from the CDO.
2. The securing pendant will be attached to the bladder and the ship.
3. A UAV Detachment Officer or Chief Petty Officer will be present to ensure fuel quality and sign for fuel received.
4. The DCA will have the Fire and Crash Crew personnel man the flight deck AFFF hoses and AFFF stations and have the Rescue and Assistance Detail man one charge 2-1/2 inch saltwater hose on the pier at the fuel truck.
5. The fuel truck operator will inspect and verify the proper material condition of the truck's fueling hose and equipment and report the same to the ship.
6. A "salt and pepper" line will be strung between the AVGAS bladder on the ship and the fuel truck and be manned by fueling detail personnel.
7. Prior to the hose being passed to the ship from the fuel truck, the CDO will be notified, the smoking

lamp will be out throughout the ship, all hot work, grinding, and spark-producing work will cease, and the BRAVO flag will be closed up.

8. A MAA will be posted on the flight deck to ensure all unauthorized personnel stand clear.
9. The truck fuel hose will be connected to the bladder and verified secure.
10. Commence fueling until the bladder is sufficiently filled.
11. Ensure the bladder indicator/strike plate is no closer than 1/4 inch to the grating above it.
12. Ensure the bladder fill valve is closed, then disconnect the hose.
13. AVGAS fueling operations are not complete until the hose is returned to the pier. When stowed, personnel may be secured from AVGAS fueling/defueling operations.

Note

Fueling of UAVs will not commence until the proper fuel to oil mixture of 50:1 is obtained by mixing fuel from the AVGAS bladder with oil in the receiving bowser.

11.15 OBSERVATION OF UAV OPERATIONS

UAV launch and recovery operations may be observed in any area not otherwise restricted. Restricted areas for UAV operations are the flight deck, catwalks, and the vicinity of the EP when UAV Flight Quarters are in effect.

11.16 MISSION COMMANDER CHECKLIST (SHIPBOARD)

1. Air tasking order/flight times
2. Maintenance prep/hrs to launch
3. Mission tasking/Brief/preparation/weather Air space coordination
4. Crew Brief 2 HRS PTL
5. Comm Checks
6. Deck clearance/net rigging
7. Flight Quarters 1 HR PTL

- 8. AMBER DECK/RATO upload clearance 45 MIN PTL
- 9. Engine Start 20 MIN PTL
- 10. Take-off Winds 5 MIN PTL
- 11. Airspace Clearance 5 MIN PTL
- 12. Take-off clearance/GREEN DECK
- 13. IFF Checks
- 14. Update Position and RETURN HOME — Coordinates at 10 min intervals
- 15. Return clearance/MOCA/altimeter setting
- 16. Net rigged for recovery
- 17. Recovery winds

- c. Request amber deck/clearance to upload RATO
- d. Conduct RATO bottle pre launch inspect IAW NA A1-SRRPV-RATO-820
- e. Flight deck clear of unauthorized personnel
- f. Check VGU, COMM, ERC, and BATT switches off
- g. Secure power to UAV
- h. Disconnect external power
- i. Upload RATO IAW NAVAIR A1-SRRPV-RATO-280
- j. RATO upload final checks complete
- k. Apply external power
- l. VGU and comm switches on.

11.17 CREW CHIEF PRE-TAKEOFF CHECKLIST (SHIPBOARD)

- 1. NLT 2:00 hrs prior to launch
 - a. Comm check with GCS/PCS
 - b. Clearance to rig the net
 - c. Inspect net assembly and poles
 - d. Rig the net
 - e. UAV configured and daily completed
 - f. Launch stand into position
 - g. Techs conduct interactives
 - h. Conduct FOD walkdown.
- 2. NLT 1:15 hrs prior to launch
 - a. Perform Pre RATO Checks IAW NA A1-SRRPV-RATO-820
 - b. Commence FOD walk down.
- 3. NLT 1:00 hrs prior to launch
 - a. UAV flight quarters set
 - b. Crew chief pre-launch checks complete

- 4. 20 min prior to launch
 - a. IP commences Engine Start Checklist
 - b. Follow IP checklist for remainder of start and launch sequence.

11.18 INTERNAL PILOT PRE-TAKEOFF CHECKLIST (SHIPBOARD)

- 1. AC CONTROL PANEL
 - GENERATORGEN 1
 - VOLTAGE115±5
 - FREQUENCY60 HZ
 - MAIN POWER CIRCUIT BREAKER.....ON
 - RDC CIRCUIT BREAKERON
 - 28V DC CIRCUIT BREAKERON
 - OBY, PBY, 115 Vac CB'sON
 - OBY, TBY, PBY
 - PLP, INT CIRCUIT BREAKERSON
 - EXT & INT SOCKETS 1, 2, & 3ON
- 2. DC CONTROL PANEL
 - RDC CURRENT25 AMPS ±5
 - VOLTAGE28Vdc ±2
- 3. FAILURE WARNING PANELTEST LAMPS
- 4. PILOT BAY LAMP TESTTEST LAMPS

5. OBY & PBY MONITORSON/ADJUSTED

6. VIDEO TELEMETRY RECORDER

POWERON
 TAPELOADED/REWOUND
 TIME COUNTER
 DISPLAY SWITCHCOUNTER
 TIME COUNTER DISPLAYRESET
 LOCAL/REMOTELOCAL
 AUDIO LEVELS0 DB (EXCEPT PCM CH-3
 (VOICE) ADJUST TO LEVEL 2)
 PHONE LEVELMIDRANGE
 MODE SELECTNORMAL
 METER SELECTAS REQD
 ASSEMBLEOFF
 INSERT INDICATIONSOFF
 TAPE TRANSPORT INDICATORSOUT

7. PANEL INTERACTIVE

STEPS 7 (CBX) & 8 (PBX)COMPLETED

8. ELECTRICAL POWER TO UAVON

UAV COMM & VGU SWITCHESON
 ERC & BATT SWITCHESOFF
 STATION #SELECTED
 UAV #SELECTED
 FREQUENCY SELECTION
 THUMBWHEELSSET
 STATION XMTRSON/LOW
 REFLECTED POWERTESTED
 UAV XMTRON/LOW
 TRANSPOFF
 RH DELAYOFF
 PRI UPLSHORT/SECURE
 RCVR SIGNAL STRENGTH>6
 NO REPORT LIGHTOFF
 PRI/SEC LINK LOSS LIGHTSOFF
 COMMANDING LINKSECONDARY

9. PRESETSELECTED

a. ALTIMETER CAL AND WARNING SET

(1) SEA LEVEL (FT)40
 (2) FIELD LEVEL (FT)4
 (3) SEA LEVEL QNHRECORD
 (4) FIELD LEVEL QNHRECORD

10. PILOT DISPLAY PANEL

a. WARNING LIGHTS

LOW IASON
 LOW ALTON
 BATT FAILON
 GEN FAILON
 ENG CUTON

All other caution/warning lightsOUT

b. UAV FLIGHT/SYSTEMS DATA

ENG RPM0
 ENG TEMPOAT
 FUELCHECKED
 BUS VOLTAGE28V (±2)
 ATTITUDE INDICATORCHECKED
 IAS0-20
 RATE OF TURN0
 TRACKING AZIMUTH
 NEEDLECHECKED UAV HEADING
 NEEDLEVERIFY HEADING
 FL/SL SWITCHFL
 RATE OF CLIMB0
 MISSION TIMERESET
 LOCAL TIMESET

11. PILOT CONTROL DESK

DISENG/AUTOPLTENGAGED
 MASTER/CAUTIONOFF
 FLT TO/LDTO/LD
 GEN RESETOFF
 REPORT INHIBITOFF
 LIGHTSOFF
 LAUNCH MODEOFF
 PROG COUNTEROFF
 NAV TO COOROFF
 AUTOLND GO ARNDOFF
 CAMERA GUIDEOFF
 KNOB CONTROFF
 STICK CONTRSELECTED
 PLT BOXSELECTED
 COPLT BOXOFF
 KNOB CONTROLS
 ROLL0
 IND AIRSPEED60 KTS
 HEADINGAS REQD
 ALTITUDE1000 FT
 ROLL/READYOFF
 IAS/READYREADY
 HDG/READYOFF
 ALT/READYREADY

12. PILOT CONTROL TABLE

PILOT BOX (PBX)

READY LIGHT.....ON
 FLIGHT CONTROL
 SURFACE LIGHTS.....ON
 ENGINE SWITCH.....ON
 TRIM WHEELS.....CENTERED
 THROTTLE.....IDLE

11.19 PRESETS (SHIPBOARD)

1. ALT CAL & WARNING (PRESET 1)

- a. SEA LEVEL (FT).....40 FT
- b. FIELD LEVEL (FT).....4 FT
- c. SEA LEVEL QNHRECORD
- d. FIELD LEVEL QFE.....RECORD
- e. LOW AIRSPEED LIMIT (KTS).....60 KTS
- f. LOW ALTITUDE WARNING (FT)....300 FT
- g. LOW FUEL WARNING (LTRS).....10 LTRS

2. RETURN HOME (PRESET 2)

- a. CRUISE ALT.....3, 6, 9, 12 KFT
- b. CRUISE SPEED60, 70, 80 KTS
- c. FINAL ALTITUDE-1, 1, 3, 5 KFT
- d. CLIMBING SPIRALYES OR NO
- e. RETURN HOME
 COORDINATESSHIPS COORD
 (Update every 10 minutes during flight)
- f. NAV PROGRAMMER.....RETURN HOME
 (Same as last active nav prog way point)

3. NAVIGATION PROGRAMMER / MISSION COMPUTER (PRESET 3)

Complete after RATO Upload

4. RANGE CALIBRATION (PRESET 4)

Complete after RATO Upload

5. METEOROLOGICAL DATA (PRESET 5)

UPDATE AS AVAILABLE

- a. MODE SELECTION

- b. PRESSURE TABLE

- c. WIND TABLE

- d. TEMP TABLE

6. CAMERA GUIDE (PRESET 6)

SET DEFAULT VALUES

- a. CIRCLING RADIUS1.0 KM
- b. CIRCLE—TARGET DISTANCE0 KM
- c. CIRCLE—TARGET AZIMUTH.....0 DEG

7. GEOGRAPHICAL DATA (PRESET 7)

- a. TARGET ALTITUDE.....AS REQD
- b. STATION COORDINATE
 (Update every 10 minutes during flight)
 (Set AUTO POSITION UPDATE to NO to update the station coordinates.)
- c. STATION ALTITUDE.....AS REQD
- d. AUTO POSITION UPDATE.....YES
- e. GRID ZONE INPUTNO
 (YES if system will not set grid zone)
- f. GRID ZONEAS REQD
- g. MAG DECLINATIONAS REQD

8. TRACKER CALIBRATION (PRESET 8)

- a. AZIMUTHNA
- b. CORRECTION OFFSET0
- c. MASKED ZONE AAS APP
- d. MASKED ZONE BAS APP
- e. AUTO SHIP HEADING UPDATEYES
- f. OWN SHIP TRUE HEADINGAS REQD
 (Use if heading input is unavailable)

9. RETRIEVAL NET DATA (PRESET 9).....N

10. RPV DATA (PRESET 10)

- a. ZERO FUEL WEIGHT.....___ KG

- b. RPV MODELAS REQD
- c. PAYLOADAS APP
- d. CAMERA CONTROL1 OBY
- e. MISSION COMPUTERYES

11. NAVIGATION DATA (PRESET 11).....AS REQD

12. GPS INITIALIZATION (PRESET 12).....NOT USED

13. MISSION COMPUTER (PRESET 13)

- a. GENERALUPDATE

14. MULTIFUNCTION TEST POINTS (MULTIFUNCTION 4)

- a. 51
- b. 52
- c. 53
- d. 56
- e. 01

not to be greater than 30 KTS from any direction during net erection. Advise MC if winds cannot be brought below 30 KTS relative.

- c. Determine relative winds and ship's course/speed for launch and pass to mission commander whether port or starboard side launch is prepared.

2. Approximately 60 min. prior to launch (or when requested), if flight quarters not already set:

- a. Sound flight quarters, announce:

“Flight quarters, flight quarters, all hands man your flight quarters stations for UAV operations. All hands remain clear of the flight deck while conducting UAV operations. Remove all hats topside. Now flight quarters for UAV operations.”

(FOXTROT at the DIP)

- b. Man the sound-powered phone circuit to coordinate with the Mission Commander in the GCS and the Air Officer in PRIFLY.

- c. Establish sound-powered phone communications with:

Note

11.20 OOD CHECKLIST FOR UAV OPERATIONS (SHIPBOARD)

- 1. Approximately 1.5 hours prior to launch (or when requested):
 - a. Grant permission to UAV Det to erect recovery net.

Note

The flight deck will be fouled until the UAV recovery net is derigged. The UAV recovery net can be derigged in under ten minutes to clear Spot One in the event of an emergency involving AH/UH-1 or H-46 helos. Full derigging will take approximately 20-30 minutes after notification to clear Spot Two or after UAV launch.

- b. Minimize ship's maneuvering consistent with safety while erecting net. Relative winds are

STATION	MANNED	READY
(1) GCS (MC)	_____	_____
(2) HELO CONTROL	_____	_____
(3) CIC	_____	_____
(4) BRIDGE	_____	_____

Notify the MC (GCS) and PRIFLY of all course and speed changes during final launch procedures and at all times when the EP is controlling the UAV (immediately after launch and during final approach for recovery).

3. Approximately 45 minutes prior to launch:

- a. Verify FLT QTRS manned and ready with MC (GCS).

- b. Authorize “Amber Deck” when requested by MC via Air Officer (required for RATO loading).
- c. Confirm FOX CORPEN/Speed (See launch wind charts).

FOX CORPEN for launch _____ °T
 Speed: _____ KTS

Note

Verify desired relative wind against UAV wind envelopes and with Mission Commander.

- d. UAV Launch Angle—90 deg. relative port/starboard.
- e. MC reports commencement of RATO upload.

4. 5 minutes prior to launch:

- a. Turn to FOX CORPEN/Speed for launch.
- b. Grant “GREEN DECK” when requested by MC via PRIFLY and when ship is on FOX CORPEN.
- c. Close up FOXTROT.

5. Just prior to launch:

- a. GCS relays 10 sec launch count down via sound-powered phone.

Note

If RATO misfires, maintain course and speed. MC shall execute RATO Misfire Checklist.

6. Post launch:

- a. MC will report status of launch (RATO clear/Aborted).
- b. Remain at FOX CORPEN (if possible) until UAV control checks are complete and MC reports “Good Flyer.”
- c. If helo operations are not scheduled following UAV launch, pass, “Stand down from UAV flight quarters. Expect to re-man at short notice.”

7. 30 minutes prior to UAV recovery:

- a. If helo operations are not in progress, pass, “Re-man all flight quarters stations for UAV operations.”
- b. Determine FOX CORPEN/Speed for recovery:

FOX CORPEN for recovery _____ °T
 Speed: _____ KTS

Note

Verify desired relative wind against UAV wind envelopes and with Mission Commander.

8. NLT 10 minutes prior to recovery:

- a. MC will verify UAV recovery net rigged/flight deck crew ready.
- b. MC will request “GREEN DECK” via PRIFLY.
- c. Turn to FOX CORPEN for recovery.
- d. Close up FOXTROT.
- e. Grant “GREEN DECK” to MC when on recovery course/speed. Verify winds are within recovery envelope.

9. Recovery/Post Recovery:

- a. At recovery PRIFLY will announce UAV recovery over 5MC.
- b. Post recovery/refueling:
 - (1) After recovery, while UAV is being fueled/refueled, announce over the 1MC, “The Smoking Lamp is out Main Deck and below, aft of frame 120 while conducting UAV fueling operations.”
 - (2) Upon completion of UAV fueling/refueling operations relight the Smoking Lamp.
 - (3) Consistent with helo flight operations, secure from UAV flight quarters.

11.21 PRIFLY CHECKLISTS (SHIPBOARD)

11.21.1 PRIFLY UAV Pre-launch Checklist.

Commence NLT 60 minutes prior to scheduled UAV launch:

1. Establish comms with:
 - a. Bridge
 - b. CIC
 - c. Flight Deck Crew
 - d. Mission Commander (GCS).
2. Test 5MC.
3. Test deck status lights and rotary beacon.
4. Test flight deck crash alarm.
5. For Night Operations:
Test amber floodlights.
6. PRIFLY/Flight Deck Manned and Ready:
 - a. Phone Talker (as required)
 - b. Flight Deck CPO/LPO
 - c. Fire Party
 - (1) Scene
 - (2) Five hose team members.
 - d. Corpsman.
7. Report to the OOD and MC:
"PRIFLY Pre-launch Checklist complete".

11.21.2 PRIFLY UAV Launch Checklist

1. Approximately 45 minutes prior to scheduled launch, MC should request "AMBER DECK" for RATO upload.
2. When the OOD grants "AMBER DECK," announce on the 5MC:

"AMBER DECK. Clear the flight deck of all unauthorized personnel. Flight deck helmets on and

buckled, goggles down, sleeves rolled down and buttoned. Stand clear while loading RATO."

3. Crew Chief will report RATO uploaded, all hands clear, and ready for engine start.
4. When permission is given to start engine, announce on the 5MC:

"Stand by to start UAV."
5. After engine start and all post-start checks complete, MC will request "GREEN DECK" for UAV launch.
6. When OOD grants GREEN DECK, announce on the 5 MC:

"GREEN DECK. On the flight deck, stand by to launch UAV."
7. After UAV launch report "RATO clear."
8. After "Good Flyer" report from MC, set "RED DECK" and, if no helo operations scheduled, stand down from flight quarters as required.

11.21.3 PRIFLY UAV Pre-Recovery Checklist.

Complete NLT 30 minutes prior to recovery:

1. Establish comms with:
 - a. Bridge
 - b. CIC
 - c. Flight Deck Crew
 - d. Mission Commander (GCS).
2. PRIFLY/Flight Deck manned and ready:
 - a. Phone Talker
 - b. Flight Deck CPO/LPO
 - c. Fire Party
 - (1) Scene
 - (2) Five Hose Team Members.
 - d. Corpsman.
3. Verify recovery net is rigged and ready for recovery.

11.21.4 PRIFLY UAV Recovery/Post Recovery Checklist

1. Approximately 10 minutes prior to recovery MC will request "GREEN DECK" for UAV recovery.
2. When OOD grants GREEN DECK, announce on the 5MC:

"Green Deck. All unauthorized personnel clear the flight deck. Flight deck helmets on and buckled, goggles down, sleeves rolled down and buttoned. Stand by to recover UAV."
3. After UAV is in the net:
 - a. Announce on the 5MC:

"UAV in the net, RED DECK."
 - b. Engage RED DECK light.
4. While UAV is lowered to flight deck, announce on the 5MC:

"On the flight deck, all unauthorized personnel remain forward of Spot 1 while lowering UAV and Recovery Net System."
5. Inform OOD, "UAV fueling in progress."
6. When fueling/refueling is complete, and no helo operations are scheduled, inform the OOD to secure from flight quarters.

11.22 CIC UAV CHECKLIST

1. Prepare a written tactical flight brief utilizing the appropriate portions of the designated format (Figure 11-3) approximately two and one-half hours prior to the scheduled launch.
2. Check air-plan for any changes.
3. Check message traffic concerning operations area.
4. Brief aircrew and TAO on tactical data and provide a copy of the briefing sheet to the aircrew, TAO, and OOD.
5. Check wind repeaters for proper operation.
6. Check all radio, sound-powered phone, and radar equipment for proper operation and frequencies (EMCON permitting).

7. Man appropriate flight quarters stations, including Air Controller and JA phone talker.
8. Test intercom and sound-powered phone circuits.
9. Report "Manned and Ready" to OOD.
10. Coordinate control of UAV in accordance with desired tactical employment and safety of flight considerations.
11. Plot UAV positions and tactical information and make recommendations when appropriate.
12. Keep Bridge informed of progress of flight.
13. Update MC on weather, EMCOM, and changes to flight requirements as appropriate.

11.23 RATO MISFIRE PROCEDURES

In the event of a RATO misfire during the launch sequence, the MC will announce misfire and relay such over the sound-powered phone circuit. Refer to emergency procedure 13.2.1, RATO MISFIRE.

11.24 UAV WATER RECOVERY PROCEDURES

In the event that an unmanned air vehicle enters the water within visual sight of the ship, the following action shall be taken for the safe and speedy recovery of the air vehicle.

Note

Safety of personnel is paramount. Abort the evolution if at any time safety of personnel is in jeopardy.

11.24.1 UAV Mission Commander

1. Inform the bridge that the UAV has entered the water, the approximate time of water entry, and approximate location relative to the ship.
2. Monitor the progress of the recovery evolution.

11.24.2 OOD

1. Maneuver the ship in order to position the UAV on the starboard side.
2. Inform the First Lieutenant that a UAV is in the water, and direct him to prepare the recovery boat and the B&A crane.

MISSION:	
Type/Purpose _____	(NGFS, SURV, RECON, VID, SSC, TRNG)
Date _____	Duration _____ Payload _____ (D/N)
Operation area _____	
Other Ship evolutions _____	
FLIGHT DATA:	
Launch time _____	Land time _____
Altitude assigned _____	Altitude restrictions _____
Target/Waypoint coordinates _____	
Search Sector _____	
Controlling Agency _____	Controlling frequencies _____
Airspace restrictions _____	
Other known air traffic _____	
WEATHER: (attached weather brief sheet)	
Special instructions (ROE, Over-flight Guidance, Sensitivity, etc.) _____	
ADDITIONAL INFORMATION: (alert status, deck coord., gun firing, etc.) _____	

Figure 11-3. CIC UAV Operations Brief Sheet

11.24.3 Master-At-Arms Division will ensure proper crowd control and that only official Navy photographs are taken.

11.24.4 UAV Crew Chief will take hoisting strap assembly and tending lines to the Boat Crew.

11.24.5 Boat Crew

1. Under the direction of the Boat Officer, position for UAV recovery.
2. Upon arrival at the UAV, evaluate the condition of the UAV and determine if it can be safely retrieved.
3. Attach one strap around the nose landing gear.
4. If well deck is available, tow UAV into well deck.
5. If well deck recovery is not available, tow air vehicle to the ship's B & A crane.
6. When alongside and under the B & A crane, attach a second wire strap around engine. Once the second wire strap is attached, the first strap around nose landing gear will be loosened and repositioned around fuselage as close to the wings as

possible. The straps will then be attached to the B & A crane hook.

7. When the air vehicle has been raised until nose landing gear has cleared the water, attach a tending line around the port or starboard tail boom and one tending line around the nose landing gear. A salvage diver, when available, will accompany the recovery boat to assist in positioning the straps and links.

11.24.6 B & A Crane Deck Crew

1. When given the signal from the Boat Officer, raise the air vehicle while the Boat Crew keeps tension on the tending lines, keeping air vehicle in a flat attitude.
2. Once the air vehicle reaches the B & A crane, the Deck Crew will position the air vehicle over the deck and lower the air vehicle to the deck.
3. When safely on the deck, disconnect the hoisting straps and tending lines.
4. Turn the UAV over to UAV Maintenance Chief for emergency reclamation.

11.24.7 Ship Lookouts shall relay any sightings of the UAV, green dye marker, or debris to the OOD via any means available. Should the ship pass close aboard the UAV prior to boat launching, a visual marker such as float coat with strobe should be thrown in the water to mark the UAV position.



Do not use a smoke or flare to mark the UAV position due to the presence of AVGAS.

PART IV

Flight Characteristics

Chapter 12 — Flight Characteristics



CHAPTER 12

Flight Characteristics

12.1 TAXIING

The UAV is taxied with engine running and the throttle at idle. Three people are required to taxi the aircraft, a crew chief and two handlers. Ground handlers should guide the UAV during taxi by holding the leading edge of the vertical stabilizers.



Do not put excessive force high on the vertical stabilizers. Turns should be accomplished by pushing down on the booms, raising the nosewheel to avoid damage to the nosewheel linkage.

12.2 TAKEOFF

12.2.1 Rolling Takeoff. Lineup should be accomplished using the crew chief to align the aircraft on runway centerline, making sure that sufficient straight roll is allowed. When the checklist is complete and clearance for takeoff has been given, the EP will announce “going to max power.” The IP will announce max RPM. A minimum of 6700 must be reached before the aircraft is released for takeoff roll. The EP will ask for a second call to verify sufficient RPM. Full throttle should not be maintained for more than 10 seconds during this period. If the RPM is insufficient, the EP will bring the throttle back to idle, and the crew chief will taxi the aircraft back to the maintenance line.

