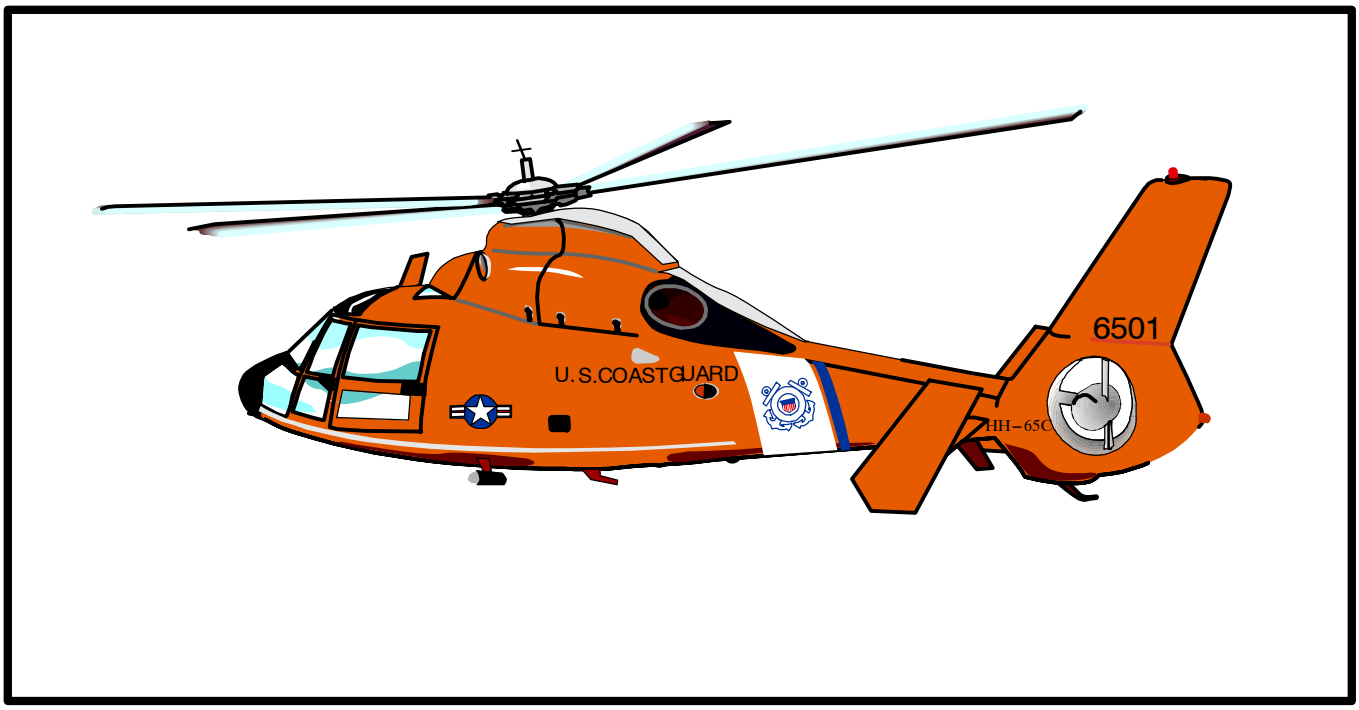
# FLIGHT MANUAL

## U.S. COAST GUARD

# SERIES HH–65C HELICOPTER

Interim Change 1




**COMMANDING OFFICERS ARE RESPONSIBLE FOR BRINGING THIS PUBLICATION TO THE ATTENTION OF ALL AFFECTED COAST GUARD PERSONNEL.**

**PUBLISHED BY DIRECTION OF THE COMMANDANT OF THE U.S. COAST GUARD.**

**BASIC 25 AUGUST 2005**

U.S. Department of Transportation
**United States Coast Guard**

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United States Coast Guard

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3711

AUG 2 5 2005

# MEMORANDUM

From: W. M. Moore, CAPT
COMDT (G-OCA)

Reply to Attn of: LCDR B. Decker
G-OCA
(202) 267-0534

To: Distribution

Subj: FLIGHT MANUAL, USCG HH-65C AIRCRAFT (CGTO 1H-65C-1)

1. PURPOSE: This letter promulgates the HH-65C Flight Manual (CGTO 1H-65C-1).

2. ACTION: Commanding Officers of Air Stations sited with the HH-65C series aircraft shall ensure compliance with the provisions of this Manual.

3. DIRECTIVES AFFECTED: None.

4. DISCUSSION: This letter promulgates the first edition of the HH-65C Flight Manual dated 01 March 2005. A thorough reading is required to understand the many changes and differences, operational and procedural, between the HH-65C and the HH-65B.

5. CHANGES: Recommendations for changes and improvements to the Manual shall be submitted via the Chain of Command using the HH-65C Flight Manual Change Recommendation Form. This Manual will be reviewed on a regular basis.

#

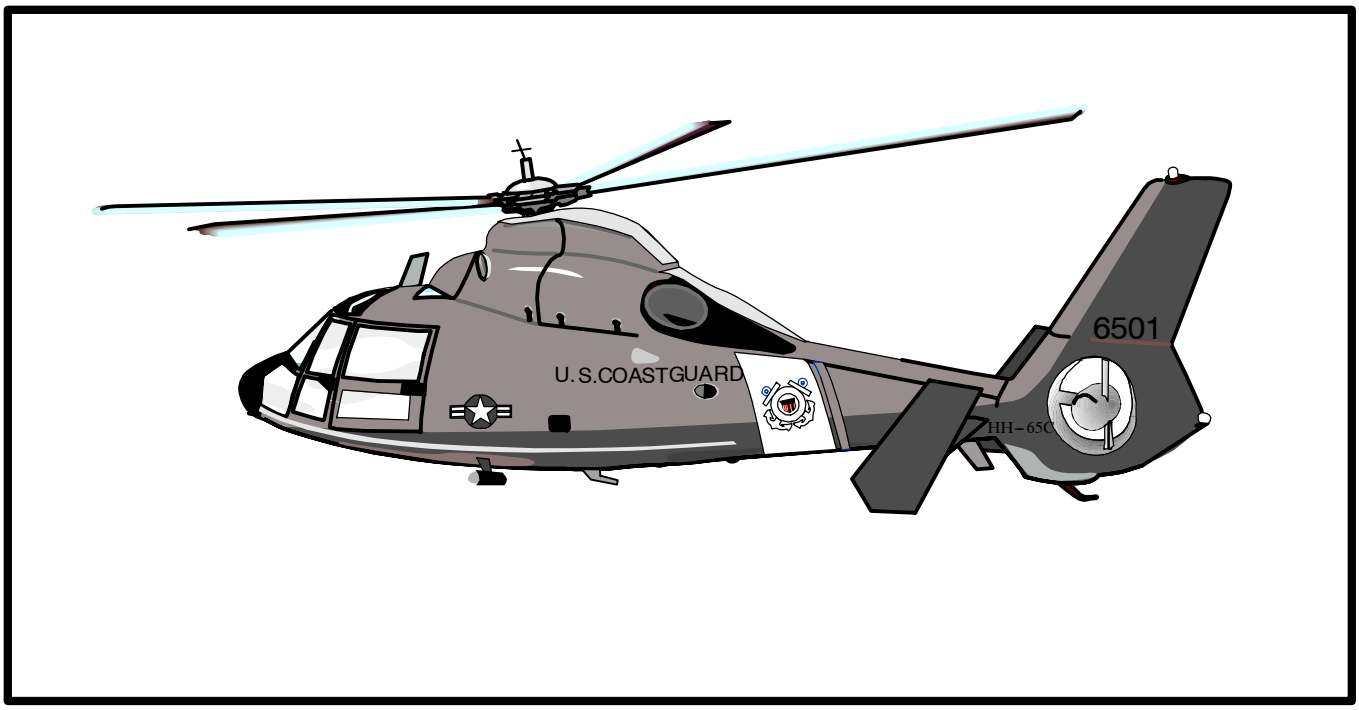
Enclosures: (1) 1-H-65C-1, HH65C Flight Manual
(2) 1-H-65C-Cl 1, HH-65C Emergency Procedures
(3) 1-H 65C-Cl 2, HH-65C Operating Procedures
(4) HH-65C Tri-Fold Checklist

Distribution: All current operators of the HH-65C

# FLIGHT MANUAL

## U.S. COAST GUARD

# SERIES HH–65C HELICOPTER




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**PUBLISHED BY DIRECTION OF THE COMMANDANT OF THE U.S. COAST GUARD.**

**BASIC 25 AUGUST 2005**

# CERTIFICATION PAGE

This certification page must be used by any person who incorporates any change into this copy of the manual. A separate entry is required for each change. Each entry certifies that the person whose signature appears guarantees the accuracy and completeness of that change as it was made in this copy.

After the change has been incorporated, page check the manual. Be sure each instruction was followed accurately and completely. Before discarding superseded or deleted pages, check the change number listed for that page on the List of Effective Pages at the front of the manual or on the title page of the Interim Manual change, whichever applies. Be sure written entries are accurate and placed correctly.

Make the required entry in the spaces below. Enter the date the check was made. List the official identification of the change. For printed changes use "Manual Change No. dated ___," or "Interim Manual Change No. ___," as applicable. Write the letters OK under Pages Checked to indicate page check compliance. Sign your name.

| Date | Amendment/Change Incorporated | Pages Checked | Signature |
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| | | | |

# SAFETY AND OPERATIONAL SUPPLEMENT SUMMARY

Safety Supplements are numbered as follows: T.O. 1H–65C–1SS–1, T.O. 1H–65C–1SS–2, etc. Operational Supplements continue in sequence and are numbered as follows: T.O. 1H–65C–1S–3, T.O. 1H–65C–1S–4, etc. The supplements you receive should follow in sequence and if you are missing one, check with the Flight Manual authority, COMDT (G–OCA), or ATC Mobile (H–65 Branch) to see whether the supplement was issued and, if so, is still in effect. It may have been replaced or rescinded before you received your copy. If it is still active, see your Publications Distribution Officer and get your copy. It should be noted that a supplement number will never be used more than once.

## ACTIVE SUPPLEMENTS

This portion is to be filled in by you as additional supplements are received.

Supplements outstanding at the time of preparation of this page have been listed below for your convenience.

| NUMBER | DATE | SHORT TITLE | DISPOSITION |
|---|---|---|---|

# CHANGE SUMMARY

## ACTIVE CHANGES

| NUMBER | DATE | SHORT TITLE |
|---|---|---|

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## LIST OF EFFECTIVE PAGES

**Dates of Issue for original and changed pages are:**

Original 0 25 August 2005

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 593, CONSISTING OF THE FOLLOWING:


| Page No. | Change No. | Page No. | Change No. |
|---|---|---|---|
| Title | 0 | 5-1 - 5-20 | 0 |
| Cert 1 - Cert 2 blank | 0 | 6-1 - 6-8 | 0 |
| Flyleaf 1 - Flyleaf 4 | 0 | 7-1 - 7-6 blank | 0 |
| i - ii | 0 | A-1 - A-58 | 0 |
| 1-1 - 1-292 | 0 | Glossary 1 - Glossary 6 blank | 0 |
| 2-1 - 2-78 | 0 | Index 1 - Index 12 | 0 |
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**CHANGE RECOMMENDATION** **DATE**

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| FROM (ORIGINATOR) | UNIT |
|---|---|
| TO (COMMANDING OFFICER CGATC (HH-65) MOBILE, AL 36808 | |

| COMPLETE NAME OF MANUAL /CHECKLIST | REVISION DATE | CHANGE DATE | SECTION/CHAPTER | PAGE | PROGRAM |
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☐ **Your change recommendation is reclassified URGENT and forwarded for approval to _____.**

/s/_____

Change Recommendation Form

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# INTRODUCTION

## SCOPE

This manual contains the necessary information for safe and efficient operation of your aircraft. These instructions provide you with a general knowledge of the aircraft and its characteristics and specific normal and emergency operating procedures. Your experience is recognized; therefore, basic flight principles are avoided.

## PERMISSIBLE OPERATIONS

The flight manual takes a positive approach and normally states only what you can do. Unusual operations or configurations are prohibited unless specifically covered herein. Procedures prescribed in this manual are mandatory but it is expected that they will be executed with sound professional judgment. Nothing in this manual shall be construed to relieve personnel of responsibility for using initiative in prosecuting a mission or taking such emergency action as the situation warrants.

## INTERIM CHANGE SYSTEM

Essential and urgent changes to this technical manual shall be issued by an interim change system. These changes shall be distributed to you on a non-scheduled, as-needed basis to disseminate important information at the earliest possible date and eliminate many of the page change collation problems associated with large revisions.

Interim changes shall consist of three types: (1) brief write-in instructions, (2) supplemental pages, paragraphs, and illustrations, and (3) replacement or additional pages. Write-in instructions indicated must be made directly on the affected page. Supplemental pages will be placed in front of the manual and will remain there until the information is incorporated in the manual. Replacement and additional pages must be collated into the manual and superseded pages removed. The changes shall be issued in message or printed form. All changes shall have a change number for control purposes which you must enter on the interim change summary (flyleaf) in this manual.

Periodically, all interim changes will be considered to become a permanent part of the basic manual and shall be incorporated as a formal, printed amendment or revision.

## ARRANGEMENT

The manual is divided into seven sections and appendix containing performance data, a glossary, and index and fold out illustrations.

## WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to WARNINGS, CAUTIONS, and NOTES found throughout the manual. Two or more WARNINGS, CAUTIONS, or NOTES placed in sequence are denoted by use of a large dot in the left margin. The heading (WARNING, CAUTION, NOTE) is not repeated.

**WARNING** — Operating procedures, techniques, etc., which could result in personal injury or loss of life if not strictly followed.

**CAUTION** — Operating procedures, techniques, etc., which could result in damage to equipment if not strictly followed.

**NOTE** — An operating procedure, technique, etc., which is considered essential to emphasize.

## USE OF WORDS SHALL, WILL, SHOULD AND MAY

The words “shall” or “will” are used to indicate a mandatory requirement. The word “should” is used to indicate a non-mandatory desire or preferred method of accomplishment. The word “may” is used to indicate an acceptable or suggested means of accomplishment.

## YOUR RESPONSIBILITY - TO LET US KNOW

Every effort is made to keep the Flight Manual current. Review conferences with operating personnel and a constant review of accident and flight test reports assure inclusions of the latest data in the manual. However, we cannot correct an error unless we know of its existence. In this regard, it is essential that you do your part. Comments, corrections, and questions regarding this manual or any phase of the Flight Manual program are welcomed. These should be forwarded to the Commanding Officer, CGAVTRACEN (HH-65), 8501 Tanner Williams Rd., Mobile, Alabama 36608-9682.

## ACTION

Operating commands and individual flight crews shall comply with the procedures and limitations specified in this publication and such duly promulgated changes thereto as may be directed. A copy of this manual shall be in each helicopter.

# SECTION I

# DESCRIPTION AND OPERATION

## TABLE OF CONTENTS


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# THE HELICOPTER

The U.S. Coast Guard HH-65C Short Range Recovery (SRR) helicopter, a product of Aerospatiale Helicopter Corporation, is designed for short range search and rescue operations. Secondary mission roles are patrol and observation, passenger transport, and cargo hook operations. It is capable of operating from prepared and unprepared areas in visual and instrument flight conditions, day or night and is configured with Night Vision Goggle (NVG) compatible cockpit lighting. The main sections of the fuselage are the forward section consisting of the cockpit, cabin area and baggage compartment, and the aft (tail boom) section. The forward section is constructed primarily of longitudinal, aluminum alloy beams and non-metallic honeycomb, laminated with fiberglass cloth. The aft section consists of a truncated cone of composite honeycomb fiberglass with a metal covering which supports the vertical fin and a fixed horizontal stabilizer. Cockpit entrance is through two hinged doors located forward of the cabin next to the pilot's and copilot's stations. Entrances to the passenger area are a hinged door on the left side of the cabin aft of the copilot's station, and a sliding door on the right side of the cabin aft of the pilot's station. A baggage compartment door is located on the right side aft of the cabin for exterior access to the baggage compartment. The side-by-side cockpit arrangement is equipped with dual flight controls augmented by an Automatic Flight Control System (AFCS). Each station has a full instrument panel and controls for the avionics systems. Refer to Figure 1-1 for general cockpit arrangement. The passenger-cargo area is designed to accommodate a rescue basket, litter configurations, and a hoist operator station. Seats may be installed for five passengers and a crew of three. The propulsion system, consisting of two turboshaft engines and a drive system, is mounted above the fuselage on a platform located above the aft cabin area. The engines and drive systems are enclosed by a cowling which may be swung open or removed for access. The rotor system consists of a single 4-blade main rotor, which may be folded for shipboard parking or storage, and a multi-bladed shrouded tail rotor located within the vertical fin. Two independent hydraulic systems provide power for the flight controls, retractable landing gear, TALON, wheel brakes, and a 600 pound capacity rescue hoist. The electrical system includes dual AC and DC generating systems: two alternators to supply AC power, and

two starter/generators for DC power. In addition, each engine has a dual channel alternator to run its Full Authority Digital Engine Control (FADEC) computer. Electrical power can also be supplied by an internal battery or transformer/rectifier for emergency DC power, or AC and DC external sources. An integrated avionics system provides capability for automatic cockpit management, mission navigation, communication, and flight guidance and control through selection of special sensors, and use of data stored in on-board Control Display Units (CDU). The Flight Director System (FDS) may be coupled to the AFCS to enhance airborne control of the helicopter. Additional equipment includes a search radar, an Environmental Control System (ECS), emergency pop-out flotation system, a 2,000 pound capacity cargo hook, and a controllable searchlight.

The maximum unrestricted gross weight of the helicopter is 8,900 pounds. Restricted operations may be conducted up to a maximum weight of 9,480 pounds.

**NOTE**

For complete weight and balance information refer to HH-65 Weight and Balance Data, C.G.T.O. 1H-65A/B/C-5 specific to that model airframe.

Maximum overall dimensions of the helicopter are shown in Figure 1-2.

**NOTE**

Duplicated components are labelled by numerals 1 or 2, in two general groups. AIRFRAME components (such as engines and generators) are labelled conventionally, #l for left side and #2 for right side. AVIONICS components (such as gyros and radios), on the other hand, are labelled #l for the right side and #2 for the left side.

# ENGINES

The two Turbomeca Arriel 2C2-CG engines (Figure 1-3) are of turboshaft design. Standard day ratings are: 1,053 shp for single engine operation and 853 shp for dual engine operation. 100 % MGB torque represents 1,294 shp.

## ENGINE DESCRIPTION

The Arriel 2C2 is of modular design and can be divided into five distinct sections: (1) transmission shaft and accessory gearbox, (2) axial compressor, (3) gas generator, (4) power turbine, and (5) reduction gearbox. During engine operation, inlet air passes through the axial compressor and radial inlets to the centrifugal compressor. Air mass flow is increased by the single stage axial and single stage centrifugal compressors before being delivered to the combustion section. Pressurized fuel is sprayed into the combustion chamber by two fuel nozzles and is combined with compressed air. The fuel air mixture is ignited by two ignitors for starting only. Once the start is self-sustaining, the ignitors and fuel nozzles are no longer operable and fuel is delivered by a centrifugal fuel wheel rotating inside the combustion chamber up to 52,000 rpm. Expanding gases are discharged from the aft end of the combustion chamber towards the gas turbine assembly. The single stage gas turbine turns the compressor assembly and directs gases to the free power turbine inlet. The free power turbine, which is mechanically independent of the gas generator, extracts energy from the hot gases and transmits it to the power shaft via the reduction gearbox. The gases exit through the exhaust pipe at the rear of the engine. Heat shields are installed aft of each engine exhaust to prevent overheating of the surrounding composite. The reduction gearbox reduces engine power turbine speed from 39,000 rpm at 100 percent N2 to 6,000 rpm engine output shaft speed.

### Gas Generator Turbine (N1)

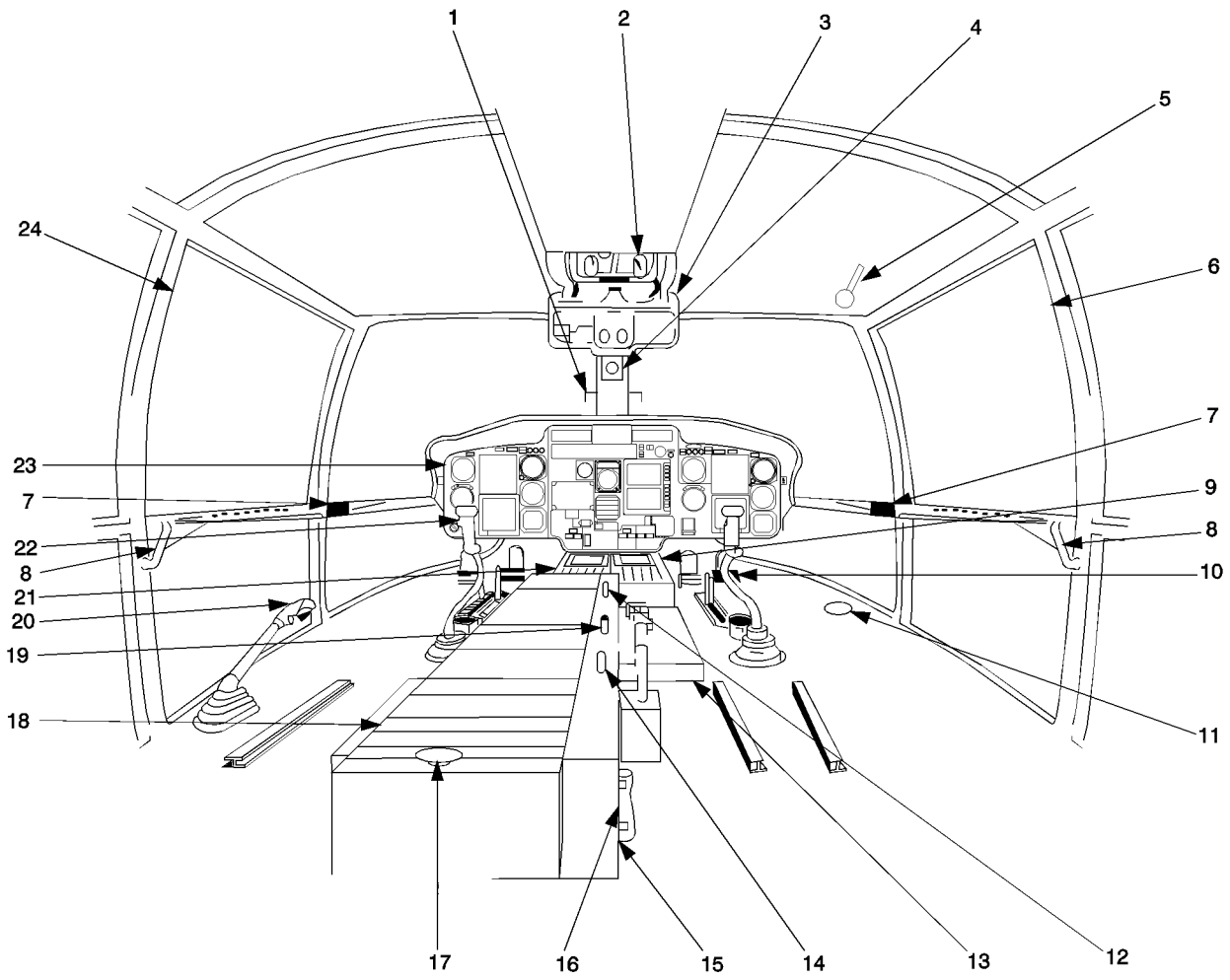
At 100% N1 the gas generator turbine shaft turns at 52,000 RPM. The rotational speed is measured by an electro-magnetic sensor mounted on the FADEC alternator drive shaft. This signal (N1C) is sent to the EBCAU (engine back-up control auxiliary unit) for engine control in the event of a major FADEC failure, and VEMD (vehicle and engine multifunction display) for cockpit display. The secondary and tertiary N1 signals which are used by the FADEC (N1A and N1B) for engine control, are derived from the dual channel engine alternators. The gas generator drives the oil pump, fuel pump, starter generator, and the FADEC alternator.

### Free Power Turbine (N2)

At 100% N2, the free power turbine shaft turns at 39,000 RPM. The rotational speed is measured by three sensors (N2A, N2B, N2C) located on the reduction gearbox casing and power turbine case. N2A is transmitted directly to the pilot's Nr gauge in the cockpit. N2B and N2C are transmitted to the FADEC and VEMD for N2 speed control and overspeed protection. Accessories driven by the power turbine include the output shaft and the engine compartment cooling fan.

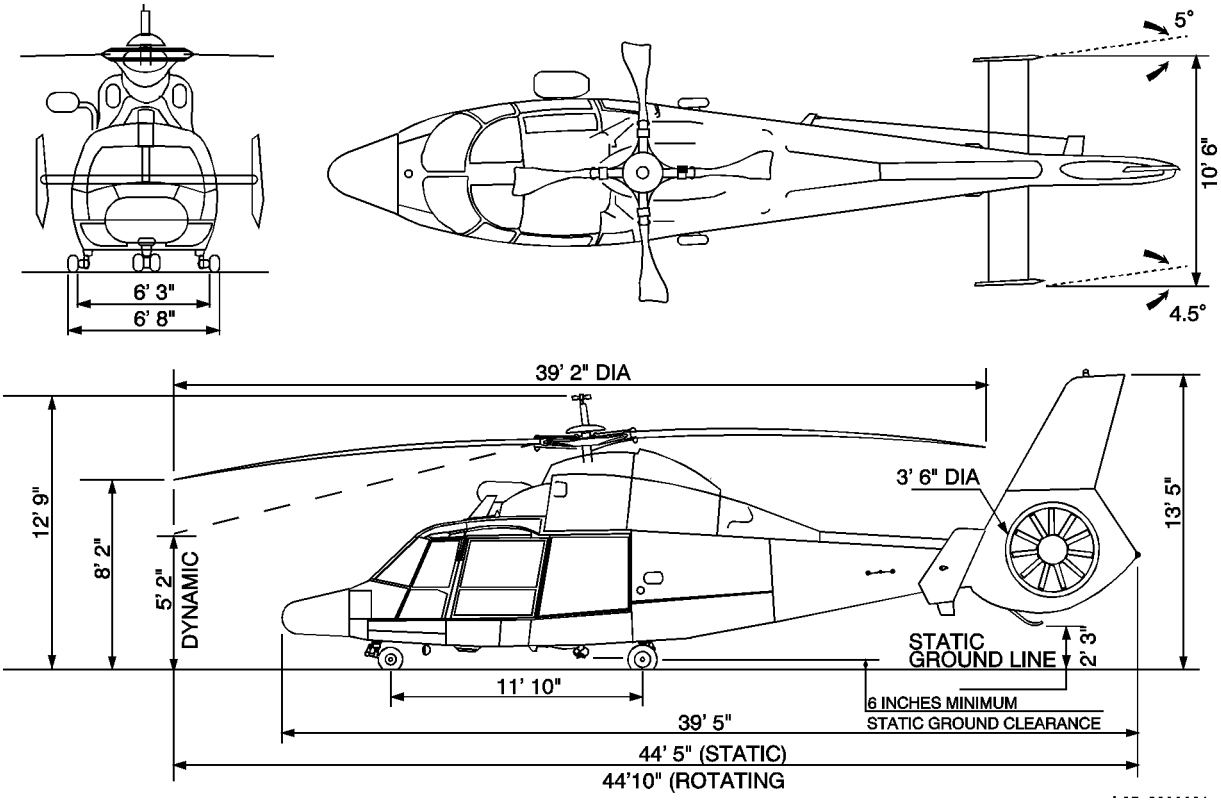
### Free Power Turbine Overspeed

Each engine is provided overspeed protection by its respective FADEC in conjunction with the engine interface unit (BIM) located in the baggage compartment. When the N2 B and C sensors detect an N2 speed of 122.4% (plus or minus 1%), the FADEC will operate the stop-electro valve via the BIM and shut the engine down. Once an engine is shut down




1. Air Distribution Levers
2. Overhead Control Quadrant
3. Overhead Control Panel
4. Standby Compass
5. Outside Air Temperature Gage
6. Pilot's Door
7. Door Jettisoning Handle
8. Door Handle
9. Pilot's Forward Circuit Breaker Panel
10. Tail Rotor Control Pedals
11. Accumulator Pressure Indicator
12. Nose Landing Gear Locking Handle
13. Cockpit Avionics Circuit Breaker Panel
14. Parking Brake Handle
15. Pilot's Aft Circuit Breaker Panel
16. Locator Searchlight Control Grip
17. Cargo Hook Manual Release
18. Center Console
19. Emergency Landing Gear Extension Handle
20. Collective
21. Copilot's Circuit Breaker Panel
22. Cyclic
23. Center Instrument Panel
24. Copilot's Door

*Figure 1-1. Cockpit Arrangement*




**AIRCRAFT DIMENSIONS**

| | |
|---|---|
| ROTOR DIAMETER | 39 feet – 2 inches |
| OVERALL LENGTH (STATIC) | 44 feet – 5 inches |
| HEIGHT TO TOP OF ROTOR HEAD | 12 feet – 9 inches |
| HEIGHT TO TOP OF FIN | 13 feet – 5 inches |
| MAIN LANDING GEAR TRACK | 6 feet – 3 inches |
| WHEEL BASE | 11 feet – 10 inches |
| MINIMUM GROUND CLEARANCE WITH CYCLIC DISPLACED TO LIMIT LIGHT ILLUMINATION (100% NR) | 7 feet – 7.2 inches |
| MINIMUM STATIC GROUND CLEARANCE (BLADE AT 12 O'CLOCK) | 8 feet – 2 inches |
| GROUND CLEARANCE (UNDER FUSELAGE) | 6 inches |
| TAIL ROTOR DIAMETER | 3 feet – 6 inches |
| CYCLIC FULL FORWARD, DYNAMIC | 5 feet – 2 inches |
| AIRCRAFT WITH BLADES FOLDED | |
| LENGTH | 39 feet – 5 inches |
| WIDTH (AT STABILIZER) | 10 feet – 6 inches |
| AIRCRAFT DISASSEMBLED FOR SHIPMENT | |
| LENGTH | 21 feet – 5 inches |
| WIDTH (STABILIZER REMOVED) | 6 feet – 8 inches |
| HEIGHT (ROTOR HEAD AND LANDING GEAR REMOVED) | 8 feet – 4 inches |

*Figure 1-2. Dimensions*

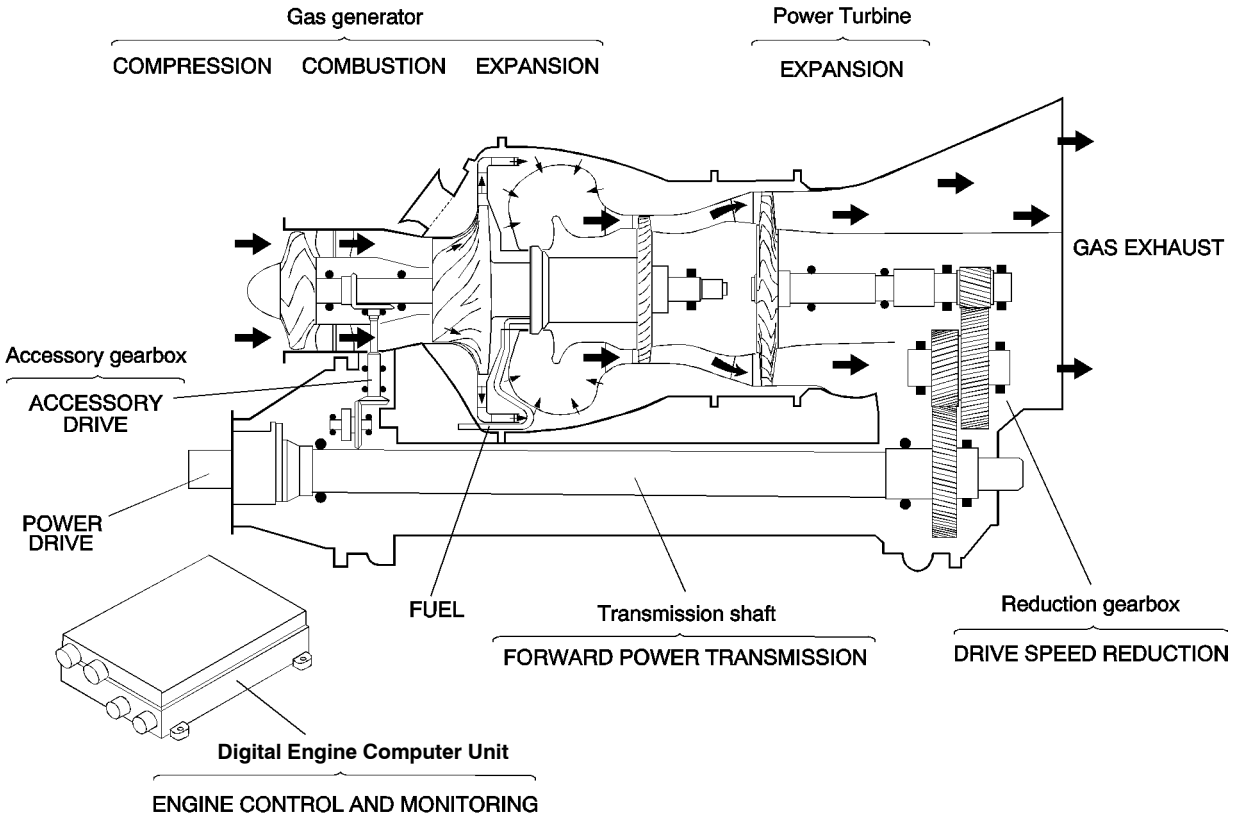



*Figure 1-3. Turbomeca Arriel 2C2-CG Engine*

by the FADEC/BIM, overspeed protection is automatically inhibited on the second engine. Once the system has been tripped, it will remain in overspeed mode until the BIM has been reset. The BIM is also used to periodically check the overspeed system of each engine, but this is strictly a maintenance function. In addition, the BIM acts as a start relay between the FADEC and the respective engine.

**CAUTION**

In the event of a post shutdown fire or excessively slow engine cool down after an FCS (FADEC control switch) is switched to the OFF position, the stop-electro valve on the corresponding engine should be inspected for proper operation. A malfunctioning stop-electro valve will inhibit overspeed protection on that engine.

## ENGINE INSTRUMENTS

The operation of the engines is monitored by the Vehicle and Engine Multifunction Display (VEMD) (Figure 1-4) located on the instrument panel. Refer to VEMD, in this Section, for a detailed description of system operation. Refer to Section V for instrument range markings and limitations.

### Engine Oil Pressure System

Oil pressure is monitored by a pressure switch and a transmitter located downstream of the engine oil filter on the left side of each engine accessory gearbox. Each engine's transmitter is connected to the ENG OIL 1 and 2 PSI indicators on the VEMD. The indicating scales are graduated from 0 to 140 PSI. When oil pressure drops below the 22 PSI minimum, the respective warning light, ENG 1 OIL P or ENG 2 OIL P, located on the Warning, Caution, Advisory (WCA) panel, illuminates in addition to the red engine status light located on the overhead console.

### Engine Oil Temperature System

Oil temperature is monitored by a sensor located downstream of the oil tank in each engine oil system. Each sensor transmits oil temperature data to ENG OIL TEMP indicators on the VEMD. The indicating scales are graduated from -40 to 120 degrees C.

### Turbine Outlet Temperature (TOT) or T4

The TOT for each engine is measured at the free power turbine inlet by eight dual-thermocouples connected to a tem-

perature conformation box. The conformation box provides an average TOT signal to the FADEC and the VEMD. Eight of the signals are used for the FADEC and eight are used by the VEMD but are designed to be redundant for each system. For example, if the TOT signal is lost to the FADEC, the FADEC will use the TOT signal from the VEMD. Refer to the engine section for Gas Generator Speed (N1) and Free Power Turbine Speed (N2) sensing.

## VEMD (Vehicle and Engine Multifunction Display)

The VEMD is a dual LCD screen indicator that provides indications of all pertinent engine, MGB, and hydraulic systems. It also incorporates a First Limit Indicator (FLI), fuel information and maintenance functions. The VEMD consists of three modules: one display module that includes the two LCD screens and two processing modules, one for each screen. Each processing module receives information from both FADECs and the Air Data Unit (ADU), compares the information through cross talk links between processors, and displays the information on the screens. Power is provided through the respective DC Bus. In the event of a DC Bus short, the operating DC Bus will provide power to both processing modules. The VEMD has three modes; Operational, Maintenance, and Configuration (Figure 1-4).

### AIR DATA UNIT

The Air Data Unit (ADU) is an electronic sensor that delivers Pressure, Airspeed, and OAT data to the VEMD. It is composed of a Pressure and Temperature Measurement Unit (PTMU) located in the avionics rack and a temperature probe located underneath the radome. It receives and processes Static and Total pressure information from the Copilot's Air Data System.

### VEMD CONTROLS

The VEMD functions are controlled by 10 pushbuttons located on the right side of the VEMD. OFF1 and OFF2 secure the power to the respective processing module and associated screen. SCROLL selects different pages on the VEMD. RESET returns the VEMD to normal configuration. SELECT, +, -, and ENTER allow the pilot to select and modify various data fields. BRT+ and BRT- control the brightness of both screens. Pressing both BRT buttons simultaneously for 3 seconds places the VEMD in a NVG compatible mode.

### VEMD DISPLAY

Under normal operating conditions, the top LCD will display the First Limit Indicator while the bottom LCD will be scrollable between the Vehicle, Fuel, Engine Power Check (EPC), and System status pages. If either screen fails, the remaining screen will be scrollable between the FLI, Vehicle, and Fuel pages. EPC and System status pages will no longer be available. A flight report will automatically be displayed at the end of every flight (Figure 1-5).

### FIRST LIMIT INDICATOR (FLI)

The FLI Page is comprised of four zones; the Upper Information Zone, Message Zone, Lower Information Zone, and FLI zone (Figure 1-6).

### UPPER INFORMATION ZONE

The top strip of the screen displays bleed valve symbols, OEI mode display, and the ENG IDLE annunciation. The bleed air symbol is a green and white striped rectangle and is displayed anytime the respective bleed valve is open. If OEI settings are available, the current stop will be displayed in blue. CT (OEI Continuous), LO (2 min OEI), or HI (30 sec OEI) are the possible annunciations. The ENG IDLE annunciation is displayed in yellow whenever the corresponding FADEC switch is placed in the idle position.

### MESSAGE ZONE

The bottom line of the screen displays pertinent information relating to the VEMD. A LANE 1 (or 2) FAILED --> PRESS OFF 1 (or 2) appears when the corresponding processing module has failed. CROSSTALK FAILED --> PRESS OFF 2 (or 1) indicates a failure of the cross-talk function between VEMDs. VEH (or FUEL) PARAM OVER LIMIT indicates that a parameter monitored on the Vehicle (or Fuel) Page is out of limits and not currently displayed. If a discrepancy between engine torques occurs, a CHECK TRQ annunciation will appear.

### LOW INFORMATION ZONE

This zone, located above the Message zone, is dedicated engine start annunciations and degradations or failures of the FLI. A flashing START message is displayed in blue for the relevant engine anytime the starter is engaged. An amber FLI DEGR annunciation will appear anytime a N1, TOT, or TRQ parameter is not valid for the relevant engine. The invalid parameter will change from white to amber and lose its numerical value. FLI FAIL will display anytime N1, TOT, and TRQ parameters are not valid on the relevant engine. All three parameters will change to amber and lose their numerical value (Figure 1-7).

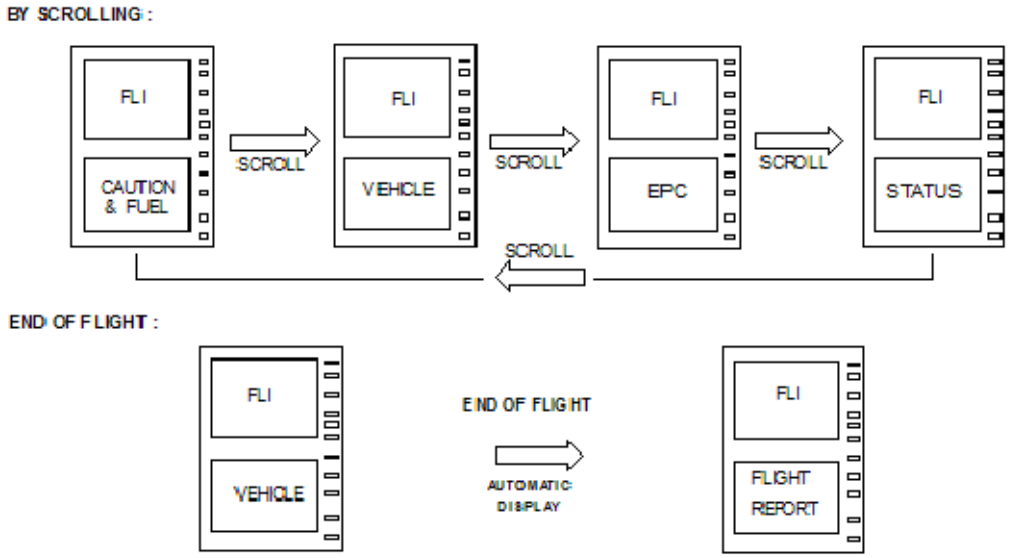
### FLI ZONE

This zone displays all primary engine parameters and limitations. Torque (TRQ), Turbine Outlet Temperature (TOT), and Engine Turbine Speed (N1) are digitally displayed along either side for the corresponding engine. The single needle




*Figure 1-4. Vehicle and Engine Multifunction Display (VEMD)*

Normal Operation;




Degraded Operation;

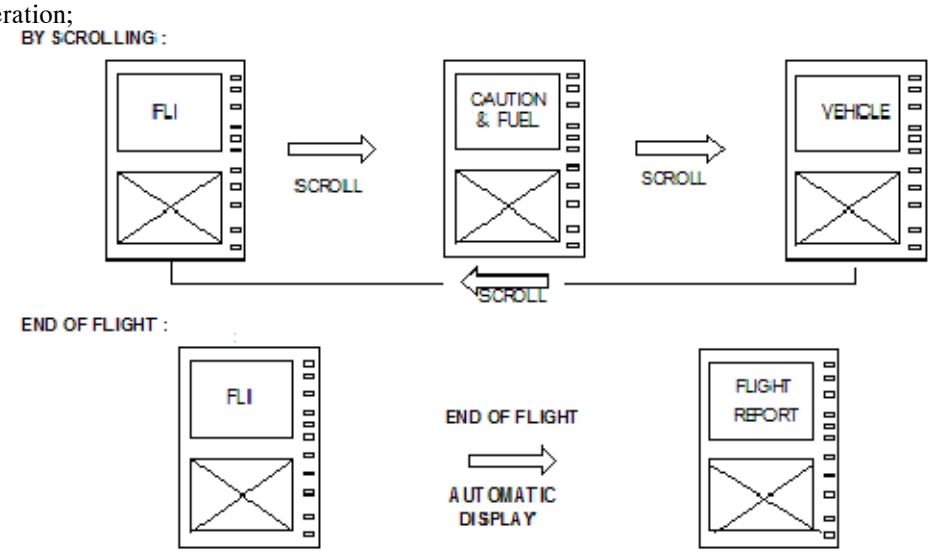



*Figure 1-5. VEMD Scroll Logic*

in the center of the screen measures the parameter closest to reaching its limit, given the current operating condition (dual engine, single engine, or training mode). A yellow triangle with the letter T inside is displayed when the training mode is active. A white circle inside a white square with a diagonal bar through it is displayed whenever P3 bleed air is used for cabin heating.

## FLI-ALL ENGINE OPERATING (AEO) MODE

The FLI will appear in AEO mode anytime both engine N1s are above 40% and neither FADEC is in an OEI, training, or idle state. A yellow arc runs from 8.8 FLI (maximum continuous power) to a red bar at 10.0 (maximum takeoff power). A red diode at 10.7 FLI indicates maximum transient power. Anytime the FLI needle enters the yellow zone, the limiting parameter(s) will be underlined in yellow. If the FLI needle exceeds the red bar, the limiting parameter(s) will be underlined in red. If the FLI needle exceeds 8.8 for 5 minutes with either N1 or TOT as the limiting parameter, the HIPSARM counter (white pie shape) will appear underneath the needle. The counter will flash for 2 minutes and 30 seconds before turning solid white at 30 minutes. The HIPSARM counter will also appear anytime maximum takeoff power (10.0 FLI)

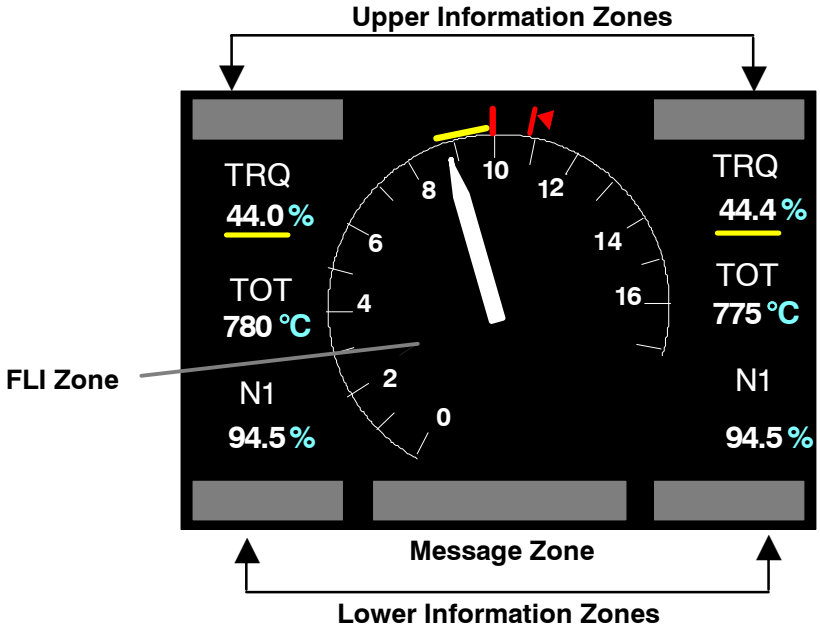
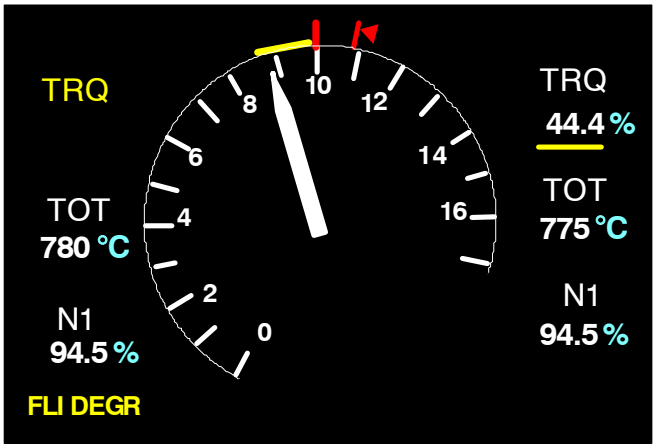
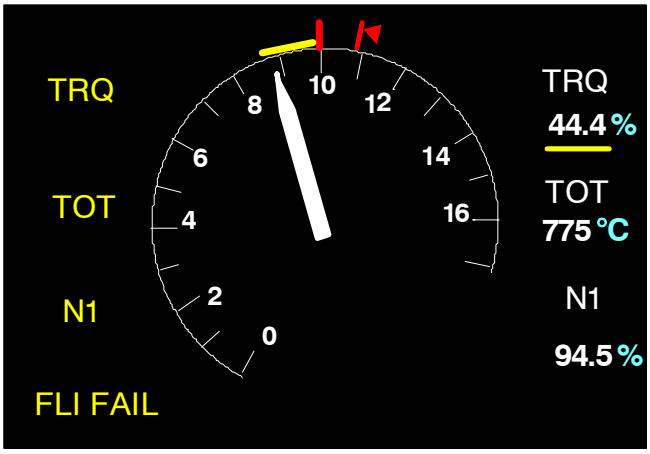



*Figure 1-6. First Limit Indicator*




**FLI Degraded Operation**




**FLI Fail Configuration**

*Figure 1-7. Failure Modes*

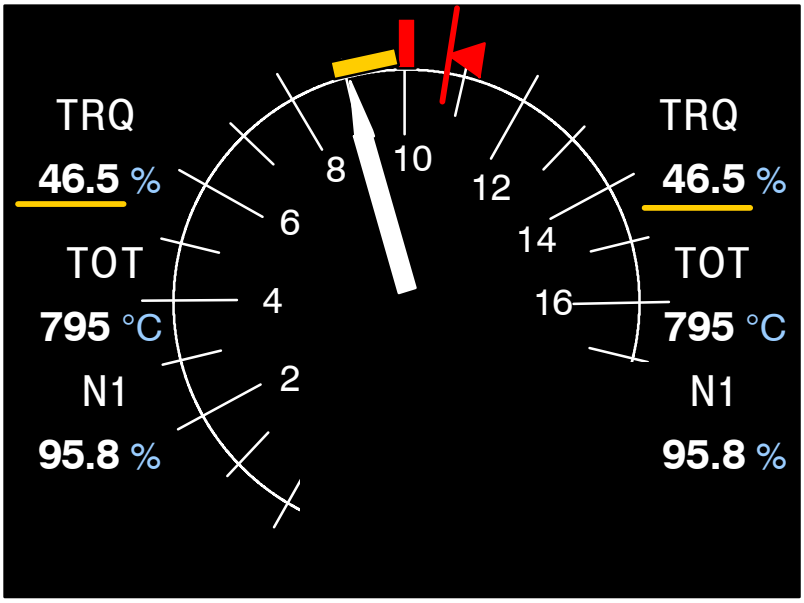



*Figure 1-8. All Engine Operating (AEO) Mode Page*

is exceeded and either N1 or TOT is the limiting parameter (Figure 1-8).

## FLI-START MODE

The start mode display will appear whenever either FADEC is in STOP mode or the N1 of one engine is increasing and lower than 60% or decreasing and lower than 40%. A flashing Start annunciation will appear in blue in the lower information zone whenever the FADEC senses the starter is engaged. The digital value for TOT will be underlined with a flashing red line whenever TOT is greater than 750 °C. If TOT reaches 865 °C, the digital value will be underlined in solid red (Figure 1-9).

## FLI-OEI MODE

Whenever N1 of either engine is lower than 40% or either engine is in idle, the FLI will display the OEI mode. The single engine display will include a yellow dashed bar indicating Continuous OEI power, a dashed red bar for 2-minute OEI power, and a solid red diode for 30 second OEI power. If the FLI needle passes the OEI Continuous bar, the limiting parameters will be underlined in yellow. If the needle passes the 2-minute OEI bar, the limiting parameters will be underlined in red. When the FLI needle enters the 2-minute OEI range, the 2-minute counter (yellow pie symbol) will appear below the needle. If power remains inside the 2-minute range for 115 seconds, the counter will flash for 5 seconds before turning into a solid yellow circle at 2 minutes. The 30-second counter (red pie symbol) will appear anytime the FLI needle enters the 30-second OEI range. If power remains in the 30-second range for 25 seconds, the counter will flash for 5 seconds and turn into a solid red circle at 30 seconds. An OEI HI annunciation will appear at the onset of the single engine condition and may be scrolled down to the LO or CT position using the collective OEI buttons (Figure 1-10).

## FLI-OEI TRAINING MODE

The FLI will switch to FLI Training mode anytime both engine N1s are above 40% and FADEC is in training mode. Indications on the FLI will duplicate those of the OEI mode with the addition of a yellow triangle with a “T” inside underneath the FLI needle. The engine parameters of the simulated failed engine will simulate an actual failed engine, not current conditions (Figure 1-11).

## FLI-OEI GOV MODE

The FLI will switch to the OEI GOV Mode whenever N1 on both engines is higher than 40% and one of the FADECs is in an OEI state, but not in an Idle state. The display will resemble the AEO display with two notable exceptions: the current OEI setting will be displayed in the upper information zone and the maximum transient limit (red diode) will shift to match the maximum takeoff power (10 FLI) (Figure 1-12).

## VEHICLE PAGE

The Vehicle page displays the following parameters and their limits; Engine Oil Temperature, Engine Oil Pressure, MGB Oil Temperature, MGB Oil Pressure, and Primary and Secondary Hydraulic Pressures. A vertical yellow bar along




*Figure 1-9. Start Mode Page*

the side of the scale indicates caution ranges while limits are marked with a horizontal red bar. Digital numerical values can be displayed underneath each scale by pressing Select, +, and Enter. If a parameter enters the caution range, the numerical value will be displayed under the scale and underlined in yellow. When a parameter enters the warning range, the numerical value will be underlined in red and the vertical scale will increase in size. A VEH PARAM OVER LIMIT annunciation will appear in the message zone if the Vehicle page is not selected. If a parameter indication fails, the scale and label will both turn amber and the range markings and pointer will disappear. OAT, fuel state and fuel endurance are also displayed (Figure 1-13).

## FUEL PAGE

The Fuel page displays fuel pressure, fuel flow, quantity and endurance. Fuel pressure is displayed in a vertical scale similar to those located on the Vehicle page. Fuel flow is a digital numerical representation. Total fuel quantity is represented numerically between graphic representations of the fuel quantity in each system. Whenever fuel quantity drops below 3%, the bar and quantity will change to amber and a "LOW" alert will appear. Fuel endurance is based on current fuel flow and is displayed in hours and minutes until all fuel, with the exception of the fuel in the feeder tanks, is exhausted. The upper portion of the Fuel page contains the following annunciations: ENG 1 CHIP, ENG 2 CHIP, MGB CHIP, TGB CHIP, SERVO LIMIT, PEDAL LIMIT, and LDG LOCK. The Chip indications will appear when the corresponding chip detector circuit is closed. A SERVO LIMIT VEMD Caution will illuminate in conjunction with the Hydraulic LIMIT light. PEDAL LIMIT will appear when full right pedal deflection is achieved. A green LDG LOCK indicates that the landing gear is in the down position (Figure 1-14).

## ENGINE POWER CHECK (EPC)

An EPC is initiated by the VEMD and performed by the FADEC and provides TOT and TRQ margins for each engine. The check can be performed whenever Nr is between 340 and 360 rpm, N1 is between 92 and 101%, and the bleed valve is closed. Selecting the EPC page will cause a white

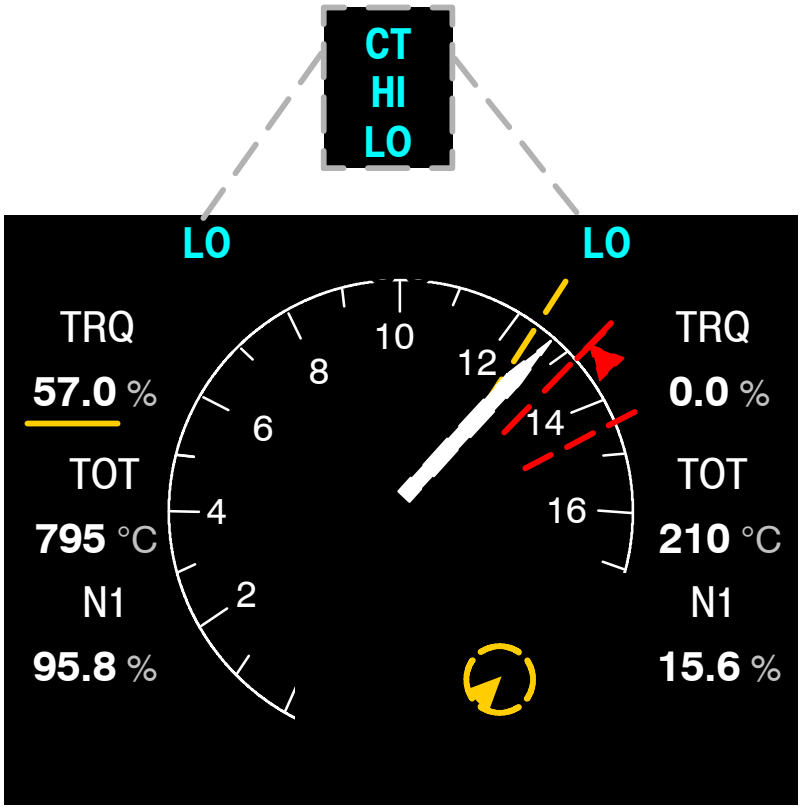



*Figure 1-10. OEI Mode Page*

timer bar to increase for 45 seconds while the VEMD checks for system stability (Figure 1-15). During the stability check, it is necessary to maintain straight and level flight with a constant power setting. If the power is not stable enough and one of the engine parameters falls out of range, an EPC NOT VALID annunciation will appear. A failure of any one of the input parameters will result in an EPC NOT AVAILABLE annunciation (Figure 1-16).

## SYSTEM STATUS PAGE

The System Status page displays FADEC system data. The top line displays FADEC messages. Failures will be displayed on line two. Pressing the SELECT key while on the Status page displays a white box around the message line. Pressing SELECT again moves the box to the FAIL line. Pressing the + and - keys scrolls the various messages on either line by circular permutation. Current Static Pressure (P0), Compressor Outlet Pressure (P3), Engine Turbine Speed (N1), Free Turbine Speed (N2), Turbine Outlet Temperature (TOT), and Torque (CLP) inputs to each FADEC are displayed beneath the FAIL line. The amount of cumulative time spent in both 2-minute OEI (OEI lo) and 30 second OEI (OEI hi) is also displayed. Finally, the amount of accrued HIPSARM time is displayed as a percentage of allowable time on the bottom line. If HIPSARM usage reaches 100%, major engine maintenance is required (Figure 1-17).

## FLIGHT REPORT PAGE

A Flight Report is generated and the page automatically displayed at the end of each flight. The report contains N1 and N2 cycles, flight duration and any FADEC failures that occurred during flight. Flight duration counts the time from initial power pull (collective pitch above 25% and Nr >80%) until engine shutdown (collective pitch below 28.5% and Nr <50%). Any internal VEMD failures encountered during flight will also be recorded. Pressing the reset button on the VEMD will bring the report back to the Vehicle page and page scrolling will again be available (Figure 1-18).

## VEMD MAINTENANCE MODE

The maintenance mode allows the recall of the past 256 internal VEMD failures, the last eight EPC results, the last seven flight reports and the last two flights worth of overlimit recording. The Maintenance Mode is only accessible on the ground and when the VEMD is off. To access the mainte-

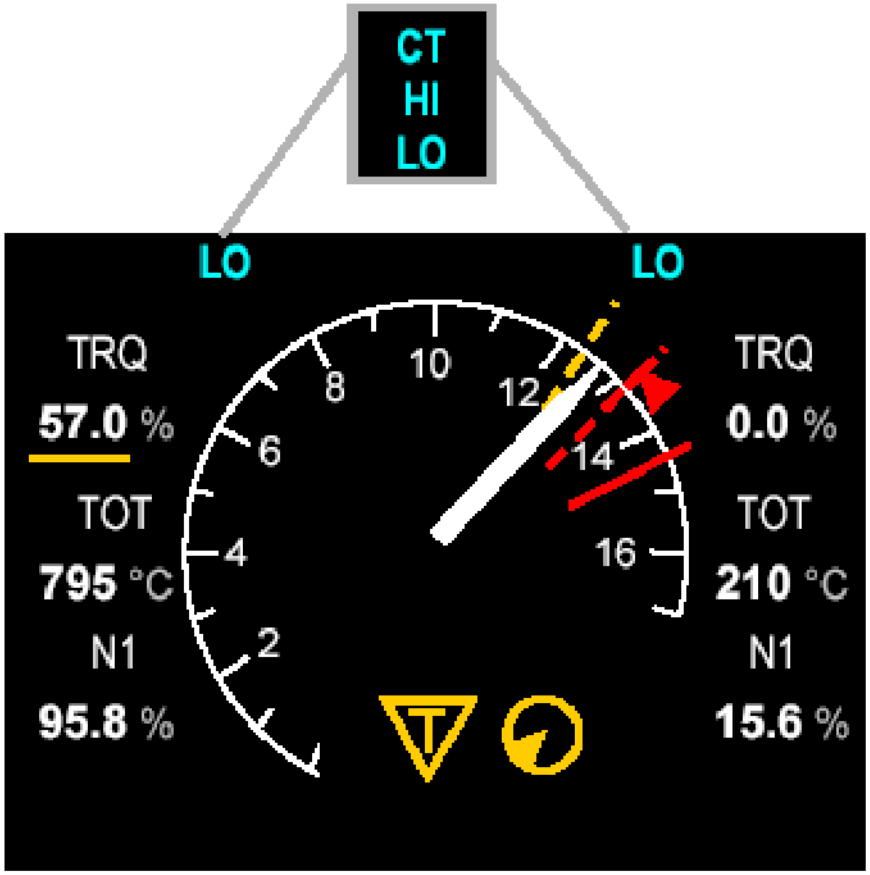



*Figure 1-11. OEI Training Mode Page*

nance mode, turn the VEMD on while pressing and holding the SCROLL and RESET keys until a RELEASE KEY annunciation is displayed. The maintenance mode will only be displayed on one VEMD screen at a time. While in the maintenance mode, pressing SELECT will change fields, ENTER enters a new page or initiates a procedure, RESET returns to the previous page, + and - increase or decrease values, and SCROLL goes to the next page of the same application (Figure 1-19).

## MAINTENANCE FLIGHT REPORT

The Maintenance Flight Report function allows the display of the previous seven flight reports, numbered from 1 to 7 starting with most recent report. The report is identical to the Flight Report received at the end of each flight. Pressing + or - moves from one report to the next and RESET returns to the Maintenance Menu page.

## FAILURE HISTORY FUNCTION

The failure history function allows the detected VEMD failures of a specific flight to be displayed. Up to 256 flights with failures can be recorded. After selecting the FAILURE page, the FAILURE DIAGNOSIS page will be displayed (Figure 1-20).

a. The flight number of the most recently completed flight.

b. Total number of flights with a recorded failure.

c. The sequential number of flights with recorder errors, i.e., flight 4 of 5 with errors.

d. The number of failures during the selected flight.

e. The flight number of the selected flight with errors.

Pressing ENTER will select the Complete Diagnosis page for a selected flight. The Complete Diagnosis page includes a failure code number, time of failure (after initial takeoff), affected VEMD module, failure type (intermittent or permanent), and the number of occurrences (Figure 1-21).

## OVERLIMIT MENU

The Overlimit Menu displays the previous two flight numbers. Pressing ENTER displays the 2-minute and 30-second OEI time and occurrence counters for both engines (Figure 1-22).

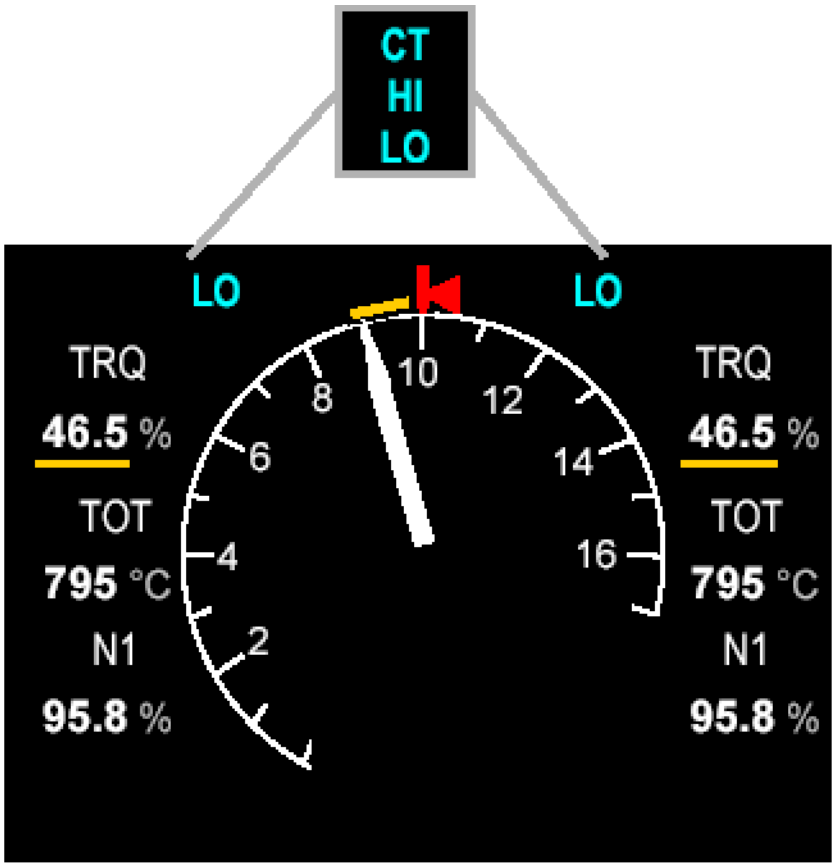



*Figure 1-12. OEI GOV Mode Page*

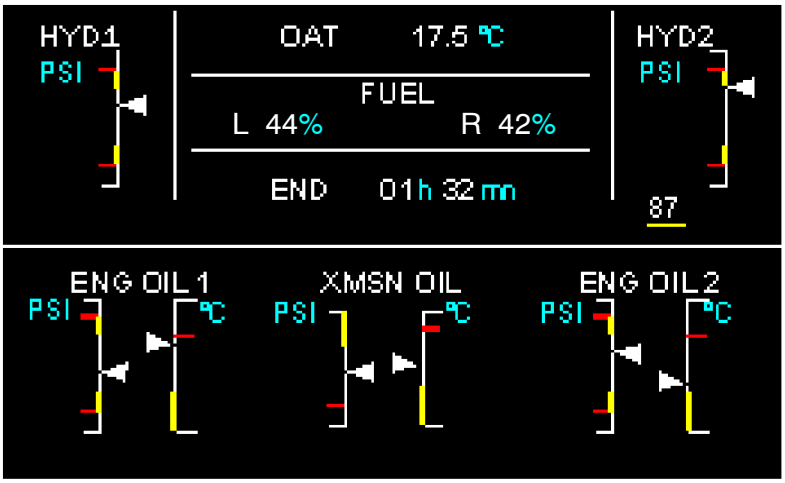



*Figure 1-13. Vehicle Page*

## ENGINE POWER CHECK MENU

This menu can only be displayed on VEMD 2. When the EPC function is selected, the most recent EPC will be displayed. The previous eight EPCs can be selected using the + and - keys.

## AIRCRAFT CONFIGURATION MODE

The Aircraft Configuration Mode allows the VEMD to be expanded with extra equipment, including additional fuel tanks, a second battery, and additional fuel flow sensors. The unit(s) of measure for displayed parameters can also be changed in this mode. Imperial units of measure shall be used in flight (Figure 1-23).

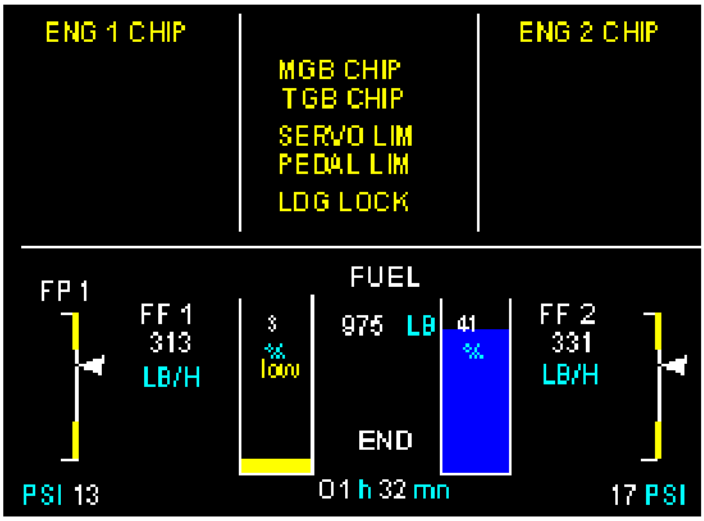



*Figure 1-14. Caution and Fuel Page*

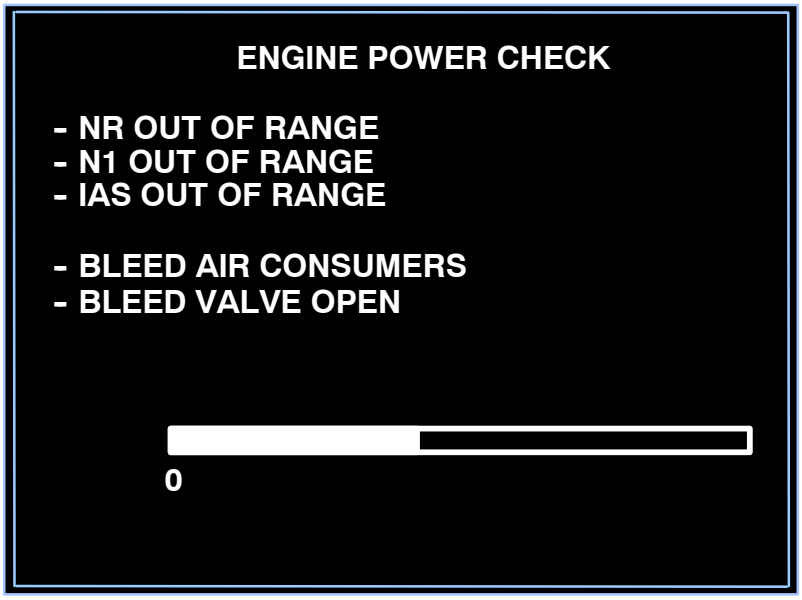



*Figure 1-15. Engine Power Check Stability Page*

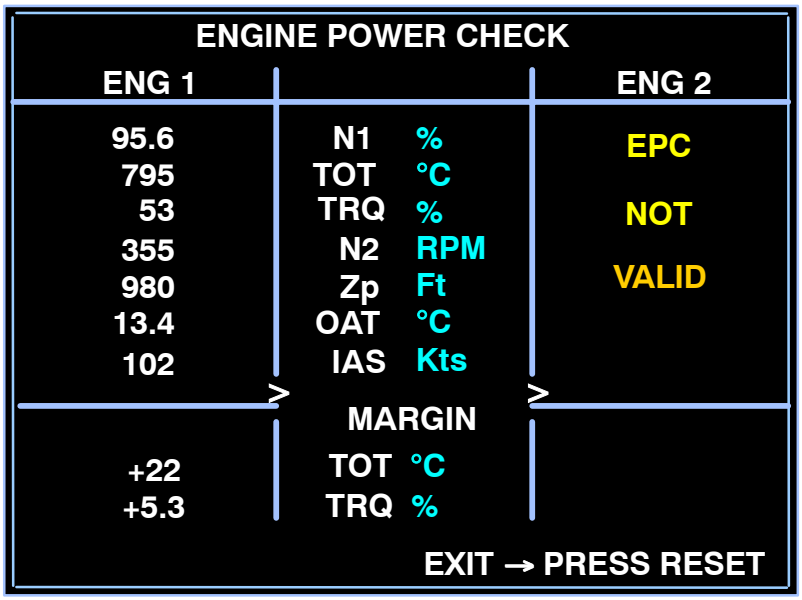



*Figure 1-16. Engine Power Check (EPC) Page*

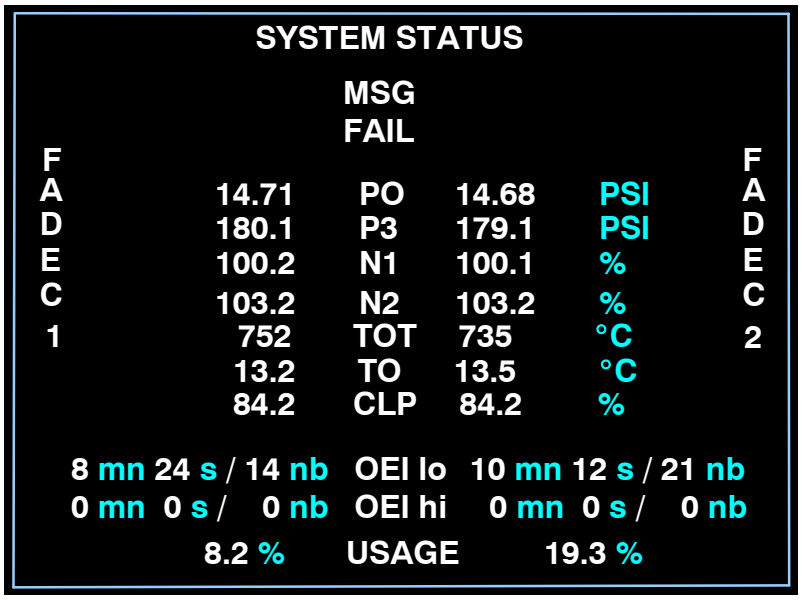



*Figure 1-17. System Status Page*

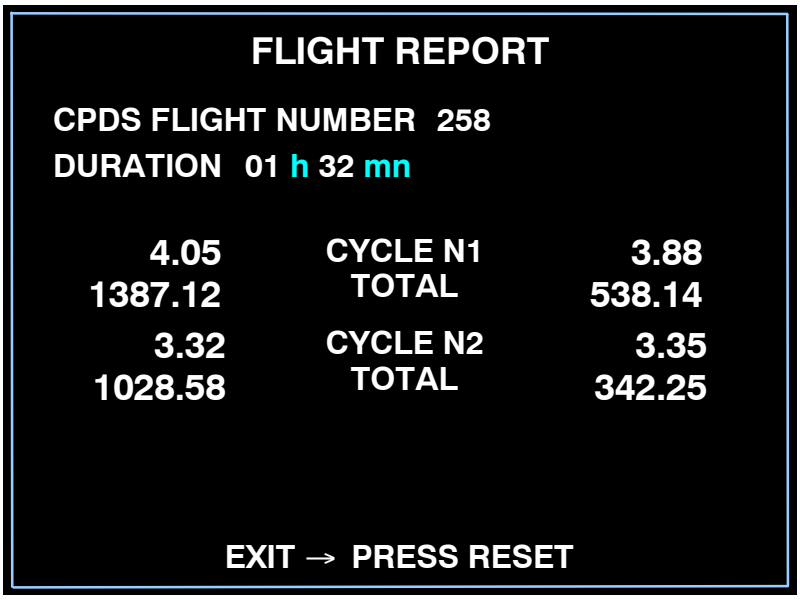



*Figure 1-18. Flight Report Page*

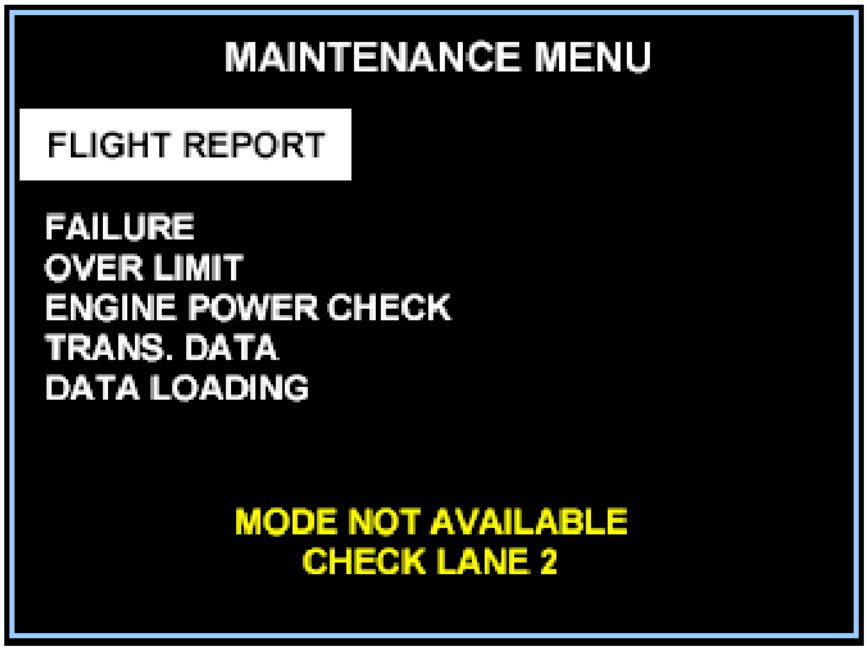



*Figure 1-19. Maintenance Menu Page*

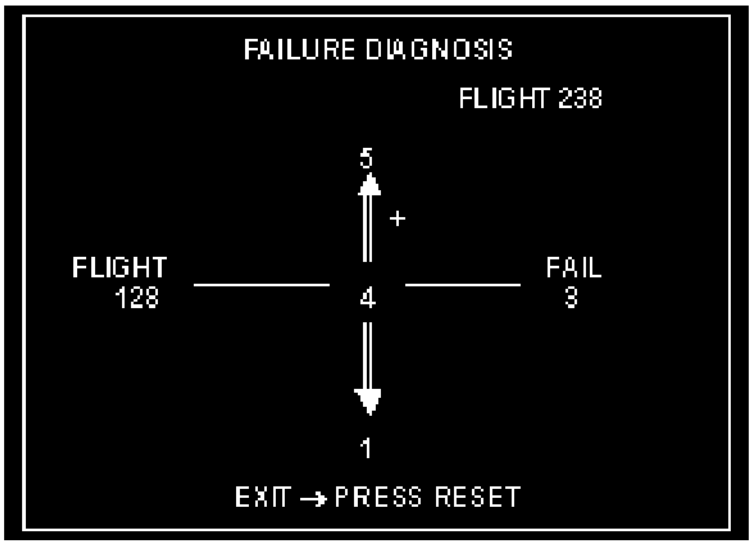



*Figure 1-20. Failure Diagnosis Page*

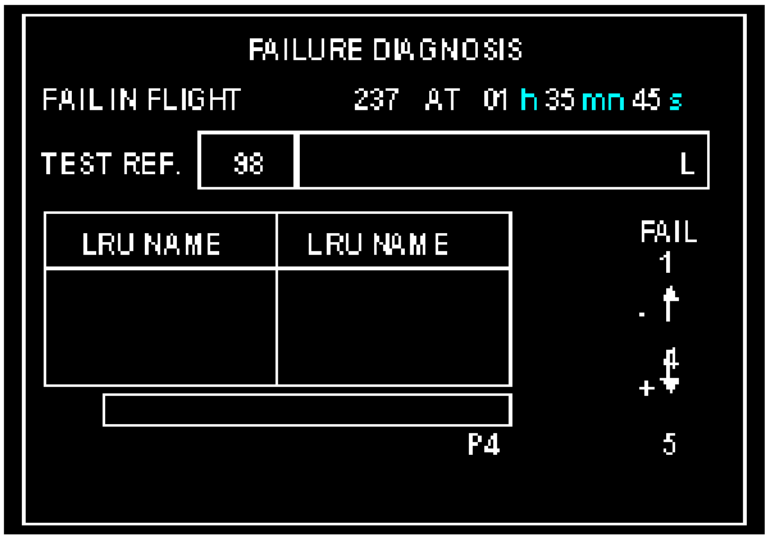



*Figure 1-21. Complete Diagnosis Page*

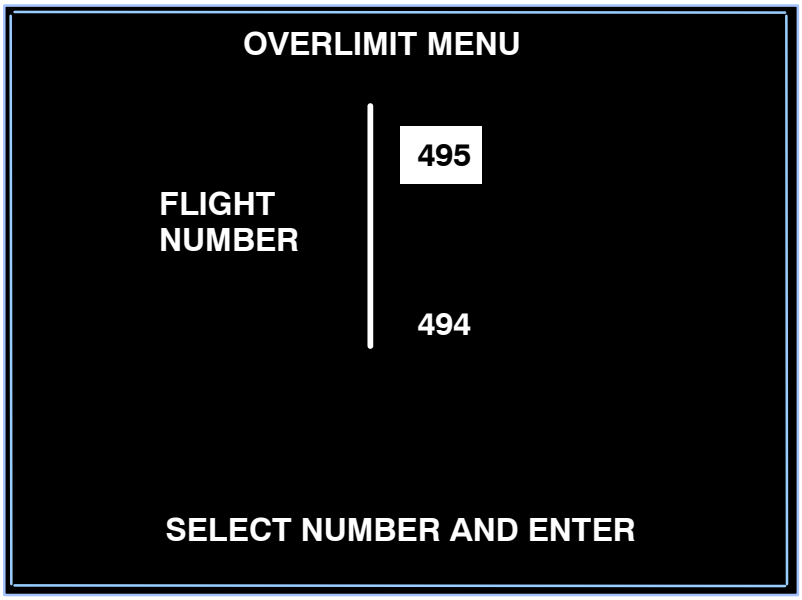



*Figure 1-22. Overlimit Menu Page*

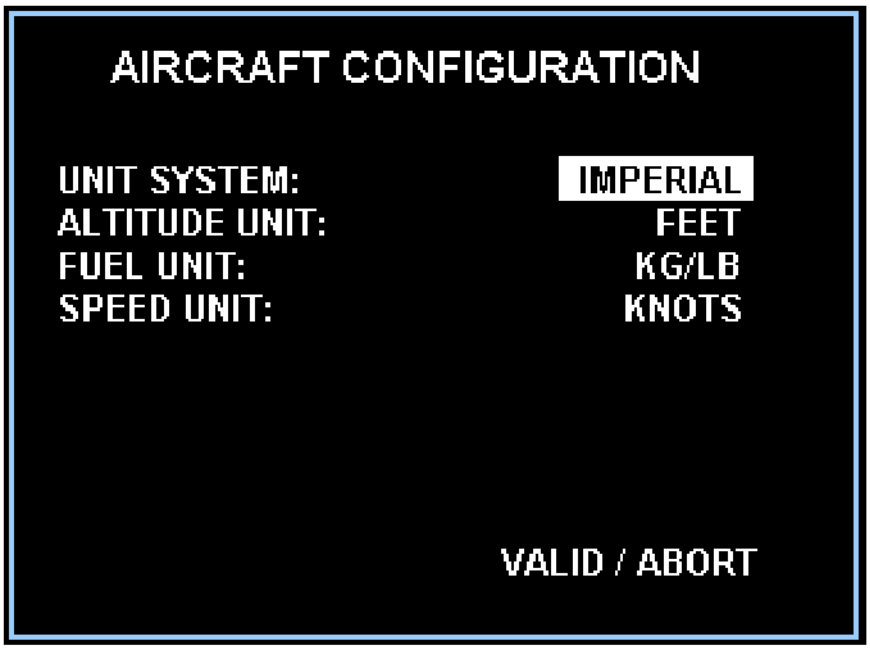



*Figure 1-23. Aircraft Configuration Mode*

# ENGINE FUEL SYSTEM

The fuel system ensures fuel supply, distribution, control, metering and injection to the engine. Each engine fuel system (Figure 1-24) consists of a dual stage pump (low pressure and high pressure), fuel filter, fuel valve and metering assembly.

## ENGINE FUEL SYSTEM OPERATION

Fuel flow for engine operation is provided by dual-stage engine driven fuel pumps which suction lift the fuel from the helicopter fuel supply system. Two boost pumps are incorporated into each fuel system to aid in the delivery of fuel to the engine fuel pump.

Fuel from the aircraft travels through the low pressure pump which gives an initial pressure rise. The outlet side of the low pressure pump is fitted with a low pressure switch that will activate the ENG FUEL P on the warning-caution-advisory panel whenever engine fuel pressure is less than 6 psi. From the low pressure pump fuel then travels through a fuel-oil heat exchanger (incorporated into the oil filter) to heat the engine fuel and aid in cooling the engine oil. From the heat exchanger the fuel passes through a 20 micron filter which incorporates a blockage indicator and filter pre-blockage switch for indication in the cockpit. If the pressure difference across the filter increases to approximately 10 psi, the pre-blockage switch will close and illuminate the FUEL FILT 1 or FUEL FILT 2 caution light on the warning-caution-advisory panel. This caution light warns the pilot that the filter is becoming clogged and fuel may be bypassing the filter. Actual bypass occurs at 17 psi. From the filter the fuel then passes through the high pressure pump. The high pressure pump always provides more fuel than the engine needs and excess fuel is rerouted to the entry side of the low pressure pump. The fuel then travels through the emergency shutoff valve assembly before reaching the fuel pressure transmitter. It provides a fuel pressure signal from 0 to 55 psi to the VEMD fuel page. Fuel then enters the fuel metering assembly where flow is controlled by the FADEC.

## FUEL METERING ASSEMBLY

The fuel metering assembly controls fuel flow in normal operating modes in response to signals from the FADEC. It also provides fuel control in back-up mode in the event of

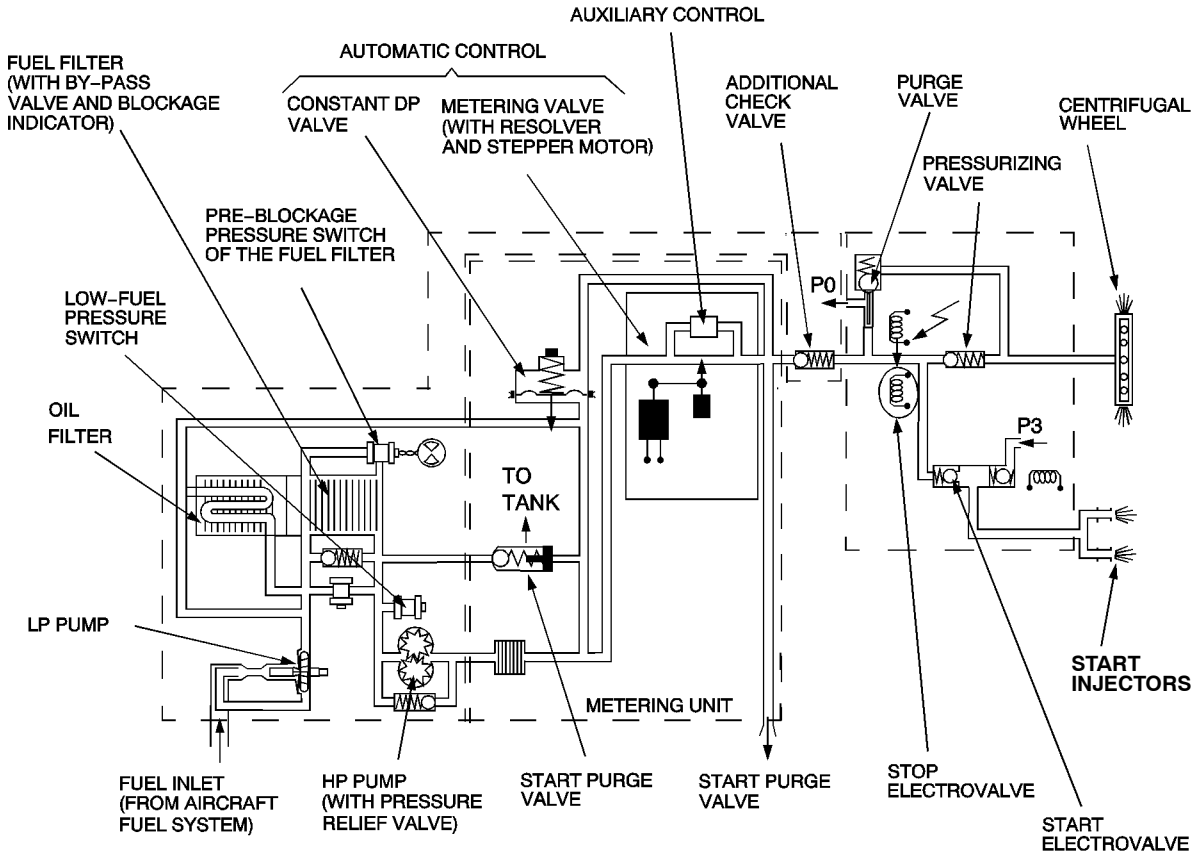



*Figure 1-24. Engine Fuel System*

a FADEC failure. It is made up of an actuator and metering needle, actuator and by-pass valve, metering needle position transmitter, constant pressure valve and additional check valve. From the fuel control, metered fuel travels through the flow meter. Flow meter and fuel manifold pressure transmitters provide signals for Engine Condition Monitoring System (ECMS) and fuel alert (BINGO) as well as cruise calculations. Refer to Mission Navigation and ECMS in this Section. On startup fuel flow is preset to a "basic" flow amount based on OAT and residual TOT to allow proper starting of the engine. During flight, the fuel flow is determined by FADEC operating laws. Refer to FADEC Operation in this Section for amplifying information. Within the fuel control, a bypass valve maintains a constant fuel pressure differential across a metering valve. When the FADEC sends a fuel demand to the metering unit, the unit actuates a dual stepper motor that controls the fuel flow and returns a signal to the FADEC. This return signal tells the FADEC that the fuel adjustment was made and whether or not the stepper motor is working properly. In the event of a dual stepper motor failure, a FADEC FAIL caution light will illuminate on the WCA. On shutdown the stepper motor automatically goes to the closed position. Fuel in the combustion chamber after shutdown is drained into the fuel tanks via a stop purge valve.

### ENGINE DRIVEN FUEL PUMP

The engine driven fuel pump is a dual stage pump consisting of low pressure and high pressure stages. The low pressure pump is centrifugal and includes an impeller that is driven proportional to the N1 speed. The low pressure pump incorporates an ejector to improve fuel pump efficiency. It is designed to operate even if the fuel is contaminated so there is no filter at this stage. The second stage, or high pressure pump, is a gear type pump. It is driven by the same shaft and is also proportional to N1 speed. It incorporates a pressure relief valve that reroutes fuel to the entry side of the pump when excess flow is present.

### EMERGENCY FUEL SHUTOFF LEVERS (EFSL)

Two emergency fuel shutoff levers, one for each engine, are mounted on the overhead control quadrant (Figure 1-25) and operate the shutoff valves. The shutoff valves are mounted forward of the engine firewall. Each lever is used for emergency shutdown of the respective engine. The levers are breakaway wired in the open (forward) position. Pulling both levers aft shuts off all fuel flow. The levers also incorporate a fire detection light that works in conjunction with the fire detection system. Refer to Figure 1-34. They serve as a back-up to the center instrument panel lights and enhance the pilots' capability of determining the appropriate engine to shut down in the event of a fire.

## ENGINE OIL SYSTEM

An independent oil system is provided for each engine. Refer to Figure 1-26. Each system is identical and consists of an oil tank, oil cooler, variable pressure pump and three scavenge pumps, filter/heat exchanger, magnetic plugs, electrical chip detector, and indicators for temperature, pressure, and chip detection. The oil pump unit is made up of a rotor pump and three scavenger elements all driven on the same shaft. Oil under pressure from the pump is routed through the filter and pressure regulator where it is delivered to the gas generator front bearings, axial compressor bearing, centrifugal compressor bearing, accessory drive bearings, gas generator rear bearing, power turbine bearings, reduction gearbox and accessory gearbox. A pressure relief valve is incorporated into the system to prevent overpressure, greater than 218.5 PSI, and reroutes oil to the inlet side of the oil pump. The oil filter is rated at 20 microns and incorporates a visual pre-blockage indicator that is visible when the engine's cowling is open. The filter incorporates a fuel-oil heat exchanger to aid in cooling the engine oil and heating the engine fuel. The pre-blockage indicator will activate at 36 PSI while actual bypass occurs at 82 PSI. Just after the oil filter is the low pressure switch mechanism which will activate when oil pressure drops below 25 PSI. After lubrication, the oil falls by gravity to the bottom of the sumps. The oil is then immediately drawn out by the three

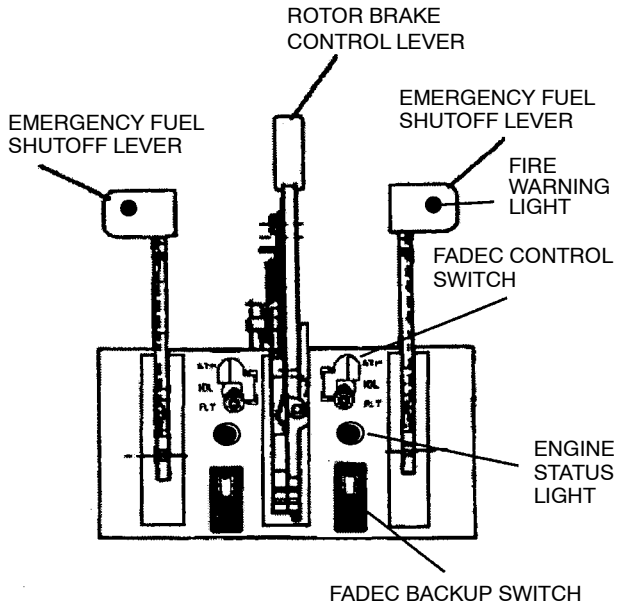



*Figure 1-25. Overhead Quadrant*

scavenge pumps and returned to the oil tank after passing through a check valve and the oil cooler. Strainers incorporated into the system protect the scavenge pumps from debris in the system. Prior to reaching the oil cooler the three scavenge lines merge into one and pass through the electrical magnetic plug. Although there are three magnetic plugs, only one is electrical and will give the pilot an indication on the VEMD and WCA panels. When oil temperature is less than 45 degrees Celsius, the oil will bypass the cooler. The oil mist that results from lubrication is returned to the accessory gearbox where the oil is separated by a centrifugal breather and vents overboard.

### OIL TANK

Each tank has a maximum capacity of approximately 2.0 gallons. A temperature probe located on the outlet side of the tank sends a signal for oil temp indication on the VEMD. A sight gauge in the side of each tank can be viewed from the ground. Proper servicing levels must be checked within 30 minutes of engine shutdown due to draining from the oil tank to the engine gearbox. During preflight, the oil level should be between the minimum and maximum lines.

### ENGINE OIL COOLERS

Two engine oil coolers (one for each engine) are mounted forward of the Main Gearbox (MGB) in series with the MGB oil cooler. A fan driven by the MGB provides air flow through the coolers when sufficient ram air is not available. When MGB oil is less than 45 °C it will bypass the oil cooler. Above 75 KIAS forward, ram air alone is sufficient for oil cooling.

## FADEC (Full Authority Digital Engine Control)

Engine operation in the HH-65C is managed by a digital control system known as FADEC. The system is designed to deliver engine performance based on pilot input while preserving engine life through the constant monitoring of defined operating limits. Numerous redundancies have been built into the system to provide increased reliability over traditional engine control systems. Its main functions are starting, speed control, automatic back-up control, overspeed protection, system monitoring and fault management. It is redundantly powered by the engine-driven, dual channel alternators as well as aircraft power supply. If one channel of the engine alternator fails, the FADEC will automatically switch to the other alternator channel. If both channels fail, the internal transformer rectifier will allow the FADEC to operate normally on DC power. The FADEC is a dual-channel (A and B) computer that controls engine operation and is designed to match the N1 of both engines. Each engine utilizes its own FADEC computer that is located in the baggage compartment overhead. Each channel of the FA-

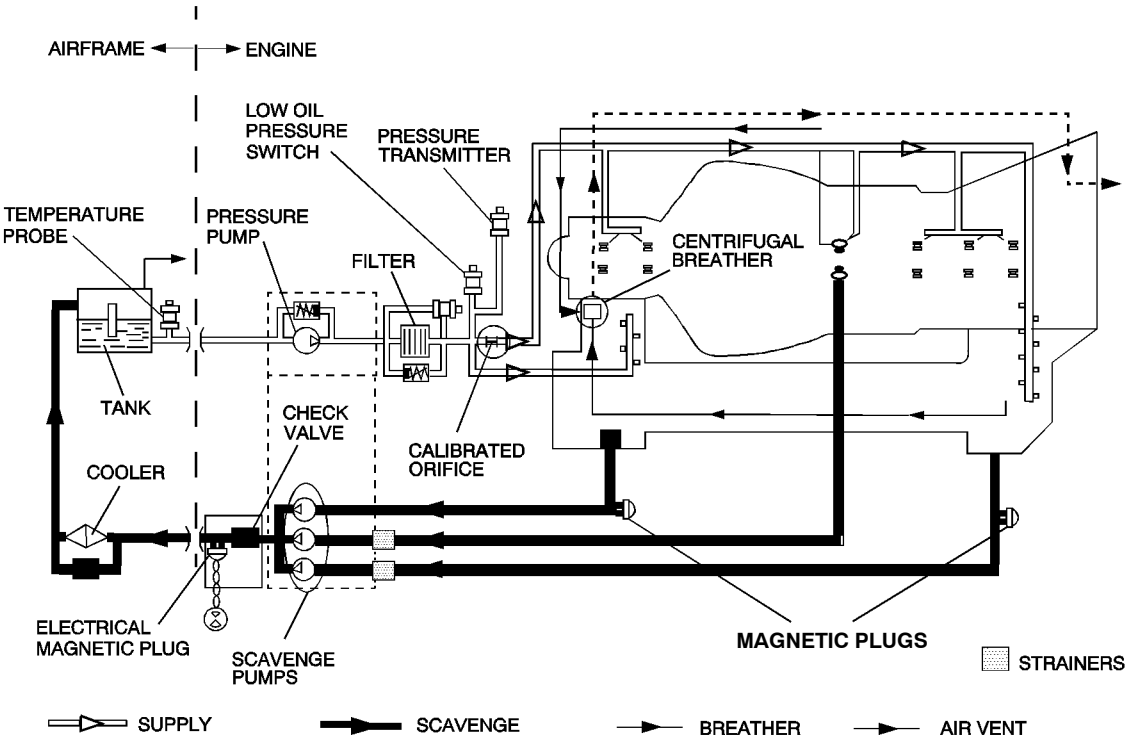



*Figure 1-26. Engine Oil System*

DEC contains identical software and each has the ability to perform all necessary functions for normal operation. If one of the channels fails, the other will automatically control the engine. If neither channel can control the engine, a major FADEC failure has occurred and fuel metering is frozen. Back-up operation is available through a secondary device known as the Emergency Back-Up Control Auxiliary Unit (EBCAU). The FADEC system is made up of airframe, electrical and hydromechanical components. Aircraft components consist of switches, buttons, indicators, warning lights, and DECU power supply. Engine components consist of check valves, start injectors, high and low pressure fuel pumps, filters, the main injection system, and fuel metering unit. Electrical components consist of control sensors, indicator sensors, DECU dual-channel alternators, a resolver (fuel meter), stepper motor, stop electrovalve, start electrovalve, ignition unit, starter and the EBCAU.

## DIGITAL ENGINE COMPUTER UNIT (DECU)

Two DECUs, commonly referred to as FADEC computers, are located in the aft cargo compartment overhead. The DECUs receive information from various sensors, the opposite engine DECU, FADEC control panel, VEMD, and collective anticipators. They process this information to control electronic fuel flow governing. The DECUs crosstalk function allows seamless operation of both engines when an individual sensor fails for system redundancy. They control start, IDLE, and FLIGHT condition through the FADEC control switch. Figure 1-28 is a block diagram that depicts this relationship.

## FADEC CONTROL SWITCH

Two FADEC Control Switches (FCS), one for each engine, are located on the overhead control quadrant (Figure 1-25). The three positions of the FCS are: SHUTOFF, IDLE, and FLIGHT. Each FCS is equipped with a safety lock that is installed when the aircraft is not in use. Additional safety guards located in conjunction with each FCS can be engaged once an FCS is moved to the FLT position to prevent inadvertent manipulation of an FCS during flight.

## SIGNALS

The two channels of each FADEC receive multiple inputs including, but not limited to, the following: P3 (compressor outlet pressure), TOT (turbine outlet temperature), fuel meter position, Tq, P0 (local atmospheric pressure), T0 (engine inlet temperature), collective pitch and conformation resistances for Tq and TOT. Conformation resistance modules ensure accurate signals are sent to the FADEC and VEMD and that any anomalies are removed prior to signal transmittal. Inputs are shared between the two channels, but channel A will normally control the engine. If a parameter is lost from channel A, the input from Channel B will be used. This configuration ensures that if the signals of one channel fail, the other can safely control the engine. As depicted in Figure 1-27, discrete inputs are shared by both channels, but the discrete outputs are determined by the channel in control.

## GENERAL FADEC CONTROL LOGIC

The FADEC is designed to provide optimal engine performance throughout all flight regimes. Operating laws that determine FADEC performance are based on system status, ambient conditions and phase of flight. For example, the FADEC will take into account certain parameters during the FLIGHT phase (i.e., collective lever position) that it may not use during the IDLE phase. The position of the FADEC control switch, STOP/IDLE/FLIGHT, will determine the set of basic operating laws of the FADEC.

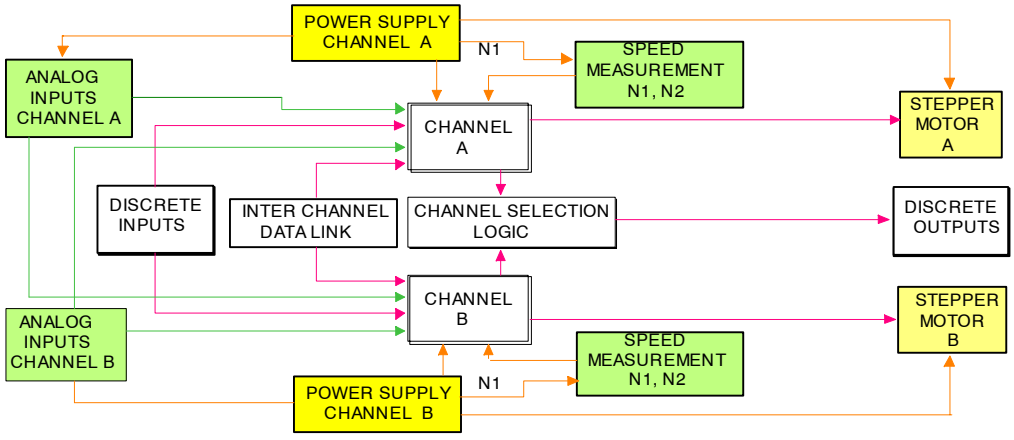



*Figure 1-27. FADEC Logic*

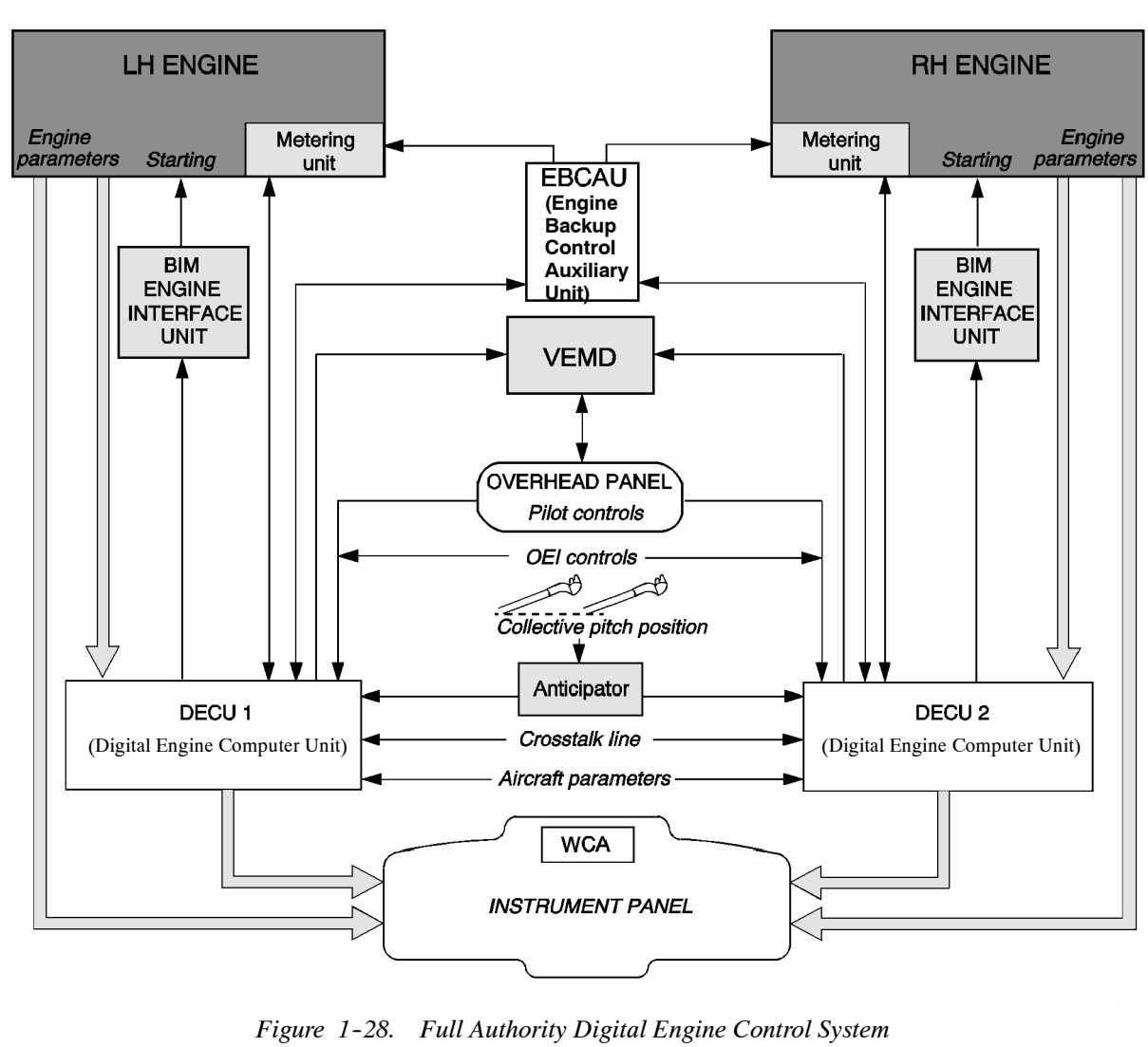



*Figure 1-28. Full Authority Digital Engine Control System*

## STOP POSITION

In the STOP position the FADEC is in an idle state. The FADEC is energized when the battery is turned on and will perform a self-test. It will also provide indication in the cockpit of any malfunction by way of a GOV caution light or FADEC FAIL light on the WCA panel. A flashing GOV light or FADEC FAIL light on the WCA panel indicates a fault in the system and should be investigated prior to starting.

## START PHASE

When the FADEC Control Switch (FCS) is moved to the IDLE or FLIGHT position with the rotor brake off, the START sequence is initiated. In the event the FCS is placed in the IDLE or FLIGHT position prior to the battery being turned on, FADEC logic will prevent the START sequence from occurring. FADEC fault detection logic will also prevent the second engine from starting on an alternate power source. The START sequence can not be initiated until the FCSs are switched to the off position prior to turning on the battery. During the START phase, the FADEC references basic fuel flow laws, starting flow laws, flow correction laws, TOT correction and surveillance, and N1 speed so that the engine start is rapid yet controlled without overtemperature. The basic flow law is based upon residual TOT and OAT at the engine inlet (T0). Failure of either of these inputs will not prevent a start but will cause the FADEC to use conservative baseline parameters to avoid over-temperature. Starting flow laws are based on N1 acceleration while flow correction laws are based on TOT referenced to N1. The start becomes self-sustaining at 45% N1 with a normal idle speed of 68% N1. Automatic engine shutdown will occur when the FADEC detects a TOT of 840 degrees C or if the TOT does not exceed 100 degrees C by 27% N1. In the event of an in-flight restart, the start sequence will not initiate until N1 is below 17%.

## IDLE POSITION

If the FCS is placed in the IDLE position, the engine will complete the start sequence and remain at 68% N1 until advanced to the FLT position. At IDLE, the FADEC is powered by its dual-channel alternator once the N1 reaches 65%. The FCS may be advanced directly to the FLT position unless OAT is less than 0 degrees Celsius.

## ENGINE START-LOW IDLE FUNCTION

The engine start-low idle function of the engine enables the rotor brake to remain engaged for the start of one engine only. This is normally done for maintenance purposes. To utilize this function, depress the START RBK button, located on the center instrument panel. The button remains illuminated green when the system is not operating. When depressed, an amber ON will illuminate. Once START RBK/ON is selected and the FCS is moved to the IDLE position, the engine will perform a normal start and idle at 52%.

**CAUTION**

Operation in the START RBK mode is limited to 60 seconds with ≤ 16 PSI engine oil pressure.

To cancel this function, depress the START RBK button again. Normal idle speed will be inhibited until the rotor brake is released. The start idle function may not be selectable if one engine is already operating. In addition, if the FCS is advanced to the FLT position, the engine will remain at 52% until the mode is cancelled and the rotor brake is released. It is disabled in flight by the weight on wheels switch.

## FLIGHT POSITION

Once the FCS is advanced to the FLIGHT position, the FADEC will operate on FLIGHT governing laws. During the acceleration phase, torque and TOT are limited until Nr has reached 350 RPM. The advancement of the second engine is optimized to take into account that the first engine has taken the load of the rotor head. Once the FADEC is established in the FLIGHT phase it monitors for single and dual engine operation. Detection of single engine will allow selection of OEI limits. Refer to One Engine Inoperative in this Section for further information. As with most helo-turbine systems, the N1 is adjusted to maintain a constant N2 or Nr. During flight, collective lever position represents the power required and will determine the N1 operating datum. This function, also known as anticipation, permits an initial adaptation of the N1 or gas generator to balance the power required to keep N2 constant. The anticipator also supplies an instant signal of load variation to the FADEC which reduces the reaction time of the engines. The anticipator signal is not sufficient to balance the N1 and N2 alone as the power demand depends on various other factors. To ensure alignment of the engines an additional function of the FA-

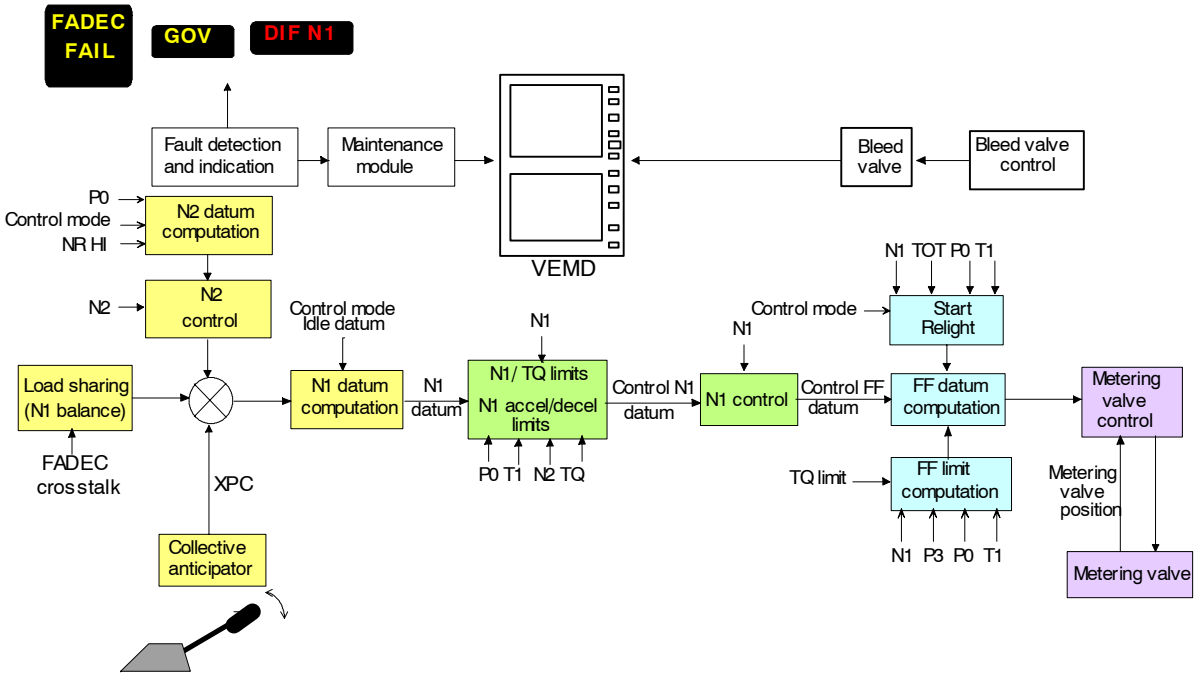



*Figure 1-29. FADEC Architecture*

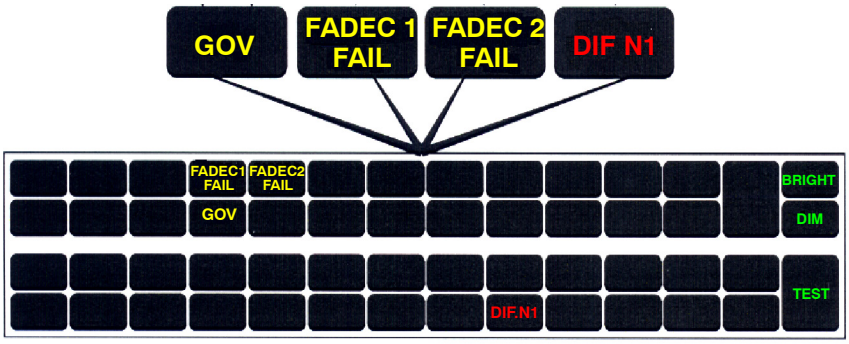



*Figure 1-30. FADEC Failures*

DEC known as load-sharing matches the N1 of the engines by increasing the output of the lower engine until engine outputs are matched. The N2 controller, which determines Nr speed, is referenced to balance the power required vs the power supplied. Thus, the N1 datum is derived from anticipator position, the N2 controller and the load-sharing function. The N1 datum is then restricted in order to assure optimal acceleration, deceleration, torque limiting, and adherence to OEI ratings. This N1 datum determines the appropriate fuel flow to maintain a constant N2 without droop. Lastly, the fuel flow limiter is referenced to prevent surge or flameout.

## N2 CONTROLLER

The N2 datum is calculated according to the control mode (IDLE, IDLE TRAINING, FLIGHT, FLIGHT TRAINING). It is also dependent on aircraft altitude. At sea level, under standard day conditions, the Nr speed is 355 RPM. The pilot has the capability to operate the aircraft at 365 RPM by selecting NR HI on the overhead control panel (Figure 1-29). The NR HI mode is used during hover flight, single engine operations, and other demanding low speed maneuvers as it provides a greater margin for Nr droop as well as increased tail rotor authority. Its use is limited to 135 KIAS and 40 degrees angle of bank. A second function of the N2 controller is the variable Nr system. It is designed to increase rotor RPM at higher altitudes to maintain rotor efficiency and reduce the aircraft's noise signature. Above 1,650 ft, Nr is increased 1 RPM for every 840 ft to a maximum of 360 RPM at 5,740 ft. If the variable Nr system fails, the Nr will default to 360 RPM.

## FADEC FAILURES

FADEC failures are classified into three categories depending on the severity of the malfunction with Level 3 being the most severe. Level 1 failures (loss of redundancy), such as a TOT signal loss, will not be evident in flight. Such failures will be annotated by a flashing GOV light on the WCA panel when N1 is less than 20% (before start-up and after shutdown). Level 1 failures have no affect on FADEC performance. Level 2 failures (loss of a non-redundant resource), such as FADEC crosstalk failure, will manifest as a steady GOV light on the WCA panel at the time of failure. Level 2 failures represent a degraded operation state of the FADEC. Level 3 failures (major FADEC failure), such as a dual-channel FADEC failure, represent a total failure of the respective FADEC. A major FADEC failure will manifest as a FADEC FAIL annunciation on the WCA (Figure 1-30) panel along with illumination of the red engine status light. Fuel flow on the affected engine will be frozen at its present value. Reference Section III for amplifying information on corrective actions for FADEC failures.

## HOVER INCREASED POWER SEARCH AND RESCUE MISSION (HIPSARM)

During demanding hover maneuvers, and when mission urgency dictates, 5 minute power may be accessed for up to 30 minutes, also known as HIPSARM power. The HIPSARM power rating is a dual engine rating above max continuous (8.8 FLI) and below the maximum takeoff power rating (10.0 FLI). The HIPSARM rating is an engine limitation only. Normally, operation in the takeoff power range for more than 5 minutes constitutes HIPSARM time. Due to the limitations of the main rotor head in the HH-65C, only N1 and TOT, not engine torque, determine the use of HIPSARM time. Therefore, during hover operations above 8.8 FLI, HIPSARM time will not be accrued unless N1 or TOT is underscored in yellow for more than 5 minutes or if the maximum takeoff limits are exceeded, regardless of duration. A white clock symbol will appear at the bottom of the FLI Page when this occurs. The HIPSARM counter is presented on the VEMD status page and indicates percentage of total permissible HIPSARM time before engine maintenance is required.

## ONE ENGINE INOPERATIVE (OEI)

OEI ratings permit use of emergency power during single engine operation, degraded engine operations, or major FADEC failures. The FADEC will adjust the N1 limits to permit OEI Continuous (CT), 2 minute (LO), or 30 second (HI)

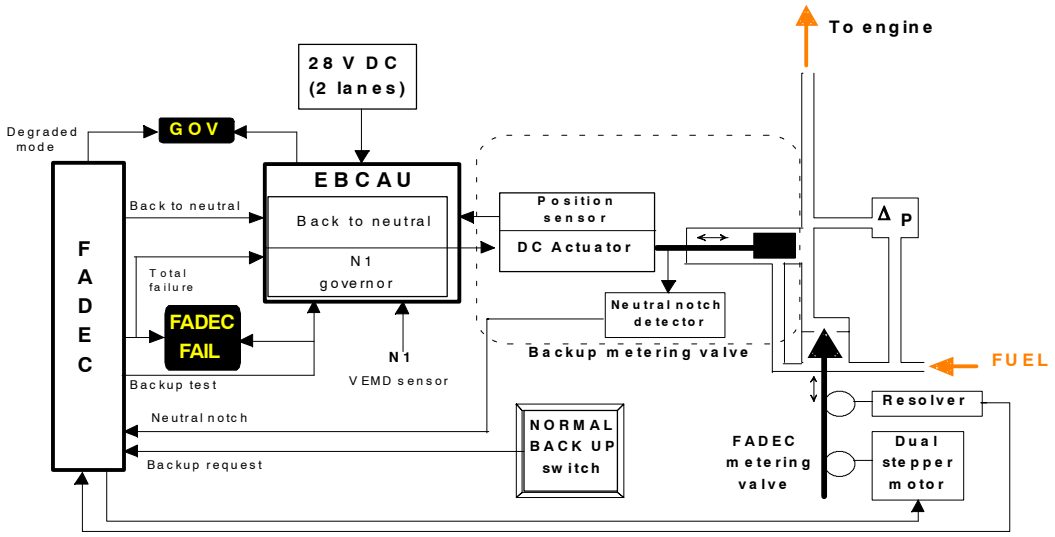



*Figure 1-31. EBCAU*

operation as selected by the pilot. The system is self-arming for single engine scenarios, actual or training, and can not normally be accessed during dual engine operation except as noted below. Any time the FADEC detects a 6% N1 split (DIF N1 or engine failure) or a frozen fuel meter (major FADEC failure), the OEI HI operation is enabled; if in training mode, the OEI LO range. The pilot may select the desired OEI range with two guarded select buttons located on the collective (Figure 1-46). The forward-most button will select HI or LO while the rear button selects CT. On initial power-up, both engines are topped at torque takeoff rating stops. If Nr droops below 335 RPM, torque stops will increase linearly to provide a maximum of 8% additional power at 300 RPM. Any use of OEI ratings will be logged on the VEMD. A yellow (OEI LO) or red (OEI HI) clock symbol will appear at the bottom of the FLI Page when operating in the corresponding range. If during flight the Nr droop exceeds 301 RPM or if the rate of droop is greater than 17.5 RPM per second below 308 RPM, dual engine, the OEI 2 minute stop may be accessed. Any time the RPM climbs above 315 RPM this function is inhibited. OEI usage can be accessed on the VEMD status page. Refer to Section V, Operating Limitations, for specific limitations.

## EBCAU (EMERGENCY BACK-UP CONTROL AUXILIARY UNIT)

The EBCAU is designed to provide emergency control of the engine in the event of a dual-channel FADEC failure. The computer module is located in the nose compartment and operates a back-up fuel actuator with 28 VDC. The EBCAU is energized by switching the FADEC normal/back-up control switch, located on the overhead quadrant, to BACKUP. To assist the pilot in identifying the proper engine, an engine status light is located next to the back-up switch and illuminates during a dual channel FADEC failure or loss of oil pressure. The system is designed to align the N1 of the malfunctioning engine to the N1 of the normal operating engine. Although N1 matching is assured, there will be some acceleration delay on the malfunctioning engine.

**NOTE**

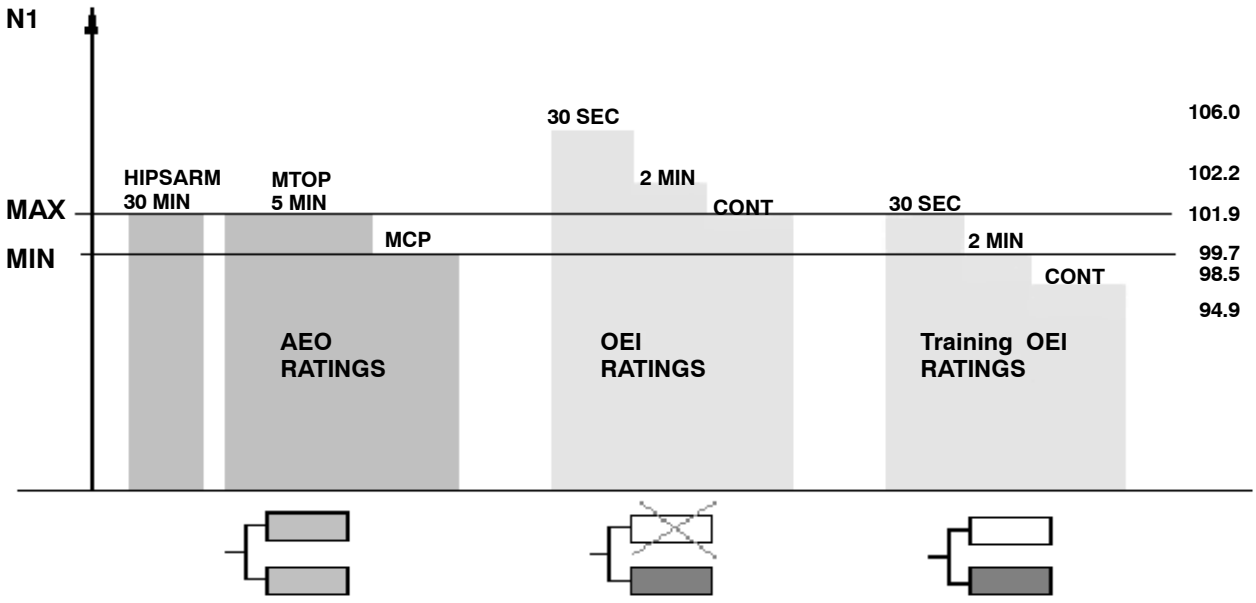
Operation of the EBCAU is prohibited for training.

## TRAINING MODE

**CAUTION**

Movement of the training switch back to flight with the FLI above 8.0 should only be done in extreme circumstances when aircraft damage is likely to result if the training switch is left in Idle 1/2. If the training switch is placed to flight at power settings above 8.0, actual OEI time may be accrued which shall be annotated on the CG–4377.

A unique function of the FADEC is the ability to simulate single engine operations. This mode is activated through the use of the training switch located on the center console (Figure 1-33). The training switch is held in the neutral position by a safety lock that prevents inadvertent activation. When training mode is selected, the simulated failed engine is reduced to 320 RPM N2 and the single engine FLI is displayed on the VEMD. OEI HI operation depicted on the VEMD while in training mode corresponds to maximum continuous power (Figure 1-32). Because of this reduced power, the aircraft performs as if it were operating at a higher gross weight. Reference Chart A-12 for the corresponding training




Note: The power indicated corresponds to the following configuration: engine installed, max torque in the corresponding rating. ISA condition at sea level.

*Figure 1-32. Engine Ratings*

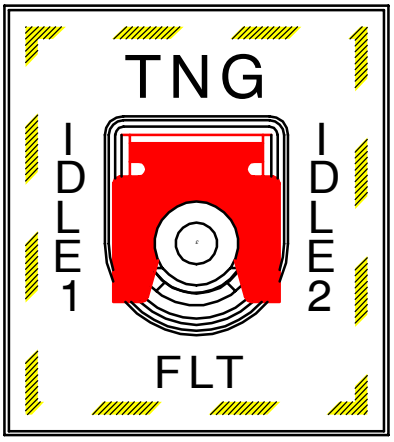



*Figure 1-33. Training Switch*

weight. If the Nr droops below 320 RPM, the "idle" engine will provide power up to the actual selected OEI stop in order to prevent excessive Nr droop below 320 RPM.

## MOTORING WITHOUT IGNITION

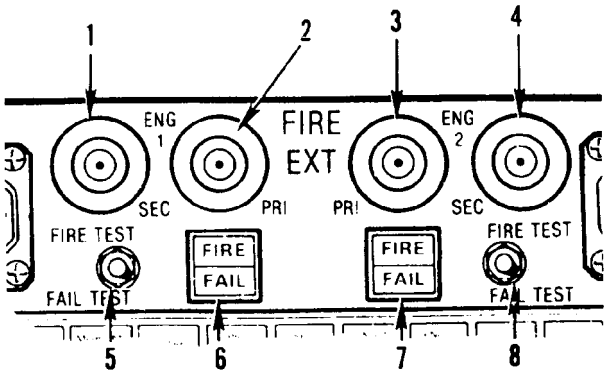
Pressing the CRANK pushbutton on the overhead console operates the starting system in a manner similar to that described for starting, except that the ignitor circuitry is bypassed. This allows the starter/generator to motor the engine without ignition.

**CAUTION**

Do not crank the engines if the EFSL(s) are in the shut-off position as severe damage will occur to the engine fuel pump(s).

## ENGINE FIRE WARNING SYSTEM

The engine fire warning system (Figure 1-34) provides the pilot with an immediate warning of fire in either engine compartment. Each engine fire warning circuit consists of three bimetallic fire detectors which are wired in series; two located on the accessory/reduction gearbox section (200 °C), and one located on the gas generator (400 °C). Any detector will sense an overheat condition and cause the respective FIRE light on the instrument panel and the fire light on the respective EFSL to illuminate. An associated FAIL light located below the FIRE light will illuminate if an open circuit occurs in the detector wiring harness or if power is lost to the fire detection circuit. Two TEST switches with positions marked FIRE TEST, and FAIL TEST located outboard of each FIRE/FAIL warning light, are used to test the fire detector and fail circuits. Positioning the test switches to FIRE TEST or FAIL TEST will cause the corresponding FIRE or FAIL lights to illuminate and test the system circuitry.




1. **Engine 1 Secondary Extinguisher Pushbutton**
2. **Engine 1 Primary Extinguisher Pushbutton**
3. **Engine 2 Primary Extinguisher Pushbutton**
4. **Engine 2 Secondary Extinguisher Pushbutton**
5. **Test Switch for Left Extinguisher Circuit**
6. **Engine 1 Fire Warning and Circuit Power Failure Lights**
7. **Engine 2 Fire Warning and Circuit Power Failure Lights**
8. **Test Switch for Right Extinguisher Circuit**

*Figure 1-34. Engine Fire Warning and Extinguisher Controls*

## ENGINE FIRE EXTINGUISHER SYSTEM

The fire extinguisher system consists of two spherical bottles, a distribution system, and an electrical control system. The extinguishers are mounted on the engine deck aft of each engine bay in a fire protected zone. Each is equipped with a dual discharge head activated by explosive squibs, a pressure relief valve, and a pressure switch. Each bottle contains bromtrifloromethane (CF3BR) and is inspected periodically. Electrical control consists of four pushbutton switches (Figure 1-34) located on the instrument panel above the FIRE and FAIL warning lights, and two low pressure caution lights. The caution lights, labeled L EXT (left extinguisher) and R EXT (right extinguisher) and located on the warning-caution-advisory panel, illuminate when pressure in the corresponding extinguisher drops below 230 psi. One extinguisher may be discharged into each engine compartment or both bottles may be discharged into either engine compartment. Depressing the primary (PRI) pushbutton for engine 1 will discharge the left extinguisher into the left engine compartment. Depressing the Primary (PRI) pushbutton for engine 2 will discharge the right extinguisher into the right engine compartment. Depressing the Primary (PRI) and Secondary (SEC) pushbuttons for a particular engine discharges both extinguishers into the same engine compartment. The pushbutton associated with the left extinguisher and right extinguisher receives 28 volts DC from the No. 1 and No. 2 main DC buses, respectively, and for redundancy all four receive power from the battery bus.

## ROTOR SYSTEM

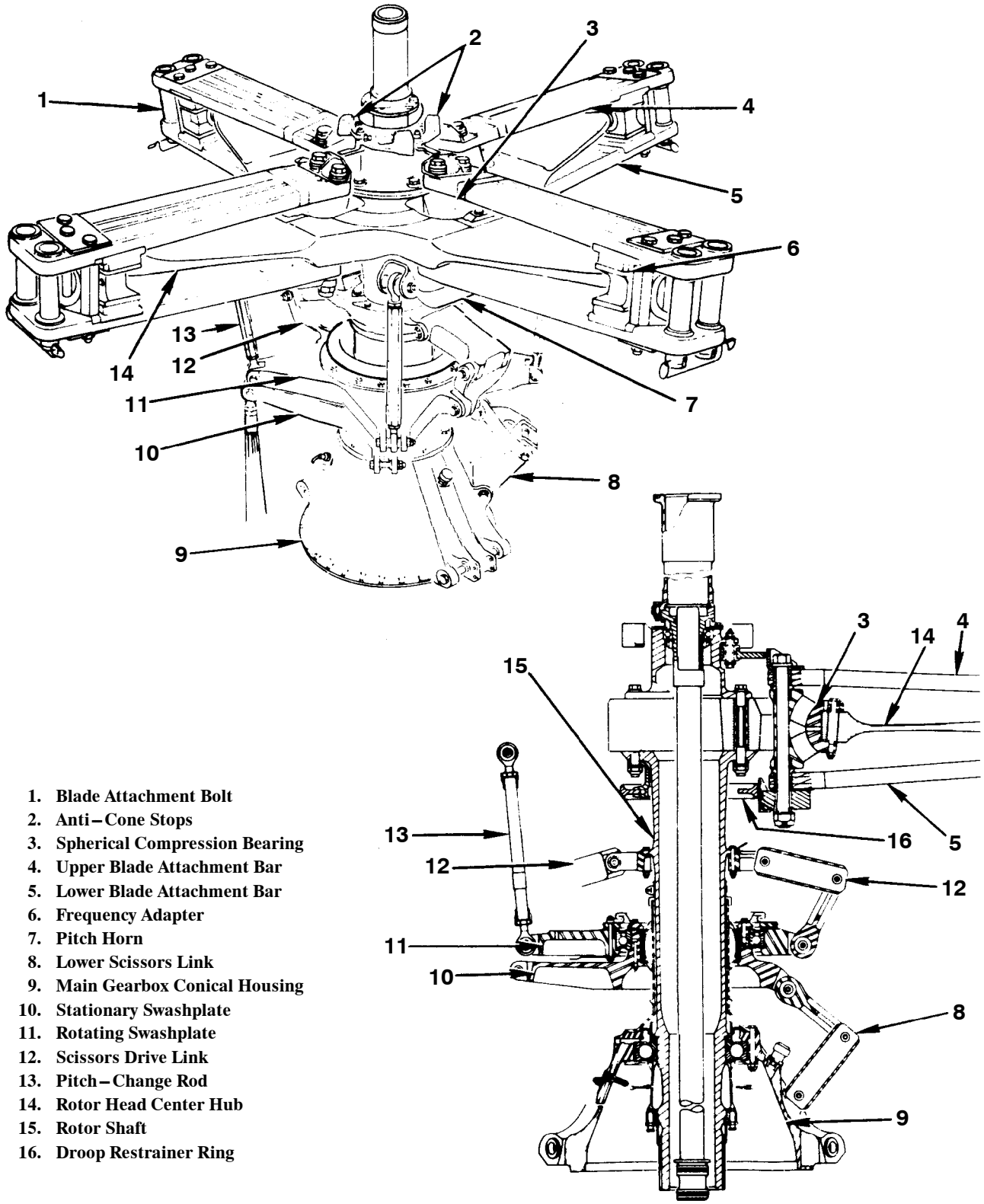
The aircraft is configured with a four blade main rotor and a multi-bladed, ducted, fan-in-fin type, tail rotor.

### MAIN ROTOR SYSTEM

The main rotor system consists of a semi-rigid main rotor head, shaft, and four main rotor blades. The system rotates clockwise as viewed from above. The main rotor is constructed of composite materials, including laminated spherical thrust bearings for sustaining rotor motion and loads, elastomeric blocks for damping action, and self-lubricating bearings.

### Main Rotor Head

The rotor head (Figure 1-35) center hub forms a star with four arms which are flexible in the flapping axis, but rigid in the lead/lag axis. The rotor blades are connected to the center hub by means of rigid attachment bars that permit flapping, drag and pitch change functions through the use of laminated spherical thrust bearings and sheer-deformable frequency adapters. An anti-cone stop for each blade facilitates starting in high winds. Centrifugal force causes the stops to retract as rotor speed increases. When the rotor speed decreases, the stops are extended to their initial position by return springs. Spring activation is between 181 and 202 RPM. The assemblies that make up the rotor shaft assembly are the rotor shaft, swashplates, a conical housing, pitch change rods, and a blade droop restrainer ring. The main rotor shaft is splined at the lower end and mated with the MGB. The main rotor head is bolted to the upper end of the shaft. The center of the shaft is hollow and provides clearance for the Omnidirectional Air Data System (OADS) mounted on the rotor head. A stationary swashplate, secured from rotational movement by scissors mounted on the conical housing, receives cyclic and collective inputs through the hydraulic servos. These inputs are transmitted to the rotor blades through the rotating swashplate which is driven by two rotating scissors secured to the rotor shaft. Pitch change rods complete the connection between the rotating scissors and the rotor blade pitch horns. The main rotor head is rigged to provide the best capabilities in forward flight. This configuration usually provides negative pitch with the collective in the full down position, although negative pitch is not guaranteed. It is possible for the optimum forward flight rigging to provide up to 200 lbs of lift with the collective in the full down position. The droop restrainer ring is mounted on the rotor shaft immediately below the rotor head to pre-




1. Blade Attachment Bolt
2. Anti–Cone Stops
3. Spherical Compression Bearing
4. Upper Blade Attachment Bar
5. Lower Blade Attachment Bar
6. Frequency Adapter
7. Pitch Horn
8. Lower Scissors Link
9. Main Gearbox Conical Housing
10. Stationary Swashplate
11. Rotating Swashplate
12. Scissors Drive Link
13. Pitch–Change Rod
14. Rotor Head Center Hub
15. Rotor Shaft
16. Droop Restrainer Ring

*Figure 1-35. Main Rotor Head*

vent rotor blade droop. Droop restrainer action is entirely automatic as the rotor slows and requires no action on the part of the aircrew or ground personnel.

### Main Rotor Blade Construction

Each main rotor blade (Figure 1-36) has a stainless steel leading edge strip for protection against erosion and abrasion. An integral brass weight is installed inside the leading edge to counteract natural flapping frequencies that result from the light composite blades. The outer skin is made of carbon fiber cloth. A fiberglass main spar is located between the foam core and stainless steel leading edge. A lightweight, fiberglass and carbon fiber, swept-back tip fairing aids in reducing vibrations and torsional loading. Six trim tabs are installed on the outer trailing edge for dynamic tracking and balancing. Two steel bushings are installed at the blade root for attaching the blade to the rotor head by quick-disconnect attachment bolts secured with safety pins. A grounding connector, located on the inboard leading edge, minimizes radio and radar interference by equalizing static charges that may accumulate on the blade.

### Rotor Brake

The rotor brake is used to prevent the rotor from turning while the aircraft is parked, and is also used to reduce the coast down time of the rotors after engine shutdown. The brake is a mechanically operated friction disk and brake caliper device mounted on the MGB oil cooler fan shaft. The rotor brake must be disengaged prior to starting unless the START IDLE function is selected.

### Rotor Brake Control Lever

The rotor brake control lever (Figure 1-25) is located between the FADEC control switches on the overhead control quadrant in the cockpit. In the released position, the rotor brake control is fully forward. In the applied position, the rotor brake control is fully aft. Uneven and excessive wear on the rotor brake will occur when the rotor head is turning and the rotor brake handle is in any position other than fully on or fully off. The control lever is held in the off position by a locking device that prevents inadvertent engagement. FADEC logic will prevent engine start unless the rotor brake is released or the START RBK function is utilized.

### Tail Rotor System

Within the tail rotor system (Figure 1-37), the shrouded tail rotor is located within the lower section, or ducted area, of the vertical fin and consists of multiple blades, simultaneously articulated in pitch only, and a rotor head with associated bearings and controls. The tail rotor is driven, via the Tail Gearbox (TGB), by a segmented drive tube extending aft from the MGB along the top of the tail boom. Multiple bearing supports and flexible couplings minimize vibration and prevent shaft loads resulting from tail boom deformations. For optimum aerodynamic efficiency, the shroud (or duct) is rounded at the upstream air intake and slightly flared downstream.

### Tail Rotor Head

The tail rotor head consists of a rotor hub, central plate, pitch change spider, and a fairing. The hub includes multiple holes to accommodate the tail rotor blades and related bushings and bearings. The tail rotor blade horns are fitted to the central plate which is actuated by the pitch-change mechanism. Motion of this central plate provides blade pitch change.

### Tail Rotor Blades

Each blade consists of a composite material spar which extends to the tail rotor axis. Each torsion-type spar is bolted to the rotor hub center. The spar is bonded to the larger blade surface, consisting of a foam internal filler, and covered with a composite material skin. The leading edge of each blade is protected by a titanium erosion shield.

## TRANSMISSION SYSTEM

The transmission system (Figure 1-37 and 1-38) consists primarily of two gearboxes (main and tail), a tail rotor drive shaft, and two engine-to-MGB coupling units. Power from the engines is dynamically linked to the MGB by the coupling units, each of which consists of a drive shaft protected by a casing used as a forward anchoring point for each engine. A freewheeling unit, located within each input housing to the MGB, permits the MGB to operate at a higher rpm than either engine input during single engine operation or autorotation. Tail rotor drive output from the MGB is transmitted to the tail gearbox (TGB) by a three piece drive shaft mounted on the engine deck and tail boom.

### MAIN GEARBOX (MGB)

The MGB (Figure 1-38), mounted above the cargo compartment and forward of both engines, is a three stage reduction gear system which reduces engine input rpm by a ratio of 17 to 1 to drive the main rotor, and 1.5 to 1 to drive the tail rotor. In addition to the main gear case, which houses the reduction gear system to drive the main and tail rotors, the MGB consists of: left and right engine input housings and accessory gearboxes, shafts for driving the Nr tachometer generator and MGB oil system pump, and an accessory drive for the oil cooler and rotor brake. The left accessory gearbox drives the secondary hydraulic pump and the No. 1 alternator. The right accessory gearbox drives the primary hydraulic pump and the No. 2 alternator.

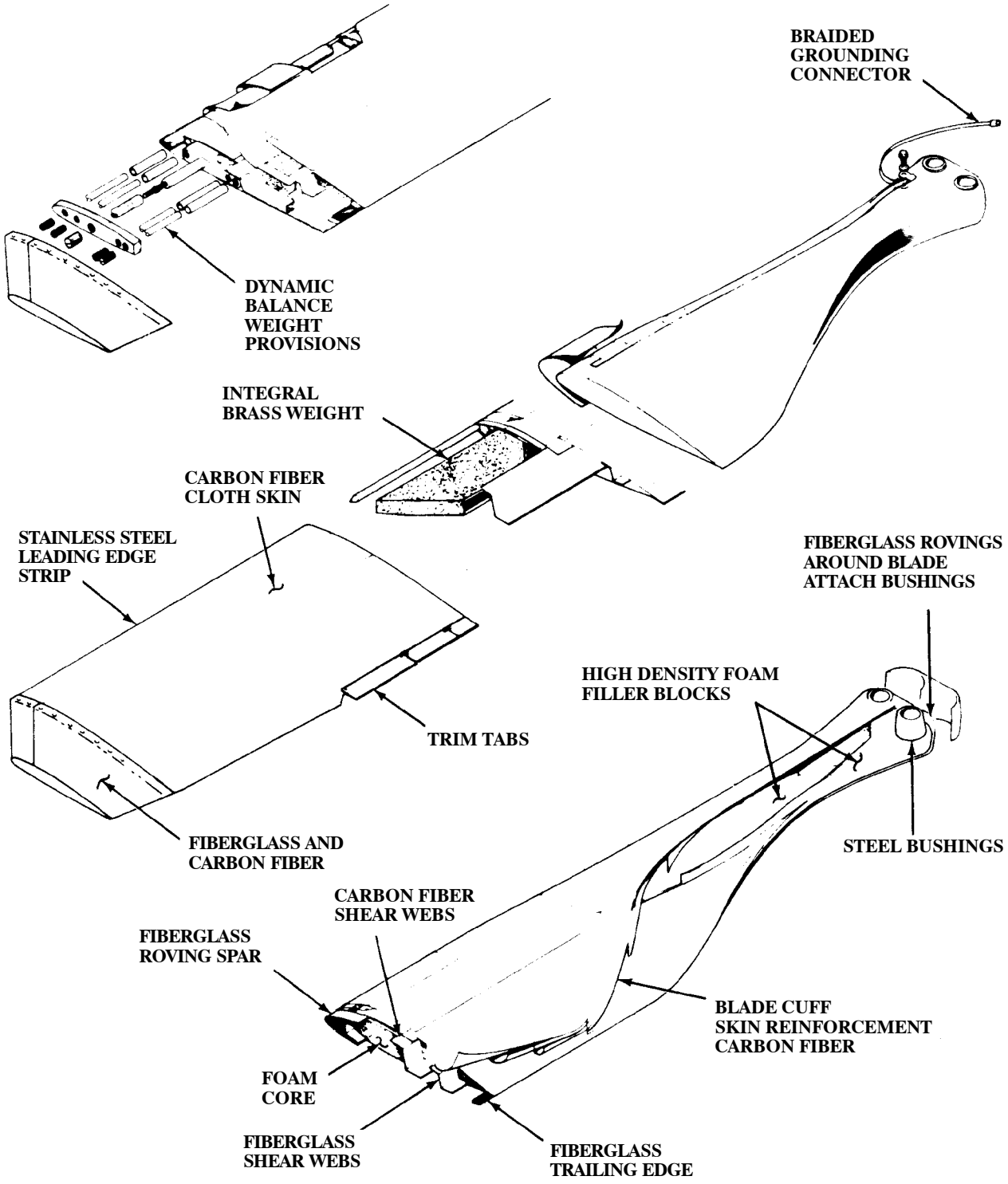



*Figure 1-36. Main Rotor Blade*

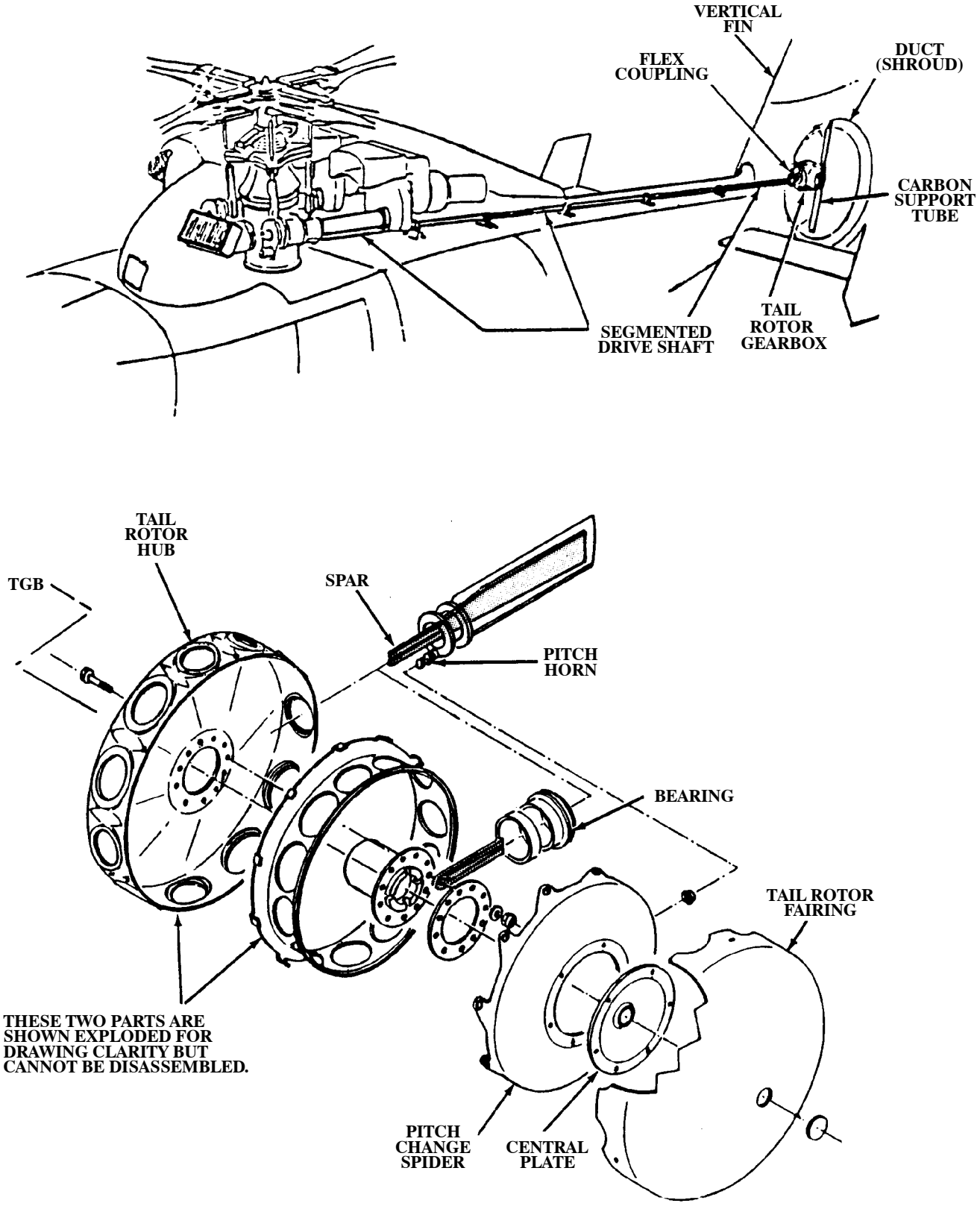



*Figure 1-37. Tail Rotor System*

## MAIN GEARBOX OIL SUPPLY SYSTEM

The main gearbox has two lubricating systems (Figure 1-39), consisting of a two stage oil pump with main and auxiliary pumping elements connected by a shear shaft, a main system for providing oil flow through external lines and the oil cooler, and an auxiliary system for providing internal oil flow only. The total oil quantity of 9.34 quarts is self-contained. During normal operation, the main pump circulates oil through the oil cooler, filter, and to the MGB jets. Should pressure exceed 130.6 psi, oil is bypassed to the MGB sump through the main system relief valve. During normal operation, the auxiliary pump operates, but its output is blocked by a shuttle valve which is held closed by higher pressure from the primary system, causing auxiliary system oil flow to return to the MGB sump via the auxiliary relief valve. In the event of main pump failure or shaft shearing, the auxiliary pump will continue to operate. The shuttle valve opens and oil is pumped from the MGB sump directly through the filter to the jets at a lower pressure and without the benefit of cooling.

**NOTE**

An increase in oil temperature and a lower oil pressure will occur when the auxiliary pump is providing MGB lubrication.

Should an external oil leak develop, oil will be lost until the main pump inlet uncovers, at which time the MGB PMP main warning light will illuminate. The auxiliary pump, which draws oil from lower in the MGB, will continue to provide lubrication, but the pilot may have to reduce power to maintain MGB temperature within limits.

### Main Gearbox Oil Cooler

The main gearbox system oil is cooled by a radiator mounted forward of the MGB. The radiator is grouped with the engine oil coolers and is cooled by a fan driven by the MGB. Above 120 KIAS ram air alone is sufficient for cooling.

### Main Gearbox Indicators and Lights

The MGB indicating system (Figure 1-39 and FO-2) monitors oil temperature, oil pressure, and metal chip detection. If oil temperature or pressure exceeds operating limits, warning and caution lights located on the warning-caution-advisory panel will illuminate. MGB oil pressure is measured by three pressure switches. One switch is located in the oil filter outlet line, a second in the main oil system, and a third in the auxiliary system. A minimum pressure of 9 ($\pm$1) psi at the filter outlet will cause the MGB PRESS warning light to illuminate and the two master WARNING lights located on the instrument panel to flash. If the minimum

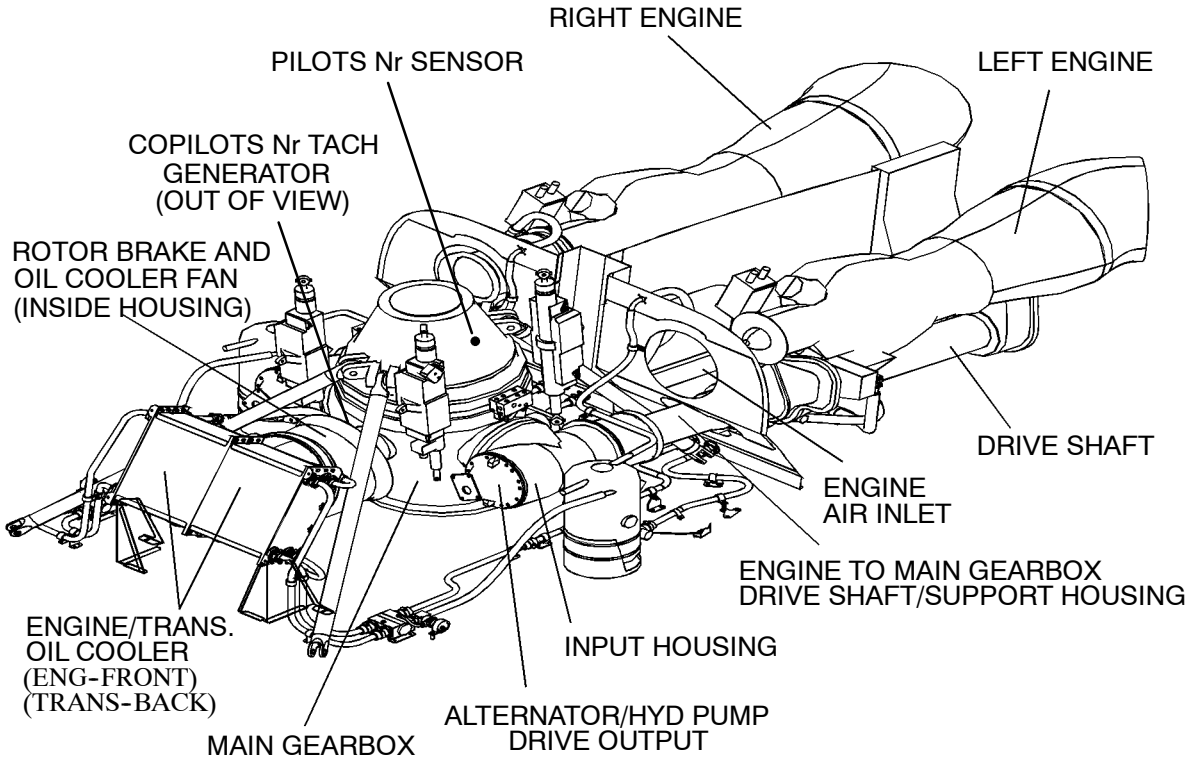
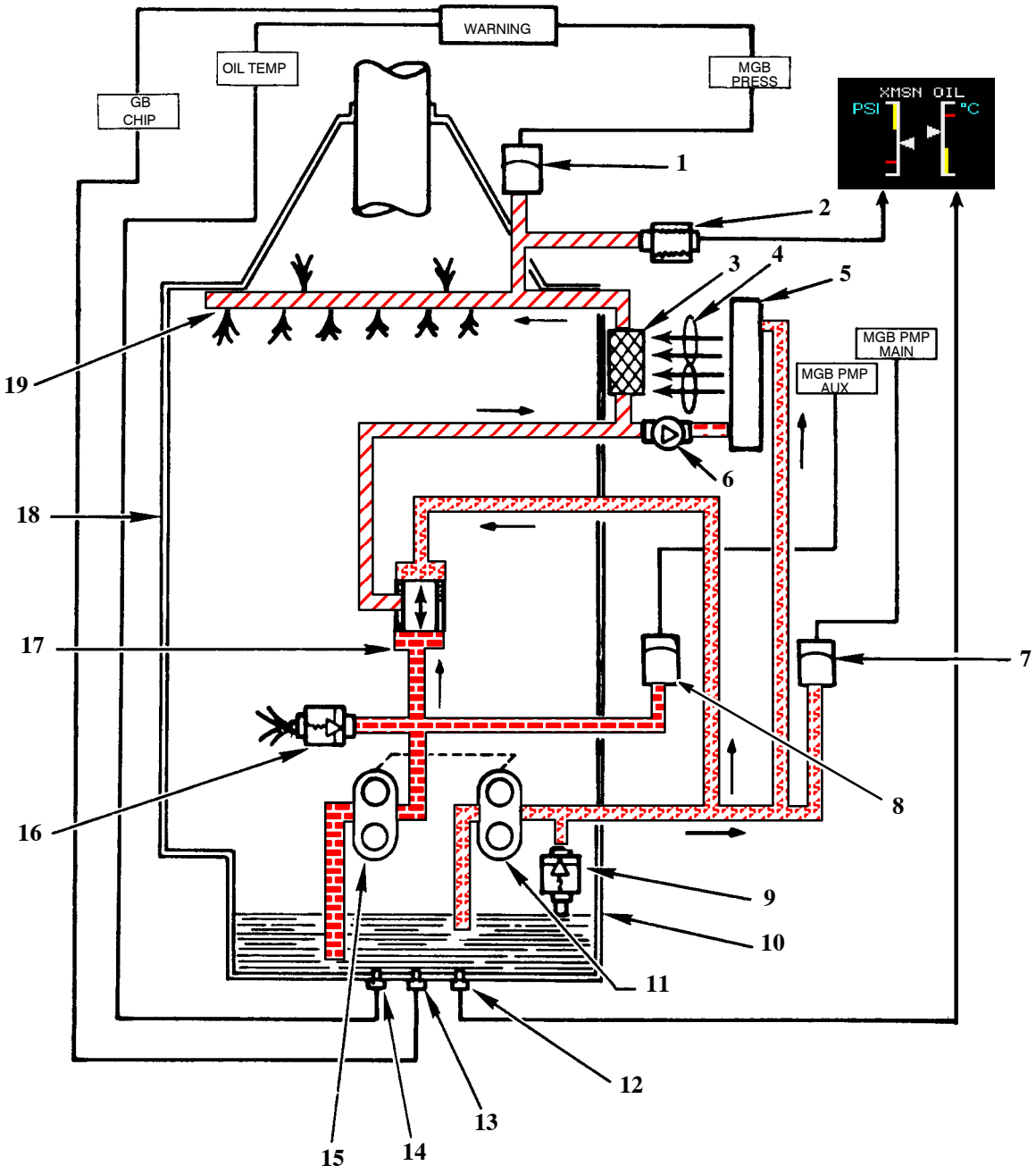



*Figure 1-38. Transmission System*




1. MGB Pressure Switch
2. Pressure Transmitter
3. Filter
4. Oil Cooler Fan
5. Oil Cooler
6. Main Oil System Check Valve
7. Main Pump Pressure Switch
8. Auxiliary Pump Pressure Switch
9. Main System Relief Valve
10. MGB Sump
11. MGB Main Pump Element
12. Temperature Sensor
13. Chip Detector
14. Thermal Switch
15. MGB Auxiliary Pump Element
16. Auxiliary System Relief Valve
17. Auxiliary Oil System Shuttle Valve
18. MGB Case
19. Oil Distribution Jets

MAIN SYSTEM OIL FLOW

AUX SYSTEM OIL FLOW

COMMON OIL FLOW

ELECTRICAL

*Figure 1-39. Main Gearbox Lubrication System*

pressure is sensed at the pump output of the main or auxiliary system, either the MGB PMP MAIN caution light or MGB PMP AUX caution light will also illuminate. MGB oil pressure is measured by a pressure transmitter mounted on the oil filter outlet line, and is displayed on the XSMN OIL P scale on the VEMD. Main gearbox oil temperature is monitored by a temperature sensor in the MGB sump, and is displayed on the temperature side of the XMSN OIL indicator on the VEMD. The master WARNING lights and the OIL TEMP warning light will illuminate if the MGB oil exceeds the maximum allowable temperature of 130 °C. Two electromagnetic plugs (chip detectors) are installed in the MGB sump and one in the MGB conical housing. Metal contamination of the oil will cause illumination of the master WARNING light and the GB CHIP light located on the warning-caution-advisory panel and a MGB CHIP annunciation on the VEMD Caution and Fuel page.

### Rotor System Tachometer

Main rotor speed is presented on two analog indicators located on the instrument panel. The copilot's indicator is powered by a tachometer generator mounted on and driven by the MGB. The pilot's indicator receives its signal from a phonic wheel located on the upper left housing of the MGB.

### Aural Warning

A magnetic sensor, located on the MGB upper housing, detects the rotational speed of the main rotor shaft to provide an aural warning of a main rotor underspeed or overspeed condition. Two aural warning tones sound in the pilot's and copilot's headsets. One signal is a 3 Hz modulated tone for rotor underspeed when RPM is less than 345 and the other is a 10 Hz modulated tone for rotor overspeed at RPM greater than 380. During rotor engagement, the underspeed warning tone is automatically suppressed until rotor speed reaches 172 RPM, at which time the tone will sound until rotor speed reaches 345 RPM or the horn is silenced.

### Aural Warning Control

A switch labeled HORN AURAL WARN, located on the overhead control panel, allows for aural warning deactivation. Positioning the switch to OFF deactivates aural warning to the pilot's and copilot's headset, and illuminates the HORN caution light. Positioning the switch to ON will extinguish the HORN caution light and arm the aural warning system. Redundant electrical power is provided from the 28 volt DC battery bus through a circuit breaker marked HORN located on the pilot's forward circuit breaker panel, and from the No. 1 main DC bus through a circuit breaker marked HORN located on the pilot's aft circuit breaker panel.

## MAIN GEARBOX FIRE WARNING SYSTEM

The MGB fire detector system alerts the pilot to a fire or overheat condition in the MGB compartment. The system consists of a MGB FIRE/FAIL warning light mounted on the instrument panel, four bimetallic fire detectors located in the MGB compartment, and a control unit. A fire or overheat condition in the MGB compartment will cause the FIRE light to illuminate. A FAIL light located below the FIRE light will illuminate if an open circuit or power loss occurs in the detector circuitry. A TEST switch with positions marked FIRE and FAIL is located below the FIRE/FAIL warning light. This switch is used to test the fire and fail circuit. The system is redundantly powered and receives 28 volts DC from the No. 1 and No. 2 main DC buses with two circuit breakers marked MGB FIRE DET on the pilot's aft circuit breaker panel.

**NOTE**

No fire extinguishing capability is provided for the Main Gearbox compartment.

## TAIL GEARBOX (TGB)

The TGB and pitch change mechanisms are located within the rotor hub which is supported by a vertically mounted carbon tube and a metal shaft housing attached to the duct. The TGB changes direction of drive by 90 degrees and reduces tail rotor drive output rpm by a ratio of 1 to 0.914. The gearbox assembly consists of a main housing bolted to an input housing and an output housing. The input housing contains an input gear which is connected to the tail rotor drive shaft by means of a flexible disk coupling. The rotor shaft is mounted inside the main housing. Blade pitch control is provided by a pitch-change control rod sliding inside the rotor shaft and actuated by a flight control servo secured to the main housing. The rotor shaft transmits MGB output power to the tail rotor at approximately 4,000 rpm at a main rotor speed of 355 rpm (100 percent Nr). The TGB is splash lubricated from a self-contained oil supply.