When the EP has received the second RPM call (minimum 6700), he will announce “release.” During the takeoff roll, directional control of the aircraft will require gentle and smooth application of control inputs. Very small inputs will result in smooth corrections to yawing tendencies caused by low speeds and crosswinds. From the start of the takeoff roll, until the aircraft is airborne, the IP will announce airspeeds in 5 kt increments only. As the aircraft accelerates and reaches

computed rotation speed (but not less than 58 KIAS), light back-pressure on the elevator stick should be applied to lift the aircraft off the runway. Too much back stick will result in the tail section impacting the runway as the nose of the aircraft comes up.

WARNING

Do not use rapid or abrupt movement of the nosewheel steering during takeoff roll. This could result in over control, and could create an extremely hazardous condition to the flight crew and UAV. Rudder effectiveness also increases as airspeed increases.

Engine or propeller malfunction during takeoff can cause directional control problems as well as have an adverse effect on acceleration and climb. Utilization of the abort procedures will enable the pilot to maintain directional control of the UAV while a safe stop is accomplished. An abort decision should be based on available runway length, rotation speed, environmental conditions, obstruction clearance, and takeoff ground roll.

12.2.2 Crosswind Takeoff. Directional control is more urgent at the early part of the takeoff roll, and at times holding the correct amount of rudder will be necessary. As acceleration increases, ease out of the excessive rudder as necessary to maintain centerline and directional control.

12.3 CLIMB AND CRUISE

12.3.1 Climb Procedures. When the aircraft is definitely airborne, the remaining length of the runway in use will determine if an abort can be executed safely. Be sure to discuss this possible situation in the preflight brief. Climb to 300 ft AGL or 1.2 km before attempting to execute the crosswind turn.

Note

300 ft. gives the EP enough altitude to attempt a safe return to the runway in case of engine failure. 1.2 km gives the EP good visual, at low altitude, to make the crosswind turn safely.



If 300 ft. has not been accomplished at the 1.2-km point and the crosswind turn is executed, local terrain must be observed for UAV clearance.

Hold the aircraft in a steady turn through the crosswind, and maintain airspeed of 60-70 kts, climbing into the downwind to a minimum altitude of 500 ft AGL. Once a safe altitude for controllability checks has been reached, the EP will notify the IP to standby for controllability checks.

With an airspeed of 70 kts, the EP will pull “full up” for maximum climb until the IP states the degree of pitch, maintaining greater than 60 kts. The EP will bring the throttle to idle and at the same time nose the UAV forward “full down” until a reading of negative pitch has been observed by the IP. If the UAV has increased its airspeed above 70 kts, be sure to slow the UAV to a safe airspeed of 70 kts before attempting the next control check. With wings level, move the ailerons “full right” until a reading of maximum right roll has been observed, then level the wings and move the ailerons “full left” until a reading of maximum left roll has been observed. Either direction may be flown first depending upon UAV position near runway and EP discretion. Once again level the wings and maintain controlled airspeeds. A low-level pass down the runway may be necessary for an altitude check.



All stick movements should be gentle and smooth. Rapid and abrupt movements could have adverse effects on the performance of the UAV.

12.3.2 Maneuvering. The UAV was not designed for aerobatic maneuvers. The maximum allowable maneuvering load factor is +3g/-1.5g. Large abrupt control movements must be avoided.

12.3.3 Stall Recovery. The optimum method of stall recovery in sticks is the application of forward stick (down elevator) to reduce the angle of attack and the addition of power as necessary to maintain angle of attack in the normal flying range. Aileron and rudder may be used as necessary to maintain balanced flight or reduce yawing motions.

12.3.4 Changing Flight Modes. When changing from sticks mode to knobs mode, match the control knobs as closely as possible to the UAV’s current altitude, airspeed, and heading to avoid abrupt UAV movements.

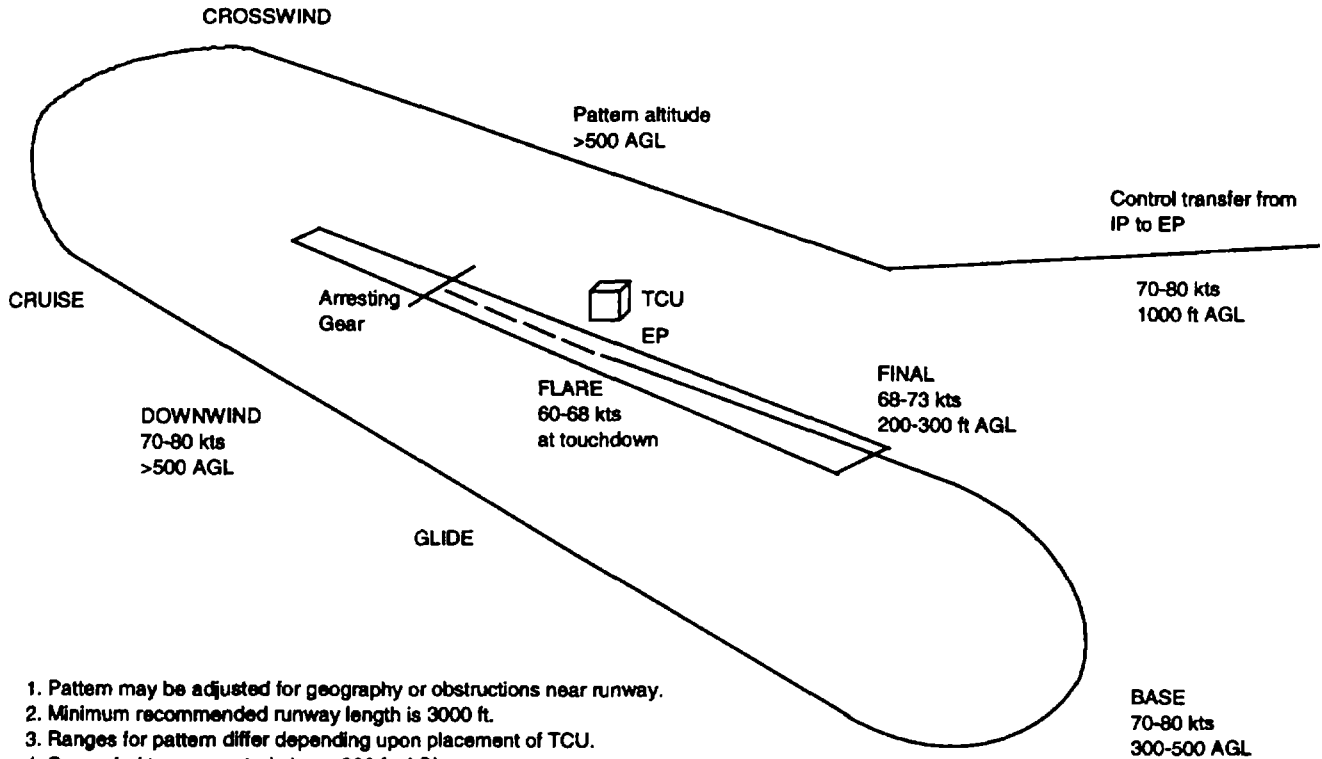
12.3.5 Autopilot Disconnect (DISCO) Flight. Experience in autopilot disconnect (DISCO) flight over the history of the airframe reflects a severe departure from controlled flight. Depending on entry attitude the operator should anticipate a departure from wings level and nose low spin if corrective action is not taken. Trim positions should be set in level, controlled flight to eliminate unwanted changes in UAV attitude. All control inputs should be small and made gradually. The operator should anticipate extreme attitudes while in DISCO and must be ready to make immediate corrective inputs to the controls.

Although practicing DISCO flight regularly is highly encouraged, consideration must be given to local weather conditions and visibility, and should be thoroughly discussed during briefing. DISCO training should not be attempted by the IP if he does not have a discernible horizon with the video platform caged. DISCO should not be practiced by IPs or EPs in high wind conditions.

12.4 LANDING

12.4.1 Normal Landing (See Figure 12-1). Normal landing at sea level with no wind and warm temperatures should be executed at a safe airspeed. Use elevators and throttle control to settle the UAV into the landing zone. The UAV should be landed main gear first, with the nosewheel held off with elevator control. As the nosewheel touches the runway, be prepared to input smooth steering corrections as required to maintain runway centerline. Engine cut should be performed after the UAV has settled onto the runway, at idle power, to eliminate the possibility of becoming airborne again. Maintain directional control of the UAV until engagement of the arresting gear.

12.4.2 Crosswind Landing. The EP may land the UAV by either of two methods. The first is to adjust heading into the wind, maintaining wings level (crabbing). This method can be used until just before



1. Pattern may be adjusted for geography or obstructions near runway.
2. Minimum recommended runway length is 3000 ft.
3. Ranges for pattern differ depending upon placement of TCU.
4. Crosswind turn executed above 300 ft. AGL.
5. IP calls airspeed, altitude and range throughout pattern on ICS.
6. EP cuts engine after landing and engages arresting gear.

Figure 12-1. Typical Landing Pattern

touchdown, when the UAV heading must be corrected to runway centerline. The UAV can also be flown with one wing slightly down into the wind and opposite rudder applied (slipping). This results in an increased rate of descent, but the UAV can be flown to landing with the heading of the UAV on runway centerline.

12.4.3 Autopilot Disconnect (DISCO) Landing



During actual DISCO EMERGENCY, the controlling and backup stations' IPs should have payload caged and DISCO selected in the event either is required.

Once in DISCO, adjust trim for level flight. Traffic pattern entry should be from a lower than normal altitude.

A tighter pattern should be flown to enhance visual reference of the UAV, at an airspeed that is 3-5 knots above normal. This altitude is contingent on geographical features of the area of operation.

Enter the downwind leg maintaining a slight nose low attitude with wings level. Adjust all flight inputs smoothly to avoid over-control of the UAV. Begin base turn, avoiding excessive bank angles through wings level on final. Continue on final approach utilizing power as necessary to control the aircraft rate of descent. Input any required corrections to maintain the UAV's orientation to the runway centerline. At approximately five (5) feet AGL, begin to flare aircraft to touchdown.

In the event of a missed approach, apply full power and rotate the air vehicle once at rotation speed. Repeat the traffic pattern until a smooth, safe landing is attained.

PART V

Emergency Procedures

Chapter 13 — Emergency Procedures

CHAPTER 13

Emergency Procedures

Emergency procedures are presented by flight phase. Those emergencies that are executed identically, regardless of phase, are only listed once, generally in the INFLIGHT section.

Although the primary method of recognizing a failure or malfunction is the associated warning lamp, some emergencies can occur with no such indication. The decision to execute a particular set of emergency procedures may not be based solely on the illumination of a warning lamp but will include analysis of all indicators, such as instruments, warning lamps, and payload video. In the event of more than one warning lamp being lit, those lamps that are red in color shall be reacted to prior to yellow warning lamps.

Finally, emergency procedure checklists cannot cover every possible contingency. Compound emergencies have not been addressed. Execution of any emergency procedure shall be conducted using all available knowledge and experience.

Note

For all emergency procedure checklists, an asterisk (*) denotes those items that shall be performed from memory.

13.1 GROUND EMERGENCIES

13.1.1 FIRE ON DECK

- * 1. NAVLIGHTS.....ON (EP)
- * 2. ENG.....CUT (EP)
- * 3. FIRE CONTROL BOX.....OFF (CC)
- * 4. SAFE/ARM Switch.....SAFE/OFF (CC)
- 5. FireEXTINGUISH (ALL)

WARNING

If RATO bottle is on fire, it may explode. Do not approach the bottle for 30 minutes after fire and flames have been extinguished. RATO Safety Officer shall take control of the area and accomplish the post-shut down checks on the UAV. EOD shall safe the rocket bottle for disposal.

WARNING

If the fire occurs while positioned on the pneumatic launcher, all personnel shall remain behind the wing line while fighting the fire.

13.1.2 ENG FAILS TO CUT ON COMMAND

Note

The ENG CUT switch will not work in mixed mode flight. Full sticks must be selected to cut the engine from that control box.

- * 1. ATTEMPT A GO AROUNDIF ABLE (EP)

CAUTION

Do not attempt a go around unless the ENG CUT switch has remained on for at least 2 secs (approx 230 ft).

- * 2. FULL STICKS.....CONFIRM (IP)
- * 3. "STURNS"EXECUTE (EP)



Although S turns will help slow the vehicle, ensure the UAV engages the arresting gear perpendicular and as close to centerline as possible.

- * 4. ENG CUT SWITCH.....REMAIN OFF (EP)

13.1.3 POWER FAILURE (CONTROL STATIONS)

This emergency procedure should be utilized for power failure warnings in GCS, PCS and TCU.

- * 1. POWER DISTRIB. VERIFY SWITCHES/PANELWARNINGS (MC)

Note

If the power failure is to one of the bays or TCU, the affected bay or component warning lamps will be illuminated on the PDP. If power to the shelter is affected, the interior lights, OBY monitors, and the plotter are automatically disabled. For UPS configured GCS, this condition is not applicable.

- * 2. UAV CONTROL.....VERIFY (IP/EP)

Note

Payload controls will still function. The Payload Operator may use the PTMP to view the video.

- * 3. FAIL CHECK.....CHECK (IP)
- 4. ALTERNATE PWR SOURCE.....USE (MC)
- 5. UAV HEADING.....RTB (IP)

If an alternate power source is not immediately available:

- 6. AIRSPEED.....INCREASE (IP)
- 7. PILOT TV MONITORSAS REQD (IP)
- 8. OBY SecureAS REQD (PO)

Note

The Mission Commander may wish to turn the monitors off to conserve battery power.

This should be considered if the UAV is beyond 100 km from station.

- 9. PCS / GCS (Non-controlling).....AS REQD (MC)

Note

The unused control station may be powered down in the event the controlling station battery power is the only source of power. Presets must be re-entered before control is transferred.

- 10. CONTROL STATION TRANSMITTER.....LOW PWR / AS REQD (IP)



The UAV may execute Return Home if the UAV is at extended ranges once Low Power on the transmitters is selected.

- 11. CONTROL STATION TRANSFERAS REQD (IP)
- 12. LAND.....AS SOON AS POSSIBLE (IP)

13.2 LAUNCH AND RECOVERY EMERGENCIES

13.2.1 RATO MISFIRE

- * 1. THROTTLEIDLE (EP)
- * 2. CBXMANNED (EP)



The EP shall remain at his station until engine shutdown. In the case of inadvertent launch, immediately select full throttle.

- 3. Fire Control Box.....OFF (CC)
- 4. SAFE/ARM Switch.....SAFE (CC)
- 5. Fire Line Cable W1DISCONNECT (CC)
- 6. Shorting Jack J1INSTALL (CC)
- 7. Nav Lights.....ON (EP)

8. ENG.....CUT (EP)

6. Arresting GearENGAGE (EP)

WARNING

If RATO bottle is on fire, it may explode. Do not approach the bottle for 30 minutes after fire and flames have been extinguished. RATO Safety Officer shall take control of the area and accomplish the post-shut down checks on the UAV. EOD shall safe the rocket bottle for disposal.

13.2.4 HUNG RATO BOTTLE

- 1. Hdg to Hung
Ordnance Jett AreaSET (IP/EP)
- 2. High G ManeuversEXECUTE (IP/EP)

Note

Attempt to dislodge bottle by entering a shallow dive, not to exceed 20° pitch down or 90 KIAS. Smartly pull positive g's by bringing nose up to the horizon. Repeat a maximum of three times.

13.2.2 PNEUMATIC LAUNCHER FAILURE

- * 1. THROTTLEIDLE (EP)
- * 2. CBXMANNED (EP)

CAUTION

The EP shall remain at his station until engine shutdown. In the case of inadvertent launch, immediately select full throttle.

- 3. Launching Control
Box S2 switch.....OFF (CC)
- 4. V6 Valve.....CLOSED (CC)

CAUTION

Do not get nose high as bottle may impact prop on release.

If RATO fails to jettison:

- 3. LandAS REQD (ALL)

WARNING

Hung RATO bottle may jettison on landing or net recovery. Clear projected flight path of non-essential personnel. Plan touchdown at or beyond the EP position to minimize potential danger from RATO bottle releasing from UAV during landing. Arresting hook could miss arresting gear cable due to RATO bottle obstruction.

WARNING

When closing the V6 valve, personnel must stay clear of the UAV launch path in case of inadvertent launch.

- 5. Nav Lights.....ON (EP)
- 6. ENG.....CUT (EP)

13.2.5 LOSS OF VISUAL CONTACT

13.2.3 ROLLING TAKEOFF ABORT

- * 1. THROTTLEIDLE (EP)
- * 2. NAV LIGHTSON (EP)
- * 3. ENG.....CUT (EP)
- 4. FLT-TO/LDTO/LD (IP)
- 5. Payload ShieldDEPLOY (PO)

- * 1. NOTIFY CREW.....ALL (EP)
- * 2. KNOBS CONTROL
(ROLL 0°)SELECT (IP)
- 3. Steer UAV
using Roll Knob.....SAFE HDG (IP)



If the Heading knob does not exactly match the current UAV heading, the UAV will execute an immediate turn once KNOBS control is selected. Therefore, to prevent inadvertent turns into obstacles, roll control with 0° should be readied prior to selecting KNOBS.

13.2.6 ENGINE CUT (EP AT THE CONTROLS)



The decision to return to the runway should only be made if conditions allow for a safe recovery. Consideration shall be given to winds, operator experience, altitude, and distance. A safe landing can generally be attempted for UAV altitudes above 300 ft AGL. In all cases, the IP shall frequently provide airspeed and altitude information to the EP.

- * 1. OPTIMUM GLIDE.....SET (EP)

Note

Optimum glide is achieved at +3° pitch.

- * 2. FLT-TO/LDTO/LD (IP)
3. Payload ShieldDEPLOY (PO)



The payload shield should only be deployed if time permits, especially when engine cut occurs under PCS command.

- 4. Land or Ditch in a safe areaAS ABLE (EP)

13.3 IN-FLIGHT ENGINE EMERGENCIES

During in-flight emergencies particular attention shall be given to the selected flight mode in all stations involved in the flight event. Split site operations may require communications between control stations in order to properly prepare for a precautionary or emergency recovery of the Pioneer UAV.



If any station has selected Autopilot Disengage (DISCO) for an emergency condition, all stations shall select Autopilot Disengage.

13.3.1 ENGINE CUT (IP AT THE CONTROLS)

- * 1. SAFE HEADINGSELECT (MC)
* 2. OPTIMUM GLIDE.....SET (IP)

Note

Optimum glide is achieved at +3° pitch. With the engine off, the UAV will glide 2.9 km for every 1000 ft of altitude on a 6° glideslope (no wind, 0° pitch). By setting the camera to 6° depression, the crosshairs will indicate the approximate point of touchdown.

- 3. Ditch heading.....SET (IP)

Note

Although STICKS mode will function, KNOBS mode is the preferred method of setting optimum glide (+3° pitch) and fixed heading.

- 4. FLT-TO/LDTO/LD (IP)
5. Payload Shield.....DEPLOY (PO/IP)
6. UAV Location.....MARK (PO/IP)

13.3.2 ENGINE TEMP

Note

The REPORT INHIBIT light will normally illuminate coincident with an ENG TEMP warning light. This is a software anomaly and can be ignored.

- * 1. EDC DNL.....CHECK (IP)

If Eng Temp >260°C:

- * 2. RPM.....REDUCE (IP/EP)

If Eng Temp <110°C:

- * 3. RPMINCREASE (IP/EP)



In order to minimize the potential for catastrophic engine failure, all subsequent RPM adjustments should be done gradually.

Note

The most practical method for controlling RPM is to select STICK Throttle.

If Eng Temp >230°C but <260°C:

- 4. RPM Adjust.....AS NECESSARY (IP/EP)

If Eng Temp indicates 0°C:

- 5. Land.....AS SOON AS PRACTICAL (ALL)

Note

A reading of 0°C indicates a circuit failure. Actual engine temp cannot be determined. Avoid max or min RPM for extended periods.

- 6. Airspeed IncreaseAS ABLE (IP/EP)

- 7. LandAS SOON AS POSSIBLE (ALL)

13.3.3 STUCK THROTTLE

- * 1. RTB/SAFE Heading.....SELECT (ALL)
- 2. Sufficient Altitude / RPM to RTBDETERMINE (MC)

If insufficient altitude / RPM to RTB:

- 3. Full SticksSELECT (IP/EP)
- 4. Throttle (Idle to WOT).....CYCLE (IP/EP)
- 5. Abrupt Flight ManeuversPERFORM (IP/EP)
- 6. DITCHIF NECESSARY (ALL)

If sufficient altitude / RPM exists to RTB:

- 7. PBX / CBX WOT.....SELECT (IP/EP)
- 8. Manual Throttle.....SELECT (IP)
- 9. Land..... AS SOON AS PRACTICAL (ALL)



- Due to difficulty descending and landing with high RPM, consideration should be given to securing engine in overhead pattern (with landing assured) or on short final.
- A transient non-responsive throttle may indicate impending throttle servo failure. If transient non-responsive throttle condition occurs, execute Stuck Throttle Emergency Procedure without delay.

Note

If landing at runway, it may be necessary to turn on NAV lights and cut engine on short final or overhead.

13.3.4 HIGH IDLE (ABOVE 4800 RPM) WITH MIN THROTTLE

- 1. NAV Lights.....ON (EP)
- 2. Pattern (for shallow approach).....EXTEND (EP)
- 3. Maximum electrical load setVERIFY (IP)
- 4. Land.....AS SOON AS PRACTICAL (ALL)

Note

Be alert to go around in the event of bounce at touchdown. If unable to land after several attempts, it may be necessary to turn on NAV lights and cut engine in flight on short final or overhead.

13.3.5 HIGH FUEL CONSUMPTION

- 1. Heading.....RTB/LAND (IP/EP)
- 2. Airspeed.....MAX (IP/EP)
- 3. EDC DNL/Fuel Gauge.....COMPARE (IP)

- 4. Climb.....AS REQD (IP)

Note

Calculate time required to land vs. time to fuel starvation. Climbing may provide more time and range after ENG CUT.

If unable to safely return:

- 5. Ditch.....SAFELY (ALL)

13.4 ELECTRICAL EMERGENCIES

13.4.1 GENERATOR FAILURE. A GEN FAIL light does not in and of itself indicate a catastrophic failure. It does, however, require the UAV to maintain all electrical requirements from the onboard backup battery. Depending on the charge of the battery and UAV power requirements of the UAV, this can amount to as much as 40 min. (5AH battery) or 20 min. (4AH battery), or as little as 2-3 min. for either. It is therefore imperative that the electrical load be reduced by the greatest amount possible and land as soon as possible to limit the possibility of a mishap. In addition to the checklist procedures, the flight crew should determine if recovery at the GCS or an alternate control site is feasible. If glide range and battery life charts indicate insufficient battery life for safe recovery at these sites, then an alternate landing site must be selected.

- * 1. GEN.....RESET (IP)
- * 2. NAV LIGHTS.....OFF (IP/EP)
- * 3. RPV XMTR.....LOW (IP)
- * 4. KNOBS/STICKS.....SELECT (IP)
- * 5. PLATFORM/VIDEO.....OFF (PO/IP)
- * 6. HEADING.....RTB/LAND (IP/EP)
- * 7. AIRSPEED.....MAX (IP/EP)

Once Payload Platform has caged and video is off:

- 8. Gen.....RESET (IP)



At this point, further attempts to reset the generator should not be conducted. A safe RTB or landing shall be made as soon as possible since battery life is limited. The preferred method for a rapid RTB is to select KNOBS control for heading and max airspeed, and deselect altitude. However, since any combination of flight modes can be used, care should be taken to choose that mode which can be most easily accomplished.

- 9. RPV XMTR.....AS REQD (IP)

Note

The decision to turn the RPV XMTR off should compare the benefits of increased battery life to the ability to monitor UAV response to flight control inputs.

- 10. NVC operating mode DR/GPS.....VERIFY (IP)
- 11. Test Point 53.....CHECK (IP)
- 12. ETE and Battery Life.....DETERMINE (IP)



Below 24 Vdc (TP 53 = 3.0), the servos become unreliable. Therefore, the decision to continue flight below that voltage should consider terrain, proximity to population and distance to a safe landing area. If the UAV is fast or high on the approach and battery voltage is 25 Vdc (3.125) or less, you should consider cutting the engine in flight. Go-around decision should be based on battery life remaining.

If unable to RTB:

- 13. Airspeed.....OPTIMUM GLIDE (IP)

Note

Optimum glide is achieved at +3° pitch.

- 14. FLT-TO/LDTO/LD (IP)
- 15. Video.....ON (IP)
- 16. Landing or Ditching Site.....SELECT (IP)

Note

Although caged, the payload in combination with a nose down attitude can be used to select an appropriate landing or ditching site.

- 17. Controlled Landing or Ditching.....ATTEMPT (IP)

13.4.2 BATTERY FAILURE. Increase of battery voltage at TP 53 to 4.00 does not mean that the battery is fully charged. Battery may be cumulative and any consumption of battery life must be monitored closely. Battery use during preflight should be avoided. If the BATT FAIL lamp is illuminated on deck but TP-53 is reading $\geq 3.62V$ and increasing, takeoff is permitted with the BATT FAIL lamp illuminated. Given a fully charged battery, a battery discharge for more than 1.5 mins will require immediate replacement of the battery prior to takeoff. Test points are not accurate at any time when program mode is in GCS mode.

- 1. NVC Operating Mode DR/GPS.....CONFIRM (IP)
- 2. Test Point 53CHECK (IP)

Note

The following test points can be used to further analyze the status of the battery pack:

TP	STATUS
53	Battery Voltage
52	One side of 4AH BEU
56	Charger Output
01	Bus Voltage

If TP-56 is 0 Vdc then the charger is not working and the decision to continue the mission should be based on whether or not TP-53 indicates a fully charged battery (at or near 4.0 reading). If TP-53 shows a steadily decreasing value with no other indications, then a shorted battery should be suspected. A

slowly increasing value of TP-53 is normal following a discharge. In this case, the BATT FAIL light will normally extinguish within minutes.

Note

This table is only valid for the 4AH battery packs. Battery life values for the 5AH pack should be as good or better.

TIME	TP-53	85 kts	95 kts	105 kts
(Min)	Vdc	No Wind Dist (km) Traveled		
1		2.6	2.9	3.2
2	3.08 ± .12	5.3	5.8	6.4
3	3.20 ± .12	7.8	8.7	9.7
4	3.30 ± .10	10.4	11.7	12.9
5	3.36 ± .08	13.1	14.6	16.2
6	3.40 ± .08	15.7	17.5	19.4
7	3.40 ± .08	18.3	20.5	22.6
8	3.44 ± .08	20.9	23.4	25.9
9	3.48 ± .04	23.5	26.3	29.1
10	3.48 ± .04	26.2	29.3	32.4
11	3.48 ± .04	28.8	32.2	35.6
12	3.50 ± .04	31.4	35.1	38.8
13	3.52 ± .04	34.0	38.0	42.1
14	3.52 ± .04	36.6	41.0	45.3
15	3.56 ± .04	39.3	43.9	48.6
16	3.60 ± .04	41.9	46.8	51.8
17	3.60 ± .04	44.5	49.8	55.0
18	3.62 ± .06	47.1	52.7	58.3
19	3.64 ± .08	49.7	55.6	61.5
20		52.4	58.6	64.8
25		65.5	73.2	81.0
30		78.6	87.9	97.2
35		91.7	102.5	113.4
40		104.8	117.2	129.6

If BATT FAIL remains lit:

- 3. Land.....AS SOON AS PRACTICAL (ALL)

13.5.1 NO REPORT

- * 1. UAV IN SIGHTLAND AS SOON AS POSSIBLE (ALL)
- 2. TrackingCHECK (IP)
- 3. RPV ANTOMNI (IP)
- 4. KNOBS ControlSELECT (IP)
- 5. HeadingRTB (IP)
- 6. Present location/Time.....RECORD (PO)
- 7. RPV XMTRCYCLE OFF/ON (IP)
- 8. RPV XMTRCYCLE LOW/HIGH (IP)
- 9. Dish ElevationADJUST (MC)
- 10. UAV PositionDETERMINE (MC)

Note

All available resources shall be used to determine the UAV position and ground track. This will include but is not limited to FAA or ATC, ship's radar, visual sighting, DR calculations, etc.

- 11. Fail Check.....CHECK (IP)

Note

This step will identify TCU problems.

- 12. Alternate stationCHECK & XFER (MC)
- 13. Notify Ground CrewCOMPLETE (MC)

If unable to locate:

- 14. Orbit/Ditch.....AS APPROPRIATE (MC)

13.5.2 DUAL UPLINK FAILURE

- 1. Control station indicators.....CHECK (IP)



EMI or proximity to another control station may cause intermittent loss of command.

- 2. Uplink XMTR indicatorsCHECK (IP)
- 3. PRIM/SEC XMTRHIGH (IP)
- 4. UPL Code.....SHORT (IP)
- 5. Fail Check.....CHECK (IP)
- 6. TCU Warning PanelsCHECK (MC)

Note

At a minimum, check the DC Distribution Panel, UHF Xmtr Power, VSWR warning lamps, and the CCB.

If unable to regain RPV control:

- 7. Emer control station XFER.....AS ABLE (MC)
- 8. Controlling agencyCONTACT (MC)

13.5.3 SINGLE UPLINK FAILURE

- 1. CODE PRIMUPLSHORT AS REQD (IP)
- 2. RPV ANTOMNI AS REQD (IP)
- 3. RH DelaySELECT (IP)
- 4. Affected XMTRHIGH (IP)
- 5. GCS/PCS/PWR Fail, Low PwrOUT (IP)
- 6. Dish Antenna ElevationAS REQD (MC)
- 7. HeadingCHANGE (IP)

Note

UHF Uplink loss may occur at extended ranges due to the relatively low signal strength of the UHF transmitter. Changing UAV heading and altitude may unmask the antenna and restore uplink.

- 8. UPL Code short/longAS REQD (IP)

Note

If C-Band uplink is lost for an extended period, sync can only be accomplished in SHORT.

- 9. ClimbAS ABLE (IP)

Note

Continued flight with only a single uplink may be conducted if operationally required. However, loss of the other uplink will cause the UAV to enter RH flight mode.

13.5.4 UAV FAILURE TO RESPOND (GCS LOCKUP). This checklist is executed whenever the UAV fails to properly respond to UPL commands. Other symptoms may include keyboard lock-up, inability to change flight modes, frozen instruments, or inaccurate system calculations.

- 1. Fail Check.....CHECK (IP)
- 2. Bays PBY SwitchCYCLE OFF-ON (MC)
- 3. UAV Response to Flt Cmnds.....CHECK (IP/EP)

If problem continues:

- 4. Fail Check.....CHECK (IP)

If no indicated GCS failures:

- 5. COMMUNICATION PANEL
(CCB) PWR Switch.....CYCLE (MC)
- 6. Alt Station Control XFERAS REQD (MC)

If control is established:

- 7. Presets.....RE-ENTER (IP)

Note

Only initializing the NAV Card is required.

13.5.5 EMERGENCY CONTROL STATION TRANSFER

- * 1. XFER STATION
PRIM/SEC XMTRSOFF (IP)
- * 2. KNOBS CONTROL
(ROLL 0°).....VERIFIED (RCV IP)



If the heading knob does not exactly match the current UAV heading, the UAV will execute an immediate turn once KNOBS control is selected. Therefore, to prevent inadvertent turns into obstacles, the roll loop should be readied and set to 0° prior to selecting KNOBS.

- * 3. RCV STATION
PRIM/SEC XMTRS.....ON/HIGH (IP)
- 4. Steer UAV using
Roll Knob.....SAFE HDG (IP)

13.5.6 PROG FAIL LIGHT ILLUMINATED (-30 CONFIGURED NVC)

Note

The PROG FAIL Light will illuminate if the current waypoint is in the same grid zone, but is an excessive distance away (300 or 400 km). This warning is cleared by reloading General Data (thereby changing current position), or by selecting a different way point (program leg). With the updated -30 configuration NVC card (ECNs 32055 and 32088) installed, the PROG FAIL Light also illuminates when the NVC card processor hangs up and stops communicating. If it does occur in flight, the operator should follow the procedures below:

- * 1. KNOBS/STICKSSELECT (IP)

Note

If the UAV was operating in PROG Mode when the warning occurred, the UAV will return to Knob control mode for each control loop that has the appropriate READY light already lit on the PCD. Any control loop that does not have a READY light lit will default to STICKS control mode.

- 2. PRESET 3 (NPL) / MISSION COMPUTER
MenuSELECT (IP)
- 3. MISSION/GENERAL
MenuSELECT (IP)
- 4. NVC Bypass (item #3).....SELECT +YES (IP)

Note

If the cause of the PROG FAIL light was an NVC card hang-up, then the PROG FAIL light should be extinguished. If not, cycle Step 4 to - no, and back to + yes. If this does not clear the warning light, examine one of the other causes (listed above). Normal flight operation (all modes of flight except Program Mode) can be resumed.

- 5. NVC Bypass (item #3)SELECT-NO (IP)
- 6. Normal Operations restoredVERIFY (IP)

13.6 FLIGHT CONTROL EMERGENCIES

13.6.1 FLIGHT CONTROL MALFUNCTION.

This emergency covers any instance of anomalous UAV response to flight control inputs. This includes but is not limited to A-PLT FAIL, A-PLT MAL, VGU drift or failure, and control box malfunction. Control malfunctions may occur without illumination of an associated warning lamp. If a failure occurs with one of the control box potentiometers, the CBX/PBX FAIL light may not illuminate nor transfer to an alternate control box. In such cases, only proper instrument scan will identify a possible problem.

- * 1. CONTROL BOXVERIFY (IP)
- * 2. FULL STICKSSELECT (IP)
- * 3. PLATFORMOFF (PO)

Note

Do not delay steps 4 - 7 while waiting for platform to cage.

- * 4. UAV ANTENNAOMNI (IP/PO)

Note

If the UAV is fully controllable after selecting STICKS, then it may be possible to return to KNOBS control by incrementally selecting one loop at a time until the problem reappears, then deselecting that loop.

If still uncontrollable:

- * 5. AUTOPILOTDISENG (IP/EP)
- * 6. CONTROL BOX/TRIMNEUTRALIZE (IP/EP)

If no recovery:

- * 7. THROTTLEIDLE (IP/EP)
- * 8. INSTRUMENTS/UAVMONITOR/
RECOVER (IP/EP)

Note

Monitor payload video, VSI, rate of turn to identify direction and nature of departure.

If UAV recovers:

- * 9. THROTTLEAS REQD (IP/EP)
- 10. LandAS SOON AS POSSIBLE (ALL)



During actual DISCO EMERGENCY, the controlling and backup stations' IPs should have payload caged and DISCO selected in the event either is required.

Note

Autopilot Disconnect (DISCO) Landing. Once in DISCO, adjust trim for level flight. Traffic pattern entry should be from a lower than normal altitude. A tighter pattern should be flown to enhance visual reference of the UAV, at an airspeed that is 3-5 knots above normal. This altitude is contingent on geographical features of the area of operation.

Enter the downwind leg maintaining a slight nose low attitude with wings level. Adjust all flight inputs smoothly to avoid over-control of the UAV. Begin base turn, avoiding excessive bank angles through wings level on final. Continue on final approach utilizing power as necessary to control the aircraft rate of descent. Input any required corrections to maintain the UAV's orientation to the runway centerline. At approximately five (5) feet AGL, begin to flare aircraft to touchdown.

In the event of a missed approach, apply full power and rotate the air vehicle once at rotation speed. Repeat the traffic pattern until a smooth, safe landing is attained.

13.6.2 UAV OSCILLATIONS/CNTRL BOX FAILURE (ACFT WITHIN AUTOPILOT LIMITS)

- * 1. CNTRL MODE/BOXEVALUATE/
CHANGE (IP/EP)
- * 2. PLATFORMOFF (PO)



- If the UAV continues pitch and roll oscillations, an impending VGU failure may be indicated. Refer to Flight Control Malfunction.
- If the UAV is operating within A-PLT limits but one control axis is pegged or not responding, then a control box malfunction should be suspected. In this case, selecting A-PLT DISENG may cause the UAV to become uncontrollable. However, if the UAV maneuvers beyond the Autopilot Limits, immediately select DISENG.



If the heading knob does not exactly match the current UAV heading, the UAV will execute an immediate turn once KNOBS control is selected. Therefore, to prevent inadvertent turns into obstacles, the roll loop should be readied and set to 0° prior to selecting KNOBS.

Note

At this point, the problem is most likely in the control box or it cannot be corrected. Options for deselecting the control box include: transferring to the CBX, SBX, or PBX; or selecting KNOBS; or conducting an emergency transfer to another control station.

PART VI

Control/Flight Modes

Chapter 14 — Control/Flight Modes



CHAPTER 14

Control/Flight Modes

14.1 PILOT CONTROL MODES

The pilot control modes allow the internal pilot to perform various computerized tests and set up procedures using a menu tree system. It is made up of ten basic sub-functions: test mode, preset mode, calibration mode, failure display mode, multifunction mode, target altitude mode, camera guide mode, Nav programmer updating mode, return home and navigation to coordinate mode. Each of these control modes are controlled from the internal pilot bay PCT.

14.1.1 Test Mode. Used to preflight test the GCS and UAV. Pressing the Test Mode Push-button generates the Test Mode menu tree, which consists of BAY AUTOMATIC TEST (Item #1), PANEL INTERACTIVE TEST (Item #2), RPV AUTOMATIC TEST (Item #3), DOWNLINK PLAYBACK MODE (Item #4), CABLE/ COMMUNICATION (Item #5), and TEST SUMMARY (Item #0).

[TEST MODE] pushbutton	
TEST	
1.	BAY AUTOMATIC TEST
2.	PANEL INTERACTIVE TEST
3.	RPV AUTOMATIC TEST
4.	DOWNLINK PLAYBACK MODE
5.	CABLE/COMMUNICATIONS
0.	TEST SUMMARY

14.1.1.1 Bay Automatic Test. (Item #1 in the Test Mode menu). This automatic test, performed by the controller card in each bay (PBY, TBY, and CBY) checks the functional performance of the bay's subsystems and the peripheral communications devices. All tests are controlled and monitored by the SMP subsystem and test results are displayed on the PTMP.

During test running, the system displays the message "RUNNING BAY AUTO TEST" in the steady message field. When the test is completed, the system displays

"BAY AUTO TEST - COMPLETED" in the steady message field and the diagnostics for the bays tested.

To view the list of the malfunctioning cards, enter the FAILED bay's item number into the item number field.

14.1.1.2 Panel Interactive Test. (Item #2 in the Test Mode menu). It provides a selecting menu for eight interactive functional tests for the PBY front panel. Each functional test enables the user to check the following segments:

1. Lamps and numerical displays (segment #1). Turns ON/OFF all lamps, including lighted pushbuttons, and sets all numerical displays to 8.
2. Lighted pushbuttons (segment #2). Turns ON lamps in all lighted pushbuttons. The pushbuttons are pressed, one after another, to extinguish the lamps. When all the lamps are extinguished, the test is complete.
3. Meters (segment #3). Checks the indication of the analog meters on the panel in two positions and allows calibration of the meters.
4. Knobs, sticks, and thumbwheels (Segment #4). Checks the response of the panel knobs, sticks, and thumbwheels and allows their calibration.
5. Switches and unlighted pushbuttons (segment #5). Checks the response of the panel switches and unlighted pushbuttons.

The Panel Interactive Test checks the following front panels:

Note

Not all five-segment tests are applicable to each panel. When a segment test is not applicable, the segment line is not shown.

1. Tracker Control Desk (Item #1). Tests the TCD controls and indicators (applicable segments: #1, #2, #3, and #4).
2. Pilot Monitor Panel (Item #2). Test the PTMP display quality by showing a test screen.
3. Pilot Display Panel (Item #3). Tests the PDP controls and indicators (applicable segments: #1, #3, and #5).
4. Pilot Control Desk (Item #4). Tests the PCD controls and indicators (applicable segments: #1, #2, #3, #4, and #5).
5. Pilot Control Table (Item #5). Tests the PCT controls and indicators (applicable segments: #2, #4, and #5).
6. Pilot Box (Item #6). Tests the PBX controls and indicators (applicable segments: #1, #4, and #5).
7. Copilot Box (Item #7). Tests the CBX controls and indicators (applicable segments: #1, #4, and #5).
8. Student Box (Item #8). Tests the SBX controls and indicators (applicable segments: #1, #4, and #5).

14.1.1.3 RPV Automatic Test. (Item #3 in the Test Mode menu). It generates the LOAD Default Program which loads and runs a predefined UAV preflight test from the system memory. The program is an interactive test that checks the UAV operation. The UAV default preflight test program is based on the principle of transmitting uplink frames, including commands and data, while checking and evaluating data that is received and reported in the downlink channels. This preflight test includes a voltage test of the airborne BITE subsystem. The tests are divided into three main phases, which are carried out simultaneously:

1. Electric System Test — which checks EPS and engine cut signals.
2. Communication Test — which checks address and frame-sync words, and data transfer validity.
3. Central Processing runs tests in the following areas:

- a. Autopilot Test checks the control loops, the rate mode with/without autopilot and the servos and sensors.
- b. Programmed Sources checks the Return Home circuit and programmed navigation circuit.
- c. Logic Module test checks flight switching modes and RF communication control.
- d. Payload Test checks operational control and logic and command.

The TEST/RPV mode also allows the user to customize a preflight check and LOAD and run that custom check.

14.1.1.4 Downlink Playback Mode. (Item #4 in the Test Mode menu). With the selection of this item, the decoder in the EDC is locked onto the recorder downlink data by connecting the decoder inputs to the cassette recorder outputs. When the DCR is turned on to replay a recorded cassette, the flight data is replayed on the station indicators, allowing the operator to review events in the flight.

14.1.1.5 Cable Communication. (Item #5 in the Test Mode menu). This function sets the communication link between the station and the UAV either via the TEST Cable or the UPL/DNL communication system. When not set, the default option of this function is the UPL/DNL System.

14.1.1.6 Test Summary. (Item #0 in the Test Mode menu). It returns the system to the last automatic (bay/UAV) test result display. The system is then ready to accept malfunction display requests.

14.1.2 Preset Mode. Pressing the PRESET Push-button allows checking and presetting all parameters required by the UAV system during the mission. Some of the parameters can be viewed, changed, and/or updated directly during the flight using other functional pushbuttons.

The Preset Mode Menu Tree identifies the software version (top right corner of the display) and provides the PRESET selection, which consists of ALTIMETER CAL & WARNING SET, RETURN HOME DATA, NAVIGATION PROGRAMMER, RANGE CALIBRATION, and METEOROLOGICAL DATA.

[PRESET] pushbutton	
PRESET	VER X X
1.	ALTIMETER CAL & WARNING SET
2.	RETURN HOME DATA
3.	NAVIGATION PROGRAMMER
4.	RANGE CALIBRATION
5.	METEOROLOGICAL DATA
6.	CAMERA GUIDANCE
7.	GEOGRAPHIC DATA
8.	TRACKER CALIBRATION
9.	RETRIEVAL NET DATA
10.	RPV DATA
11.	POINT NAVIGATION DATA
12.	GPS DATA
13.	MISSION COMPUTER

14.1.2.1 Altimeter Cal & Warning Set. (Item #1). Allows the user to calibrate the altitude indicator (analog and digital) in the PDP and set the warning flight/system limits for the mission. This function can be entered directly by selecting the Calibration mode (pressing the CALBR push-button).

ITEM #1	
PRESET/ALT & WARN	
1.	ALTITUDE ABOVE SL 2140 FT
2.	ALTITUDE ABOVE FL 2 FT
3.	PRESSURE AT SL (QNH) 1027 MB
4.	PRESSURE AT FL (QFE) 940 MB
5.	LOW AIRSPEED LIM & WARN 55 KT
6.	LOW ALTITUDE WARNING 2440 FT
7.	LOW FUEL WARNING 10.0 LT

- Altitude Above SL (Item #1). Enters/shows the UAV altitude above sea level, in feet. Range: -1,500 to 21,000 ft.
- Altitude Above FL (Item #2). Enters/shows the UAV altitude above field level, in feet. Range: -9,999 to 23,000 ft.
- Pressure at SL (QNH) (Item #3). Enters/shows the barometric pressure at sea level, in millibars (mb). Range 940 to 1,080 mb.
- Pressure at FL (QFE) (Item #4). Enters/shows the barometric pressure at field level, in millibars (mb). Range: 500 to 1,080 mb.

Note

Entering the altitudes (Items #1 and #2) the system calculates the barometric pressures and displays them in Items #3 and #4 and vice versa.

- Low Airspeed Lim & Warn (Item #5). Sets the level for activating the low airspeed warning lamp and limits the minimum airspeed command that can be set by the control knob, in knots (kt). Range: 40 to 70 kt.
- Low Altitude Warning (Item #6). Sets the level for activating the low altitude warning lamp in feet above sea level. Range: -1,500 to 21,500 ft.
- Low Fuel Warning (Item #7). Sets the level for activating the low fuel warning lamp, in liters (l). Range: 0 to 20.0 liters.

14.1.2.2 Return Home Data. (Item #2). Allows the user to set up the RH parameters. This function can be entered directly by selecting the Data Change function in the Return Home Updating Mode.

ITEM #2		
PRESET/RETURN HOME DATA		
1.	CRUISE ALTITUDE	9 KFT
2.	CRUISE AIRSPEED	60 KT
3.	FINAL HOLDING ALTITUDE	-1 KFT
4.	FIRST CLIMBING SPIRAL	+YES
COORDINATES		
5.	HOME E569000	N3792000
6.	NAVPROGRAM END E574000	N3794000

- Cruise Altitude (Item #1). Sets up the RH cruise altitude in KFT. Option: 3, 6, 9, 12 KFT.
- Cruise Airspeed (Item #2). Sets up the RH cruise airspeed, in knots. Option: 50, 60, 70, and 80 kt.

WARNING

RH cruise airspeed of 50 kts. shall not be entered due to aircraft stall margin.

- Final Holding Altitude (Item #3). Sets up the RH final holding altitude, in feet. Option: -1, 1, 3, 5 KFT.
- First Climbing Spiral (Item #4). Enables/disables (+YES/-NO) climbing spiral. If YES is selected, UAV will attempt to do a spiral climb to cruise altitude.
- Coordinates Home (Item #5). Sets up the return coordinates for the UAV.

6. Coordinates/NavProgram End (Item #6).

Note

This selection not functional.

14.1.2.3 Navigation Programmer. (Item #3). The MISSION COMPUTER Navigation Programmer function is only accessible when the Mission Computer selection on the PRESET/RPV DATA menu (Preset Item #10) is set to + yes. With this condition set, the MISSION COMPUTER Navigation Programmer function is started by either selecting Item #3 from the PRESET menu tree or by pressing the NPL push-button on the PCT. Activating the MISSION COMPUTER Navigation Programmer selection accesses the MISSION COMPUTER Navigation Programmer menu branch, which provides operational control of the NVC capabilities for GPS navigation. The MISSION COMPUTER Navigation Programmer menu branch (Figure 3-12) consists of:

ITEM #3	
PRESET/NAVIGATION PROGRAMMER (MISSION)	
1	CURRENT REPORT
2	GENERAL
3	GROUND PROGRAMMER
4	QUERY
5	RPV PROGRAMMER
6	MASK
7	COMMAND
8	LOAD PROGRAMMER
9	CLEAR RPV PROGRAMMER
10	RESET PROGRAMMER

1. Current Report (Item #1). Displays current NVC/RPV/GPS status information, which is updated approximately every second.

PRESET/MISSION/CURRENT REPORT	
STEP #	1
GRID ZONE	E123456 N1234567
PRSENT POS	12
GRID ZONE	E123456 N1234567
RANGE	000.0 KM
ETA	00.00 HR:MIN
OPERATION MODE	D.R.
GPS STATUS	GPS IS NOT INSTALLED
NVC STATUS	00000000
NVC FAILURES	00000000
WARNINGS	00000000

a. Step #. Indicates the current (active) program step of the NVC (regardless of whether or not

the programmer mode is active). When the NVC is operating in the programmer mode, the step # is the step (waypoint) to which the UAV is directed.

Note

The location and grid zone displayed for the step are obtained from the ground program (in the GCS/PCS) not from the NVC (in the UAV). Thus, if the ground program has been changed and not loaded to the UAV, then the location and grid zone displayed may not correspond to the UAV flight program.