### Tail Gearbox Warning Light

A GB CHIP light on the warning-caution-advisory panel illuminates and the master WARNING light flashes when metallic particles in the gearbox lubricating system activate a chip detector mounted in the TGB. In addition, a TGB CHIP annunciation will appear on the VEMD Caution/Fuel page.

# FUEL SUPPLY SYSTEM

Each engine is supplied by its own independent, crash resistant, suction feed fuel system, located beneath the floor panels in sealed compartments formed by the airframe structure (Figure 1-40). The No. 1 System has three cells: the right forward, left forward, and left center, with a combined capacity of 964 pounds. The No. 2 System has two cells: the right center and aft, with a combined capacity of 1,005 pounds. This arrangement minimizes lateral and longitudinal center of gravity changes as fuel is consumed. Each system has an engine feed tank (capacity of 43 pounds), located in its center cell, from which fuel is drawn by suction to its respective engine. Each system is vented to an expansion tank mounted in the baggage compartment. Interconnecting ports allow gravity fuel flow between the cells within each system. Dual boost pumps, located in each system's feed tank, provide positive pressure to the engines for ease of starting and the necessary pressure to drive the ejector pumps. Scavenge ejector pumps, driven by boost pump pressure, are located within the left forward cell and the aft cell to ensure that all fuel from those cells reaches their respective center cells. An ejector pump in each center cell engine feed tank keeps the tank filled. A flapper valve allows the fuel level in the feed tank to seek the fuel level of the center cell in the event of an ejector pump failure. A two-way transfer pump, rated at approximately 600 pounds-per-hour, connects the two center cells by allowing fuel transfer between systems. As fuel is transferred from one tank system to the other, the scavenge ejector pump will continue to pump fuel into the center cell and the feed tank ejector pump will continue to fill the feed tank. The transfer pump will pump all fuel from the system being emptied, minus fuel in the feed tank and unusable fuel.

## FUEL JETTISONING

Fuel may be jettisoned by gravity from either fuel system. Each system has an electrically operated valve. When the FUEL JETT 1 or FUEL JETT 2 switch on the fuel management panel is positioned to ON, the jettison valve for the respective fuel tank system will open and allow fuel to drain from the cells of that system. Fuel is carried aft along the bottom of the fuselage through external plumbing and exits overboard through a nozzle common to both tank systems. The fuel jettison rate is approximately 270 pounds per minute (40 gpm) and will exhaust jettisonable fuel within 6.5 minutes. Remaining fuel will consist of 43 pounds in each feed tank plus residual fuel which is retained by those cells not having a jettison valve. This amounts to 158 pounds in the left (No.1) system, and 174 pounds in the right (No.2) system. During normal (two engine) operation, the remaining fuel is consumable except for approximately 27 pounds in the left system and 14 pounds in the right system which is unusable. If an engine failure occurs after jettisoning all available fuel, transferring fuel to the operating engine will increase the amount of usable fuel to 239 pounds in the left system or to 246 pounds in the right system. This will ensure sufficient fuel for approximately 20 minutes of flight at maximum endurance power setting.

## REFUELING PROVISIONS

Three means of refueling the aircraft are available. Two external gravity refueling receptacles, one for each set of tanks, are located on the left side of the fuselage just aft of the cabin. A single plug-in type refueling receptacle, located on the right side of the fuselage, is used for single point pressure refueling. When pressure refueling by this method, high level shutoff valves are provided to prevent overfilling the tanks. A push-pull knob, located next to the pressure receptacle, is used to test the automatic shutoff feature prior to pressure refueling. The helicopter can also be refueled by Helicopter In-Flight Refueling (HIFR). The in-flight refueling pressure receptacle is located inside the cabin, in the floor aft of the pilot's seat. The high level shutoff feature of the fuel system also functions during HIFR to provide overfill protection.

**NOTE**

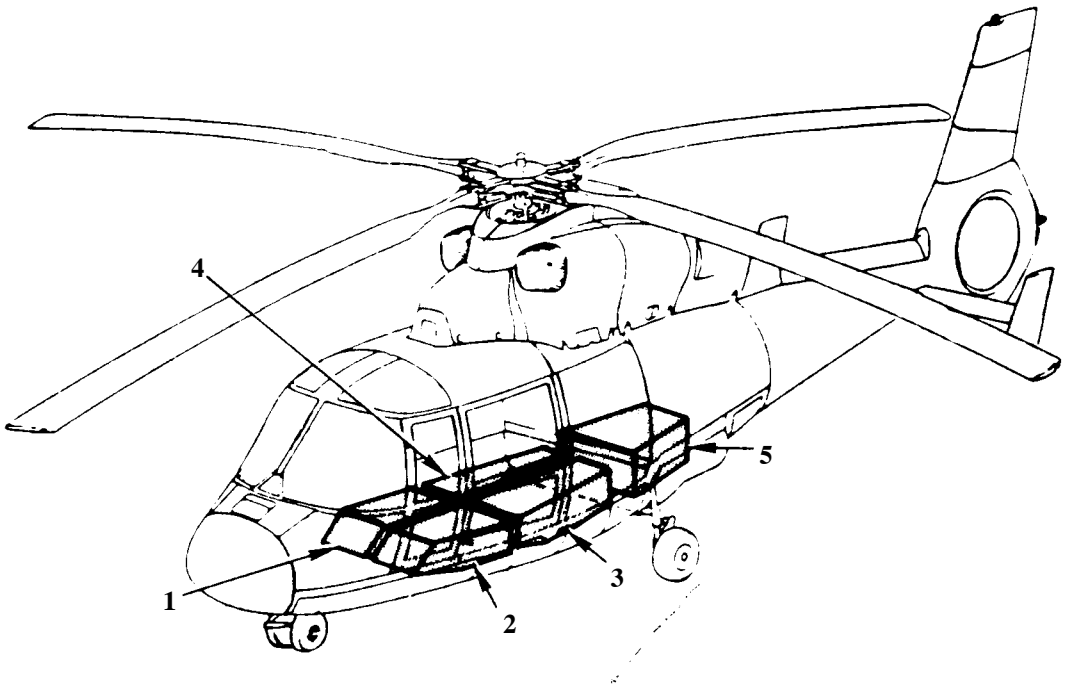
Maximum allowable pressure for pressure refueling is 55 psi.

## FUEL MANAGEMENT

All controls for the fuel supply system are located on the fuel management panel (Figure 1-41). The TRANSFER PUMP switch has three positions. In the mid-position, the TRANSFER PUMP is off. The left and right positions cause the electrically driven pump to transfer fuel from either center cell to the other cell in the selected direction. An illuminated green arrow indicates direction of flow. Two guarded switches, labeled FUEL JETT 1 and FUEL JETT 2, operate the fuel jettison valves. Placing either JETT switch to ON opens the respective valve and illuminates the jettison OPEN light. Four, two position boost pump switches turn two pumps located in each feed tank on and off. The boost pumps are powered through two circuit breakers on the pilot's aft panel. Pump pressure is shown on the VEMD fuel page.

## FUEL SYSTEM MONITORING

All the fuel cells, except the right forward cell, are provided with a variable capacitor fuel gage transmitter. The transmitter for the left forward cell is calibrated to also monitor the fuel in the right forward cell. Fuel quantity information is




| FUEL CAPACITY | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TANKS | LEFT SYSTEM (No. 1) | | | | | | | | RIGHT SYSTEM (No. 2) | | | | | | | |
| | PRESSURE FUELING | | | | GRAVITY FUELING | | | | PRESSURE FUELING | | | | GRAVITY FUELING | | | |
| | GALS. | POUNDS | | | GALS. | POUNDS | | | GALS. | POUNDS | | | GALS. | POUNDS | | |
| | | JP-4 | JP-5 | JP-8 | | JP-4 | JP-5 | JP-8 | | JP-4 | JP-5 | JP-8 | | JP-4 | JP-5 | JP-8 |
| 1 RIGHT FORWARD | 39.6 | 257 | 269 | 265 | 43.8 | 285 | 298 | 293 | | | | | | | | |
| 2 LEFT FORWARD | 37.0 | 241 | 252 | 248 | 42.5 | 276 | 289 | 285 | | | | | | | | |
| 3 LEFT CENTER | 59.6 | 387 | 405 | 399 | 55.4 | 360 | 377 | 371 | | | | | | | | |
| 4 RIGHT CENTER | | | | | | | | | 71.6 | 465 | 487 | 480 | 59.1 | 384 | 402 | 396 |
| 5 AFT | | | | | | | | | 74.8 | 486 | 509 | 501 | 88.7 | 577 | 603 | 594 |
| TOTAL | 136.2 | 885 | 926 | 912 | 141.7 | 921 | 964 | 949 | 146.4 | 951 | 996 | 981 | 147.8 | 961 | 1005 | 990 |

NOTES:

- Amounts shown above reflect total fuel capacity.
- Approximately 40 pounds total is unusable.
- Figures are estimates and the weight is based on JP-4 fuel at 6.5 pounds per gallon, JP-5 fuel at 6.8 pounds per gallon, and JP-8 fuel at 6.7 pounds per gallon.
- Figures used in the Fuel Supply System text are based on JP-5 fuel at 6.8 pounds per gallon.

*Figure 1-40. Fuel Quantity and Tank Arrangement*

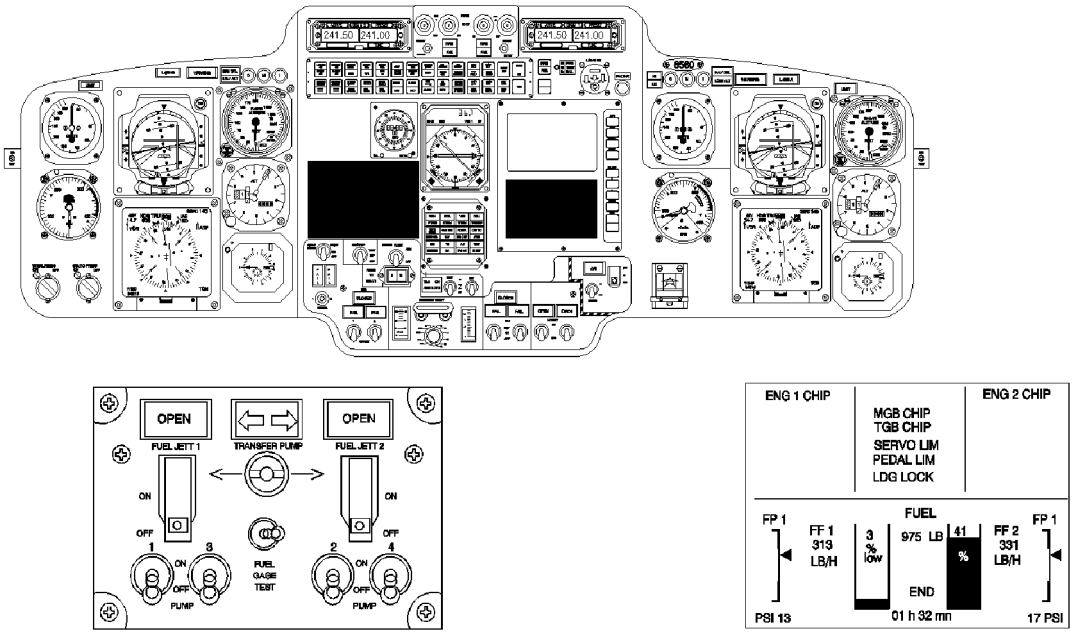



*Figure 1-41. Fuel Management Panel and Fuel Quantity Indicator*

transmitted to each cell group amplifier, totaled, and displayed on the VEMD Caution and Fuel page (Figure 1-14). Two low-level warning lights marked FEED TANK 1 and FEED TANK 2 are located on the warning-caution-advisory panel. The master WARNING lights flash and the FEED TANK 1 or FEED TANK 2 warning light illuminates when the fuel level in the No. 1 or No. 2 feed tank drops below approximately 37 pounds of usable fuel. Refer to Section III for corrective action. The HI FUEL LEVEL 1 or HI FUEL LEVEL 2 caution lights were disabled by TCTO 928030.

## FUEL QUANTITY INDICATING SYSTEM

Indicated fuel is determined at nose level attitude. In the normal hover attitude (4° nose up) indicated fuel is approximately 10% less than actual fuel. Refer to Figure 1-40 for fuel system capacities. The total fuel quantity display indicator, located on the Fuel/Caution page of the VEMD, is graduated in pounds or kilograms as determined by the VEMD setting. Normal setting will be in pounds total. System 1 and system 2 are graduated in percentage of 2,205 pounds total (1,000 kilograms). The system is designed so that when the fuel tanks are completely full, the quantity displays will indicate total fuel capacity (including full feed tanks), minus approximately 40 pounds of unusable fuel. When a fuel quantity display drops to 3%, the respective fuel quantity will turn yellow and a "LOW" annunciation will appear under the fuel percentage. When the LEFT or RIGHT displays drop to zero percentage, the respective feed tank remains full. However, failure of the left forward ejector, aft cell ejector or both boost pumps on the same side will result in trapped fuel and the only indication to the crew will be illumination of the corresponding FEED TANK warning light. In the case of a dual boost pump failure on one side, zero fuel pressure will be displayed on the VEMD prior to illumination of a FEED TANK warning light. The engine driven low pressure fuel pump will continue to draw fuel from its respective system until approximately 280 pounds is indicated in the event of a left failure or 60 pounds for a right failure. If fuel is not transferred immediately, flameout of the corresponding engine will occur when the feed tank empties (approximately 5 minutes).

**NOTE**

As either feed tank begins to empty, the crew will be alerted to a low fuel condition by illumination of the respective feed tank warning light accompanied by flashing of the master WARNING lights. The amplifier circuits of the fuel gage are tested by moving the FUEL GAGE TEST switch, left or right, on the fuel management panel. All of the fuel displays will decrease in value as long as the button is depressed. When the FUEL GAGE TEST switch is released, the fuel gage should return to the original indication.

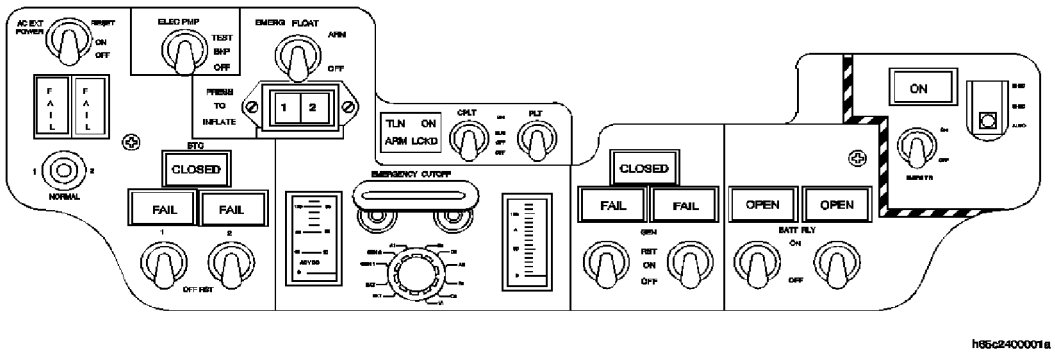



*Figure 1-42. Electrical Control Panel*

# ELECTRICAL SYSTEM

The electrical power supply system consists of an alternating current power supply system and a direct current power supply system. The MGB driven alternators supply 200 volts, three-phase (115 volt, single phase) power to the AC electrical distribution system. Two engine driven generators supply 28 volts power and one battery supplies 24 volts power to the DC electrical distribution system. The AC and DC systems are independent, each having the capability to generate AC and DC power, respectively, from separate driving sources. Each distribution system may be powered by an external power source. This redundancy of power sources and control features prevents the loss of electrical power to flight essential systems in the event of multiple electrical failures. In an emergency, a cutoff switch is provided to simultaneously disconnect all electrical power (AC and DC) from the helicopter, except for those circuits supplied by the battery. Centrally located on the electrical control panel, the dual action bar switch is labeled EMERGENCY CUTOFF and is normally break-away wired in the up (on) position. Moving the switch down (off) opens the battery relays and disconnects both generators and both alternators. The battery provides DC power for a limited time when the DC system is not otherwise energized. Engine driven alternators supply 100 volts, three phase (48 volt, single phase) power to their respective FADEC when N1 is at or above 68%. Each alternator has dual channels and can power the FADEC with either channel. In the event of a dual channel alternator failure, the internal transformer rectifier of the FADEC will enable use of aircraft DC power for FADEC operation. The dual channel alternators are not affected by the position of the emergency cutoff switch.

## DIRECT CURRENT POWER SUPPLY

The 28 volt DC power supply system (Figure 1-42) is powered by two starter/generators which serve the dual function of starting each engine and generating DC power. The generators are normally operated in parallel to provide for all DC electrical loads on the helicopter. Power is distributed through two main buses, with each main bus being served by a line contactor and battery relay for protection and isolation, and a bus tie contactor (relay) to connect both main buses to provide power to the entire DC system from one starter/generator in the event of single generator operation. A transformer-rectifier powered from the AC system provides emergency DC power to the battery bus if both starter/generators are inoperative.

### Starter/Generator

Two 4.5 kVA starter/generators, one of which is mounted on the accessory/reduction gearbox of each engine, supply a regulated output of 28 volts DC whenever the engines are operating at or above 60 percent N1. Each generator supplies power through a line contactor to its respective main bus which is also connected to the battery bus by a battery relay. During normal operation, the No. 1 generator will supply the No. 1 main DC bus and the battery bus, and the No. 2 generator will supply the No. 2 main DC bus and the battery bus. If one starter/generator is not operating, the bus tie contactor will close and allow the remaining starter/generator to power the entire DC system. The line contactor for the inoperative starter/generator will open to isolate the circuit.

### DC Control Panel

Cockpit controls and indicators for the DC power system are mounted on the right side of the electrical control panel located on the lower portion of the instrument panel (Figure NO TAG). The panel contains the BATT RLY 1 and BATT RLY 2 ON OFF switches and associated OPEN lights, the GEN 1 and GEN 2 switches and associated generator FAIL and BTC CLOSED lights, the PLT and CPLT AVIONICS switches, the automatic SHED switch, and the EMERG T/R switch and ON light. The DC and AC power systems share the EMERGENCY CUT OFF switch and the voltmeter selector switch located between the voltmeter and the ammeter.

## External DC Power

The external DC power receptacle is located on the right side of the fuselage, just aft of the nose compartment, and adjacent to the AC power receptacle. With external DC power connected, the two line contactors open (to isolate both generator circuits), both battery relays open (to isolate the battery bus), and the Bus Tie Contactor (BTC) closes. The generator FAIL lights, battery relay OPEN lights, and the BTC CLOSED light will illuminate. The external power contactor then closes and power is applied to the DC system. The aircraft is equipped with a spike suppression switch located in the forward right-hand chine panel (External Power Panel) which is used during DC external power starts. This switch places the battery in parallel with the external power supply to absorb any DC external power supply spikes. With the switch in the "START PROTECTION" position, BATT RLY switches ON, and DC external power applied, the BATT RLY 2 OPEN light will extinguish indicating parallel operation.

**CAUTION**

Do not use the spike suppression switch to charge the aircraft battery. Moving the spike suppression switch to the "START PROTECTION" position places the battery in parallel with DC external power and will allow DC external power to energize the battery. The circuit is not intended to be used for battery charging. Prolonged application of DC external power may cause Battery Overtemp/Thermal Runaway.

## Battery

A 24 volt DC nickel-cadmium battery rated at 43 ampere-hours is located in the nose compartment and is accessible only from outside the helicopter. Battery power may be used for limited ground operations, including engine start, and may also be used as an emergency power source in the event of total electrical failure. Placing the BATT RLY 1 and BATT RLY 2 switches ON simultaneously will close both battery relays to supply battery power to both main DC buses. Switching one BATT RLY switch to ON prior to the other will close only one battery relay. When the second BATT RLY switch is positioned ON, the short circuit protection system will sense an undervoltage condition and prevent the second battery relay from closing. The second BATT RLY OPEN light will remain illuminated. Should this occur, both BATT RLY switches must be recycled to OFF, then to ON simultaneously.

**NOTE**

A fully charged battery will power the DC system for approximately 4 minutes. However, placing the CPLT AVIONICS switch to OFF will shed the copilot's manual shed buses, and extend battery life to approximately 8 minutes.

## Generator Control

The generator switches have three positions, RST, ON and OFF. With the switch ON and proper voltage sensed by the Generator Control Unit (GCU), the line contactor closes and completes the circuit from the generator to the respective main DC bus. The RST position resets the generator after a fault is cleared. The switch is spring loaded from the RST position to return to ON when released. The OFF position opens the line contactor, removes generator power from the system, and energizes the generator FAIL light. The BTC CLOSED light illuminates simultaneously with the generator FAIL light to indicate that the bus tie contactor has closed to connect both main DC buses.

## Short Circuit Protection System

The DC short circuit protection system is an automatic feature which is capable of isolating a fault while maintaining the remainder of the generating system on-line. Specifically, the system will recognize and isolate a short circuit in either main bus, the battery, and either generator, and operates automatically even if one generator has previously been isolated by its respective line contactor. In the case of a short circuited main bus, the respective line contactor and battery relay will de-energize and illuminate the associated battery relay OPEN light and generator FAIL light. If a short is detected in one of the generators, the respective line contactor will de-energize and illuminate the associated generator FAIL light, and the bus tie contactor will close to connect both main buses, and illuminate the BTC CLOSED light. In the case of a shorted battery, both battery relays will de-energize to isolate the battery from both main buses and both battery relay OPEN lights will illuminate.

## Transformer-Rectifier

The transformer-rectifier, located in the nose compartment, supplies 28 volts DC emergency power to both main DC buses (through the battery bus) should both generators fail. The transformer is powered by three-phase, 200 volts AC from alternator No. 2 of the AC system. Placing the EMERG T/R switch to ON allows the transformer-rectifier to energize the battery bus, and illuminate the transformer-rectifier ON light.

**NOTE**

The transformer-rectifier will energize the battery bus only when both generators are switched off, or have failed.

### Shed Buses

The shed buses are powered by the main DC buses. However, provision is made to limit DC load by disconnecting non-essential equipment automatically or manually when necessary. The guarded, two-position SHED switch, labeled AUTO and O/R (override), will (when in the AUTO position) automatically disconnect the auto shed bus from the No. 1 main DC bus when one or both starter/generators are off line. Should this occur, the BTC CLOSED light and the appropriate generator FAIL light or lights will illuminate. The automatic load shedding function can be overridden by positioning the SHED switch to O/R which retains power to the auto shed bus. The PLT and CPLT AVIONICS switches may be used to manually disconnect power to the cockpit avionics circuit breaker panel. Placing the CPLT AVIONICS switch to OFF will also disconnect the auto shed bus when the SHED switch is in the AUTO position.

**NOTE**

When the copilot's AVIONICS switch is turned off, the IFF automatically switches to the emergency mode and 7700 in mode 3A. This squawk and code are locked in. Air traffic control may or may not receive the emergency and 7700 squawk. The only way to regain control of the IFF is to turn the copilot's AVIONICS switch on.

### Voltmeter

A dual purpose voltmeter with an AC and DC scale is provided to measure the operating voltages of both the AC and the DC systems. The rotary switch has positions for measuring external DC voltage, battery voltage, the output of both starter/generators, the three phases of power of each main AC bus, and the output voltage of the transformer-rectifier. Voltage readout is displayed on the dual scaled indicator located left of the rotary switch.

**NOTE**

Leaving the voltmeter switch in the BAT position for an extended period of time will deplete the battery.

### Loadmeter

A loadmeter is mounted to the right of the voltmeter rotary switch and indicates the amperage being used by the electrical system when the generators and alternators are operating. It also indicates transformer-rectifier amperage when the transformer-rectifier light is on. The loadmeter is calibrated and read as a percentage of total generator, alternator, or transformer-rectifier capacity.

## ALTERNATING CURRENT POWER SUPPLY

The AC system (Figure FO-5) supplies and distributes 115 volts AC power to two main AC buses, each normally powered by a dedicated alternator. Line contactors are provided for protection and isolation of each alternator. A bus tie circuit is provided for connecting both main buses to provide power to the entire AC electrical system from one alternator in the event one alternator is inoperative or when external power is used. External power is routed through an external power contactor to provide AC power during ground operations. Two 26 volt AC transformers supply power for the navigation instruments.

### AC Control Panel

Cockpit controls and indicators are mounted on the left side of the electrical control panel (Figure 1-42) located on the lower center portion of the instrument panel. The panel contains the ALTNR (alternator) 1 and ALTNR 2 switches with positions labeled ON and OFF/RST with associated FAIL lights, the BTC CLOSED light, a three position AC EXT POWER switch, two AC 26 V push-to-test FAIL lights, and a three position XFER (transfer) switch.

### External AC Power

The AC power receptacle is located on the right side of the fuselage aft of the nose compartment and adjacent to the DC power receptacle. When external AC power is applied, the AC EXT POWER switch, which is spring loaded to ON, must be momentarily held in the RST position to reset the external power monitor. The external power monitor will analyze the external power input for proper phase sequence, voltage, and frequency. If power is acceptable, external power circuitry will isolate the alternators; both alternator FAIL lights illuminate, the bus tie circuit operates to connect both main AC buses and illuminate the BTC CLOSED light, and the external power contactor closes to supply AC power to the aircraft.

**NOTE**

The engines cannot be started using external AC power. The purpose of external AC power is to provide electrical power to the AC system for ground maintenance functions or pre-flight operations.

## Alternators

The two 10.5 kVA alternators are mounted on and are mechanically driven by the left and right accessory drive of the MGB. Each alternator produces a three-phase, 200 volt (115 volt, single-phase), 400 Hz regulated output when the main rotor is turning at 93 percent Nr or higher. With external AC power disconnected and the ALTNR 1 and ALTNR 2 switches positioned to ON, each alternator will supply power to its respective main bus. During normal operation, the No. 1 alternator will supply the No. 1 main AC bus through the No. 1 line contactor, and the No. 2 alternator will supply the No. 2 main AC bus through the No. 2 line contactor. If one alternator is not operating or a short circuit is detected, the respective line contactor will open and isolate the inoperative alternator from the main bus. The bus tie circuit will then operate to connect both main buses and allow the remaining alternator to power the entire AC system.

## Alternator Control

The alternator switch positions are: ON and OFF/RST. When the switch is positioned to ON and the alternator control unit senses proper voltage, the respective line contactor closes and completes the circuit from alternator to main bus. If the switch is positioned to OFF or the alternator fails, the line contactor opens to isolate the alternator, and the alternator FAIL light illuminates. The BTC CLOSED light illuminates indicating that the bus tie circuit has connected the two main AC buses. The RST (reset) position is used to regain alternator power after a fault or underfrequency condition has been corrected.

## Alternator Control Units

Two alternator control units, one for each alternator, regulate alternator voltage and current, and provide the following protective features: short circuit and overload protection, undervoltage and overvoltage protection, and underfrequency protection. Underfrequency protection is provided only during ground operations and is inhibited after takeoff by deactivation of the weight-on-wheels switches on the main landing gear.

**NOTE**

The underfrequency protection feature causes an alternator FAIL light to illuminate when alternator frequency drops below 385 Hz (approximately 93% Nr). When the frequency is again brought above 385 Hz, the associated alternator will require resetting by placing the ALTNR switch to OFF RST, then ON.

## 26 VAC Transformers

Two transformers convert 115 volts AC into 26 volts AC for instrument and avionics usage. An undervoltage detection circuit connected to each transformer detects low voltage from either transformer and allows for self-testings of the circuit. Each detector causes its respective AC 26 V push-to-test FAIL lights to illuminate whenever the related transformer output drops below 14 ($\pm$1) volts. Using the XFER (transfer) switch, the circuit load from a malfunctioning transformer may be transferred to the other transformer by moving the XFER switch in the direction of the failed side. The XFER switch also transfers the associated 115 volts AC, single phase A equipment to ensure proper phasing. The FAIL light may remain on after transfer to indicate that a short circuit has occurred in the transformer or that power has been lost. If the light goes out, the fault is on the bus side of the applicable 115/26 volts AC circuit breaker.

The low voltage detector can be verified by momentarily depressing the push-to-test FAIL light. The light should illuminate when depressed, indicating that the detector is operable. Refer to Figure 1-43 for explanation of all electrical panel control and indicator functions.

## Circuit Breaker Panels

Six circuit breaker panels are accessible to the crew in flight. The circuit breakers are ON when pushed in, OFF when pulled out. The breakers automatically pop out when the circuit they protect becomes overloaded; or, they can be pulled out manually to disconnect the circuit from the bus.

**NOTE**

All circuit breakers are trip-free. They will open the circuit, regardless of the position of the operating control (i.e., switch or knob) if a fault is detected. Common practice allows one reset of a popped circuit breaker, if no other indications of a failed circuit are present. If the circuit breaker pops again or cannot be reset, it may be assumed that the fault was not of a transient nature.

The circuit breaker panels are shown in Figure FO-2 and are described as follows:

- The pilot's aft circuit breaker panel, located on the right, aft corner of the center console, is lighted and has six rows of circuit breakers. Main circuitry necessary for helicopter control have been grouped on this panel.

- The cockpit avionics circuit breaker panel is located on the right side of the center console, forward of the

| CONTROL/INDICATOR | FUNCTION |
|---|---|
| AC EXT POWER Switch | ON - Enables external ac power to be supplied (unless external power fault exists). |
| AC 26V FAIL and PTT (push-to-test) Detector Test Lights | ON - Indicates low voltage or short circuit of the associated 26 volt ac circuit. PTT on indicates low voltage detector is operable.<br>OFF - Indicates circuit is satisfactory. |
| XFER (transfer) Switch | NORMAL - Normal switch position with no fault in 26 Vac transformers.<br>1, 2 - Positions for transfer of a failed 26 Vac transformer load to opposite transformer. |
| BTC CLOSED Light (dc) | ON - Indicates bus tie contactor is closed.<br>OFF - Indicates bus tie contactor is open. |
| BTC CLOSED Light (ac) | ON - Indicates bus tie circuit is operating.<br>OFF - Indicates bus tie circuit is not operating. |
| Alternator FAIL Lights | ON - Indicates associated alternator is not on line. |
| ALTNR 1 and 2 Switches | ON - Enables alternator to come on line when Nr is approximately 93 percent or higher.<br>OFF RST - Isolates alternator from ac system and resets the alternator field circuit, if fault is removed. |
| Voltmeter | Measures operating voltages of both ac and dc system. |
| EMERGENCY CUT OFF Bar Switch | CLOSED - Breakaway wired in up position.<br>OPEN - Down position opens both battery relays and disconnects generators and alternators. Removes all electrical power except battery bus. |
| Voltmeter Loadmeter Rotary Switch | EXT - Measures input of dc external power (voltage only).<br>BAT - Measures aircraft battery output (voltage only).<br>GEN 1 - Measures output of generator No. 1.<br>GEN 2 - Measures output of generator No. 2.<br>A1, B1, C1 - Measures three phases of No. 1 main ac bus.<br>A2, B2, C2 - Measures three phases of No. 2 main ac bus.<br>T/R - Measures dc output of transformer rectifier. |
| Loadmeter | Indicates amount of current flowing through electrical system. |
| Generator FAIL Lights | ON - Indicates associated generator not on line. |
| GEN 1 and 2 Switches | ON - Enables the generator to come on line (if voltage is proper) when Ng is approximately 48 percent or higher.<br>OFF - Isolates generator from dc system.<br>RST - Resets generator circuit after drop off has occurred (spring loaded to return to ON position). |

*Figure 1-43. Electric Control Panel Control and Indicator Functions (Sheet 1 of 2)*

| CONTROL/INDICATOR | FUNCTION |
|---|---|
| Battery OPEN Lights | ON - Indicates battery relays are open. |
| BATT RLY 1 and 2 Switches | ON - Provides aircraft battery power for dc electrical system. |
| | OFF - Removes battery power from respective main dc bus. |
| SHED Guarded Switch | AUTO - Normal position to automatically disconnect auto-shed bus upon generator failure. |
| | O/R - Overrides automatic feature. |
| EMERG T/R Switch | ON - Connects the ac powered transformer-rectifier to the dc system. |
| EMERG T/R ON Light | OFF - Normal indication with both generators operating. |
| | ON - Indicates emergency power is being supplied to the dc system. |
| CPLT AVIONICS Switch | ON - Connects copilot's manual-shed bus to the dc system. |
| | BUS OFF - Disconnects copilots avionics components for FMS reversionary operation. |
| | OFF - Disconnects copilot's manual-shed and auto shed buses from dc system. |
| PLT AVIONICS Switch | ON - Connects pilot's manual-shed bus to the dc system. |
| | BUS OFF - Disconnects pilots avionics components for FMS reversionary operation. |
| | OFF - Disconnects pilot's manual-shed bus from the dc system (COMM 1 and intercom remain powered). |

*Figure 1–43. Electric Control Panel Control and Indicator Functions (Sheet 2 of 2)*

pilot's aft circuit breaker panel and is lighted. It has nine rows of circuit breakers. Main circuitry necessary for the communications/navigation systems, AFCS, and flight instruments are grouped on this panel.

- The copilot's circuit breaker panel and the pilot's forward circuit breaker panel are located on the sides of the center console, and each has three rows of circuit breakers. These circuit breaker panels are used for the remaining aircraft equipment which is of less importance than the equipment located on the pilot's aft circuit breaker panel and the cockpit avionics circuit breaker panel.

- The avionics rack circuit breaker panel is located on the forward end of the avionics rack in the cabin. This panel provides power to equipment on the avionics rack.

- The overhead circuit breaker panel is located overhead on the left side of the cabin, just forward of the 9 degree frame. This panel is equipped with three-phase and two-phase circuit breakers to protect the buses and the power supply cables to the avionics rack circuit breaker panel.

- In addition to the circuit breakers on the circuit breaker panels, the DC master electrical box, located in the nose of the aircraft, is equipped with current limiters and circuit breakers to protect the subbuses, the circuit breaker panel power supply cables, and the short circuit protection system. Two 28 volt DC circuit breakers, labeled HOIST ACT CONTROL and HOIST ACT PWR, are mounted overhead in the forward cabin area, inboard and forward of the overhead circuit breaker panel. These circuit breakers guard the power for control of the rescue hoist boom motor. An alternate set of four circuit breakers protecting the No. 1 and No. 2 115/26 volts AC transformers are located on the left side of the baggage compartment. Eight additional circuit breakers are installed overhead in the baggage compartment to guard the emergency flotation system.

# HYDRAULIC SYSTEM

The aircraft hydraulic system (Figure 1-44) consists of two separate and independent systems. The primary system supplies hydraulic pressure to the main and tail rotor flight control servos. The secondary system supplies hydraulic pressure to the main and tail rotor flight control servos, the landing gear extension and retraction system, the wheel brake system, the rescue hoist system, and the TALON system.

## PRIMARY SYSTEM

The primary hydraulic system supplies a rated pressure of 870 psi to the upper bodies of the main rotor flight control servos and the right body of the tail rotor control servo. Refer to Figure 5-10 for the system operating range. The hydraulic reservoir, located on the forward right area of the transmission deck, contains one gallon of hydraulic fluid and has a sight glass visible from ground level. A gear type pump, driven by the right accessory drive of the MGB, provides hydraulic pressure to the primary system. The pump operates and supplies pressure to the flight controls whenever the main rotor is turning. A pressure transmitter provides an electrical measurement of hydraulic pressure to the HYD2 indicator on the VEMD. A pressure switch is connected to the PRI SERVO P warning light on the warning-caution- advisory panel. A 10 micron filter, which has a pop-up button type clogging indicator, is installed in the regulation manifold located in the transmission compartment. The red clogging indicator extends to warn of impending filter stoppage. The pop-up indicator is not visible with the cowling closed. Two distribution manifolds, attached to each side of the MGB, provide supply to and return from the main rotor flight control servos.

## SECONDARY SYSTEM

The secondary hydraulic system operates at a rated pressure of 3,000 psi. It consists of a hydraulic reservoir, a self-regulating pump driven by the left accessory drive of the MGB, pressure reducers, and a hydraulic supply manifold. The secondary hydraulic system provides hydraulic pressure to the rescue hoist, the three landing gear actuators and two wheel brake units, the lower bodies of the three main rotor flight control servos, the left body of the tail rotor flight control servo, and the TALON system. A pressure transmitter provides an electrical measurement of hydraulic pressure to the HYD1 indicator on the VEMD. The secondary hydraulic reservoir, located on the left forward area of the transmission deck, has a total capacity of 2.1 gallons and a sight glass visible from ground level. A 3 micron filter is mounted on top of the reservoir and features a pop-up button type clogging indicator which extends to warn of impending filter bypass.

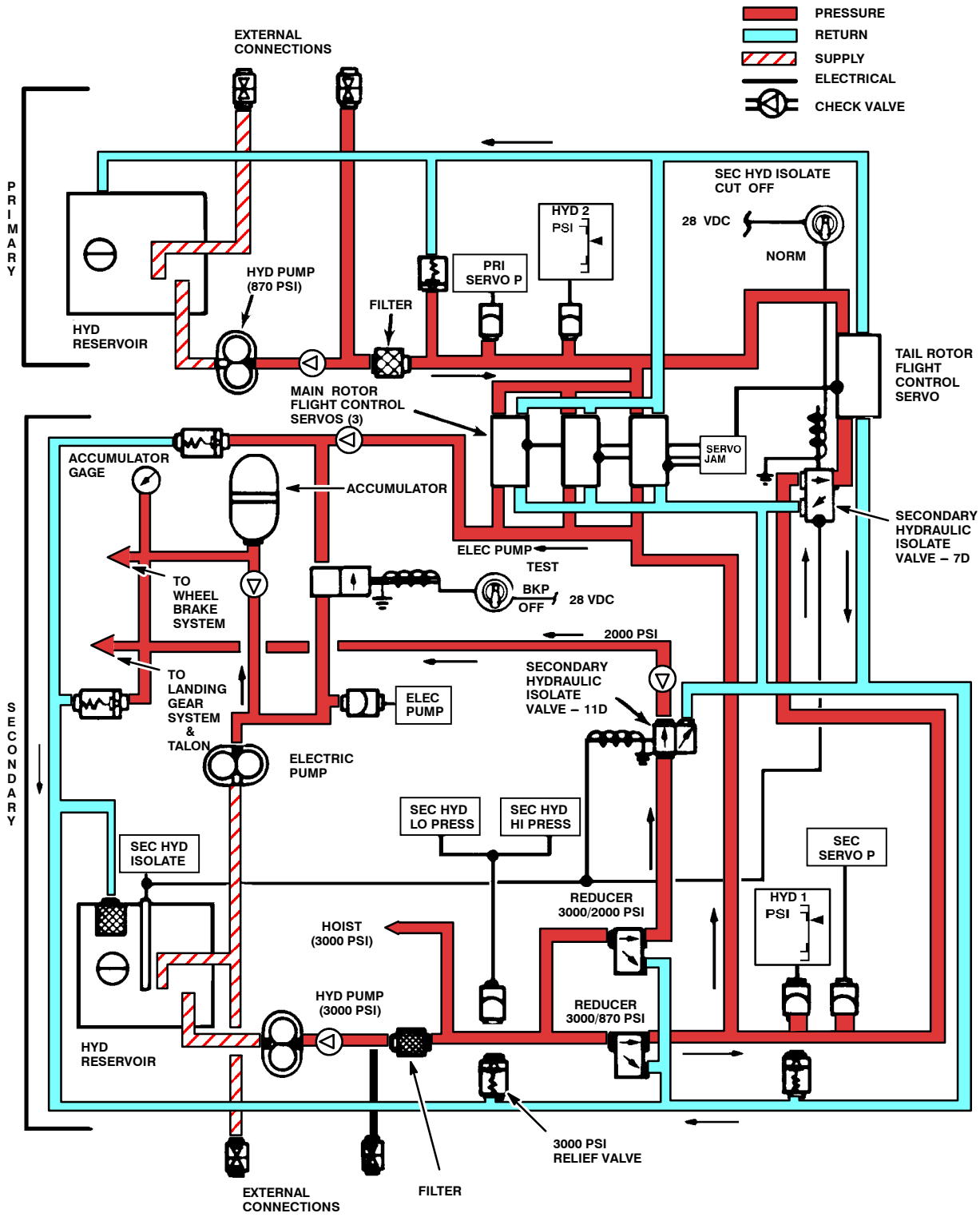



*Figure 1-44. Primary and Secondary Hydraulic System (sheet 1 of 3)*

The red clogging indicator is visible through a viewing port adjacent the reservoir sight glass. A 10 micron filter, which also has a pop-up button type clogging indicator, is installed in the generation manifold located on the transmission deck. The red clogging indicator extends to warn of impending filter stoppage, but is not visible with the cowling closed. The pump provides hydraulic pressure whenever the main rotor is turning. The secondary system supplies fluid at 3,000 psi to the rescue hoist and to reducers, which supply fluid at 2,000 psi to the landing gear, TALON, and brake units, and at 870 psi to the lower bodies of the main rotor flight control servos and to the left body of the tail rotor flight control servo. Refer to Figure 5-10 for system operating range.

## Wheel Brake Accumulator

An accumulator is used in the secondary system to provide hydraulic pressure for the wheel brake system when the secondary hydraulic system or electric hydraulic pump is not operating. An accumulator pressure gage is located on the cabin floor forward and to the right of the pilot's seat. When the secondary system is operating, the gage indicates system pressure downstream of the 3,000 to 2,000 psi reducer. When the secondary system is not operating, the gage indicates accumulator pressure and will allow for approximately 20 braking cycles when fully charged.

## Alternate Hydraulic System

An alternate hydraulic capability is incorporated into the secondary system and consists of an electrically driven hydraulic pump, a three position switch on the instrument panel labeled ELEC PMP and an ELEC PMP warning light. The system provides a means of checking the collective load LIMIT and cyclic travel LIMIT lights prior to flight without the need for a ground powered hydraulic unit, and an alternate means for providing pressure to the accumulator. The electric pump also provides an alternate source for secondary hydraulic pressure to extend the landing gear after secondary system malfunction. With the ELEC PMP switch in the TEST position, the electric pump is actuated and a solenoid valve opens to provide hydraulic pressure to the lower bodies of the three main rotor flight control servos and the left body of the tail rotor flight control servo. This will allow actuation of the load LIMIT lights. Refer to FLIGHT CONTROL SYSTEM in this Section for further discussion of load LIMIT lights. Placing the ELEC PMP switch to BKP actuates the electric pump only and pressurizes the accumulator to a maximum of 1,800 psi. Refer to WHEEL BRAKE SYSTEM in this Section.

## Hydraulic Isolation Valves

Two electrically operated isolation valves, attached to the bulkhead on the left side of the baggage compartment, are provided to safeguard against total secondary hydraulic system depletion. If the secondary hydraulic reservoir level drops below one gallon, one isolation valve downstream of the 3,000 to 2,000 psi reducer will close to isolate the landing gear, wheel brake, and TALON systems, as well as isolate normal electrical power to the rescue hoist. The other isolation valve will close to isolate the left body of the dual body tail rotor flight control servo. The isolation valves may also be isolated by placing the TAIL HYD ISOLATE switch, mounted on the overhead control panel, to the CUT OFF position.

Both isolation valves are controlled by a relay located under the copilots landing light, which receives power from the SEC HYD circuit breaker. The SEC HYD circuit breaker receives 28 VDC power from the #2 DC Bus. When the battery switches are "ON," power is transferred to the tail rotor isolation valve via the relay and opens it. The 2,000 psi isolation valve is fail safe open and remains open unless an isolation occurs (tail rotor isolation valve requires power to open it, the 2,000 psi isolation valve requires power to close it). During an isolation condition due to a low fluid scenario, or, the TAIL HYD ISOLATE switch being placed to Cut-Off, the relay transfers power away from the tail rotor isolation valve and redirects it to the 2,000 psi isolation valve, closing both valves. If power is secured to the relay via a popped circuit breaker or a DC Bus #2 failure, the isolation valves will move to their fail safe position and a partial isolation will occur, i.e., 2,000 psi valve remains open and tail rotor valve moves to the closed position. The following is a list of isolation components; refer to the Figure 1-44 for further explanation.

1. ISOLATE SWITCH: The isolate switch marked TAIL HYD ISOLATE is located on the overhead control panel. The switch is used to manually activate the isolation system. The switch has two positions, NORM and CUT OFF. When in the NORM position, the switch is connected with the low level probe and completes the ground circuit to the Isolation relay. When placed to the CUT OFF position, the isolate switch removes the ground path to the Isolation relay and de-energizes it, this simulates a low fluid condition.
2. LOW LEVEL PROBE: The low level probe is a magnetic float switch and is located in the secondary hydraulic reservoir. The low level probe is connected in series with the isolate switch. When the reservoir

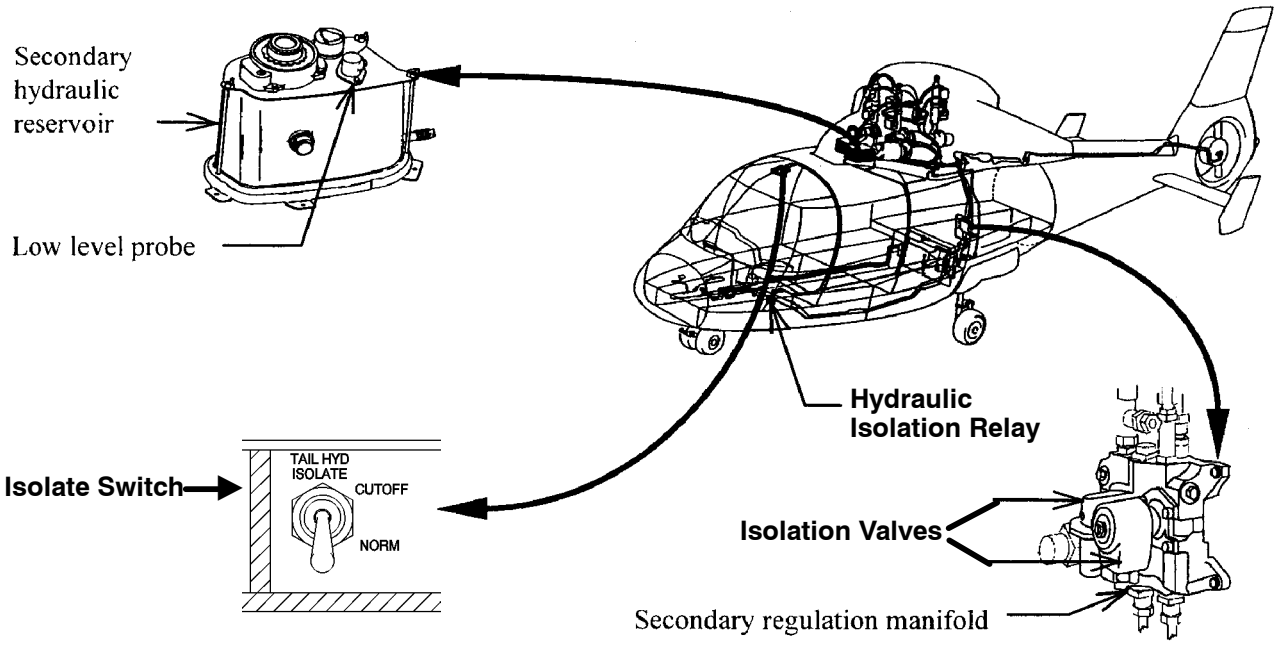



*Figure 1-44. Secondary Hydraulic System (sheet 2 of 3)*

fluid drops below 1.05 gallons, the low level probe removes the ground path to the Isolation relay and de-energizes it.

3. ISOLATION RELAY: The Isolation relay is located in the copilot's landing/hover light compartment. It controls the position of the tail rotor's left body isolation valve and the isolation valve that controls all components running off the 2,000 psi system. When de-energized, both valves return to their fail-safe position.
4. T/R ISOLATION VALVE: The Isolation valve secures hydraulic fluid to the left body of the tail rotor servo when DE-ENERGIZED.
5. 2,000 PSI ISOLATION VALVE: The Isolation valve secures hydraulic fluid to the landing gear, brakes and talon when ENERGIZED.

When no power is applied to the aircraft, the isolation relay is de-energized OPEN, T/R Isolation valve is de-energized CLOSED, and the 2,000 psi Isolation valve is de-energized OPEN. When power is applied to the aircraft via battery, external power, or normal generator power: the isolation relay is energized CLOSED, T/R Isolation valve is energized OPEN, and the 2,000 psi Isolation valve is de-energized OPEN. If hydraulic fluid is low or tail isolate switch is placed to the CUT-OFF position, the Isolation relay transfers power away from T/R Isolation valve and powers the 2,000 psi Isolation valve, resulting in the T/R Isolation valve losing power and de-energizing CLOSED. The 2,000 psi Isolation valve receives power and energizes CLOSED (resulting in BOTH valves CLOSED).

| | Isolate Relay | T/R Isolate Valve | 2000 PSI Isolate Valve |
|---|---|---|---|
| **NO POWER** | Circuit Open | Valve Closed | Valve Open |
| **DC Power** (Ext Pwr, Bat, or Gen) | Circuit Closed | Valve Open | Valve Open |
| **Low Fluid or Switch CUT–OFF** | Circuit Transfer | Valve Closed | Valve Closed |
| **#2 DC Bus Short or SEC HYD Breaker Popped** | Circuit Open | Valve Closed | Valve Open |

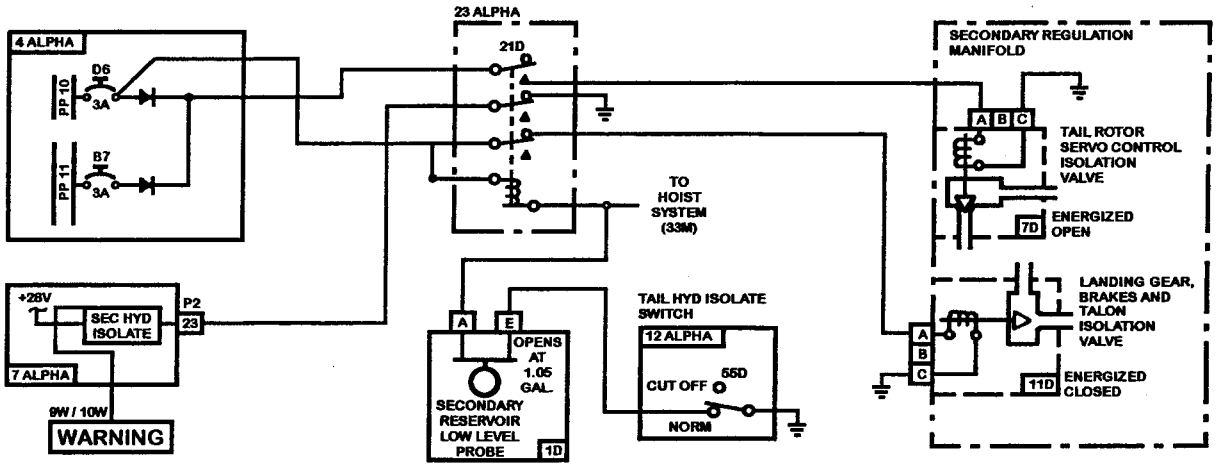



*Figure 1-44. Secondary Hydraulic System Block Diagram (sheet 3 of 3)*

**NOTE**

If an actual low fluid condition exists, placing the gear handle to the down position before completing the appropriate emergency procedure will result in loss of braking accumulator pressure.

If power to the isolation relay is secured via #2 DC Bus Short or securing the SEC HYD circuit breaker, the T/R Isolation valve is de-energized CLOSED, and the 2,000 psi Isolation valve is de-energized OPEN, all components running off the 2,000 psi system will continue to operate normally.

## Servo Jam Detection

Each main and tail rotor flight control servo, for both primary and secondary hydraulic systems, is equipped with a rotary distributor valve. These rotary distributor valves receive mechanical inputs to direct hydraulic pressure to the appropriate sides of the servo pistons. Should one or more of the valves become jammed or if there is a loss of hydraulic pressure to either system, a SERVO JAM warning light on the warning-caution-advisory panel will illuminate. The light will remain illuminated as long as a distributor valve remains jammed or either hydraulic system remains unpressurized.

## Hydraulic System Controls and Indicators

Hydraulic pressure for the primary and secondary hydraulic systems is displayed on the HYD1 and HYD2 indicators on the VEMD. The PRI SERVO P and SEC SERVO P warning lights on the warning-caution-advisory panel illuminate when hydraulic pressure to the flight controls in either primary or secondary system drops below 145 psi to indicate system pressure loss. When the secondary system hydraulic pump pressure drops below 2,450 psi, the SEC HYD LO PRESS warning light will illuminate. The SEC HYD HI PRESS warning light illuminates when the secondary system hydraulic pump pressure exceeds 3,480 psi. The SEC HYD ISOLATE warning light illuminates when the hydraulic fluid level in the secondary system reservoir is below one gallon, indicating that the landing gear/wheel brake/TALON hydraulic supply system, the normal hoist power, and the left body of the tail rotor flight control servo are automatically shut off.

The SERVO JAM warning light will illuminate in the event of loss of hydraulic pressure to either system or with a jammed rotary distributor valve on any of the main or tail flight control servos.

**NOTE**

All of the above mentioned warning lights will be accompanied by flashing of the master WARNING light.

A test of the SERVO JAM detection circuit can be accomplished by momentarily depressing the TEST SERVO push-to-test button located on the overhead control panel. When either hydraulic system is not pressurized, the SERVO JAM light will be on. Depressing the TEST SERVO pushbutton will extinguish the SERVO JAM light by simulating the operation of the servo jam circuitry during normal hydraulic

operation. Conversely, with hydraulic pressure applied, the SERVO JAM light will normally be extinguished. In this case, depressing the TEST SERVO pushbutton will illuminate the SERVO JAM light by simulating the operation of servo jam circuitry during a jammed distributor condition.

The ELEC PMP warning light on the warning- caution-advisory panel will illuminate when the electric pump switch on the main instrument panel is positioned to BKP and system pressure rises above 1,377 psi.

# FLIGHT CONTROL SYSTEM

The flight control system (Figure 1-45) consists of the main rotor controls, tail rotor controls, and associated hydraulically operated servos. Control components of the system include two coupled cyclics, two coupled collectives, and two coupled sets of tail rotor control pedals. Control inputs may be provided directly by either the pilot or via the AFCS. Flight control is achieved through control rods, bellcranks, and hydraulic servos. Each of the three vertically mounted main rotor hydraulic servos is a dual body, tandem unit. Control of the tail rotor is maintained through a horizontally mounted dual body, tandem hydraulic servo. With the AFCS engaged and flight director coupled, the aircraft responds to all maneuvers selected by the pilot as well as by VOR, localizer, TACAN, and Flight Management System (FMS) commands. The flight controls for the main rotor are shown in figure 1-45 and figure 1-47.

## MAIN ROTOR CONTROL

The main rotor flight control components provide vertical, lateral, and longitudinal control of the aircraft. The vertical inputs from the collective and the pitch and roll inputs from the cyclic are combined by two mixing units, which are located on the left and right sides of the aircraft at the bottom of the fuselage and mounted on the nine degree frame. The main rotor flight controls terminate at the stationary swashplate of the main rotor system, and control motion is transmitted to the main rotor through the rotating swashplate and the pitch change rods.

### Cyclic Control

The cyclic provides directional control of rotor lift by varying the pitch of each main rotor blade. The cyclic components consist of a pilot's cyclic and a copilot's cyclic with a counterbalance weight attached to the cyclic yoke beneath the cockpit floor. The two are connected by a torque tube for pitch control and by rods and bellcranks for roll control.

### Cyclic Travel Limit Warning

At the left end of the cyclic torque tube a cam operates a micro-switch whenever cyclic travel exceeds 20 percent on either side of the neutral stick position. Should this occur with the aircraft on the ground, both LIMIT lights on the instrument panel will illuminate with an audio tone, cautioning the pilot to reduce cyclic displacement in order to prevent excessive stress on the main rotor. Reducing cyclic displacement will cause the light to extinguish. Pressing the pushbutton built into the LIMIT light will test the circuit. There is no lateral cyclic travel limit warning.

### Parallel Trim/Feel Units

Two multi-function trim/feel units are incorporated into the cyclic flight controls. Working in conjunction with the AFCS (refer to Automatic Flight Control System in this Section), they are attached to the control rods between the cyclic and the hydraulic servo controls. Each device, one for pitch and one for roll, partly consisting of a load spring and electromagnetic clutch arrangement, provides artificial (or force) feel to the cyclic whenever it is moved. Whether or not the AFCS trim system is on, depressing the separately powered TRIM REL (sync/trim release) switch on either cyclic or placing the TRIM switch to OFF will release the artificial feel and neutralize the cyclic control at its new position. When the TRIM REL switch is released or the overhead TRIM switch is placed to ON, artificial feel is reestablished.

### Collective Control

The collective controls the magnitude of rotor lift by varying the pitch angle of all main rotor blades simultaneously and equally. The collective components consist of a pilot's collective (Figure 1-46) with an adjustable friction ring and a coupled copilot's collective connected to the main rotor hydraulic servos by rods, bellcranks, and mixing units. When the aircraft is on the ground, the low pitch position can be maintained by a down-lock.

The down-lock is a flexible blade with a locking hole for the insertion of a stem protruding from the top of the collective grip. To lock the collective down, the collective must be lowered and the flexible blade manually placed over the stem on the grip. The down-lock is released by pushing down slightly on the collective to release the tension on the flexible blade and allowing it to spring clear of the collective. At the base of the pilot's collective, a pointer moves along a reference scale graduated in degrees to indicate the collective pitch setting of the main rotor blades.

### Load Limit Warning

A load limit warning is provided to warn the pilot of a main rotor condition that could exceed design limits. If a rotor

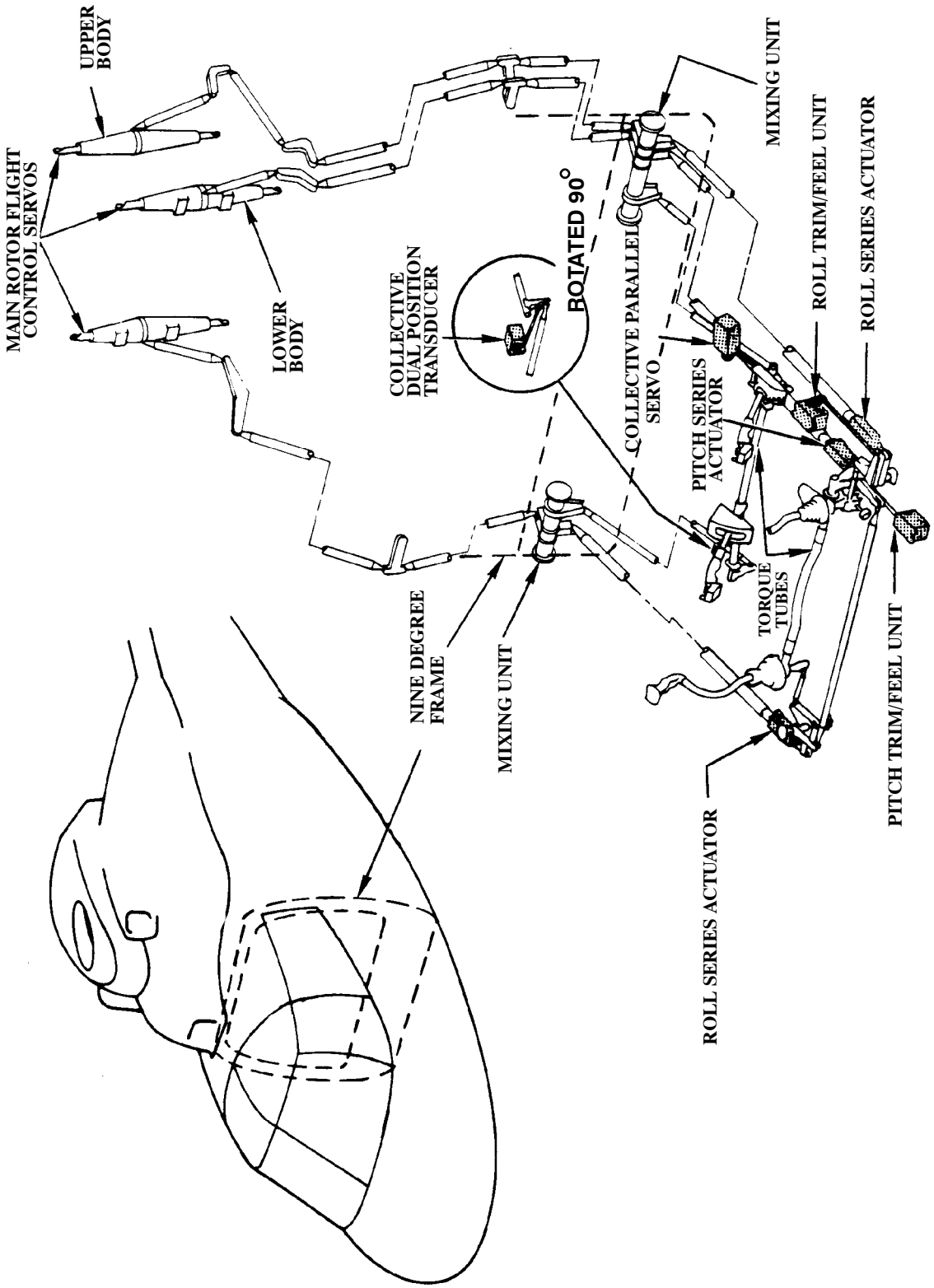



*Figure 1-45. Main Rotor Flight Control System*

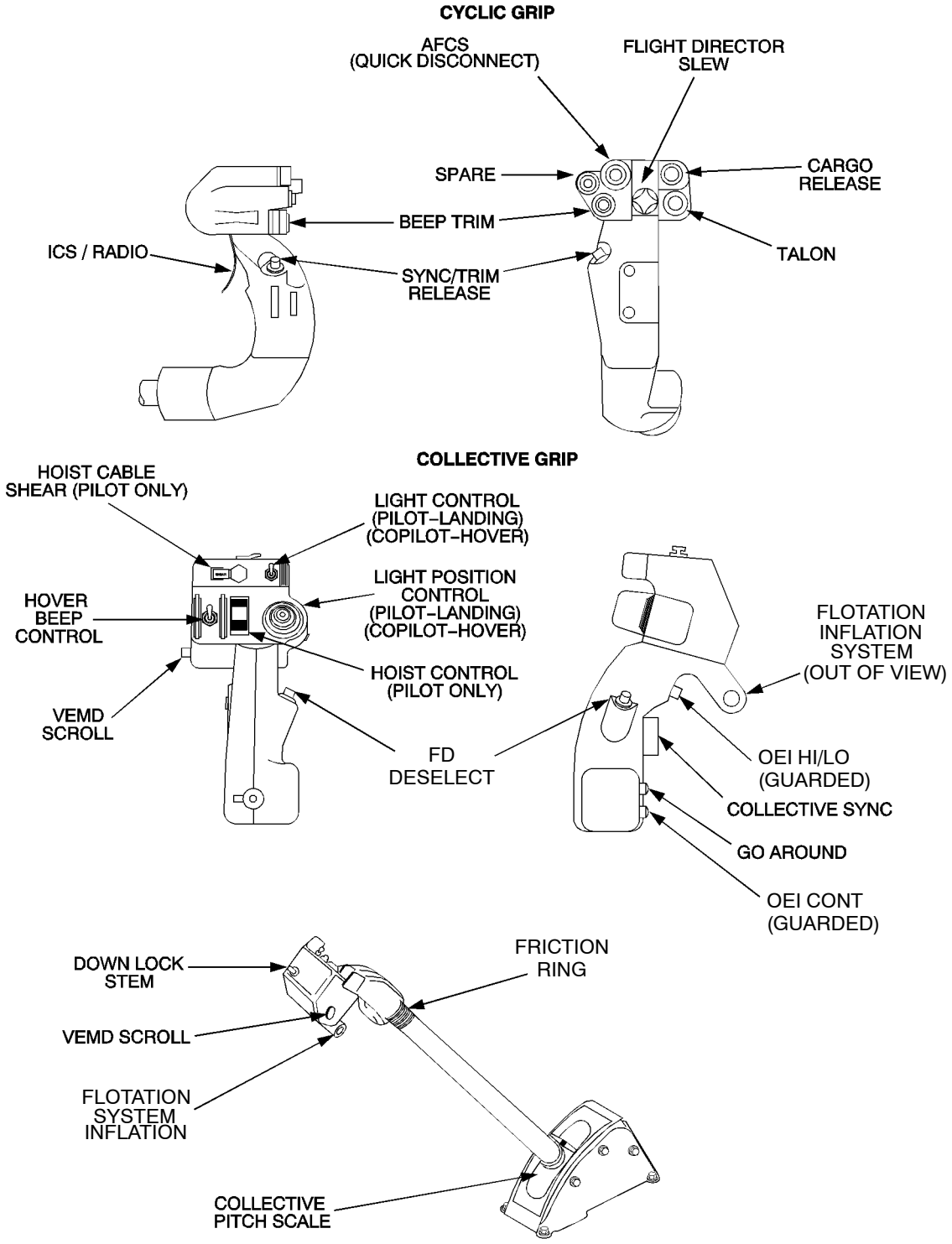



*Figure 1-46. Collective and Cyclic Grips*

load limit is approached such as during a high collective pitch setting or high g maneuver, a microswitch located on the right lateral hydraulic servo control will close and cause both LIMIT lights on the main instrument panel to illuminate with the associated audio tone and a servo limit annunciation will appear on the VEMD Caution and Fuel page. Reducing the collective or severity of the maneuver will cause the light to extinguish.

**NOTE**

- An electric hydraulic pump is installed to check the load limit warning system during preflight. Refer to NORMAL PROCEDURES in Section II.

- Rapid control inputs during maneuvers at high angle of bank may cause momentary locking of the flight controls following, or concurrently with, illumination of the LIMIT light and audio tone.

### TAIL ROTOR CONTROL

The tail rotor flight control provides directional control of the helicopter by collectively varying the pitch of the tail rotor blades to counteract the effect of main rotor torque. Tail rotor control consists of two sets of control pedals (Figure 1-47). Both sets are coupled and connected to the tail rotor servo through a series of rods and bellcranks. Toe brake controls, mounted on the pilot's and copilot's pedals, are used to operate the wheel brake system. A hydraulic cylinder, along with a sight gage, is mounted on each pedal. The sight gages may be viewed through the left and right chine windows. Fore and aft adjustment of the pedals is provided by an adjustment knob mounted on the floor aft of each pedal unit. Adjustments should be made with feet off the pedals.

## LANDING GEAR SYSTEM

The electrically controlled, hydraulically actuated landing gear system consists of two main landing gear assemblies, a dual wheel nose gear assembly, and an actuating system. Each gear retracts aft into the fuselage. The landing gear system (Figure 1-48) is normally operated from the secondary hydraulic system. Electrical power is provided by 28 volt DC. No. 1 main bus is protected by two circuit breakers, marked GEAR IND and GEAR CONT, located on the pilot's aft circuit breaker panel. No. 2 main bus is protected by one circuit breaker marked GEAR IND, located on the copilot's circuit breaker panel. The landing gear panel and control are located on the instrument panel.

### MAIN LANDING GEAR

The main landing gear assemblies consist of an upper strut housing attached to the airframe structure by a tapered hinge pin, and a lower oleo shock strut integral to the upper strut housing. These two components are connected by torque link scissors. A weight-on-wheels microswitch located on the strut housing assembly of each landing gear prevents gear retraction when weight is on the wheels. The microswitches are connected in series to provide 28 volts DC through the GEAR CONT circuit breaker on the pilot's aft circuit breaker panel to the retraction solenoid of the landing gear selector valve. Retraction of the landing gear will take place only if the nosewheel is centered and all oleo struts are fully extended. The main landing gear actuating cylinder is attached to the aircraft structure and to the upper strut housing. The actuating cylinder is hydraulically actuated to provide gear extension, retraction, and gear locking in both the gear up and gear down positions. Each landing gear actuating cylinder has an uplock and a downlock microswitch that provides control of the cockpit gear position indicator lights and termination control of the UP/DOWN solenoid valve. All three landing gear assemblies can be equipped with skis for operating on snow covered terrain. The skis mount to the axles with the tires protruding through their lower surface to allow normal takeoff, landing, taxiing, and towing on hard surfaces, as well as snow. Each ski is equipped with a pneumatic damper mounted between its trailing edge and the landing gear scissors to prevent excessive motion and inflight oscillations. The landing gear must remain in the down position with skis installed.

### NOSE LANDING GEAR

The nose landing gear assembly (Figure 1-49) is a dual wheel, 360 degree swiveling type gear. The nose and main landing gear cannot be retracted unless the nose wheels are centered. As the oleo strut reaches the fully extended position after takeoff, the nosewheel is automatically centered by a cam arrangement within the strut assembly. The centering device is automatically disengaged when the strut is compressed with weight on the gear. An external nosewheel locking mechanism is operated by a handle on the center console. To engage the locking mechanism, rotate the handle 90° clockwise and pull up. Upon nosewheel centering, the pin is forced into the locking detent by a compression spring. With the handle pushed down, the pin is retracted, allowing the nosewheel to swivel freely while taxiing. A red metal flag on the locking pin assembly provides visual indication of the locked position from outside the helicopter. When the nosewheel is unlocked, the flag disappears from view.

### LANDING GEAR ACTUATING SYSTEM

The landing gear system is actuated from a control switch mounted on the instrument panel, or by the landing gear emergency extension handle on the right side of the center console. Positioning the landing gear handle on the instrument panel to the UP or DOWN position activates a landing gear solenoid valve which delivers 2,000 psi secondary hydraulic system pressure for the direction selected. For normal operation, pressure is routed through the normal-emergency valve, then through the landing gear solenoid valve to the landing gear actuators. An accumulator maintains resid-

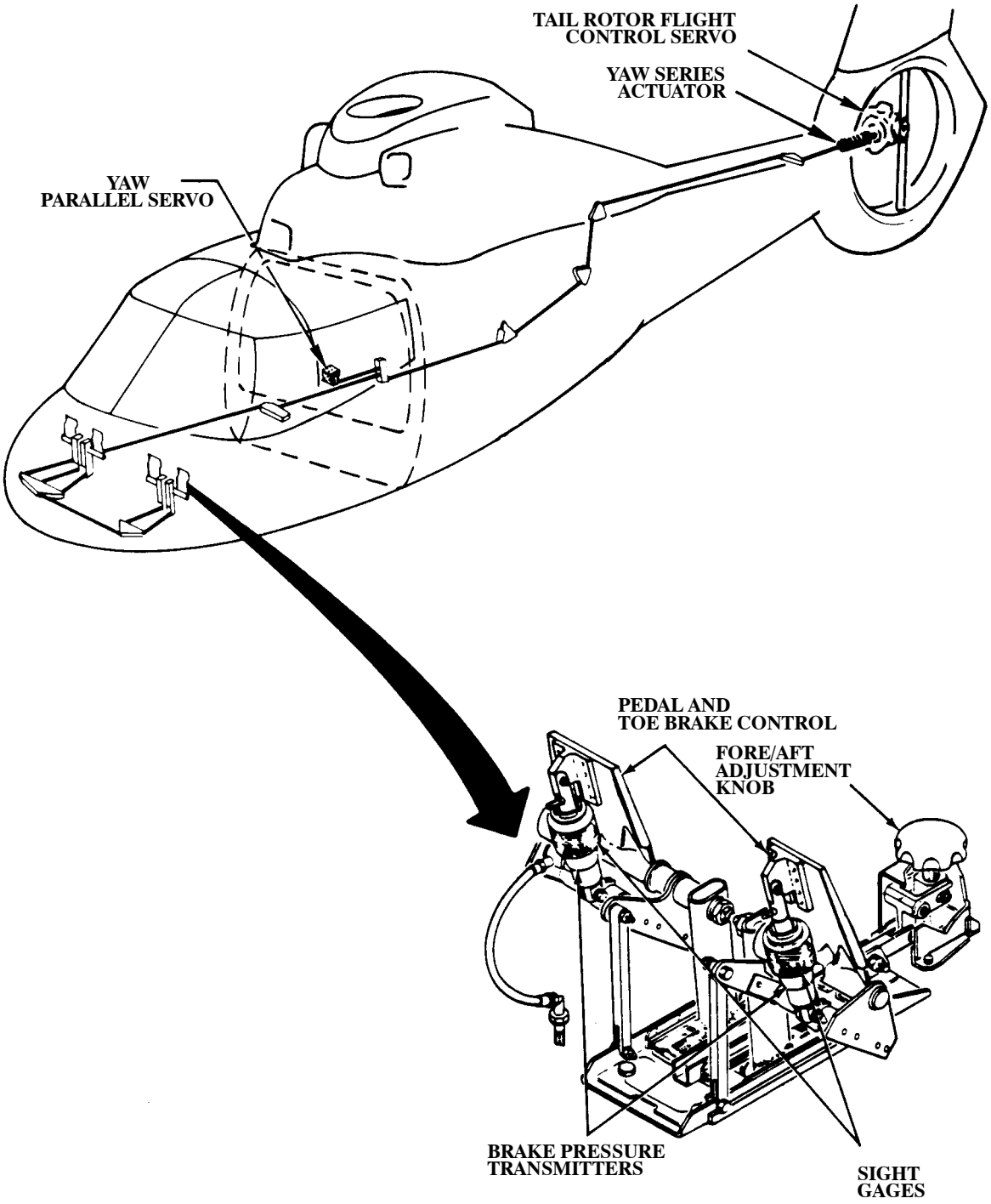



*Figure 1-47. Tail Rotor Control*

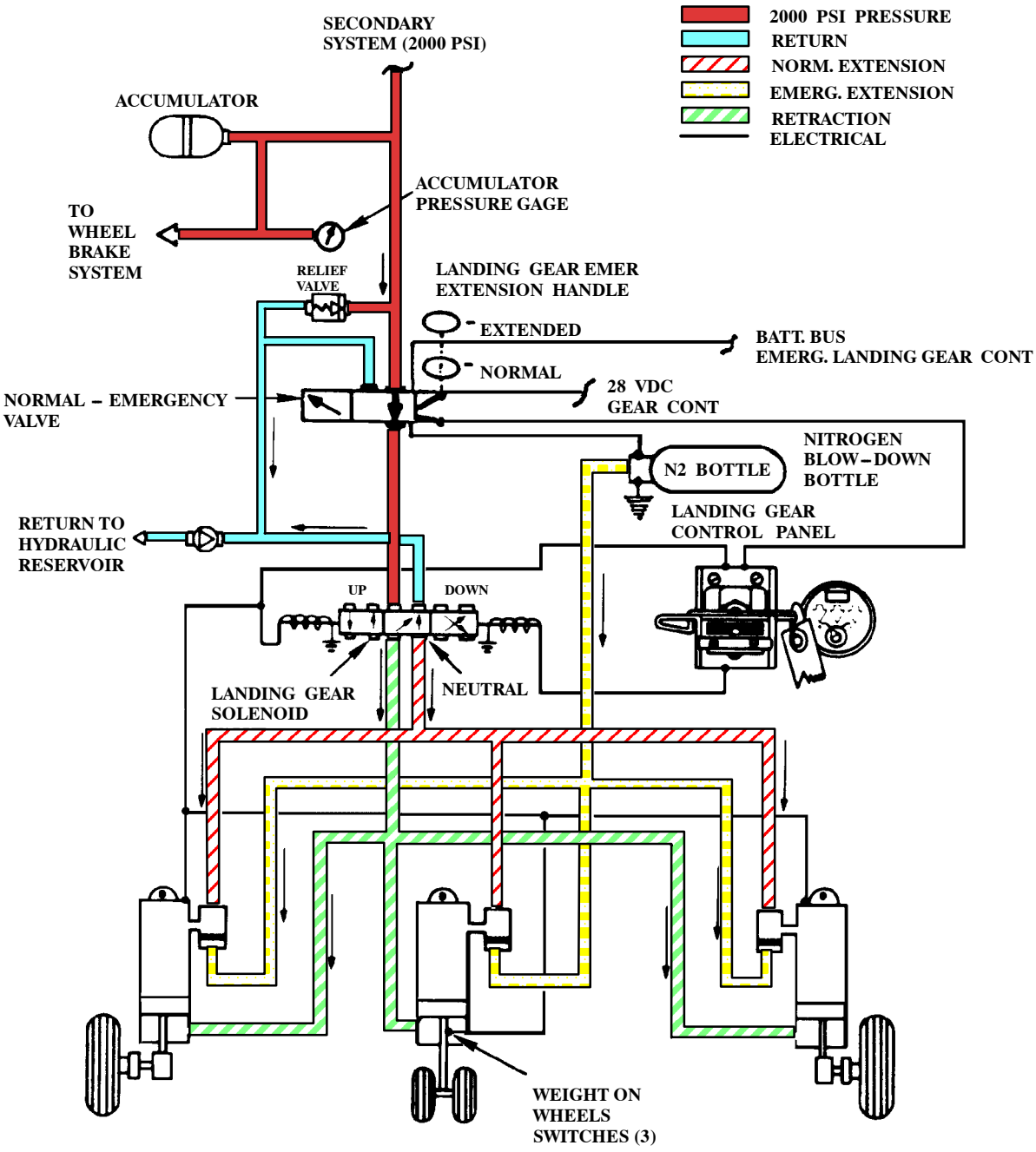
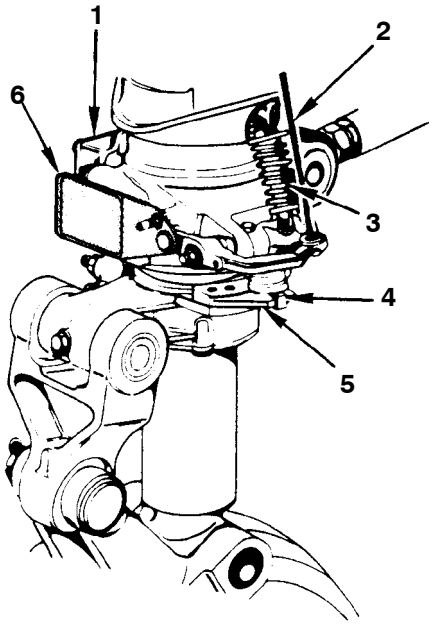



*Figure 1-48. Landing Gear Hydraulic System*




1. Weight-On-Wheels Microswitch
2. Control Cable
3. Compression Spring
4. Locking Pin
5. Locking Cam
6. Red Metal Flag

*Figure 1-49. Nose Landing Gear Locking Mechanism (Locked Position)*

ual pressure in the system. A pressure gage mounted on the deck at the right side of the pilot's T/R pedals displays landing gear/brake system pressure.

## EMERGENCY LANDING GEAR EXTENSION SYSTEM

In the event of an electrical failure or failure of the secondary hydraulic system, an emergency extension system (blowdown) for lowering the landing gear is provided. The system consists of a bottle installed forward of the left main gear wheel well, a normal-emergency valve, and a landing gear emergency extension handle in the cockpit. The bottle contains nitrogen pressurized to 2,500 psi which is totally expended in one application. A sight gage is viewed (external to the helicopter) through a peep hole forward of the left main landing gear. Raising the landing gear emergency extension handle manually moves the normal emergency valve to the emergency position. This discharges nitrogen to the down-side of the landing gear actuators through a shuttle valve which isolates the secondary hydraulic system from the emergency system. Simultaneously, electrical power to the landing gear solenoid valve is shut off to neutralize the valve and allow hydraulic fluid to the reservoir (Figure 1-48). Down-locking is indicated when the three green arrows on the landing gear panel control illuminate.

**NOTE**

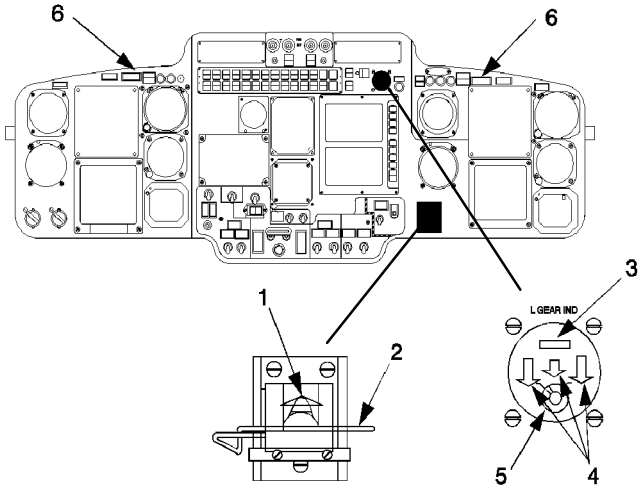
Landing gear handle should be placed in the down position prior to emergency gear extension.