- b. PRSENT POS. Indicates the present position of the UAV. These data are sent from the NVC in the UAV to the ground station.
- c. Range. Indicates the calculated distance from the UAV to the waypoint.
- d. ETA. Indicates the estimated time required to arrive at the waypoint (not including any holding time at the waypoint).
- e. Operation Mode. Indicates the current mode of operation for navigation.
 - (1) GPS mode. Navigation uses GPS satellite fixes.
 - (2) GCS mode. Navigation uses the GCS tracking information.
 - (3) DR mode. Navigation uses dead reckoning calculations. This mode is active when GPS or GCS mode is selected, but conditions (such as satellite coverage, PDOP, etc.) are not suitable to allow GPS or GCS solutions. DR mode uses the last usable solution to calculate flight to the waypoint. When conditions improve to allow GPS or GCS solutions, DR mode automatically changes to the selected mode.
- f. GPS Status. Provides text message of the status of the GPS sensor and its ability to provide location fixes.
- g. NVC Status. Indicates status of the navigation programmer card in an 8-bit format.
- h. NVC Failures. Indicates failure detections of the navigation programmer in an 8-bit format.

- i. Warnings. Indicates warning flags status of the navigation programmer card in an 8-bit format.

2. General (Item #2)

PRESET/MISSION/GENERAL		
1. CRITICAL FUEL		12 LT
2. OPERATIONS MODE	COMMAND	ACTUAL
0 - GPS	2	2
1 - D.R.		
2 - GCS		
3. NVC BYPASS		- NO

- a. Critical fuel. Allows the fuel level to be specified below which the low fuel flag on the MISSION/CURRENT REPORT menu is set.
- b. Operations mode. Defines the operation mode for the NVC.
 - (1) GPS mode. The NVC uses the GPS satellite fixes for navigation.
 - (2) DR mode. The NVC uses dead reckoning calculations from UAV's altitude, speed, and heading inputs.
 - (3) GCS mode. The NVC uses the position data provided in the uplink.
- c. NVC Bypass. Allows the NVC to be "taken out of the loop." When set to + yes, the NVC is reset and routes certain control signals directly through the card without processing them.



A power fluctuation on the UAV with NVC Bypass -NO may cause an unrecoverable NVC hang. NVC Bypass +YES should be selected for all UAV operations except Dual UAV control from one controlling station.

- 3. Ground Programmer (Item #3). Used to define and load navigation programs (ground programs) using the GPS navigation capability of the NVC.

PRESET/MISSION/GROUND PROG	
1. ADVANCE STEP	1
2. STEP #	
3. ACTIVE	+ ACTIVE
4. COORDINATES	E123456 N1234567
5. GRID ZONE	12
6. HOLDING TIME	0.00 00 HR. MIN. SEC
7. ALTITUDE	00 0 KFT
8. AIRSPEED	00 KT
9. COMMAND	+ RECEIVE
10. TRANSMITTER	+ ON
11. BEACON	- OFF
12. FILM CAMERA	- OFF
13. VIDEO CAMERA	+ ON
14. PROGRAM	+ CONTINUE
0. LOAD STEP	

Note

This menu accesses the ground program memory in the GCS/PCS only. It does not access the flight program in the UAV air vehicle. The ground program is loaded to the air vehicle (option 0) for execution.

- a. Advance step (Item #1). Used to display/increment the program step.
- b. Step # (Item #2). Used to display/select a specified step.
- c. Active (Item #3). Allows steps to be specified as enable (+ active) or disable (- inactive). Inactive steps are not executed by the UAV.

Note

When the ground program is loaded to become the flight program, at least one step must be active to maintain communications between the NVC and the GCS/PCS (the clear/reset commands leave step 1 active with zero data). If a manual change of the program forces all steps inactive and communications are lost, making a step in the ground program active and loading it to the UAV should remedy the condition.

- d. Coordinates (Item #4). Allows the waypoint to be specified in UTM coordinates.
- e. Grid zone (Item #5). Allows the waypoint grid zone to be defined.
- f. Holding time (Item #6). Specifies how long the UAV should circle the waypoint (indefinite holding time: 8 hr: 31 min: 0 sec).

Note

If the holding time is zero, the UAV will fly to within 1,000 meters of the waypoint and either proceed to the next active program step or exit the NavProgrammer mode (Item #4, "Program" defines). If the holding time is non-zero, the UAV will fly to within 2,000 meters of the waypoint before leaving its track to establish a 1200 meter circling radius about the waypoint for the designated holding time. Upon completion of the holding time, the UAV will either proceed to the next active program step or exit the NavProgrammer mode (Item #14, "Program" defines).

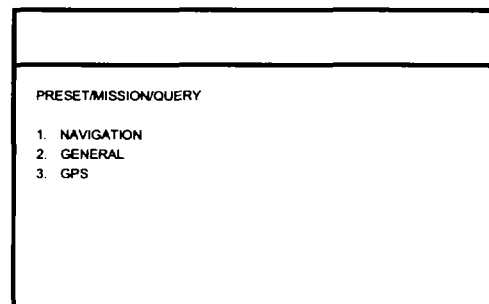
- g. Altitude (Item #7). Specifies UAV flight altitude per programmed step (Options: 1 to 20 KFT in 100 ft. increments).
- h. Airspeed (Item #8). Specifies UAV airspeed per programmed step (Options: 50 to 80 kts in 1 knot increments).
- i. Command (Item #9). This option, which normally is used to permit command inhibit, is currently not allowed by the software. This option should be set to + receive.
- j. Transmitter (Item #10). Commands the UAV transmitter during the step. The options are + on and - off.
- k. Beacon (Item #11). Commands the beacon mode if the transmitter is off. If the transmitter (Item #10) is commanded - off during a step, + on in this item commands the UAV transmitter to beacon mode (8 seconds on, 8 seconds off). If Item #10 is + on, this Item has no effect. If a failure occurs on the UAV with Items #10 and #11 - off, the UAV transmitter will come on in beacon mode. The options are + on and - off.
- l. Film camera (Item #12). Selects the IFF/Strobe Light mode of operation during the step. The options are + on and - off.
- m. Video camera (Item #13). Selects the video camera operation mode during the step. The options are + on and - off.

- n. Program (Item #14). Controls the execution of the program. Selection of + continue branches the program to the next active step for execution. Selection of - end stops the program and exits from the program mode.

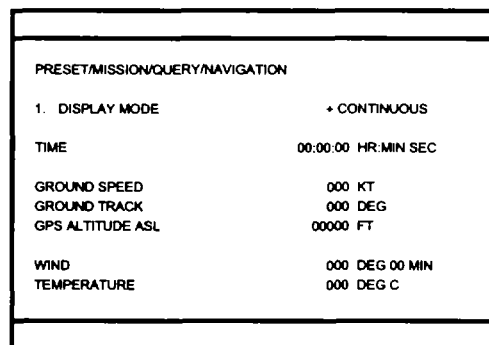
Note

The load step cannot be selected if none of the items have been modified or reentered. Items that have not been downloaded are marked by an asterisk on the left of the display.

- o. Load step (item #0). Performs a download of the displayed step to the UAV. A load in progress message is displayed until a successful load is completed. An error message is displayed if a load failure is detected.
4. Query (Item #4). Allows monitoring of NVC sensed conditions. The options for the submenu branches are:



- a. Navigation (Item #1). The Mission/Query/Navigation menu provides various navigation related data reports:



- (1) Display mode. Controls the refresh/update rate of the Mission/Query/Navigation menu data. Selection of (+ continuous) causes the data to update every few seconds. Selection of (- once) causes the data to update once (upon initial menu entry).

Note

Changing the display mode does not have an immediate effect. The command is not executed until the menu is exited. Thus, the selected display mode will not be observed until the menu is re-entered.

- (2) Time (GMT). The time reported via GPS in terms of GMT.
- (3) Ground speed. The calculated current ground speed of the air vehicle as derived by the NVC from GPS or GCS inputs.
- (4) Ground track. The calculated current heading of the air vehicle as derived by the NVC from GPS or GCS inputs.
- (5) GPS altitude ASL. The height above the WGS-72 datum as determined by the GPS sensor.
- (6) Wind. The direction from which the wind is blowing, and the speed of the wind as calculated by the NVC from GPS or GCS inputs and the airspeed sensor inputs.
- (7) Temperature. The air temperature is the same as the data sent to the NVC from the GCS.
- b. General (Item #2). Provides information relevant to the entry of Preset/Navigation Computer general data as stored by the NVC:

PRESET/MISSION/QUERY/GENERAL	
1 DISPLAY MODE	+ CONTINUOUS
TIME	00:00:00HR:MIN:SEC
DATE	00/00/00MM/DDYY
HEMISPHERE	+ NORTH
GRID ZONE	12
MAGN DECLIN	000 DEG 00 MIN
PRESSURE AT SL	00000 MB

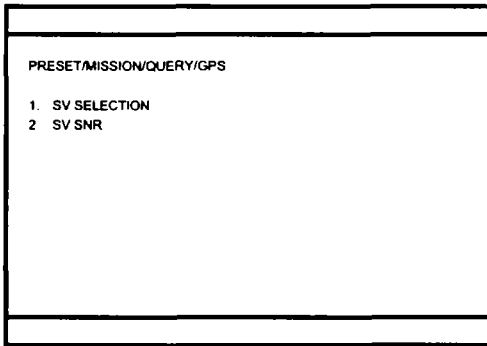
- (1) Display mode. Controls the refresh/update rate of the Mission/Query/Navigation menu data. Selection of (+ continuous) causes the display to update every few seconds. Selection of (- once) causes the data to update once (upon initial menu entry).

Note

Changing the display mode does not have an immediate effect. The command is not executed until the menu is exited. Thus, the selected display mode will not be observed until the menu is re-entered.

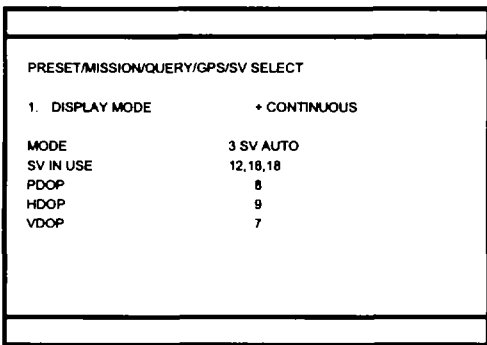
- (2) Time (GMT). The current time (in GMT) as received by GPS satellites.
- (3) Date. The current date as received by GPS satellites.
- (4) Hemisphere. The hemisphere of operation as defined by GPS.
- (5) Grid Zone. The current grid zone number, either that defined for the current step or, if none, the area defined on MISSION/GENERAL menu.
- (6) Magn declin. The magnetic declination sent by the GCS to the NVC.
- (7) Pressure at SL. The sea level air pressure sent by the GCS to the NVC.

c. GPS (Item #3). The Mission/Query/GPS menu allows the selection and display of GPS satellite data through a branch to a submenu.



(1) Space Vehicle (SV) Selection. Calls up a submenu which displays the satellites currently in use for positional solutions:

(a) Display mode. Controls the refresh/update rate of the Mission/Query/Navigation menu data. Selection of (+ continuous) causes the data to update every few seconds. Selection of (- once) causes the data to update once (upon initial menu entry).



Note

Changing the display mode does not have an immediate effect. The command is not executed until the menu is exited. Thus, the selected display mode will not be observed until the menu is re-entered.

(b) Mode. Identifies the current operating mode of the GPS sensor.

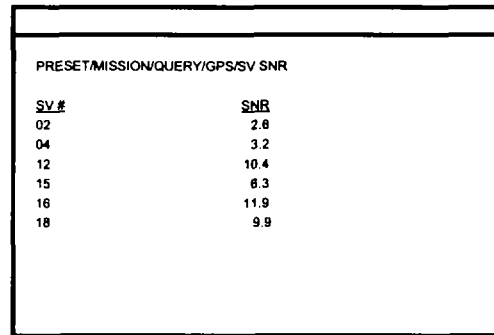
(c) SV in use. Lists the identification numbers for the satellites currently being used by the GPS sensor.

(d) Positional Dilution of Precision (PDOP). Identifies the precision factor of the positional calculations.

(e) Horizontal Dilution of Precision (HDOP). Identifies the horizontal component of the PDOP.

(f) Vertical Dilution of Precision (VDOP). Identifies the vertical component of the PDOP.

(2) Space Vehicle Signal-to-Noise Ratio (SNR). Calls up a submenu, which displays the satellites available for GPS solutions and their SNRs.



(a) SV #. Lists the satellites currently received by the GPS sensor and identifies them by their space vehicle number.

(b) SNR. Lists the signal-to-noise ratio for the signals received from each satellite.

5. RPV Programmer (Item #5). Similar to the Mission/Ground Prog menu in that it is used to control the navigation program used during GPS navigation. The difference is that the Mission/RPV Prog menu displays data directly from the UAV flight program as opposed to the ground program resident in the GCS or PCS. Changes made on this menu do not affect the ground program until they are loaded (Item #0) to the UAV, at which time the change is also copied into the ground program. If changes are made, but not loaded, they are lost when the menu is exited.

PRESET/MISSION/GROUND PROG	
1	ADVANCE STEP
2	STEP # 1
3	ACTIVE * ACTIVE
4	COORDINATES E123456 N1234567
5	GRID ZONE 12
6	HOLDING TIME 0:00:00 HR:MIN:SEC
7	ALTITUDE 00.0 KFT
8	AIRSPEED 00 KT
9	COMMAND * RECEIVE
10	TRANSMITTER * ON
11	BEACON - OFF
12	FILM CAMERA - OFF
13	VIDEO CAMERA * ON
14	PROGRAM * CONTINUE
0	LOAD STEP

- a. Advance step (Item #1). Used to display/increment the program step.
- b. Step # (Item #2). Used to display/select a specified step.
- c. Active (Item #3). Allows steps to be specified as enabled (+ active) or disable (- inactive). Inactive steps are not executed by the UAV.

Note

When the ground program is loaded to become the flight program, at least one step must be active to maintain communications between the NVC and the GCS/PCS (the clear/reset commands leave step 1 active with zero data). If a manual change of the program forces all steps inactive and communications are lost, making a step in the ground program active and loading it to the UAV should remedy the condition.

- d. Coordinates (Item #4). Allows the waypoint to be specified in UTM coordinates.
- e. Grid zone (Item #5). Allows the waypoint grid zone to be defined.
- f. Holding time (Item #6). Specifies how long the UAV should circle the waypoint (indefinite holding time: 8 hr.: 31 min.: 0 sec.).

Note

If the holding time is zero, the UAV will fly to within 1,000 meters of the waypoint and either proceed to the next active program step or exit the NavProgrammer mode (Item #14, "Program" defines). If the holding time is non-zero, the UAV will fly to within 2,000 meters of the waypoint before leaving its

track to establish a 1200 meter circling radius about the waypoint for the designated holding time. Upon completion of the holding time, the UAV will either proceed to the next active program step or exit the NavProgrammer mode (Item #14, "Program" defines).

- g. Altitude (Item #7). Specifies UAV flight altitude per programmed step (Options: 100 FT to 20 KFT in 100 ft increments).
- h. Airspeed (Item #8). Specifies UAV airspeed per programmed step (Options: 50 to 80 kts in 1 knot increments).
- i. Command (Item #9). This option, which normally is used to permit command inhibit, is currently not allowed by the software. This option should be set to + receive.
- j. Transmitter (Item #10). Commands the UAV transmitter during the step. The options are + on and - off.
- k. Beacon (Item #11). Commands the beacon mode if the transmitter is off.
- l. IFF/Strobe (Item #12). Selects the IFF/Strobe operation mode during the step. The options are + on and - off.
- m. Video camera (Item #13). Selects the video camera operation mode during the step. The options are + on and - off.
- n. Program (Item #14). Controls the execution of the program. Selection of + continue branches the program to the next active step for execution. Selection of - end stops the program and exits from the program mode.

Note

The load step cannot be selected if none of the items have been modified or re-entered. Items that have not been downloaded are marked by an asterisk on the left of the display.

- o. Load step (Item #0). Performs a download of the displayed step to the UAV. A load in progress message is displayed until a successful load is completed. An error message is displayed if a load failure is detected.

6. Mask (Item #6). GPS sensor control parameters.

PRESET/MISSION/MASK		
1. ELEVATION		0 DEG
2. SNR		0
3. PDOP		00
4. PDOP SWITCH		00
5. DYNAMICS CODE		00
6. SET DEFAULT		
0. LOAD MASK		

- a. Elevation (Item #1). Allows the minimum angle (in degrees above horizon) for satellites used in GPS solution to be set. Satellites below this angle will not be used by the air vehicle GPS system. Default value is 5 degrees.
- b. SNR (Item #2). Allows the minimum signal-to-noise ratio (SNR) for satellites used in GPS solution to be set. SNRs below this level will not be used by the air vehicle GPS system. SNR levels below 5 are not generally visible to the GPS system. SNRs from 5 to 7 are generally sporadic in nature. SNRs of 8 or better should provide reliable results. Default value is 0.
- c. PDOP (Item #3). Allows the positional dilution of precision (PDOP) for the GPS system to be set. This factor is a measurement of accuracy for the geometric GPS calculations. Values less than 8 are considered good (1 - best) for GPS solution. The mask value specifies the maximum PDOP allowed. If the best PDOP available by the GPS system is higher than the value specified, then the GPS system stops generating positional fixes and the NVC switches to dead reckoning (DR) mode until the PDOP improves. Default value is 40.
- d. PDOP switch (Item #4). Allows the PDOP value for switching between 3- dimensional (3D) and 2-dimensional (2D) GPS solutions to be defined. When the GPS system is operated in auto mode, it automatically switches between 3D and 2D modes depending on the number of satellites it can receive. The PDOP switch mask specifies how good the PDOP must be for using 3D solutions over 2D solutions. If the solution for a 3D fix is higher than this value (less accurate), then the GPS system uses 2D solutions. This value should be less

than the PDOP mask above (Item #3). Default value is 12.

- e. Dynamics Code (Item #5). Not currently used. Intended for future expansion.
- f. Set default (Item #6). Allows the default values for each menu item to be selected.

Note

The load mask cannot be selected if none of the items have been modified or reentered. Items that have not been downloaded are marked by an asterisk on the left of the display.

- g. Load mask (Item #0). Performs the download of the mask entries to the UAV GPS sensor. A load in progress message is displayed until a successful load is completed. An error message is displayed if a load failure is detected.

7. Command (Item #7). Allows entry of navigation control commands to the NVC.

PRESET/MISSION/COMMAND		
1. GOTO NAV POINT	E123456	N1234567
ALT/AIRSPD	00:0 KFT	0 KT
GRID ZONE	12	
2. JUMP TO STEP #	18	
3. DIMENSIONS MODE	+ AUTO	
DIMENSIONS SET	2	
4. RESET OSCILLATOR (OFFSET 00 HZ)		
5. RESET SYSTEM & TEST		
0. CLEAR DATA & RESET SYSTEM		

- a. GOTO Nav point (Item #1). Allows the operator to command the UAV to “go to” a specific waypoint and hold there (in a 1200 meter radius orbit) until commanded to another active program step, (via line 2, “Jump to Step #”) or until taken out of the NavProgram mode. The waypoint coordinates, UAV airspeed and altitude, and the grid zone are all entered in sequence.

Note

When Item #1 is entered, the data is downloaded as program step 0 (only accessible through this option) with indefinite hold time (8 hr., 31 min., 0 sec.). The command is

then executed upon placing the UAV into the NavProgram mode.

- b. Jump to Step # (Item #2). Allows the operator to specify a particular program step to be executed in the flight program. If the UAV is not currently in program mode, then the specified step becomes the first waypoint when the UAV is placed in program mode.

Note

If the step specified in the Jump to Step # option is not an active step, then the first active step number greater than the specified is selected.

- c. Dimensions Mode/SET (Item #3). Allows the operator to define how the GPS sensor uses the GPS satellites for positional fixes.

(1) Dimensions Mode. Automatic mode (+ auto) cause the GPS sensor to calculate 3D solutions using four satellites when possible. If four usable satellites are not available, the system reverts to 2D fixes until 3D solutions become possible. When 3D solutions are possible, the system automatically switches to 3D mode. Manual mode (- manual) causes the GPS sensor to obtain fixes only in the specified mode (2D or 3D).

(2) Dimensions SET. Allows the operator to specify 2 or 3 (2D or 3D) for - manual dimension mode.

- d. Reset oscillator (Item #4). Allows the operator to manually force a reset to the GPS sensor oscillator. This is not normally required unless the sensor is suspected to be malfunctioning.
- e. Reset system & TEST (Item #5). Allows the operator to manually force a reset to the NVC and start an NVC and GPS sensor self test. This also results in a display of the test results. Reset system and test is only possible when NVC Bypass -NO is selected.

- f. Clear data & Reset system (Item #0). Allows the operator to force a reset to the GPS sensor as well as clear the battery backup memory. This is not normally required unless the sensor is suspected to be malfunctioning.

8. Load Program (Item #8). Used to load groups of navigation program steps to the NVC.

PRESET/MISSION/LOAD PROGRAM	
1	LOAD PROG F 11 T 14
0.	LOAD ALL STEPS

- a. Load prog. Performs the download of a group of ground program steps (from step # to step #) to the RPV flight program. A load in progress message is displayed until a successful load is completed. An error message is displayed if a load failure is detected.

Note

If the single step load option (Option #0 on the Ground Program and/or RPV Program menus) is used, then the group loading method is not required.

- b. Load all steps. Downloads all possible ground program steps (1 to 96) to the UAV flight program. A load in progress message is displayed until a successful load is completed. An error message is displayed if a load failure is detected.

Note

This process is time consuming and could take 20 minutes or more to complete.

14.1.2.4 Range Calibration. (Item #4). Allows the user to obtain accurate data from the communications system by trimming away lags generated by the system units.

ITEM #4	
PRESET/RANGE CAL	
RANGE	
1. PRIMARY LINK	0.047 KM
2. SECONDARY LINK	0.047 KM
CALIBRATION OFFSET	
1. PRIMARY LINK	35.010 KM
2. SECONDARY LINK	32.570 KM

1. Range/Primary & Secondary Link (Items #1&2). Enters the actual range, in kilometers (km), between the station and the UAV, for the primary communication link and secondary link. The two parameters entered in Items #1 and #2 enable the station system to calculate the calibration offset required by each communication link (primary/secondary) for a specific station/UAV configuration. These offset factors are valid as long as no changes/replacements have been made in the system units and are updated automatically in Items #3 and #4 during the calibration process.

Note

Range calibration using Items #1 and #2 can be performed only when the UAV is on the ground, near the station. When conducting range calibration do not switch control link until calibration is completed.

2. Calibration Offsets (Items #3 and #4). When the range to the UAV is not known or not fixed (as for an airborne UAV), but the calibration offsets (Item #3 & #4) for the UAV and the station are known and valid (no changes/replacements have been made in the station or UAV), the range can be calibrated by entering the calibration offsets in Items #3 and #4. Items #1 and #2 (and the digital range display in the PDP) are updated automatically.

14.1.2.5 Meteorological Data. (Item #5). Allows the user to preset the meteorological data supplied to the system. The Meteorological Data menu branch consists of mode selection, pressure table, wind table and temperature table.

ITEM #5	
PRESET/METEOROLOGY	
1.	MODE SELECTION
2.	PRESSURE TABLE
3.	WIND TABLE
4.	TEMPERATURE TABLE

1. Mode Selection (Item #1). Allows the user to select one of the following updating modes:

- a. Alti/pres. table data (+YES/-NO) if yes is selected computer uses tables for information/data update. If no is selected computer uses "standard" day values.

Note

The barometric pressure is required in the target coordinates and artillery adjustment calculations. Using the pressure table is more accurate, but it requires constant follow-up and updating of data entered in the table, as well as constant updating from meteorological sources.

Automatic Wind Updates. Activates (+YES) or deactivates (-NO) the wind calculation program. For wind updates to be accurate UAV must be flown straight and level for two minutes.

- b. Data Entry/Pressure Table (Item #2). Allows updating of the barometric pressure table, in millibars (mb). Entering empty table automatically sets Alti/pres table data to no.
- c. Data Entry Wind table (Item #3). Allows updating of the wind direction and speed table, in degrees and knots.
- d. Data Entry/Temperature Table (Item #4). Allows updating of the temperature table, in degrees Celsius.

Note

Each table consists of 15 entries (Items #2 to #16) providing the table data at a specific altitude (2,000 to 16,000 ft). Item #0 in each table erases all entries in the table. The user

can enter or change part of the 15 entries. The remaining entries are either estimated by the system using available data or calculated from real-time data collected by the UAV when flying at the specified altitude. An “In” is found beside the values if the data was user input. An “Est” is found when the system calculates the data.

14.1.2.6 Camera Guidance. (Item #6). Allows the user to set the parameters for the Camera Guided Flight Mode. Changed parameters take effect upon menu exit.

ITEM #6	
PRESET/CAMERA GUIDANCE	
1. CIRCLE RADIUS	1.0 km
2. CIRC TARGET DISTANCE	3.0 KM
3. CIRC TARGET AZIMUTH	090 DEG
NOTE: CHANGED PARAMETERS TAKE EFFECT UPON MENU EXIT.	
0. DEFAULT PARAMETERS	

1. Circling Radius (Item #1). Sets the radius, in km, of the flight circle that the UAV has to follow while the camera is locked on the target. The circling radius can be set from 1.0 to 9.9 km.
2. Circ-Target Distance (Item #2). Sets the distance, in km, between the target and the center of the UAV flight circle. The circ-target distance can be set from 0.0 to 15 km.
3. Circ-Target Azimuth (Item #3). Sets the azimuth, in deg., of the UAV-target line. The azimuth can be set from 0° to 359°.
4. Default Parameters (Item #0). Loads predefined parameters of 1 km, 0 km and 0°.

14.1.2.7 Geographical Data. (Item #7). Allows the user to preset geographical data and parameters in the system.

ITEM #7	
PRESET/GEOGRAPHIC	
1. TARGET ALTITUDE	788 M
<u>STATION DATA</u>	
2. COORDINATES	E574299 N3792030
3. ALTITUDE	716 M
4. AUTO POSITION UPDATE	-NO
5. GRID ZONE INPUT	-NO
6. GRID ZONE	12
7. MAGN DECLIN	14 DEG 23 MIN
NOTE + MAGN EAST TO MAP GRID - MAGN WEST TO MAP GRID	

1. Target Altitude (Item #1). Sets the target altitude above sea level in meters. The data is required for target coordinates and artillery adjustment calculations. This function can be entered directly by pressing the TARGET ALT push-button.
2. Station Data/Coordinates (Item #2). Sets the TCU station coordinates relative to map working coordinates, in E/N UTM coordinates. Valid only when auto position update (Item #4) is disabled.
3. Station Data/Altitude (Item #3). Sets the station altitude above sea level in meters. The station data is required for RH data, target coordinates, UAV coordinates, GPS input data, and other calculations.
4. Auto Position Update (Item #4). Used to enable/disable automatic updating of the station coordinates from data received from the Global Positioning System (GPS) in the TCU. A + yes indicates that the station coordinates are obtained from the GPS and the values in Item #2 are not valid. A - no indicates that normal operation and station coordinates are defined in Item #2. Upon loss of GPS, Item #4 is automatically changed to -no and the message “Manual Position Update” is displayed. Item #2 provides the station coordinates to the GCS.

Note

If GPS coverage becomes sporadic, Item #2 station coordinate should be updated immediately. If there is no GPS receiver connected to the GCS, auto position update will be - no and cannot be changed.

5. Grid Zone Input (Item #5). Enables (+ yes) or disables (- no) the alternate grid zone entered in Item #6 below. When the grid zone input is - no, the GCS obtains coordinate data from either the PRESET/GEOGRAPHIC coordinates or the Navigational Data System, for selecting the source of the coordinate data. When the grid zone input is + yes and the GCS is receiving coordinate information from the Navigational Data System, the grid zone provided in Item #6 below is used by the GCS instead of the calculated grid zone from the Navigational Data System. This data enables the system to work across grid zones during a mission.

Note

The grid zone can only be altered by 1 in either direction.

6. Grid Zone (Item #6). This item is provided so that the operator can alter the station grid zone by 1 in either direction from the grid zone calculated by the Navigational Data System. The grid zone is enabled/disabled by the grid zone input (Item #5).
7. Magnetic Declination (Item #7). Sets the magnetic declination parameter, in degrees and minutes (deg/min), relative to the map grid. The parameter compensates for the deviation between magnetic north (read by the magnetic compass) and the grid north (on map), and is used for target location, artillery adjustment, navigation, and RH data calculations. A positive angle means that the magnetic north is east (right) of the map grid north (and vice versa).

14.1.2.8 Tracker Calibration. (Item #8). Allows the user to calibrate the tracking unit readings relative to the map grid used.

ITEM #8	
PRESET/TRACKER	
1 AZIMUTH	355.15 DEG
2 CORECTION OFFSET	51.08 DEG
3 MASKED ZONE A	F 351 DEG T 359 DEG
4 MASKED ZONE B	F 0 DEG T 8 DEG
5 AUTO SHIP HDG UPDATE	-NO
6. OWN SHIP TRUE HDG	250.00 DEG

1. Azimuth (Item #1). Allows the user to enter the known direction between the station and the beacon unit, during the azimuth calibration procedure.
2. Correction Offset (Item #2). Displays the offset between the measured direction to the beacon unit and the direction read by the tracking unit. Ground based units will input the value determined by the calibration procedure. This will calibrate the direction read by the tracking unit true or relative depending on selection of Item #5. Ship based units will input zero.
3. Masked Zone A (Item #3). Defines a blind area of the directional antenna caused by an obstruction such as the superstructure. When the antenna is pointing to the blind zone, a warning (approaching Antenna Blind Zone) is displayed on the TV monitor. The zone is defined by entering the degrees at which the blind zone starts (F-from) and ends (T-to). The From value entered must be less than the To value entered. Values must be less than 360 degrees.
4. Masked Zone B (Item #4). Defines a second blind area of the directional antenna.
5. Auto Ship Heading Update (Item #5). Enables (+ yes) or disables (- no) the automatic ship heading update mode. Should be set to Yes for ship-board operations only. If Yes (+), antenna azimuth is corrected to read true bearing, using ship heading as provided by the navigation interface system (IBX/Magnavox GPS). If No (-), antenna azimuth is corrected to true bearing based on the ship's heading as manually entered in Item #6. Should always be set to No (-) for ground based operations.

6. Own Ship True Heading (Item #6). The default value used for ship's heading if the auto ship heading update (Item #5) is disabled (- no), or ship heading is not available from the navigation interface system (IBX/Magnavox GPS). This value can only be changed when Item #5 is disabled. This value should always be set to zero for land based operations.

Note

UAV/Target coordinate accuracy is directly dependent upon an accurate ship's heading value. For example, at a range of approx. 60 km, 1 degree of ship's heading error will result in a corresponding error of 1 km in UAV/Target coordinates. When Item #5 is disabled (- no), the manual entry of ship's heading in Item #6 should be changed as often as required to maintain navigation / targeting accuracy. If Item #5 is disabled and a value of zero is entered in Item #6, antenna azimuth will be relative to the ship's bow.

14.1.2.9 Retrieval Net Data. (Item #9). It allows the user to enter data necessary for use of the Automatic Landing Procedure (Autoland). Retrieval net is used primarily by Navy units.



Use of Autoland mode not authorized.

Note

Autoland is not used. Set all values to zero.

ITEM #9	
1.	STATION GLIDE PATH DISTANCE - 0M
2.	STATION NET DISTANCE - 0M
NOTE: + NET IN BACK OF STATION - NET IN FRONT OF STATION	
3.	ENG CUT POINT NET DISTANCE - 0M
4.	NET ALTITUDE - 0M

14.1.2.10 RPV Data. (Item #10). Allows the user to determine the identification data for the controlled UAV. The following items are provided:

ITEM #10	
PRESET/RPV DATA	
1	WEIGHT (EMPTY FUEL TANK) - 149 KG
2	RPV MODEL #907
	850- OPTION I
	907- OPTION II
	910- OPTION II +
3.	PAYLOAD 1
	0 - NONE
	1 - MKD 200
	2 - MKD 400
	3 - RADIO RELAY
	4 - EO/FLIR
6.	CAMERA CONTROL BAY
	1 - OBY
	2 - PBY
7	MISSION COMPUTER + YES

1. Weight (Empty Fuel Tank) (Item #1). UAV weight in kilograms with fuel tank empty.
2. RPV Model (Item #2). Code number for the UAV model controlled by the station. Option II UAV is a model #907 and Option II+ is #910.
3. Payload (Item #3). The payload to be used in the UAV.
4. Camera control bay (Item #6). Assigns control of the camera payload to either the OBY or PBY operator position. If PBY is selected then the student box is used to control payload.
5. Mission Computer (Item #7). Allows the user to define the type of CPA and Navigation Card (NVC) used in the present UAV configuration. Selection of +yes indicates that the Option II configuration is used (new CPA and NVC installed) and CPS navigation capability is available for the air vehicle. Selection of - no indicates that the Option I configuration is used (old CPA and Programmer Card) and GPS navigation capability is not available.

14.1.2.11 Navigation Data. (Item #11). Allows the user to enter up to 10 target coordinates. These targets are used by the pilot in the nav-to-coordinates flight mode. In addition, the function allows the operator to define what the UAV should do when a target is reached.



Use of Nav-to-Coordinate mode not authorized

ITEM #11		
PRESET/NAVIGATION UPDATE		
COORDINATES		MODE
1 E585000	N3804000	+CONTINUE
2 E598000	N3811000	-HOLD
3 E***	N***	-HOLD
4 E***	N***	-HOLD
5 E***	N***	-HOLD
6 E***	N***	-HOLD
7 E***	N***	-HOLD
8 E***	N***	-HOLD
9 E***	N***	-HOLD
0 DESELECT		

Continue (+): UAV will proceed to the next target.

Hold (-): UAV will circle over the target using camera guide parameters until commanded to proceed.

14.1.2.12 GPS Initialization. (Item #12). NOT USED.

14.1.2.13 Mission Computer. (Item #13). Allows the user to set up and load NVC waypoint navigation programs and control. The Preset/Mission Computer program menu branch consists of six additional items.

ITEM #13	
PRESET/MISSION COMPUTER	
1	GENERAL
2	MASK
3	GROUND PROGRAMMER
4	DATUM SELECTION
5	LOAD PROGRAM
8	CLEAR RPV PROGRAMMER
7	RESET PROGRAMMERS

1. General (Item #1). Normally used during preflight to initialize the UAV position, critical fuel level, date, and time. If operation in GPS mode is planned, the coordinates need not be exact. The correct UAV position, date, and time are obtained by the GPS system in the air vehicle. The coordinates should be correct to within 100 miles and the time correct to within 1 hour (GMT), and the date, area number, and hemisphere should be correct.

- a. Coordinates (Item #1). The air vehicle's position.
 - b. Hemisphere (Item #2). The northern (+) or southern (-) hemisphere.
 - c. Grid zone (Item #3). Allows selection of UTM grid zone.
 - d. Critical fuel (Item #4). When the fuel level during flight falls below this level, a warning flag is set on the MISSION/CURRENT Report menu. This fuel setting is independent of low fuel set in "PRESETS."
 - e. Date (Item #5). The current date set (using GMT).
 - f. Time (Item #6). The current time (Using GMT).
 - g. Load data (Item #0). Performs the download of the data entries to the UAV. A load in progress message is displayed until a successful load is completed. An error message is displayed if a load failure is detected. LOAD data cannot be selected if none of the menu items have been modified. Items that have been entered are marked by an asterisk on the left of the display.
2. Mask (Item #2). Used to initialize GPS sensor control parameters in the UAV.
- a. Elevation (Item #1). The minimum angle (in degrees above horizon) for satellites used in GPS solution. Satellites below this angle will not be used by the air vehicle GPS system. Default value is 5°.
 - b. SNR (Item #2). The minimum signal to noise ratio (SNR) for satellites used in GPS solution. SNRs below this level will not be used by the air vehicle GPS system. SNR levels below 5 are not generally visible to the GPS system. SNRs from 5 to 7 are generally sporadic in nature. SNRs of 8 or better should provide constant reliable results. Default value is 0.
 - c. PDOP (Item #3). The Positional Dilution of Precision (PDOP) for the GPS system. This factor is a measurement of accuracy for the geometric GPS calculations. Values less than 8 are considered good (1 = best) for GPS solutions. The mask value specifies the maximum PDOP allowed. If the best PDOP available by the GPS system is higher than the value speci-

fied, than the GPS system stops generating positional fixes and the NVC switches to dead reckoning (DR) mode until the PDOP improves. Default values is 40.

- d. PDOP Switch (Item #4). The PDOP value for switching between 3-dimensional (3D) and 2-dimensional (2D) GPS solutions. When the GPS system is operated in auto mode, it automatically switches between 3D and 2D modes depending on the number of satellites it can receive. The PDOP must be for using 3D solutions over 2D solutions. If the solution for a 3D fix is higher than this value (less accurate), then the GPS system uses 2D solutions. This value should be less than the PDOP mask above (Item #3). Default value is 12.
 - e. Dynamic Code (Item #5). Not currently used. Intended for future expansion.
 - f. Set Default (Item #6). Allows the default values for each menu item to be selected.
 - g. Load mask (Item #0). Performs the download of the mask entries to the UAV GPS sensor. A load in progress message is displayed until a successful load is completed. An error message is displayed if a load failure is detected. The load mask cannot be selected if none of the items have been modified or reentered. Items entered are marked by an asterisk on the left of the display.
3. Ground Programmer. (Item #3). Used to define and load navigation programs. This menu accesses the ground program memory in the GCS/PCS only. It does not access the flight program in the UAV air vehicle. The ground program is loaded to the air vehicle (Item #0) for execution.
- a. Advance step (Item #1). Used to display/increment the program step.
 - b. Step # (Item #2). Used to display/select a specified step.
 - c. Active (Item #3). Allows steps to be specified as enabled (+ active) or disabled (- inactive). Inactive steps are not executed by the UAV. When the ground program is loaded to become the flight program, at least one step must be active to maintain communications between the NVC and the GPS/PCS. If a manual change of the program forces all steps inactive and communications are lost, making a step in the ground program active and loading it to the UAV should remedy the condition.
 - d. Coordinates (Item #4). Allows the waypoint to be specified in UTM coordinates.
 - e. Grid zone (Item #5). Allows selection of UTM grid zone.
 - f. Holding time (Item #6). Specifies how long the UAV should circle the waypoint. The UAV will fly to the next defined waypoint along the track (straight line) from the previous waypoint. If the holding time is zero, then the UAV flies to 1,000 meters from the current waypoint, the program step ends, and the program executes the next step. If the holding time is not zero, then the UAV flies to 2,000 meters from the waypoint and then begins circling the waypoint at a radius of 1,200 meters for the time specified.
 - g. Altitude (Item #7). Allows any altitude within the UAV flight envelope to be specified for that step of the programmed flight.
 - h. Airspeed (Item #8). Allows any airspeed within the UAV flight capabilities to be specified for that step of the programmed flight.
 - i. Command (Item #9). This option, which normally is used to permit command inhibit, is currently not allowed by the software. This option should be set to + receive.
 - j. Transmitter (Item #10). Controls the UAV transmitter during the step. The options are + on and - off.
 - k. Beacon (Item #11). Controls the transmission mode during the step. The options are + on and - off.
 - l. Film Camera (Item #12). Selects the film camera operation mode during the step. The options are + on and - off.
 - m. Video Camera (Item #13). Selects the video camera operation mode during the step. Options are + on and - off.
 - n. Program (Item #14). Controls the execution of the program. Selection of + continue branches the program to the next active step for execution. Selection of - end stops the program and exits from the program mode.

o. Load step (Item #0). Performs a download of the displayed step to the UAV. A load in progress message is displayed until a successful load is completed. An error message is displayed if a load failure is detected. LOAD step cannot be selected if none of the items have been modified or reentered. Items that have been entered are marked by an asterisk on the left of the display.

4. Datum Selection (Item #4). Selects the datum used for Global Positioning System (GPS) position calculations. WGS 84 is the default selection.

5. Load Programmer (Item #5). Used to load groups of navigation program steps to the NVC.

a. Load prog. Performs the download of a group of steps (from step # to step #) to the UAV. A load in progress message is displayed until a successful load is completed. An error message is displayed if a load failure is detected.

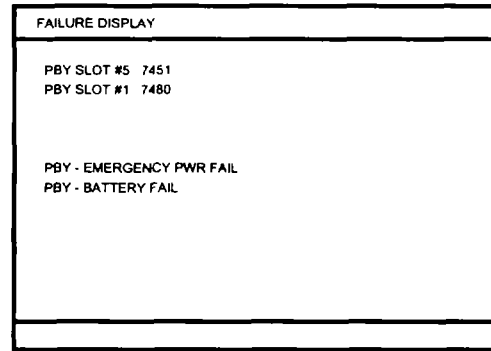
b. Load all steps. Downloads all possible program steps (1 through 96) to the UAV. A load in progress message is displayed until a successful load is completed. An error message is displayed if a load failure is detected.

6. Clear RPV Programmer (Item #6). Clears the program memory in the NVC. All steps will change to inactive except step one.

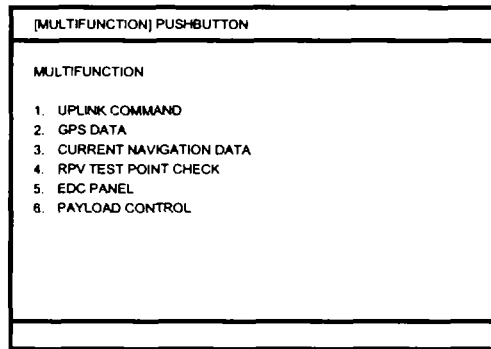
7. Reset Programmers (Item #7). Clears the program memory in both ground programmer and the NVC.

14.1.3 Calibration Mode. (CALBR Push-button). The Calibration Mode is started by pressing the CALBR push-button on the PCT. It provides direct access to the Altimeter Cal. & Warning Set submode (Item #1 in the Preset Mode).

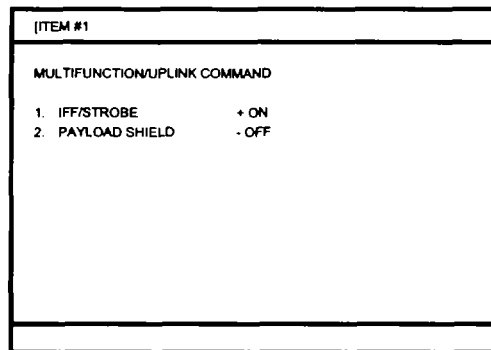
14.1.4 Failure Display Mode. This push-button may be used at any time for troubleshooting or emergency procedures, or to verify normal system operation. It should be selected if the PWR FAIL, GCS FAIL or RH FAIL lamps illuminate on the PDP. It can also be selected if the CAMERA GUIDE lamp blinks on the PCD to determine which parameter is out of limits. When the FAIL CHECK button is pressed, the GCS FAIL light goes out (if it was on). Any new failure will illuminate the GCS FAIL light, but will not update the message screen unless the FAIL CHECK button is cycled off and on again.



14.1.5 Multifunction Mode. (MULTIFUNCTION Push-button). Generates the multifunction mode menu tree, which consists of Uplink Command, GPS Data, and current Navigation Data, UAV Test Points, and Uplink/Downlink Frame Check.



14.1.5.1 Uplink Command. (Item #1). The IFF/strobe functions on the UAV can be turned on/off by selecting Item #1 of the Multifunction menu. In addition, the payload shield can be deployed by selecting ON.



14.1.5.2 GPS Data. (Item #2). This includes:

1. Station Coordinates (Item #1). Displays the current UTM grid map coordinates. These coordinates are updated by the GPS. In the event of

marginal GPS coverage, manual coordinates are displayed.

ITEM #2	
MULTIFUNCTION/GPS DATA	
STATION COORDINATES	W***** S*****
VELOCITY	X*** M/S Y*** M/S
GRID ZONE	--
STATUS CODE	01000000
ERROR CODE	11001111
SHIP TRUE HDG	00 00 DEG
SHIP PITCH	00 00 DEG
SHIP ROLL	0.00 DEG

Note

The Easting coordinates have an extended range from 0 to 999 kilometers. If the Easting value becomes less than zero, the display changes from EXXXXX to WXXXXX. If the Easting value exceeds 999 kilometers, then \$0 is displayed. In both cases, the pilot bay continues to operate but tracking bay and observer bay produce erroneous results.

The Northing coordinates have a range from 0 to 9999 kilometers. If the ship moves south of the equator, the Northing value changes from NXXXXXXXXX TO SXXXXXXXXX.

- 2. Velocity (Item #2). Indicates station velocity. This value is calculated from GPS data.
- 3. Grid Zone (Item #3). Indicates the calculated UTM grid number from the Navigational Data System in which the GCS is located. If the Grid zone Input (Preset Geographic Item #5) is enable (+ yes), the grid zone number entered in Preset Geographic Item #6 is displayed.
- 4. Status Code (Item #4). This is an 8-bit code indicating the status of the GPS. The status codes are (in binary code form):

- 00000000 - Doing position fixes
- 00000001 - Don't have GPS time yet
- 00000010 - Waiting for almanac collection
- 00000011 - PDOP is too high
- 00000100 - No satellites available
- 00000101 - Only 1 satellite available
- 00000110 - Only 2 satellites available
- 00000111 - Only 3 satellites available

- 00001000 - No usable satellite
- 00001001 - 1 usable satellite
- 00001010 - 2 usable satellites
- 00001011 - 3 usable satellites

- 5. Error Code (Item #5). An 8-bit binary code indicating the error status of the GPS. The bit values and their meanings are:

- 00000001 - Battery backup failed
- 00000010 - Signal Processor error
- 00000100 - Alignment error, channel 1
- 00001000 - Alignment error, channel 2
- 00010000 - Antenna feed line fault
- 00100000 - Excessive bias dot

Note

Once detected, these error bits remain set until the GPS is reset with the exception of bit value 16. This bit follows the current status of the antenna feed fault detection circuitry.

- 6. Ship True Heading (Item #6). Reports ship's true heading from data received from the ship's gyro compass.
- 7. Ship Pitch (Item #7). Reports ship's pitch from data received from the ship's gyro compass.
- 8. Ship Roll (Item #8). Reports ship roll data received from the ship's gyro compass.

14.1.5.3 Current Navigation Data Display Function. (Item #3). The Current Navigation Data display function is prompted to the PTMP data monitor.

ITEM #3	
MULTIFUNCTION/NAVIGATION DATA	
INDICATED AIRSPEED	70 KT
TRUE AIRSPEED	72 KTS
GROUND AIRSPEED (156 KMH)	85 KY
MAGNETIC HEADING	030 DEG
TRUE HEADING	044 DEG
GROUND TRACK	048 DEG
WIND	15 KT 045 DEG
CROSS	03 KT RIGHT
TAIL	13 KT
FUEL	34 8 LT

14.1.5.4 RPV Test Point Check Function. (Item #4). The function enables dialing up to five computerized test points (BITE TP) in the UAV, and displays the voltage at that point. Dialing to a BITE TP is performed by selecting an Item # (Item #1 through Item #5) and writing the BITE TP ID number. When Item #0 is

selected, all BITE TP's are erased. To receive data on requested TP you must have control of UAV at your station.

ITEM #4	
MULTIFUNCTION/RPV T.P.	
TEST POINT	VOLTAGE
1. 51	4.08
2. 52	2.02
3. 53	4.08
4. 56	2.56
5. **	** **
0. ERASE TEST POINTS	

attempt to control the payload from a station other than the one defined in Presets.

ITEM #6		
MULTIFUNCTION/MOKED 200		
	COMMAND	REPORT
1. PAYLOAD	- OFF	- OFF
2. RATE	+ HIGH	
3. CAMERA	+ ON	+ ON
4. IRIS MODE	+ AUTO	
5. IRIS SET	*****	
6. MODE CONTROL	-RATE	

14.1.5.5 EDC Panel Check Function. (Item #5). The function displays the data transmitted/received on the UPL/DNL in voltage and physical values. The EDC Panel check function generates a branch tree menu, which enables the user to select the data required for display.

ITEM #6		
MULTIFUNCTION/MOKED 400		
	COMMAND	REPORT
1. PAYLOAD	-OFF	-OFF
2. FLIR	-OFF	-OFF
3. DATA	-OFF	-OFF
4. POLARITY	-WHITE	
5. LEVEL MODE	-MAN	
6. LEVEL SET	0	
7. GAIN SET	0	
8. MODE CONTROL	-RATE	

ITEM #5
MULTIFUNCTION/EDC PANEL
1. UPLINK ANALOG
2. UPLINK DIGITAL
3. DOWNLINK ANALOG
4. DOWNLINK DIGITAL

ITEM #6		
MULTIFUNCTION/RADIO RELAY		
	COMMAND	REPORT
1. RADIO POWER	-OFF	-OFF
2. CHANNEL 1	+ INH	+1
3. CHANNEL 2	+ INH	+1
4. CHANNEL 3	+ INH	+1
5. CHANNEL 4	+ INH	+1
6. CHANNEL 5	+ INH	+1
7. SCAN MODE	- MAN	
8. STEP	- OFF	
BIT		-OK

1. Uplink Analog (Item #1). Displays the voltage and physical values of the analog uplink commands.
2. Uplink Digital (Item #2). Displays the binary value (in binary and hexadecimal numbers) of the digital uplink words.
3. Downlink Analog (Item #3). Displays the voltage and physical values of the analog downlink reports.
4. Downlink Digital (Item #4). Displays the binary value (in binary and hexadecimal numbers) of the digital downlink words.