**WARNING**

When the wheels are blown down, a burning electrical smell, accompanied by possible residual gas, may be detected in the cockpit and should not be confused with a possible electrical malfunction/fire.

## Landing Gear Control

The landing gear control handle (Figure 1-50) located on the lower right side of the instrument panel, is a lever lock type which guards against inadvertent operation. Installation of a safety pin prevents movement of the handle. Movement of the handle to the UP or DOWN position electrically actuates the UP/DOWN solenoid valve. Illumination of the three green arrows on the landing gear monitoring panel indicates that both the main and nose gear are down and locked. The amber light indicates that the landing gear is in




1. Landing Gear Control Handle
2. Safety Pin
3. Gear Unsafe Light (Amber)
4. Gear Down and Locked Lights (Green)
5. Light Dimmer
6. Landing Gear Up Warning Lights (Red)

*Figure 1-50. Landing Gear Control and Indicators*

transit, or is unsafe. A two position dimmer switch provides brightness control.

### Landing Gear Lights

Two gear up warning lights, marked L GEAR, are located adjacent to the master WARNING lights on either side of the instrument panel (Figure FO-2). Both L GEAR (landing gear) lights will illuminate in conjunction with an aural intercom signal when the aircraft descends below 200 feet radar altitude, if the wheels are up. The lights and the steady 285 Hz aural signal (heard in headsets only) will remain on for 3 seconds or may be cancelled by momentarily placing the HORN AURAL WARN switch, located on the overhead control panel, to RST (reset). The lights may be tested by depressing the landing gear control dimmer switch. A blue light, mounted externally on the fuselage and forward of the nose gear, illuminates to confirm to a ground observer that all wheels are down and locked.

## WHEEL BRAKE SYSTEM

The wheel brake system (Figure 1-51) operates the main landing gear disk brakes. Brake pressure is supplied by the secondary hydraulic system. The brake system consists of a brake control valve, four hydraulic cylinders mounted on the pilot and copilot tail rotor control pedals, and a parking brake handle. The control valve regulates secondary system pressure by reducing the pressure to a maximum of 875 psi, and by delivering a variable pressure to the left or right wheel brake according to pilot inputs on the brake pedals or by operating the parking brake.

### BRAKE PEDALS

The brake pedals are incorporated in the top portion of the pilot and copilot tail rotor control pedals. A hydraulic cylinder is mounted on each of the pedals for operating the brake control valve when the top of the pedals are depressed. A dual purpose accumulator maintains a residual pressure on the landing gear and wheel brake system. In the event of hydraulic failure, pressure normally supplied by the secondary hydraulic system can be supplied by the accumulator. Charging of the accumulator for emergency brake operation is accomplished by placing the ELEC PMP switch, located on the instrument panel, to the BKP position.

### PARKING BRAKE

A parking brake handle, marked PARKING, is mounted on the right side of the center console. The parking brake is set by pulling up the control handle and rotating it 90 degrees. When DC power is applied, setting the brake illuminates the PARKING BRAKE caution light on the warning- caution-advisory panel.

**NOTE**

Illumination of the PARKING BRAKE light indicates parking brake handle position only. It does not necessarily mean that brake pressure is applied.

Pulling the PARKING handle operates the brake control valve directly through mechanical linkage. The control valve, in turn, simultaneously provides both wheel brakes with the maximum pressure available.

**CAUTION**

The parking brake system does not allow for gradual braking pressure to be applied. If the parking brake handle is pulled up while aircraft is still in motion, maximum brake pressure will be applied and cause sudden, full braking action.

## TALON DECKLOCK SYSTEM

The TALON Decklock System consists of an electro-hydraulically operated probe assembly, two strut assemblies, a hydraulic manifold, control switches, and indicators. The probe assembly is mounted vertically in the TALON bay between the main landing gears. It is stabilized by the dampening struts, mounted fore and aft on the underside of the fuselage, which allows the cylinder to move slightly in any direction to center on a hole in the grid. A two-fingered "beak" is installed on the end of the cylinder and is free to rotate 360 degrees within the cylinder. With the system deactivated, the probe maintains a retracted position in the TALON bay. The probe may be operated by the pilot or the copilot. It is powered by 28 volts DC electrical power supplied by the battery bus, protected by a 3 amp circuit breaker (marked "TALON") located on the copilot's circuit breaker panel. The power is controlled by a two position, pushbutton master switch on the instrument panel. A pushbutton momentary switch on the cyclic controls operation of the probe. Two weight-on-wheels switches, one on each main landing gear, prevent the probe from extending until the helicopter is firmly on deck. The system operates on 2,000 psi pressure from the secondary hydraulic system. An accumulator maintains hydraulic pressure when the rotor is secured, and may be charged from the cockpit by placing the electric hydraulic pump in the "BKP" position. The master switch con-

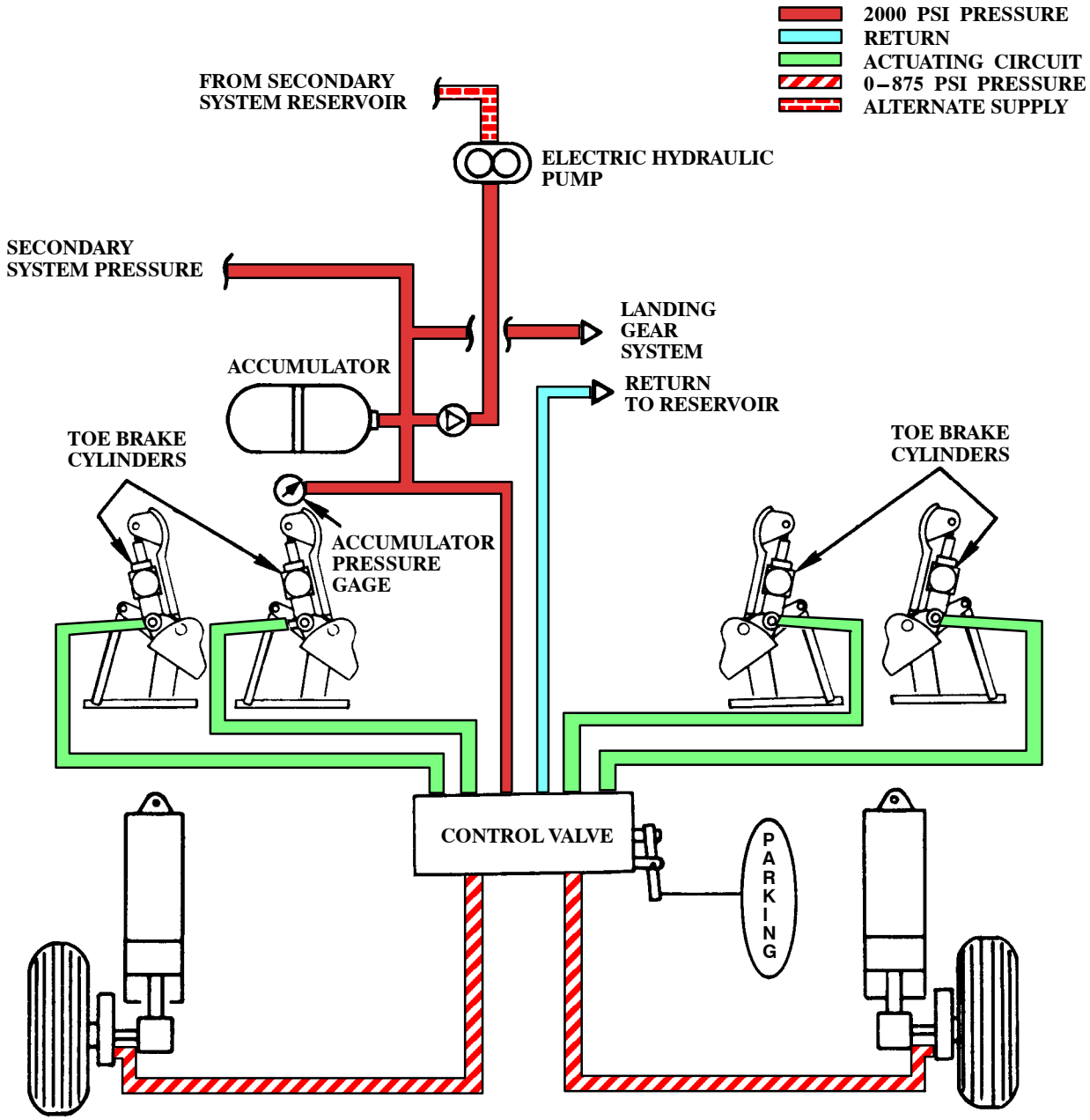



*Figure 1-51. Wheel Brake System*

tains four light segments on its face: one to provide night illumination ("TAL") and three that indicate the status of the system. "ON" indicates there is electrical power to the system; "ARM" indicates the momentary switch is in the engage position; "LKD" indicates that the probe is engaged. Depressing the master switch illuminates the "ON" segment. With the momentary switch in the engage position, "ARM" will illuminate and the probe will automatically extend when the weight-on-wheels switches are activated. When the probe is actuated, the piston extends downward. The long finger on the beak finds any hole in the grid and the short finger finds an adjacent hole. After sensing contact with the grid, the beak closes and the piston reverses direction, tensioning the helicopter to the deck. The "LKD" segment will illuminate indicating positive engagement in the TALON grid. The "ARM" segment will remain illuminated until the TALON probe is returned to its stowed position. If the probe does not engage the grid on the first attempt, the piston will retract and extend again, repeating the cycle until it does engage.

The probe is released by depressing the cyclic switch (with the system armed). The piston extends downward, releasing the tension, and the latch releases. The probe then retracts clear of the grid.

**WARNING**

Applying collective pitch prior to releasing the probe may cause the nose of the helicopter to pitch up, striking the tail on the deck.

To release the probe with the helicopter shut down, turn on the battery, arm the system, and depress the cyclic switch. After the probe releases, turn off the master switch, and recharge the TALON accumulator to 2,000 psi. Then turn off the battery. The same procedure is used to reengage the probe.

**NOTE**

The TALON accumulator is precharged during installation to assist the electric pump in obtaining 2,000 PSI.

**CAUTION**

When used in conjunction with the TALON system, the electric pump should not be operated for over 30 seconds. Allow 3 minutes cooling between cycles.

A manual release lever on the probe allows it to be released in case of electrical failure. If the manual release is used, the system must be reset by turning on the master switch and pressing the cyclic switch once. This resets the system to the disengage condition.

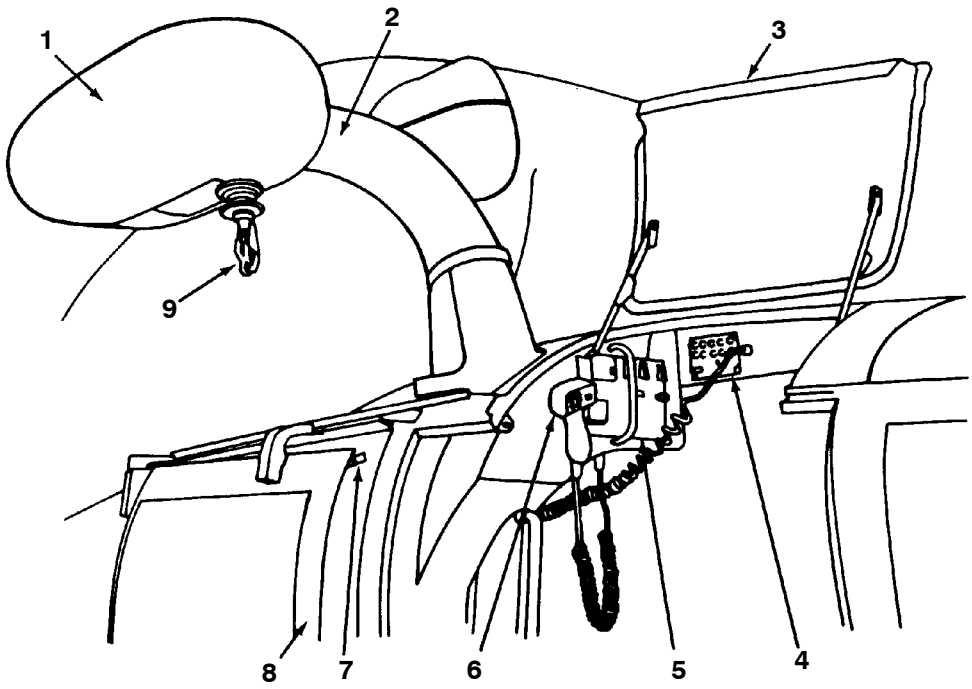
## RESCUE HOIST

The principal components of the rescue hoist system are the hoist, a control box, and hoist operator's pendant assembly. The hoist assembly is mounted on the electrically driven pivoting boom located on the right side of the aircraft. When not in use, the boom is stowed in a position which minimizes drag. To reduce glare during NVG operations, the front of the hoist boom is painted flat black. Hoisting operations are conducted through the sliding door. A hatch is provided above the door to permit the boom to pivot into the crew compartment and to allow the hoist operator to stand upright. Hoisting operations are normally conducted from the hoist control box, located adjacent to the sliding door.

Selection of hoist operator's station or pilot's station is controlled by the HOIST master switch on the overhead control panel marked PLT/OFF/CREW. The hoist (Figure 1-52) is capable of lifting 600 pounds at variable speeds from 0 to 200 feet-per-minute, except for the 10-foot cable extremities where speed is limited to 0 to 50 feet-per-minute. When controlling the hoist with the pilot's control located on the pilot's collective, the hoist is limited to a fixed rate of 100 feet-per-minute, except for the 10-foot cable extremities where speed is limited to 50 feet-per-minute. The total usable cable length is 245 feet.

### HOIST SYSTEM OPERATION

The hoist is hydraulically raised and lowered utilizing 3,000 psi pressure from the secondary hydraulic system (Figure 1-44) and electrically controlled by 28 volts DC provided from the No. 1 main DC bus. Circuit protection is through a circuit breaker marked SLG HOIST located on the pilot's aft circuit breaker panel. In the event of electrical failure, the hoist may be manually operated by hydraulic controls mounted inside the hoist operator's control box. In emer-



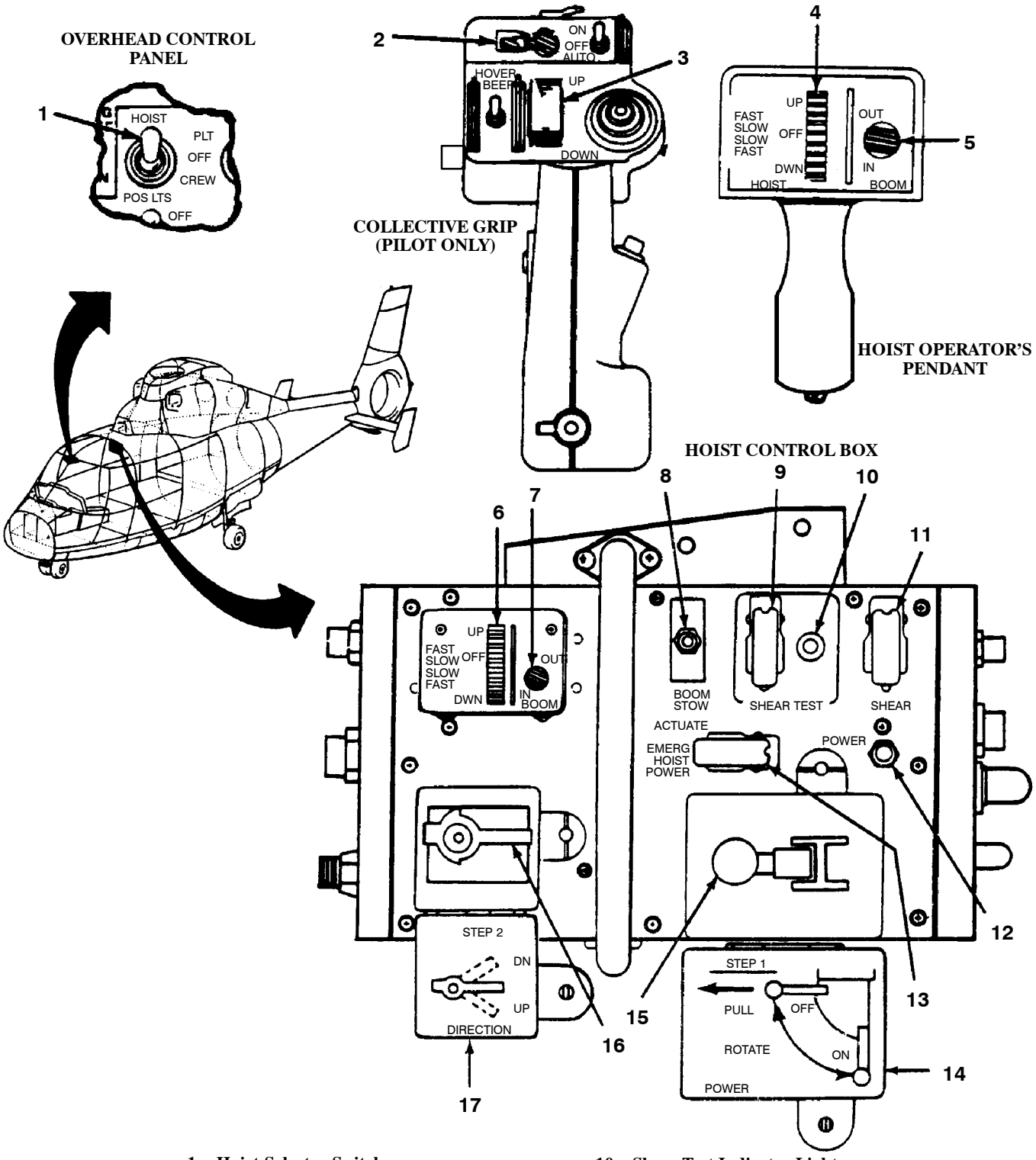

1. **Hoist Fairing**
2. **Pivoting Boom**
3. **Hatch**
4. **Hoist Operator's Audio Control Panel**
5. **Hoist Control Box**
6. **Hoist Operator's Pendant**
7. **Sliding Door Open Lock**
8. **Sliding Door**
9. **Hook Assembly**

*Figure 1-52. Rescue Hoist*

gency situations, the hoist cable may be sheared by an electrically operated cable cutter installed on the hoist assembly. The cable shearing power circuit is armed anytime the hoist selector switch is in the PLT or CREW position. Cable shearing can be accomplished from the pilot's collective or the hoist control box whenever the hoist master switch is in the PLT or CREW position. Normal cable shear power is provided from the No. 1 main DC bus through a circuit breaker marked HOIST SHEAR located on the pilot's aft circuit breaker panel. In case of total generator failure, cable shear power is provided from the battery bus through a circuit breaker marked HOIST SHEAR located on the pilot's forward circuit breaker panel. Electrical power for pivoting the boom is provided from the No. 1 main DC nonshed bus through a fusible link located in the lower nose compartment and is further protected by two circuit breakers located in the cabin overhead. Electrical power for controlling the hoist in case of total generator failure is provided from the battery bus through a circuit breaker marked EMER HOIST CONTROL, located on the pilot's forward circuit breaker panel.

## Hoist Operator's Controls

The hoist operator's controls (Figure 1-53) are located on the hoist control box and on a handheld pendant. The hoist thumb-wheel switch marked UP/OFF/DWN provides a variable speed signal; proportional to the movement of the switch, which controls the speed of the hoist. The BOOM IN/OUT switch controls the boom motor for pivoting the boom to the selected position and the BOOM STOW switch is a momentary switch for positioning the boom to the stowed position. A detachable crank is supplied to manually pivot the boom in case of failure of the hoist arm pivoting motor. The guarded SHEAR TEST switch is used to test the cable cutter electrical circuit and the SHEAR TEST indicator light provides visual indication that the electrical circuit is functioning properly. The guarded SHEAR switch activates the cable cutter. The guarded EMERGENCY HOIST POWER switch provides power directly from the battery should the electrical system fail. The POWER switch is a pushbutton type switch with an integral green light to indicate that normal power is available to the hoist when the HOIST selector switch on the overhead control panel is in the CREW position. In an emergency, electrical power may be interrupted by the hoist operator by depressing the POWER switch. By opening the MANUAL OPERATION STEP 1 door, the hoist operator can manually control hydraulic pressure to the hoist control box. Inside the MANUAL OPERATION STEP 2 door, a control lever allows the hoist operator to raise or lower the hoist by positioning a lever in the direction desired. Hoist rate in the manual mode is preset at




1. Hoist Selector Switch
2. Pilot's Cable Shear Switch
3. Pilot's UP–DOWN Switch
4. Hoist Operator's Speed Control Switch
5. Boom IN–OUT Switch
6. Speed Control Switch
7. Boom IN–OUT Switch
8. Boom Stow Switch
9. Shear Test Switch
10. Shear Test Indicator Light
11. Cable Shear Switch
12. Power Indicator Light/Switch
13. Hoist Emergency Power Switch
14. Manual Operation (Step 1) Door
15. Manual Shutoff Valve
16. Manual UP/DOWN Valve
17. Manual Operation (Step 2) Door

*Figure 1-53. Rescue Hoist Controls*

50 feet-per-minute. The handheld pendant (stowed on the bulkhead adjacent to the hoist support post) is fitted with a 7.5 foot coiled cord to provide the operator with mobility during a hoist procedure. The pendant has controls which duplicate the normal hoist up/down and boom in/out controls on the hoist control box.

### Pilot's Hoist Controls

The pilot's controls consist of an UP-DOWN switch and a guarded SHEAR switch on the collective grip and overrides the hoist operator's control when the overhead switch is in the PLT position. The copilot's station does not have hoist controls.

## HOISTCAM

The rescue hoist camera (HOISTCAM) system provides an opportunity to videotape hoisting evolutions. The permanently installed portion of the HOISTCAM system consists of a fixed video camera, 4 mm wide-angle lens, environmental housing, mounting bracket, and associated data feed cables. The camera is enclosed in the environmental housing and mounted to a bracket attached to the rear of the hoist drum. Its field of view is 34° - in a 30 foot hover, the viewed area would consist of a 26 foot radius around a point directly under the hoist cable, excepting that area which is blocked by the airframe. The audio signal is obtained from the alternate output of the left passenger ICS control box. The combined audio/video data feed cable terminates in a pigtail which extends from the lower rear edge of the 9 degree frame cowling, and is kept coiled in a pouch secured to the frame cowling when not is use.

A Portable Recording Unit (PRU) is required for recording. It consists of a waterproof (Pelican) case containing a Hi-8 mm video recorder, power supply, audio interface, and camera control unit. The PRU utilizes 115 volt AC power provided by the utility receptacle located on the Avionics Rack circuit breaker panel. Video images and sound are provided by connecting the Audio/Video data feed cable to the receptacle on the PRU. The PRU automatically begins recording when the master power switch (located on the outside of the PRU) is turned on and continues to record until switched off or the end of the video tape is reached.

**NOTE**

When the PRU is turned on, it will record all selected audio from the flight mechanic station. To prevent unintentional recording of sensitive or classified information, the flight mechanic should secure radios over which such transmissions might be received. If a classified transmission is recorded, the videotape must be handled at the appropriate classification level until the information is properly deleted.

## AIR DATA SYSTEM

The air data system displays indicated airspeed, vertical speed, and altitude in the cockpit and provides airspeed and altitude data to the FDS, MFDs, AFCS, FMS, Air Data Converter (ADC), and IFF transponder system. The air data system (Figure 1-54) is made up of two separate systems: one for the pilot and one for the copilot.

The pilot's air data system consists of a pitot head, static ports, an airspeed indicator, a vertical speed indicator, an altimeter-encoder, a static source select valve, tubing and drains. The copilot's air data system consists of a pitot head, static ports, an airspeed indicator, a vertical speed indicator, an altimeter, an Indicated Airspeed (IAS) sensor, an electronic altitude controller, tubing and drains. The pilot's air data system provides airspeed, vertical speed, and altitude indications to the pilot's side of the cockpit and an encoded altitude output to the IFF transponder for transmission whenever Mode C is interrogated. The copilot's air data system provides airspeed, vertical speed, and altitude indications to the copilot's side of the cockpit. In addition, airspeed, altitude, altitude rate, altitude error, and valid air data outputs are provided by the IAS sensor and the altitude controller, both of which are located in the avionics rack.

### PILOT'S PITOT-STATIC SYSTEM

The pilot's static circuit has provisions for normal operation using external static ports and standby operation using a cabin static pressure port. Normal static pressure is sensed at a static port located on each side of the fuselage at the baggage compartment location. The supply lines are routed through the top section of the cargo compartment and cabin ceiling to a static valve on the overhead control panel. From the overhead control panel, the lines are routed down the canopy vertical post to the pilot's altimeter-encoder, vertical speed indicator, and airspeed indicator. During operation, the STATIC PRESS valve on the overhead control panel is positioned to NORMAL and static pressure is supplied from the

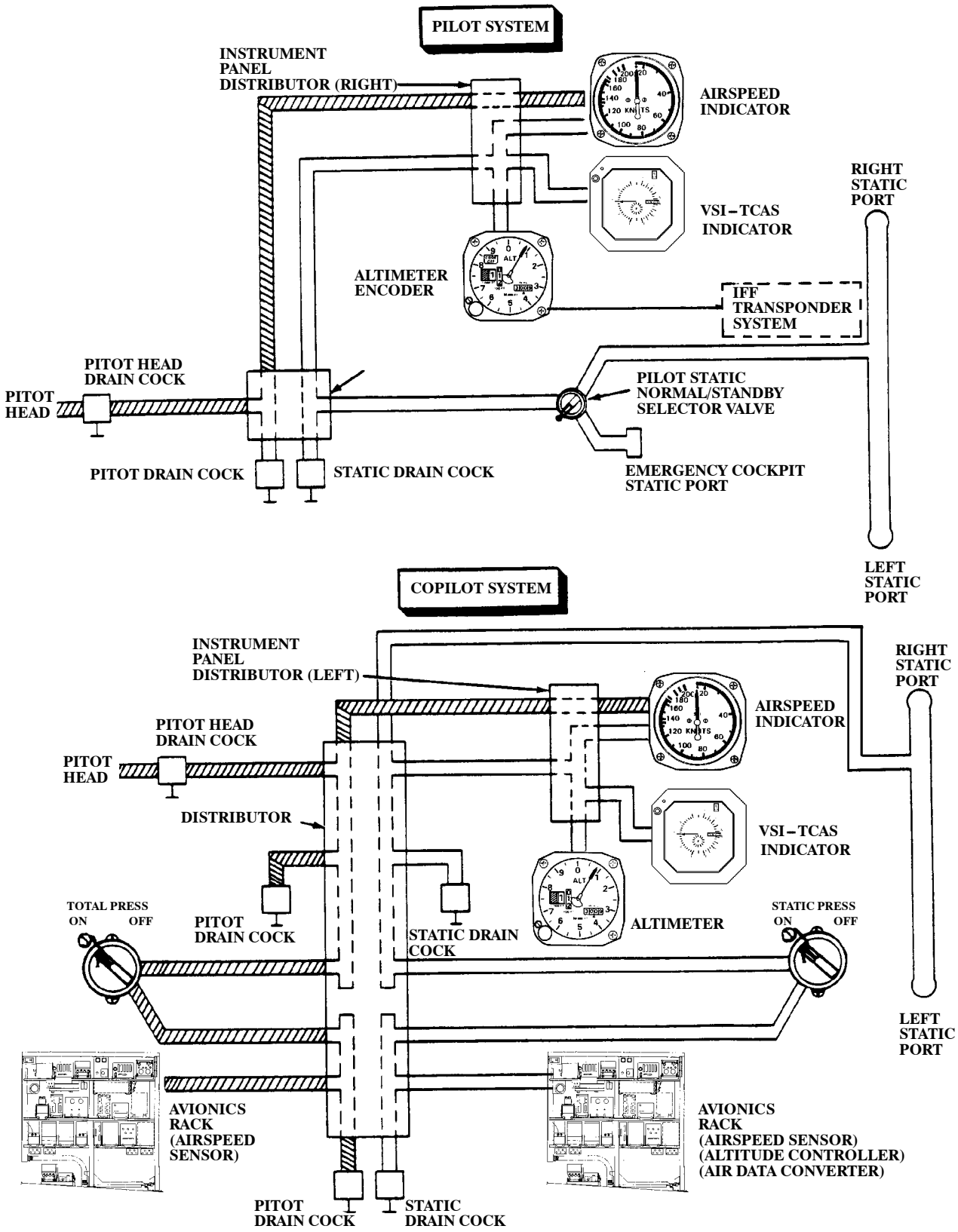



*Figure 1-54. Air Data System Diagram*

two external ports. If the pilot's altimeter-encoder and vertical speed indicator display erratic or erroneous information, the STATIC PRESS valve can be positioned to STAND BY for alternate static pressure. The valve is secured in the NORMAL position with breakaway wire. In the STAND BY position, static pressure is taken directly from the cockpit through a short piece of tubing routed behind the overhead control panel.

The pilot's pitot head is located under the radome, on the right side of the aircraft nose. Any condensation in the system is removed through a drain which is located aft of the pitot head mount. The supply line is connected to a manifold which directs the supply through a hose to the airspeed indicator.

## COPILOT'S PITOT-STATIC SYSTEM

The copilot's static pressure circuit is similar to that of the pilot's but does not incorporate an alternate static pressure source from the cockpit. The copilot's system has an outlet for supplying static pressure to the altitude controller and the IAS sensor through the STATIC PRESS isolating valve. This valve, located on the lower left corner of the instrument panel, is used to shut off static pressure to the avionics rack if the copilot's altimeter and vertical speed indicator display erratic or erroneous indications. The valve is secured in the ON position with breakaway wire.

The copilot's pitot circuit is similar to that of the pilot's except the pitot head is mounted on the left side of the aircraft nose and it has an isolating valve. An outlet is used to supply pitot pressure to the IAS sensor through the TOTAL PRESS isolating valve. This valve, located on the lower left corner of the instrument panel, is used to shut off pitot pressure to the avionics rack if the copilot's airspeed indicator displays erratic or erroneous information. This valve is secured in the ON position with breakaway wire.

### Pitot Heater

Both pitot heads are electrically heated to prevent the formation of ice. Each pitot system includes a heater in the pitot head, an ON/OFF control switch located on the overhead control panel, and a L PITOT (left pitot) or R PITOT (right pitot) caution light on the warning-caution-advisory panel. Either caution light will illuminate when power is applied to the aircraft and the related PITOT HEAT switch is OFF or if the switch is ON and the related pitot heat circuit has failed. Each circuit receives 28 volts DC through the pilot's aft circuit breaker panel. The left pitot circuit is protected by a circuit breaker labeled PITOT 1 and the right pitot circuit by a circuit breaker labeled PITOT 2.

### Altitude Controller

The altitude controller converts a static pressure input into a DC barometric altitude signal which is sent to the FMS. The DC barometric altitude signal is also used by the altitude controller to develop altitude rate and altitude hold error outputs which are sent to the FDC for use by the Flight Director when in the ALT (altitude hold) mode. The altitude controller receives power from the FDC which is powered by 28 volts DC and is guarded by a circuit breaker marked FDS on the cockpit avionics circuit breaker panel.

### Indicated Airspeed (IAS) Sensor

The IAS sensor uses a transducer to develop a DC indicated airspeed signal and compares pitot pressure to static pressure inputs. The transducer develops a DC voltage that increases in proportion to the increase in indicated airspeed. The transducer output is sent to the AFCS computer, the copilot and pilot HSVD systems, and to the FDC. Like the altitude controller, the IAS sensor is powered from the FDC.

## WARNING-CAUTION-ADVISORY PANEL

The indicator lights, located on the warning-caution-advisory panel (Figure 1-55) on the instrument panel, indicate a specific condition, or direct the crew's attention to some other display in the cockpit. The individual indicator modules contain two bulbs, each receiving 28 volts DC power from separate nonshed buses through two circuit breakers marked ADV PNL (advisory panel) located on the pilot's aft circuit breaker panel. A BRIGHT/DIM push-button switch on the warning-caution-advisory panel controls the intensity of both bulbs in each indicator module. Depressing the push-button marked TEST simultaneously illuminates the lights on the warning-caution-advisory panel, fuel management panel, electrical control panel, the master WARNING lights and the VEMD test pattern. The aircraft is equipped with chip detector continuity sensors that monitor the chip detectors in both engines, the main gearbox and the tail gearbox. The two master WARNING lights, located on the instrument panel to the right and left of the warning-caution-advisory panel, will flash simultaneously when a warning light on the warning-caution-advisory panel illuminates to alert the crew to a fault in an essential aircraft function. Depressing either of the lighted WARNING lights causes both WARNING lights to stop flashing, but the warning light on the warning-caution-advisory panel will remain illuminated until the fault is corrected. The modules are color coded according to their importance. Advisory (green) lights indicate normal operation of a selected system. Caution (amber) lights indicate an abnormal condition that must be moni-

tored and appropriate action taken as soon as practicable. Warning (red) lights indicate abnormal conditions or failures that require immediate action.

# ENVIRONMENTAL CONTROL SYSTEM (ECS)

The environmental control system (Figure FO-8) provides conditioned hot and cold air and outside ram air to provide heating, cooling, and ventilation for the crew and passenger compartments, avionics rack cooling, and windshield defogging. The ECS consists of an air conditioning compressor, heat exchanger fan pack, a system of ducts, bleed air valves, and controls which modulate the air distribution and an outside ram air system which provides air for ventilation. Separate air intake and exhaust ports, located in the left side of the fuselage, are provided to furnish the ECS with ambient air for circulation through the ECS condenser. An external air conditioning receptacle, located on the left side of the fuselage forward of the ECS exhaust port, is provided for attaching a ground air conditioning unit.

## CABIN AIR DISTRIBUTION SYSTEM

The cabin air distribution system is composed of an upper duct system extending from the ECS outlet through the overhead structure of the aircraft to a plenum at the 9-degree frame. Two large ducts carry the conditioned air forward to another plenum at the top of the windshield center column. A duct leads down through the center column to the ram air intake and connects to the lower duct system consisting of defogger diffusers and cockpit and cabin nozzles. Under normal operation, the cooling system uses the upper ducts and the heating system uses the lower ducts.

Control levers are incorporated into the windshield center column duct to control conditioned air or ram air. The right mounted lever is labeled RAM AIR and controls ram air ventilation. The left mounted lever, the duct interconnect, is labeled DUCT/INTCON and controls airflow between the upper and lower duct systems.

### Ram Air Ventilation System

Ram air ventilation is provided by an air inlet chamber in the nose of the aircraft which incorporates a flapper valve actuated by the RAM AIR control lever on the right side of the windshield center column duct. Moving the lever to the OPEN position allows ram air to supply both the upper and lower duct system when the DUCT/INTCON control lever is in the open position, or to the upper duct system alone, when the DUCT/INTCON lever is closed.

## SYSTEM OPERATION

### Cooling

A vapor cycle air conditioning unit, using Freon as a refrigerant, provides avionics compartment and cabin cooling through the upper duct system. The cooling system can be operated alone or in conjunction with the heat system and/or ram air, depending on requirements. It is pressurized by a compressor mounted on the MGB. The compressor is equipped with a magnetic clutch and is belt driven utilizing a pulley installed on the MGB tail rotor drive output. Two flexible hoses, routed through the right engine deck and into the ECS compartment, connect the compressor to the Heat Exchanger Fan Pack assembly. The ECS consists of two heat exchangers (condenser and evaporator), electric fan, filter/dryer, receiver tank, Freon level sight glass, thermostatic expansion valve, and a high pressure sensor with accompanying light.

To initiate the cooling cycle, gaseous Freon, at high pressure and high temperature, is discharged from the compressor into the condenser. Outside ambient air, drawn into the ECS compartment from an opening in the side of the aircraft, is passed through the condenser to cool the Freon, then dumped overboard. An electric fan with two fan wheels, one at each end of a common shaft, is mounted in a distribution box which separates condenser airflow from evaporator airflow. The constant speed fan serves the dual function of drawing outside air through the condenser while simultaneously drawing cabin air through the evaporator. Upon leaving the condenser, Freon, now at lower temperature and changing to liquid form, enters the filter/dryer where contaminants and moisture are removed. The Freon then passes into the receiver tank which stores extra refrigerant until needed by the evaporator. The thermostatic expansion valve modulates Freon flow from the receiver tank to the evaporator. As high pressure liquid Freon is sprayed through the expansion valve, a sudden drop in pressure takes place causing immediate vaporization. The vaporized Freon absorbs heat from the recirculated cabin air passing through the evaporator. This action lowers airflow temperature to cool the avionics compartment and cabin interior. From the evaporator, gaseous Freon is drawn back to the compressor at low pressure and low temperature to complete the cooling cycle.

The COOL switch is powered by 28 volts DC and is guarded by a 7.5 amp circuit breaker labeled ECS located on the copilot's circuit breaker panel. The ECS fan is powered by 3-phase, 115 volts AC from the No. 1 main AC bus and is guarded by a 15 amp circuit breaker marked AIR COND FAN on the copilot's circuit breaker panel. When the cooling system is operating, the Freon level can be checked ex-

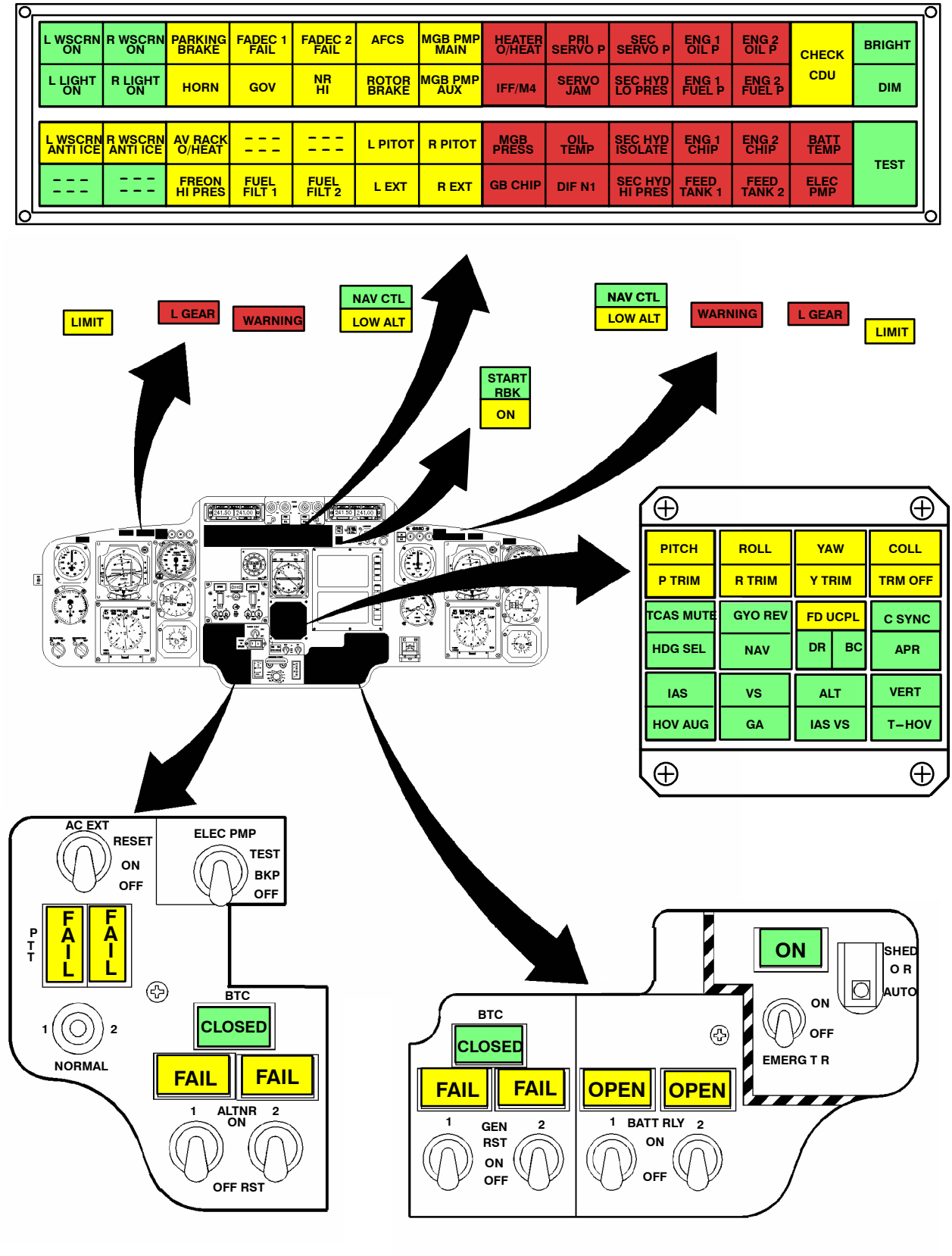



*Figure 1-55. Warning, Caution, and Advisory Lights*

ternally through an opening located in the left side of the fuselage below the ECS air intake.

## Heating

The heating system uses engine bleed air mixed with recirculated cabin air and distributes the air through the lower duct system. A shutoff valve, controlled from the cockpit by the HEAT switch, supplies bleed air from both engines. The heating system is electrically/pneumatically controlled and operates independently of the cooling system. It provides warmth through the lower duct system by mixing engine bleed air in the injector nozzles with recirculated cabin air. Placing the overhead HEAT switch to ON illuminates the BLEED AIR ON advisory light on the warning-caution-advisory panel, energizes the cabin temperature probe fan and opens the bleed air shutoff valve. This provides a bleed air source to the regulator valve. This bleed air source is used for injector nozzles and system control. Assuming the cabin temperature is less than 68 °F, the heat switch is ON, and the CABIN HEAT selector knob is OFF, bleed air is supplied to the regulator valve which provides a continuous air supply to the pneumatic control system. The pneumatic control system has three valves that can bleed pneumatic control pressure: the cabin heat selector, the regulation/sensor unit, and the duct thermostatic probe. With the CABIN HEAT selector knob in the OFF position, its pneumatic valve is open, leaving the control system unpressurized and allowing spring pressure in the regulator valve to shut off bleed air to the injector nozzles. Turning the CABIN HEAT selector knob clockwise starts restricting the pneumatic control pressure, and opens the heat supply of the regulator valve. The CABIN HEAT selector knob controls pneumatic system control pressure from minimum to maximum, providing a crew selectable temperature control. When or if cabin temperature detected at the cabin temperature sensor probe reaches and stabilizes at approximately 68 °F, the regulation/sensor will open/modulate, thereby controlling pneumatic system pressure and the regulator valve to limit cabin temperature to approximately 68 °F when the CABIN HEAT selector knob is in any position but override. Rotating the CABIN HEAT selector knob to the override position activates a solenoid which closes the regulation/sensor unit and provides continuous heat to the cabin. If the override position is selected, Freon cooling must be provided to the avionics compartment to ensure proper cooling of the avionics rack equipment.

Any time either engine exceeds approximately 101.9 N1 +0.8%, the bleed air shutoff valve automatically closes and the air conditioner compressor clutch disengages. When N1 (both engines) is again below approximately 101.9%, heating can be restored by placing the HEAT select switch to RST, then ON. Air conditioning can be regained at any time by selecting OFF then ON.

The HEAT switch is powered by 28 volts DC and is guarded by a 7.5 amp circuit breaker labeled ECS located on the copilot's circuit breaker panel.

# CONTROLS

## Cooling Switch

The Freon Cooling System is controlled by a three position switch, labeled COOL, mounted on the overhead control panel. Switch positions are marked OFF, FAN, and ON. Positioning the switch to ON energizes the cooling unit fan and engages the compressor. The cooling unit will provide conditioned air at a temperature dependent upon OAT, cabin ambient temperature, and humidity. The volume and temperature of conditioned air to the avionics compartment cannot be varied by the crew. Air distribution to the cabin is through ducts mounted in the cabin and cockpit overhead and controlled by a series of discharge nozzles (wemacs) which can be rotated to increase or decrease discharge airflow.

## Bleed Air Heating Switch

The Bleed Air Heating System is controlled by a three position switch, labeled HEAT, mounted on the overhead control panel. Switch positions are marked OFF, ON, and RST. Positioning the switch to ON opens the bleed air shutoff valve, energizes the cabin temperature probe fan, and illuminates the BLEED AIR ON advisory light on the warning-caution-advisory panel.

**CAUTION**

When operating the heat system, ensure all lower duct heat air nozzles (wemacs) are completely open. Any other configuration may cause illumination of the HEATER O/HEAT warning light.

Bleed air heat will automatically shut off in the event of an engine failure.

## Cabin Heat Selector Knob

The CABIN HEAT selector knob, located on the overhead console aft of the FFCLs controls temperature and volume from zero to maximum by rotating from OFF to WARMER.

Control is automatically limited to a maximum cabin temperature of approximately 68 °F (19 °C), unless the selector

knob is placed in the OVERRIDE position. Selecting OVERRIDE deactivates the temperature control and provides maximum heat and volume.

## ECS WARNING-CAUTION LIGHTS

### Freon High Pressure Caution Light

An automatic shutoff feature detects high refrigerant pressure. If the condenser inlet pressure exceeds approximately 392 psi for more than 20 seconds, the FREON HI PRES caution light on the warning-caution-advisory panel will illuminate and the compressor will disengage. The dual-wheel electric fan continues to operate; providing recirculated cabin air to the avionics compartment. The compressor can be reengaged and the FREON HI PRES light extinguished after pressure falls below approximately 392 psi by moving the COOL switch to FAN then back to ON.

### Freon Low Pressure

A similar feature detects low pressure at the evaporator outlet. Approximately 20 seconds after low pressure is detected (29.02 PSI) the compressor disengages, but no visual cue is provided. Several things can cause compressor disengagement. Insufficient Freon or clogged filter/dryer means the compressor will not reengage. However, if ice has formed on the evaporator, continued ECS fan operation during compressor inactivation will defrost the evaporator and system pressure will increase. Once proper pressure is restored, the compressor will automatically reengage after approximately 20 seconds.

### Heater O/Heat Warning Light

To provide overheat protection, a thermostatic probe is installed in the lower right heat duct aft of the 9-degree frame, which will direct the regulator valve to close if the duct temperature is approximately 185 °F. When the temperature drops below the actuating point, the regulator valve will reopen. For additional overheat detection, six thermoswitches are strategically placed to detect a bleed air supply leak or duct overheat. A HEATER O/HEAT warning light on the warning-caution-advisory panel will illuminate when a temperature of approximately 275 °F and above is sensed at one or more thermoswitches near the FADEC computers, the bleed air pneumatic control valve in the aft cabin overhead or the lower duct system.

**WARNING**

Illumination of the HEATER O/HEAT warning light may indicate a fire hazard due to a bleed air leak.

## AVIONICS RACK

### Avionics Rack Temp Control

The ECS provides conditioned air to the duct leading into the avionics rack at a temperature of normally 40 °F - 60 °F. Under most conditions, this will provide adequate cooling to the avionics rack. If OAT is above 85 °F, the ECS system may not be adequate to cool the avionics rack and illumination of the AV RACK O/HEAT light will occur. ECS temperature is unaffected by heater operation. In the event of an ECS failure, an avionics fan mounted in the avionics rack draws cabin air in the avionics rack for backup cooling.

### Avionics Rack Fan Control Switch

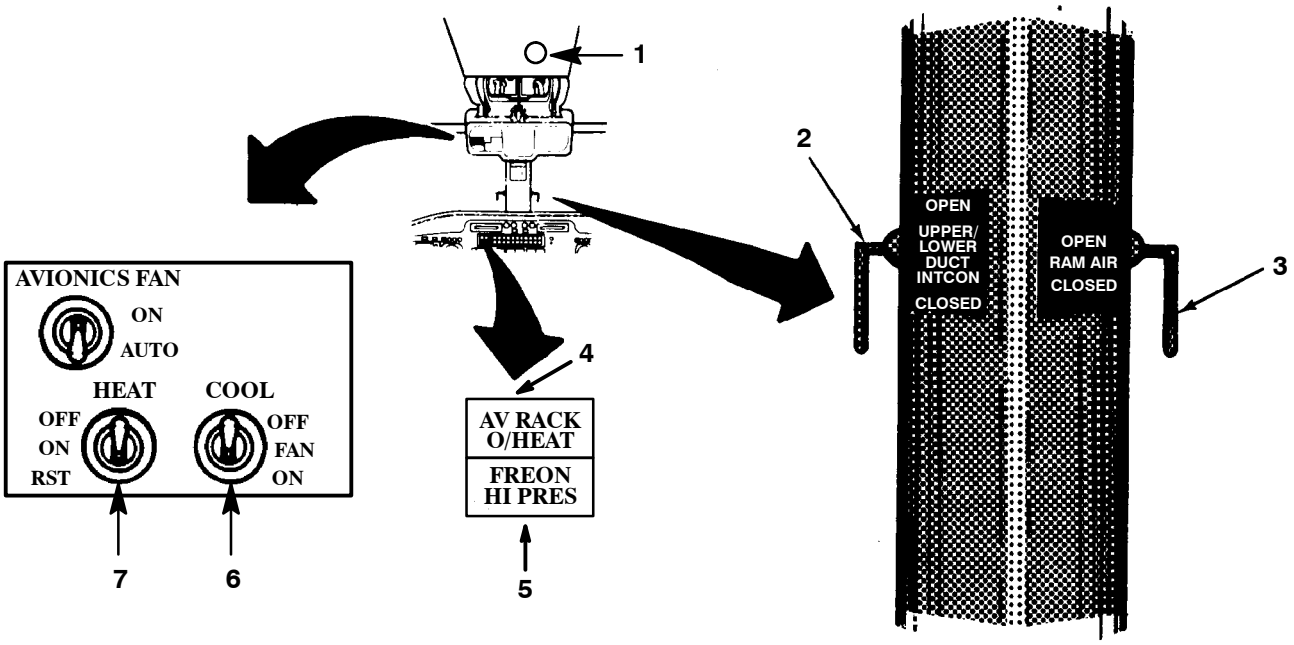
The avionics rack fan control switch, located on the overhead control panel (Figure 1-56), is labeled AVIONICS FAN and has two positions marked ON and AUTO. The switch provides power to the avionics cooling fan. Placing the switch to the ON position operates the fan continuously. With the switch in the AUTO position, the fan will operate any time AC power is applied whenever the ECS is not operating. The fan is powered by 115 volts AC through the avionics rack circuit breaker panel and protected by a circuit breaker labeled RACK BLOWER.

Additional avionics equipment located in the nose compartment is cooled by cabin air forced into the nose compartment by two fans located behind the instrument panel. These fans, powered by 115 volts AC, are protected by dedicated circuit breakers labeled PILOT FAN and COPILOT FAN located on the pilot's forward circuit breaker panel. The fans operate any time AC power is applied.

### AV Rack O/Heat Caution Light

When the inlet air to the avionics rack goes above 68 °F (±4 °F), a thermoswitch in the avionics rack plenum illuminates the AV RACK O/HEAT light on the warning- caution-advisory panel. The sensor is connected in parallel with an existing thermoswitch, which also illuminates the AV RACK O/HEAT light at 109.4 °F.

The Avionics Cooling Maintenance Disable switch, labeled AV CLG SW MAINT DISABLE, located on the forward




1. **Rotary Heat Rheostat**
2. **Defog and Floor Vents Control Lever**
3. **Ram Air Control Lever**
4. **Avionics Rack Overheat Caution Light**
5. **Freon High Pressure Caution Light**
6. **ECS Control Switch**
7. **Heat Control Switch**

*Figure 1-56. Environmental Control System Controls and Indicators*

avionics compartment bulkhead is a latching pushbutton type and functions to disengage the illumination of the AV RACK O/HEAT light circuit. It will still allow illumination of the AV RACK O/HEAT light at 109.4 °F. The pilot can reset the Avionics Cooling Maintenance Disable switch by pulling and resetting the ECS circuit breaker on the copilot's forward circuit breaker panel. However, due to the tolerances and reset parameters of the sensor, the warning light may reilluminate. A properly functioning Freon ECS should be capable of extinguishing the 68 °F AV RACK O/HEAT light at temperatures of approximately 85 °F OAT or less.

**NOTE**

With an OAT of 10 °C (50 °F), the cabin environment, due to ancillary heat sources of avionics, engines, and instrumentation, will normally be above 70 °F and the Freon environmental cooling system must be ON.

## WINDSHIELD WIPER AND ANTI-ICING SYSTEMS

The windshield wipers (Figure 1-57) are controlled by a three position switch, marked OFF, L (low), H (high), located on the overhead control panel. When the wiper switch is placed to OFF, the wiper arms move to the park position. The windshield wiper system is redundantly powered and operates on 28 volts DC from the No. 1 and No. 2 main DC buses and is protected by circuit breakers marked WINDSHIELD WIPER for the wiper motor and WINDSHIELD WIPER CONTROL located on the pilot's aft and copilot's circuit breaker panels.

**CAUTION**

To prevent scratching of the windshield, never operate the wipers on a dry surface.

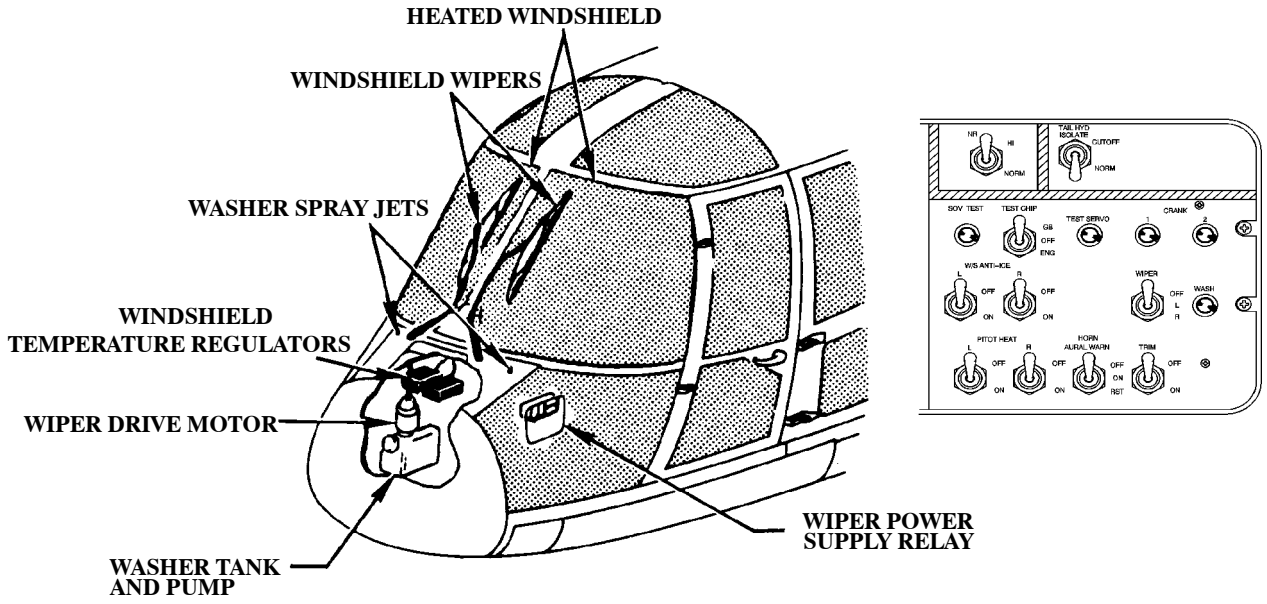



*Figure 1-57. Windshield Wiper and Anti-Ice System*

## WINDSHIELD WASHER

The windshield washer (Figure 1-57) consists of a plastic tank filled with a water-ethylene glycol solution, and an electric pump and timer mounted on the tank. The tank has a capacity of three pints and is located in the nose compartment. Fluid level may be observed through the translucent tank. Depressing the WASH pushbutton on the overhead control panel energizes the washer for 10 seconds. The two spray jets are mounted just below the base of each windshield. The windshield washer system operates on 28 volts DC from the No. 1 main DC bus and is protected by a circuit breaker labeled W/S WASH on the pilot's aft circuit breaker panel.

## WINDSHIELD ANTI-ICE

Electrical anti-icing (Figure 1-57) is provided for the right and left windshields. Each anti-ice circuit operates independently of the other and consists of an on-off switch labeled W/S ANTI ICE, a heating element and temperature sensor located within the windshield, a temperature regulator located in the nose section, and advisory and caution lights. With either circuit energized, heating of the respective windshield will occur if the temperature sensed at the windshield is below 22 °C. Heating will continue until the windshield temperature rises to 28 °C, at which time it will automatically cycle off and continue to cycle until the W/S ANTI ICE switch is turned off. Should the temperature sensor in one windshield fail, continued temperature control is automatically provided through the temperature regulator of the opposite windshield. The heating element in the left windshield receives 200 volts AC, three-phase alternator power from the No. 1 main AC bus. The heating element in the right windshield receives 200 volts AC, three-phase alternator power from the No. 2 main AC bus. Each heating element is guarded by three separate circuit breakers marked LEFT W/S HEATING and RIGHT W/S HEATING and are located on the pilot's forward circuit breaker panel. The temperature regulators are powered by 28 volts DC from the No. 1 and No. 2 main DC buses, and are guarded by circuit breakers marked R W/S CONT (right windshield control) and L W/S CONT (left windshield control) located on the pilot's aft circuit breaker panel.

### Controls and Indicators

Placing either the W/S ANTI ICE switch, located on the overhead control panel, to ON will arm the respective anti-ice circuit and illuminate the L WSCRN ON (left windscreen on) or R WSCRN ON (right windscreen on) advisory lights located on the warning-caution-advisory panel. Failure of a temperature sensor will illuminate the L WSCRN ANTI ICE or R WSCRN ANTI ICE caution light. Each circuit will remain armed until the associated windshield anti-ice switch is moved to the OFF position.

# LIGHTING SYSTEM

All lights (Figure 1-58), except the instrument console and panel lights, are powered from the DC electrical system and protected by circuit breakers on the copilot's circuit breaker panel and the pilot's forward and aft circuit breaker panels. All instrument and interior lights are NVG compatible except the crew cabin lights. The EXT LT switch located on

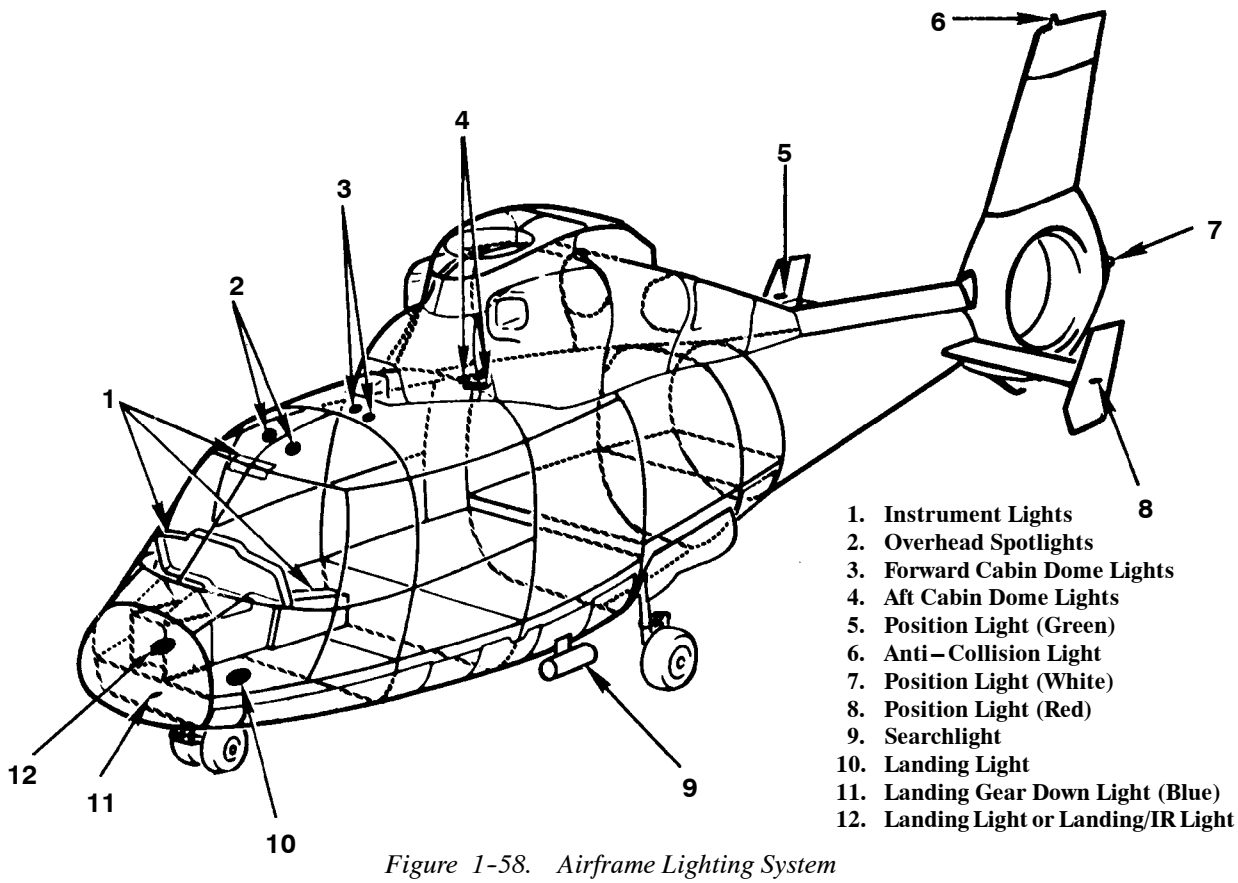



*Figure 1-58. Airframe Lighting System*

the overhead lighting control panel selects between the normal landing light and the IR light portion of the pilot's landing light when the combination bulb is installed. The IR portion of the light will provide illumination visible only through NVGs. When the single element bulb is installed, the switch must remain in the NORM position. Refer to Figure 1-59 for lighting system controls. Normal power for the instrument lights comes from the main AC buses. An emergency battery pack located on the left equipment rack in the baggage compartment provides lighting in the cabin and cargo compartment should total DC power failure occur. The emergency lights will also illuminate in the event of an impact force in excess of 3.2 vertical g's or 4.0 horizontal g's, thus providing automatic lighting for emergency egress. The battery pack is trickle charged through a 28 volt DC circuit breaker marked CAB LTS (cabin lights) located on the pilot's aft circuit breaker panel.

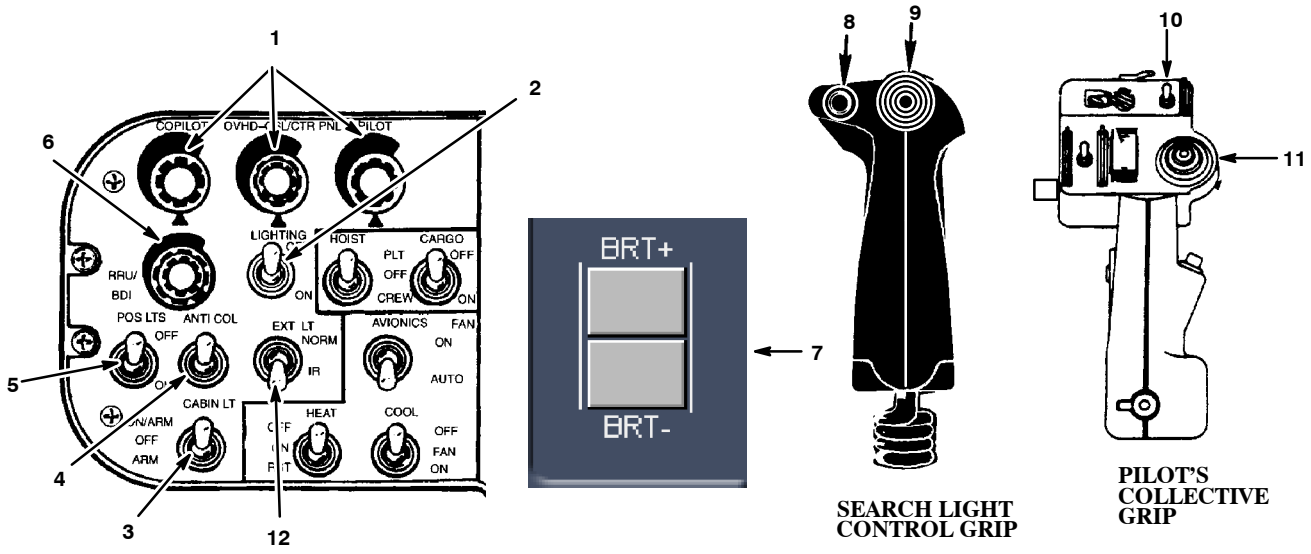
## INTERIOR LIGHTS

### Cabin Lighting

Cabin lighting is provided by two cabin dome lights mounted forward and aft of the 9-degree frame. The forward unit has two individually trainable swivel lights and the aft unit has four. The lights are operated by the CABIN LT switch (Figure 1-59), with positions marked ON/ARM, OFF, and ARM, located on the overhead control panel. The ON/ARM position turns the cabin lights on and arms the emergency light system. The OFF position turns the lights off and disarms the emergency lighting system. The ARM position arms the emergency lighting system only. Should total DC power failure occur, the emergency lighting system will illuminate if the CABIN LT switch is in any position other than OFF. In the emergency lighting mode, both lights in the forward unit and one light in the aft unit are illuminated. In the normal lighting mode, brightness of the lights is controlled by rheostats mounted on the light fixtures. In the emergency lighting mode, the lights come on at full intensity and the rheostats have no effect on brightness. Power is provided from the No. 2 main DC bus. The circuit is protected by a circuit breaker labeled CAB LTS, located on the pilot's aft circuit breaker panel. This circuit breaker also protects the cabin dome lights.

### Overhead Spotlights

Two overhead spotlights with coiled cords are secured to mountings located on the cockpit overhead panel within the pilot's and copilot's reach. The lights may be adjusted on their mountings to direct the light beams, or they may be removed and used as portable utility lights. Each light has a rheostat/switch which turns the light on or off and varies the brightness. A red press-to-test button is on the rear of the




**LIGHTING CONTROL PANEL**

1. **Cockpit Lighting Control Knobs**
2. **Cockpit Lighting Power Switch**
3. **Cabin Lights Switch**
4. **Anti–Collision Lights Switch**
5. **Position Lights Switch**
6. **RRU/BDI Lighting Control Knob**
7. **VEMD Dim Control**
8. **Search Light ON/OFF Switch**
9. **Search Light Position Control Button**
10. **Landing Light Control Switch**
11. **Landing Light Position Control Button**
12. **External Light Switch**

*Figure 1-59. Lighting System Controls*

rheostat/switch. The lights receive power from the battery bus and are protected by a circuit breaker labeled O/HEAD LTS, on the pilot's forward circuit breaker panel. Each light has a variable beam for either white or NVG compatible lighting.

## Instrument Lighting

The instrument lighting system consists of edge lighting or backlighting of the pilot's and copilot's instrument panels (except MFDs), the center section of the instrument panel, the center console (except CDUs), the overhead panel, the Outside Air Temperature (OAT) indicator, the clock, and the standby compass.

## Instrument Light Control

The cockpit LIGHTING power switch supplies AC power to the rheostats located on the overhead panel. The rheostats, labeled COPILOT, OVHD-CSL/CTR PNL, and PILOT (Figure 1-59), vary the brightness of the lights. The rheostat marked COPILOT controls the copilot's instrument lights, including edge lighting for the copilot's vertical scale instruments. The rheostat marked CSL/OVHD is a dual rheostat with two concentric knobs. The inner knob controls the lights for the center console and the pilot's aft and cockpit avionics circuit breaker panels. The outer knob controls the lights on the overhead control panel, OAT indicator, standby compass, and the center of the instrument panel. The rheostat marked PILOT controls the pilot's instrument lights, including edge lighting for the pilot's vertical instruments and back lighting for the BDI. The rheostat marked RRU/BDI varies the brightness of the digital display readout on the COM 1 and COM 2, RRUs, and the BDI. It is powered through the circuit breaker labeled RRU located on the cockpit avionics circuit breaker panel. Protection for the instrument edge lighting and backlighting is provided through four circuit breakers located on the pilot's forward circuit breaker panel and labeled as follows: I/PNL LT 1 for the copilot's instrument lights; I/PNL LT 2 for the pilot's instrument lights; O/HD PNL LT for the overhead panel, OAT indicator, standby compass, and center section of the instrument panel; CONS PNL LT for the center console and the circuit breaker panels. The MFD lighting is controlled through respective digital control panels.

# EXTERIOR LIGHTS

## Position Lights

Three conventional position lights are installed. The white position light is located at the aft end of the vertical tail and the left (red) and right (green) position lights are mounted outboard of the left and right horizontal stabilizers. The position lights are controlled by an ON-OFF switch marked

POS LTS, located on the overhead control panel. The 28 volt DC position lights are redundantly powered from the No. 1 and No. 2 main DC buses and are protected by circuit breakers located on the pilot's aft and copilot's circuit breaker panels labeled POS LTS.

### Anticollision Light

The anticollision light, mounted on the top of the vertical fin, consists of a halogen lamp and a red/forward-clear/aft split lens. The light illuminates at a rate of approximately 50 times per minute by the anticollision light power supply. It is controlled by an ON-OFF switch marked ANTI COL on the overhead control panel. The anticollision light operates on power from the No. 2 main DC nonshed bus and is protected by a circuit breaker located on the pilot's aft circuit breaker panel labeled ANTI COL LT.

### Landing Lights

Both the normal landing lights and the combination landing/IR light (when installed) are flush mounted on the underside of the fuselage on the copilot's and pilot's sides. The light control switch on the collective energizes the respective side landing light. The normal landing light provides 400,000 candlepower and the combination landing/IR light (when installed) provides approximately 200,000 candlepower in the NORM position. Elevation and azimuth are controlled by using the light position control button on the related collective grip. The lights can be positioned at any vertical angle between straight down (fully retracted) and 30 degrees above horizontal (fully extended) and rotated 360 degrees in azimuth. The pilot's landing light operates on power from the No. 2 main DC bus. The copilot's landing light receives power from the auto-shed bus. Circuit breakers marked HOV LT and HOV CNTL are located on the avionics circuit breaker panel and R LD LT PWR and R LD LT CONT on the pilot's aft circuit breaker panel.

### Searchlight

The SX-5 Starburst searchlight consists of a junction box assembly, a gimbal assembly, a control box assembly, and a searchlight assembly. Electrical power to the searchlight is supplied by the No. 1 DC bus to the auto-shed bus, which provides the light with 27.5 volts of DC power. The searchlight assembly consists of a 500 watt xenon arc lamp producing 15 million peak beam candle power, a reflector assembly, cooling fan, focus motor, and high-voltage electrical components which are the final stages of the starting circuits. The searchlight assembly is mounted to a "u" shaped gimbal assembly which contains two gearboxes (azimuth and elevation) each driven by a small DC motor. The removable searchlight is mounted on the lower left side of the fuselage, below the avionics rack access panel. The light circuit is protected by a circuit breaker labeled LCTR LT on the avionics rack circuit breaker panel. The removable junction box mounts on top of the KY-58/DES mount aft of the copilot's seat. The control box is mounted atop the junction box when not in operation. The control box is a small rectangular metal box, which contains the searchlight operator's controls. There are three control features on the control box. The master "OFF-ON-START" switch controls all the electrical power to the searchlight system and is operated exactly like an automobile ignition switch. The "OFF" position turns off the entire searchlight system and extinguishes the light if operating. The "ON" position closes a relay circuit to furnish power to the lamp and fan, and directly feeds the focus switch and eight-way directional control switch. The "START" position is a spring-loaded momentary contact position, which energizes the lamp starting circuit. Once the lamp starts, the switch is released and returns to the "ON" position for continuous operation. The focus knob labeled "FOCUS" is a momentary contact pushbutton switch, which when activated adjusts the beam from 2 degrees to 10 degrees on demand. The last feature is an eight-way directional control switch labeled "DOWN, UP, RIGHT, LEFT." When activated, the switch operates the two reversible constant speed motors mounted on the gimbal assembly. Final output speed of the gearboxes is 6 degrees per second. Full motion from 10 degrees above horizontal to 50 degrees below horizontal takes 13 seconds. Full horizontal motion for an installation with 180 degrees from one stop to the other takes 30 seconds.

**CAUTION**

If the locator searchlight is ON and placed in the 30° up position, the heat from the unit's 380 watts is directed at the left chine panel area which can cause damage to paint on the aircraft surface.

## CABIN INTERIOR ARRANGEMENT

The cockpit area provides control positions for the pilot and copilot. The cabin area can be converted to configurations for search and rescue, passenger transportation, and/or cargo. The cabin area can be configured to transport at least five passengers. Typical interior arrangements are shown in Figure 1-60.

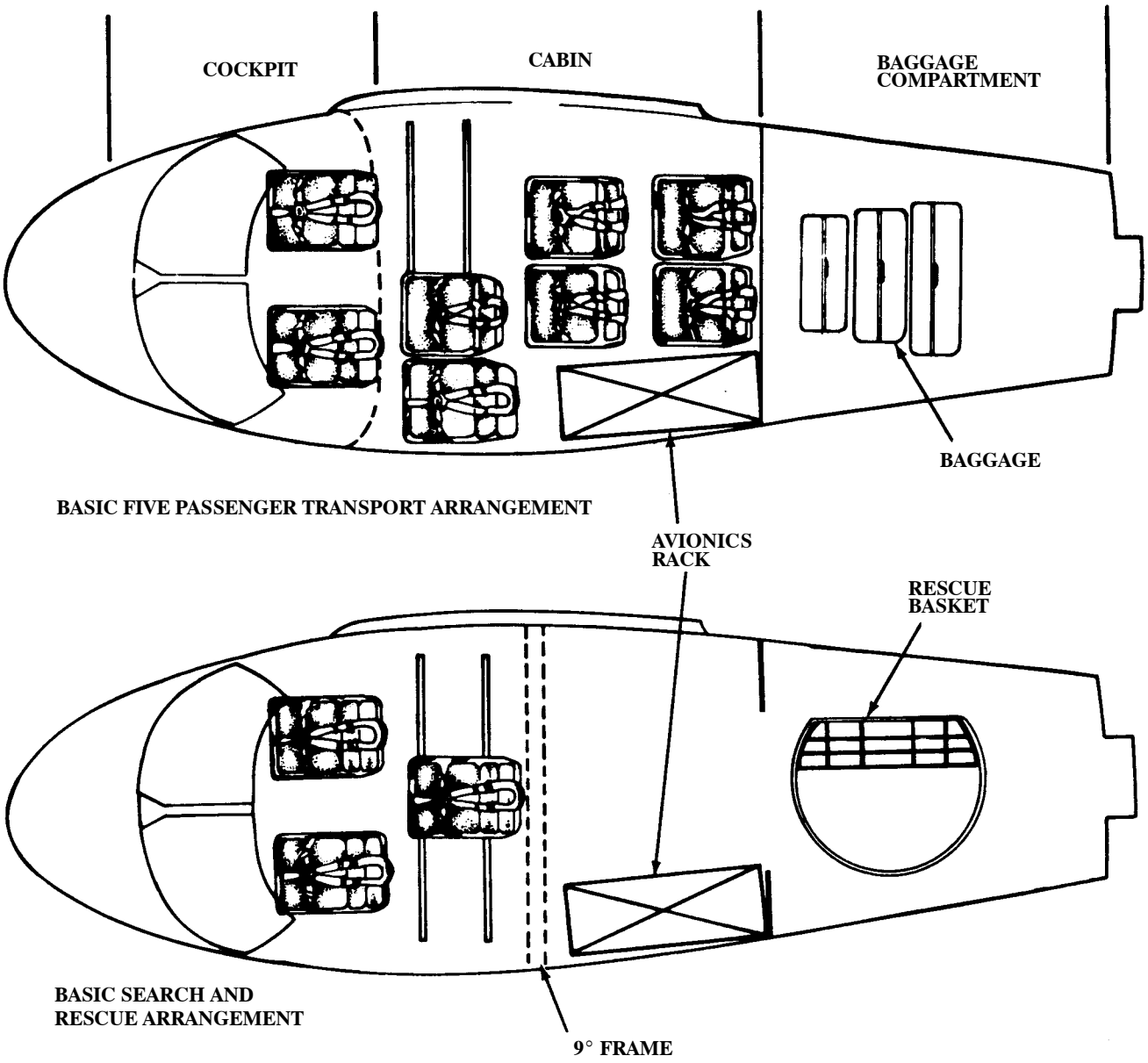



*Figure 1-60. Interior Arrangements*

## CREW SEATS

The aircrew seats provide occupant restraint and crash protection. Energy absorbing capabilities called Variable Load Energy Absorber (VLEA) assemblies are incorporated in the seat design. The VLEA is mounted on each side of the seat and is a wirebender–type system. This system provides a relatively constant predictable load when a positive or negative G-load is experienced limiting the compressive load to the occupant's spine. The VLEA control lever is mounted on the left aft side of the seat bucket. Occupants are required to set the lever for their weight prior to each flight.

## EQUIPMENT AND STORAGE

The litter can be carried in the cabin area where it is available for use, or stowed in the baggage compartment behind the baggage compartment cargo net. In cabin area, the litter is secured by cargo straps to four tie-down rings on the cabin floor. In the stowed position in the baggage compartment, it is secured behind the baggage compartment cargo net. The rescue basket is stowed in the baggage compartment and secured behind the baggage compartment cargo net.

## CARGO

The entire cabin area may be utilized in the transport of cargo by removing the hoist operators seat. The tie-down system in the cabin area has been designed to accommodate two pallets of 32 x 48 inches each. The cabin floor is fitted with 24 tie-down rings positioned so as to secure loose cargo or cargo mounted on the pallets. The baggage compartment can be used for transporting baggage or light bulk loads. There are four tie-downs in the baggage compartment.

**WARNING**

Any item not secured in the cabin is likely to become a missile hazard in the event of a mishap. All cargo and/or personal gear should be properly secured to the aircraft prior to transition to forward flight whenever possible.

# DOORS

The helicopter is equipped with four personnel access doors, a baggage compartment door, and an overhead hatch. All of the doors are opened with lever-type handles. The four personnel access doors can be locked by raising the door handles to a horizontal position. A colored metal flag projects from the rear of each door frame to indicate that the door is not locked. The flags are visible from either cockpit position and disappear from view when the respective door is locked. If the helicopter is to be left unattended, each door can be externally locked with a key.

## COCKPIT DOORS

The cockpit doors are opened by rotating downward on the lever mounted on the aft door frame. A gas filled strut holds each door open. Emergency release handles marked DOOR JETTISON HANDLE are mounted on each door post. The doors are jettisoned by raising and pulling aft on the jettison handle and pushing outward on the doors. Door jettison can also be accomplished from the outside by raising the release handle on the door post at the bottom outside corner of the windshield and pulling the wire T-handles attached to the hinge pins.

## PASSENGER DOORS

The left passenger door is hinged and is opened identically to the cockpit doors. Door jettisoning can be accomplished externally and internally with a combined lever actuated handle installed in the door, near the forward edge. The door is jettisoned by rotating upward on the lever and moving the door outward until it is clear of the fuselage. The right passenger door may be closed or opened from inside or outside by: rotating downward on the handle on the aft portion of the door, moving the door outward (away from the fuselage), and sliding it aft. It is held in the full open position by a manually operated latching mechanism located inside the door at the top, forward corner. A device is installed in the upper track to ensure that the door cannot be closed without first closing the hoist operator's overhead hatch. The door can be jettisoned internally or externally by rotating downward on the yellow handle located on the forward portion of the door and moving the door outward until it is clear of the fuselage. The maximum airspeed for opening and closing the sliding door is 80 KIAS. For airspeeds from 80 to 100 KIAS, the door shall be latched full open or closed, and maintained closed above 100 KIAS.