ITEM #6		
MULTIFUNCTION/O FLIR		
	COMMAND	REPORT
1. PAYLOAD	-OFF	-OFF
2. FLIR	-OFF	-OFF
3. PILOT WINDOW		
4. STOW		
5. MODE		
6. GAIN		
7. IRISLEVEL	0-NONE 1-INCR 2-DECR	
8. TRACK		
9. TRACK POLARITY		
10. HEAT POLARITY		
11. SCENE TEMP	0-HOT 1-NORM 2-COLD	
12. CALIBRATE		
13. SENSOR		
14. MODE CONTROL		

14.1.5.6 Payload Control. (Item # 6). The function displays one of the three Item #6 menus depending on the type of payload selected for the mission. The value 6 will flash in the lower left corner of the screen if you

14.1.6 Target Altitude Updating Mode. (TARGET ALT Push-button). In Normal Operation it allows updating of target altitude by internal pilot. In Mark Target Mode, it allows entering target altitude for the Target Altitude Iteration procedure.

14.1.7 Camera Guide Updating Mode. (CAM GUIDE Push-button). Provides direct access to the Camera Guidance setup function (Item #6) in the Preset Mode.

14.1.8 Nav Programmer Updating Mode. (NPL Push-button). Provides direct access to the Navigation Programmer setup function (Item #3) in the Preset Mode or the Mission Computer Navigation Programmer menu tree depending on the system configuration.

14.1.9 Return Home Updating Mode. (RHL Push-button). Generates the return home updating mode menu tree.

14.1.9.1 UAV Last Update Function. (Item #1). Allows the user to view the updated UAV RH parameters. The parameters displayed are as follows:

1. Cruise Time. Shows the cruise leg time parameter for the RH function in hours/minutes (hr:min). The date is updated in real time.
2. Cruise Heading. Shows the heading parameter for the RH function, in degrees. The data is updated in real time.
3. Cruise Altitude. Shows the selected RH cruise altitude, in thousands of feet (KFT).
4. Cruise Airspeed. Shows the selected RH cruise airspeed, in knots.
5. Final Holding Altitude. Shows the selected RH final holding altitude, in thousands of feet. (KFT)
6. First Climbing Spiral. Shows the selected climbing mode. Options: + yes or - no.
7. Elapsed Time. Shows the time that has passed since the last successful RH data update in minutes/seconds. The data is updated in real time.

14.1.9.2 Data Change Function. (Item #2). Allows the user to change the parameters loaded and provides direct access to the Return Home Data submode (Item #2) in the Preset Mode.

14.1.9.3 Load Nav Prog Return Home Data Function. (Item #3). Loads the RH parameters as calculated for the NavProgram END coordinates, and inhibits data updating from the ground (calculated for the real-time position of the UAV). During the loading, the system displays a Loading Return Home message on the steady message field. After the loading terminates successfully, the system displays a Return Home - Updated message on the steady message field.

Note

If the UAV does not start a programmed flight within 30 seconds from NavProgram RH updating, this data is canceled (on the UAV) and the system returns to the normal RH routine.

14.1.9.4 Auto Loading Function. (Item #4). Enables/disables automatic loading of the predefined return home parameters.

14.1.9.5 Return Home Man Data Function. (Item #5). Allows the user to define and load new return home parameters.

1. Cruise Time (Item #1). Sets the cruise leg time parameter for the return home function, in hours/minutes.
2. Cruise Altitude (Item #2). Sets the cruise altitude parameter for the return home function, in 1000s of feet (KFT).
3. Cruise Airspeed (Item #3). Sets the cruise airspeed parameter for the return home function, in knots.
4. Final Holding Altitude (Item #4). Sets the final holding altitude for the return home function, in 1000s of feet (KFT).
5. Load Man Return Home Data (Item #0). Loads the manually define return home parameters into the system.

14.1.10 Nav-to-Coordinate Mode



Use of Nav-to-Coordinate mode not authorized.

14.2 FLIGHT MODES

14.2.1 Position Stick — Manual Flight Mode (“STICKS”). This flight mode is usually used during takeoff and landing. The pitch and roll control loops are engaged and the UAV is controlled from the flight control box. The right stick sideways movement controls the roll angle, which is proportional to the amount of stick deflected to that side. When the stick is moved to its maximum position, the UAV is set to a 60° roll. The forward-backward movement of the stick sends pitch angle commands that are proportional to the amount of stick deflection. The maximum pitch command is +20° and its minimum is -17°.

The left stick sideways movement controls the rudder angle movement and its forward-backward movement controls the throttle. It should be emphasized that the yaw damper acts and its commands are summed with the rudder stick commands. The throttle linearization circuit also operates and improves the pilot's control of the engine.

In this flight mode the UAV is stabilized in pitch and roll and any surrounding interference in the flight surface angles set are corrected by the autopilot.

14.2.2 Autopilot Disengage (Bypass) — Manual Emergency Flight Control “DISCO.” The UAV flies in this mode when the autopilot is disconnected from the servo actuators and steering commands are sent directly from the flight box to the servo actuators. This mode is used primarily when flight control sensors, autopilot, or VGU malfunctions.

The right stick sideways movement sends commands directly to the aileron servo and controls the UAV's roll rate. The angle of aileron deflection is proportional to the amount of stick deflection. The forward-backward movement of the right stick sends commands to the elevator servo to control the UAV's pitch angle.

The left stick sideways movement sends commands to the rudder and nose wheel steering servos. Its forward-backward movement sends commands to the throttle servo to open/close the throttle.

Controlling the UAV in this state is similar to controlling in a light aircraft and the pilot refers to the flight instruments, the video picture, or to visual control of the UAV in order to fly it. This type of controlling is called rate stick mode. During flight in the rate stick mode, none of the flight control loops in the autopilot are functional, including the yaw damper and the throttle linearization circuit.

14.2.3 Knob Flight Mode. This flight mode is commonly used in flight (out of sight) and it engages three loops: Hold Altitude, Hold Airspeed (IAS), and Hold Heading or Hold Roll. The pilot in the GCS uses a control desk that includes four knobs; three of which function at the same time. The required flight command is sent to the UAV with them. The ALTITUDE knob allows the sending of altitude commands in the range -1,500 to +20,000 ft. The AIRSPEED knob allows the continuous sending of airspeed commands from a minimum value set on the PRESET/ALTI & WARN Menu, up to an airspeed of 95 knots. The HEADING knob allows the continuous sending of heading commands between 0° and 360°. The ROLL knob allows sending of roll commands between -30° left bank and +30° right bank.

14.2.4 Combination Flight-Manual (position stick) and Knobs. In this flight mode, one or two knobs are engaged and the other control loops are Position STICK. This mode is employed in cases of autopilot non-critical failure/malfunction. The pilot can disconnect the outer loop control circuit and remain within control of the inner loop (pitch or roll).

In case of failure in a given outer loop, the loop is disconnected and the flight control surface is manually controlled by the flight box stick. The other two control loops still function. All combinations are possible between the knobs and sticks. The advantage of this method of steering is that, when non-critical failures occur, it is not necessary to disconnect the autopilot. It is possible to isolate only the loop that has been damaged and to leave the UAV under full control of the other loops.

14.2.5 Nav to Coordinate Flight Mode. In this flight mode the airspeed and altitude of the UAV are controlled by the knobs and UAV heading is computed by the ground station based upon the following inputs: Tracker azimuth angles, UAV to station slant range, Plotter map coordinates, UAV magnetic heading, and Coordinates of flight destination.

The ground station calculates UAV position from Tracker azimuth and UAV to station range and references it to plotter map data. UAV heading to destination is determined by comparing the UAV's present position to destination coordinates. A magnetic heading command is then sent to the UAV heading control loop. This process is continuously updating the heading while enroute to the destination.

14.2.6 Camera Guide Flight Mode. In this flight mode the UAV's airspeed and altitude are controlled by the corresponding knobs on the PCD. UAV heading is

calculated by the ground station based on the following inputs: Tracker azimuth angle, UAV to TCU range, UAV magnetic heading, and Payload bearing and depression angle.

The ground station calculates UAV position from Tracker azimuth and UAV to TCU range. Payload bearing and depression angles are compared to UAV heading and a magnetic heading is sent to the Heading Control loop in the autopilot to fly the UAV to the camera optical axis point.

14.2.7 UAV Logic Flight Modes. Flown by the UAV automatically upon loss of communication with the GCS/PCS (no uplinks). There are three types of Logic Modes: Freeze, Glide and Return Home.

14.2.7.1 Freeze Data Flight Mode. The UAV flies in this mode from the moment there is a loss of communication with the GCS. It flies using the last flight data entered and “frozen” at the output of the EDU decoder until it enters into Glide or Return Home Mode.

14.2.7.2 Glide Mode. In the event of loss in both uplinks and the IP has selected TO/LD the UAV will enter glide mode after two seconds. The UAV logic card switches the autopilot to fixed flight data. All flight control surfaces go to 0° and throttle is set at minimum. As long as the autopilot is engaged the UAV will attempt to maintain 0° pitch, 0° roll, 0° yaw, and minimum throttle. With the autopilot disengaged the control surfaces will remain at 0° and no corrections will be made for external forces on the UAV.

14.2.7.3 Return Home Flight Mode. Selected independently by the logic module when there is communication loss in both uplink channels, and on condition that the pilot has preset this mode. After a time delay of 2 seconds (or 30 seconds if RH DELAY pushbutton on the PCD is illuminated), the logic card switches the autopilot control to the RH memory card in which the RH flight data is stored and which is updated during the flight via the uplink channel. RH delay circuit does not work in TO/LD. The RH flight program has three stages: spiral climb, cruising, and final spiral.

1. Spiral Climb to RH Altitude. This spiral is performed with the roll loop engaged (10° to the right). The altitude and airspeed loops are engaged when the UAV is flying within the Climb Law and climbing at an airspeed of 60 knots. This climb can be performed within a maximum of 8 minutes, or

until the UAV reaches the RH altitude (whichever occurs first, altitude or time out). The UAV can skip this spiral (if first climbing spiral is set to NO). The UAV then immediately enters the second stage of the RH program. The spiral can be performed only in climb. If there is a failure in the UAV, the logic module causes the spiral to be automatically omitted. The purpose of this stage is to attempt to renew communications when there is communication loss caused by line-of-sight obstruction.

2. Cruising. The UAV cruises in heading, altitude, and airspeed control loops according to values updated and sent in the last UPL message and for the period of time updated in the last message. This flight data is intended to bring the UAV back to its predetermined location. If the UAV enters this stage when it is not at cruise altitude, it performs climb or descent at the beginning of the leg.
3. Final Spiral. In this stage, the UAV ascends or descends to the final altitude updated in the last UPL message and remains in it until communication is regained or fuel runs out. ROLL is engaged (10° to the right), the airspeed loop is at 60 knots, and the altitude command is one of the following: -1, 1, 3, or 5 (x 1000) ft.

If communication with the UAV is regained at any stage of the RH flight, the UAV exits the RH flight mode and returns to the GCS UPL command.

14.2.7.4 NAV Programmer Mode. In this flight mode the UAV flies autonomously from an onboard program. The operator may enter up to 96 different waypoints that will also command various airspeeds and altitudes. A timed orbit can also be selected to have the UAV orbit around the waypoint or continue on to the next waypoint. The UAV's transmitters and payload may be turned off and on during predetermined steps for tactical purposes.

Heading control is via one of three modes, GPS, GCS, or Dead Reckoning (DR). With GPS on board the program utilizes GPS input to steer the air vehicle to the designated waypoint. If GCS is selected the air vehicle relies on uplinked calculations from the ground station for heading. Failure with either GPS or GCS mode results in the program defaulting to DR where the air vehicle calculates the waypoint based on time and heading and will not compensate for unknowns such as wind.



PART VII

Performance Data

Chapter 15 — Performance Data

CHAPTER 15

Performance Data

15.1 STANDARD DATA

15.1.1 Crosswind Components

1. Subtract runway heading and wind direction.
2. Enter chart at difference and move along radial until you intercept wind velocity arc.
3. Move horizontally to determine headwind (tailwind) component.
4. Move horizontally to determine headwind (tailwind) component.

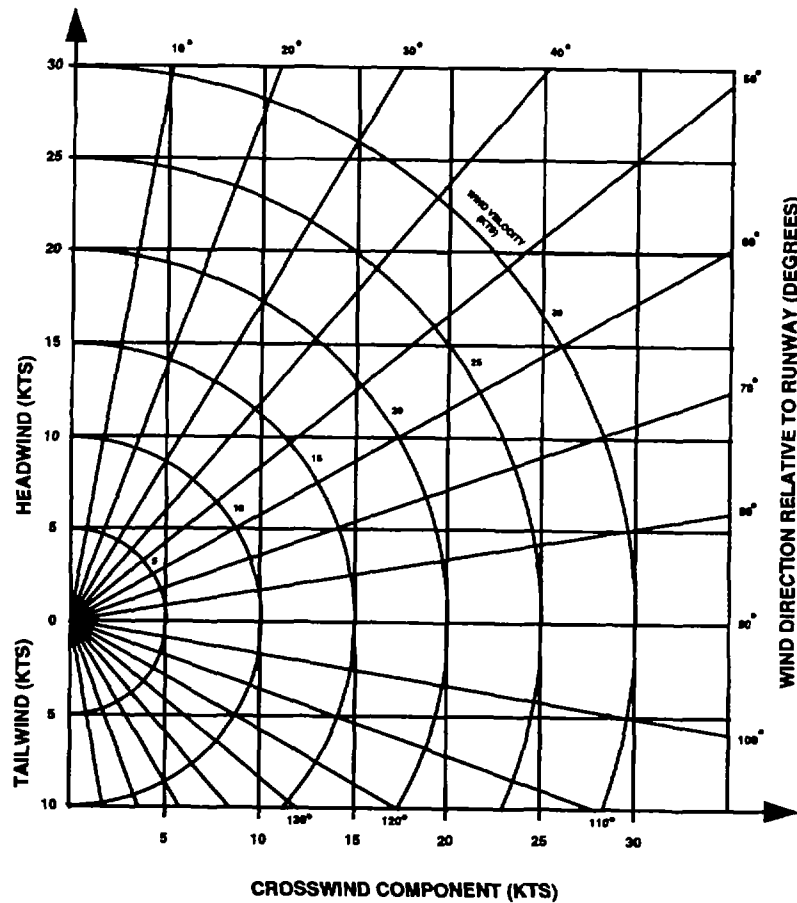


Fig. 15-1. Crosswind Components.

15.1.2 Ambient Temperature vs. Altitude

1. Determine difference between standard day (15°C/59°F) and your field level standard temperature.

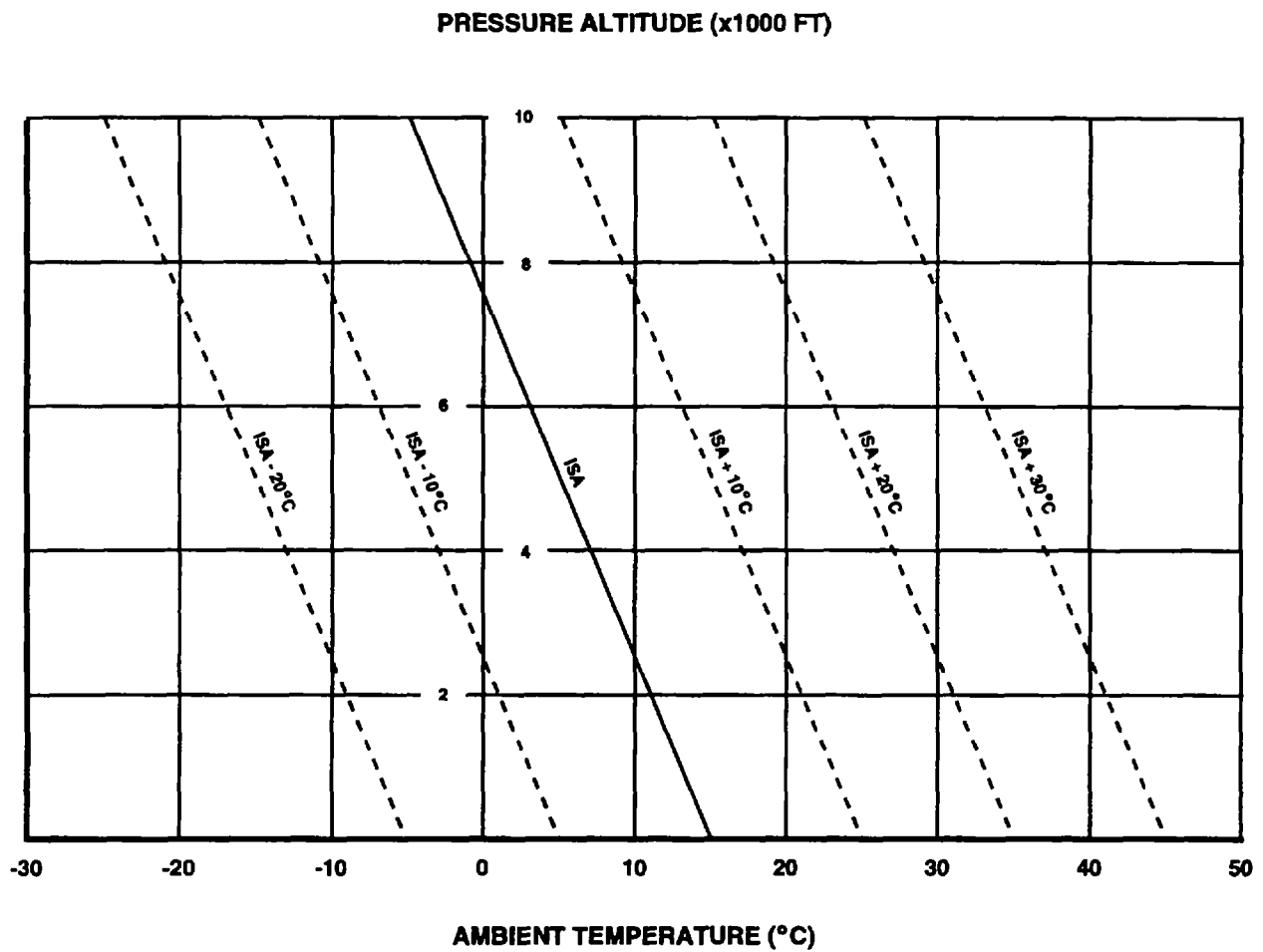


Fig. 15-2. Ambient Temperature vs. Altitude

15.1.3 Line-of-sight Altitude Calculations

RANGE		LOS
NM	KM	ALTITUDE
5	9	30
10	18	70
15	27	160
20	37	290
25	46	460
30	55	660
35	64	900
40	73	1170
45	82	1480
50	91	1830
55	101	2210
60	110	2630
65	119	3090
70	128	3580
75	137	4110
80	146	4680
85	155	5280
90	165	5920
95	174	6590
100	183	7310

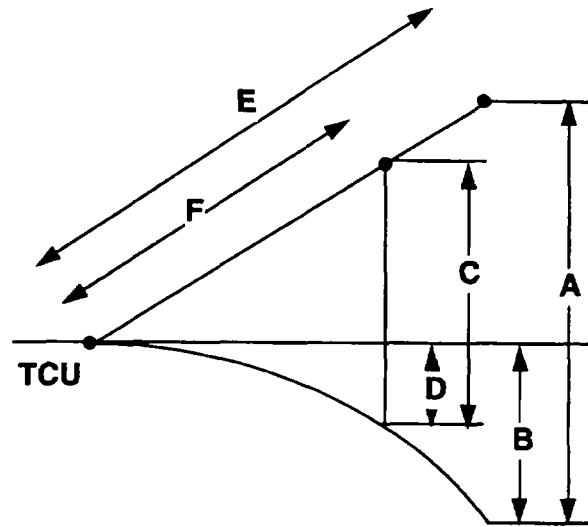


Fig. 15-3. Line-of-sight Altitude Calculations

ABOVE DATA DERIVED USING THE FOLLOWING FORMULAS:

$$\text{RANGE (NM)} = 1.17 \times (\text{LOS ALTITUDE (FT MSL)})^{1/2}$$

$$\text{LOS ALTITUDE (FT MSL)} = (\text{RANGE (NM)} / 1.17)^2$$

ASSUMES TCU IS AT 0 FT MSL

$$A = B + ((C - D) \times E / F)$$

- A = UAV ALTITUDE REQUIRED TO MAINTAIN LOS OVER OBSTRUCTION
- B = LOS ALTITUDE AT UAV RANGE (FT MSL)
- C = OBSTRUCTION HEIGHT (FT MSL)
- D = LOS ALTITUDE AT OBSTRUCTION RANGE (FT MSL)
- E = RANGE TO UAV (NM OR KM)
- F = RANGE TO OBSTRUCTION (NM OR KM)

NOTE: USE NM OR KM FOR RANGE THROUGHOUT CALCULATION.

IF OBSTRUCTION HEIGHT IS LESS THAN LOS ALTITUDE AT OBSTRUCTION RANGE, UAV LOS IS NOT AFFECTED.

15.2 TAKEOFF DATA

15.2.1 Takeoff Ground Run Distance Charts. Figure 15-4 presents the takeoff ground run distance at the minimum required engine RPM of 6700. Takeoff distances are computed for a normal takeoff technique on a hard, dry runway for a rotation velocity of 60 KIAS. Gross weight, pressure altitude, ambient temperature, headwinds, and runway gradient are the plotted variables. For rotation speeds other than 60 KIAS, a multiplication factor for alternative rotation speeds is present. A multiplication factor for wet runway conditions is also present.

Figures 15-5 through 15-7 represent tabular data extracted from Fig. 15-1 as follows:

Fig. 15-5 — T/O Weight = 420 lb
Rotation Speed = 60 KIAS

Fig. 15-6 — T/O Weight = 440 lb
Rotation Speed = 60 KIAS

Fig. 15-7 — T/O Weight = 460 lb
Rotation Speed = 60 KIAS

Figures 15-5 through 15-7 are to be used for computation of takeoff ground run distance only. Rotation speed will be no less than 58 KIAS.

15.2.1.1 Chart Use. Enter Fig. 15-4 at the weight scale and proceed vertically to intersect the pressure altitude. Standard day temperatures are shown along with their respective altitudes. Project horizontally to the temperature baseline and using the guidelines, proceed to the appropriate delta temperature (difference between standard day and flight condition temperature). Project horizontally to the headwind baseline and using the guidelines, proceed to the appropriate effective headwind (use positive numbers for headwinds, and negative numbers for tailwinds). Project horizontally to the runway gradient baseline and using the guidelines, proceed to the appropriate gradient. Project horizontally to the liftoff ground run scale and read the appropriate distance.

This chart is based on a rotation velocity of 60 KIAS. The takeoff distance for rotation velocities other

than 60 KIAS can be calculated with the use of the Rotation Velocity multiplier. From the Rotation Velocity Effect Table, find the multiplier for the desired rotation velocity. Multiply the takeoff distance obtained from above by the rotation velocity multiplier to obtain the takeoff distance at the alternative rotation velocity. To correct for a wet runway, determine the wet runway multiplier from the table using the runway distance calculated from above. Multiply that runway distance by the wet runway multiplier to obtain wet runway takeoff distance.