## BAGGAGE COMPARTMENT DOOR

A hinged baggage compartment door is located on the right side of the fuselage and provides access to the baggage compartment. The minimum door opening is 19 inches high by 28 inches long. The door is not jettisonable.

**NOTE**

The baggage compartment door has an exterior mounted door handle only. However, the door opening mechanism is accessible from the inside and allows the door to be opened from the inside and used as an alternate emergency exit.

### HOIST OPERATOR'S HATCH

A small hatch is provided on the right side of the cabin above the sliding door to facilitate moving the hoist inboard into the cabin and to enable the hoist operator to stand upright. The hatch cannot be opened unless the sliding door is open. It is unlocked by a lever, and held open by two support rods. A handle is installed on the hatch frame to facilitate opening and closing in flight. A portion of the upper track for the sliding door is attached to the hatch. Therefore, the hatch must be closed before the sliding door can be closed. The hatch is not jettisonable. The maximum airspeed for opening and closing the hatch is 60 KIAS forward airspeed and 30 knots sideward flight. For speeds from 60 to 80 KIAS forward airspeed and up to 35 knots sideward flight, the hatch may be latched full open, or closed, and closed above 80 KIAS forward airspeed and 35 knots sideward flight.

## EMERGENCY EQUIPMENT

Emergency equipment items are carried aboard the aircraft at all times; within easy reach of the crew, and ready for immediate use. Refer to Figure 3-3 for specific location of emergency equipment.

### PORTABLE FIRE EXTINGUISHER

A hand operated portable fire extinguisher is installed on the back of the pilot's seat and held in place by a bracket with a tight fitting quick release spring. The capacity is 2.5 pounds of Halon liquified gas pressurized with nitrogen to 125 psi. A pressure gage, located on the side of the fire extinguisher, indicates the normal operating pressure in the green area, with discharge and overcharge pressures in red. The extinguisher is operated by removing the locking pin and squeezing the operating lever while directing the agent at the base of the fire. Duration of operation is approximately 10 seconds with a horizontal range of between 9 and 15 feet.

### FIRST AID KITS

Two first aid kits are installed. One is mounted on the front of the 9-degree bulkhead and the other is stowed in a bag attached to the inside of the baggage compartment door.

### LIFE RAFT

Provisions are made for stowage of the life raft package secured near the cabin door.

### ESCAPE AXES

Two crash axes are available for emergency use. One axe is mounted on the back side of the copilot's seat. A second axe is mounted on the baggage compartment door.

### EMERGENCY LOCATOR TRANSMITTER (ELT)

The ELT transmits a signal on the international distress frequencies of 121.5 and 243.0 MHz to a distance of approximately 200 miles. It is mounted inside the baggage compartment above the baggage door and connected to the helicopter electrical system. It may be armed and activated for use on the helicopter or removed for portable use. The ELT can be operated remotely by the ON/ARM/RESET switch on the IFF/COMM control panel (Figure FO-2) or directly by the ARM/ON/OFF switch located on the face of the ELT. Normal operation is performed with both switches in the ARM position. Operation is then controlled automatically by an internally mounted impact switch which causes activation of the ELT on impact of 5 g's or more in the direction of flight. Manual operation is accomplished by placing either switch position to the ON position. To reset, the ELT switch on the IFF/COMM control panel must be held in the RESET position for a minimum of 3 seconds before returning to the ARM position. The ELT is powered from an internal 9 volt battery with an estimated operating life in excess of 100 hours. Power to reset the ELT is supplied from the No. 2 main DC bus through a circuit breaker labeled ELT located on the copilot's circuit breaker panel. The ELT may be removed from the aircraft by disconnecting the external antenna and electrical leads, and pulling the plastic knob on the forward portion of the mounting bracket. A 14 inch portable antenna is attached to the ELT.

### UNDERWATER ACOUSTIC BEACON (UAB)

The UAB is mounted to the Voice and Flight Data Recorder in the avionics rack and is contained in a watertight case capable of withstanding high g impact shock and deep water immersion up to 20,000 feet. When immersed in water, the UAB automatically activates and transmits a distress signal on 37.5 kHz. The unit has an operating life of 30 days after activation and a detection range of 2,000 to 4,000 yards. The UAB is powered by an internal 9 volt battery.

## RESCUE EQUIPMENT

The rescue basket, litter, or dewatering pump can be stowed in the baggage compartment. The collapsible basket may be stored with the litter in the baggage compartment. A standardized SAR equipment storage board is installed below the right rear window.

## EMERGENCY FLOTATION SYSTEM

The helicopter is equipped with an emergency flotation system designed to keep the helicopter afloat to allow the safe evacuation of passengers and crew. The flotation gear (Figure 1-61) consists of two cylindrical floats, each partitioned into three independent air bags and stored in a compartment on each side of the forward fuselage, and two spherical floats, one mounted in a compartment on each side of the aft fuselage. Two helium filled gas cylinders, located in the aft float compartments, provide for inflation of all floats; left bottle for left side and right bottle for right side. The flotation gear is powered directly from the No. 1 main DC and No. 2 main DC buses through two fuses located in the master electrical box in the nose compartment and is protected by eight circuit breakers in the baggage compartment overhead. Additional buoyancy is provided by water tight compartments which consist of a sealed tail boom and sealed fuel tank cavities beneath the cabin floor.

With all four floats properly deployed, the helicopter will remain afloat upright in a Sea State 2 condition for at least 4 minutes with the waterline below the cabin floor ensuring easy door jettisoning, launching of the life rafts, and evacuation of passengers and crew. The floating helicopter should remain stable enough to tow in conditions up to Sea State 5 and remain afloat, with the loss of one rear float or loss of one airbag in one of the forward floats, for at least 12 hours in Sea State 2. Refer to DITCHING, Section III and EMERGENCY FLOTATION GEAR, Section V.

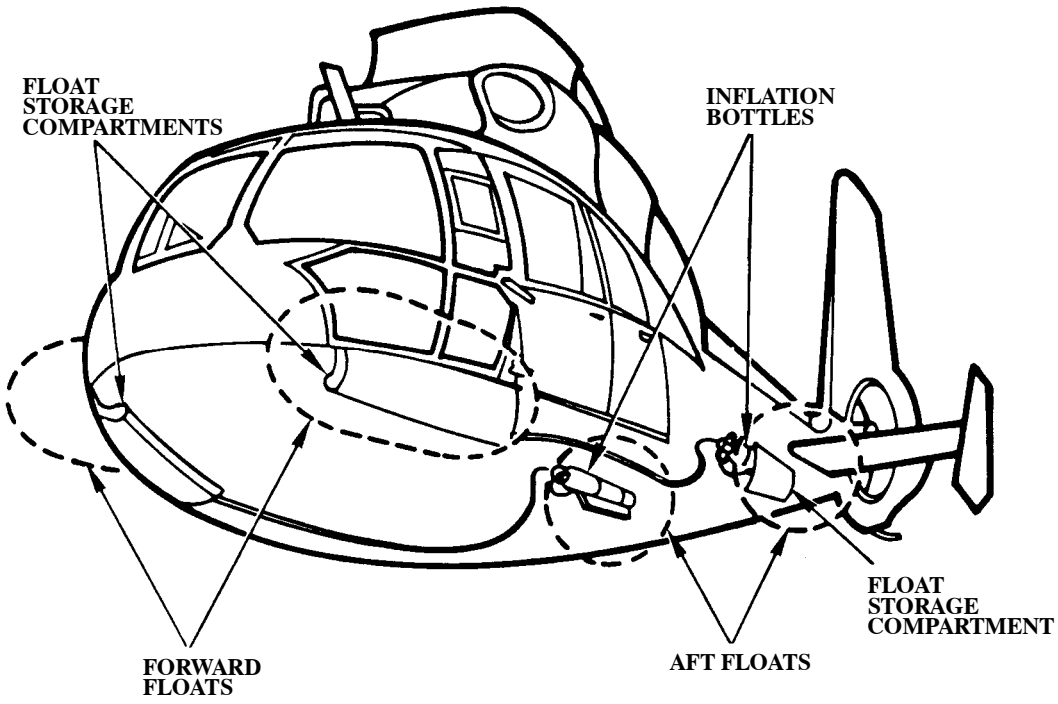



*Figure 1-61. Emergency Flotation System*

**WARNING**

When the emergency flotation gear is activated, a burning electrical smell, accompanied by possible residual gas, may be detected in the cockpit and should not be confused with a possible electrical malfunction/fire.

**CAUTION**

With the flotation gear inflated, a vertical landing should be made to prevent damage to the floats.

## FLOTATION GEAR CONTROLS

Control and monitoring (Figure 1-62) of the emergency flotation system is accomplished by switches and lights mounted on the instrument panel and on the pilot's and copilot's collective. The two-position EMERG FLOAT control switch controls the firing circuits located on the cylinders. In the OFF position, the system is unarmed. In the ARM position, both firing circuits are powered and the two PRESS TO INFLATE lights illuminate.

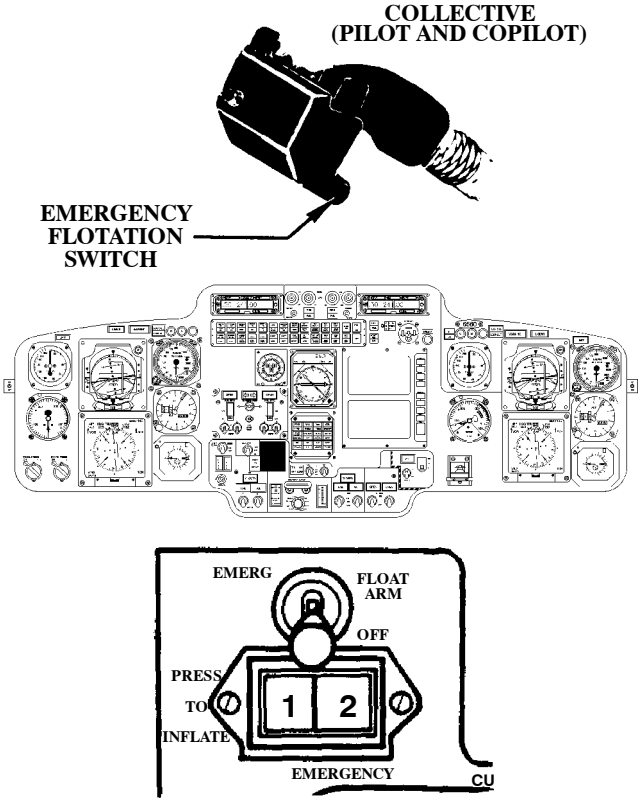



*Figure 1-62. Flotation Gear Controls*

**NOTE**

Lights marked 1 and 2 illuminate to alert the crew that power is available to the left and right circuits and to confirm that electrical connectors are installed on the bottles.

In the armed configuration, the four floats may be inflated by pressing the PRESS TO INFLATE pushbutton switch on the instrument panel, or by pressing either EMERG FLOAT switch on the pilot's or copilot's collective. The floats are inflated to shape in less than 2.5 seconds and the cylinders are completely discharged in less than 4 seconds.

**NOTE**

The activation switch on the instrument panel is covered by a mica protective cover. Activation of the flotation gear with that switch requires the mica to be pressed hard enough to also depress the switch; this may result in the mica cover developing a crack, but the cover will not "break" during the process.

# CARGO HOOK

The cargo hook assembly (Figure 1-63) can be mounted on the underside of the helicopter directly below the main rotor head and is rated at 2,000 pounds. A gimbal permits the hook to swing laterally 60 degrees and longitudinally to 30 degrees aft.

## CARGO HOOK CONTROLS

Controls for the cargo hook consist of an ON-OFF switch on the overhead panel marked CARGO and a CARGO RE-

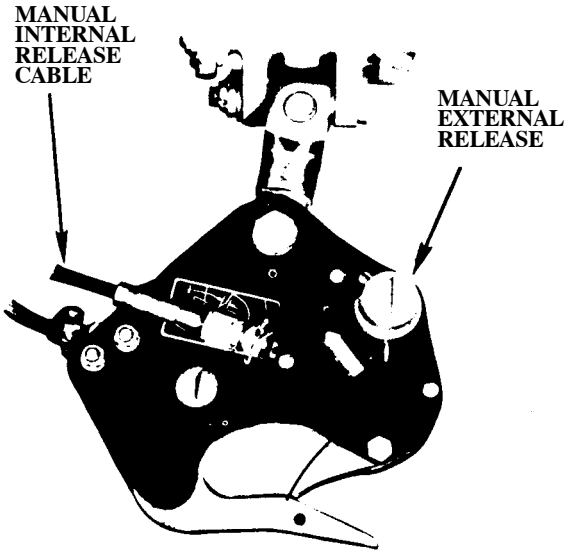



*Figure 1-63. Cargo Hook*

LEASE pushbutton on the pilot's and copilot's cyclic. The release mechanism is powered by 28 volts DC from the No. 1 main DC nonshed bus. Protection for the circuit is provided by two circuit breakers labeled SLING RELEASE and SLING HOIST RELEASE located on the pilot's aft circuit breaker panel. When the CARGO switch is positioned to ON, the release control unit is powered and the cargo may be released by depressing the CARGO RELEASE switch on either the pilot's or copilot's cyclic. A manual release handle, located on the aft end of the center console and accessible to all crewmembers, can be raised to mechanically release the load in the event of electrical failure.

# FLIGHT INSTRUMENTS

The flight instruments consist of the instruments which provide the airspeed and altitude data, navigation guidance, and attitude information necessary for normal operation of the aircraft. These instruments are: Attitude Director Indicator (ADI), Multifunction Display (MFD), Bearing Distance Indicator (BDI), standby compass, altimeter, vertical speed indicator (VSI-TCAS), airspeed indicator, and radar altimeter. The flight instruments are NVG compatible.

## ATTITUDE DIRECTOR INDICATOR (ADI)

The pilot and copilot have identical ADIs (Figure 1-64). Each consists of an attitude indicator, a turn and slip indicator, glide slope indicator, localizer pointer, pitch and roll command bars, collective command pointer, radar altitude pointer, Decision Height (DH) annunciator, and the necessary flags to warn of instrument malfunctions. Each ADI has five signal sources. The pilot's ADI receives signal inputs from the Flight Director Computer (FDC), radar altimeter, attitude gyro No. 1, yaw rate gyro No. 1, and the VOR/localizer receiver . The copilot's ADI receives signal inputs from the FDC, radar altimeter, attitude gyro No. 2, yaw rate gyro No. 2, and the VOR/localizer receiver. Both ADIs are powered by 115 volts AC and are protected by separate circuit breakers marked ADI on the cockpit avionics circuit breaker panel. Refer to Figure 1-64 and the following paragraphs for a detailed description of ADI functions and warning flags.

### Attitude Reference Gyros

Two attitude reference gyros are located in the baggage compartment and provide attitude inputs for pitch and roll axis control. Attitude Gyro No. 1 sends signals to the pilot's ADI and the AFCS computer. Attitude Gyro No. 2 sends signals to the copilot's ADI, the AFCS computer, the FD computer, and the radar antenna stabilization unit. Both attitude gyros are powered by 115 volts AC, 400 Hz through separate circuit breakers marked ATT located on the pilot and copilot AC areas of the cockpit avionics circuit breaker panel.

### Yaw Rate Gyros

Two yaw rate gyros are mounted in the avionics rack and provide yaw rate inputs for yaw axis control. Yaw rate gyro No. 1 sends signals to the pilot's ADI and the AFCS computer. Yaw rate gyro No. 2 sends signals to the copilot's ADI and the AFCS computer. Both yaw rate gyros are powered by 28 volts DC through separate circuit breakers marked R/T located on the pilot and copilot DC areas of the cockpit avionics circuit breaker panel.

### Bank Index and Bank Scale

The bank index is a stationary pointer used as a reference for bank angle. The bank scale has line markers for right and left bank angles of 10, 20, and 30 degrees and with arrows for 45 degrees and 0 degrees. These markers are read in reference to the bank index.

### Pitch and Roll Command Bars

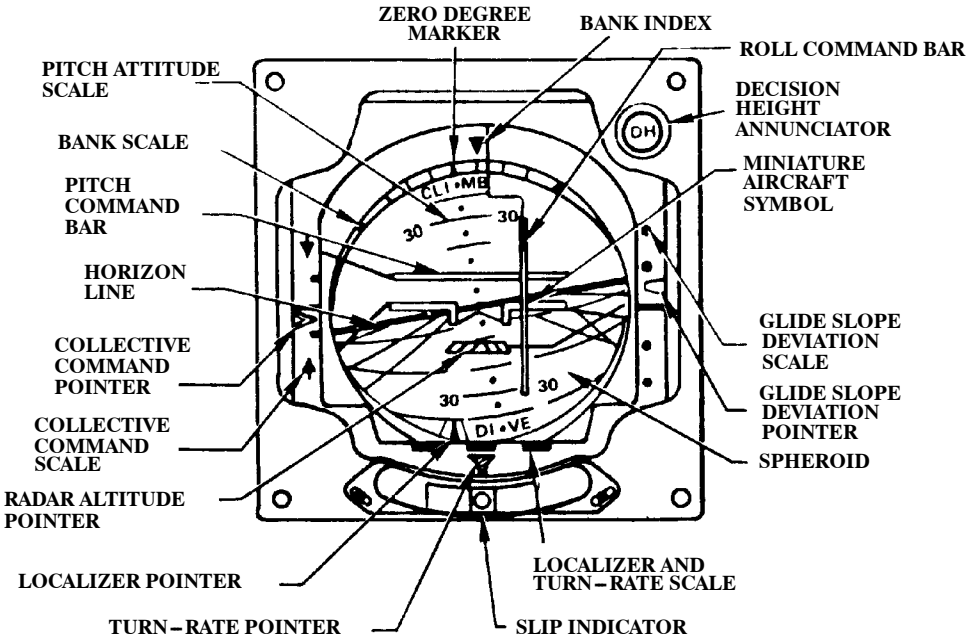
The pitch and roll command bars display steering information to intercept, or maintain, a desired flight path. The attitude of the aircraft must be adjusted as necessary to center the bars. To center the roll command bar, the aircraft must be banked toward the bar. Keeping the bar centered will provide the amount of bank necessary to roll in, turn, roll out, and maintain a selected heading or navigation (RNAV, VOR/ILS, or TACAN) course. To center the pitch command bar, a pitch attitude change toward the bar is required. Keeping the bar centered will result in the proper pitch attitude necessary to fly to, or maintain, the desired flightpath. When the bars are centered, the aircraft is either correcting to, or is on, the desired flightpath.

### Decision Height Annunciator

A light labeled DH (decision height) is located at the top right corner of each ADI. The light illuminates when the aircraft descends to the radar altitude that has been set on the respective radar altimeter. The light will remain on until the aircraft climbs above the preset altitude or until the radar altimeter is set for an altitude which is lower than the aircraft altitude. The annunicator can be tested by momentarily depressing the pushbutton built into the light and can be dimmed by rotating the light fixture.

### Glide Slope Indicator

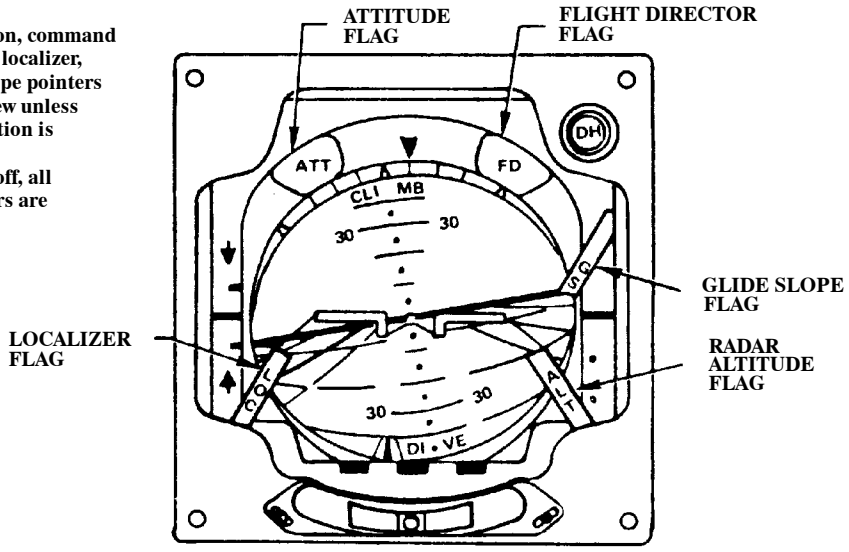
The glide slope indicator consists of a deviation scale and a deviation pointer on the right side of the ADI. The scale consists of a center line and two dots above and below the center




**ADI DISPLAY FUNCTIONS**

**NOTES:**

- **With power on, command bars, radalt, localizer, and glide slope pointers are out of view unless specific function is selected.**
- **With power off, all flags and bars are in view.**




**ADI WARNING FLAGS**

*Figure 1-64. Attitude Director Indicator*

line. The glide slope pointer displays valid glide slope information whenever a localizer frequency is selected and received, the VOR navigation source is selected, and GS (glide slope) flag is not displayed. If the pointer is above or below the center line, the glide slope is above or below the aircraft, respectively. Pointer deviation to the second dot above or below the center line constitutes full scale deflection.

## Turn and Slip Indicator

The turn and slip indicator consists of a mechanical ball inclinometer type slip indicator and a turn-rate pointer. The combination turn-rate and localizer deviation scale is used to indicate a deviation from the localizer course for the localizer pointer and provides a turn-rate scale for the turn rate pointer. One needle-width of the turn-rate pointer equals a standard rate turn (3 degrees per second equals a 2-minute turn). The turn-rate pointer disappears from view whenever a valid signal from the yaw rate gyro is not received in the instrument.

## Localizer Pointer

The localizer pointer (runway symbol) displays the localizer course in relation to the aircraft position whenever a localizer frequency is selected and received. If the pointer is to the left of the center marker on the combination turn-rate and localizer deviation scale, the aircraft is to the right of the localizer course as established with the course select knob on the DCP, and vice versa. If a back course approach is flown, proper sensing will only occur if the front course is selected with the course select knob. The pointer will drop out of view if frequency is changed or signal strength is lost.

## Radar Altitude Pointer

The green and white radar altitude pointer (representing the ground) activates when the aircraft descends through 200 feet radar altitude. The pointer rises vertically to the miniature aircraft symbol and corresponds to the aircraft height above the ground. Whenever the radar altitude is greater than 200 feet (or is not operating) the pointer will retract from view.

## Collective Command Pointer and Scale

A movable collective command pointer and a fixed scale consisting of three markers and two opposing arrows indicates the direction and amount of collective movement necessary to maintain a selected vertical flight path. The collective command pointer is active when any flight director mode is captured regardless of navigation source. If the pointer is above or below the center marker, the arrows indicate the direction the collective has to be moved to correct to the desired flight path. The pointer retracts from view whenever the instrument is not receiving a valid signal from the flight director computer.

**CAUTION**

The collective command pointer represents the collective pitch required to obtain the commanded flight profile. This requirement can exceed engine and/or helicopter capabilities. The pilot shall monitor the appropriate instruments and modify the flight profile or override the collective (if flight director coupled), as necessary, to maintain the engines and power train within operating limits.

## Attitude Flag

A red flag marked ATT (attitude) will appear in the upper left corner of the ADI whenever there is a loss of ADI power or loss of a valid signal from the attitude gyro No. 1 for the pilot's ADI and attitude gyro No. 2 for the copilot's ADI.

## Flight Director Flag

A red flag marked FD (flight director) will appear in the upper right corner of the ADI whenever there is a loss of a valid FDC signal. When the flag appears, the pitch and roll command bars and the collective command pointer will retract out of view.

## Glide Slope and Localizer Flags

Two red flags, one marked GS (glide slope) and the other LOC (localizer), will appear in the ADI whenever the VOR navigation source is selected on the display control panel or a localizer frequency is selected and received, but there is a loss of signal strength or validity from the glide slope or localizer, respectively.

## Radar Altitude Flag

A red flag marked ALT will appear in the lower right corner of the ADI if there is a loss of a valid radar altitude signal. When the flag appears, the radar altitude pointer will disappear from view.

## MULTI-FUNCTION DISPLAY (MFD) HORIZONTAL SITUATION INDICATOR (HSI)

The HSI page is a horizontal situation display mode of the MFD. Refer to the FMS system (Figure 1-204) for a detailed description of the display control panel and other multifunction display modes.

### Lubber Line, Compass Card, and Aircraft Symbol

The aircraft heading is read from the compass rose in relation to the lubber line. A loss of compass validity will cause the lubber line to disappear and a slashed heading symbol to appear in its place. In this case, the desired course pointer will point to the original position of the lubber line, and the display becomes a course deviation indicator.

### TO-FROM Arrow

The function of the to-from arrow is dependent upon the navigation source selected on the HSVD control panel. When the VOR/ILS or TACAN modes are selected, the arrow will switch from TO to FROM according to the angular difference between the selected station and desired course. When the angular difference is less than 89 degrees, the arrow display will point in the direction of the course pointer. When the angular difference is greater than 91 degrees, the arrow display will point away from the course pointer. Between 89 and 91 degrees angular difference, the arrow display will be blanked. When RNAV is selected, the arrow display will always point in the direction of the course pointer until passing the last waypoint in the flight plan, then switch to a FROM indication. Regardless of navigation mode selected, the arrow display will be blanked whenever signal validity is lost.

### Course Deviation Indicator (CDI)

The function of this indicator is dependent upon the navigation source selected. Deviation is measured with respect to the deviation scale consisting of two square dots to the left and right of the CDI. In the lateral flightpath mode of LNAV, the CDI indicates deviation from the RNAV course and each dot equals 1.25 miles. In the lateral flightpath mode of LOC, the CDI indicates deviation from the localizer course and each dot equals 1.25 degrees. In the lateral flightpath mode of VOR or TCN, the CDI indicates deviation from the VOR or TACAN course and each dot equals 5 degrees.

## BEARING DISTANCE INDICATOR (BDI)

The BDI is located on the pilot's instrument panel (Figure FO-2). The instrument consists of a rotating compass card, a lubber line, a single bar pointer, a single bar pointer pushbutton switch, a double bar pointer, a double bar pointer pushbutton switch, two distance readout windows, a compass warning flag, and MAN (manual) and DF (direction finding) annunciators. The compass warning flag will appear if power is lost to the BDI, or if the copilot's compass signal becomes invalid. The BDI receives 28 volt DC power from the copilot's manual shed bus and 26 volt AC power from the No. 1, 26 volt transformer. The BDI is protected by two circuit breakers labeled BDI on the cockpit avionics circuit breaker panel. For a detailed description of the BDI components, refer to Figure 1-65 and the following paragraphs.

### Compass Card and Lubber Line

Aircraft heading is read on the compass card at the lubber line. The compass card receives magnetic heading from the copilot's compass system when the compass is in the MAG mode. When the compass system is in the DG (directional gyro) mode, the card will indicate gyro heading. The compass card can be set using the compass synchronization knob located on the copilot's compass control panel.

### Double Bar Pointer Pushbutton Switch

The double bar pointer pushbutton switch is used to select either VOR or ADF/DF bearing information for display on the double bar pointer. When the switch is depressed, it will latch in that position and an ADF annunciator flag will appear next to the switch to indicate that either an ADF or DF bearing, if available, is being displayed on the double bar pointer. If a DF bearing is being displayed on the pointer, the DF annunciator in the upper right corner of the BDI will illuminate.

### Single Bar Pointer Pushbutton Switch

The single bar pointer pushbutton switch is used to select either VOR or TACAN bearing information for display on the single bar pointer. When the switch is depressed, it will latch in that position and the following will occur:

- A TCN (TACAN) annunciator flag will appear next to the switch to indicate that a TACAN bearing, if available, is being displayed on the single bar pointer.
- The MAN (manual) annunciator in the upper left corner of the BDI will illuminate if the TACAN is operating in the manual mode as selected on the CDU NAV page display.
- The TCN distance readout will display the slant range distance to the TACAN station.

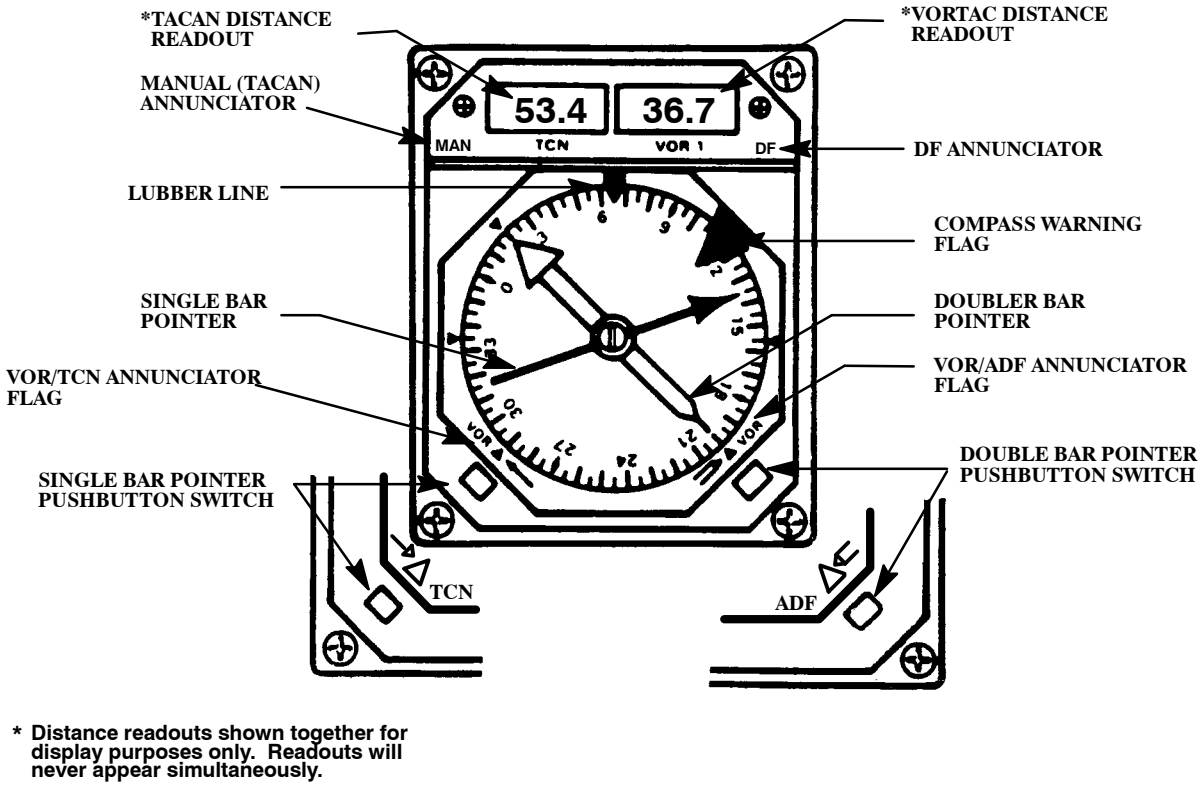



*Figure 1-65. Bearing Distance Indicator*

Depressing the switch a second time will unlatch it and the following will occur:

- A VOR annunciator flag will appear to indicate that VOR bearing information is being displayed on the single bar pointer.

- If VOR 1 is tuned to a VOR station that is paired with a TACAN (VORTAC station) the VOR distance readout will display the slant range distance to the VORTAC station.

## BDI Distance Readouts

Two distance readout displays, labeled TCN and VOR, are incorporated into the BDI indicator. The readouts are digital displays and indicate slant range distance to TACAN stations in increments of tenths of a nautical mile for ranges less than 100 miles and in one mile increments for ranges greater than 100 miles. When a TACAN station is tuned in the MAN mode and the single bar pointer is selected to TCN, the left readout (labeled TCN) will indicate the slant range distance to the station and the MAN annunciator will illuminate to indicate the TACAN is in the manual mode. TACAN distance will be displayed in the right readout (VOR) if: the TACAN is paired (VORTAC), VOR is on the single bar pointer, and the VOR is tuned to the VORTAC station.

## DF Annunciator

The DF annunciator, located in the upper right corner of the BDI, when illuminated, indicates that the double bar pointer is displaying relative bearing to a VHF, UHF, or VHF FM radio as selected on the DF mode panel.

## MAN Annunciator

The MAN (manual) annunciator, located in the upper left corner of the BDI, when illuminated, indicates that the left distance readout is displaying slant range distance to a TACAN station that has been tuned manually.

## STANDBY MAGNETIC COMPASS

The standby magnetic compass (Figure 1-1) located on the center windshield post, is a self-contained indicator that shows the heading of the aircraft with respect to magnetic north. A deviation correction card for the compass is located beneath the compass.

## DIGITAL ELECTRONIC AIRCRAFT CLOCK

The Digital Electronic Aircraft Clock (Figure 1-66) provides Universal Coordinated Time (UTC), Date, Elapsed

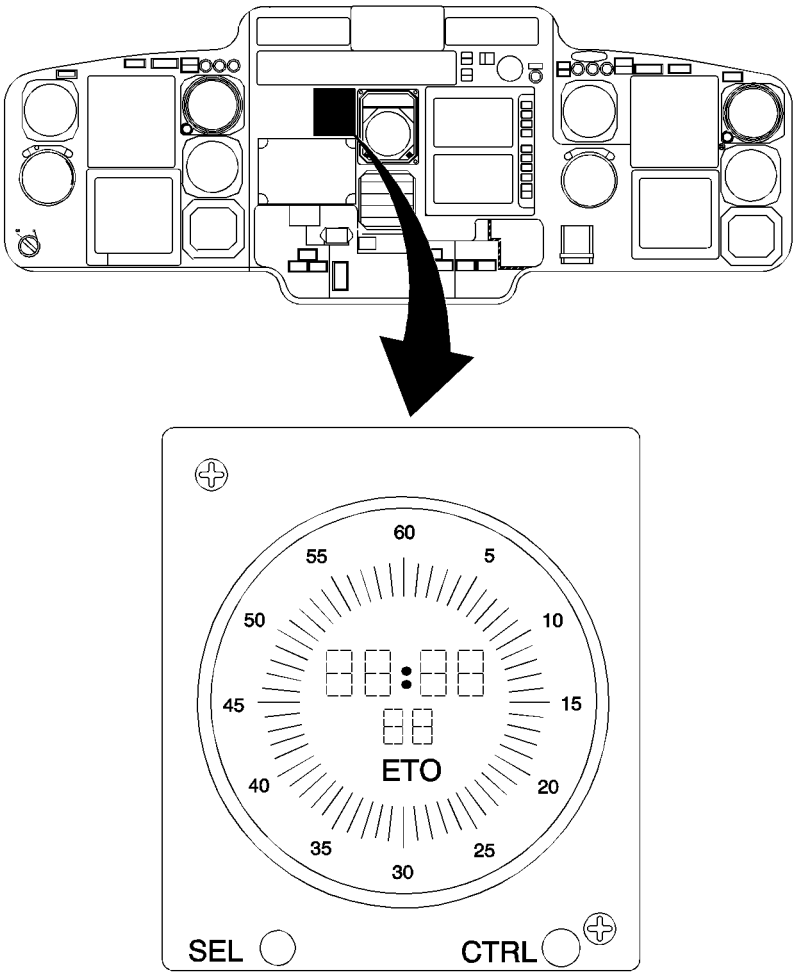



*Figure 1-66. Digital Electronic Clock*

Time, Sweep Second Pointer and automatic control of the Day/Night lighting.

The Time is controlled by a quartz crystal oscillator. Accuracy is maintained within 2 seconds per day under stabilized temperature conditions.

The Digital Aircraft Clock is powered by 28 VDC and protected by the CLOCK LT and CLOCK LIGHT circuit breakers on the pilot's aft panel and copilot's forward panel, respectively. When aircraft power is turned off or disconnected, the Digital Aircraft Clock receives power from an internal 1/2 AA lithium keep-alive battery.

## Clock Mode

On power-up the clock always starts in the UTC mode. The legend "C" is active below the time display. The UTC is displayed as HOURS-MINUTES-SECONDS. The seconds are displayed by the second pointer around the face of the display and the UTC second digits. The UTC can be manually set. The CTRL button is used to set the clock hours and minutes. When the clock is being set, the SEL button moves the operator from the hour field to the minutes field.

## Date Mode

On the first press of the SEL button, the clock enters the date mode. The date information is displayed as DAY-MONTH-YEAR. The day information appears in the two left digits, the month information appears in the two right digits and the year appears in the bottom digits. "D" is displayed in the legend. The CTRL button is used to set the date. While setting the date, the SEL button moves the operator from the day field to the month and then year.

## Elapse Time Mode

On the second press of the SEL button, the clock enters the elapsed time mode. "ET" is displayed in the legend. The CTRL button is used to start, stop, and reset the elapsed timer.

## ALTIMETER-ENCODER (AAU-32/A)

The altimeter-encoder (Figure 1-67) is installed in the pilot's instrument panel. The altitude-encoder combines a conventional barometric type altimeter with a counter-drum-pointer display and an altitude reporting encoder in one self-contained unit. The 10,000 and 1,000 foot counters and the 100 foot drum provide a direct digital output and readout of altitude in units of 100 feet from -1,000 to 50,000 feet. The digital output is referenced to 29.92 and is not affected by change of barometric setting. The pointer repeats the indications of the 100 foot drum. The self-contained servo driven encoder provides altitude encoded in 100 foot units for automatic transmission when the IFF transponder is interrogated on Mode C. In case of power loss to the encoder servo system, a CODE OFF flag appears in the window in the upper left portion of the display, indicating that altitude information is no longer being transmitted. In this condition, the instrument continues to function as a normal barometric altimeter. The barometric pressure is entered by a barometric set knob in the lower left corner of the instrument. The altimeter setting appears on the counters in the window at the lower right of the display and has a range of settings from 28.1 to 31.0. The altitude encoder function is powered by 115 volts AC from the No. 2 main AC bus and protected with a circuit breaker marked ENC located on the cockpit avionics circuit breaker panel.

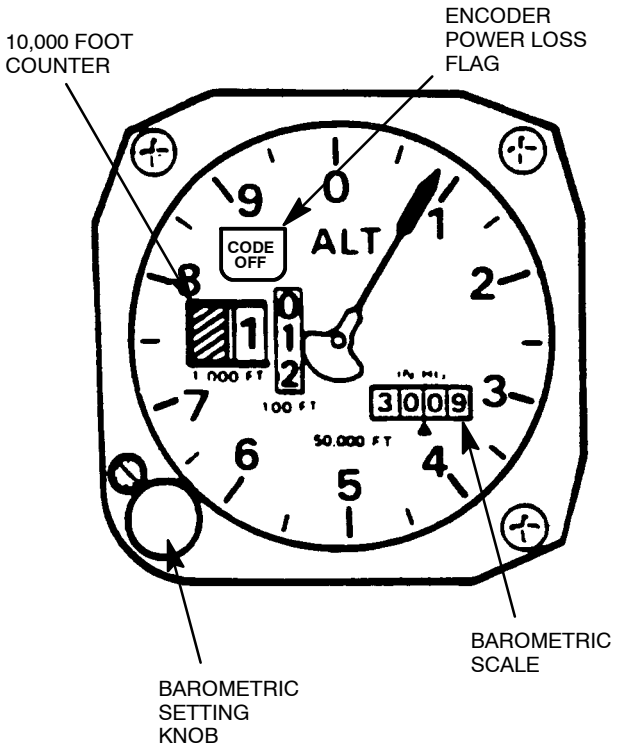



*Figure 1-67. Altimeter-Encoder*

## ALTIMETER (AAU-31/A)

The copilot's altimeter (Figure 1-68) instrument is the same as the altimeter-encoder, except that it does not have an altitude encoder or a CODE OFF display mechanism.

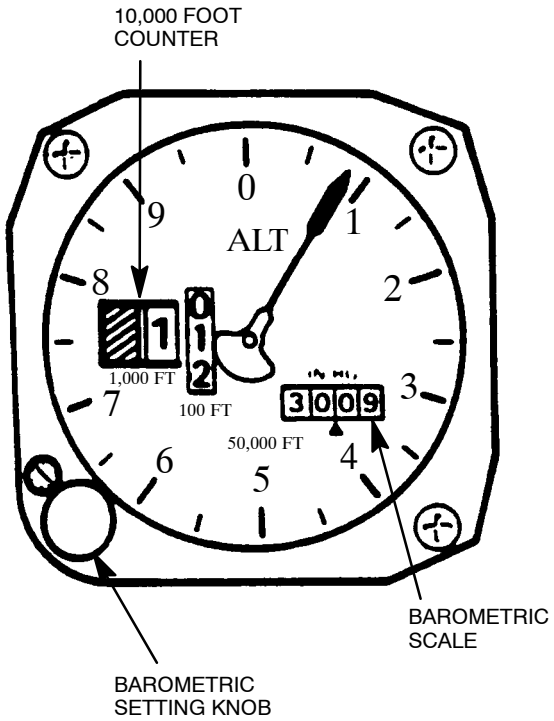



*Figure 1-68. Altimeter*

## VERTICAL SPEED INDICATOR

The vertical speed indicator (Figure FO-2) is a static pressure sensitive instrument that indicates the vertical rate of change in aircraft altitude. The vertical speed indicator is calibrated in 100 feet-per-minute increments from 0 to 1,000 feet, and 500 feet-per-minute increments from 1,000 to 3,500 feet, up or down.

## AIRSPEED INDICATOR

The airspeed indicator (Figure FO-2) measures indicated airspeed through differential pressure from the pitot and static systems. The indicator dial is calibrated from 20 to 200 in increments of 10 knots.

## OUTSIDE AIR TEMPERATURE (OAT) INDICATOR

The outside air temperature indicating system consists of an indicator (Figure 1-1) and a temperature sensing bulb. The

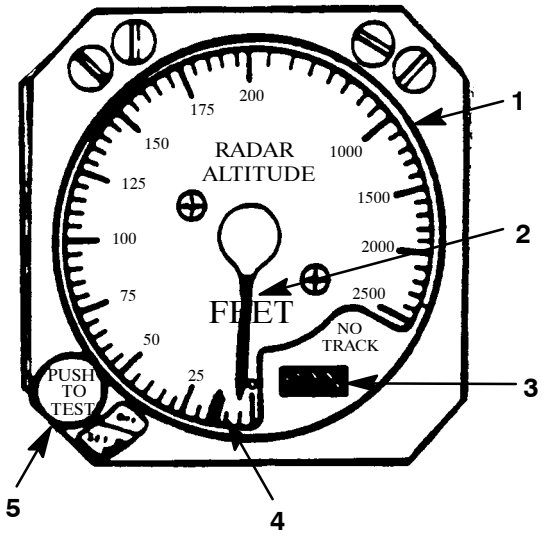
temperature sensing bulb extends through the pilot's overhead window. The OAT is a direct reading instrument graduated in increments from -60 to + 70 degrees C. The OAT reading on the CDU is taken from the temperature sensor on the OADS assembly. The OAT on the VEMD is taken from the ADU.

## RADAR ALTIMETER

Radar altitude data is made available to the CDUs via the MFD for use in navigation and approach-to-hover computations. The Radar Altimeter system provides altitude above ground level (AGL) flight below 2,500 feet AGL for display on the radar altitude indicators, ADI, MFD, and altitude data for use by the Flight Control and FMS systems. Separate radar altitude indicators (Figure 1-69) are provided for pilot and copilot with independent selectable decision height (DH) controls. Decision height control on each indicator provides the following: Radar altitude visual annunciation on the ADI. Aural annunciation from the pilot's DH control only. The Radar Altimeter consists of a receiver-transmitter, antenna system and panel mounted Radar Altitude indicators. This unit provides altitude and validity output to the indicators, flight director computer, and MFD. When below the selected DH, an annunciator light on the Attitude Director Indicator (ADI) is illuminated. When below the pilot's set DH, the altitude aural warnings are enabled. An indicator warning flag is provided on the indicators to indicate power failure or self test. Self test is initiated when the self test button on the indicator is pressed. The self test is inhibited if the Radar Altimeter is coupled to the Flight Director Computer. Figure 1-70 is a block diagram of the Radar Altimeter system.

### Radar Altimeter Operation

A control knob, located on the lower left corner of each indicator, combines functions to serve as a test switch and a low altitude warning index set control. The indicators are powered when the pilot's avionics switch is placed in the ON or BUS OFF position. Approximately 30 seconds must be allowed for system warmup. Clockwise rotation of the control knob will permit each pilot to select any desired low-altitude limit, which will be indicated by the low-altitude warning index marker (bug) on the indicator. The DH annunciator, located on the upper right corner of each ADI, will illuminate whenever the helicopter is at, or below, the altitude set on the related radar altimeter indicator.




1. **Altitude Scale**
2. **Altitude Pointer**
3. **No Track Indicator**
4. **Low–Altitude Warning Index (Altitude Bug)**
5. **Function Control Knob**

*Figure 1-69. Radar Altimeter*

**NOTE**

Although illumination of the DH light on each ADI is separately controlled by the associated radar altimeter low-altitude index setting, the 800 Hz aural warning is controlled by the pilot's radar altimeter low-altitude index setting only.

Depressing the function control knob provides a testing feature of the radar altimeter at any time and altitude. When the control knob is depressed, the altitude pointer should read $400 \pm 40$ feet to verify satisfactory system operation. Releasing the control knob restores the indicator to the actual reading.

**NOTE**

The test function is inhibited by the Flight Director Computer when T-HOV, HOV AUG, or APPR mode is selected.

### Radar Altitude Warning System

The radar altimeter provides a combination of audio signals to the pilot's and copilot's headsets and displays the following visual signals on the instrument panel to warn or inform the pilot of certain altitude conditions.

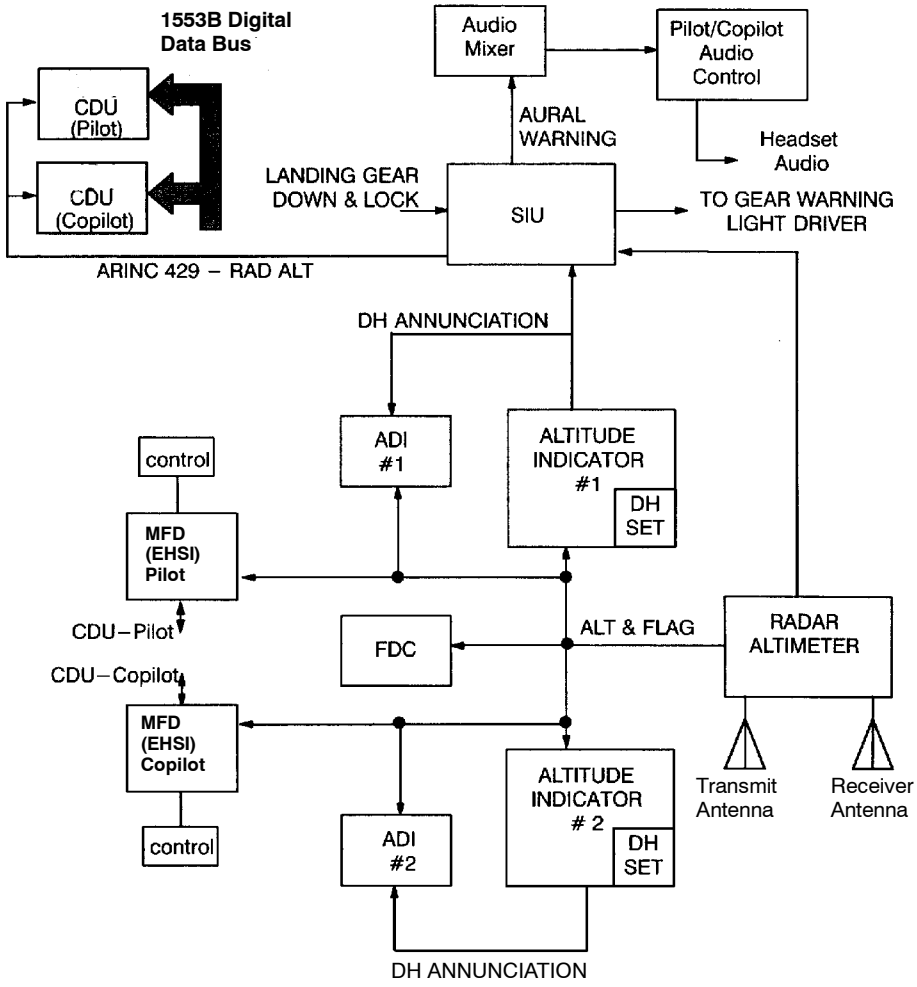



*Figure 1-70. FMS Architecture*

### Landing Gear Up Warning

Whenever the helicopter descends below 200 feet radar altitude with the landing gear not down and locked, the following will occur simultaneously:

- Both L GEAR warning lights on the instrument panel will illuminate for 3 seconds.
- A steady 285 Hz aural tone will sound in the pilot's and copilot's headset for 3 seconds.

### Decision Height Warning

In conjunction with the pilot's low-altitude warning index, the following will occur simultaneously:

- The DH annunciator on the ADIs will illuminate when the helicopter descends to the low-altitude index setting on the pilot's radar altimeter indicator.
- An intermittent 800 Hz aural tone will sound in the pilot's and copilot's headset for 3 seconds.

### Forty-Foot Altitude Warning

When the helicopter descends below 40 feet radar altitude, an alternating on and off 285 Hz aural tone will sound in the pilot's and copilot's headsets for 3 seconds.

**NOTE**

Any low altitude aural signal can be cancelled by placing the HORN AURAL WARN switch located on the overhead panel in the spring-loaded RST (reset) position.

## Failure Indications

Should the radar altimeter become unreliable, or signal validity is lost, the following failure indications will occur:

- The black and yellow striped NO TRACK flag will appear in both indicators.

- A continuous aural tone will sound in the pilot's and copilot's headsets.
- The altitude pointer will go behind the NO TRACK mask.
- The RA flag will appear on the MFD hover page.
- Vertical guidance in the T-HOV and HOV AUG modes of the flight director will become inoperative.
- The red ALT flag will appear in the lower right corner of each ADI.

# FLIGHT MANAGEMENT SYSTEM (FMS)

## INTRODUCTION

The FMS (Figure 1-70) enables crewmember interface with the helicopter integrated avionics system (Figure 1-71). Performing the two functions of cockpit management and mission navigation elements within the FMS include:

- Dual Control Display Units (CDUs) for performing cockpit management functions, mission navigation functions and provide navigation outputs via the dual data bus.
- A dual data bus to provide high speed signal distribution within the FMS.
- Dual System Coupler Computers (SCCs) which control dual data bus operation, format CDU pages, and provide Interface Adapter Module (IAM) control.
- A Signal Interface Unit (SIU) to provide signal interfacing and conditioning for the FMS.

The cockpit management function provides for control of the communications and navigation radio equipment through the use of a CDU at each pilot's station. The mission navigation function includes flight plan management, guidance and steering, automatic navigation, fuel alert and cruise calculations, and engine/transmission monitoring. The FMS is dual configured for redundancy and ease of operation from either the pilot or copilot position. Figure 1-72 illustrates a functional block diagram of the FMS. Figure FO-1 depicts the title and location of avionics Line Replaceable Units (LRUs) installed primarily in the helicopter's avionics rack. The primary FMS components are briefly described below. For a more detailed explanation of the FMS operation and all avionics components, refer to the Avionics Systems Maintenance Manual, USCG T.O. 1H-65A-2-3.

# CONTROL DISPLAY UNIT OPERATIONAL CONCEPTS

The primary control of the flight management system is through two Control Display Units (CDUs), one for each pilot position, located on the center console. Each CDU consists of a data display page, a multifunction keyboard, eight line select keys, and vertical scroll keys. Each unit can be operated simultaneously or independently by either pilot. For example, the pilot may change a navaid frequency on the pilot's CDU while editing the flight plan on the copilot's CDU.

Primary operating power for the CDUs is 28 VDC. The CDUs are protected by the CDU circuit breakers located on the cockpit avionics panel. Each CDU contains a GPS receiver capable of tracking five satellites. Each CDU also contains a mission computer capable of performing all flight related mission calculations.

### Dual Data Bus

A two wire dual data bus provides high speed distribution of signals within the FMS on a single transmission line. In addition to connecting the CDUs and SCCs; the dual data bus interfaces the FMS with the COMM 1 and COMM 2 radios, the MDL and VADR. See Figure 1-72. Two buses are available (BUS A and BUS B) to prevent a single bus failure from stopping dual data bus operation. Utilization of the dual data bus is controlled by the SCCs.

### System Coupler Computer (SCC)

The SCCs provide complete integration of the tuning, control, and display of the communication and navigation radios. The SCCs contain Interface Adapter Modules (IAMs) to interface those avionics LRUs that are not connected directly to the dual data bus. The SCCs also provide operator selected pages to the CDUs for display. Processors within the SCCs provide primary and backup dual data bus control for all cockpit management functions.

### Dual Data Bus Control

The CDUs are responsible for managing the data flow over the 1553B data bus. During normal operation, the pilot's CDU assumes data bus control (BC) while the copilot's CDU acts as a remote terminal (RT). If the RT CDU detects a quiet bus for a predetermined time period, then the RT CDU takes over bus control. In addition to controlling the data bus, the BC CDU maintains data bases (magnetic variation database, Reversionary Site Database), performs all navigation com-

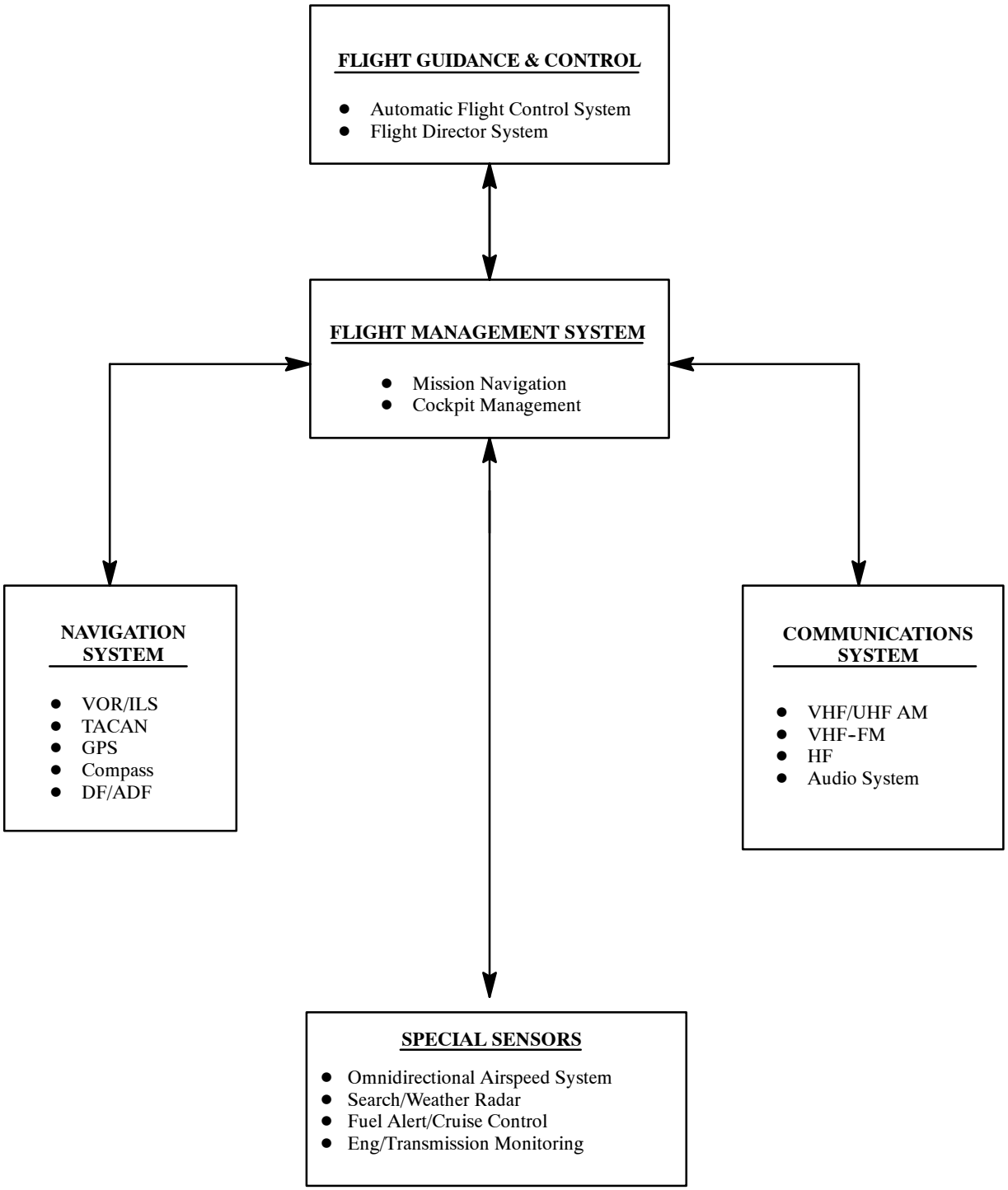



*Figure 1-71. Integrated Avionics System Block Diagram*

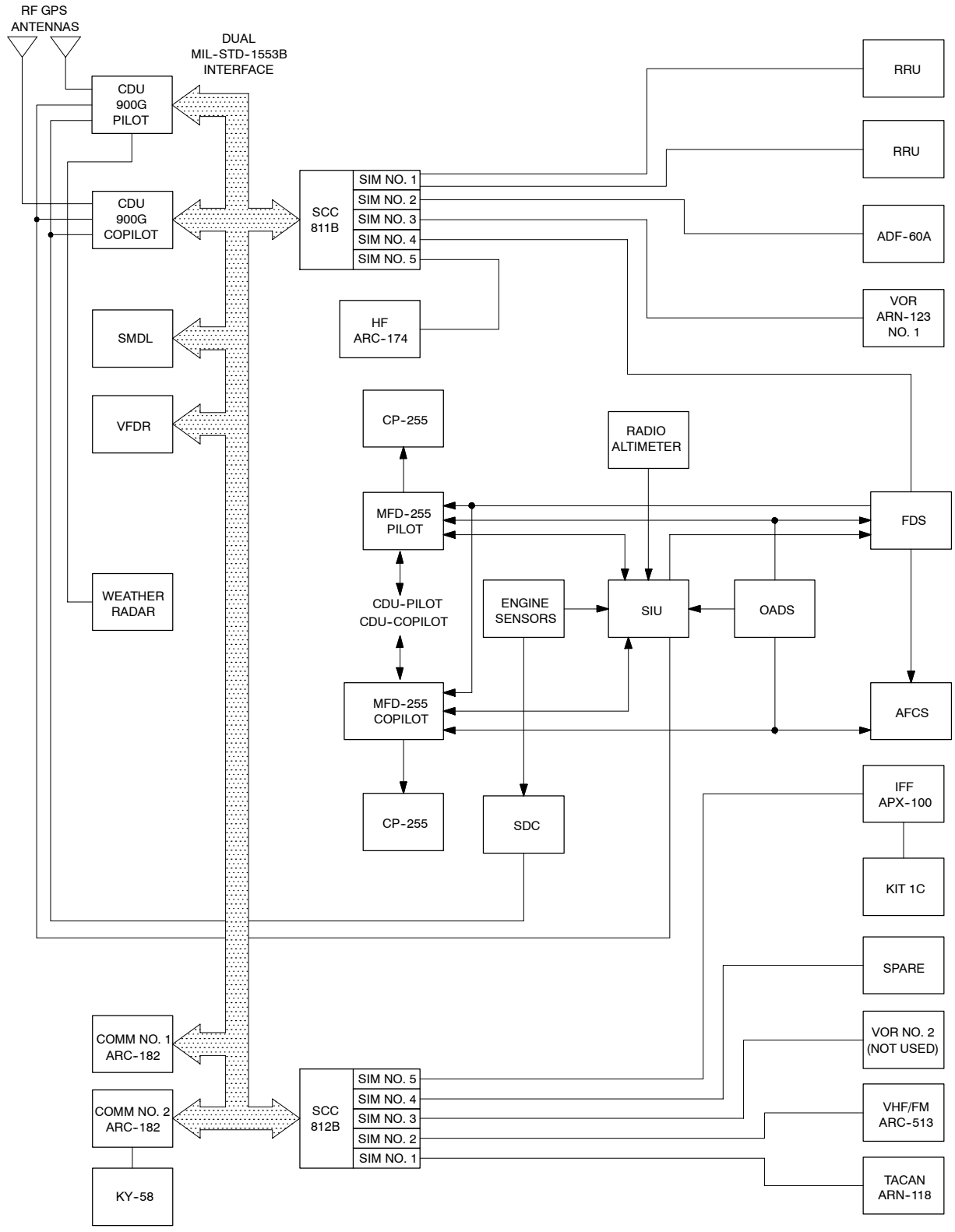



*Figure 1-72. HH-65C Avionics System Architecture*

putations, collects system status information, etc. The RT CDU merely processes keystrokes and displays data.

## Interface Adapter Module (IAM)

Each SCC also contains IAMs for interfacing the LRUs connected to them. The SCCs and the IAMs they control are:

| SCC 1 | SCC 2 |
|---|---|
| HF | IFF |
| VOR | VHF/FM |
| DF/ADF | TACAN |
| RRU 1/ RRU 2 | |
| STR | |

The SCCs are powered by 28 volts DC from the pilot's and copilot's shed buses. Each SCC is protected by a circuit breaker marked SCC on the avionics cockpit circuit breaker panel.

## SIGNAL INTERFACE UNIT (SIU)

The SIU is an LRU located in the avionics rack and provides signal interfacing and conditioning of signals for various unrelated avionics systems. These include, but are not limited to: routing audio warning tones to alert the crew to failures and/or unsafe conditions, routing CDU alert signals from SCCs to the Warning-Caution-Advisory panel, processing radar altimeter self-test and altimeter trip warning signals, routing time data and engine sensor signals to the CDU, converting air data signals for CDU utilization, routing compass system valid signals to the BDI, performing the NAV TRANSFER function, and routing VOR and TACAN monitor signals to the BDI.

The SIU is dual powered by 28 volts DC routed through the pilot's and copilot's shed buses and protected by two circuit breakers labeled SIU. Both circuit breakers are located on the cockpit avionics circuit breaker panel.

## REVERSIONARY FMS SWITCH OPERATION AND CONTROL

Electrical power is supplied to the components of the FMS upon initial power application when the CPLT and PLT AVIONICS switches on the electrical panel are turned on. However, should a malfunction occur in the FMS, such as signal lockup, or freeze of the dual data bus, reversionary relays mounted within the center console allow for removal of DC power from selected FMS components. The reversionary relays are controlled by the CPLT and PLT AVIONICS three position switches. The switch labels and the components they control are shown in Figure 1-73.

| PLT | CPLT |
|---|---|
| SCC 1 | SCC 2 |
| CDU 1 | CDU 2 |
| COMM 1 | COMM 2 |
| GPS 1 | GPS 2 |

*Figure 1-73. FMS Components*

The AVIONICS switches are normally in the ON position. For reversionary operation, moving a switch to the BUS OFF position will depower and isolate the components controlled by that switch. If this action also isolates the malfunction, then normal FMS operation will be automatically restored to the opposite side of the cockpit and allow CDU, MFD, and RRU presentations to reappear.

**NOTE**

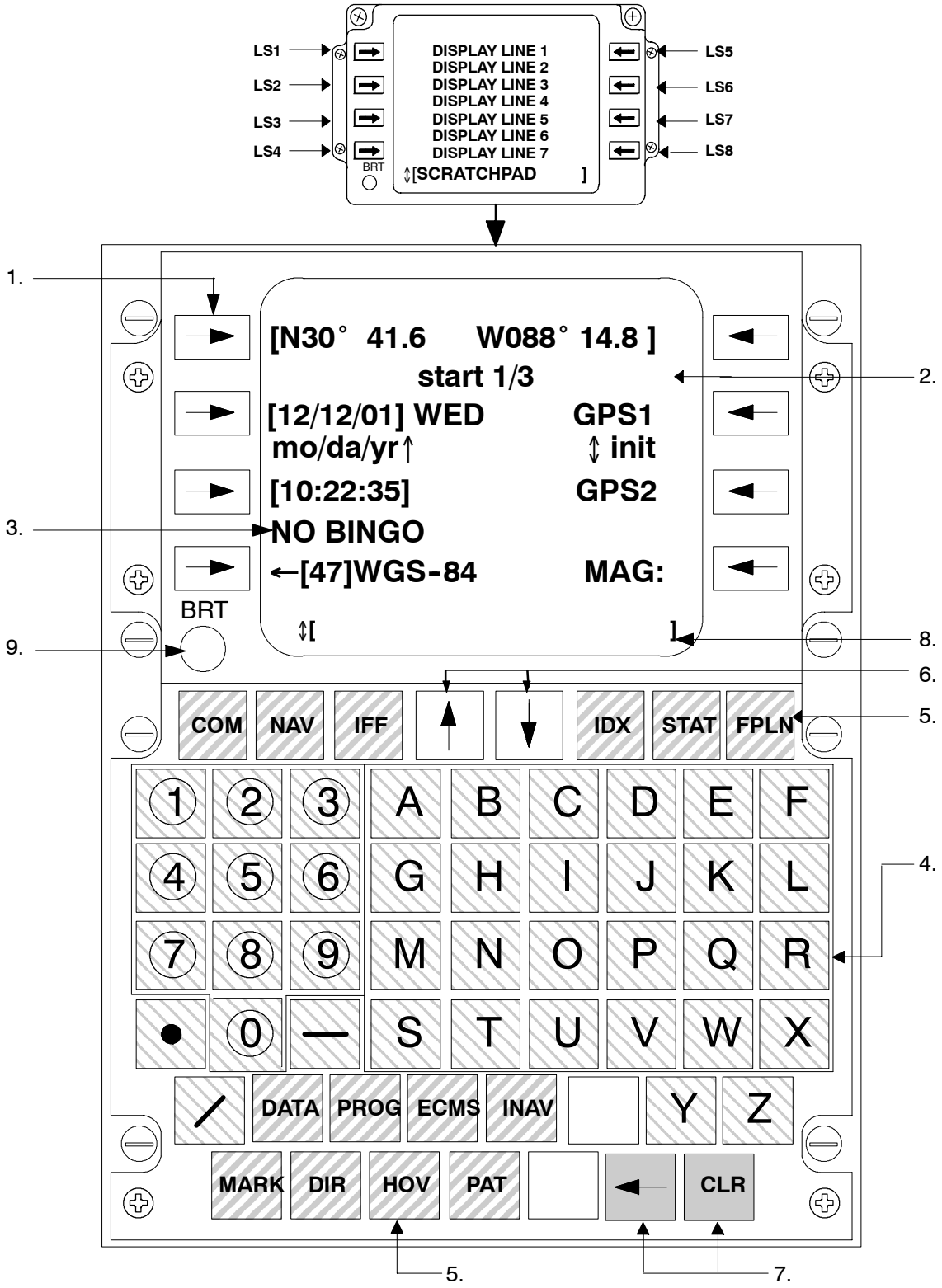
RRU presentations will not reappear if the pilot's avionics switch is moved to BUS OFF because both RRUs are controlled through SCC 1.

The presentations displayed by the components that have been isolated will be blanked. If the above procedure fails, AC power may be removed from the CDUs in a final effort to restore FMS operation to at least one side of the cockpit. This is accomplished by pulling the CDU circuit breaker mounted on the cockpit avionics circuit breaker panel to isolate the defective CDU. Refer to Section III for the reversionary FMS operational procedure.

## CDU DISPLAY

The display page of each CDU displays data received or data entered from the keyboard (Figure 1-74). This data is presented in clear language, abbreviations, and special symbology which is displayed in the following manner:

- EIGHT DISPLAY LINEs permit the display of up to 22 alphanumeric characters or symbols.
- DISPLAY LINEs 1, 3, 5 and 7 are data lines with a line select key on both the right and left of the field.




1. Line Select (LS) Key
2. Display Line 2, Page Title
3. Annunciator Line (DL 6)
4. Alphanumeric Keys
5. Page Access / Function Keys
6. Vertical Scroll Keys
7. Clear / Backspace (◄— ) Keys
8. Scratchpad (DL 8)
9. Brightness Control

*Figure 1-74. Control Display Unit (CDU)*

- DISPLAY LINE 2 displays the page title.
- DISPLAY LINE 4 is an unreserved display line.
- DISPLAY LINE 6 is an annunciator line, which provides messages to the crew.
- DISPLAY LINE 8 is a scratchpad line used to make data entries for insertion into DISPLAY LINEs of the various CDU page displays.

Special symbology is employed on the pages to indicate control status or operations that may be performed (Figure 1-75). These symbols and their definitions are as follows:

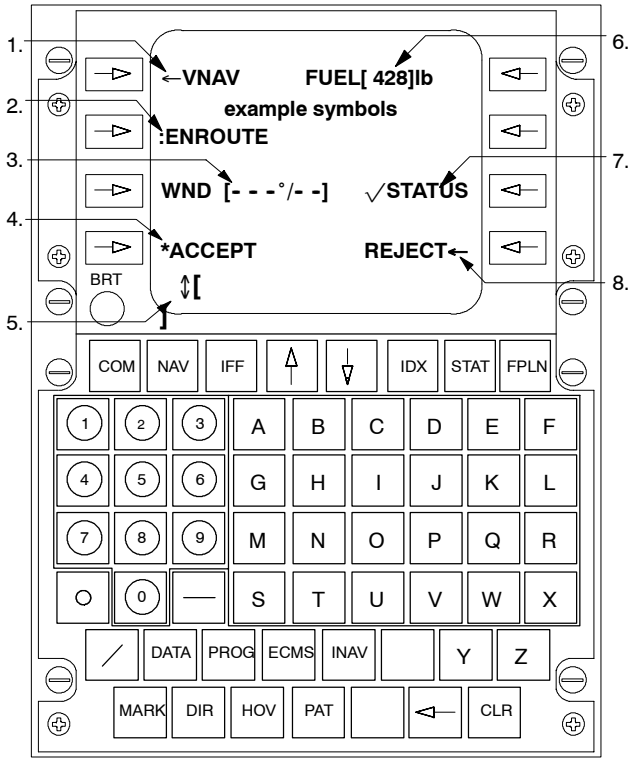



*Figure 1-75. CDU Display Symbology*

1. ←→ An arrow pointing outward to individual line select keys instructs the operator to depress the indicated key to access additional pages.

2. **:** A colon indicates that you can toggle the line function through various modes.

3. **---** Dashes indicate no computed data, power is off, or a sub-system has a malfunction.

4. ***** An asterisk next to a line select key means that the adjacent function or mode is on, engaged, or selected.

5. ↓↑↕ Appears in DISPLAY LINE 8 and indicates page scrolling, discrete switching, or control using the vertical scroll keys. A double-headed arrow indicates scrolling in either direction. A single up or down arrow indicates scrolling is limited to up or down.

6. [ ] Brackets indicate that data entry by the operator is possible or required.

7. ✓ Indicates check status for equipment failures.

8. →← Inward pointing arrows indicate that pushing the line select key selects the item or enables the mode that the arrow is addressing.

## CDU KEYBOARD

The CDU keyboard provides 59 keys for making entries in the scratchpad and for calling up access pages on the display page. The scratchpad is a buffer to hold all keystrokes prior to executing the input. Data and messages in the scratchpad can be cleared using the clear (CLR) key or the backspace (←) key. The scratchpad clears automatically when the system accepts valid inputs.

### Clear Key (CLR)

If there is manually entered data in the scratchpad, pressing the CLR key once deletes the last character entered. Depressing the CLR key twice deletes the entire line. If invalid data is inputted into a data field, the scratchpad data alternately flashes with an "ERROR" annunciation. Pressing the CLR key completely clears the "ERROR" and deletes the scratchpad data.

### Backspace Key (←)

If there is data manually entered in the scratchpad, the first press of the backspace key (←) deletes the last character entered. Additional presses continue to delete the last character in the scratchpad. If invalid data is inputted into a data field, the scratchpad data alternately flashes with an "ERROR" annunciation. Pressing the Backspace key clears the flashing "ERROR" message and leaves the data in the scratchpad. Additional presses continue to delete the last character in the scratchpad.

## LINE SELECT KEYS

Eight line select keys (Figure 1-74), four on each side of the display page, are provided on the CDU. The line select keys provide access to lower-level pages, toggle the modes of specific functions, enter data into fields, and execute functions. When an access page is displayed on the display page, depressing the line select key adjacent to one of the DISPLAY LINEs calls up additional data pages, if available, concerning that line function. For example; with the COMM

access page displayed, selection of the line select key adjacent COMM 1 calls up the data page for that radio. Line select keys also serve as insert keys for transferring scratchpad entries to a DISPLAY LINE displayed on the display page.

## CDU DISPLAY SCROLLING

When more data is available than fits on a single display page, scrolling is used to access all related information. Scrolling with the scroll keys can involve vertical page scrolling, which changes the display to a different page, or vertical line scrolling which scrolls the page one line at a time. Vertical Arrows are displayed adjacent to the scratchpad to indicate that scrolling is available on the current page. Holding the arrow keys causes the scrolling to continue until the key is released. Only vertical scrolling is allowed.

### Vertical Page Scrolling

Vertical page scrolling advances an entire page at a time to the next set of data. Vertical scrolling is accomplished by pressing the UP and DOWN arrow keys. Pressing the UP arrow key moves toward the beginning of a set of data and vice versa for the DOWN arrow key. For example, pressing the down arrow with Start Page 1/3 displayed changes the display to Start Page 2/3. Pressing the up arrow with Start Page 1/3 displayed changes the display to Start Page 3/3.

### Vertical Line Scrolling

With vertical line scrolling, only one new display line is shown for each press of the UP or DOWN arrow key. For example, after accessing the flight plan, pressing the DOWN arrow key shifts the current flight plan route down two display lines and displays the first history waypoint in display line one. Additional presses of the DOWN arrow brings waypoints out of history. Conversely, after accessing the flight plan, pressing the UP arrow key shifts the current flight plan route up two display lines and brings future waypoints to display line seven.

## CONFIRMATION FUNCTION

Certain functions that involve deleting or replacing significant data, or functions which significantly alter the state of the system, require confirmation before execution. Functions that require confirmation before execution result in a CONFIRM scratchpad message. The CONFIRM is cleared by re-selecting the appropriate line select key to confirm the selection, leaving the page, or by pressing the CLR key if the function is not desired. If no action is taken by the user within 3 seconds, the condition is cancelled and the CONFIRM scratchpad message is automatically cleared and the system configuration remains unchanged.

## DEDICATED PAGE AND FUNCTION ACCESS KEYS

Several CDU pages and functions have single key access through dedicated keys. Dedicated page access keys include COM, NAV, IFF, IDX, STAT, FPLN, DATA, PROG, ECMS, INAV, HOV and PAT. MARK and DIR are dedicated function keys that provide specific functions addressed in the individual page access section. These keys allow the operator to directly activate a function or access top-level or commonly used displayed pages. Once a top-level page is accessed, additional display pages may be accessed from the top-level page and are addressed in the individual page access section.

## SYSTEM ANNUNCIATIONS AND SCRATCHPAD MESSAGES

The annunciation line is reserved for page independent messages to the flight crew advising them of events within the system which may require an operator response. The annunciation line is divided into two fields that have independent display queues and priority schemes. At any time, onset of conditions for a higher priority annunciation preempts display of a lower priority annunciation. Status annunciations are covered in detail in the status annunciation section.

## SYSTEM TESTS

The CDU provides two tests, the Initiated Built-In Test (IBIT) and Continuous Built-In Tests (CBIT), to provide monitoring of the Line Replaceable Units (LRU). The IBIT is an operator initiated self-test on the LRU. The IBIT is available when the system senses it is on the ground through activation of the weight on wheels switch. Operation and execution of the IBIT is covered in detail in the System IBIT section.

The CBIT provides continuous monitoring of all LRU self tests and automatically provides a $\surd$ STATUS alert when a failure occurs. The CBIT operates in-flight and on the ground, and provides the operator with the current status of each LRU. A detailed explanation of CBIT is covered in the System CBIT section.

## STATUS ANNUNCIATIONS

The CDU alerts the crew of LRU failures, degraded operations or operator entry errors through:

- Annunciation on the “CHECK CDU” advisory light.
- Annunciations on annunciation line (DL 6).
- Scratchpad messages (displayed only in the CDU with the error condition).

The following annunciations activate the "CHECK CDU" advisory on the WCA panel:

- BINGO
- RESERVE FUEL
- ENG EXCD
- √STATUS (due to either CDU failing or a GPS failure)
- KEY ALERT
- INVLD APP
- INVLD TRM
- INVLD ENR
- ZONE EXCD
- NAV FAIL
- NO RAIM (if RAIM is toggled to "ON" on the GPS RAIM page)
- RAIM WARN

Table 1-1 lists CDU annunciations and scratchpad messages. The following abbreviations are used in the table indicating the type of display:

| | | |
|---|---|---|
| Location | SP | SCRATCHPAD |
| | DL6 | DISPLAY LINE 6 |

***Table 1-1.*** **CDU ANNUNCIATIONS AND SCRATCHPAD MESSAGES**

| Annunciation | Condition | Reset By | Location |
|---|---|---|---|
| √BARO ALT | Loss of valid barometric altimeter data during an approach to hover | Clear key or cancel approach to hover | DL6 |
| √MAG VAR | Invalid magnetic variation | Not clearable except by condition corrected | DL6 |
| √WIND LINE | Hover course is > +/-20 degrees from the Hover page wind | Clear key | SP |
| √STATUS | Requested operation not possible due to equipment status/failures | Clear key | SP |
| √STATUS | Equipment failure | Clear key | DL6 |
| √SW VERS | Software part numbers of the CDUs are different | Not clearable except by condition corrected | DL6 |
| APPROACH ACTIVE | Attempt to delete the active "TO" when it is an Approach waypoint, an attempted course edit, change sequencing mode when the MAP is in the future, or enter a parallel offset, while the Approach is active | Clear key or a valid selection of another waypoint | SP |
| APPROACH DEFINED | Attempt to enter data (except the barometric setting) on the Approach page when an approach is defined in the FPLN, or attempted Approach insert when an approach already exists in the flight plan | Clear key | SP |
| APPROACH WPT | Attempt to attach a search pattern to a MAP, LOP or FAF | Clear key | SP |
| ATTACH CIRCLE? | Inserting Circle Pattern, prompts crew to select location to attach the pattern | Clear key or attach waypoint selected | SP |
| ATTACH EXP SQ? | Inserting Exp Sq Pattern, prompts crew to select location to attach the pattern | Clear key or attach waypoint selected | SP |
| ATTACH HOLD? | Inserting Hold Pattern, prompts crew to select location to attach the pattern | Clear key or attach waypoint selected | SP |
| ATTACH HOVER? | Inserting Hover Pattern, prompts crew to select location to attach the pattern | Clear key or attach waypoint selected | SP |
| ATTACH LADDER? | Inserting Ladder Pattern, prompts crew to select location to attach the pattern | Clear key or attach waypoint selected | SP |

*Table 1-1.* **CDU ANNUNCIATIONS AND SCRATCHPAD MESSAGES (CON.)**

| Annunciation | Condition | Reset By | Location |
|---|---|---|---|
| ATTACH SECTOR? | Inserting Sector Pattern, prompts crew to select location to attach the pattern | Clear key or attach waypoint selected | SP |
| BINGO | When time to Bingo goes to zero | Clear key or condition corrected | DL6 |
| CIRCLE ACTIVE | Attempt to delete the active "TO" when it is a Circle waypoint or an attempted course edit while the Circle is active | Clear key | SP |
| CIRCLE WPT | Attempt to modify a waypoint that is associated with a Circle | Clear key | SP |
| COMPARE GPS | When GPS 1 and 2 disagree by greater than the navigation limits for the current flight mode | Clear key | DL6 |
| CONFIRM | Operation requires a confirmation to perform action | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CONFIRM STORE | Request to store the current Mission ID DB into long term NVM following a search of the Primary ID DB | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CONFIRM ZERO KEYS | Request to zero keys | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CONFIRM CANCEL | Request to cancel the search of the Primary ID DB for creation of the Mission ID DB | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CONFIRM ERASE ALTN | Request to erase the alternate flight plan | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CONFIRM ERASE FPLN | Request to erase the flight plan | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CONFIRM HOLD PPSN | Request to hold at present position | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CONFIRM LOAD ALM | Request to load almanac data into the selected GPS | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CONFIRM LOAD SITE | Request to load site data | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |

*Table 1-1.* **CDU ANNUNCIATIONS AND SCRATCHPAD MESSAGES (CON.)**

| Annunciation | Condition | Reset By | Location |
|---|---|---|---|
| CONFIRM S/N | Request to enter serial number for the ECMS function | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CONFIRM SEARCH | Request to begin a search of the Primary ID DB to create a Mission ID DB | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CONFIRM STAT | Request to enter ECMS statistical data | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CONFIRM ZONE | Request to enter ECMS zone data | Clear key, a second selection of the action, a 3-second time-out, or leave the page | SP |
| CRS CHANGE >90 | Attempt to apply course edit greater than 90 degrees from the current inbound course, auto mode only | Clear key | SP |
| DB NOT STORED | Display when attempt is made to modify the anchor fix or radius or to leave the Mission Data Load before storing the Mission ID Database | Clear key | SP |
| D/R | Dead reckon navigation | Not clearable except by condition corrected | DL6 |
| ENG EXCD | Parameters for engine/trans exceed the normal operating limits | Clear key | DL6 |
| ENTER PARAMETERS | Attempt to insert a rendezvous, approach, search pattern or hover without all required data defined | Clear key | SP |
| ENTER GMT | On power up if GPS is not available and the crew has not entered time, also if bus control switch with GPS time not valid, or a power interrupt greater than 2 seconds with GPS time invalid | Clear key or condition corrected | DL6 |
| ERROR | Attempt to enter data which does not pass format or range tests or an attempt of an invalid operation | Clear key or selecting an appropriate line select key | SP |
| FPLN FULL | Attempt to enter more than 50 waypoints | Clear key | SP |
| FPLN NOT FOUND | FPLN not found on the MDL | Clear key | SP |
| GRD ACTIVE | An attempt to tune a comm radio which is currently in the guard mode of operation | Clear key | SP |
| GROUND ONLY | Attempt to initiate an operation while in the air which may only be performed on the ground | Clear key | SP |
| hh:mm:ss | System clock display | Deselect clock display | DL6 |
| HOLD ACTIVE | Attempt to delete the active “TO” when it is a Hold waypoint, or an attempted course edit while the Hold is active, or an attempt to activate a hold at the present position when the Hold is already active | Clear key or valid selection of another waypoint | SP |
| HOLD WPT | Attempt to modify a waypoint that is associated with a Hold | Clear key | SP |

*Table 1-1.* **CDU ANNUNCIATIONS AND SCRATCHPAD MESSAGES (CON.)**

| Annunciation | Condition | Reset By | Location |
|---|---|---|---|
| HOVER ACTIVE | Attempt to delete the active "TO" when it is a Hover waypoint or an attempted course edit while the active waypoint is Hover | Clear key or valid selection of another waypoint | SP |
| HOVER IN FPLN | Attempt to insert a Hover into FPLN when one already exists in the FPLN | Clear key | SP |
| HOVER WPT | Attempt to modify a waypoint that is associated with a Hover | Clear key | SP |
| INSERT APPROACH? | An Approach has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT CIRCLE? | A Circle Pattern has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT EXP SQ? | An Expanding Square Pattern has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT HOLD? | A Hold Pattern has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT HOVER? | A Hover Pattern has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT IMPROMPTU? | An Impromptu Pattern has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT LADDER? | A Ladder Pattern has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT RENDZ1? | Rendezvous 1 has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT RENDZ2? | Rendezvous 2 has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT ROUTE? | A flight plan has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT SECTOR? | A Sector Pattern has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT SPOT? | A Spot Pattern has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INSERT WPTS? | A group of waypoints from the Waypoint List has been selected for insertion into the FPLN | Clear key or valid input into FPLN | SP |
| INVALID DELETION | An attempt to delete data for a rendezvous that has been inserted into the FPLN or an attempt to delete the center point for a Circle Pattern on the Circle definition page | Clear key | SP |
| INVLD APP | EHE greater than levels allowed in the approach flight mode | Clear key or condition corrected | DL6 |
| INVLD ENR | EHE greater than levels allowed in the approach flight mode | Clear key or condition corrected | DL6 |
| INVLD TRM | EHE greater than levels allowed in the approach flight mode | Clear key or condition corrected | DL6 |
| KEY ALERT | GPS SA/AS keys expiring in 2 hours | Clear key or the entry of new keys which pass the time test | DL6 |
| LOAD FAIL | MDL related load failures | Clear key | DL6 |

*Table 1-1.* **CDU ANNUNCIATIONS AND SCRATCHPAD MESSAGES (CON.)**

| Annunciation | Condition | Reset By | Location |
|---|---|---|---|
| MAX PATTERNS | An attempt to insert or attach a pattern into the FPLN when three patterns already exist in the FPLN, Spot and Hold Patterns are not counted, or an attempt to enter more than one Spot Pattern into the FPLN | Clear key | SP |
| M4 REPLY | If Kit 1C is installed and IFF replies to an interrogation, and light is enabled on the IFF page | Auto reset by IFF | DL6 |
| MDA | Arrival at the approach MDA | Clear key | DL6 |
| MDL BUSY | Attempted access to the MDL when the MDL is busy with a requested operation | Clear key | SP |
| NAME IN USE | An attempt to attach a user defined label with a name already in use in the FPLN, ALT FPLN, Waypoint List or Mark List | Clear key | SP |
| NAV FAIL | No valid navigation mode | Upgrade to a valid navigation mode | DL6 |
| NEED KEY | Insufficient GPS SA/AS keys for mission duration | Clear key, loading of more keys greater than mission duration, or decreasing the mission duration | DL6 |
| NO BINGO | If last waypoint in the FPLN is a Rendezvous or insufficient data is available to calculate a BINGO | Clear key or condition corrected | DL6 |
| NO APPR TO HOVER | An attempt to enter a Hover into the FPLN with insufficient data (invalid baro altitude or radar altitude, radar altitude > 2,500 ft., or system calculated wind is invalid) or when the HOV key is pressed and baro altitude or radar altitude is invalid | Clear key | SP |
| NO KEYS ZERO | An attempt to zeroize the SA/AS keys in the GPS has failed | Clear key or a subsequent successful clear of the keys | DL6 |
| NO MISSION DB | An attempt to store the Mission Identifier Database when none has been created | Clear key | SP |
| NO RAIM | If the RAIM function is toggled to “ON” and if the RAIM is unavailable for more than 30 seconds in the selected GPS (ignored if the unit is not available) or RAIM Available indicates no RAIM when the MAP becomes the “TO” waypoint | Clear key or RAIM function toggled to OFF | DL6 |
| NO RENDZ | When a Rendezvous solution is a point of closest approach and the rendezvous becomes the “TO” waypoint in the flight plan | Clear key or a valid Rendezvous solution | DL6 |
| NOT FOUND | An unsuccessful attempt to find data on the MDL | Clear key | SP |
| OFFSET | Parallel Offset is applied | Offset cancelled | DL6 |
| OFFSET CNCLD | Parallel Offset is cancelled | Clear key | DL6 |
| PATTERN ACTIVE | An attempt to activate a hold at present position when a pattern is active in the flight plan | Clear key | SP |
| PATTERN WPT | An attempt to attach user defined label to a pattern waypoint, or to insert or attach another pattern to pattern waypoint | Clear key or valid selection of another waypoint | SP |

*Table 1-1.* **CDU ANNUNCIATIONS AND SCRATCHPAD MESSAGES (CON.)**

| Annunciation | Condition | Reset By | Location |
|---|---|---|---|
| RAIM WARN | RAIM Approach Alarm or RAIM Integrity Alarm | RAIM Approach Alarm or RAIM Integrity Alarm reset | DL6 |
| RENDZ ACTIVE | Attempt to delete the active "TO" when it is a Rendezvous waypoint, or an attempted course edit while the Rendz is active | Clear key or selection of another waypoint | SP |
| RENDZ WPT | An attempt to attach a user defined label to a rendezvous waypoint, or to insert or attach a pattern to a rendezvous waypoint | Clear key or a valid selection of another waypoint | SP |
| RESERVE FUEL | Reserve fuel is being burned | Condition corrected | DL6 |
| SEARCH IN PROGRESS | Attempt to modify Mission ID DB parameters; radius, anchor fix or attempt to Store while a search is in progress | Clear key or condition corrected | SP |
| SEARCHING | Mission ID DB search in progress | Search complete or press CANCEL or WOW false | DL6 |
| WPT PASSED | An attempt to attach a search pattern to the active waypoint while on the From side, while manual sequencing is selected | Clear key or a valid selection of another waypoint | SP |
| WRONG KEY | Incorrect SA/AS key received | Clear key or correct key entered | DL6 |
| ZONE EXCD | Main Gear Box Zone Exceedance | Clear key | DL6 |

*Table 1-2. CDU Annunciation Line Priority*

| Left Justified | Right Justified |
|---|---|
| BINGO | M4 REPLY (transitory) |
| ENG EXCD | √STATUS |
| ZONE EXCD | NAV FAIL |
| RESERVE FUEL | √BARO ALT |
| NO BINGO | NO RAIM |
| RAIM WARN | INVLD APP |
| NO RENDEZ | INVLD TRM |
| OFFSET CNCLD | INVLD ENR |
| MDA | KEY ALERT |
| COMPARE GPS | NEED KEY |
| √COMPASS | WRONG KEY |
| ENTER GMT | LOAD FAIL |
| NO KEYS ZERO | √MAG VAR |
| OFFSET (non clearable) | √SW VERS |
| D/R (non clearable) | hh:mm:ss |
| SEARCHING (non clearable) | |

Table 1-2 lists the priorities (highest priority at top of list) for CDU annunciations. Onset of conditions for a higher priority annunciation preempts display of a lower priority annunciation.

## STANDARD CDU DATA ENTRY AND DISPLAY FORMATS

The scratchpad is independent of the page display and is used to make up data entries for insertion into data fields on the various CDU access pages. The crew also uses the scratchpad to delete data entries by use of the minus sign on the CDU keyboard. The scratchpad on each CDU is independent of the other. Scratchpad entries are made by using the alphanumeric or symbol keys on the keypad. A total of 19 characters can be entered into the scratchpad line. Scratchpad entries remain on the bottom of the display regardless of pages accessed until the data is cleared or until a line select key is selected that has a corresponding data field for which the scratchpad entry is valid. If the entry in the scratchpad is valid for the line key selected, the data is transferred to the data field and the scratchpad is automatically cleared. When attempting to insert scratchpad data that is not valid or is in an improper format, a flashing ERROR annunciation appears in the scratchpad line alternately with the invalid data. The error can be corrected by selecting a line select key for which the scratchpad data is compatible, or through use of the CLR or backspace keys. The CLR and backspace keys can also be used to remove data from the scratchpad as discussed in the CLR Key/Backspace Key sections.

### ENTRY AND DISPLAY OF LATITUDE/LONGITUDE WAYPOINTS

Latitude/longitude waypoints are entered in the form of degree and minutes. Data can be entered into the CDU to the thousandth of a minute, although the data is displayed on the Flight Plan Page to the nearest tenth of a minute. The “N”/ “S,” “E”/ “W” characters may be included or omitted. If omitted, the position defaults to North Latitude and West Longitude. If used, latitude/longitude input is limited to hundredths of degrees.

The two and three character degree / minute fields are range checked as follows in Table 1-3:

| Quantity | Minimum | Maximum |
|---|---|---|
| Latitude degrees | 0 | 90 |
| Latitude minutes | 0 | 59.999 |
| Longitude degrees | 0 | 180 |
| Longitude minutes | 0 | 59.999 |

*Table 1-3. Lat/Long Range*

If latitude is 90° or longitude is 180°, then the associated minutes must be 0. Latitude / longitude waypoints are displayed left justified in the form “N42 °34.5 W105°25.6” on all CDU pages except on the Integrated Navigation pages. The Update Page and the Waypoint Data Page display thousandths of minutes as “N42°34.513 W105°25.647.” The Alternate Flight Plan Waypoints Page does not display the tenths or hundredths of minutes.

## ENTRY AND DISPLAY OF IDENTIFIER WAYPOINTS

Waypoint Identifiers are entered as up to five alphanumeric characters, with alphabetic characters written as capital letters. Waypoint Identifiers must be entered and stored in the primary or reversionary sites or "NOT STORED" annunciation results.

## ENTRY AND DISPLAY OF IDENTIFIER / BEARING / DISTANCE WAYPOINTS

Identifier/bearing/distance (IBD) waypoints enable the crew to define a position by referencing a primary or reversionary site waypoint, navaid or mark position. Using the scratchpad, the IBD waypoint is entered as the valid identifier (the primary or reversionary site waypoint, navaid or mark position) followed by "/," the bearing, followed by "/" and the distance in nautical miles. The bearing, entered in degrees and tenths of degrees, may optionally be specified as true (T) or magnetic (M). When not specified, the true/magnetic setting chosen on Start Page 1/3 is the default. Distances from 0.1 to 999.9 miles may be entered. For display purposes, the CDU shows the bearing rounded to the nearest degree on the Waypoint and Flight Plan Pages.

## ENTRY AND DISPLAY OF MILITARY GRID REFERENCE SYSTEM WAYPOINTS

Military Grid Reference System (MGRS) coordinates are defined in the Defense Mapping Agency Technical Manual 8358.1, Datums, Ellipsoids, Grids and Grid References. They are entered as three components:

1. Grid zone designation.
2. 100,000 meter square identification.
3. The grid coordinates.

The MGRS is divided into two distinct segments:

1. Locations based on Universal Transverse Mercator (UTM) grid projection.
2. Locations based on the Universal Polar Stereographic (UPS) grid projection.

The format for points based on UTM and UPS are identical except for the grid zone designation.

The 100,000 meter square identification is entered as two alphabetic characters, identifying the individual 100,000 meter squares within the grid zone. The specific combinations of characters that are valid depends on which grid zone is specified. Many anomalies exist at the boundaries of different grid zones and where the base spheroid changes at boundaries between major mapping divisions. DMA TM 8358.1 provides the detailed definition of these boundaries as well as listing all the valid 100,000 meter square identifiers for the entire surface of the earth.

The grid coordinates are entered as an Easting component followed by a Northing component. The number of digits is variable, but the total number must be even (i.e., Easting and Northing both have same number of digits). If ten digits are used (five Easting, five Northing) then the least significant figure represents one meter. If eight digits are used, the precision is 10 meters. If six digits are used, the precision is 100 meters.

Display format for MGRS waypoints is the grid zone designation followed by the 100,000 meter square identification, followed by a space, followed by the grid coordinates. Six-digit grid coordinates (i.e., 100 meter precision) are used everywhere except on the Integrated Navigation Pages, Progress Page 1/2, Rendezvous Pages, Flight Plan Data Page, Alternate Flight Plan Data Page, Update Page and the Waypoint Data Page where ten-digit coordinates (1 meter precision) are used. This yields roughly the same display precisions used in the latitude/longitude format.

## ENTRY OF UNIVERSAL TRANSVERSE MERCATOR (UTM) WAYPOINTS

UTM based waypoints use grid zone designators that represent segments of the earth that span 6° of longitude and 8° of latitude (with the exception of the north-most grid zone which spans 12° of latitude). These grid zones are defined from 80° South Latitude to 84° North Latitude. This results in 60 zones around the earth in longitude, and 20 zones in latitude.

The grid zone designation for UTM based waypoints is a number followed by a character. The number may be from 1 to 60 (no leading zero required). This number identifies the reference meridian for the zone, with 1 being defined at 177° West and numbers increasing as one moves to the East. The character must be between C and X (inclusive, but with I and O omitted). This character identifies the reference line of latitude, with C being defined at 76° South latitude and letters increasing as one moves to the North (Figure 1-76).

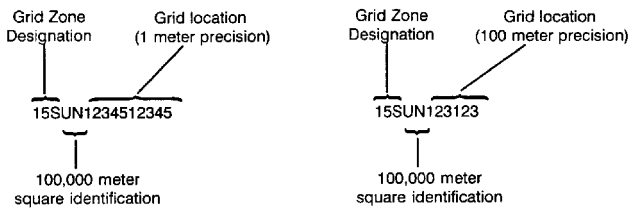



*Figure 1-76. UTM Waypoint Examples*

## ENTRY OF UNIVERSAL POLAR STEREOGRAPHIC (UPS) WAYPOINTS

UPS based waypoints use grid zone designators that represent the segments of the earth that span 180° of longitude and 6° of latitude from the North Pole or 10° of latitude from the South Pole. Only two grid zones are required at each of the North and South poles.

The grid zone designation for UPS based waypoints is a single character. A is for West longitudes at the South pole and B is for East longitudes. Y is for West longitudes at the North Pole and Z is for East longitudes.

Figure 1-77 shows examples of valid MGRS waypoints based on UPS coordinates (i.e., latitude below 80° South and above 84° North).

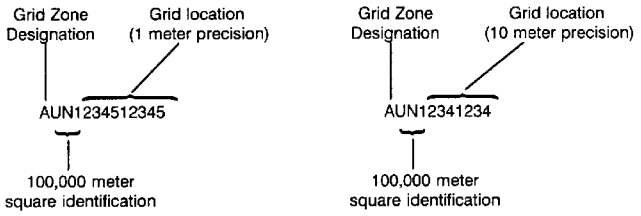



*Figure 1-77. UPS Waypoint Examples*

## ENTRY AND DISPLAY OF BEARINGS AND COURSES

Courses are entered as integers. Bearings (0° to 360.0°) are entered as three digits optionally followed by a decimal point and an additional digit. Both bearings and courses are range checked for 0 to 360 so that two entries are possible for north. Display of any computer generated values are limited from 1 to 360 (i.e., "0" is not a possible display). Bearings and courses are displayed with leading zeros.

Entry and display of bearings (other than for IBD waypoints) and all courses are referenced to either True or Magnetic North unless specified during entry. The true or magnetic setting chosen on Start Page 1/3 is the default. Special display characters indicate whether the reference is True or Magnetic North.

## ENTRY AND EDIT OF USER DEFINED LABELS

A user-defined label may be assigned to any latitude/longitude, primary or reversionary site waypoint or MGRS waypoint in the flight plan, waypoint data and mark list. User-defined labels are entered as "/" followed by up to eight letters or numbers. User defined labels are removed by "/" followed by no letters or numbers. User defined labels are displayed on all pages with the "/" prefix to ensure there is no confusion between user-defined labels and primary or reversionary site waypoints. The CDU permits only a user-defined label (i.e., /rig) to be used for one waypoint in the system. An attempt to assign a waypoint a user defined label that is already in use results in the flashing "NAME IN USE" annunciation in the scratchpad.

## ENTRY AND DISPLAY OF TIME AND DATE

Time is entered with no delineators between hours, minutes and seconds. Seconds are optional, so that four or six digits are acceptable. If no time or date is available for a given field, blanks are displayed. All times are entered and displayed as Greenwich Mean Time (GMT).

# FUNCTIONAL CDU OPERATIONS

## INDEX PAGES

The Index Page provides access to various standard function pages for general control of the system and for special flight plan edit functions. Depressing the Index (IDX) Page access key displays Index Page 1/2 on the CDU (Figures 1-78 and 1-80). Selecting the UP arrow, DOWN arrow or pressing the IDX function key a second time scrolls to Index Page 2/2 (Figure 1-81).

## START PAGES

The Start Pages (Figure 1-82) are accessed by depressing the line select key adjacent to START on Index Page 1/2. The Start Pages are utilized to enter basic data to initiate the flight plan and Global Positioning System (GPS).

### Start Page 1/3

a. Position - should be current from previous flight or updated as required.

b. Page Title.

c. Date - should be current from previous flight or updated with month, day, year.

d. Time - should be current from GPS in GMT. Update if "ENTER GMT" is displayed.

e. GPS Datum.

f. GPS1 - commands GPS1 into initialization mode, indicated by *.

g. GPS 2 - commands GPS2 into initialization mode, indicated by *.

h. Time stamp - display of GMT from "d."

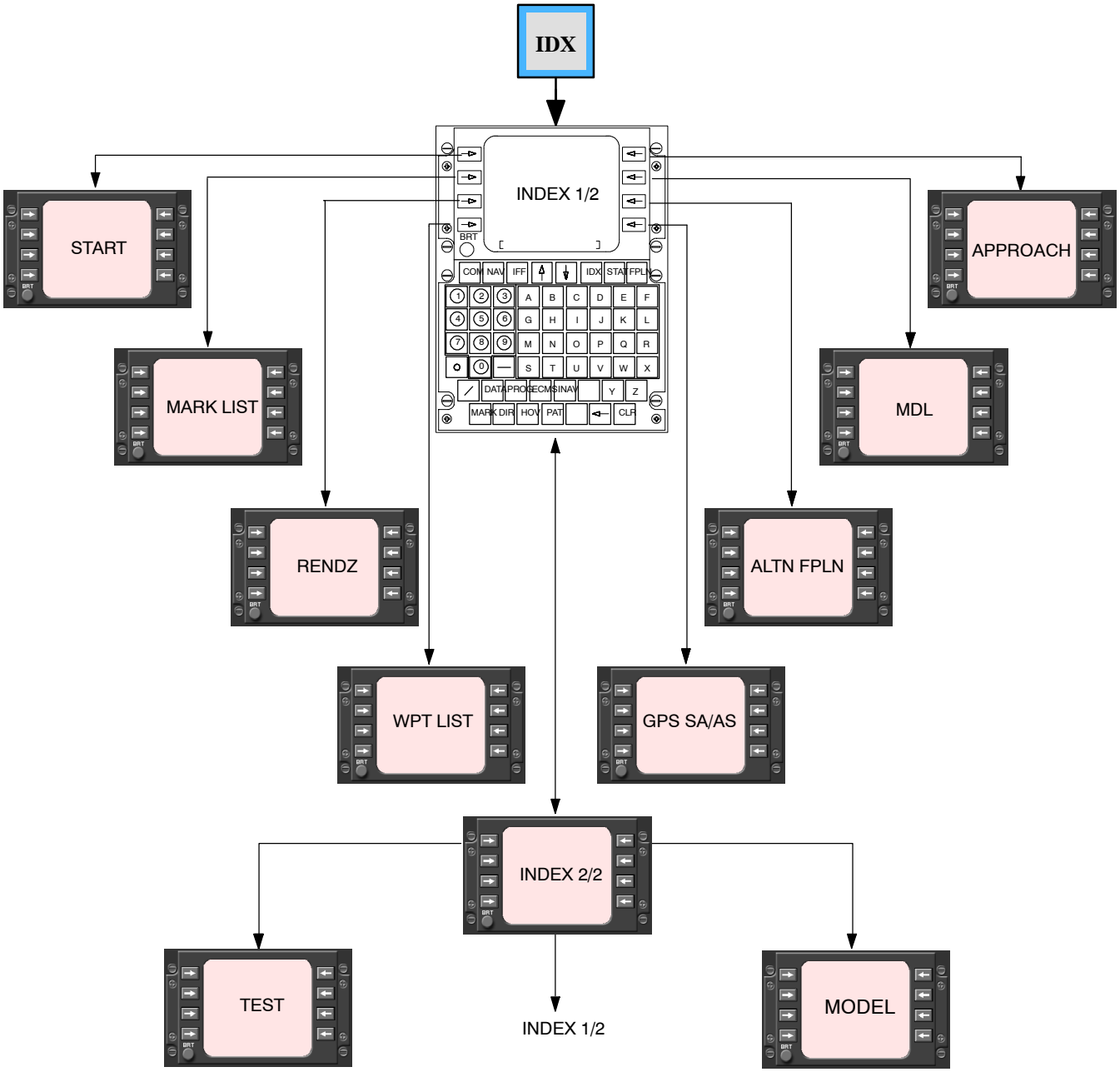



*Figure 1-78. Index Page Access*

i. Depress to toggle between True and Mag course and bearing information.

Start Page 1/3 (Figure 1-79) is used to define the data required to initialize the GPS. Valid position information should remain in DL1 from the completion of the last flight. If it is not, the valid position must be entered. Updating the current position on Start Page 1/3 may only be completed on the ground. An attempt to enter a position in flight results in a "GROUND ONLY" annunciation. The month, day and year are first entered into the scratchpad, then into the CDU by depressing LS2. Leading zeros are optional for the month and day entries. The day of the week on DL3 is automatically updated by the CDU. Normally the time, in GMT, is automatically displayed according to GPS time. If the GPS time is invalid, the time display is blank and the annunciation "ENTER GMT" appears on the Annunciation Line. The time is entered using 4 or 6 digits, with seconds being optional. With valid GMT entered in DL5, depressing LS3 permanently displays GMT, right justified, on the annunciation line. Line select 4 provides the operator with the ability to change the Horizontal Datum from the default setting of WGS-84 (number 47). Depressing LS4 on Start Page 1/3 accesses the Horizontal Datum Pages (there are 12), which list each Datum supported by the GPS. To change the datum, scroll through the available datum (the asterisk indicates the currently selected datum), and then depress the line select key adjacent to the desired datum. Refer to Table 1-4 for predefined horizontal chart datums supported by GPS. GPS #1 and #2 are initialized using LS 6 and 7. Initialization is not required during normal operations, but may be required for some maintenance operations. Depressing the line select adjacent to GPS1 or GPS2 commands the GPS into initialization and initializes the GPS with the position, date and time currently being displayed on Start Page 1/3. Initialization is indicated by the inward arrow (right of GPS 1 or GPS2) changing to an asterisk until initialization is complete. The operator may select either TRUE or MAG for the display of all course and bearing information on the CDU pages by depressing LS8 on Start Page 1/3. MAG is the default setting at system power-up.

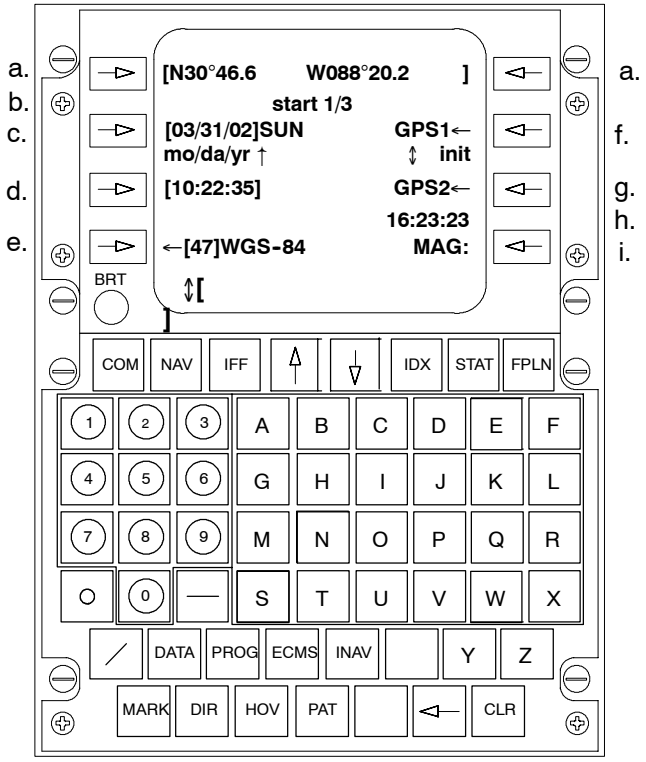
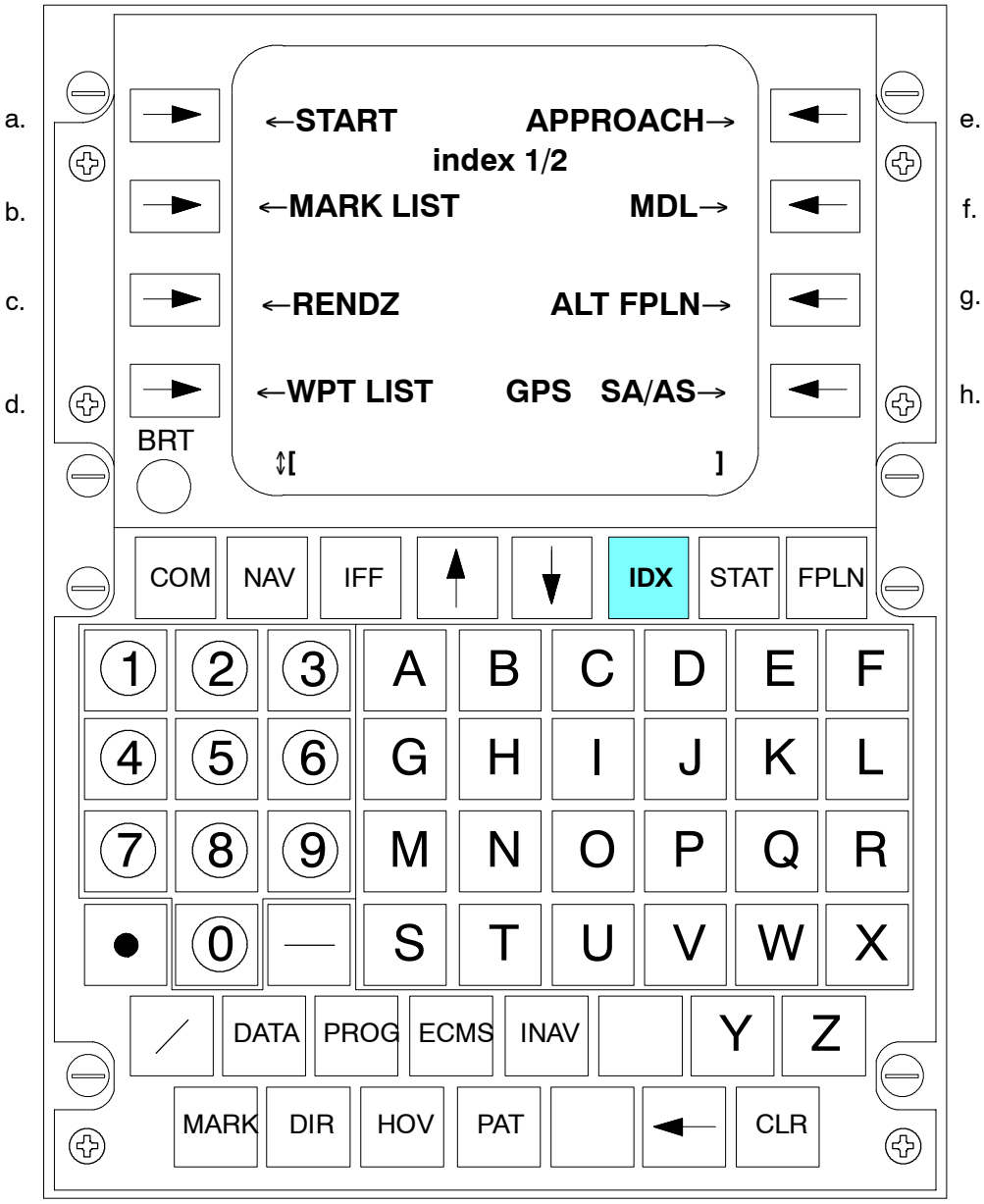
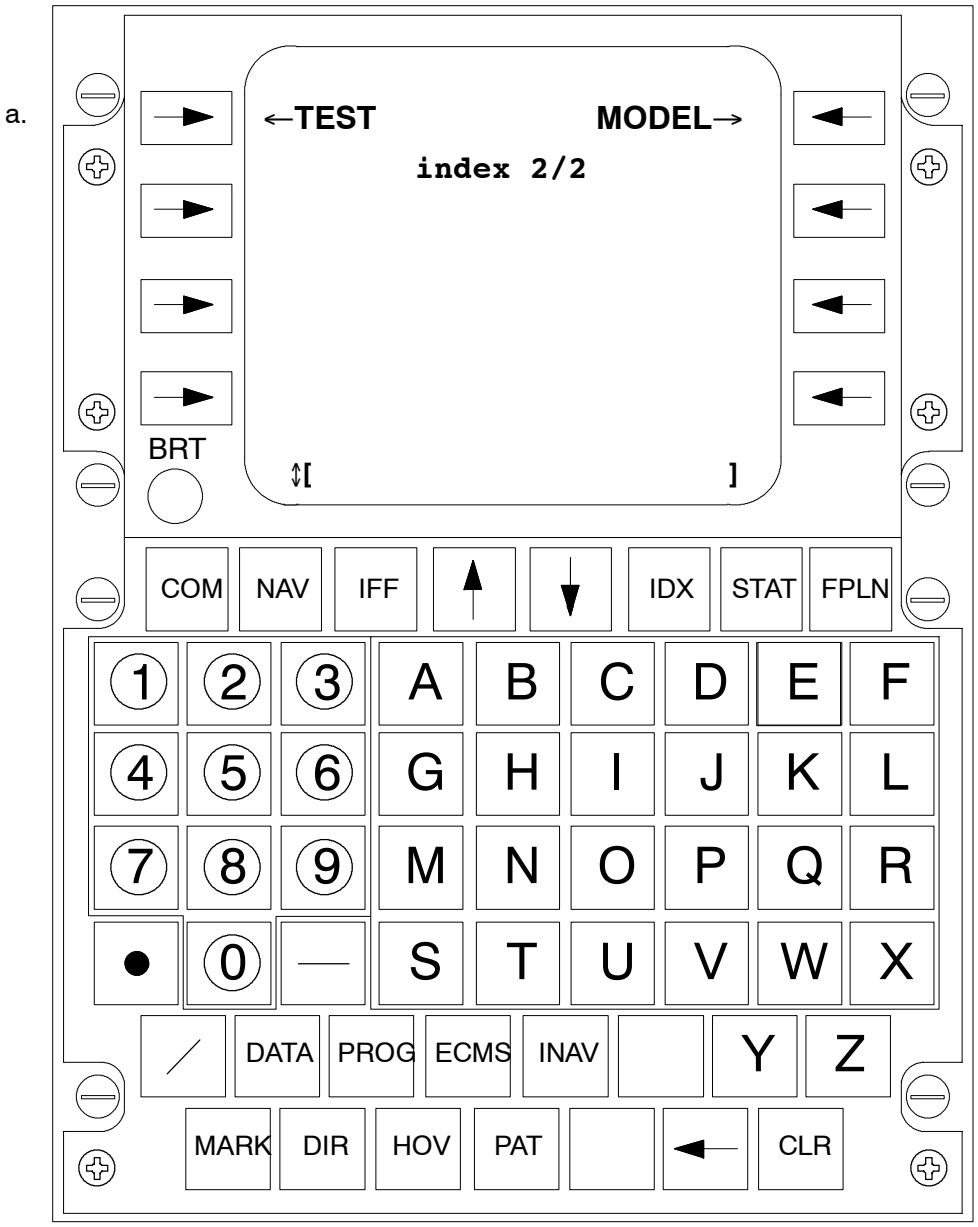



*Figure 1-79. Start Page 1/3*




a. Accesses Start Page 1/3
b. Accesses Mark List Page
c. Accesses Rendezvous Page
d. Accesses Waypoint List Page
e. Accesses FMS Approach Page
f. Accesses MDL Page
g. Accesses Alternate Flight Plan Page
h. Accesses GPS SA/AS Page

*Figure 1-80. Index Page 1/2*




a. Accesses Test Page
b. Accesses Aircraft Model

*Figure 1-81. Index Page 2/2*

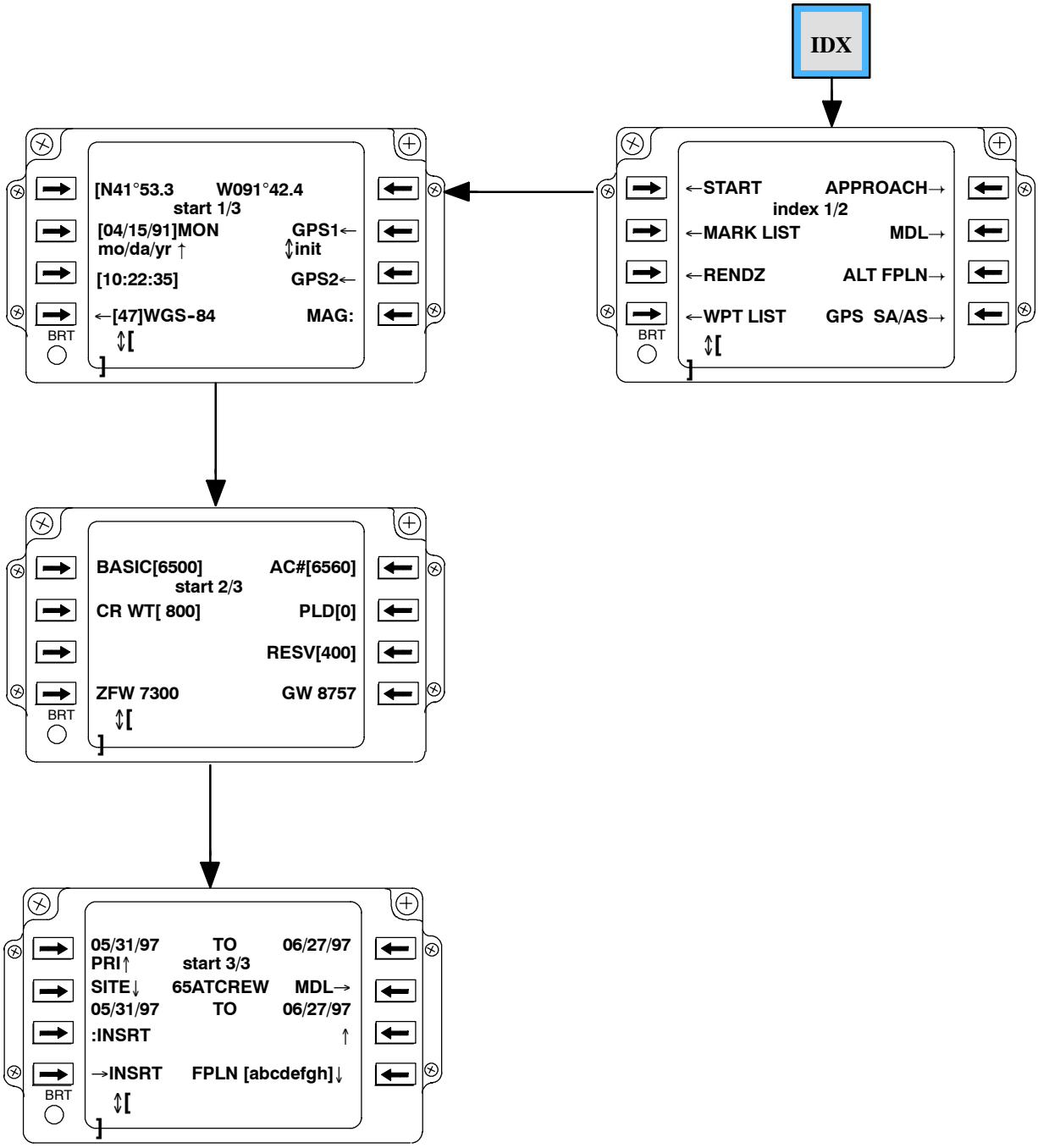



*Figure 1-82. Start Pages*

*Table 1-4. Horizontal Datum Abbreviations and Numbers*

| Datum Name | Datum Abbreviation | No. |
|---|---|---|
| Adindan | ADINDAN | 1 |
| Arch 1950 | ARC 1950 | 2 |
| Australian Geodetic 1966 | AUST GEO | 3 |
| Bukit Rimpah | BUKIT RIMPA | 4 |
| Camp Areat Astro | CAMP AREA | 5 |
| Djakarta | DJAKARTA | 6 |
| European 1950 | EUROPEAN | 7 |
| Geodetic Datum | GEODETIC | 8 |
| Ghana | GHANA | 9 |
| Guam 1963 | GUAM | 10 |
| Gunung Segara | G SEGARA | 11 |
| Gunung Serindung 1962 | G SERINDUNG | 12 |
| Herat North | HERAT NORTH | 13 |
| Hjorsey 1955 | HJORSEY | 14 |
| Hu-Tzu-Shan | HU-TZU-SHAN | 15 |
| Indian | INDIAN | 16 |
| Ireland 1965 (Eire 1965) | IRELAND | 17 |
| Kertau (Malayan Revised Triangulation) | KERTAU | 18 |
| Liberia 1964 | LIBERIA | 19 |
| Luzon | LUZON | 21 |
| Merchich | MERCHICH | 22 |
| Montjong Lowe | MONT LOWE | 23 |
| Nigeria (Minna) | NIGERIA | 24 |
| North America 1927 (CONUS) | NA 1927 CON | 25 |
| North America 1927 (Alaska and Canada) | NA CAN ALA | 26 |
| Old Hawaiian, Maui | OLD H MAUI | 27 |
| Old Hawaiian, Oahu | OLD H OAHU | 28 |
| Old Hawaiian, Kauai | OLD H KAUAI | 29 |
| Ordnance Survey of Great Britain 1936 | BRITAIN | 30 |
| Qornoq | QORNOQ | 31 |
| Sierra Leone 1960 | S LEONE | 32 |
| South American (Provisional South American 1956) | SA PROVIS | 33 |
| South American (Corrego Alegre) | SA CORREGO | 34 |
| South American (Campo Inchauspe) | SA CAMPO | 35 |

*Table 1-4. Horizontal Datum Abbreviations and Numbers (CON.)*

| Datum Name | Datum Abbreviation | No. |
|---|---|---|
| South American (Chua Astro) | SA CHUA | 36 |
| South American (Yacare) | SA YACARE | 37 |
| Tananarive Observatory 1925 | TANANARIVE | 38 |
| Timbalai | TIMBALIA | 39 |
| Tokyo | TOKYO | 40 |
| Voirol | VOIROL | 41 |
| Special Datum, Indian Special | INDIAN SPEC | 42 |
| Special Datum, Luzon Special | LUZON SPEC | 43 |
| Special Datum, Tokyo Special | TOKYO SPEC | 44 |
| Special Datum, WGS 84 Special | WGS 84 SPEC | 45 |
| WGS 72 | WGS 72 | 46 |
| Default Datum, WGS 84 | WGS 84 | 47 |
| Norh American Datum 1983 | NAD 1983 | 48 |

## Start Page 2/3

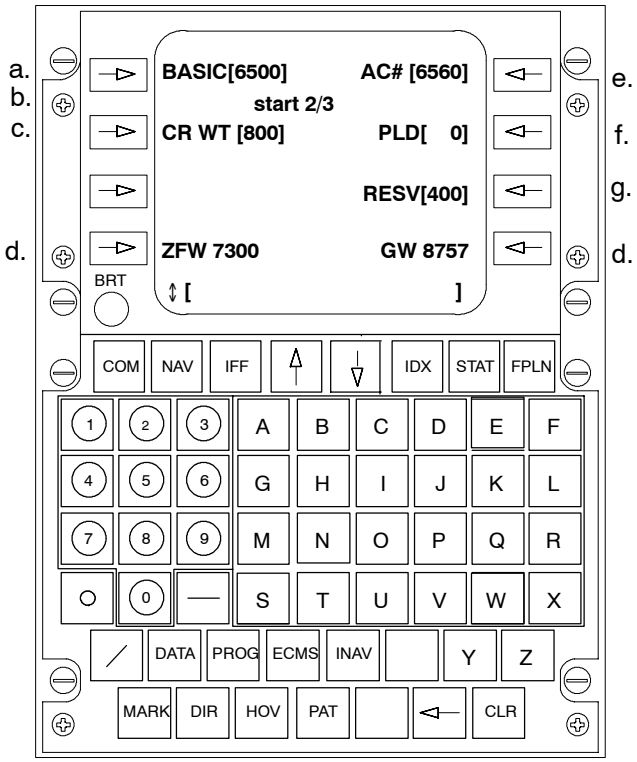



*Figure 1-83. Start Page 2/3*

a. Aircraft basic weight.

b. Page title.

c. Crew weight.

d. CDU computed zero fuel weight and gross weight.

e. Aircraft serial number.

f. Payload weight.

g. Reserve fuel.

Start Page 2/3 (Figure 1-83), used to enter fuel data and display fuel calculations, is accessed from Start Page 1/3 by depressing the DOWN arrow. Helicopter basic weight information should remain in DL1 from the completion of the last flight. If it is not, the valid weight must be entered. Aircraft tail number remains from the previous flight and can be changed via the scratchpad by depressing the respective line select key. Crew weight (which defaults to 800 pounds at system power-up) is updated via LS2. Payload weight (which defaults to 0 at system power-up) is updated via LS6. Reserve fuel (which defaults to 400 at system power-up) is updated via LS7. The CDU automatically calculates the Zero Fuel Weight (ZFW) by adding the basic, crew and payload weights. Gross Weight (GW), calculated by adding fuel weight to the ZFW, is automatically generated by the CDU.

### Start Page 3/3

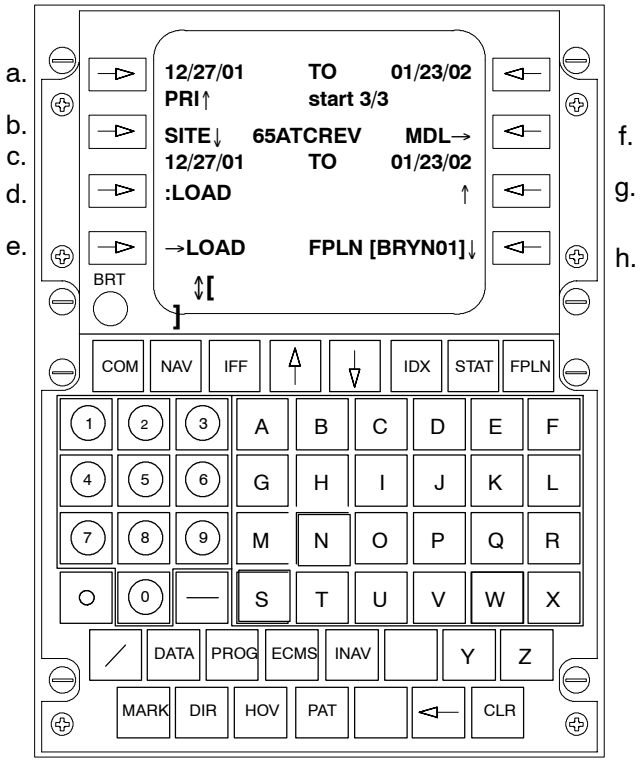



*Figure 1-84. Start Page 3/3*

a. Displays effective date of Primary Database currently being used by CDU.

b. Displays Reversionary Site Database stored in CDU.

c. Displays effective date for Reversionary Site Database stored in CDU.

d. Depress to toggle between LOAD, INSERT and ERASE.

e. Initiates selection displayed next to "d."

f. Accesses MDL page.

g. Scrolls to previous FPLN. FPLNs are displayed adjacent to "h."

h. Depressing scrolls to next FPLN on cartridge, or allows direct entering of valid FPLN name from scratchpad.

Start Page 3/3 (Figure 1-84), used to review the waypoint databases in use and to control the flight plan loading and erasing, is accessed from Start 2/3 by depressing the DOWN arrow, or from Start Page 1/3 by depressing the UP arrow. DL1 and DL4 show the effective date of the Primary and Reversionary Site Databases currently being used by the CDU. If one of the databases is unavailable, the respective display line is blank. The name of the Reversionary Site Database is shown on DL3. Line select 6 provides access to the Mission Data Loader (MDL) Control Page. The MDL Page is also accessible through the INDEX Page and is discussed in detail later in the MDL subsection. When the CDU recognizes a valid MDL cartridge, the flight plan names on the cartridge are displayed in brackets adjacent to LS8. Up to 12 flight plans of 50 waypoints each can be stored on the MDL. Depressing LS7 or 8 allows the operator to "scroll through" the MDL and view each of the flight plans on the MDL. Valid flight plan names may also be manually entered into LS8. When an invalid flight plan name is entered into LS8, the "FLPN NOT FOUND" annunciation results. Line selects 3 and 4 provide the ability to load or insert a flight plan from the MDL to the CDU Flight Plan Page, or erase the flight plan from the CDU Flight Plan Page. Line select 3 toggles between-

:LOAD – deletes the existing flight plan, loads the flight plan selected on LS8, and displays the Flight Plan Page.

:INSERT – displays the Flight Plan Page with an "INSERT ROUTE?" displayed in the scratchpad, and allows insertion of the flight plan selected on LS8 into the existing flight plan.

:ERASE – erases the existing flight plan in the system. A "CONFIRM ERASE PLAN" is displayed in the scratchpad. Depressing LS4 within 3 seconds initiates the erase and displays the Flight Plan Page.

After toggling to the desired command using LS3, the command is activated by depressing LS4. If the FPLN label adjacent to LS8 is blank, the LOAD and INSERT capabilities are disabled.

## MARK LIST PAGE

Selecting the MARK function key provides a means to quickly save the aircraft's current position and time information. Depressing the MARK function key saves the current position through the use of an automatically generated Mark Point Label. When "marked," the CDU writes the aircraft's current time, preceeded by a "/," into the scratchpad and, without changing CDU pages, places the same information into the next open storage field in the Mark List Page. The Mark List Page, accessed via Index Page 1/2, provides a list of the ten most recent "marked" points. The Mark List Page stores the waypoint data in data fields labeled A through J. Selecting the left line select key accesses the latitude/longitude of the mark. The Latitude/Longitude may also be viewed by entering a "/" in the scratchpad and then entering the slash into the mark list data field. After entering the slash, the GMT of the mark is replaced by the latitude/longitude of the marked position. Mark points in the Mark List

Page may be viewed by scrolling using the UP and DOWN arrows. Mark points are stored in the Mark List in the sequence that they were entered and remain in the Mark List Page until they are overwritten (even if power is removed from the system). For ease of use, a user-defined label may be attached to any point from the Mark List Page. When all ten fields in the Mark List Page are filled, new marks overwrite older marks. With no data in the scratchpad, depressing the left line select key adjacent to a Mark List waypoint accesses the Waypoint Data Page. Depressing the right line select key adjacent to a Mark List Waypoint automatically copies the data from that line into the scratchpad for use elsewhere by the operator. When the Waypoint Data Page is accessed via the Mark List Page, the FPLN data for the waypoint is always dashed out, even if the waypoint is in the flight plan. (Figure 1-85.)

## RENDEZVOUS PAGES

Accessed via Index Page 1/2, the Rendezvous Pages (Figure 1-87) are used to establish a rendezvous waypoint with a moving target. Two separate rendezvous waypoints may be defined and inserted into the flight plan via Rendezvous Pages 1/2 and 2/2. Both rendezvous may be active in the flight plan at the same time. With the necessary data entered into the Rendezvous Page display (Figure 1-88), the CDU can compute the heading, distance, location and time required to reach an aircraft or vessel in distress. The data required includes:

- The reported position of a target (the target's "fix") entered as a latitude/longitude, waypoint, identifier/bearing/distance waypoint, or mark waypoint.
- The fix time entered in GMT.
- The target ground track.
- The target groundspeed.

Using the aircraft's automatically updated position, true airspeed, and wind information, and the above entries, the CDU calculates the bearing and distance to the target and Time to Rendezvous (TTR).

**NOTE**

If your aircraft's groundspeed is less than 40 knots, the CDU assumes you are on deck or in a hover and a default groundspeed of 100 knots is used in the rendezvous calculation. Once airspeed increases above 40 knots, actual airspeed is used.

The rendezvous solution begins to be computed as soon as all of the required data is entered on the Rendezvous Page. If the rendezvous has not been entered into the flight plan, the bearing, distance and time to rendezvous (TTR) are updated as though they were the active waypoint.

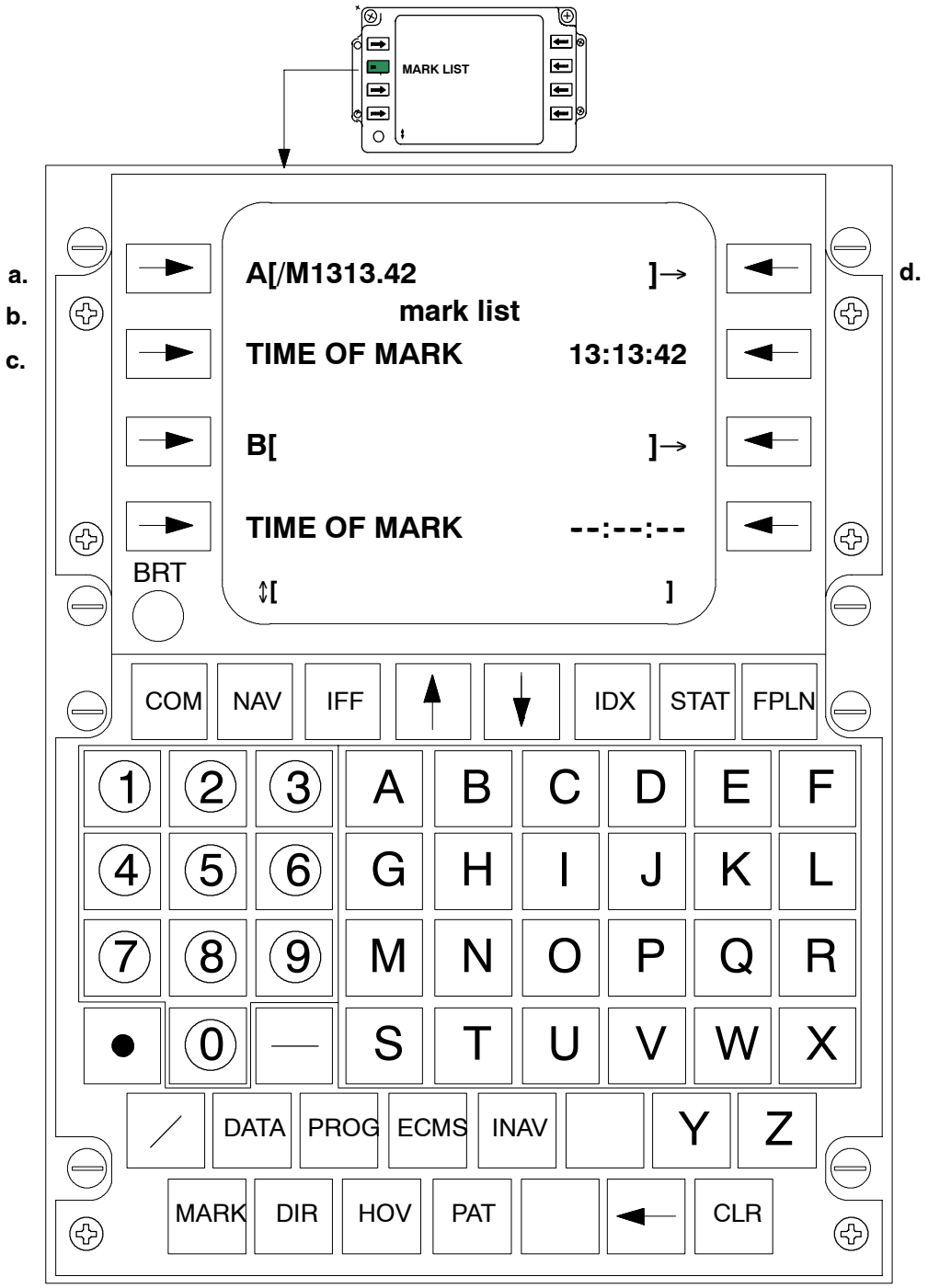
In some cases the speed or course of either the target or helicopter or the distance needed to rendezvous may prevent a successful intercept. If a rendezvous solution is not possible, the CDU generates a rendezvous to the Point of Closest Approach (PCA) from the target's entered position. The operator is informed that the rendezvous is to the PCA, and not the actual intercept point, prior to entry into the flight plan by the "PCA" annunciation on the affected Rendezvous Page. If a rendezvous with a PCA annunciation is then entered into the flight plan or an active rendezvous solution becomes a PCA, the "NO RENDZ" annunciation appears on DL6 (regardless of the CDU page displayed). With "NO RENDZ" displayed an intercept is not possible, though the CDU continues to calculate and maintain the PCA in the flight plan. A rendezvous with a PCA annunciation and calculated TTR of 00:00:00 indicates that your aircraft cannot get any closer to the rendezvous target.

If the rendezvous is not the active waypoint, it can be deleted from the flight plan by selecting the left line select key with a dash ("-") in the scratchpad. When the rendezvous is the active waypoint, it can only be cancelled by going Direct-To another waypoint. When a rendezvous is the active waypoint, attempts to perform a course edit or attempts to delete the rendezvous using a dash results in the "RENDZ ACTIVE" annunciation in the scratchpad. The annunciation may be cleared using the CLR key.

The Rendezvous Calculator (Figure 1-89), accessed from either Rendezvous Page, is used to evaluate the effects on the TTR for various airspeeds. Entering a valid airspeed into the ALTN TAS field updates the TTR calculation. When no rendezvous intercept is possible, a PCA is displayed to the right of the TTR, and TTR indicates the time to the PCA. When on deck or groundspeed is less than 40 knots, the calculator displays "DEFAULT GS 100 KTS" to indicate the CDUs use of 100 knots for the TTR calculation. While you can have two rendezvous active in the flight plan, the Rendezvous Calculator only functions for the first rendezvous in the flight plan. Attempting to activate the calculator for the second rendezvous (e.g., RENDZ2) results in an "INTERVENING RENDEZVOUS/NO CALCULATOR SOLUTION" readout on the calculator page.

If a Rendezvous is or becomes the active waypoint and the rendezvous solution is invalid, the "NO RENDZ" annunciation is displayed.

A Rendezvous inserted into the flight plan as the active waypoint is shown in Figure 1-86.




a. Displays most recent mark point in GMT. Selection with an empty scratchpad accesses the Waypoint Data Page. Selection with a "/" in the scratchpad removes the user defined label and displays the latitude/longitude.
b. Page title.
c. GMT of mark.
d. Selection copies the data into the scratchpad.

*Figure 1-85. Mark List Page*

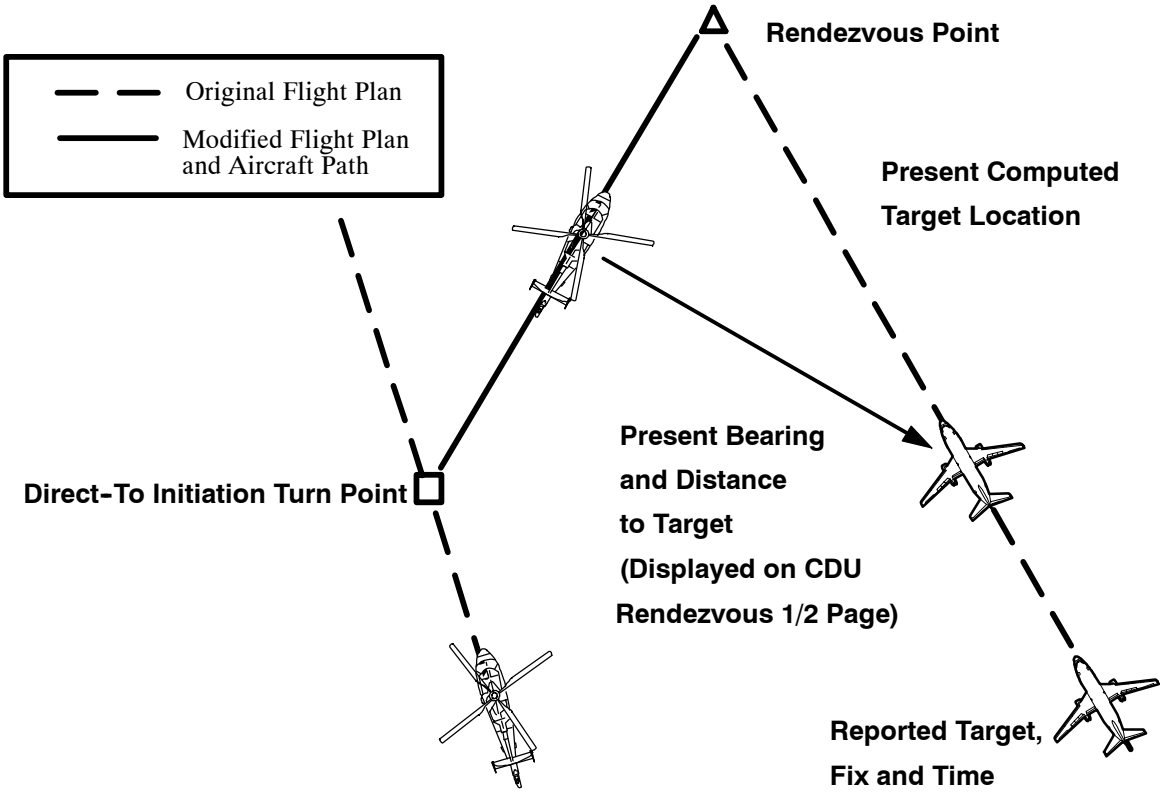



*Figure 1-86. Rendezvous Inserted as Active Waypoint*

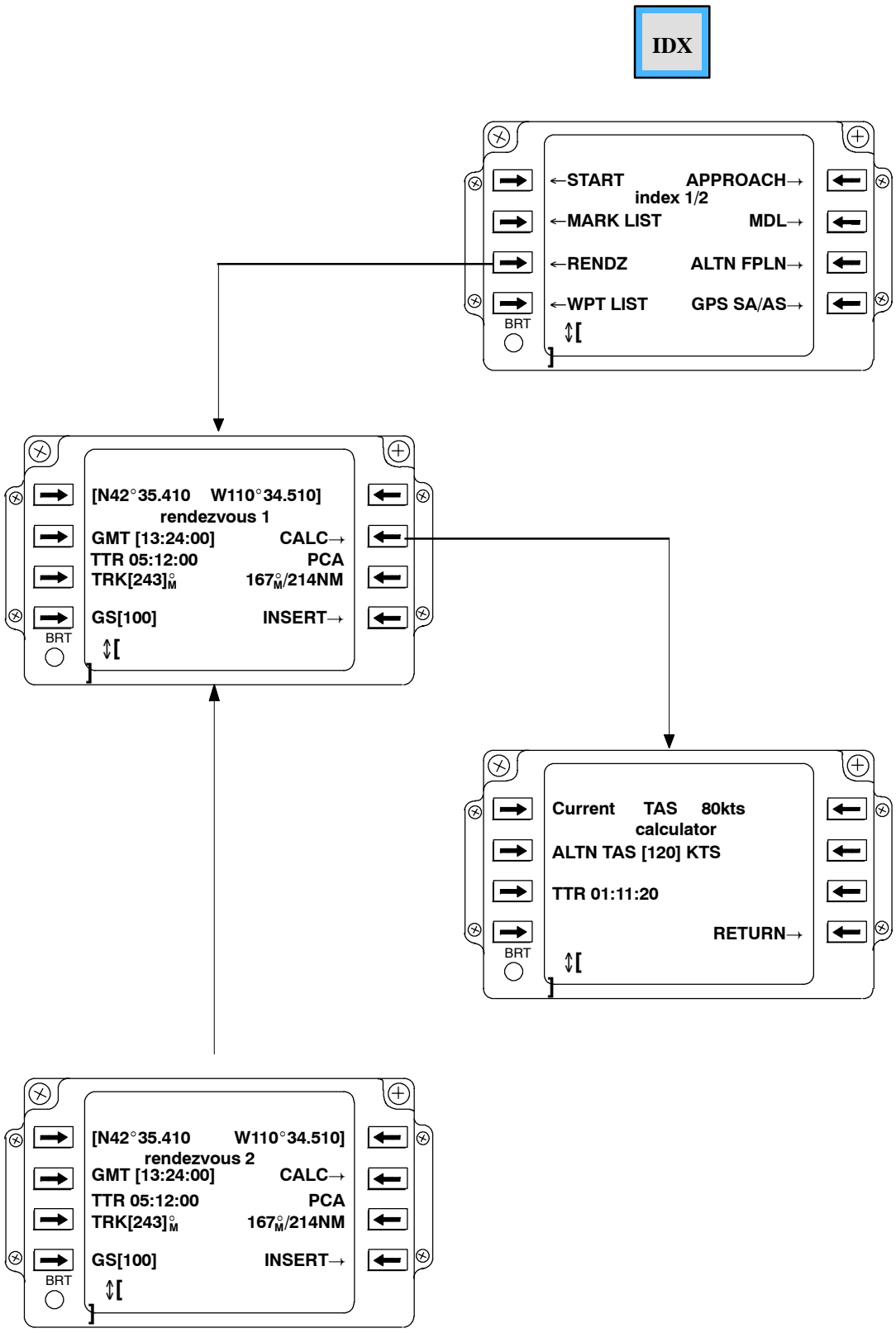
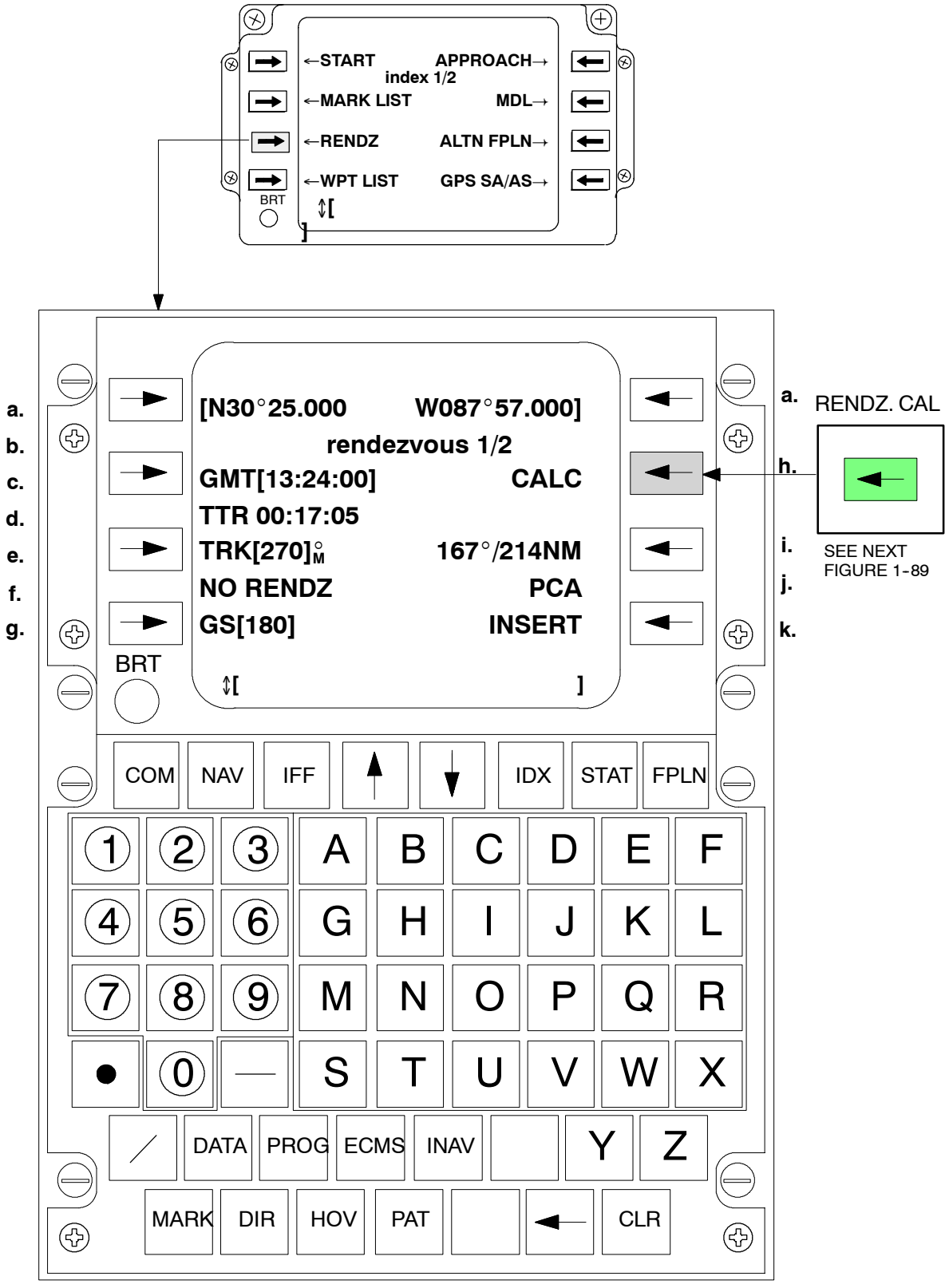



*Figure 1-87. Rendezvous Page Access*




* Rendezvous Page 2/2 is functionally identical to Rendezvous Page 1/2.

*Figure 1-88. Rendezvous Page 1/2 (sheet 1 of 2)*

a. Enter last known fix of target. Fix may be latitude/longitude, waypoint, indentifier/bearing/distance waypoint, or a position entered by pressing the MARK key.

b. Page title indicating rendezvous 1 of 2.

c. Enter fix time, in GMT, if different from current time.

d. Computed time-to-rendezvous.

e. Enter reported heading of target to be located. Ensure correct T or M reference is entered.

f. NO RENDZ annunciation indicates intercept not possible.

g. Enter speed of target.

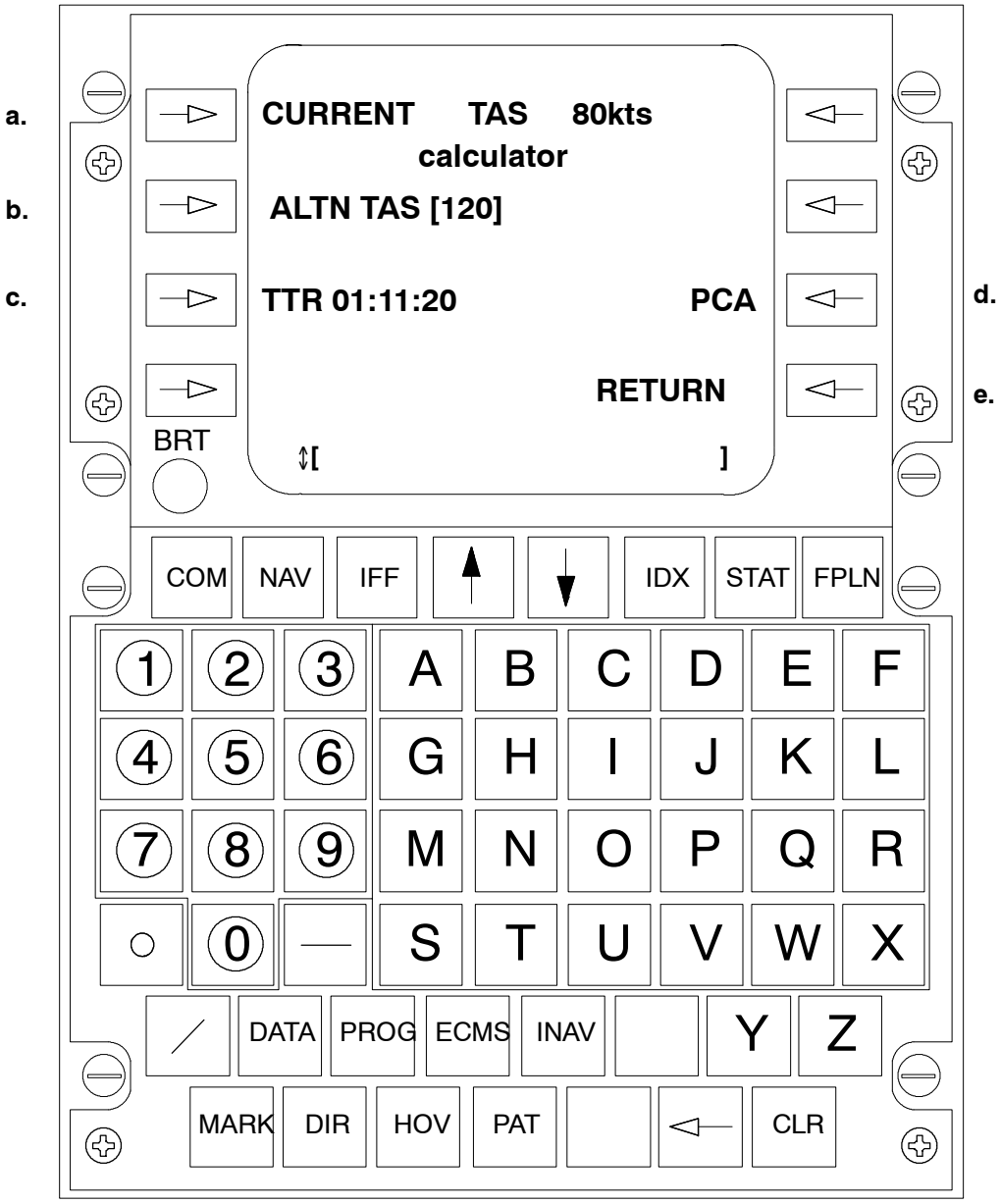
h. Depress to access RENDZ calculator.

i. Computed bearing and distance to target (not to rendezvous).

j. PCA annunciation indicates rendezvous not possible, so rendezvous to the PCA is being computed instead.

k. Selecting insert key accesses Flight Plan Page and displays "INSERT RENDZ1?" in scratchpad. Selecting a valid line select key inputs the rendezvous into the flight plan.

*Figure 1-88. Rendezvous Page 1/2 (sheet 2 of 2)*




a. Displays current TAS. If TAS is less than 40 kts, DL1 reads “DEFAULT GS 100 kts” and the CDU calculates TTR using 100 kts.
b. Enter valid alternate TAS.
c. TTR, based on alternate TAS, is displayed.
d. When no rendezvous “intercept” solution is possible, a PCA is calculated and PCA is displayed.
e. Selecting RETURN accesses the Rendezvous Page from which the Calculator was accessed.

*Figure 1-89. Calculator Page*

## WAYPOINT LIST PAGE

The Waypoint List Page, accessed via Index Page 1/2, provides a list of up to 48 waypoints that can be stored for insertion into the flight plan, alternate flight plan or stored for later use. The Waypoint List displays the stored waypoints and is scrollable, three lines at a time, using the UP and DOWN arrow keys. The Waypoint List reserves six waypoints for refueling (numbers 37-42) and six waypoints for hospitals (numbers 43-48). These waypoints are identified on the Waypoint List by their special refueling and hospital symbols (Figures 1-90 and 1-92). Waypoints are entered into the Waypoint List via the scratchpad using any of the following forms: latitude/longitude, waypoint identifier, identifier/bearing/distance waypoint, or mark waypoint. Once the waypoint is in the scratchpad, depressing a left line select key enters the waypoint into the position next to the key. If a waypoint was in that position prior to actuating the line key, it is overwritten.

The Waypoint List is managed using specific characters and the left and right line select keys adjacent to the desired waypoint. Figure 1-91 describes the role of the left line select key in the management of the Waypoint List. Depressing the right line select key selects/deselects the waypoint for insertion into the Flight Plan or Alternate Flight Plan. Multiple waypoints can be selected for insertion. An "*" is displayed when the waypoint has been selected for insertion. Subsequent activation of the line select key deselects the waypoint and the "*" is removed from the display. Line select 4 and 8 provide access to the alternate flight plan and flight plan for insertion of the selected waypoints and are functionally identical. For example, selecting FPLN changes the display to the Flight Plan Page and displays "INSERT WPTS?" in the scratchpad. Selection of a waypoint location in the flight plan inserts the selected Waypoint List Page waypoints into the flight plan in the order of their selection on the Waypoint List Page (Figure 1-91).

**NOTE**

Waypoints are identified on the CDU display lines by the numbers 01-48 and are stored in numeric order. However, selected waypoints are inserted into the flight plan in the order selected, not in the order stored.

**NOTE**

When the waypoints are transferred from the waypoint list to the flight plan, they are identified by the descriptive identifier and not as a number, (e.g., BFM/120°m/2.2 in place of waypoint 02).

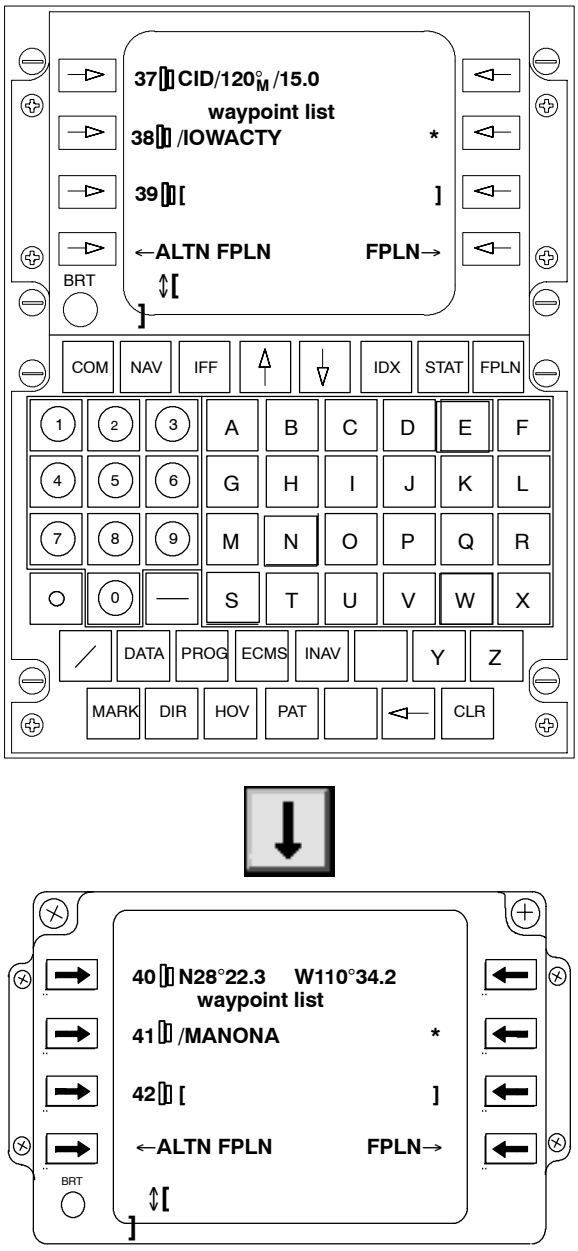
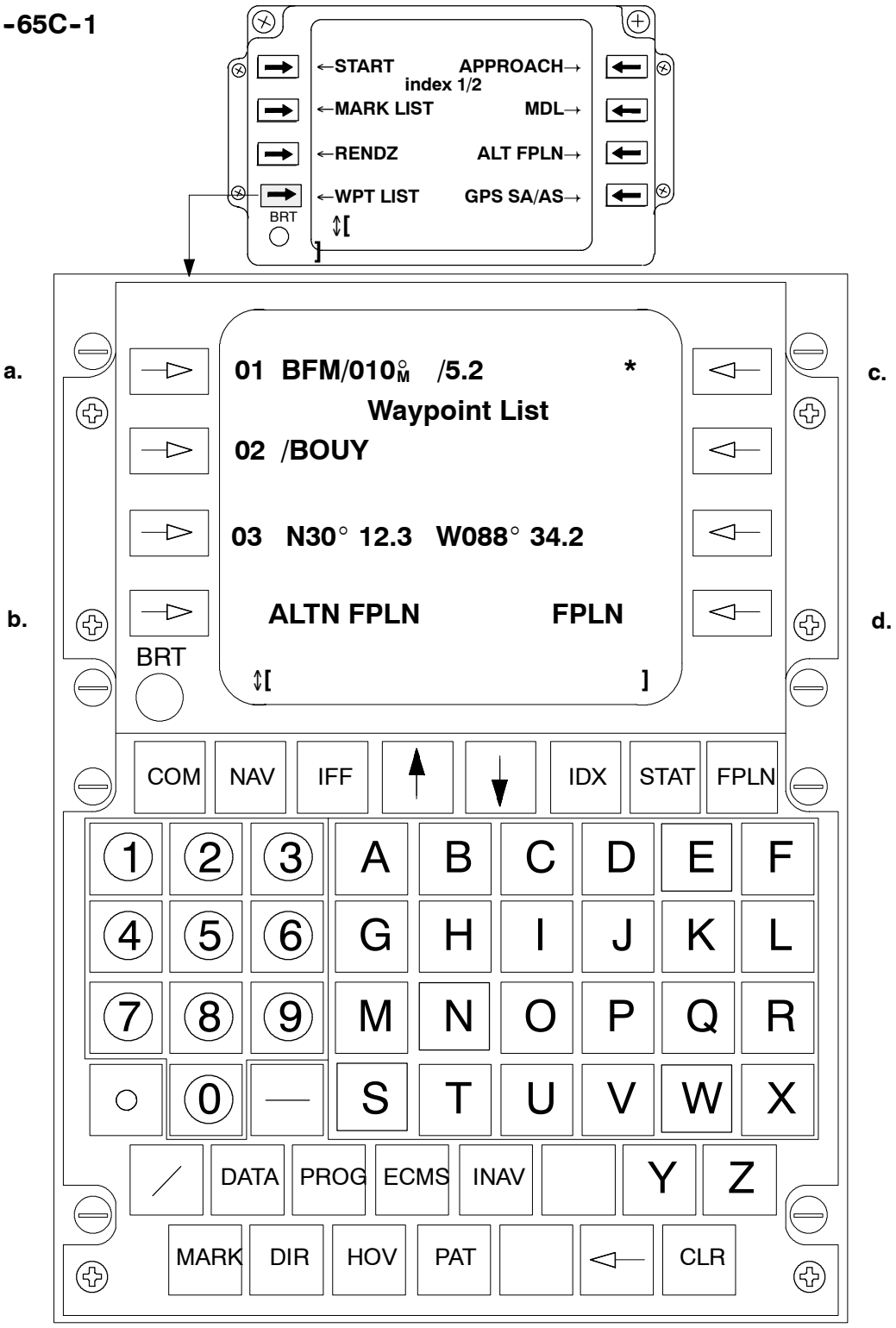



*Figure 1-90. Waypoint List Page Refueling Points*




a. Selection:
   1. Enters waypoint from scratchpad
   2. Enters/removes a user defined label
   3. Accesses Waypoint Data Page if scratchpad is empty.

b. Selection accesses alternate flight plan for insertion of selected waypoints.

c. Selects/deselects waypoints for insertion into flightplans.
   * indicates waypoint is selected for insertion.

d. Selection accesses flight plan for insertion of selected waypoints.