15.2.1.2 Sample Problem. Determine takeoff distance for the following conditions:

Takeoff Weight	460 lb (208.6 kg)
Altitude	2000 FT
Temperature	82 F (27.7 C)
Headwind	10 KIAS
Runway Gradient	-2 % (downhill)
Rotation Velocity	58 KIAS
Wet runway	Solution: Takeoff
Weight	460 lb (208.6 Kg)
Rotation Velocity	60 KIAS
Altitude	2000 FT
Takeoff Distance	1680 FT
Temperature	30 °F
	from Standard Day
	(82 F - 52 F = 30 °F)
Takeoff Distance	1980 FT
Headwind	10 KIAS
Takeoff Distance	1500 FT
Runway Gradient	-2%
Takeoff Distance	1350 FT
Rotation Velocity	58 KIAS
Rotation Velocity Multiplier	0.92
Takeoff Distance	1242 FT
	(1350 FT X 0.92 = 1242 FT)
Takeoff Distance	1242 FT
Wet Runway Multiplier	1.14
Takeoff Distance	1416 FT
	(1242 FT X 1.14 = 1416 FT)

Date: 8 May 1995
 Data Basis: Flight Test

PIONEER TAKE-OFF DISTANCES

Hard, Dry Runway
 Engine RPM: 6700
 Rotation Velocity: 60 KIAS

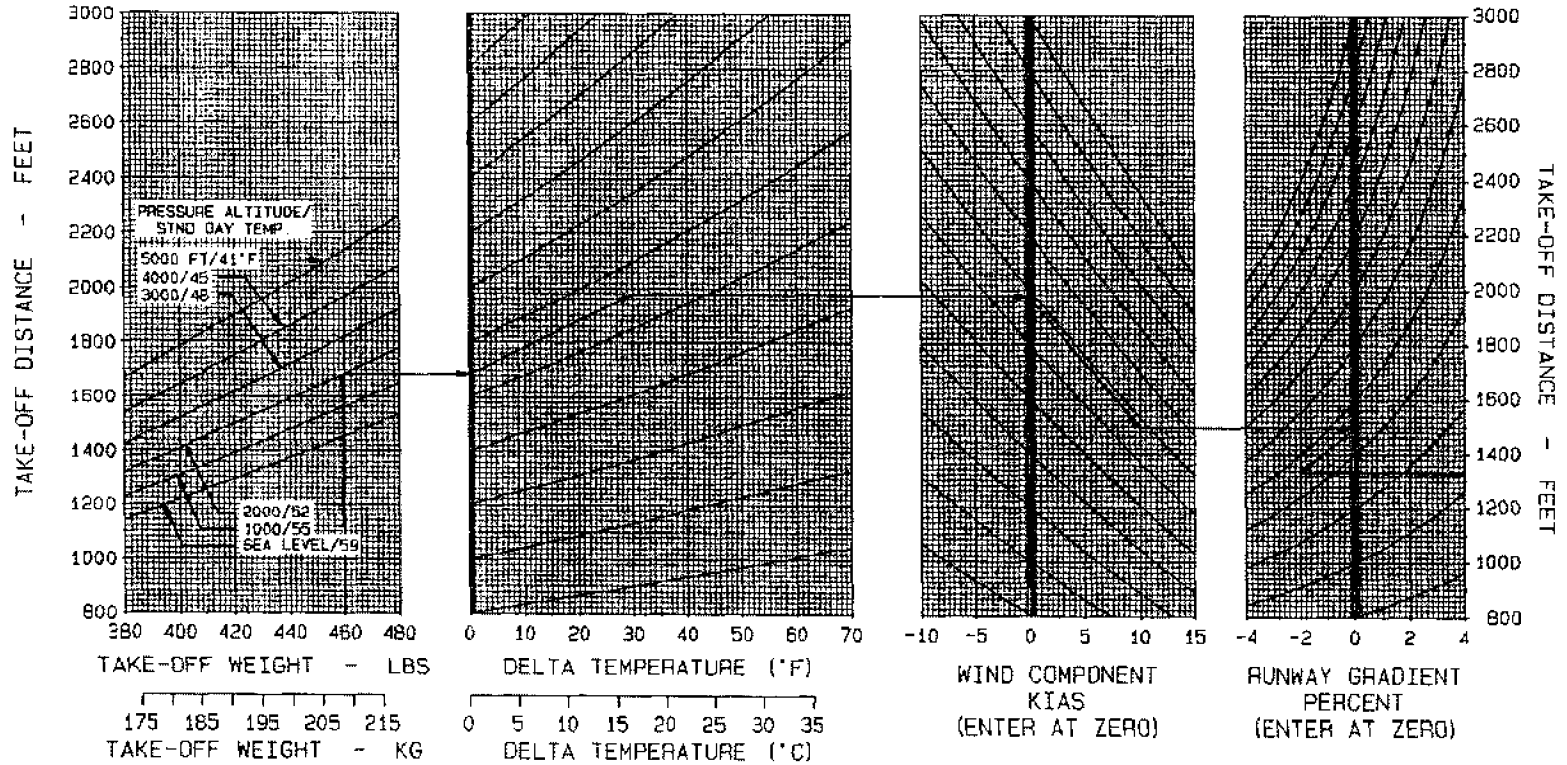


Figure 15-4. Pioneer Takeoff Distances

15-5

	ROTATION VELOCITY EFFECT						
ROTATION VELOCITY - KIAS	58	59	60	61	62	63	64
ROTATION VELOCITY MULTIPLIER	0.92	0.96	1.00	1.04	1.09	1.14	1.19

	WET RUNWAY EFFECT				
TAKEOFF DISTANCE (FEET)	1000	1400	1800	2200	2600
WET RUNWAY MULTIPLIER	1.12	1.15	1.18	1.22	1.26

7:57:41 19 NOV 1998 FROM FILE plot17.nmg

ORIGINAL

A1-SRRPV-NFM-000

TAKEOFF GROUND RUN DISTANCE

Weight = 420 lbs

Rotation Speed = 60 Kias

Hard Dry Runway
 Engine RPM: 6700
 No Runway Slope

Date: 8 May 1995
 Data Basis: Flight Test

Temperature from Std Day (° F)	Ground Run Distance (Feet)						Head Wind (Kias)
	Pressure Altitude (Feet) / Std Day Temp.° (F)						
	SL / 59	1000 / 55	2000 / 52	3000 / 48	4000 / 45	5000 / 41	
0	1290	1390	1500	1620	1750	1900	0
10	1340	1460	1560	1700	1840	2000	↓
20	1400	1520	1630	1790	1930	2100	
30	1460	1590	1700	1880	2040	2220	
40	1530	1660	1790	1960	2130	2340	
50	1590	1740	1870	2060	2250	2460	
60	1660	1820	1960	2160	2370	2590	
70	1730	1890	2040	2260	2490	2740	
0	950	1050	1140	1220	1340	1450	10
10	1010	1100	1180	1290	1400	1510	↓
20	1050	1160	1240	1360	1480	1610	
30	1100	1200	1300	1440	1560	1700	
40	1150	1260	1360	1500	1640	1810	
50	1200	1310	1430	1580	1730	1920	
60	1260	1380	1510	1650	1840	2020	
70	1300	1450	1570	1740	1940	2140	
0	810	890	970	1060	1140	1250	15
10	850	930	1020	1100	1220	1310	↓
20	880	1000	1070	1160	1280	1380	
30	930	1030	1120	1230	1350	1470	
40	990	1080	1180	1300	1410	1570	
50	1030	1130	1250	1370	1490	1670	
60	1080	1200	1310	1450	1600	1770	
70	1120	1240	1370	1500	1690	1880	

Figure 15-5. Takeoff Ground Run Distance (Weight = 420 lbs)

TAKEOFF GROUND RUN DISTANCE

Weight = 440 lbs

Rotation Speed = 60 Kias

Hard Dry Runway
 Engine RPM: 6700
 No Runway Slope

Date: 8 May 1995
 Data Basis: Flight Test

Temperature from Std Day (° F)	Ground Run Distance (Feet)						Head Wind (Kias)
	Pressure Altitude (Feet) / Std Day Temp.° (F)						
	SL / 59	1000 / 55	2000 / 52	3000 / 48	4000 / 45	5000 / 41	
0	1370	1480	1590	1720	1860	2020	↓
10	1440	1540	1670	1800	1940	2130	
20	1500	1610	1760	1890	2050	2240	
30	1570	1680	1850	1990	2160	2360	
40	1640	1770	1930	2090	2270	2500	
50	1720	1850	2030	2190	2390	2630	
60	1800	1940	2130	2300	2510	2780	
70	1870	2020	2230	2410	2630	2930	
0	1030	1120	1200	1290	1420	1550	↓
10	1080	1160	1270	1360	1480	1640	
20	1140	1220	1350	1440	1570	1740	
30	1180	1280	1410	1500	1650	1830	
40	1240	1340	1480	1600	1750	1950	
50	1290	1410	1540	1690	1860	2040	
60	1360	1490	1640	1780	1960	2180	
70	1430	1550	1730	1880	2040	2290	
0	870	950	1030	1110	1210	1350	↓
10	910	1000	1110	1180	1280	1410	
20	980	1050	1150	1260	1360	1510	
30	1010	1100	1230	1300	1450	1590	
40	1060	1160	1300	1370	1510	1700	
50	1110	1230	1340	1460	1620	1790	
60	1180	1290	1410	1540	1710	1920	
70	1220	1350	1500	1640	1790	2010	

Figure 15-6. Takeoff Ground Run Distance (Weight = 440 lbs)

TAKEOFF GROUND RUN DISTANCE

Weight = 460 lbs

Rotation Speed = 60 Kias

Hard Dry Runway
 Engine RPM: 6700
 No Runway Slope

Date: 8 May 1995
 Data Basis: Flight Test

Temperature from Std Day (° F)	Ground Run Distance (Feet)						Head Wind (Kias)
	Pressure Altitude (Feet) / Std Day Temp.° (F)						
	SL / 59	1000 / 55	2000 / 52	3000 / 48	4000 / 45	5000 / 41	
0	1450	1560	1680	1820	1970	2140	↓
10	1510	1640	1760	1910	2080	2250	
20	1580	1730	1860	2010	2200	2390	
30	1650	1820	1980	2120	2320	2500	
40	1740	1900	2050	2220	2450	2640	
50	1820	2000	2160	2340	2590	2780	
60	1910	2100	2260	2460	2750	2930	
70	1990	2200	2370	2570	2880	3000>	
0	1090	1170	1280	1380	1500	1630	↓
10	1130	1240	1350	1460	1590	1730	
20	1190	1320	1420	1540	1700	1860	
30	1250	1380	1500	1630	1800	1950	
40	1310	1450	1570	1720	1910	2050	
50	1380	1510	1650	1810	2020	2180	
60	1460	1610	1740	1920	2150	2290	
70	1520	1700	1840	2000	2260	2380	
0	920	1000	1100	1200	1300	1430	↓
10	970	1080	1150	1260	1360	1490	
20	1020	1120	1210	1340	1470	1620	
30	1070	1200	1300	1400	1560	1700	
40	1130	1270	1360	1490	1660	1800	
50	1200	1310	1450	1570	1770	1920	
60	1260	1380	1500	1670	1890	2010	
70	1320	1470	1600	1750	1960	2100	

Figure 15-7. Takeoff Ground Run Distance (Weight = 460 lbs)