*Figure 1-91. Waypoint List Page*

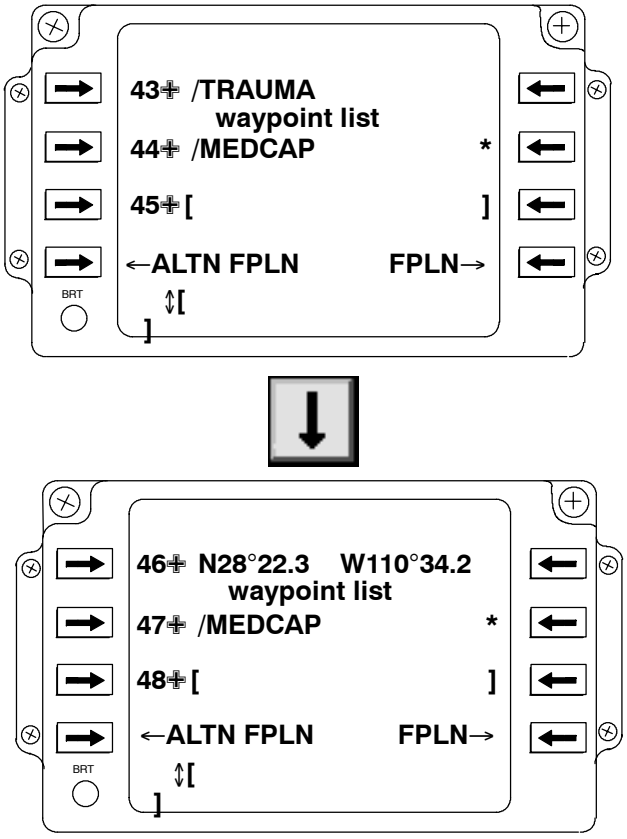



*Figure 1-92. Waypoint List Page-Hospital Waypoints*

## APPROACH PAGE

The FMS provides a means for the flight crew to define a non-precision approach with lateral and vertical guidance capability. This capability permits flying published non-precision approaches using the CDU/GPS. Refer to the FMS approach procedures in Section II for guidance and approach procedures.

The Approach Page is accessed via Index Page 1/2 and is used to define the parameters for the Approach (Figure 1-93). Only one Approach can be inserted into the flight plan. If an Approach is in history, another Approach cannot be inserted. Any attempt to define an Approach (by entering data into the required fields on the Approach Page) with an active Approach results in the "APPROACH DEFINED" scratchpad annunciation. The required parameters for an Approach are as follows:

a. Final Approach Fix (FAF) – The position used to establish the course to the missed approach point (MAP). The FAF may be defined as a latitude/longitude, waypoint identifier, identifier/bearing/distance waypoint, or mark waypoint. With no data in the scratchpad, depressing LS1 or LS5 copies the data in DL1 to the scratchpad.

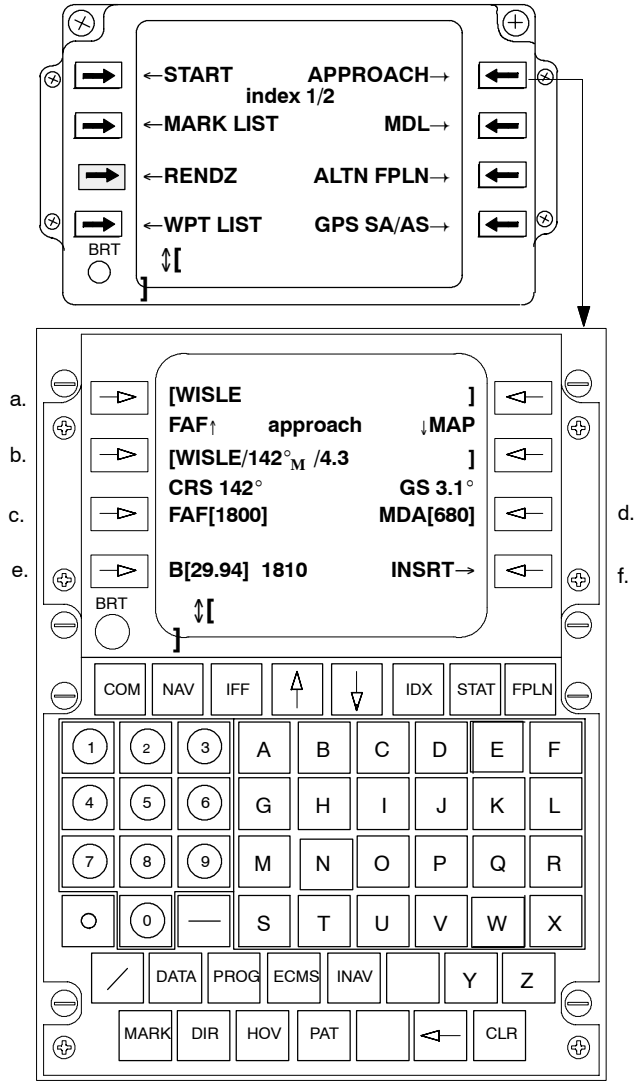



*Figure 1-93. Approach Page*

b. Missed Approach Point (MAP) – The position where a missed approach is initiated if the approach is unsuccessful. The MAP may be defined as a latitude/longitude, waypoint identifier, identifier/bearing/distance waypoint, or mark waypoint. With no data in the scratchpad, depressing LS2 or LS6 copies the data in DL3 into the scratchpad.

c. FAF - The desired altitude, in feet above mean sea level at the FAF.

d. Minimum Descent Altitude (MDA) – The lowest altitude, in feet above mean sea level, to which descent is desired on final approach.

e. Barometric Setting – Barometric setting entry. After entering the barometric pressure, the system generates and displays the corrected barometric pressure altitude.

**NOTE**

Barometric setting may be updated, but not deleted, any time after the approach is inserted into the flight plan.

f. INSRT- Selection, with all the approach parameters defined, displays the Flight Plan Page with the scratchpad message "INSERT APPROACH?." The approach may then be entered in the desired location in the flight plan.

**NOTE**

If an attempt is made to insert the approach into the flight plan without defining all the parameters, the scratchpad message "ENTER PARAMETERS" appears.

When all of the required parameters are entered, the system calculates and displays the following:

1. Final Approach Course (CRS) – The system calculated final approach course. Defaults to Start Page 1/3 selection for T or M.

2. Glide Slope (GS) – The system calculated vertical descent angle. If the approach parameters result in a calculated GS value less than 1 degree or greater than 5 degrees, dashes are displayed for GS. Attempting to insert the approach with dashes in the GS display results in an "ENTER PARAMETERS" scratchpad message.

3. Level Off Point (LOP) – The LOP is a system calculated position, 1 nm from the MAP and 50 feet in altitude above the MDA. The LOP prevents descent below the MDA by initiating the transition to level flight at MDA.

For the purpose of situational awareness, the waypoint prior to the FAF serves as the initial approach fix (IAF). After passing the IAF, the FAF (defined earlier on the Approach Page) becomes the active waypoint. When executing an Approach, a VNAV alert (indicated by the FAF waypoint flashing) occurs for 10 seconds prior to the FAF to indicate the initiation of the capture of the previously defined descent path.

**NOTE**

The aircraft's corrected barometric pressure altitude, constantly updated and displayed on the Approach Page, must be within 25 feet of the defined FAF altitude, as displayed on the CDU, for VERT to capture.

**CAUTION**

To execute the FMS approach you must have an operable altitude controller and the INAV Page GPS mode must be set to "AUTO."

The approach becomes "active" when the FAF passes into history and the LOP becomes the "TO" waypoint. The vertical profile of an Approach is shown in Figure 1-94. A second VNAV alert is generated prior to the capture of the level off segment of the Approach. The second VNAV alert is indicated by the LOP waypoint flashing for 10 seconds, followed by a flashing "MDA" annunciation. When the MAP becomes the "TO" waypoint, the flight plan sequences to manual (MAN) mode and the aircraft continues on its present course until directed otherwise. Figure 1-95 identifies the lateral and vertical navigation ceiling during an Approach. Lateral and vertical deviation are displayed on the MFD HSI Page.

Prior to entering the Approach, it may be cancelled and removed from the flight plan by selecting the left line select key of any Approach waypoint (FAF, LOP, MAP) with a "-" in the scratchpad. Once the Approach becomes active, a Direct-To to a future non-approach waypoint cancels the Approach.

## MISSION DATA LOADER (MDL)

The bus controller CDU uses three databases of five character alphanumeric International Civil Aeronautical Organization (ICAO) or user defined identifiers (IDs). The Primary Identifier Database is maintained on the MDL. The Reversionary Site Database is a small local database stored in the CDU's long term memory and accessed during reversionary operations (i.e., when the MDL has failed or is not installed, or the requested data is not on the MDL cartridge). A third database, the Mission Identifier Database, is a subset of the Primary Identifier Database and used for the management and display of non-flightplan waypoints on the MFD. The Mission Identifier Database is stored in the CDU's long term memory. Additionally, a magnetic variation database can be stored on the MDL and transferred to the CDU.

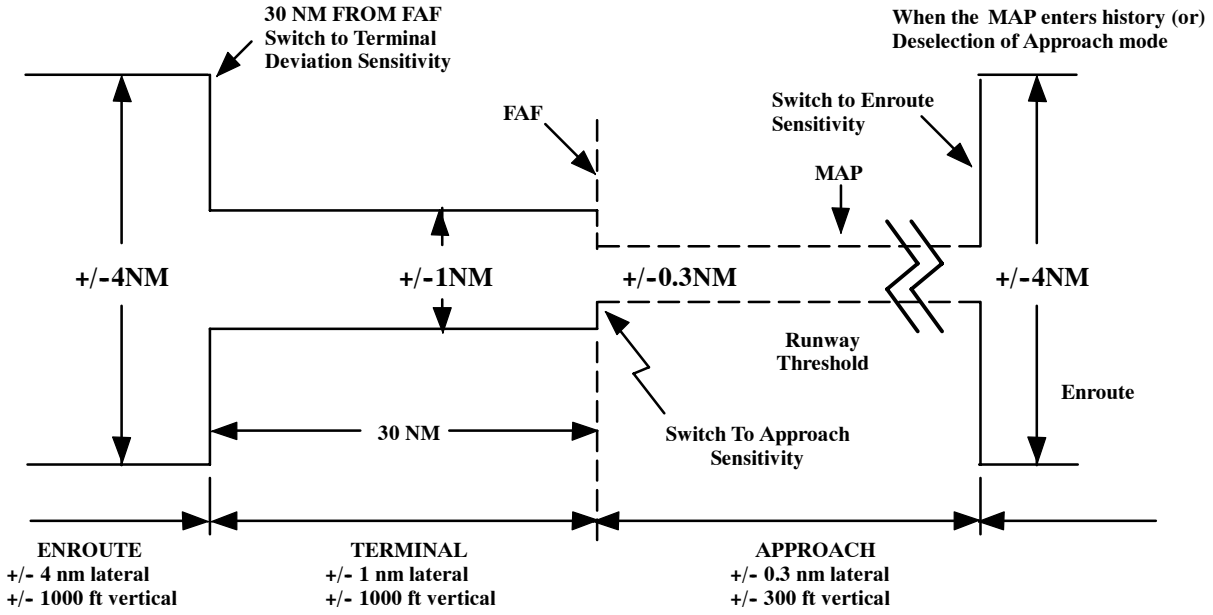



*Figure 1-94. Scaling During an Approach*

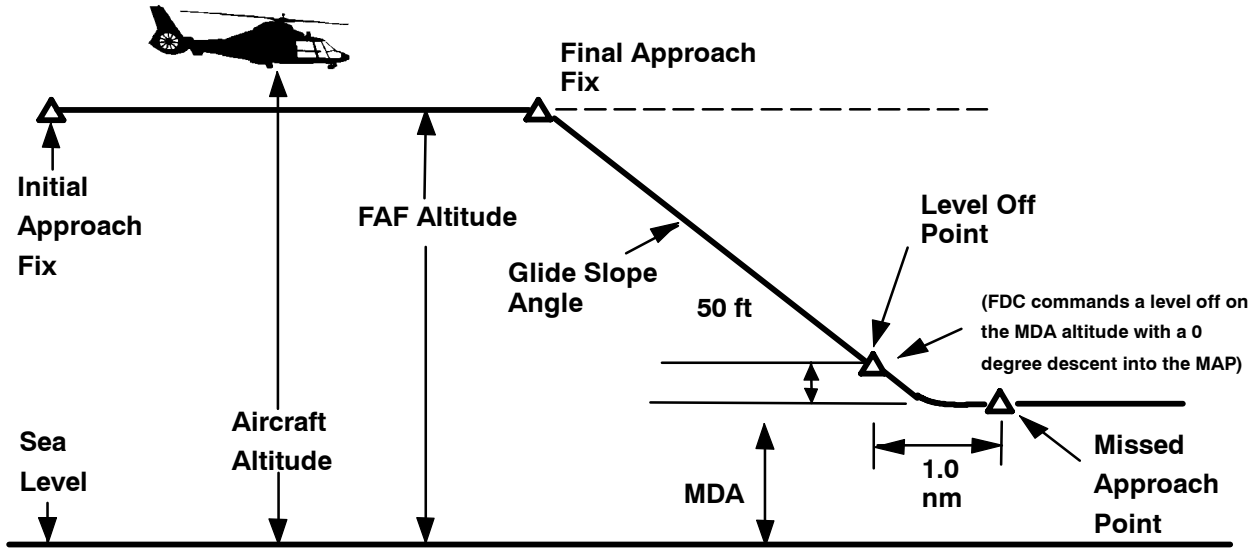



*Figure 1-95. Approach Execution*

The crew can store 12 flight plans of up to 50 geographic locations on the MDL. When displayed on the CDU, the names of the flight plans can be displayed for selection of the flight plan to load into the system. When displayed on the CDU, the flight plan waypoints appear as a vertical list of locations in the order to be flown. The flight plan may be loaded from the MDL or manually created point-by-point.

Though different crew members may access and edit different portions of the databases simultaneously from either CDU, all computations are made in the bus controller CDU which maintains the master copy of all databases. The flight plan, reversionary database, and magnetic variation database are periodically transferred to the remote terminal CDUs so they are prepared to execute from the same databases if and when they assume bus control. The indices files are automatically loaded from the MDL when a new CDU becomes bus controller.

Figure 1-96 shows the relationships between the various databases and the flight plan.

## MDL Waypoint Databases

The Primary Identifier Database is maintained on the MDL. Data for individual IDs is recalled as needed (identifier, lat/

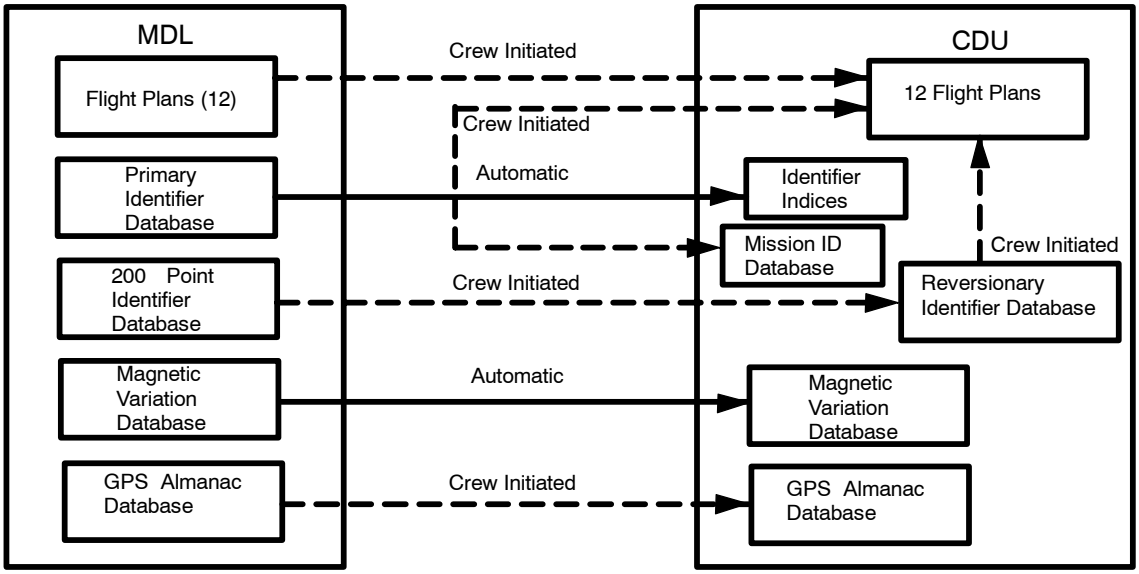



*Figure 1-96. Waypoint and Flight Plan Database Relationships*

long, elevation, station declination, etc.). These ID definitions cannot be edited by the crew. The effective beginning and ending dates for the associated identifier data are stored in the database.

## Identifier Indices File

The Identifier Indices file contains the American Standard Characters for information exchange (ASCII) of the first and last identifiers contained in each of the identifier directories. The starting address of that associated identifier directory is included in the index record. The index records are arranged in alphabetical order. The identifier indices file is transferred into the CDU whenever a cartridge is inserted into the MDL. A rapid search to identify the required section of the indices file containing the required identifier can be made prior to any accesses of the MDL. The index records are then retrieved from the cartridge and searched to identify the required identifier directory. The current software design supports an identifier indices file for up to 20,004 identifiers.

## Identifier Directories

Identifier Directories contain the starting address for individual identifier data records. The identifiers are arranged in alphabetical order within the directory file. Identifier directories are accessed directly (after processing the indices file internally in the CDU) rather than through the Table of Contents used by standard MDL files.

## Identifier Data Records

Identifier data records contain detailed data for the identifiers as follows:

Radio Navigation Aids

- Latitude / longitude
- Navigation Aid Type
- Station Declination
- Frequency
- Elevation
- Waypoints
- Latitude / longitude
- Airports
- Latitude / longitude
- Elevation

Identifier data records are accessed directly rather than through the Table of Contents used by standard MDL files.

Refer to Figure 1-97 for the relationship between the three data structure types (Identifiers indicies, directories, data records).

## CDU Reversionary Site Database

The CDU stores a Reversionary Site Database containing 200 waypoint identifiers. These waypoints cannot be edited by the crew, and they can only be changed by transfer in mass from the MDL cartridge. The Reversionary Site Database is a back up waypoint database for system navigation and

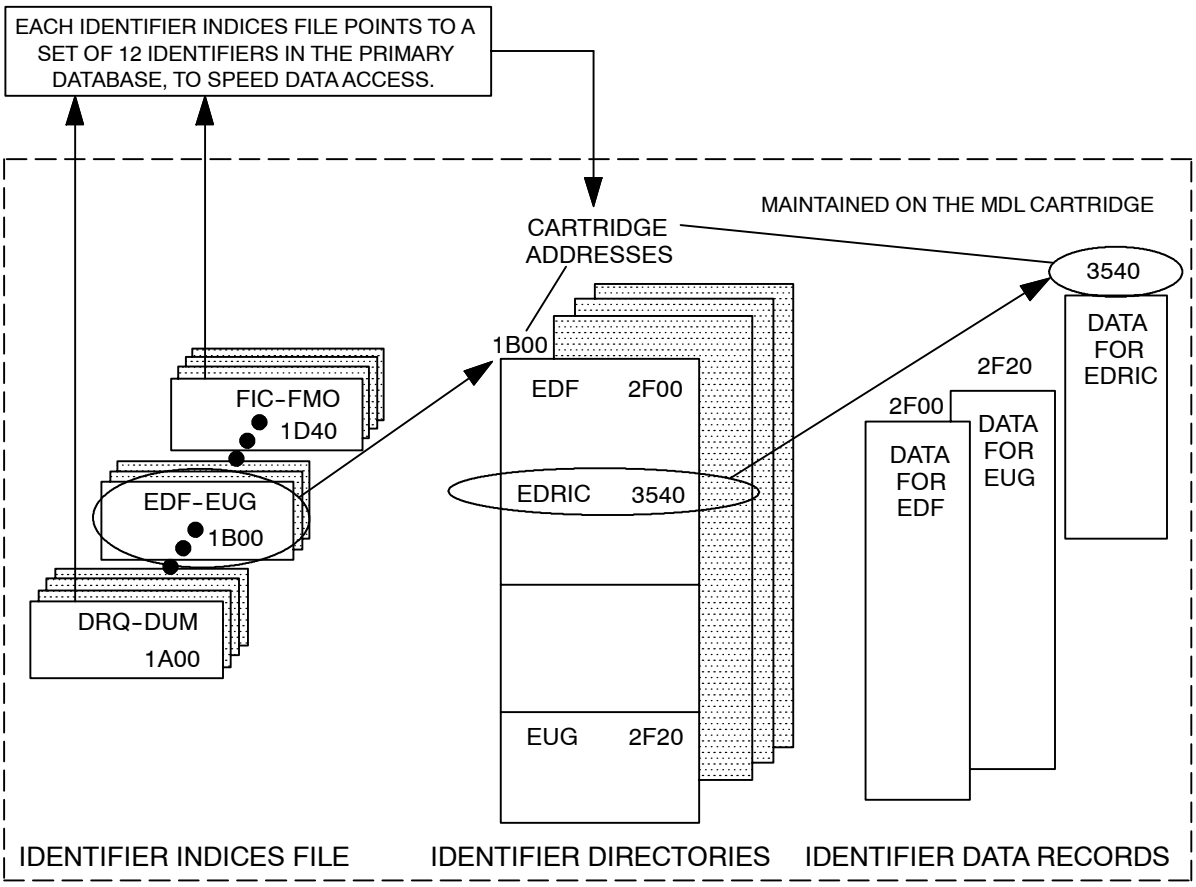



*Figure 1-97. Primary Identifier Database File Relationship*

flight plan development, only when the MDL is not present, has failed or does not contain the selected ID in the Primary Identifier Database. When its use is required, local database operation is transparent and identical to the Primary Identifier Database on the MDL, requiring no special procedures to access.

Due to the smaller size of the Reversionary Site Database and to provide for a fixed CDU memory map, the Reversionary Site Database has records of fixed length containing the following information (as applicable):

a. Identifier

b. Latitude / longitude

c. Identifier Type

d. Station Declination

e. Frequency

f. Elevation

## Magnetic Variation Database

A magnetic variation database is maintained in CDU non-volatile memory for conversion of course references from True to Magnetic North. The database (if present on the cartridge) is automatically transferred from the MDL cartridge each time the cartridge is inserted, if the date stamp indicates it to be newer than the existing CDU database. Once loaded, a magnetic variation database remains in effect until overwritten by insertion of a new cartridge containing a more recent magnetic variation database. It can be loaded as often as required without a software change, eliminating the need for application of magnetic variation rate of change.

This database is globally valid, based on linear interpolation of tabular values with entry arguments evenly spaced every 10 degrees of latitude and longitude. Only a single value is stored for the poles, representing the limit of magnetic variation as the pole is approached along the Prime Meridian (i.e., Longitude 0°). The CDU adds longitude at the North Pole and subtracts longitude at the South Pole to fill out the rectangular magnetic variation table to correctly interpolate at high latitudes.

## GPS Almanac Database

A GPS Almanac database is maintained on the MDL. The CDU loads the GPS Almanac data from the Personal Computer Memory Card International Association (PCMCIA) and transfers the data to the appropriate GPS receiver, as initiated on the MDL Page.

## MDL Page

Control of the MDL is completed by the MDL Page (Figure 1-98). The MDL is accessed by selecting MDL on Index Page 1/2, or by selecting MDL on Start Page 3/3.

a. Selects the PCMCIA card to be accessed in the MDL. Toggles between "TOP" and "BOT" (bottom). Defaults at power up to "TOP."

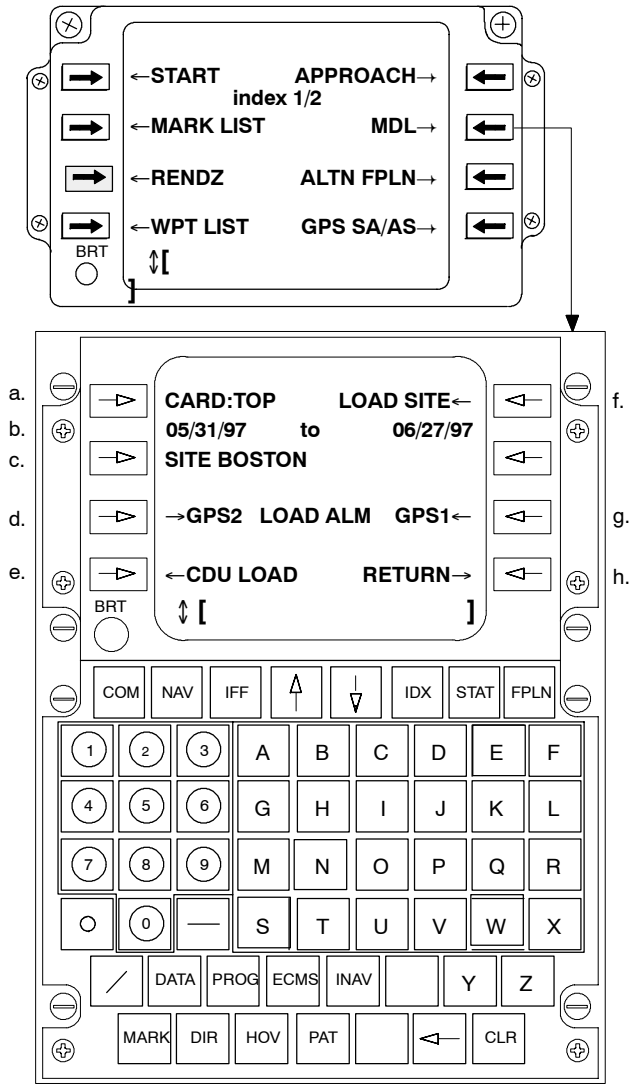



*Figure 1-98. MDL Page*

b. Displays the effective date range of the Reversionary Site Database of the selected PCMCIA card. If the card selected by LS1 does not have a PCMCIA card installed, or communication with the card is failed, the display line is blank.

c. Displays the label "SITE" followed by the 10-character name of the Reversionary Site Database stored on the selected PCMCIA card. If the selected card is not installed, or communication with the card failed, "NO CARD INSTALLED" is displayed.

d. Loads GPS almanac data from the PCMCIA card to GPS #2. This function requires confirmation. First selection displays the scratchpad message "CONFIRM LOAD ALM." A second selection initiates the load. An unsuccessful load results in a "LOAD FAIL" annunciation.

e. Selection displays the OFP Load Page of the CDU. This feature is reserved for maintenance and is inhibited in flight.

f. Selection initiates the loading of the Reversionary Site Database and displays the scratchpad message "CONFIRM LOAD SITE." A second selection of LS5 initiates the load. An unsuccessful load displays "LOAD FAIL" on the annunciation line.

g. Loads GPS almanac data from the PCMCIA card to GPS #1. This function requires confirmation. First selection displays the scratchpad message "CONFIRM LOAD ALM." A second selection initiates the load. An unsuccessful load displays "LOAD FAIL" on the annunciation line.

h. If the MDL Page was accessed from Start Page 3/3, selection displays the Start Page 3/3. If the MDL Page was accessed from the Index Page 1/2, selection displays the Index Page 1/2.

## MDL Annunciations

The CDU displays the scratchpad message "MDL BUSY" when data is requested and the MDL is already busy responding to a request. The CDU displays the scratchpad message "NOT FOUND" when the requested identifier data could not be found in the primary identifier database or the reversionary database. The CDU also displays the scratchpad message "FPLN NOT FOUND" when the flight plan which was requested by name could not be found.

## Alternate Flight Plan

The Alternate Flight Plan Page is used to develop a new flight plan, edit an existing flight plan or plan flight diversions (Figure 1-99). The Alternate Flight Plan includes its own Waypoint List that can hold up to 50 waypoints. Special features of the Alternate Flight Plan include the ability to:

- Reverse the order of waypoints;
- Switch ("exchange") the Alternate Flight Plan with the active flight plan;
- and, overwrite the active flight plan.

## Alternate Flight Plan Page

While the Alternate Flight Plan provides increased flexibility for the operator, search patterns or holding patterns cannot be attached or inserted into the Alternate Flight Plan.

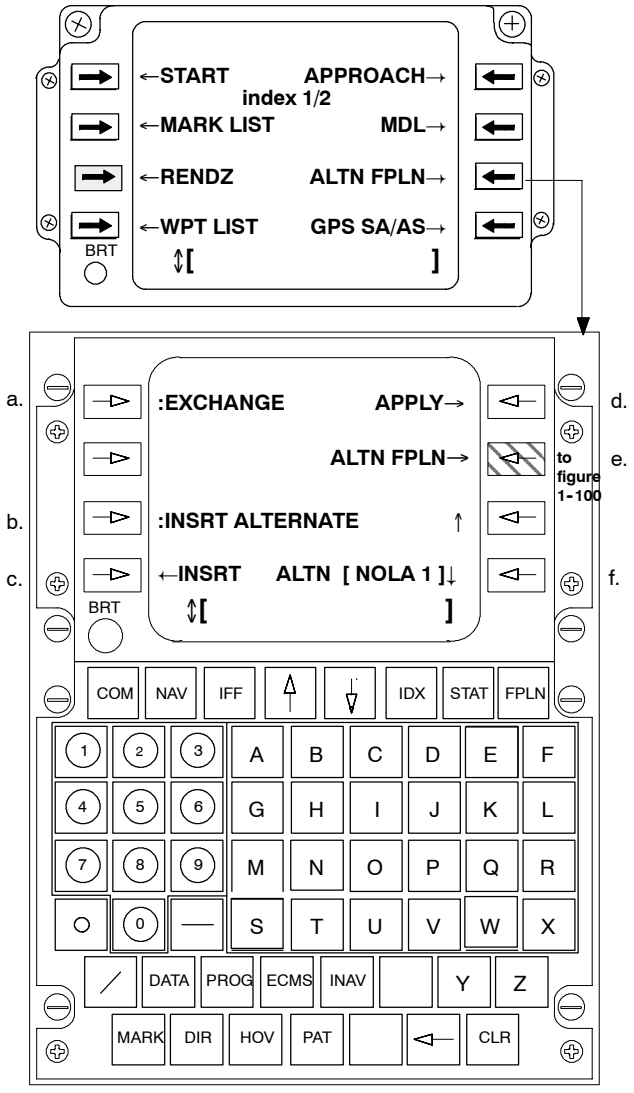



*Figure 1-99. Alternate Flight Plan Page*

a. Selection toggles display through modes:

(1) EXCHANGE, toggling to this state causes the flight plan and the alternate flight plan to trade places when APPLY is selected.

(2) COPY ALTN FPLN, toggling to this state deletes the flight plan and copies the alternate flight plan into the flight plan when APPLY is selected.

(3) REVERSE, toggling to this state reverses the order of the waypoints in the alternate flight plan when APPLY is selected.

(4) COPY FPLN IN, toggling to this state deletes the alternate flight plan and copies the active flight plan into the alternate flight plan when APPLY is selected.

b. LS3 and 4 provide the ability to load or insert a flight plan from the MDL to the CDU Alternate Flight Plan Page, or erase the flight plan from the CDU Alternate Flight Plan Page. LS3 toggles between -

:LOAD ALTERNATE – Selection deletes the ALTERNATE Flight Plan Waypoints List and loads the selected flight plan (i.e., NOLA1) into the ALTN FPLN Waypoints Page.

:INSRT ALTERNATE – Provides the ability to insert a flight plan (i.e., NOLA1) into an existing Alternate Flight Plan.

:ERASE ALTERNATE – Erases and displays the empty ALTN FPLN Waypoints Page.

c. Initiates selection displayed adjacent to line select 3.

LOAD ALTN– Erases the existing alternate flight plan, loads the flight plan into the alternate flight plan, and displays the Alternate Flight Plan Waypoints Page.

INSRT ALTN – Displays the Alternate Flight Plan Waypoints Page with the "INSERT ROUTE?" displayed in the scratchpad, and allows insertion of the selected flight plan into the existing Alternate Flight Plan.

ERASE ALTN – Erases the existing Alternate Flight Plan. A "CONFIRM ERASE ALTN" is displayed in the scratchpad. A second selection of LS4 initiates the erase and displays the empty Alternate Flight Plan Waypoints Page.

If the Alternate Flight Plan name adjacent to LS8 is blank, LOAD and INSRT capabilities are disabled.

d. Selection applies the alternate flight plan modification selected by LS1. The first selection of APPLY displays the scratchpad message "CONFIRM." A second selection of APPLY initiates the selected action.

e. Selection displays the Alternate Flight Plan Waypoints Page.

f. When the CDU recognizes a valid MDL cartridge, the flight plan names on the cartridge are displayed in brackets adjacent to LS8. Up to 12 flight plans of 50 waypoints each can be stored on the MDL. Depressing LS7 or 8 allows the operator to "scroll through" the MDL and view each of the flight plans on the MDL. Valid flight plan names may also be manually entered into LS8. When an invalid flight plan name is entered, the "FLPN NOT FOUND" annunciation results.

## Alternate Flight Plan Waypoints Page

The Alternate Flight Plan Waypoints Page (Figure 1-100) is used to develop the list of waypoints to be included in the Alternate Flight Plan. The Alternate Flight Plan Waypoints Page is accessed by selecting ALTNFPLN on the Alternate Flight Plan Page.

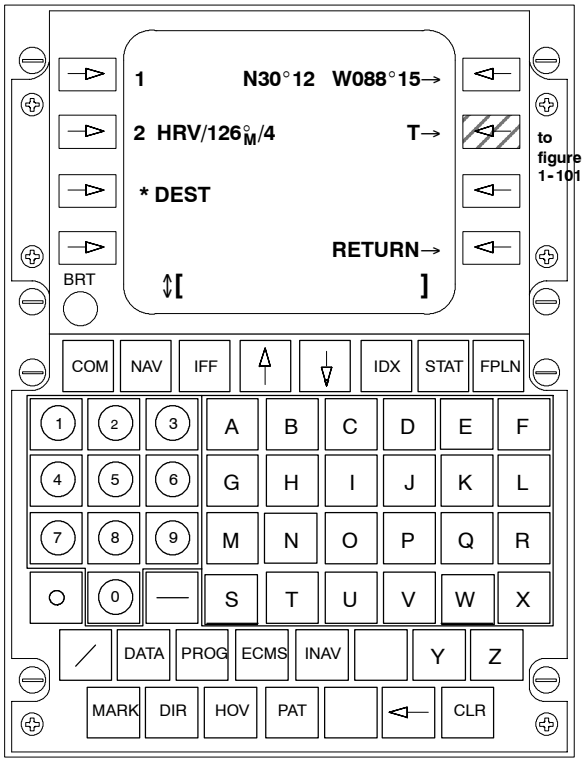



*Figure 1-100. Alternate Flight Plan Waypoints Page*

The Alternate Flight Plan Waypoints Page displays the stored waypoints (up to 50 may be stored) and is scrollable, one line at a time, using the UP and DOWN arrow keys. Waypoints are entered into the list via the scratchpad in any of the following forms: latitude/longitude, waypoint identifier, identifier/bearing/distance waypoint, or mark waypoint. Once the waypoint is in the scratchpad, depressing a left line select key enters the waypoint into the position next to the key. Similar to the Flight Plan Page, if a waypoint was in that position prior to actuating the line key, it is moved to the next lower line.

Alternate Flight Plan annunciations include:

| Annunciation | Meaning |
|---|---|
| NOT FOUND | The system could not locate a waypoint with the user defined label |
| FPLN FULL | The Alternate Flight Plan contains its limit of 50 waypoints |
| MDL BUSY | The MDL is already in use |

Depressing the right line select key with a blank scratchpad displays the Alternate Flight Plan Data Page for the waypoint selected. From the Alternate Flight Plan Data Page a Planned Time of Arrival may be assigned to a waypoint. The character "T" on the Alternate Flight Plan Waypoint Page indicates the assignment of a PTA. Selection of the right line select key with data in the scratchpad results in an "ERROR" annunciation.

## Alternate Flight Plan Data Page

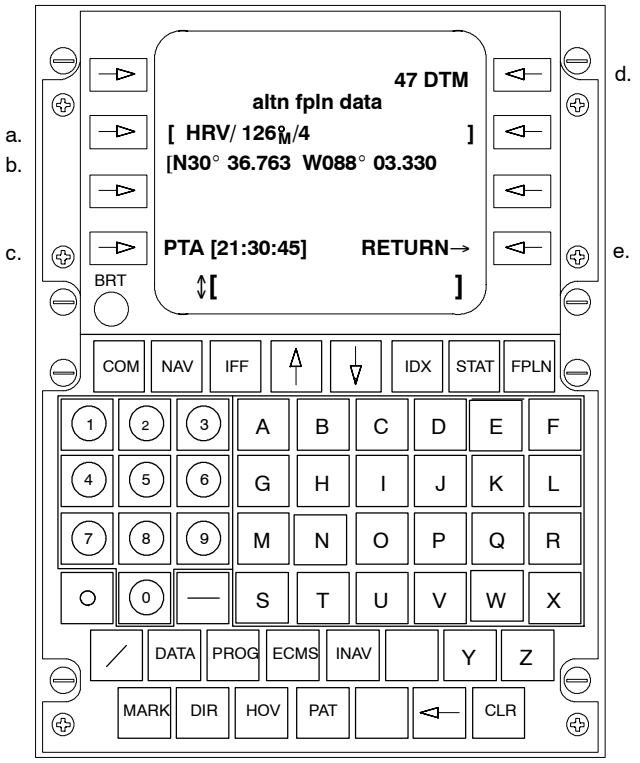



*Figure 1-101. Alternate Flight Plan Data Page*

The Alternate Flight Plan Data Page (Figure 1-101), accessed by depressing the right line select key of an Alternate Flight Plan Waypoint, is used to display data on a waypoint in the alternate flight plan. DL1 displays the Datum reference for the waypoint being displayed (defined as the datum at the time the waypoint was entered) followed by the page

title on DL2. The waypoint title is displayed on line 3, with the latitude and longitude of the position displayed on DL4. The waypoint may be redefined on line three by attaching a user-defined label (i.e., "/rig"), or by removing an existing user-defined label (by entering a "/"). Attaching a user-defined label that is used elsewhere in the system results in the "NAME IN USE" annunciation. A Planned Time of Arrival (PTA) for the displayed waypoint may be defined using LS 4. When the waypoint is viewed on the Alternate Flight Plan Waypoints Page, the character "T" is displayed adjacent to the waypoint to indicate a PTA was defined for the waypoint on the Alternate Flight Plan Data Page. Selecting RETURN changes the display to the Alternate Flight Plan Waypoints Page.

a. Alternate Flight Plan Waypoint, a user-defined label may be entered by using a "/" and up to eight alphanumeric characters.

b. Displays the latitude/longitude of the waypoint.

c. Enters the Planned Time of Arrival (PTA) for the waypoint. Selection with a "-" in the scratchpad and a PTA defined for the waypoint resets the PTA to the default value (dashes).

d. Displays the Datum reference for the waypoint being displayed (defined as the datum at the time the waypoint was entered).

e. Selection displays the Alternate Flight Plan Waypoints Page.

**NOTE**

Pressing the "UP" scroll arrow displays the Alternate Flight Plan Data Page scrolled to the previous waypoint in the Alternate Flight Plan. Pressing the "DOWN" scroll arrow displays the next waypoint in the Alternate Flight Plan.

## GPS SA/AS Page

The GPS SA/AS Page provides control of the Selective Availability/Anti-Spoofing (SA/AS) feature and the Zeroizing Keys function of the GPS. It is accessed from Index Page 1/2 using the GPS SA/AS key. The SA/AS features of the GPS SA/AS Page are functionally identical for GPS 1 and GPS 2. Figure 1-102 outlines the operation of the GPS SA/AS Page.

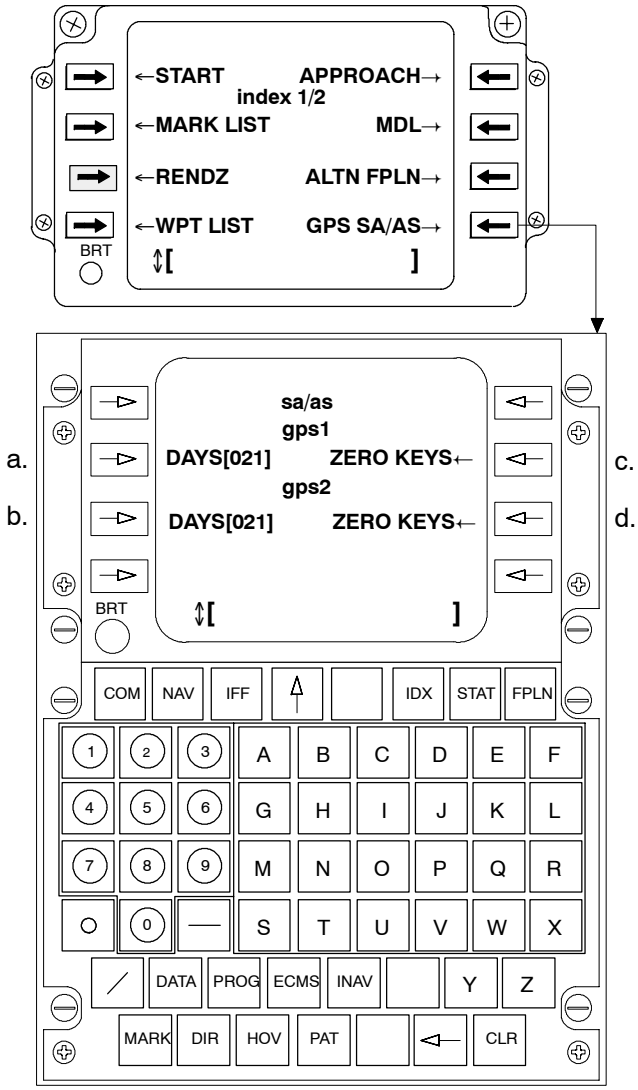



*Figure 1-102. GPS SA/AS Page*

a. Displays the current GPS1 Mission Duration for GPS1. Current GPS Mission Duration is the number of consecutive, valid daily keys beginning with the current day's key that is contained in the GPS receiver. The default is the number of days remaining in keys.

b. Same operation as "a" for GPS2.

c. Selection results in a scratchpad message of "CONFIRM ZERO KEYS." Selection a second time zeroizes GPS1 keys. If GPS1 keys are successfully zeroized, the "ZERO KEYS" label changes to "SAFE KEYS" and the arrow is removed. If the attempt to zeroize GPS1 keys is unsuccessful, a "NO KEYS ZERO" annunciation is displayed.

d. Same operation as "c" for GPS2.

Special GPS SA/AS Alerts Include:

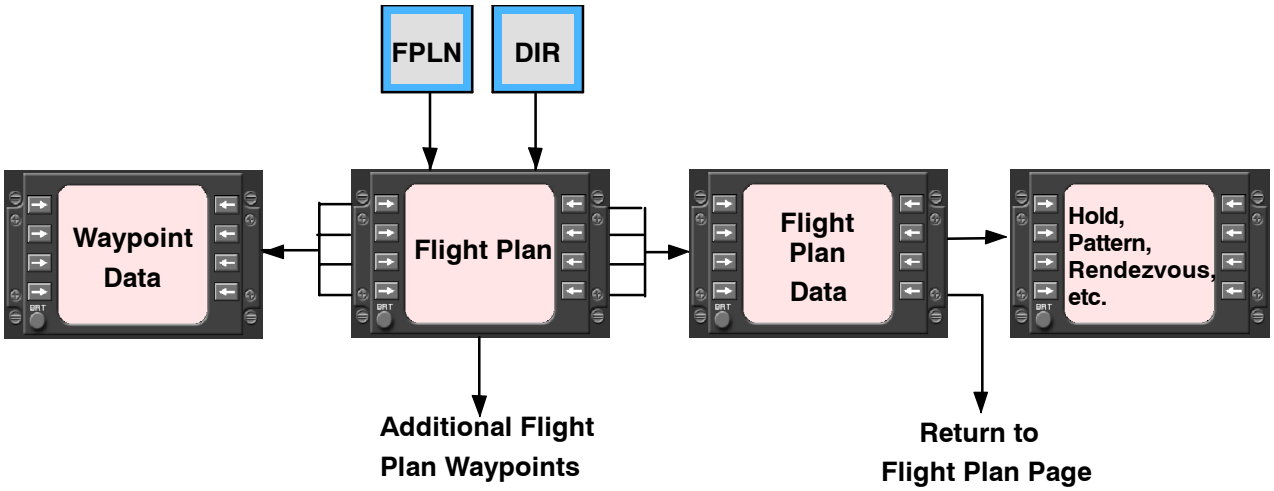



*Figure 1-103. Flight Plan Page Access*

| Annunciation | Meaning |
|---|---|
| KEY ALERT | Keys are within 2 hours of expiring |
| WRONG KEY | Incorrect SA/AS key was received |
| NO ZERO KEY | Attempt to zero keys was unsuccessful |
| NEED KEY | Operator entered a mission time greater than the value of the current key as displayed on the GPS SA/AS Page |

# FLIGHT PLAN MANAGEMENT

The Flight Plan Pages provide the capability to plan and execute flight plans world-wide through use of an active and alternate flight plan. The alternate flight plan is maintained separately from the active flight plan. The active flight plan, unlike the alternate flight plan, is dynamic; it uses real time navigation (position and velocity) and sensor inputs to perform its functions, and serves as the basis for guidance calculations. The Flight Plan Page allows access to a family of pages, as shown in Figure 1-103. The additional pages provide access to allow the crew to control and display information concerning the Flight Plan and Data Pages (Waypoint Data Page and Flight Plan Data Page).

## FLIGHT PLAN

The flight plan is an ordered sequence of up to 50 waypoints (plus up to five history waypoints) and may include one Hover At, three Search Patterns, two Rendezvous Waypoints, one Hold, and one Approach (including history waypoints). Waypoints may be entered into the flight plan via the CDU.

The "default" FPLN Page displays the active waypoint on DL3, with course, offset, and sequencing data on DL1. With the flight plan displayed, it can be scrolled through using the UP or DOWN arrow keys. Each activation of the key scrolls the display one line. The five most recent waypoints are stored as historical waypoints and may be viewed by scrolling UP from the default FPLN Page. These waypoints are distinguished from active or future waypoints by the lack of the right pointing arrows on the right side of the display. Depressing the left line select key adjacent to any flight plan waypoint (history or future) calls up the Waypoint Data Page for the selected waypoint. Depressing the right line select key adjacent to any flight plan waypoint calls up the Flight Plan Data Page for the selected waypoint. The Waypoint Data Page and Flight Plan Data Page are shown in detail in Figure 1-116 and Figure 1-117 and are discussed in detail in a later section.

Vertical scrolling moves the display up or down through the active flight plan. When the flight plan is scrolled from the initial display, the inbound course, parallel course offset, and sequencing selection on DL1 are replaced by a waypoint so that four waypoints are displayed on the page. The "↓TO↓" (or "↓FROM↓") indicator (on DL2) is only displayed if the active waypoint is displayed on DL3. Scrolling down shifts the waypoints on DL3, 5, and 7 up to DL1, 3, and 5, and an additional future waypoint is displayed on DL7. Scrolling up performs similarly in the opposite direction. Scrolling will not wrap around from the top and bottom of the flight plan. When "*DEST" is displayed on DL3, vertically scrolling down is not allowed. When the oldest history waypoint is displayed on DL1, vertically scrolling up is not allowed.

## FLIGHT PLAN WAYPOINTS

Waypoints may be entered into the flight plan via the CDU in the following ways:

1. Manual entry of three to five character identifiers (IDs).

2. Manual entry of ID with a bearing/distance offset (i.e., CID/120/23).

3. Manual entry of waypoint by its user-defined label.

4. Manual entry of latitude/longitude coordinates (defaults to North and West coordinate entries, if N/S or E/W is not entered). May be entered to thousandth of a minute through the Flight Plan Page, and is displayed to the nearest tenth of a minute.

5. Manual entry of Military Grid Reference System (MGRS) coordinates, including both Universal Transverse Mercator (UTM) or Universal Polar Stereographic (UPS) coordinate systems.

6. Entry of crew designated hospital/refuel waypoints from Waypoint List.

7. Entry of waypoint by marking the current position (by latitude/longitude).

8. Entry of cursor waypoint from the FDS-255 (by latitude/longitude).

9. Entry of a series of waypoints by inserting a route into the flight plan.

10. Entry of search patterns, three maximum (Ladder, Sector, Expanding Square, or Circle).

11. Entry of Impromptu waypoints.

12. Entry of a Holding pattern (one allowed in flight plan).

13. Entry of a Spot pattern (one allowed).

14. Entry of system generated waypoints required to execute a downwind turn for an approach to hover.

15. Entry of a rendezvous waypoint (maximum of two).

16. Insertion of computer generated turn point when Direct-To function is initiated.

17. Transfer of alternate flight plan waypoints into the flight plan.

18. Entry of an Approach.

The bearing entry for any waypoint may include the "T" or "M" for True or Magnetic. If omitted, the reference is based on the setting for True/Magnetic established on the Start Page.

In some cases the CDU rejects the entry of a waypoint. The conditions and annunciations associated with waypoint rejection include:

| Annunciation | Cause |
|---|---|
| HOLD ACTIVE | Attempt to insert a waypoint as the active waypoint while a Hold pattern is active. |
| CIRCLE ACTIVE | Attempt to insert a waypoint as the active waypoint while a Circle pattern is active. |
| APPROACH ACTIVE | Attempt to insert a waypoint as the active waypoint while an Approach is active. |
| APPROACH DEFINED | Attempt to insert a waypoint before a non-active approach LOP or MAP. |
| ERROR | Invalid scratchpad data. |
| FPLN FULL | The insertion would cause the number of waypoints in the flight plan to exceed 50. If an MDL search was required for the operation, the search was not performed. |
| ↙STATUS | An MDL search was required and the MDL is failed. |
| MDL BUSY | An MDL search was required and the MDL is currently processing an identifier search. In this case the search is not performed. |
| NOT FOUND | An ID match cannot be found on the MDL (for an ID or ID/bearing/distance entry) or a user-defined label cannot be found in the CDU memory. |

When waypoints are added into the middle of the flight plan, succeeding waypoints are automatically shifted down in the flight plan. Similarly, when waypoints are deleted from the flight plan, the remaining waypoints are automatically shifted up. The flight plan maintains its scrolled position when waypoints are added or deleted. An attempt to add a waypoint that would cause the number of waypoints in the flight plan to exceed 50 (not including history waypoints) prompts the "FPLN FULL" scratchpad message. The flight plan temporarily displays more than 50 waypoints when necessary to display the next 4 waypoints of an expanded pattern.

## MODIFYING WAYPOINTS

Waypoints may be modified in the following ways:

1. Application of a bearing/distance offset to any fixed point. By entering a valid offset (i.e., "180/3") in the scratchpad and selecting a waypoint, the scratchpad changes from the offset "180/3" to a latitude/longitude representing the offset position. The position can then be inserted into the flight plan or into any other CDU field that accepts waypoint entries.

2. Identification of a waypoint as the holding or pattern fix as discussed in detail in the Patterns Section.

3. Application of a planned time of arrival (PTA) as discussed in detail in the Flight Plan Data Page section.

4. Modification of the inbound course to the active waypoint (course edit). With a valid course in the scratchpad, selecting LS1 "CRS [xxx]" changes the course to the waypoint. In AUTO sequencing mode, course changes are limited to +/- 90 degrees from the current course. The MAN mode allows 360 degree course editing. The following annunciations are provided to the user to warn of an invalid course edit:

| Annunciation | Cause |
|---|---|
| ERROR | Invalid data in the scratchpad |
| CRS CHANGE > 90 | Attempt to change the inbound course by +/- 90 with the flight plan sequencing in AUTO mode |
| APPROACH ACTIVE | Attempt to change inbound course with LOP or MAP of an approach active |
| CIRCLE ACTIVE | Attempt to change inbound course with circle pattern active |
| HOLD ACTIVE | Attempt to change inbound course with a holding pattern active |
| HOVER ACTIVE | Attempt to change inbound course with HOVER as the active waypoint |
| RENDZ ACTIVE | Attempt to change inbound course with a rendezvous as the active waypoint |

5. Application of an automatic flight mode (sequencing change). Sequencing changes are discussed in detail in the "Waypoints Sequencing" subsection.

6. Attachment of a user-defined label to a waypoint (i.e., "/SWM02").

## WAYPOINT ATTRIBUTES

Waypoints in the Flight Plan that are search pattern, hold, approach, hover or rendezvous waypoints have attributes associated with them. Detailed discussions of approaches, patterns and rendezvous are covered in the Approach Page, Search Patterns and Rendezvous Page subsections. The possible attributes are as follows:

| Attribute | Meaning |
|---|---|
| C | The waypoint is the Commence Search Point (CSP) for a Ladder or Expanding Square or the fix waypoint for a Circle Pattern. |
| D | The waypoint is a CSP and/or datum for a Sector Pattern. |
| F | The waypoint is designated as the FAF. |
| H | The waypoint has a Hold Pattern attached to it. |
| L | The waypoint is designated as the LOP. |
| M | The waypoint is designated as the MAP. |
| R | The waypoint is designated as the rendezvous waypoint. |
| T | The waypoint has a planned time of arrival (PTA) associated with it. This indicates that a Time Navigation (TNAV) function is performed to obtain the desired time of arrival. |

The C, D, F, H, L, M, and R attributes are mutually exclusive. A TNAV may be applied to any waypoint; however, if any other attribute is associated with the waypoint, it takes precedence over the TNAV attribute for display on the flight plan.

When pattern generated waypoints are inserted into the flight plan or attached to points in the flight plan, only the CSP or fix waypoint is shown in the flight plan (with the exception of Spot or Impromptu patterns). When the CSP waypoint of a ladder, sector, or expanding square pattern becomes the active waypoint, then the flight plan displays four future pattern-generated waypoints. The four pattern generated waypoints are automatically updated during execution of the pattern. Similarly, when pattern generated waypoints are deleted, whether manually or by sequencing, the flight plan automatically eliminates holes as required. Insertion of additional waypoints or deletion of pattern generated waypoints will not alter the attribute numbering sequence. Pattern points are labeled as follows:

| Pattern Type | Label |
|---|---|
| CIRCLE | CIRCLE-x-yyyynm where "x" is the turn direction, and "yyyy" is the radius of the pattern |
| HOLD | HOLD-dxxx(T or M)-yyyy where "d" is the pattern direction and "xxx" is the holding course and "yyyy" is the leg length in nm |
| LADDER | LDR EOL x or LDR BOL x where EOL is the "end of leg," BOL is the "beginning of leg" and "x" is the number of the leg |
| EXP SQ | SQR xxx(T or M)/yyyy nm where "xxx" is the course into the waypoint and "yyyy" is the length of the leg in nm |
| SECTOR | SECT xxx(T or M)/yyyy where "xxx" is the radial from the datum and "yyyy" is the length of the leg in nm |
| SPOT | SPOT/xxx(T or M)/yyyy where "xxx" is the radial from the datum and "yyyy" is the length of the leg in nm |

The T or M label is displayed according to the system selection for magnetic or true.

## FLIGHT PLAN PAGE WITH CIRCLE PATTERN

A Circle pattern can be either inserted into the flight plan, or attached to a waypoint in the flight plan. A Circle pattern is displayed the same way in the flight plan, whether it is inserted or attached; when a Circle pattern is attached to a point, latitude/longitude or identifier display is replaced with the Circle pattern display label. Once a Circle pattern becomes active, it remains active until a Direct-To is performed, normally to the next waypoint in the flight plan.

Figure 1-104 is an example of a Circle Pattern making left hand turns with a 2.50 nm radius.

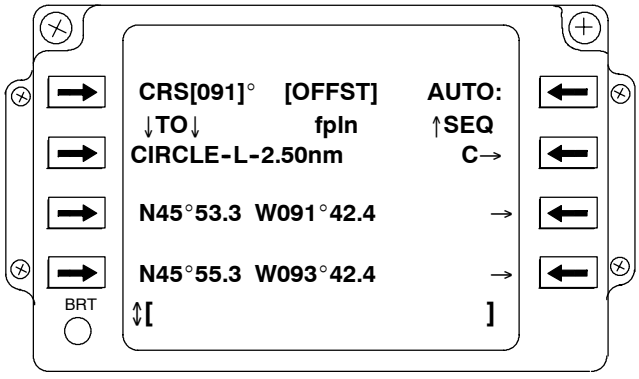



*Figure 1-104. Flight Plan Page with Circle Pattern*

## FLIGHT PLAN PAGE WITH HOLD PATTERN

A Hold pattern can be inserted into the flight plan, attached to a waypoint in the flight plan, or activated at the present position via the Hold Page. A Hold pattern is displayed the same way in the flight plan, whether it is inserted or attached; when a Hold pattern is attached to a point, latitude/longitude or identifier display is replaced with the Hold pattern display label. Once a Hold pattern becomes active, it remains active until a Direct-To is performed, normally to the next waypoint in the flight plan, or the "H" attribute is deleted from the waypoint. Figure 1-105 is an example of a Hold Pattern that makes right-hand turns on a holding course of 320 degrees magnetic. The leg length is 2.50 nm.

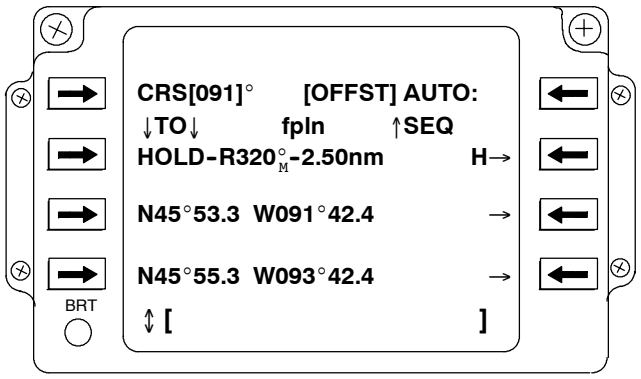



*Figure 1-105. Flight Plan Page with Hold Pattern*

## FLIGHT PLAN PAGE WITH LADDER PATTERN WAYPOINTS

When the first point of a Ladder pattern becomes active in the flight plan, the next four future pattern waypoints are generated and displayed in the flight plan. Waypoints generated for the Ladder pattern are displayed in the flight plan as "LDR," followed by "BOL" (Beginning of Leg) or "EOL" (End of Leg), followed by the number of the leg (Figure 1-106).

If the ladder pattern is defined by the search area's center point, the CSP waypoint is labeled in the same manner as the other ladder pattern waypoints (Figure 1-107).

**NOTE**

If the last point of a Ladder pattern is the active waypoint, selection of the right line select adjacent to that point adds one additional leg to the Ladder pattern, and the Flight Plan Data Page is not accessed.

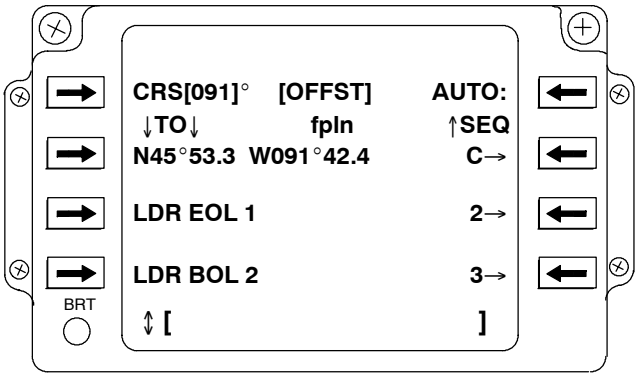



*Figure 1-106. Flight Plan Page with Ladder Waypoints*

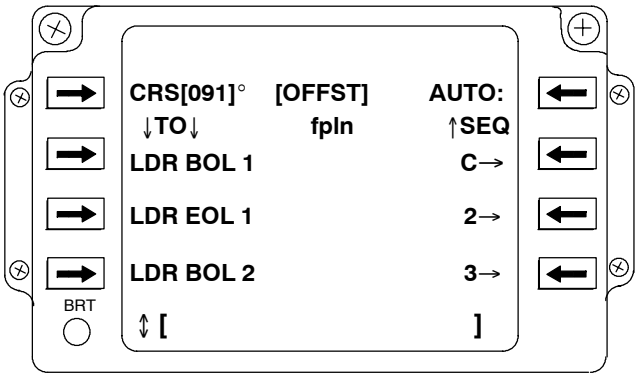



*Figure 1-107. Flight Plan Page with Ladder Waypoints (Center Point Defined)*

## FLIGHT PLAN PAGE WITH EXPANDING SQUARE WAYPOINTS

When the first point of an Expanding Square pattern becomes active in the flight plan, the next four future pattern waypoints are generated and displayed in the flight plan. The first point of an Expanding Square pattern is defined as the CSP waypoint for the pattern, and is labeled with a right justified "C" attribute. The CSP is displayed in the flight plan as Lat/Long coordinates (or by identifier if defined when pattern attached).

The Flight Plan Page with Expanding Square waypoints is shown in Figure 1-108.

## FLIGHT PLAN PAGE WITH SECTOR WAYPOINTS

When the first point of a Sector pattern becomes active in the flight plan, the next four future pattern waypoints are generated and displayed in the flight plan. The first point of a Sector pattern is defined as the Datum point for the pattern and is labeled with a right justified "D" attribute. The first instance of the Datum is displayed in the flight plan as Lat/Long coordinates (or by identifier if defined when pattern attached). Each subsequent instance of the Datum is displayed in the flight plan as "DATUM," along with a right justified "D" attribute.

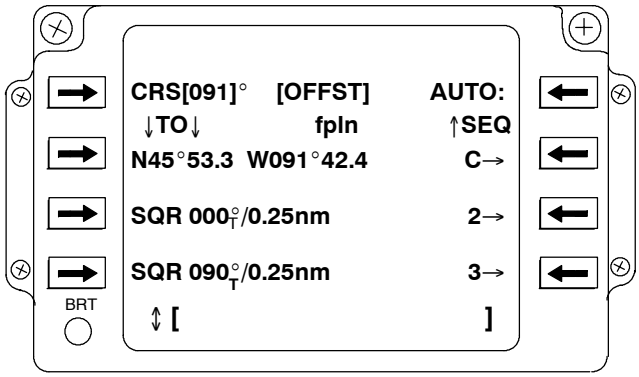



*Figure 1-108. Flight Plan Page with Expanding Square Waypoints*

The Flight Plan Page with Sector waypoints is shown in Figure 1-109.




*Figure 1-109. Flight Plan Page with Sector Waypoints*

## FLIGHT PLAN PAGE WITH SPOT WAYPOINTS

When a Spot pattern is inserted into the flight plan, all nine Spot waypoints are inserted into the flight plan. The Spot pattern is inserted into the Flight Plan before the waypoint is selected. Each instance of the Datum is displayed in the flight plan as "DATUM," along with a right justified "D" attribute. The first Spot pattern waypoint is number 2 (the first point is a flight plan waypoint).

The orientation of the Spot pattern is determined in the following manner: The course into the second Spot pattern waypoint (attribute label "2") is equal to the heading at the time the spot pattern is activated.

The Flight Plan Page with Spot pattern waypoints is shown in Figure 1-110. The Spot pattern has been inserted as the active waypoint while the course was 180 degrees.

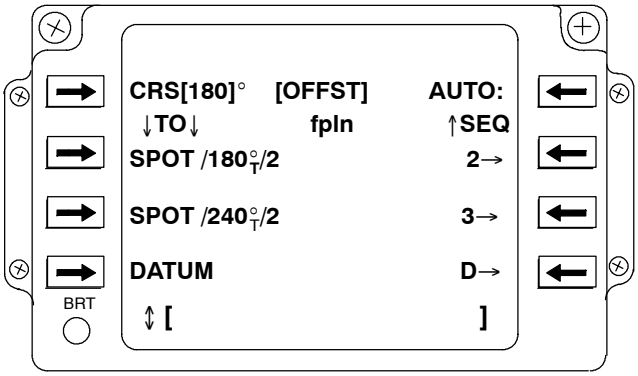



*Figure 1-110. Flight Plan Page with Spot Waypoints*

## FLIGHT PLAN PAGE WITH IMPROMPTU PATTERN WAYPOINTS

When an Impromptu pattern is inserted into the flight plan, all Impromptu points (up to nine defined on the Impromptu Page) are inserted into the flight plan (Figure 1-111).

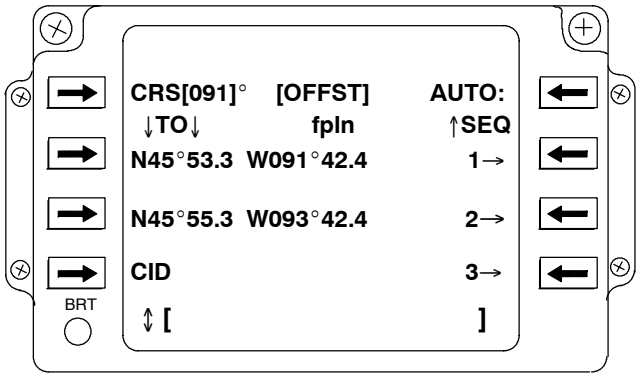



*Figure 1-111. Flight Plan Page with Impromptu Waypoints*

## FLIGHT PLAN PAGE WITH APPROACH WAYPOINTS

An Approach is displayed in the flight plan as three waypoints (in order): the Final Approach Fix, the Level Off Point, and the Missed Approach Point (shown in the flight plan as "FAF," "LOP," and "MAP" with attributes "F," "L," and "M," respectively). Once an Approach becomes active, the Approach waypoints cannot be deleted; the only way to deactivate an Approach is to perform a Direct-To to another waypoint, or fly past the MAP and then select Auto sequencing of the flight plan (Figure 1-112).

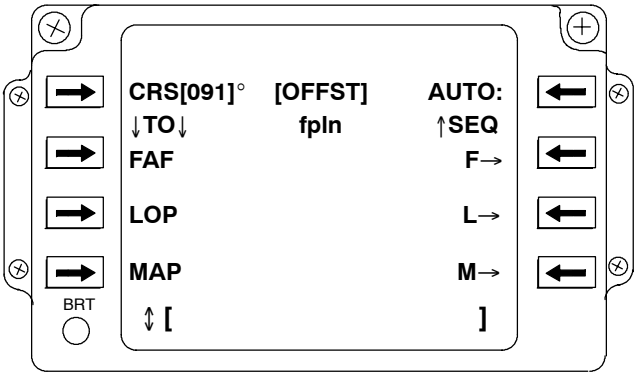



*Figure 1-112. Flight Plan Page with Approach Waypoints*

## FLIGHT PLAN PAGE WITH HOVER WAYPOINTS

A Hover is displayed in the flight plan as two waypoints (in order): the Turn point and the Hover point. No attribute is associated with these waypoints, but access to the Hover At page for the defined Hover is still allowed from the Flight Plan Data Page. Once a Hover becomes active, the Hover waypoints cannot be deleted; the only way to deactivate a Hover is to perform a Direct-To to another waypoint (Figure 1-113).

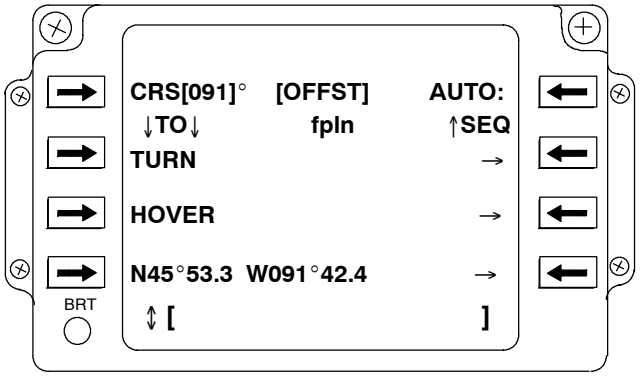



*Figure 1-113. Flight Plan Page with Hover Waypoints*

## FLIGHT PLAN PAGE WITH RENDEZVOUS WAYPOINTS

A Rendezvous is displayed in the flight plan as "RENDZ1" or "RENDZ2," along with the right justified "R" attribute. Once a Rendezvous becomes active, the Rendezvous waypoint cannot be deleted; the only way to deactivate a Rendezvous is to perform a Direct-To to another waypoint (Figure 1-114).

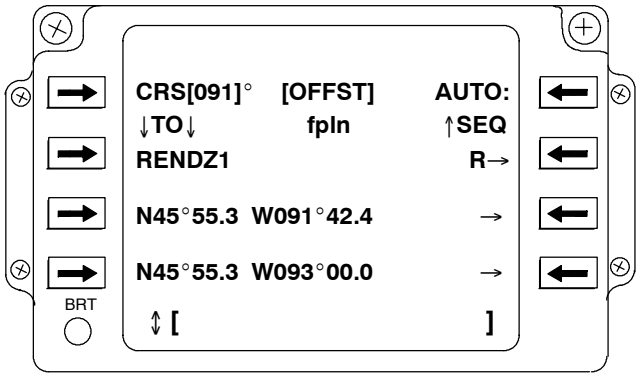



*Figure 1-114. Flight Plan Page with Rendezvous Waypoints*

## INSERT AND ATTACH

Applying patterns or rendezvous' to flight plan waypoints may be accomplished by either inserting (INSERT) or attaching (ATTACH) the pattern. Detailed discussions of patterns and rendezvous are covered in the Search Patterns and Rendezvous Page subsections. When the "ATTACH xxx" message is displayed in the scratchpad of the Flight Plan Page, depressing the left line select key adjacent to a flight plan waypoint attaches the previously specified pattern parameters to the selected waypoint. This waypoint then becomes the CSP for the specified pattern or hold. When "ATTACH xxx" appears in the scratchpad, the "xxx" may be any of the following: HOLD, CIRCLE, LADDER, EXP SQ, SECTOR, or HOVER. When the "INSERT xxx" message is displayed in the scratchpad of the Flight Plan Page, depressing LS2 – 4 inserts the specified pattern or rendezvous into the flight plan in the chosen location, and all subsequent waypoints move down in the flight plan. When "INSERT xxx" appears in the scratchpad, the "xxx" may be any of the following: WPTS, APPROACH, RENDZ1, RENDZ2, ROUTE, IMPROMPTU, SPOT, HOLD, CIRCLE, LADDER, EXP SQ, SECTOR, or HOVER.

In some cases the CDU will not allow a pattern to be attached to a flight plan waypoint. The following annunciations indicate a condition that prevents attaching a pattern:

| Annunciation | Condition |
|---|---|
| WPT PASSED | Attempt to attach to the active waypoint on the FROM side while manual sequencing is selected |
| RENDZ WPT | Attempt to attach at a rendezvous |
| APPROACH WPT | Attempt to attach at a MAP, LOP or FAF |
| PATTERN WPT | Attempt to attach at a pattern generated waypoint |
| HOLD WPT | Attempt to attach at a Hold |
| HOVER WPT | Attempt to attach at a Hover waypoint |
| MAX PATTERNS | Attempt to attach when two patterns already exist in the flight plan |

In some cases the CDU will not allow a pattern to be inserted into a flight plan. The following annunciations indicate a condition that prevents inserting a pattern or rendezvous:

| Annunciation | Condition |
|---|---|
| FPLN FULL | The insertion would cause the number of waypoints in the flight plan to exceed 50 |
| MAX RENDZ | Attempt to insert a rendezvous when two rendezvous exist in the flight plan |
| RENDZ ACTIVE | Attempt to insert a rendezvous before the active waypoint while a rendezvous is active |
| MAX PATTERNS | Attempt to insert a pattern when two patterns already exist in the flight plan |
| APPROACH DEFINED | Attempt to insert an Approach when an Approach already exists in the flight plan |
| HOVER IN FPLN | Attempt to insert a Hover when a Hover already exists in the flight plan |

## DELETING WAYPOINTS

Waypoints may be deleted in the following ways:

1. Deletion of individual waypoints. With "-" in the scratchpad, selecting the left line select key adjacent to a future waypoint deletes the waypoint and all subsequent waypoints move up in the flight plan. If an Approach or Hover waypoint is deleted, all waypoints associated with that Approach or Hover are deleted from the flight plan. Waypoints cannot be deleted from history, and attempts to do so result in an "ERROR" annunciation.

2. Automatic deletion of intervening points when a Direct-To function is initiated to an existing flight plan waypoint. Direct-to features are covered in detail in the Direct-To section.

3. Deletion of an entire flight plan in start-up procedure. This procedure is covered in detail in the Start Page section.

4. Deletion of an entire flight plan with the erase function. This procedure is covered in detail in the Start Page section.

5. Deletion of an entire flight plan when replaced with an alternate flight plan. This procedure is covered in detail in the Alternate Flight Plan Page section.

## FLIGHT PLAN PAGE

The Flight Plan Page (Figure 1-115) is accessed in the following ways:

1. Selecting the FPLN function key on the CDU.

2. Selecting the DIR function key on the CDU.

3. From the Flight Plan Data Page.

4. From the Start Page 3/3.

5. From the Patterns Pages (Hold, Ladder, Sector, etc.).

The non-scrolled Flight Plan Page is displayed upon access of the Flight Plan Page, with two exceptions:

1. If the Flight Plan Page is accessed from the Flight Plan Data Page, the Flight Plan Page is scrolled (if necessary) so that the waypoint from the Flight Plan Data Page is displayed at the top.

2. If the Flight Plan Page is being displayed when the DIR function key is selected, the flight plan retains the scrolled position (if any).

a. Selection with a valid course entry in the scratchpad edits the inbound course to the active waypoint.

b. Line selects 2-4 provide the primary means to manage flight plan waypoints.

- Selection with an empty scratchpad and a waypoint or identifier adjacent to the line select accesses the Waypoint Data Page for that waypoint.
- Selection with a valid bearing/distance in the scratchpad copies the waypoint adjacent to the line select, applies the bearing/distance offset, and writes the new waypoint (latitude/longitude) to the scratchpad; the waypoint in the flight plan is not affected, and the new waypoint is not inserted into the flight plan. If invalid data is in the scratchpad, the ERROR annunciation alternates with the data in the scratchpad.
- Selection with a valid waypoint entry in the scratchpad inserts the waypoint before the waypoint adjacent to the line select, and all subsequent waypoints move down in the flight plan. If the selection causes the new waypoint to be inserted as the active waypoint, a course from the FROM to the new TO is calculated.
- Selection with a "/" followed by a valid user-defined label in the scratchpad searches the CDU memory for a waypoint with that user-defined label. The waypoint appears in the flight plan as the user-defined label.

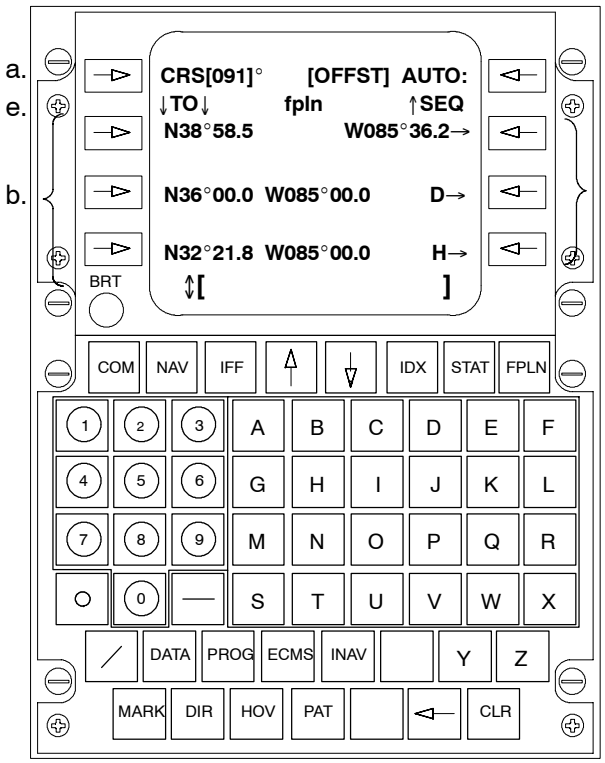



*Figure 1-115. Flight Plan Page*

c. Selection with an empty scratchpad, or a valid waypoint in the scratchpad, toggles the waypoint sequencing selection from automatic (AUTO) to manual (MAN). The waypoint sequencing selection defaults to AUTO. Selection with a valid parallel course offset entry in the scratchpad enters the offset into the offset field and raises the OFFSET annunciation on the annunciation line. Selection with a "-," "0," "L0," or "R0" in the scratchpad deletes any entered parallel course offset and clears the OFFSET annunciation. System cancellation of a parallel offset raises the OFFSET CNCLD annunciation on the annunciation line.

d. Selection accesses the Flight Plan Data Page.

- Selection with a "-" in the scratchpad and a pattern attribute (CSP or first Datum only) adjacent to the line select detaches the pattern from the waypoint,

and leaves the first waypoint of the pattern in the flight plan as a lat/long. Selection of a Spot waypoint or an Impromptu waypoint displays "ERROR." If a Hold is active when the operation is performed, the aircraft turns inbound to the holding fix. After passage of the holding fix, the holding pattern is exited. If a TNAV is active for the waypoint selected, the PTA is set to delete and the TNAV is removed from the flight plan.

e. Displays the TO/FROM label, the Page title, and the sequencing label (↑SEQ). When on the FROM side of the active waypoint, the "↓TO↓" displayed on line 2 changes to "↓FROM↓." Any course edits are applied to the inbound/outbound course as appropriate, and the TO/FROM label reflects the aircraft position relative to a line through the waypoint perpendicular to the course.

# DATA PAGES

Two CDU pages provide amplifying information on CDU waypoints: the Waypoint Data Page and the Flight Plan Data Page. Pressing Line Select Keys adjacent to waypoints, with no data in the scratchpad, accesses data pages for specific waypoints on the Flight Plan Page. Selecting the left line select key adjacent to a waypoint accesses the Waypoint Data Page. Selecting the right line select key adjacent to a waypoint accesses the Flight Plan Data Page.