15.3 CLIMB DATA

15.3.1 Time to Climb

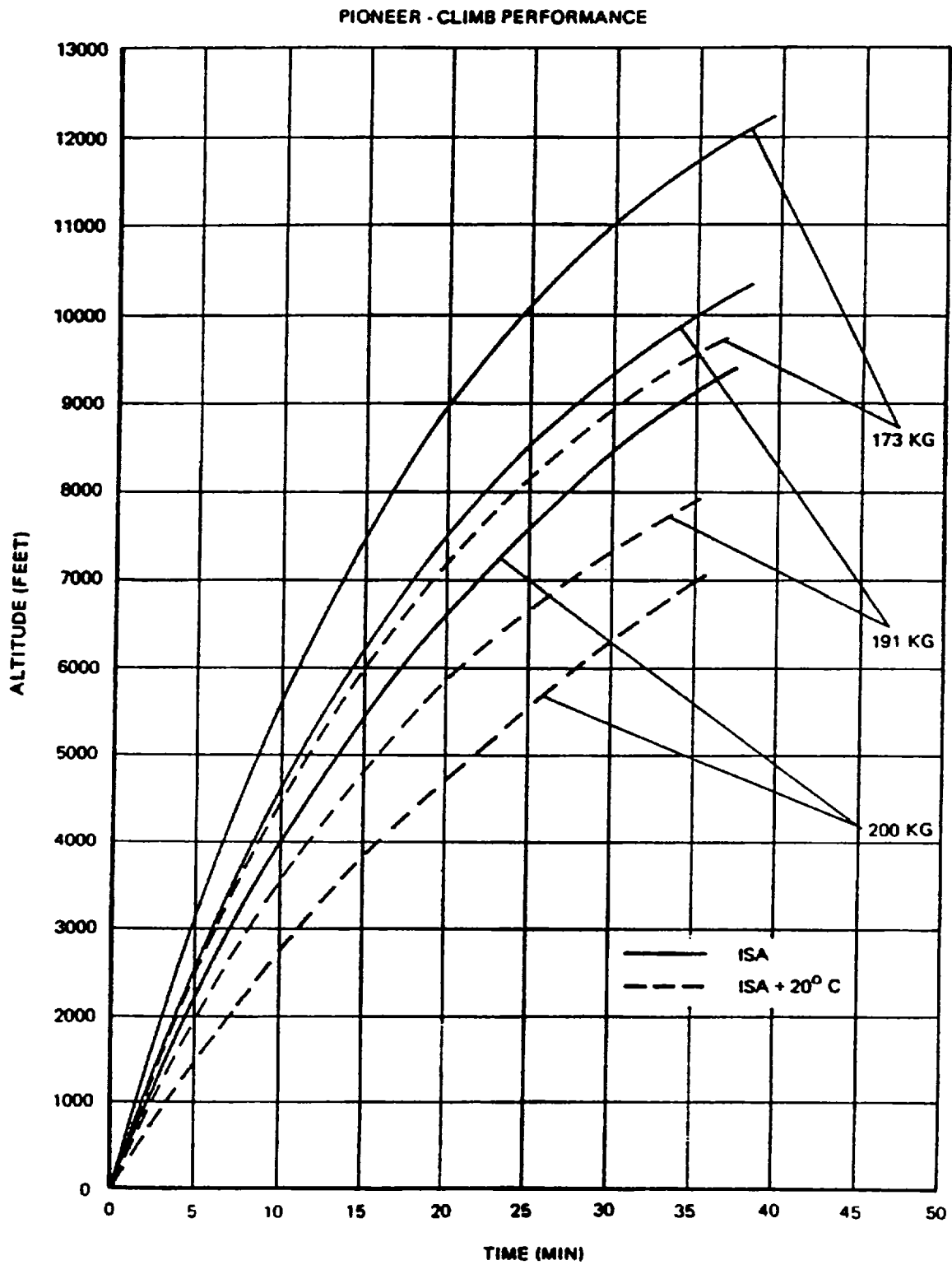


Fig. 15-8. Time to Climb

15.3.2 Distance Covered in Climb

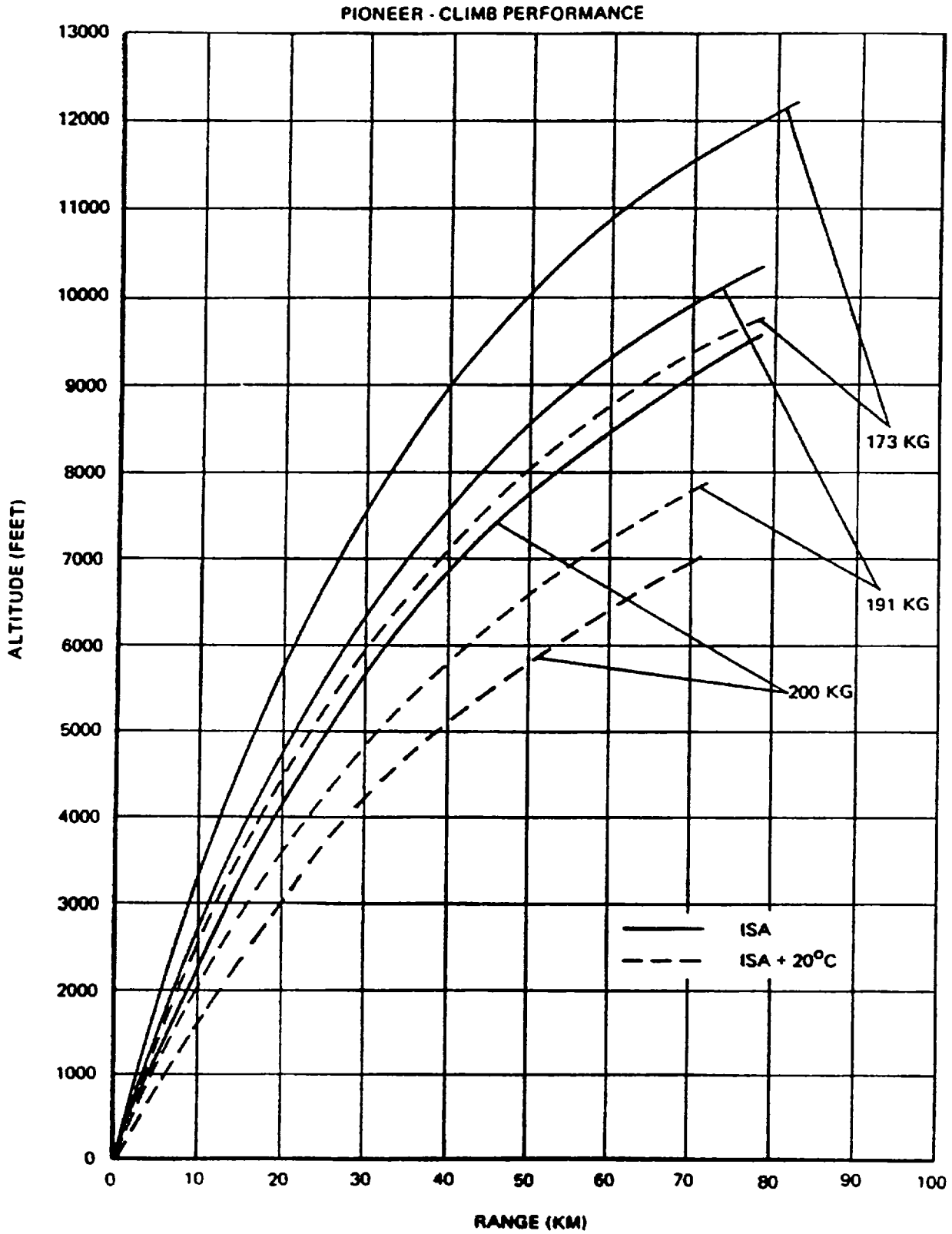


Fig. 15-9. Distance Covered in Climb

15.3.3 Fuel Consumption in Climb

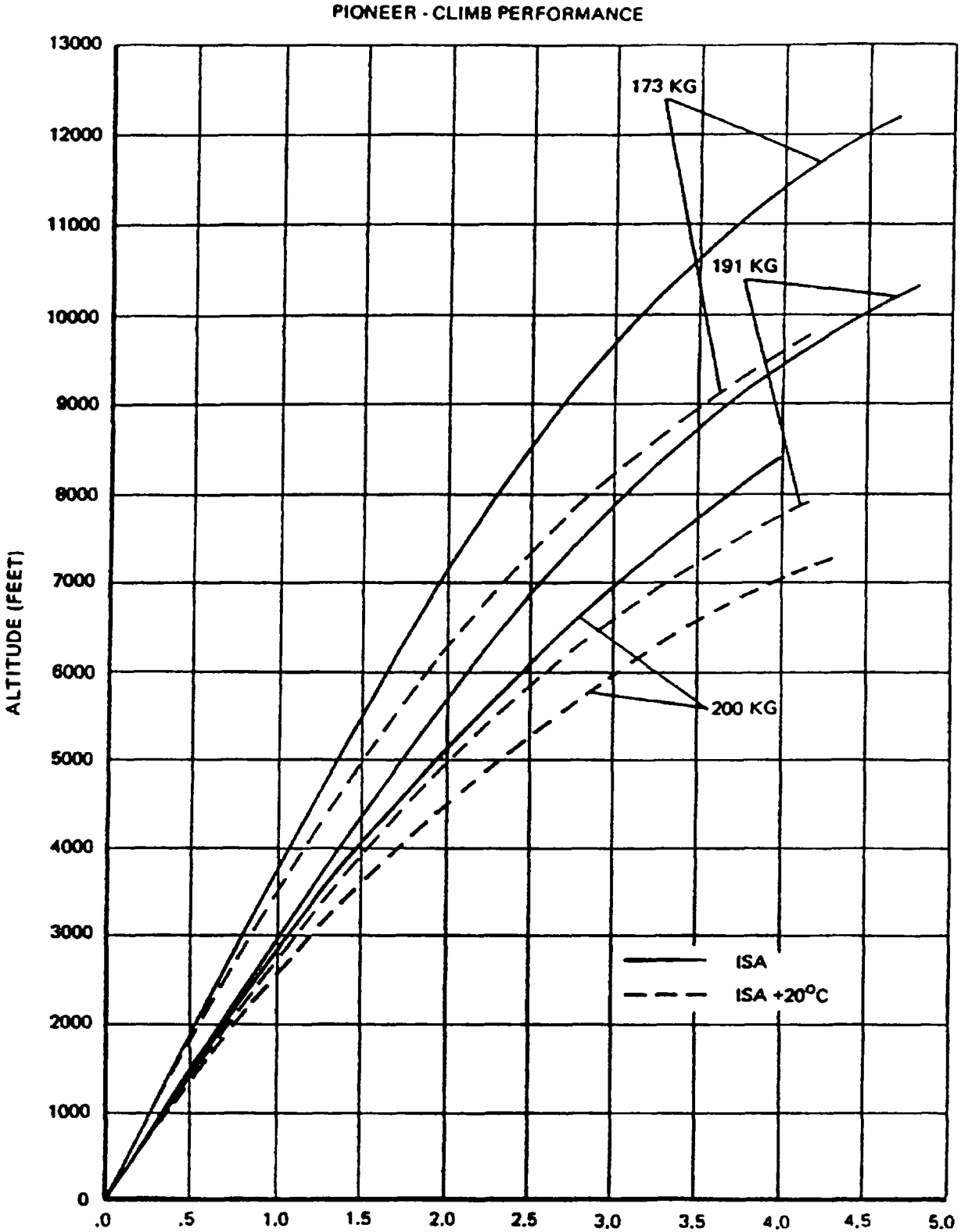


Fig. 15-10. Fuel Consumption in Climb

15.4 CRUISE DATA

15.4.1 Fuel Consumption in Cruise 173 kg

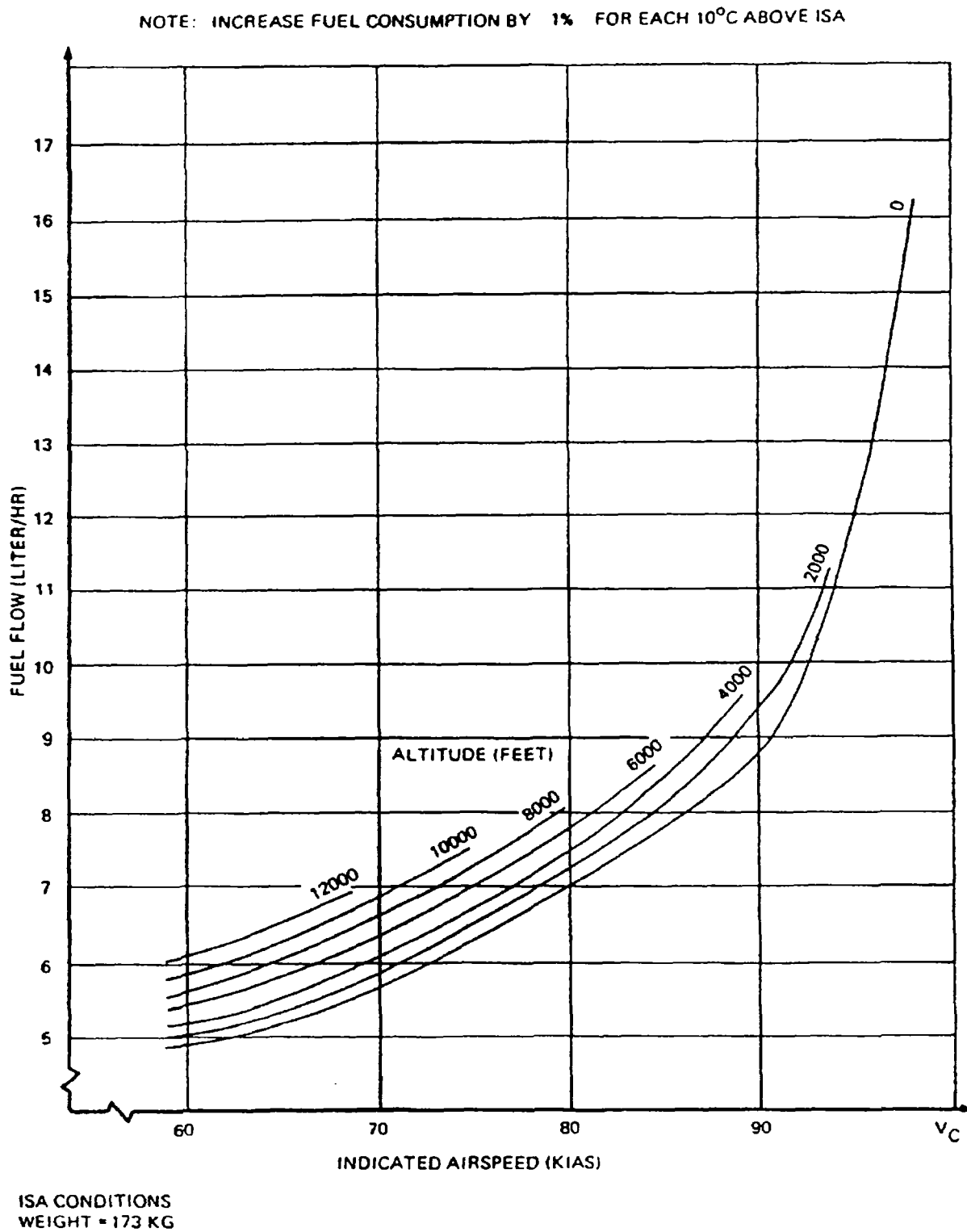


Figure 15-11. Fuel Consumption in Cruise 173 kg

15.4.2 Fuel Consumption in Cruise 191 kg

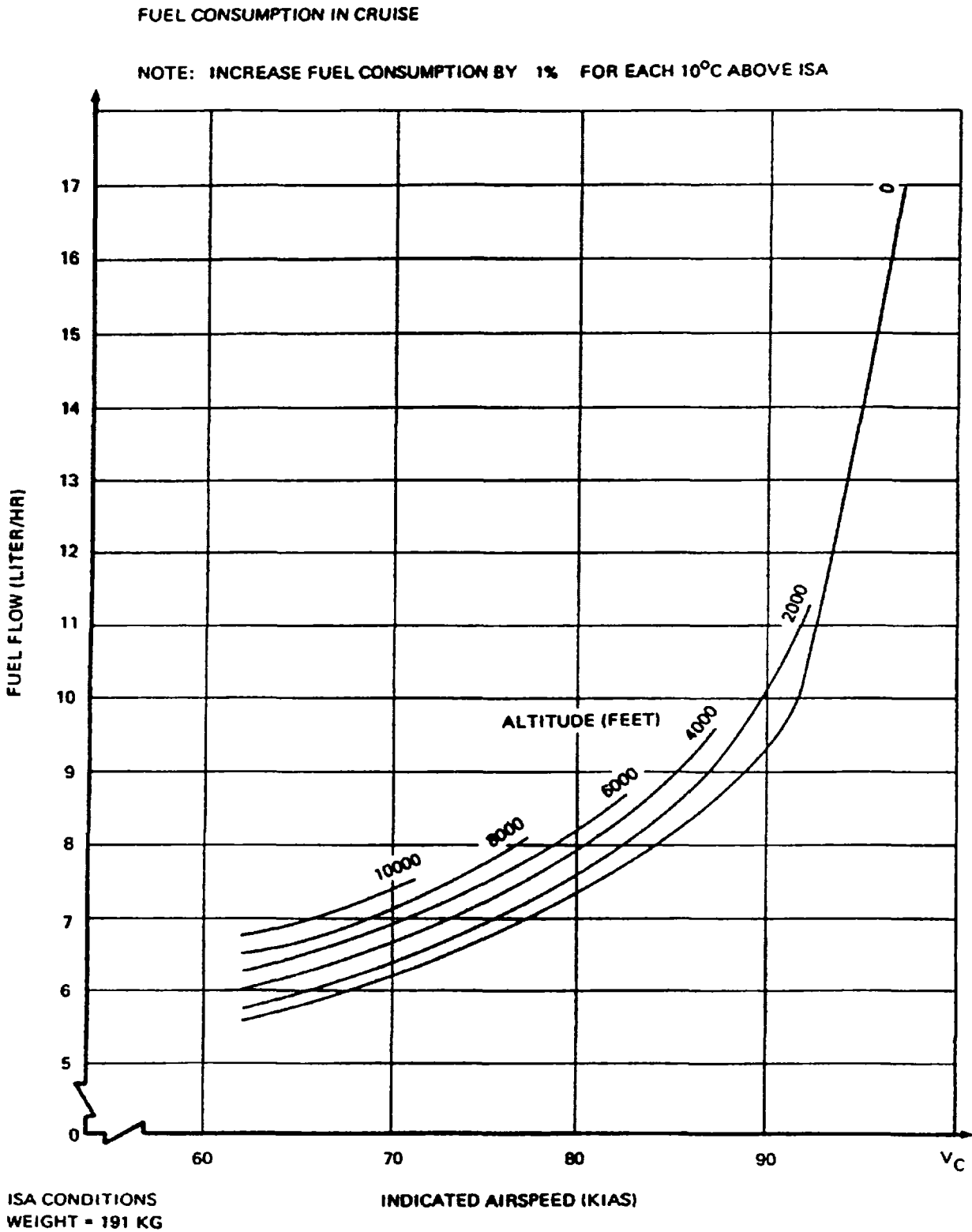


Figure 15-12. Fuel Consumption in Cruise 191 kg

15.4.3 Fuel Consumption in Cruise 200 kg

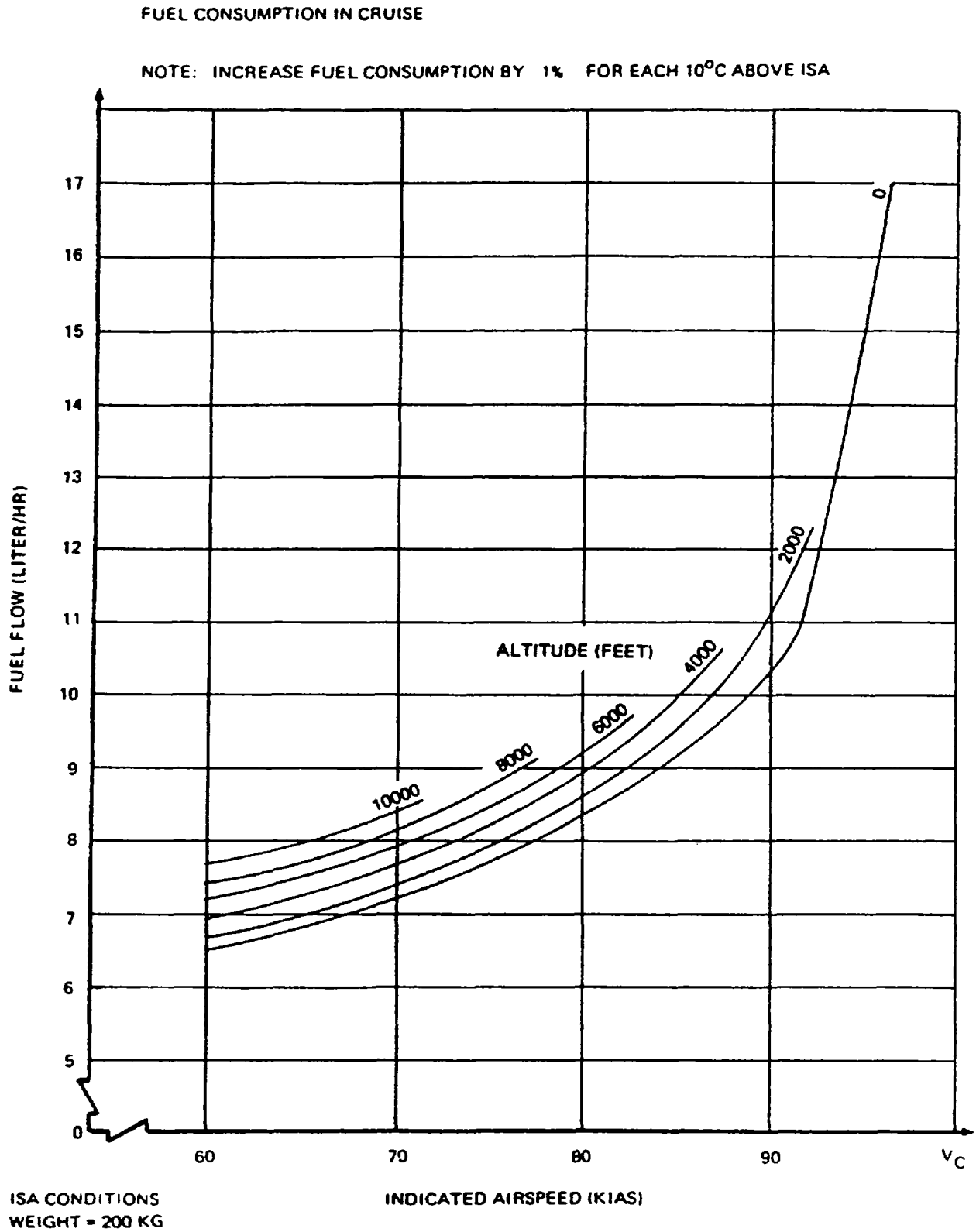


Figure 15-13. Fuel Consumption in Cruise 200 kg

15.5 EMERGENCY DATA

15.5.1 Stall Speeds

1. Enter chart at desired angle of bank (AOB).
2. Move vertically until you intercept "weight of Air Vehicle" curve.
3. Move horizontally to determine stall speed.

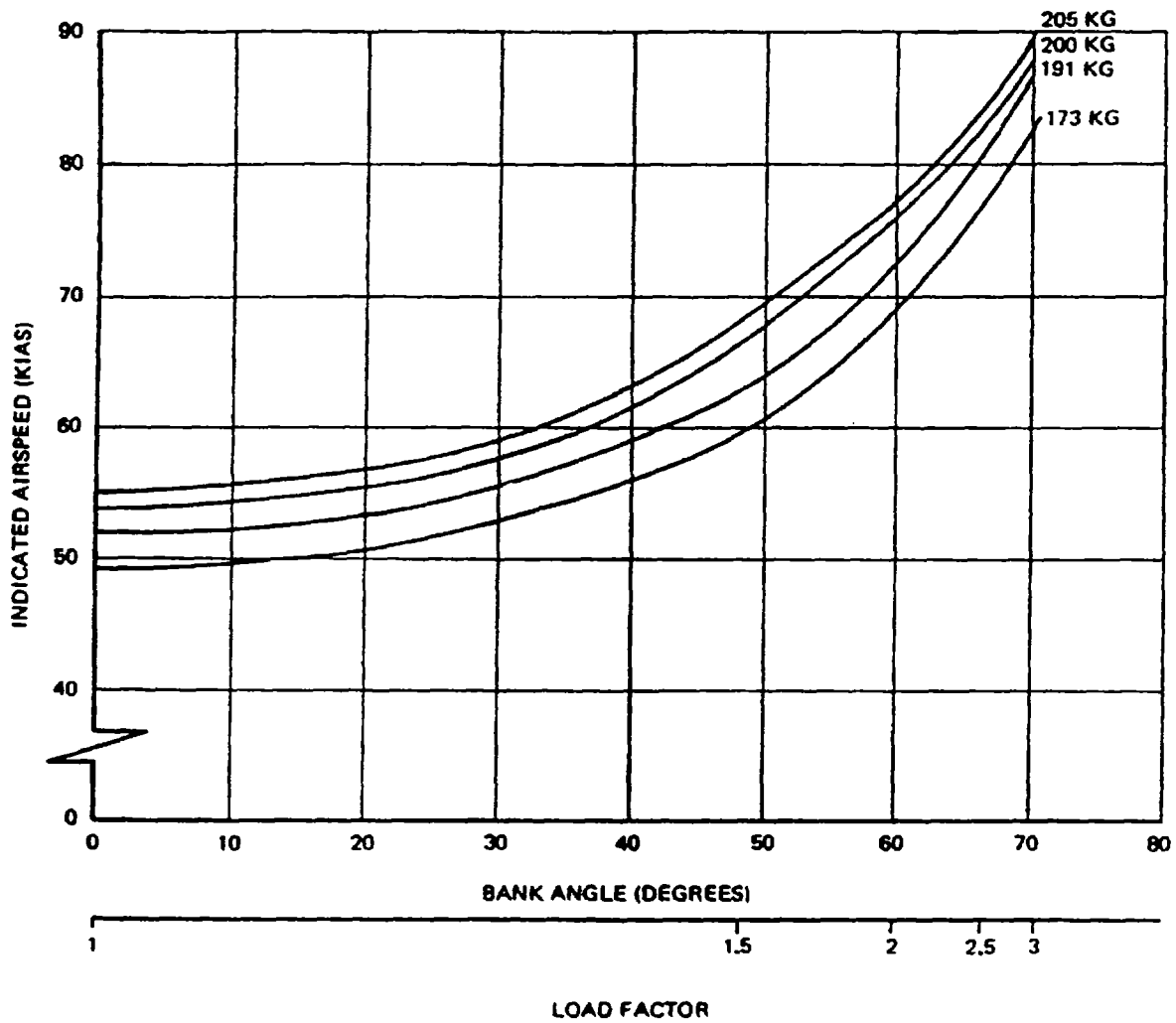


Figure 15-14. Stall Speeds

INDEX

	<i>Page No.</i>		<i>Page No.</i>
A			
Airspeed		C-band receiver	3-29
Limitations	7-2	Changing flight modes	12-2
Altitude		Chemlighting runway	10-20
Envelope	7-2	CIC UAV checklikt	11-25
Amber deck	11-14	Climb and cruise	12-1
Ambient		Climb	10-16
Temperature vs. altitude	15-2	Data	15-9
Antenna		Out	10-15
Azimuth	11-6	Procedures	12-1
Elevation	11-5	Time to	15-9
Switching	11-6	Combination	
System	3-29	Flight-manual (position stick)	14-22
Auto-tracking unit		Knobs	14-22
Microprocessor controlled	3-29	Communication	2-10
Autopilot		Control box (CCB)	3-29
Disconnect (DISCO)		Subsystem	4-2
Flight	12-2	Systems range limitations	7-3
Landing	12-3	Tracking subsystem (CTS)	3-29
Disengage (Bypas)		Control checks	10-15
Manual emergency flight		Crash	
control "DISCO"	14-22	Flight deck, on the	11-16
Limitations	7-2	Salvage scene leader	11-16
AVGAS		Crew	
Fueling	11-17	Required	1-1
Defueling	11-17	Requirements	8-1
AVGAS bladder		Crew chief pre-takeoff checklist (shipboard)	11-19
Fueling	11-18	Crosswind	
Defueling	11-18	Components	15-1
AVGAS storage bladder	11-17	Landing	12-2
Jettison procedures	11-17	Takeoff	12-1
B			
B & A crane deck crew	11-26	Cruise data	15-12
Balance	9-1	Currency	8-2
Battery failure	13-7	D	
Boat crew	11-25	Debriefing	9-3
Briefing	9-2	Deck status	
Debriefing	9-2	Authority	11-14
Guide	9-2	Criteria	11-14
C			
Calibration mode	14-18	Decoder/encoder unit (EDC)	3-29
Camera Guide		Deployment	6-2
Flight Mode	14-22	Descent	10-16
Updating Mode	14-21	Designating authority	8-1
		Designation	8-1
		Dishlock	10-15
		Displays	5-8
		Distance	
		Covered in climb	15-10
		Downlink frequency	7-3

	<i>Page No.</i>
Dual	
UAV operations	10-17
Uplink failure	13-8
Dual OPS	
Descent.	10-19
Landing	10-19
Procedures	10-17
Station turn over	10-18
E	
Electrical	
Emergencies	13-6
Power	3-1
Emergency	
Control station transfer	13-9
Data	15-15
Encoder/decoder unit (EDC).	3-29
Engine	
Cut (EP at the controls)	13-4
Engine cut (IP at the controls).	13-4
Fails to cut on command	13-1
Limitations	7-1
Shutdown	10-12
Temp.	13-4
Equipment list	9-2
External pilot (EP).	8-1
F	
Factors affecting UAV lift capability	9-1
Failure	
Display mode	14-18
Single uplink	13-9
Fire on deck	13-1
Flight	
Command/control subsystem.	4-2
Control	
Emergencies.	13-10
Malfunction.. . . .	13-10
Deck crash procedures	11-16
Modes	14-22
Quarters for UAV operations	11-13
FLIR electronic box (FEB)	5-8
Fuel consumption	
Climb.	15-11
Cruise	
173 kg	15-12
191 kg	15-13
200 kg	15-14
Planning	9-2
Functional check flights	10-33

	<i>Page No.</i>
G	
GCS	3-1
Electrical panels	11-9
PBX electrical panels	11-9
Preflight Inspection	10-3
GCS-2000 electrical system limitations.	7-3
General description	1-1, 4-2, 5-1, 5-3, 6-1
Generator failure.. . . .	13-6
Green deck	
Launch of UAVs	11-14
Recovery of UAVs	11-14
Ground	
Control station (GCS)	3-1
Emergencies	13-1
Operations.	10-1
H	
Hand signals	10-20
High	
Fuel consumption	13-5
Idle	13-5
Hung rate bottle	13-3
I	
In-flight engine emergencies	13-4
Initial training (DUTC)	8-1
Intercommunication system	11-9
Internal	
Operator (IO)	8-1
Pilot (IP)	8-1
Pre-takeoff checklist	11-19
Introduction	7-1, 8-1, 9-1, 10-1, 11-1
K	
Knob flight mode	14-22
L	
Landing	10-17, 12-2
Launch	1-1
Emergencies	13-2
Procedures	10-13
UAVs.	11-14
Line operations.	10-1
Line-of-sight altitude calculations	15-3
Logic	
Menus, use of	10-21

	<i>Page No.</i>		<i>Page No.</i>
M			
Main unit setup	6-4	Navigation data system.	11-2
Maneuvering	12-2	Night operations	10-20
Load factors.	7-2	No report	13-8
Master-at-arms division.	11-25	Normal landing.	12-2
Maximum weight	7-2	O	
Menus		Observer bay (OBY)	3-19, 11-11
Logic	10-21	Presets	10-29
Use of	10-21	Observer's control modes.	10-30
Microprocessor controlled auto-tracking unit (MCAT)		OOD.	11-25
.	3-29	Checklist for UAV operations	11-22
Mission		Operating limitations	7-1
Planning	9-1	Operation	
Procedures	6-4	Mode	6-4
Mission capabilities.	1-1, 5-1, 5-4, 1-1	Procedures	5-2, 5-6
Mission commander (MC)	8-1	Operational control modes	5-1, 5-5
Checklist (shipboard)	11-18	Organization	11-7
Mode(s)		P	
Calibration	14-18	Payload	
Camera guide		Automatic functions	5-3
Flight	14-22	Control	4-2
Updating	14-21	Electronic box (PEB).	5-8
Changing flight	12-2	Operator (PO).	8-1
Failure display	14-18	PCS	11-6
Flight.	14-22	Integrity checklist	11-9
Home updating, return	14-21	Performance	1-1
Knob flight.	14-22	Pitch limitations	7-1
Multifunction	14-18	Pilot bay	11-9
Nav		Presets	10-21
Coordinate flight	14-22	Pilot control	
Programmer updating	14-21	Bay (PBY)	3-2
Observer's control	10-30	Modes	14-1
Operation	6-4	Other functions.	10-26
Operational control	5-5	Table	10-26
Pilot control.	4-1	Pioneer preflight inspection	10-7
Position stick, manual flight ("STICKS")	14-22	Pneumatic launcher failure.	13-3
Preset	14-2	Portable control station (PCS).	4-1
Return home updating	14-21	Position stick	
Standby	6-4	Manual fight mode ("STICKS").	14-22
Target altitude updating	14-21	Post	
Test	14-1	Flight inspection	10-20
Movement	10-1	Landing	10-17
Multifunction mode.	14-18	Power	
N			
NATOPS evaluations	8-2	Distribution	3-1
Nav		Failure (control stations).	13-2
Coordinate		Supply subsystem.	4-2
Flight mode	14-22	Preflight	
Mode	14-21	Briefing.	11-12
Programmer updating mode	14-21	Inspection	10-3
		Presets.	10-21

	<i>Page No.</i>		<i>Page No.</i>
Shipboard	11-20	Stall	
Preset mode	14-2	Recovery	12-2
Pre-takeoff procedures	10-13	Speeds	15-15
Pre-taxi checks	10-12	Standard data	15-1
Prifly checklists (shipboard)	11-23	Standby mode	6-4
Prifly UAV		Starting engine	10-11
Launch checklist	11-24	Stuck throttle	13-5
Post recovery checklist.	11-24	System	
Pre-launch checklist	11-23	Acceptance	10-3
Pre-recovery checklist	11-24	Modifications	11-2
Recovery checklist	11-24	Monitor and processor (SMP)	3-1
Principal dimensions	1-1		
Prog fail light illuminated	13-9	T	
Prohibited maneuvers	7-2	Takeoff	12-1
		After	10-15
Q		Data	15-5
Qualifications	8-1	Ground run distance charts	15-5
		Launch checklist	10-14
R		Target altitude updating mode	14-21
RATO		Taxiing	12-1
Misfire.	13-2	TCU preflight inspection.	10-3, 11-8
Procedures.	11-25	Test mode.	14-1
Prestart checklist	10-10	Throttle, stuck	13-5
Recovery		Time to climb.	15-9
Emergencies.	13-2	Tracking and communication unit (TCU)	3-28
Net	11-12	Tracking bay (TBY)	3-15, 11-11
Red deck	11-14	Presets	10-28
Remote receiving station (RRS).	6-1	Training syllabus	8-1
Return home updating mode	14-21	TUA setup	6-3
RF system	11-6		
Roll Limitations	7-1	U	
Rolling takeoff	12-1	UAV	2-1
Abort	13-3	Airframe	2-1
RRS		Control	11-14
Setup	6-3	Crew chief	11-25
Startup	6-4	Defueling.	11-17
Runway, chemlighting	10-20	Electrical system	2-4
		Electronic system.	2-7
S		Engine turn procedures, preflight	11-12
Scheduling	10-1	Failure to respond (GCS lockup)	13-9
Securing flight quarters	11-14	Flight deck	
Ship lookouts	11-26	Launch procedures	11-13
Shipboard		Operations	11-7
Mission commander checklist	11-18	Recovery procedures	11-15
Single uplink failure	13-9	Flight operations, visual range of ship	11-15
Site selection.	6-2	Fueling	11-17
SPARS III	11-6	Inflight procedures	11-14
Stabilized reconnaissance payload		Landing	10-21
(MKD-200), daylight operations	5-1	Launch	
(MKD-400), day/night operation.	5-3	11-14	
		Log flight modes	14-23

	<i>Page No.</i>		<i>Page No.</i>
Mishap reporting	11-16	V	
Mission commander	11-25		
Observation of operations	11-18	Visual contact, loss of	13-3
OOD checklist (shipboard).	11-22	W	
Operation above 1000 ft MSL	11-15		
Operations below 1000 ft MSL	11-15	Weights	1-1, 9-1
Post flight procedures	11-16	Wind limitations	
Pioneer	1-1	Landings	7-2
Practice recovery procedures	11-15	Takeoff	7-2
Preflight procedures	11-8	Y	
Preflight/engine turn procedures	11-12		
Reacquisition.	10-20	Yaw limitations	7-1
Recovery	10-21, 11-14		
Simulated recovery procedures	11-15		
Water recovery procedures	11-25		
Unit training	8-1		
Uplink frequency	7-3		

LIST OF EFFECTIVE PAGES

Effective Pages	Page Numbers
Original	1 (Reverse Blank)
Original	3 (Reverse Blank)
Original	5 thru 17 (Reverse Blank)
Original	19 (Reverse Blank)
Original	21 thru 29 (Reverse Blank)
Original	1-1 thru 1-2
Original	2-1 thru 2-12
Original	3-1 thru 3-30
Original	4-1 thru 4-2
Original	5-1 thru 5-8
Original	6-1 thru 6-4
Original	7-1 thru 7-4
Original	31 (Reverse Blank)
Original	8-1 thru 8-2
Original	33 (Reverse Blank)
Original	9-1 thru 9-3 (Reverse Blank)
Original	10-1 thru 10-37 (Reverse Blank)
Original	11-1 thru 11-27 (Reverse Blank)
Original	35 (Reverse Blank)
Original	12-1 thru 12-3 (Reverse Blank)
Original	37 (Reverse Blank)
Original	13-1 thru 13-11 (Reverse Blank)
Original	39 (Reverse Blank)
Original	14-1 thru 14-23 (Reverse Blank)
Original	41 (Reverse Blank)
Original	15-1 thru 15-15 (Reverse Blank)
Original	Index-1 thru Index-5 (Reverse Blank)
Original	LEP-1 (Reverse Blank)