## WAYPOINT DATA PAGE

The Waypoint Data Page (Figure 1-116) may be accessed by: pressing the left line select key adjacent to a Flight Plan Page, Waypoint List Page or Mark List Page waypoint. Information displayed on the Waypoint Data Page includes:

1. The identifier of the selected waypoint.

2. The bearing, distance and estimated time en route from your present position direct-to the waypoint, and via the flight plan route.

3. The frequency, elevation and magnetic declination/variation.

**NOTE**

If the referenced waypoint is an identifier with an associated magnetic declination, then declination is used rather than magnetic variation (when magnetic reference is selected for display) so that the reported course is station rather than earth referenced.

If the Waypoint Data Page was accessed from the Flight Plan Page and a waypoint has not been entered via LS1, vertical scrolling accesses the Waypoint Data Pages for other waypoints in the flight plan. The right facing arrow adjacent to LS5 returns the display to the previous position in the flight plan. Information for waypoints other than the selected waypoint may also be displayed on the Waypoint Data Page. Entering a valid waypoint (other than a user-defined label) in LS1 initiates a search for the waypoint. When found, the information is displayed for the new waypoint. Vertical scrolling is disabled after a waypoint search is executed. If the search is unsuccessful, one of the following annunciations appears:

| Annunciation | Meaning |
|---|---|
| ERROR | Invalid data in the scratchpad |
| ↙ STATUS | An MDL search was required and the MDL failed |
| MDL BUSY | An MDL search was required and the MDL is currently processing an identifier search. In this case the search is not performed. |
| NOT FOUND | An ID match cannot be found on the MDL (for an ID or ID/bearing/distance entry) or a user-defined label cannot be found in the CDU memory. |

Entering a "/" followed by a valid user-defined label into LS1 initiates a CDU search for a waypoint with that user-defined label. If one is not found, the label is attached to that waypoint and the waypoint appears in the flight plan with the new user-defined label. If the assignment of a user-defined label is unsuccessful, one of the following annunciations appears:

| Annunciation | Meaning |
|---|---|
| PATTERN WPT | The waypoint adjacent to the line select is a pattern waypoint. In this case, the search is not performed. |
| ERROR | Invalid data is in the scratchpad. In this case, the search is not performed. |
| NAME IN USE | A waypoint in the CDU memory is already using the user-defined label. |

Entering a "/" in the line select adjacent to a waypoint with a user-defined label removes the user-defined label from the waypoint. Selection with a valid bearing/distance in the scratchpad (i.e., 220/2.5) copies the waypoint adjacent to the line select, applies the bearing/distance offset, and writes the new waypoint to the scratchpad; the waypoint on the page is not affected. This "appended" waypoint may then

be entered into LS1 to access Waypoint Data for that newly defined point.

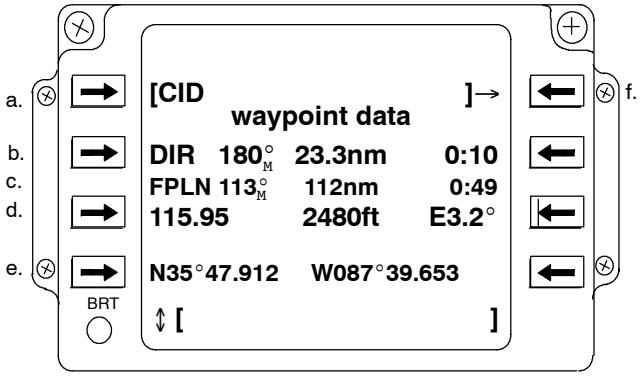



*Figure 1-116. Waypoint Data Page*

a. Displays the referenced waypoint, identifier, or ID/bearing/distance. Selecting LS1 with a blank scratchpad and a valid waypoint copies the waypoint to the scratchpad. A user-defined label may also be assigned using LS1.

b. Displays the Direct-To course, distance, and Estimated Time Enroute (ETE) from the present position to the referenced waypoint, assuming current winds and ground speed.

c. Displays the inbound flight plan course into the referenced waypoint, and the distance and ETE to the referenced waypoint along the flight plan path, assuming current winds and ground speed. If the referenced waypoint is not a flight plan waypoint, then the fields are dashed out.

d. Displays the frequency, elevation, and magnetic declination/variation. Magnetic declination is used rather than magnetic variation whenever available. If no data is available for the fields, then the fields are dashed out.

**WARNING**

When viewing the Waypoint Data Page for any Waypoint Identifiers that have appended bearing and distance (i.e., "KMOB/320/5") the elevation data represents the identifier's position (in this case KMOB), not the actual waypoint position.

e. Displays the position in latitude and longitude for the referenced waypoint.

f. Returns operator to CDU Page from which the Waypoint Data Page was accessed.

## FLIGHT PLAN DATA PAGE

The Flight Plan Data Page is accessed from the Flight Plan Page. The page provides access to Patterns, Rendezvous, Hold, Hover, and Approach Pages (when applicable), and allows assignment of user defined labels to waypoints, and definition of a Planned Time of Arrival to a waypoint. The page displays the latitude and longitude of flight plan waypoints and the selected Horizontal Datum at the time the waypoint was entered into the flight plan (Figure 1-117). Upon initial access, the waypoint data displayed corresponds to the selected waypoint on the Flight Plan Page.

Similar to the Waypoint Data Page, each activation of the UP or DOWN arrow keys with the Flight Plan Data Page displayed calls up the next page in the order the waypoints appear in the flight plan. The "RETURN" key returns the display to the previous position in the flight plan. Information for waypoints other than the selected waypoint may also be displayed on the Flight Plan Data Page. Entering a valid waypoint (other than a user-defined label) initiates a search for the waypoint. When found, the information is displayed for the new waypoint. Vertical scrolling is disabled after a waypoint search is executed. If the search is unsuccessful, one of the following annunciations appears:

| Annunciation | Meaning |
|---|---|
| ERROR | Invalid data in the scratchpad. |
| ✓ STATUS | An MDL search was required and the MDL failed. |
| MDL BUSY | An MDL search was required and the MDL is currently processing an identifier search. In this case the search is not performed. |
| NOT FOUND | An ID match cannot be found on the MDL (for an ID or ID/bearing/distance entry) or a user-defined label cannot be found in the CDU memory. |

Identical to the Waypoint Data Page, entering a "/" followed by a valid user–defined label into LS2 initiates a CDU search for a waypoint with that user–defined label. If one is not found, the label is attached to that waypoint and the waypoint appears in the flight plan with the new user–defined label. If the assignment of a user–defined label is unsuccessful, one of the following annunciations appears:

| Annunciation | Meaning |
|---|---|
| PATTERN WPT | The waypoint adjacent to the line select is a pattern waypoint. In this case, the search is not performed. |
| ERROR | Invalid data is in the scratchpad. In this case, the search is not performed. |
| NAME IN USE | A waypoint in the CDU memory is already using the user-defined label. |

Entering a "/" in the line select adjacent to a waypoint with a user-defined label removes the user-defined label from the waypoint. Selection with a valid bearing/distance in the scratchpad (i.e., 220/2.5) copies the waypoint adjacent to the line select, applies the bearing/distance offset, and writes the new waypoint to the scratchpad; the waypoint on the page is not affected.

A Planned Time of Arrival (PTA) may be assigned to any flight plan waypoint via the Flight Plan Data Page. PTA data is used to provide ground speed information to the Progress Page (discussed in the Progress Page subsection) to aid in arriving at the waypoint at a specific time. Entering a valid time establishes a Planned Time of Arrival (PTA) for the waypoint and assigns the attribute "T" to the Flight Plan Waypoint. If no time is entered, the PTA entry defaults to dashes. A PTA may be removed by depressing LS4 with a "-" in the scratchpad. When a PTA is removed, the PTA time resets to the default value (dashes). Information regarding the application of a PTA is found in the Progress Page subsection. An unsuccessfully entered PTA is indicated by one of the following annunciations:

| Annunciation | Meaning |
|---|---|
| ERROR | Invalid data is in the scratchpad. |
| RENDZ WPT | The waypoint for which the PTA is being defined is a Rendezvous waypoint, and the PTA is not allowed. |
| HOVER WPT | The waypoint for which the PTA is being defined is a Hover waypoint, and the PTA is not allowed. |

When a flight plan waypoint has an attribute assigned to it (such as a pattern or rendezvous), access to the page that defines the attribute is available by depressing LS6 on the Flight Plan Data Page. The following chart defines the attributes and related page access:

| Attribute | LS6 Accesses |
|---|---|
| "C" | The Ladder, Expanding Square, or Circle Pattern Page for the defined pattern, as appropriate. |
| "D" | The Sector Pattern Page for the defined pattern. |
| "F," "L," or "M" | The Approach Page for the defined approach. |
| "H" | The Hold Page for the defined Hold pattern. |
| "R" | The Rendezvous Page for the defined rendezvous. |
| Turn point or Hover point | The Hover At Page for the defined Hover. |

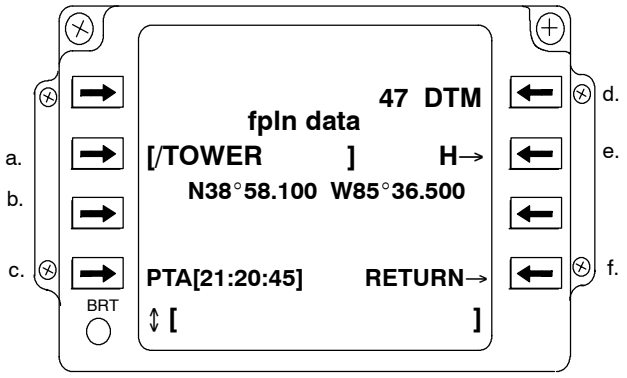



*Figure 1-117. Flight Plan Data Page*

a. Displays the waypoint identifier, ID/bearing/distance, or user-defined identifier, or is blank if waypoint does not have any of these associated with it.

b. Displays the coordinates (in latitude and longitude) of the waypoint.

c. Displays the Planned Time of Arrival (PTA) at the waypoint, if defined.

d. Displays the currently selected Horizontal Datum.

e. Displays an assigned attribute and provides access to the attribute definition page.

f. Returns the display to the previous position in the flight plan.

# PROGRESS PAGES

The Progress Pages are accessed by pressing the PROG function key on the CDU (Figure 1-118). The Progress Pages summarize the progress of the aircraft along the flight plan route and provide current fuel and performance conditions. Information on the Progress Page can be displayed in multiple formats in order to increase crew situational awareness.

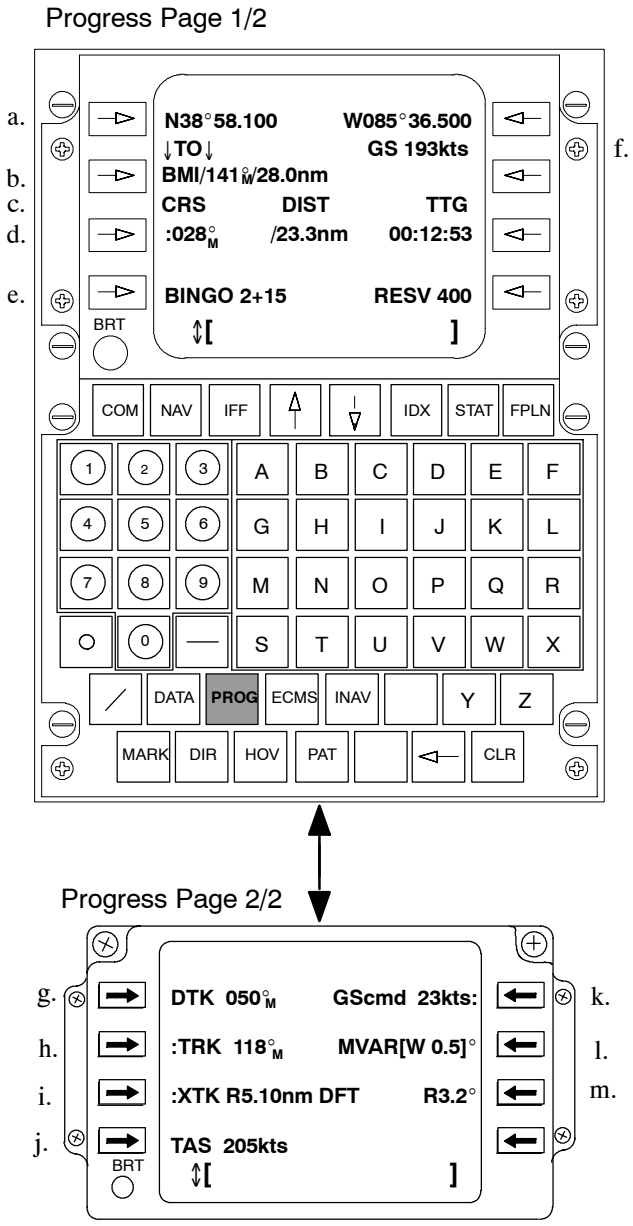



*Figure 1-118. Progress Pages*

**NOTE**

All displays are referenced to magnetic or true according to the mag/true selection made on Start Page 1/3. Magnetic variation is used to convert to magnetic reference, irrespective of the active waypoint type, when the system selection is magnetic.

a. Displays the integrated navigation present position. Displays dashes when invalid.

b. Displays the active waypoint.

c. Displays "CRS" which is the bearing *to* the active waypoint, or "FROM" which is the bearing *from* the active waypoint.

d. Selection toggles the bearing display to the active waypoint between "CRS" and "FROM." The default setting is "CRS." If manual sequencing is selected and the bearing display selection is set to "CRS" when the active waypoint is passed, the bearing display toggle selection is set to "FROM." Distance (DIST) to the active waypoint, and the time to go (TTG) to the active waypoint is also displayed. During manual sequencing, when the active waypoint has been passed, TTG counts up.

e. Displays time to Fuel Alert annunciation (BINGO, as displayed on the System Status Page) and reserve fuel weight (as entered on the Start Page 2/3). BINGO, displayed as HOURS + MINUTES, is based on maximum range airspeed, current winds at present altitude, and the direct distance to the last waypoint in the Flight Plan. If the last waypoint is a rendezvous waypoint, the annunciation NO BINGO is displayed on the annunciation line. The BINGO calculation will continue to be performed. If no Flight Plan is constructed, BINGO is calculated to the FROM waypoint. Once BINGO is reached, the time display changes to running time passed BINGO, -XX, where XX is 00 to 99 minutes. (For further amplification on fuel management see the "Fuel Optimization and Altering Calculations" subsection.)

f. Displays the current ground speed in knots.

g. Displays the desired flight plan ground track at present position.

h. Displays the track (TRK), which is the aircraft's actual ground track, or heading (HDG), which indicates the aircraft's current heading. Selection toggles the display between TRK and HDG. The default setting is TRK.

i. Displays cross track deviation or track angle error. The Cross Track Deviation (XTK) displays the aircraft's distance, in nm, from the desired ground track (DTK) while the track angle error (TKE) indicates the angular difference between the actual ground track (TRK) and the desired ground track (DTK). In both cases the display uses R or L to indicate direction left or right of the desired track and three digits to indicate the magnitude. Selection toggles the display between cross track deviation (XTK) and track angle error (TKE). The default setting is XTK.

j. Displays the present aircraft true airspeed (TAS) in knots.

k. The default setting upon page access is GS when no PTA is defined, and GScmd when a PTA is defined. When a PTA is not active in the flight plan, the current GS is displayed and the toggle is disabled.

Selection toggles the ground speed display through the following states:

- ground speed command (GScmd) – indicates the ground speed needed to make the scheduled PTA
- current ground speed (GS)- indicates the aircraft's actual ground speed, and
- ground speed error (FAST or SLOW) – indicates the ground speed error for the aircraft where FAST means the aircraft is moving too quickly and arrives early at the PTA waypoint, and SLOW means the aircraft is moving too slowly and arrives late at the PTA waypoint.

l. Computed magnetic variation is updated here automatically on a cyclic basis if the magnetic variation table is available and a value is not manually entered. Selection with a valid entry in the scratchpad enters the desired magnetic variation in degrees.

m. Drift sensing indicates the direction of the ground track with respect to the aircraft heading. The display is "R" or "L" to indicate the direction and two digits to indicate the magnitude.

## NAVIGATION PAGE

The Navigation Sensor Control Page (Figure 1-119) is accessed by pressing the NAV function key on the CDU.

a. Selection toggles the TACAN tuning mode between manual (MAN) and paired (PAIR) with the VOR. When

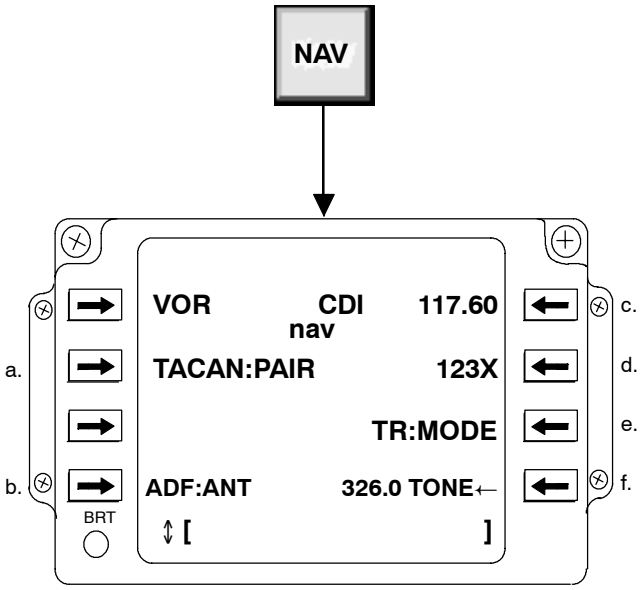



*Figure 1-119. Navigation Sensor Control Page*

PAIR is selected, the TACAN tuning mode is commanded to the SIU, the TACAN mode is changed to TR, and the TACAN is tuned to the co-located channel for the current VOR station. Operator initiated test of the TACAN has no effect on this line select. The ↙STATUS message flashes in the scratchpad if the VOR/LOC is failed or is in IBIT when the line select is pressed.

b. Selection with a valid entry in the scratchpad will tune the ADF to the desired frequency. Selection with an empty scratchpad will toggle the ADF mode between ADF and Antenna (ANT). The ADF mode will default to ADF. With invalid data in the scratchpad, selection of the LS causes the ERROR message to alternate with the data in the scratchpad. The ↙STATUS message flashes in the scratchpad if the ADF is failed or is performing an Initiated Built In Test (IBIT) when the line select is pressed.

c. Selection with an empty scratchpad will tune the VOR to the last tuned frequency, including the station identifier (if applicable). Selection with a valid station identifier in the scratchpad will prompt a search of the Primary and Reversionary Databases for the station identifier. If the search is successful, the VOR/ILS is tuned to the frequency associated with entered identifier. If PAIR is selected as the TACAN tuning mode, the TACAN is tuned to the co-located channel. If the station identifier is not in the database, the NOT FOUND message will alternate with the data in the scratchpad. Selection with a valid frequency in the scratchpad will tune the VOR/ILS to the entered

frequency, the VOR frequency field will display the entered frequency, and the station identifier field is dashed. If the entered frequency is less than 112.00 and the tenths digit is odd, Localizer is commanded to the VOR/ILS and LOC is displayed adjacent the VOR label. If PAIR is selected as the TACAN tuning mode, the TACAN is tuned to the co-located channel. With invalid data in the scratchpad, the ERROR message alternates with the data in the scratchpad. The ✓STATUS message flashes in the scratchpad if the VOR/LOC is failed or is in IBIT when the line select is pressed. Displays TEST in the ADF channel field if the ADF is currently performing an IBIT. If the ADF is failed, the ADF frequency and mode display fields are dashed out.

**NOTE**

TEST is displayed in the VOR/ILS frequency field if the VOR/ILS is currently performing an IBIT. If the VOR/ILS is failed, the station identifier and frequency display field are dashed out.

d. Selection with an empty scratchpad will tune the TACAN to the last tuned channel. Selection with a valid entry in the scratchpad will tune the TACAN to the entered channel, and the TACAN channel field will display the entered channel. If PAIR was previously selected as the TACAN tuning mode, the TACAN tuning mode will change to MAN. With invalid data in the scratchpad the ERROR message alternates with the data in the scratchpad. The ✓STATUS message flashes in the scratchpad if the TACAN is failed or is in IBIT when the line select is pressed.

**NOTE**

TEST is displayed in the TACAN channel field if the TACAN is currently performing an IBIT. If the TACAN is failed, the TACAN mode, TACAN tuning mode, and TACAN channel display field are dashed out.

e. Selection will toggle the TACAN mode through the following states: TR, R, AAR, and AATR. If PAIR was previously selected as the TACAN tuning mode, the TACAN tuning mode will change to MAN. With invalid data in the scratchpad, selection of the LS causes the ERROR message to alternate with the data in the scratchpad. The ✓STATUS message flashes in the scratchpad if the TACAN is failed or is in IBIT when the line select is pressed.

f. Selection with a valid entry in the scratchpad will tune the ADF to the desired frequency. Selection with an empty scratchpad will toggle the ADF TONE on or off. If the TONE is on, an * will replace the ~-. With invalid data in the scratchpad, selection of the LS causes the ERROR message to alternate with the data in the scratchpad. The ✓STATUS message flashes in the scratchpad if the ADF is failed or is in IBIT when the line select is pressed.

**NOTE**

TEST is displayed in the ADF channel field if the ADF is currently performing an IBIT. If the ADF is failed, the ADF frequency and mode display fields are dashed out.

## IFF PAGES

IFF Page 1/2 (Figure 1-120) is accessed by pressing the IFF function key on the CDU.

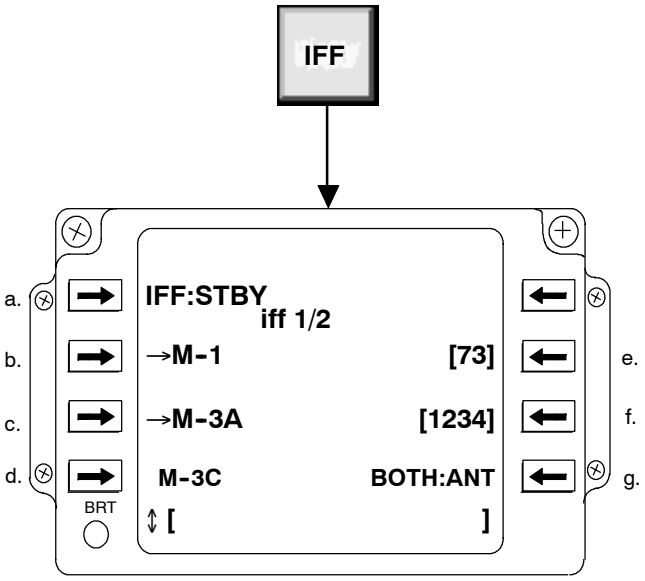



*Figure 1-120. IFF Page 1/2*

a. Selection toggles the IFF power mode between NORM and STBY. The IFF power mode defaults to STBY. If the line select key is depressed and the IFF is failed, or the IFF is in the EMERGENCY mode, the ✓STATUS message flashes in the scratchpad and the ability to toggle between NORM and STBY is disabled. TEST is displayed right justified if any IFF IBITs are currently being performed. If the IFF is failed, the IFF power mode display field is dashed out. If the IFF EMERGENCY mode is active, the IFF power mode displays EMER.

b. Selection toggles Mode 1 between ON and OFF. If Mode 1 is ON, an "*" replaces the →. If the line select key is depressed and the IFF is in IBIT, or is in the

EMERGENCY mode, the ✓STATUS message flashes in the scratchpad and the ability to change the MODE 1 status is disabled.

c. Selection toggles Mode 3A between ON and OFF (Mode 3C is set to the same state as Mode 3A). If Mode 3A is ON, an "*" replaces the →. If the line select key is depressed and the IFF is in IBIT, or is in the EMERGENCY mode, the ✓STATUS message flashes in the scratchpad and the ability to change MODE 3A status is disabled.

d. If Mode 3A is ON, selection toggles Mode 3C between ON and OFF. If Mode 3C is ON, an "*" replaces the →. If Mode 3A is OFF, Mode 3C is set to OFF, the → or "*" adjacent LS4 is removed. If the line select key is depressed and the IFF is in IBIT, or is in the EMERGENCY mode, the ✓STATUS message flashes in the scratchpad and the ability to change MODE 3C status is disabled.

e. Selection with a valid entry in the scratchpad enters the Mode 1 Code into the brackets. If the line select key is depressed when the IFF is in the EMERGENCY mode, or the scratchpad is empty or contains invalid data, ✓STATUS is displayed in the scratchpad.

f. Selection with a valid entry in the scratchpad enters the Mode 3 Code into the brackets. Displays 7700 as the Mode 3 code if the IFF EMERGENCY mode is active. If the line select key is depressed when the IFF is in the EMERGENCY mode, or the scratchpad is empty or contains invalid data, ✓STATUS is displayed in the scratchpad.

g. Selection toggles the antenna selection through the following modes: BTM (bottom), BOTH, and TOP. The IFF Antenna Selection default is BOTH. The ✓STATUS message flashes in the scratchpad if the IFF is failed when the line select is pressed.

**NOTE**

If the IFF is failed, the IFF power mode, Mode Codes, and antenna selection display fields are dashed out.

**NOTE**

Selecting the UP arrow, DOWN arrow, or IFF function key on the CDU scrolls to the IFF page 2/2.

**NOTE**

When the IFF EMERGENCY mode is secured, IFF modes M-1, M-3A, and M-3C and the Mode 3 Code revert to the state they were in prior to IFF EMERGENCY becoming active.

IFF Page 2/2 (Figure 1-121) is accessed by using the Up and Down arrow keys.

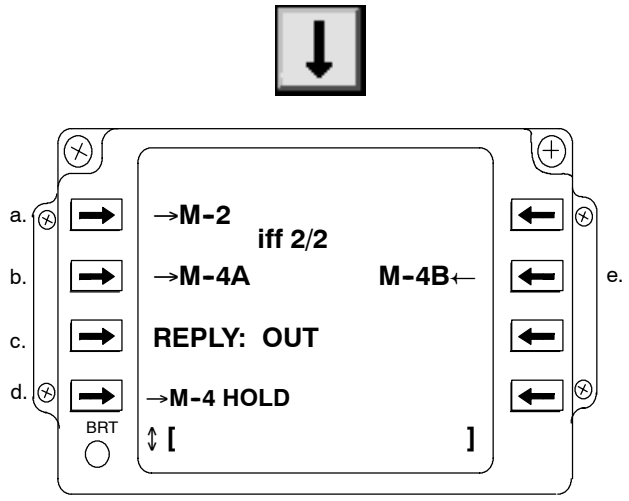



*Figure 1-121. IFF Page 2/2*

a. Selection toggles Mode 2 between ON and OFF. If Mode 2 is ON, an "*" replaces the →. If the line select key is depressed and the IFF is in MODE 2 IBIT, or is in the EMERGENCY mode, the ✓STATUS message flashes in the scratchpad and the ability to change MODE 2 status is disabled.

b. Selection toggles Mode 4A between ON and OFF. When Mode 4A (or Mode 4B) is toggled ON, the Mode IV Reply (adjacent to LS3) is set to TONE and the IFF antenna is set to BOTH. If Mode 4A is ON, an "*" replaces the → and Mode 4B is set to OFF. If the line select key is depressed and the IFF is in Mode IV IBIT or the IFF is failed, the ability to change Mode IV status is disabled and no operations are performed.

c. Selection toggles the Mode IV Reply selection through the following states: OUT, TONE, and LIGHT. The Mode IV Reply state defaults to OUT. The M4 REPLY annunciation appears if LIGHT is selected and the IFF is replying to an M4 interrogation. The ✓STATUS message flashes in the scratchpad if the IFF is failed when the line select is pressed.

d. Selection commands the Mode IV Code Hold. For approximately 15 seconds following selection, the → is

replaced by an "*"; after 15 seconds has elapsed, the * is replaced by an →, M-4 HOLD is replaced by M-4 HELD, and the Mode IV Code Hold is no longer commanded. The ↙STATUS message flashes in the scratchpad if the IFF is failed when the line select is pressed.

e. Selection toggles Mode 4B between ON and OFF. When Mode 4B (or Mode 4A) is toggled to ON, the Mode IV Reply (adjacent to LS3) is set to TONE and the IFF Antenna is set to BOTH. If Mode 4B is ON, an "*" replaces the → and Mode 4A is set to OFF. If the line select key is depressed and the IFF is in Mode IV IBIT or the IFF is failed, the ability to change Mode IV status is disabled and no operations are performed.

**NOTE**

If the IFF is failed, the Mode IV Reply selection display field is dashed out.

# NAVIGATION COMPUTATIONS

The function of the navigation computation is to maintain an estimate of horizontal present position and velocity. The method of determining the position and velocity depends on the availability of sensor data. The system automatically selects the best possible navigation mode for the purpose of calculating the present position. The possible navigation modes of operation in the "AUTO" mode are as follows:

1. GPS1/HDG/TAS (GPS #1/Heading/True Airspeed)
2. GPS2/HDG/TAS (GPS #2/Heading/True Airspeed)
3. GPS1/HDG (GPS #1/Heading)
4. GPS2/HDG (GPS #2/Heading)
5. GPS1 ONLY
6. GPS2 ONLY
7. HDG/TAS (Heading/True Airspeed)
8. FAIL

If GPS1 is selected on the INAV page, all GPS2 related modes are omitted from the list. If GPS2 is selected on the INAV Page, all GPS1 related modes are omitted from the list. The airspeed input is either TAS (OADS data if valid), or the Indicated Airspeed (IAS) from the pitot static system. The heading is calculated by the CDU from the Magnetic Compass System data. Each specific AUTO mode is discussed below.

The GPSx/HDG/TAS (where x=1,2 to define GPS1 or GPS2) mode is entered if heading, true airspeed, and GPS data are valid. Determination of position in this mode is based on true airspeed, heading, wind estimates, and computed position corrections. The wind may be either entered by the crew or computed by the navigation function, though a manually entered wind is overwritten when a valid wind is computed. The computed estimates of position error and wind are applied to the dead reckoning navigation solution to derive a best estimate of horizontal position and velocity.

The GPS ONLY mode is entered when GPS data is valid and either true airspeed or heading is invalid. In the GPS ONLY mode the position is determined using the average of the two most recent velocity measurements from the GPS receiver to interpolate the position to the next GPS measurement. The position estimate is reset to the GPS position after each measurement cycle.

The HDG/TAS mode is entered if true airspeed and heading data are valid and GPS data is invalid. In the HDG/TAS mode the position is propagated using true airspeed, heading, and wind. This mode is indicated on the CDU by the D/R annunciation. Wind is not computed in this mode though the crew can manually enter it.

The GPS #1 and #2 are aided by data that includes heading, true airspeed, barometric altitude, and the validity for each. If the true airspeed, heading, and GPS data are invalid a navigation FAIL condition exists. In the case of a FAIL condition the present position is not updated and the "NAV FAIL" annunciation is raised.

## NAVIGATION INDEX

When GPS navigation information is available, a navigation index is continuously computed that indicates the estimated horizontal error (EHE) associated with the current position estimate. The navigation index is the EHE obtained from the GPS receiver. If GPS information is invalid, a navigation index is not displayed. The EHE is continuously available for display on the GPS INAV page.

An annunciation is displayed on the CDU if the EHE exceeds the threshold of acceptable performance for the current flight mode (en route, terminal, or approach). The threshold and annunciations are defined as follows.

1. "INVLD ENR" if in enroute mode and three times the GPS EHE > 1000 meters
2. "INVLD TRM" if in terminal mode and three times the GPS EHE > 500 meters

3. "INVLD APP" if in approach mode and three times the GPS EHE > 100 meters

## GPS CONTROL (CDU)

The CDU controls the following GPS functions and data entries via the 1553B data bus:

1. Initialization
2. Navigation Mode
3. Zeroize
4. Test Synchronization
5. Almanac

The CDU commands the GPS to INIT (initialization) mode upon crew initiation on the Start page, or upon a GPS almanac load. When on the ground and requested by the operator, the CDU commands the GPS to TEST mode. With operator request and confirmation, the CDU commands a GPS zeroize. In all other cases, the BC CDU commands the GPS operation mode to NAV.

The GPS Selective Availability / Anti-Spoofing (SA/AS) Page, accessed from Index Page 1 / 2 controls the SA/AS zeroize functions.

**NOTE**

All SA/AS keys must be loaded via the CYZ-10, but may be zeroized through the CDU. By entry of mission duration, keys may be selectively zeroized, leaving only the required number of keys for a given mission.

Initialization of the CDU system occurs at power up when all CDUs in the system have been inoperative. The initialization procedure consists of operator verification or insertion of an initial position, time, and date. The CDU displays an initial position, time and date based on either the current GPS information or the last stored information. When the receiver is commanded into INIT, the position, date, and time are transferred from the CDU to the GPS receiver.

The CDU commands the GPS receiver into NAV mode immediately following a positive indication that the receiver is operational. The initial position reference in the CDU is automatically set to the GPS position if the GPS validity conditions are met. If the GPS validity conditions are not met, the CDU displays the last known position. If available, the GPS time is displayed on the CDU as the system time at power up. If the GPS receiver does not respond at power-up, "ENTER TIME" annunciation is displayed on the CDU. If the GPS UTC date is not valid, the last known date and time are displayed and propagated with an internal clock.

## GPS VALIDITY CRITERIA

Before GPS measurements are used by the CDU, the following initial acceptance criteria are met:

1. Navigation data validity bit is valid.
2. GPS Estimated Position Error < 200 meters (P-Code operation) or <400 meters (C/A Code operation).
3. The GPS receiver is incorporating at least four satellite measurements (or three satellites and valid altitude aiding) into the navigation solution.
4. The satellites are being tracked in state 5 or state 3 with valid velocity aiding.

The CDU discontinues use of the GPS measurements if one or more of the following conditions are detected:

1. Navigation data validity bit is invalid.
2. The GPS receiver is incorporating less than three satellite measurements (state 5 track or state 3 track with valid velocity aiding) for five consecutive measurements. This assumes that GPS is always receiving altitude aiding via the 1553B data bus. Once determined to be invalid, GPS measurements must pass the initial acceptance criteria before being used again by the CDU.

## GPS RAIM IMPLEMENTATION

Receiver Autonomous Integrity Monitoring (RAIM) verifies the integrity (usability) of the signals received from the GPS satellites. Potential errors that exceed the limit for the current phase of flight result in a RAIM warning. RAIM is incorporated in two ways:

- RAIM ON provides continuous RAIM monitoring and advisories, and
- RAIM Prediction provides anticipated usability for a future location and time.

Receiver Autonomous Integrity Monitoring (RAIM) defaults to Off (RAIM Disabled) when the GPS receiver is powered up or following GPS receiver initialization. RAIM Results are only monitored on the selected GPS receiver.

RAIM may be toggled to ON from its default setting of OFF on the RAIM/Prediction Page that is accessed from the

INAV Page. RAIM is also automatically set to ON when an FMS Approach waypoint becomes the active waypoint. To notify the user of specific RAIM operations or limitations, the following annunciations appear on Line 4 to indicate progress or results:

| Annunciation | Meaning |
|---|---|
| RAIM REQUESTED | Appears when a prediction has been requested but the results have not yet been reported. |
| RAIM CHECK CANCELLED | Appears when a prediction request is cancelled. Also occurs when the operator initializes the GPS on Start Page 1/3 while a RAIM is in progress. |
| APPR RAIM AVAILABLE | Appears when a predicted RAIM is available at the predicted times. |
| APPR RAIM UNAVAILABLE | Appears when a predicted RAIM is NOT available or CANNOT be computed. |
| RAIM CHECK UNAVAILABLE | Appears when the GPS has failed such that a RAIM prediction cannot be made or the GPS is in initialization mode. |
| NO RAIM | Appears when the RAIM Available input is indicating that RAIM is unavailable for more than 30 seconds in the selected GPS receiver. When GPS is unavailable, the RAIM Available is set to unavailable. |
| RAIM WARN | The approach or integrity alarm. Appears when the RAIM in the selected GPS receiver detects that the EHE exceeds the limits in Table 1-5 for more than 30 seconds in enroute flight mode or for more than 10 seconds in terminal and approach flight modes. Remains until RAIM is toggled to OFF. |
| DR | Indicates that a dead reckoning solution is being calculated using only the heading and true airspeed data due to invalid GPS data. |
| FAIL and NAV FAIL | If the GPS, heading, and true airspeed become invalid, FAIL is displayed on Line 2 of the INAV Page, and the POS IDX is "dashed" out. During this condition NAV FAIL also appears on Line 6 regardless of the CDU page displayed. |
| MODEL | When running the CDU model, MODEL is displayed on Line 2 of the INAV Page and the POS IDX is "dashed" out. |
| INVALID | Displayed on the right side of Line 2 if the GPS solution is not valid. |
| COMPARE GPS | Appears when Nav solutions for GPS1 and GPS2 disagree for the current phase of flight. |

## RAIM PREDICTION

RAIM control and prediction are accomplished on the RAIM/Prediction Page that is accessed from the INAV Page. For manually initiated RAIM predictions, a RAIM prediction is executed by initiating a Predictive RAIM Request with valid Predicted Latitude, Predicted Longitude and Predicted Time as entered on the RAIM Prediction page, Predicted Altitude, Predictive RAIM Interval Size set to 5 minutes and the Predictive RAIM Number of Intervals set to 3 (every 5 minutes, +/- 15 minutes from the Predicted Time).

Upon receipt of a RAIM prediction (Predictive RAIM Specified), the Predicted Latitude, Predicted Longitude, Predicted Time and Predicted Altitude are confirmed with the Initial Latitude, Initial Longitude, Initial Time, and Initial Altitude as received from the GPS receiver. Additionally, the Predictive RAIM Interval Size and Predictive RAIM Number of Intervals are confirmed with the Current Predictive RAIM Interval Size and Current Predictive RAIM Number of Intervals as received from the GPS receiver. If confirmation fails, "RAIM CHECK UNAVAILABLE" is displayed on the RAIM/Prediction page information line. The "COMPARE GPS" annunciation is raised when the difference between the two GPS navigation solutions exceeds the alarm limits provided in Table 1-5 for the current Phase of Flight. When transitions between ENROUTE, TERMINAL, and APPROACH modes occur, the CDU annunciates the current flight mode using the flight mode annunciators on the MFD.

## SITUATIONAL GUIDANCE COMPUTATIONS

The situational guidance computations supply information for the flight plan execution and situational display transmitted to the MFD and CDU display data. Unless the data is invalid, this information is always sent to the MFD. All com-

putations are performed referenced to True North with conversion to Magnetic made by routines that service input and output to the navigation computations.

This information corresponds at all times to the current flight plan and active waypoint. The situational guidance information available for display is comprised of the following:

1. Lateral Cross Track Distance - distance from the present position to the great circle course defined by the active waypoint position and inbound course.

2. Angular Cross Track Deviation - angular deviation at the present position between the current lateral track to the active waypoint and the track defined by the active waypoint position and inbound course.

3. Desired Track - instantaneous great circle track at the present aircraft position defined by the active waypoint position and inbound course.

4. Waypoint Bearing - direction to the active waypoint from the present aircraft position.

5. Ground Speed Command - ground speed required to reach a waypoint at the planned time of arrival.

6. Distance to Go - great circle distance from the present position to the active waypoint.

7. Time to Go - estimated time to the active waypoint calculated by dividing the distance to go by the current ground speed.

8. Lateral Alert - set when within 10 seconds from the lateral switching point.

## INTEGRATED NAVIGATION PAGES

The Integrated Navigation (INAV) pages are accessed by pressing the INAV function key on the CDU. Successive selections of the INAV function key scrolls down the page menu. Figure 1-122 illustrates the page access structure of the INAV pages.

| | Performance Item | | | |
|---|---|---|---|---|
| Phase of Flight | Alarm Limit | Max Allowable Alarm Rate | Time to Alarm | Minimum Detection Probability |
| En Route | 2.0 nm | 0.002/hr | 30 seconds | 0.999 |
| Terminal | 1.0 nm | 0.002/hr | 10 seconds | 0.999 |
| RNAV Approach (Non-Precision) | 0.3 nm | 0.002/hr | 10 seconds | 0.999 |

*Table 1-5. GPS Position Integrity Performance Requirements*

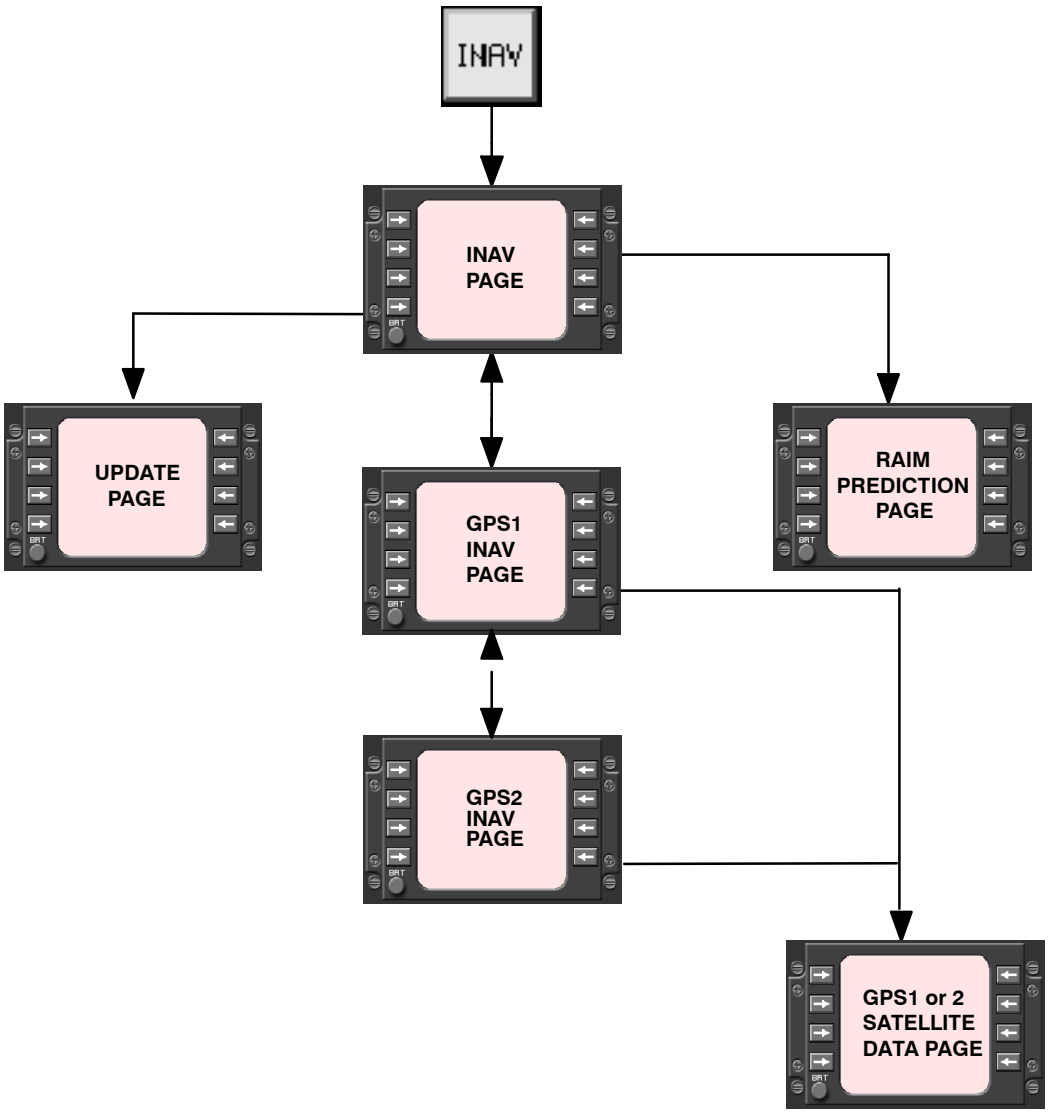



*Figure 1-122. INAV Page Access*

## INAV Page

The INAV Page (Figure 1-123) is accessed by selecting the INAV function key, or by vertically scrolling from the GPS1 or GPS2 INAV page. The INAV page displays the integrated navigation solution.

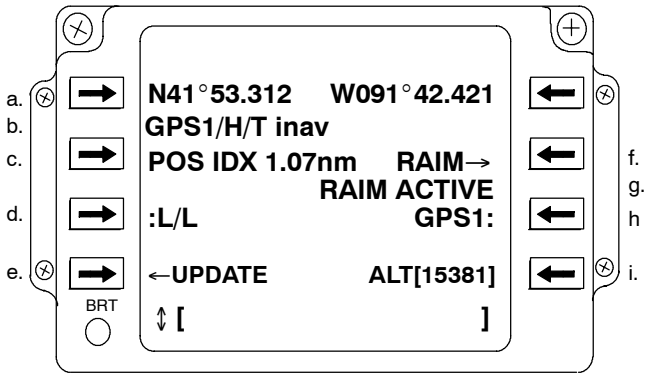



*Figure 1-123. INAV Page*

a. Displays the best estimate of present position (latitude and longitude) from the integrated navigation solution. If the position is invalid, dashes are displayed.

b. Displays the current integrated navigation mode. The modes available are listed in Table 1-6.

c. Displays the position index. For the navigation modes of "FAIL" and "MODEL," the position index displays dashes.

d. Selection toggles the present position display mode between latitude/longitude (L/L) and Military Grid Reference System (MGRS). The mode of the present position displays on INAV, Start Page 1/3 and Progress Page 1/3 correspond to the mode selected at LS3. The default selection is lat/long.

e. Selection accesses the Position Update page.

f. Selection accesses the RAIM/Prediction Page for selected GPS.

g. Displays RAIM ACTIVE when the RAIM function has been toggled to ON on the RAIM/Prediction Page.

h. Selection toggles the GPS mode through the following states: AUTO, GPS1 and GPS2. The default is AUTO.

i. Selection with a valid entry in the scratchpad enters the manual pressure altitude for GPS aiding into the brackets. The GPS aiding altitude entry defaults to the pressure altitude from the altitude controller.

**NOTE**

Selecting the UP arrow on the CDU scrolls to the GPS2 INAV Page. Selecting the DOWN arrow or the INAV function key on the CDU scrolls to the GPS1 INAV Page.

| Displayed Mode | Conditions for Display |
|---|---|
| GPS1/H/T | GPS1 is the primary navigation source and GPS navigation is being smoothed with heading and True Airspeed (TAS) |
| GPS2/H/T | GPS2 is the primary navigation source and GPS navigation is being smoothed with heading and True Airspeed (TAS) |
| GPS1/H/– | GPS1 is the primary navigation source and GPS navigation is being smoothed with heading |
| GPS2/H/– | GPS2 is the primary navigation source and GPS navigation is being smoothed with heading |
| GPS1/–/– | GPS1 is the primary navigation source and GPS navigation is not being smoothed with heading and TAS |
| GPS2/–/– | GPS2 is the primary navigation source and GPS navigation is not being smoothed with heading and TAS |
| –––/H/T | GPS is invalid and a dead reckoning solution is being computed using heading and TAS data |
| FAIL | GPS, heading, and TAS are invalid |
| MODEL | The MODEL aircraft function is providing the navigation solution |

*Table 1-6. Mode Display on INAV Page*

## Update Page

Pressing UPDATE on the INAV Page accesses the Update Page (Figure 1-124). This page permits the system present position to be updated, correcting for errors in the navigation solution.

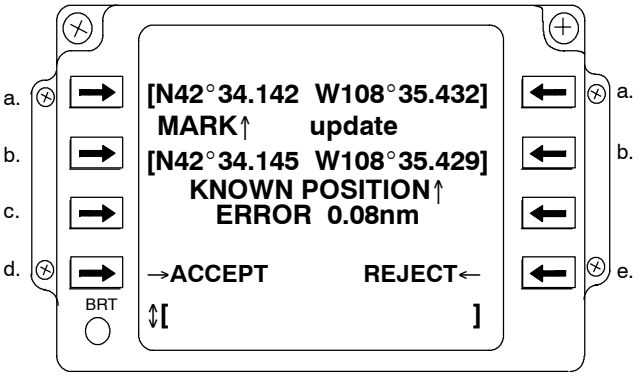



*Figure 1-124. Update Page*

a. Selection with a valid entry in the scratchpad enters a marked position into the brackets. Selection with a "/" followed by a valid user-defined label in the scratchpad searches the CDU memory for a waypoint with that user-defined label. The waypoint is displayed as a user-defined label. Selection with an ICAO identifier in the scratchpad and the MDL already processing a request displays "MDL BUSY" alternating with the data in the scratchpad. If invalid data is in the scratchpad, the "ERROR" scratchpad message alternates with the data in the scratchpad when the line select is pressed.

b. Selection with a valid entry in the scratchpad enters a marked position into the brackets. Selection with a "/" followed by a valid user-defined label in the scratchpad searches the CDU memory for a waypoint with that user-defined label. The waypoint is displayed as a user-defined label. Selection with an ICAO identifier in the scratchpad and the MDL already processing a request displays "MDL BUSY" alternating with the data in the scratchpad. If invalid data is in the scratchpad, the "ERROR" scratchpad message alternates with the data in the scratchpad when the line select is pressed.

c. Displays the position error (nm) between the waypoints entered on line 1 and 3.

d. Selection corrects the calculated best estimate of present position by the position error displayed on line 5, and resets the bracketed areas of display lines 1 and 3 to blanks.

e. Selection rejects the position update and resets the bracketed area of line 1 to blanks.

## GPS RAIM Prediction Page

The GPS RAIM Prediction Page (Figure 1-125) is accessed by pressing RAIM on the INAV Page.

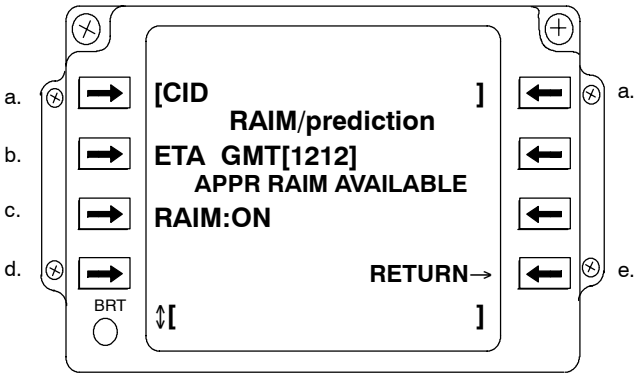



*Figure 1-125. GPS RAIM Prediction Page*

a. Defaults to the current destination waypoint in the flight plan at the time of accessing the GPS RAIM page. Selection with a valid waypoint entry in the scratchpad enters the waypoint for the predicted RAIM (Predicted Latitude and Predicted Longitude). It also erases the Estimated Time of Arrival (ETA) at LS2 if one is displayed. Selection with a " -" in the scratchpad erases the waypoint at LS1 and the ETA at LS2.

b. Selection with a valid entry in the scratchpad enters the ETA in GMT and enables the Predictive RAIM Request. Selection with a "-" in the scratchpad blanks the ETA and the appropriate scratchpad message is displayed (if applicable) if any of the following conditions are true when the line select is pressed:

1. Invalid data is in the scratchpad ("ERROR" message alternates with the data in the scratchpad).
2. The scratchpad is empty.

c. DL4 displays the following RAIM associated annunciations:

1. Blank when no destination waypoint or ETA is entered on the page.
2. Both GPS receivers perform a Predictive RAIM Request when the ETA is modified with a valid

destination at LS1. Results of predictive RAIM are only used from the selected GPS receiver. "RAIM REQUESTED" is displayed when the prediction has been requested but the results have not yet been reported (Predictive RAIM Availability is in progress). Entry of a new location or time before the results are reported cancels the original prediction request and performs a prediction using the new ETA and location. In this case, "RAIM REQUESTED" continues to be displayed.

3. "APPR RAIM AVAILABLE" is displayed when Predictive RAIM Availability indicates RAIM is available at each of the prediction times over the interval at the entered location and ETA.

4. "APPR RAIM UNAVAILABLE" is displayed if, at any of the prediction times, Predictive RAIM Availability indicates RAIM is not available or is unable to be computed.

5. Initialization of either GPS via the Start Page 1/3 cancels any RAIM prediction in progress, displays "RAIM CHECK CANCELLED" when the initialization is complete, and inhibits any RAIM prediction request. The "RAIM CHECK UNAVAILABLE" message is displayed when the GPS is in initialization mode.

6. Since the RAIM is issued for each prediction, switching the selected GPS does not cancel the RAIM prediction. However, when RAIM check results are received from the GPS, the prediction data received from the GPS is compared with the prediction data that is displayed on the CDU. If the data is not the same (e.g., the active GPS is failed such that a RAIM prediction cannot be made) the "RAIM CHECK UNAVAILABLE" message is displayed at the prediction times over the interval at the entered location and ETA.

d. Selection toggles the RAIM function and GPS RAIM annunciations between ON and OFF. When toggled to OFF, the RAIM function is off, and the RAIM Alert and NO RAIM annunciations are inhibited. When toggled to ON, the RAIM function is on, and the RAIM Alert and NO RAIM annunciations are enabled. If the GPS RAIM annunciations are set to OFF and an FMS approach waypoint becomes the active waypoint for the first time, the RAIM function and the GPS RAIM annunciations are set to ON. Manual predictive RAIM requests are possible at all times. The GPS RAIM function and the annunciations default to OFF at system power-up.

e. Selection returns to the INAV Page.

## GPS INAV Page

The GPS INAV Pages are accessed by vertically scrolling from the INAV Page or the other GPS INAV Page. The GPS INAV Page (Figure 1-126) shows GPS present position and operating status information. The GPS1 and GPS2 INAV Pages are functionally identical; the title on DL2 reflects which GPS INAV Page is displayed, and the functions of the page and data displayed on the page apply to the respective GPS.

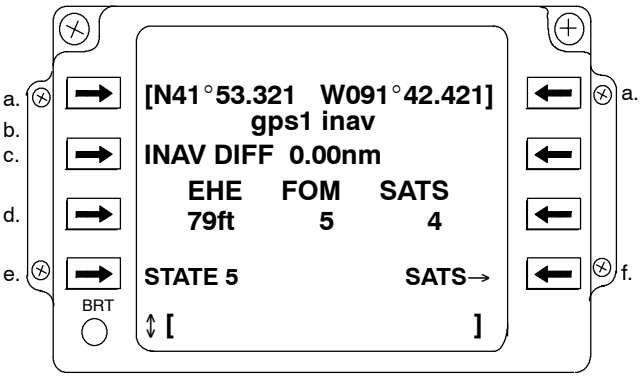



*Figure 1-126. GPS INAV Page*

a. Displays the GPS present position latitude and longitude.

b. Displays "gpsx inav" where x is the number of the GPS (1 or 2) that the INAV data corresponds to, and INVALID if GPS solution is not valid.

c. Displays the deviation of the GPS only solution from the integrated navigation solution.

d. Displays the estimated horizontal position error in integer feet, the GPS Figure of Merit (a numerical representation of several positioning calculations which range from 1 to 9 with 1 being the best), and the number of state 3 (with velocity aiding) and state 5 satellites currently tracked by GPS.

e. Displays the receiver state (5, 3, or "-") as defined by GPS State adjacent to LS4. The receiver state is 5 if four satellites in state 5 operations are currently being tracked. The receiver state is 3 if any number of satellites is being tracked in state 3 operations. The receiver state is dashed if three or fewer satellites are

being tracked in state 5 operation and no satellites are tracked in state 3 operation.

f. Selection accesses the GPS Satellite Data Page for the respective GPS.

**NOTE**

Selecting the UP arrow on the CDU scrolls to the INAV Page from the GPS1 INAV Page, or to the GPS1 INAV Page from the GPS2 INAV Page.

### GPS Satellite Data Page

Pressing SATS on the GPS1 or GPS2 INAV Page accesses the GPS1 and GPS2 Satellite Data Pages (Figure 1-127). The GPS1 and GPS2 Satellite Data Pages are functionally identical; the title on DL2 reflects which GPS Satellite Data Page is displayed, and the functions of the page and data displayed on the page apply to the respective GPS.

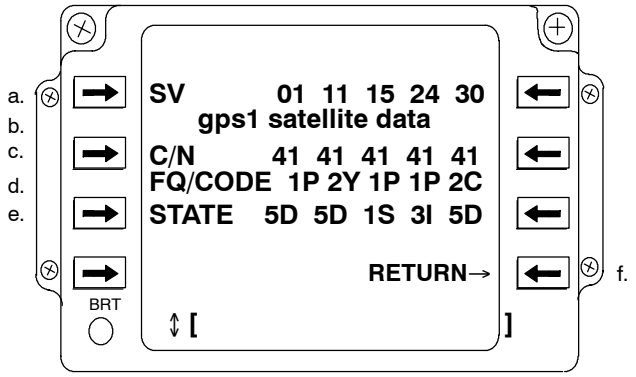



*Figure 1-127. GPS Satelitte Data Page*

a. Displays the satellite numbers of the satellite vehicles being tracked from the corresponding GPS Channel Status. When no data is available for a satellite, the field is dashed out.

b. Displays "gpsx," where x is the number of the GPS (1 or 2) that the satellite data corresponds to.

c. Displays the carrier/noise ratio for the satellites being tracked from the corresponding GPS Channel Status. When no data is available for a satellite, the field is dashed out.

d. Displays the frequency (1 or 2) and code type (P, Y, or C) for the satellite being tracked from the corresponding GPS Channel Status. When no data is available for a satellite, the field is dashed out.

e. Displays the state number tracking state for the satellites being tracked from the corresponding GPS Channel Status. When no data is available for a satellite, the field is dashed out. The possible tracking states include:

- S-Search for the satellite signal - States 1 and 2.
- T-Satellite signal is being tracked - States 4 and 6.
- I-Satellite signal track is degraded due to interference, jamming, or partial obscuration - State 3.
- D-Satellite signal is being tracked and data is being collected - State 5.
- R-Satellite signal has been lost and recovery operations are being attempted - State 7.

f. Selection returns to the respective GPS INAV Page.

## SYSTEM STATUS

The CDU provides continuous testing of the LRUs to determine the System Status through Continuous Built In Tests (CBITs). The condition of each LRU's GO/NOGO condition and status word, if available, is monitored to determine the status. The results of CBITs are only displayed on Status Pages. All CBIT status' default to NOGO at CDU power-up. Figure 1-128 details the Status Pages page access.

### STATUS PAGES

Pressing the STAT key on the CDU accesses the Status Pages. The Status Pages consist of three pages; the System Status Page, the 1553B Status Page 1/2, and the 1553B Status Page 2/2.

### System Status Page

The System Status Page (Figure 1-129) displays the currently tuned VOR and TACAN stations, the GPS accuracy (Table 1-7) and satellite status, and input and display of wind information. Additionally, important fuel management tools such as BINGO, Max Range Airspeed, Max Range distance at present course and ground speed can be viewed on the System Status Page. The System Status Page also provides the operator with a display of failed LRUs.

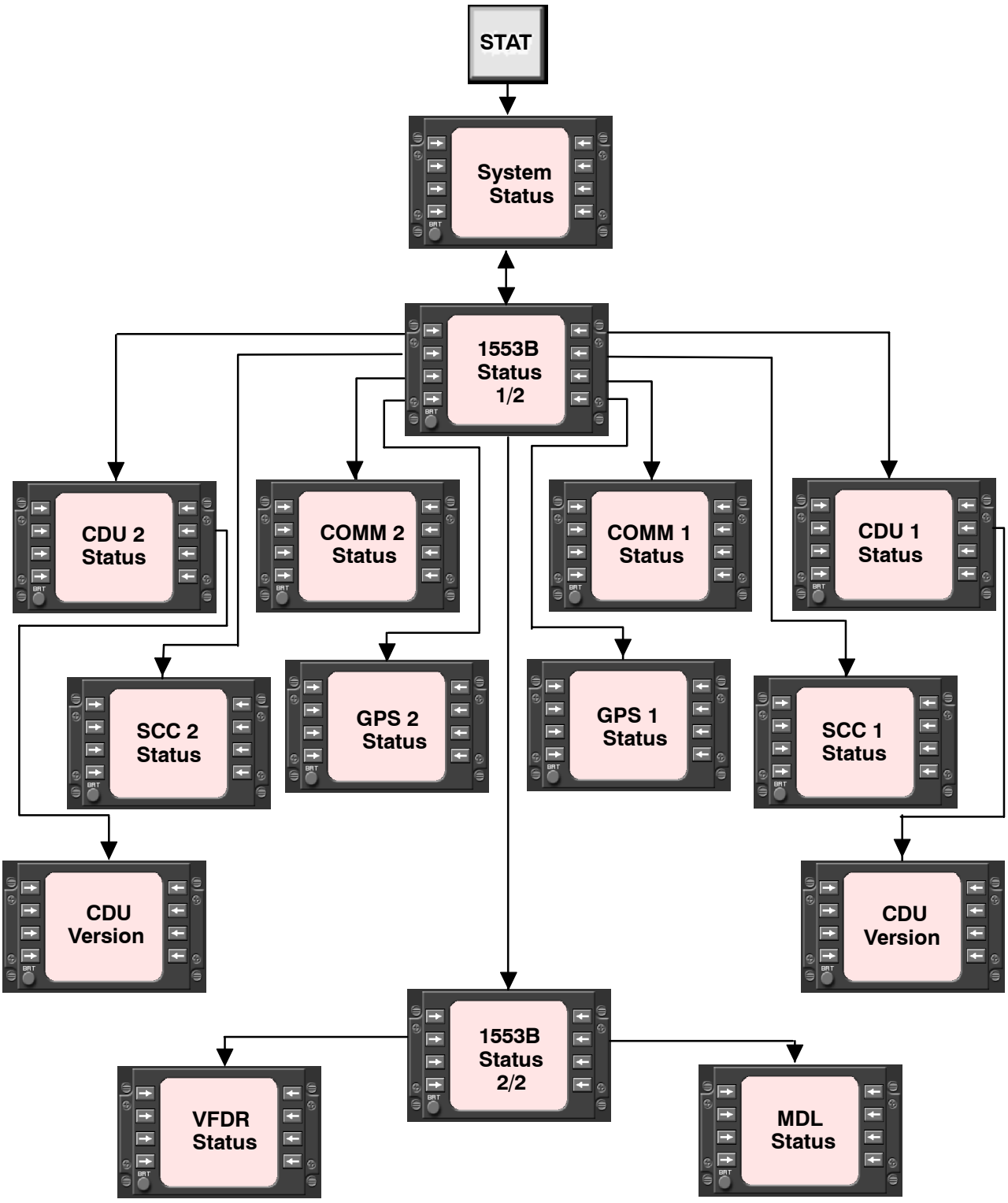



*Figure 1-128. Status Pages*

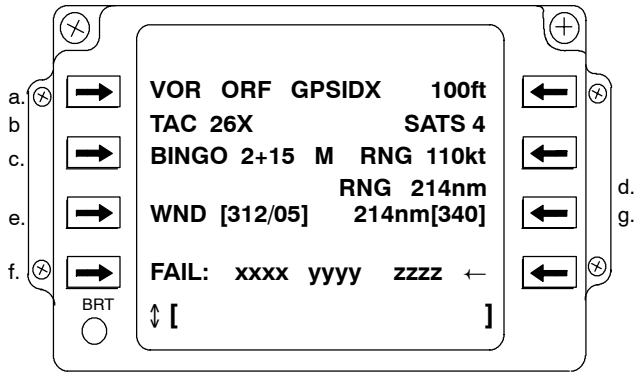



*Figure 1-129. System Status Page*

| EHE | GPSIDX |
|---|---|
| 0–25 ft | 50 ft |
| 25–50 ft | 100 ft |
| 50–100 ft | 200 ft |
| 100 ft–0.05 nm | 0.1 nm |
| 0.05–0.15 nm | 0.3 nm |
| 0.15–0.30 nm | 0.6 nm |
| 0.30–0.50 nm | 1.0 nm |
| >0.5 nm | 1 nm+ |

*Table 1-7. GPS Accuracy*

a. Displays currently tuned VOR station and GPS navigation accuracy Index of the GPS that is currently being used for navigation. If VOR station is manually tuned by frequency, the identifier field is dashed. The GPS Index is based on GPS-computed Estimated Horizon Error (EHE) (approximately 95% probability). The GPSIDX field will be dashed when no satellites are being tracked. Table 1-7 shows the displayed GPS Accuracy.

b. Displays currently tuned TACAN station and GPS Tracking Status for the GPS currently being used for navigation. The TACAN channel number is always displayed. The GPS Tracking Status displays SATS x (where x is 0, 1, 2, 3, or 4) indicating the number of GPS satellites currently being tracked.

c. Displays time to Fuel Alert annunciation (BINGO), and Maximum Range Airspeed. BINGO is displayed as HOURS + MINUTES. BINGO point is calculated based on maximum range airspeed, current winds, present altitude, and the direct distance to the last waypoint in the Flight Plan. If the last waypoint is a rendezvous waypoint, the annunciation "NO BINGO" is displayed on the annunciation line. The BINGO calculation continues to be performed. If no Flight Plan is constructed, BINGO is calculated to the FROM waypoint. Once BINGO is reached, the time display changes to the calculated BINGO time displayed as XX, where XX is 01 to 99 minutes. Maximum Range Airspeed is displayed in knots and is based on present gross weight, temperature, and altitude. Flying this airspeed provides the best range performance. (For further amplification on fuel management, see the "FUEL OPTIMIZATION AND ALERTING CALCULATIONS" subsection.)

d. Displays the current range in NM using current system parameters (actual fuel flow, heading, altitude, etc.).

e. Displays the system calculated wind direction and speed. Selection with a valid entry in the scratchpad enters the manually entered wind direction and speed.

f. Displays the abbreviated names of up to three LRUs which have failed CBIT. The abbreviated names are shown, in the order of display priority in Table 1-8. If more than three LRUs have failed CBIT, an arrow is displayed adjacent to LS8. If the arrow is displayed adjacent to LS8, selection advances the Fail line to display one additional LRU failure. The list of failures scrolls one at a time in the order shown in Table 1-8 and wraps from the bottom to the top.

g. Selection with a valid entry in the scratchpad enters course for range calculation. Based on maximum range airspeed, present ambient conditions and course entered, the range that could be flown in the entered direction is displayed. Upon accessing the page, the course defaults to the flight plan course.

**NOTE**

Selecting the DOWN arrow or STAT on the CDU accesses the 1553B Status Page 1/2 while selecting the UP arrow accesses the 1553B Status Page 2/2.

| STR (Steer–FDC SIM) |
|---|
| CDU1 |
| CDU2 |
| GPS1 |
| GPS2 |
| SCC1 |
| SCC2 |
| MFD1 |
| MFD2 |
| MDL |
| COM1 |
| COM2 |
| BUSA |
| BUSB |
| OADS |
| HDG1 |
| HDG2 |
| BARO |
| SIU |
| TAC |
| VOR |
| ADF |
| IFF |
| HF |
| FM |
| RRU |
| VFDR |

*Table 1-8. Display LRU Failures*

## 1553B Status Page 1/2

The 1553B Status Page 1/2 (Figure 1-130) shows the top-level status (GO or NOGO) of each LRU connected to the MIL-STD-1553B digital data bus. The 1553B Status Page 1/2 also provides access to the LRU detailed status pages.

a. Selection accesses the CDU2 Status Page. Displays the LRU status (GO or NOGO) of CDU2.

b. Selection accesses the SCC2 Status Page. Displays the LRU status (GO or NOGO) of SCC2.

c. Selection accesses the COMM2 Status Page. Displays the LRU status (GO or NOGO) of COMM2.

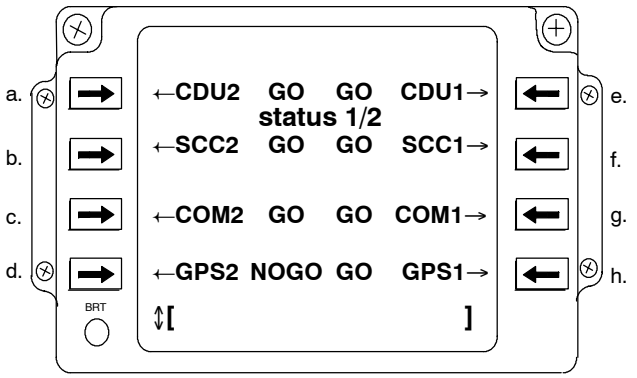



*Figure 1-130. 1553B Status Page 1/2*

d. Selection accesses the GPS2 Status Page. Displays the LRU status (GO or NOGO) of GPS2.

e. Selection accesses the CDU1 Status Page. Displays the LRU status (GO or NOGO) of CDU1.

f. Selection accesses the SCC1 Status Page. Displays the LRU status (GO or NOGO) of SCC1.

g. Selection accesses the COMM1 Status Page. Displays the LRU status (GO or NOGO) of COMM1.

h. Selection accesses the GPS1 Status Page. Displays the LRU status (GO or NOGO) of GPS1.

**NOTE**

Selecting the UP arrow key on the CDU accesses the System Status Page while selecting the DOWN arrow key or the STAT function key accesses the 1553B Status Page 2/2.

## CDU Status Pages

Pressing LS5 or LS1, respectively, on the System Status Page accesses the CDU1 or CDU2 Status Pages (Figure 1-131). The pages display the detail status of CDU1 and CDU2. The format of each page is identical except for the number on the title line (i.e., CDU1 vs. CDU2).

a. Displays the page title and LRU status (GO or NOGO).

b. Displays the bus status (GO, NOGO-A, NOGO-B, NOGO-AB, or NOGO-T) for the indicated CDU's 1553B data bus interface.

c. Displays a 16 bit data word which displays the results of a CBIT, where a "1 " indicates a fail state. The 16-bit data word displays dashes if the CDU experiences a bus terminal failure with no communication between the MIL-STD-1553B data bus and the CDU.

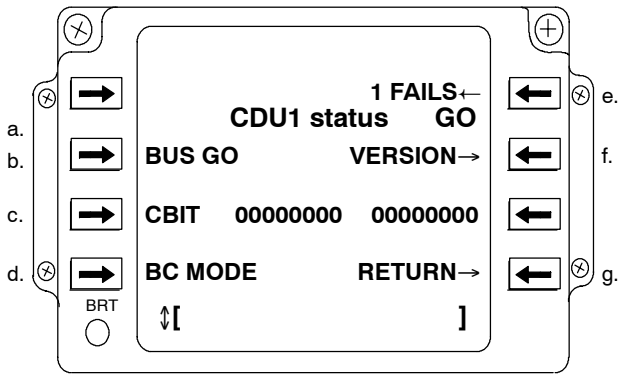



*Figure 1-131. CDU Status Page*

d. Displays the bus mode for the CDU with BC for bus controller and RT for remote terminal.

e. Displays a count of CDU or Bus failures. Selection resets the failure counter to zero.

f. Selection accesses the CDU Version Page.

g. Selection returns to the 1553B Status Page 1/2.

## CDU Version Page

The CDU Version Page (Figure 1-132), accessed from the CDU Status Page, provides the CDU software version numbers for the CDU1 and CDU2.

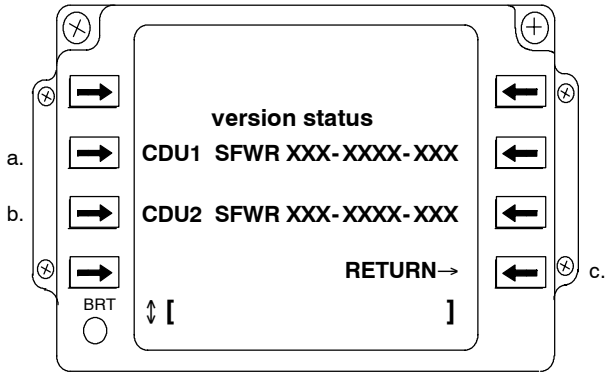



*Figure 1-132. CDU Version Page*

a. Displays the label CDU1 SFWR (software) followed by the ten-digit part number of the OFP software loaded into CDU1.

b. Displays the label CDU2 SFWR (software) followed by the ten-digit part number of the OFP software loaded into CDU2.

c. Selection returns to the CDU1 or CDU2 Status Page from which the Version Status Page was selected.

## SCC Status Page

The SCC Status Pages (Figure 1-133) provide a display count of SCC or bus failures, SCC status, and bus status for the SCC's data bus interface. The format of each page is identical except for the number on the title line (i.e., SCC1 vs. SCC2).

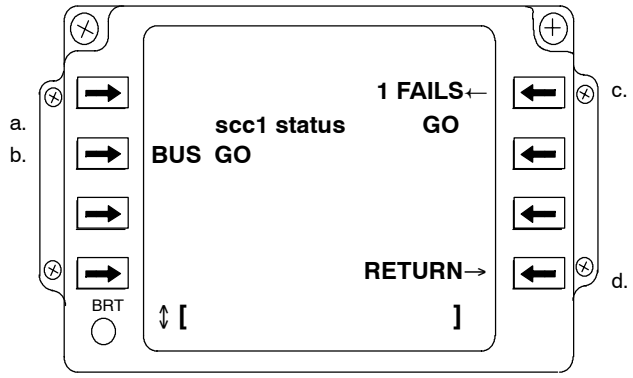



*Figure 1-133. SCC Status Pages*

a. Displays the page title and LRU status (GO or NOGO).

b. Displays the bus status (GO, NOGO-A, NOGO-B, NOGO-AB, or NOGO-T) for the indicated SCC 1553B data bus interface.

c. Displays a count of SCC or Bus failures. Selection resets the failure counter to zero.

d. Selection returns to the 1553B Status Page 1/2.

## COMM Status Pages

The COMM Status Pages (Figure 1-134) provide a display count of CDU or bus failures, CDU status, and bus status for the COMM radio's data bus interface. The format of each page is identical except for the number on the title line (i.e., COMM1 vs. COMM2).

a. Displays the page title and LRU status (GO or NOGO).

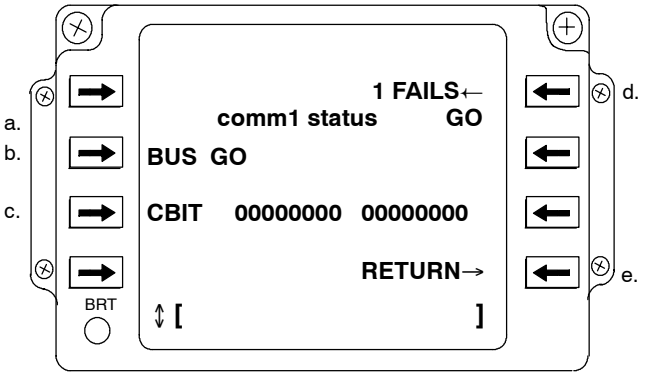



*Figure 1-134. COMM Status Pages*

b. Displays the bus status (GO, NOGO-A, NOGO-B, NOGO-AB, or NOGO-T) for the indicated COMM radio's 1553B data bus interface.

c. Displays a 16-bit data word that displays the results of a CBIT, where a 1 indicates a fail state. The 16-bit data word displays dashes if the COMM experiences a bus terminal failure with no communication between the MIL-STD-1553B data bus and the CDU.

d. Displays a count of CDU or Bus failures. Selection resets the failure counter to zero.

e. Selection returns to the 1553B Status Page 1/2.

## GPS Status Page

The GPS Status Pages (Figure 1-135) provide a display count of GPS or bus failures, GPS status, and bus status for the GPS's data bus interface, Receiver Processor Unit (RPU) status, and battery (BATT) status. The format of each page is identical except for the number on the title line (i.e., GPS1 vs. GPS2).

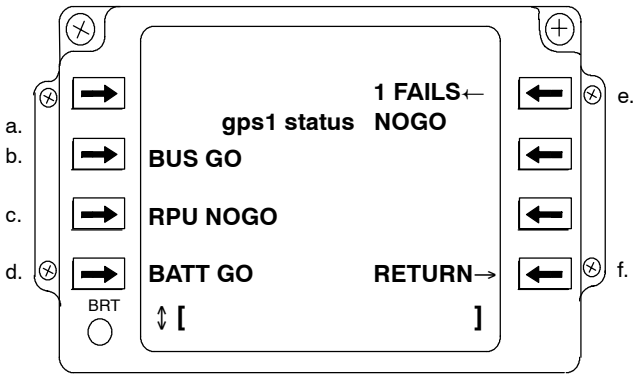



*Figure 1-135. GPS Status Pages*

a. Displays the page title and LRU status (GO or NOGO).

b. Displays the bus status (GO, NOGO-A, NOGO-B, NOGO-AB, or NOGO-T) for the indicated GPS' 1553B data bus interface.

c. Displays status of the Receiver Processor Unit (RPU).

d. Displays the battery (BATT) status (GO or NOGO).

e. Displays a count of GPS or Bus failures. Selection resets failure counter to zero.

f. Selection returns to the 1553B Status Page 1/2.

## 1553B Status Page 2/2

1553B Status Page 2/2 (Figure 1-136) displays the top-level status of the MFD, VFDR and MDL LRUs. By pressing the respective line select key, the 1553B Status Page 2/2 provides access to the VFDR and MDL Status Pages.




*Figure 1-136. 1553B Status Page 2/2*

a. Displays the LRU status (GO or NOGO) of MFD2 and MFD1 (pilot and copilot).

b. Displays the LRU status (GO or NOGO) of VFDR. Selection accesses the VFDR Status Page.

c. Displays the LRU status (GO or NOGO) of MDL. Selection accesses the MDL Status Page.

**NOTE**

Selecting the UP arrow on the CDU accesses the 1553B Status Page 1/2 while selecting the DOWN arrow or the STAT function key on the CDU accesses the System Status Page.

## VFDR Status Page

The VFDR Status Page (Figure 1-137) provides a display count of VFDR or bus failures, VFDR status, and bus status for the VFDR's data bus interface.

a. Displays the page title and LRU status (GO or NOGO).

b. Displays the bus status (GO, NOGO-A, NOGO-B, NOGO-AB, or NOGO-T) for the indicated VFDR 1553B data bus interface.

c. Displays status of the VFDR.

d. Displays a count of VFDR or Bus Failures. Selection resets the failure counter to zero.

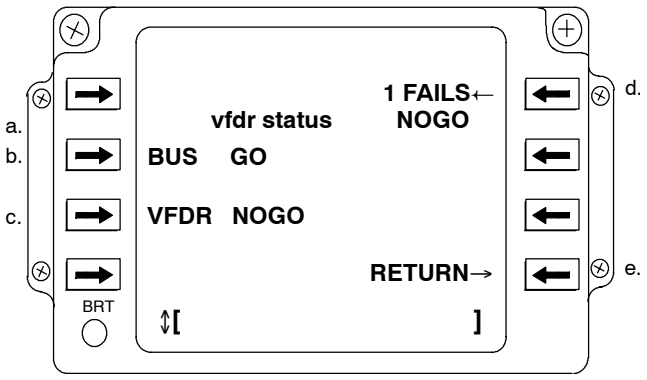



*Figure 1-137. VFDR Status Page*

e. Selection returns to the 1553B Status Page 2/2.

## MDL Status Page

The MDL Status Page (Figure 1-138) provides a display count of MDL or bus failures, MDL status, and bus status for the MDL's data bus interface.

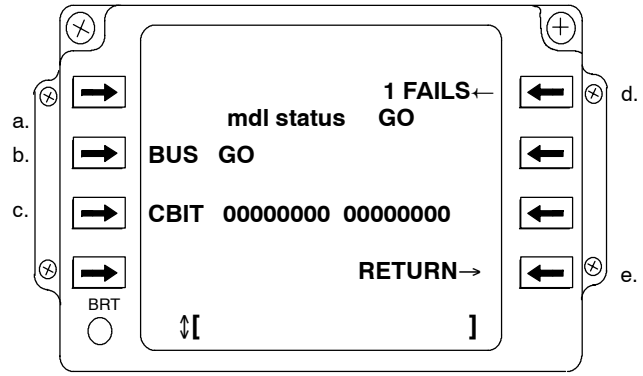



*Figure 1-138. MDL Status Page*

a. Displays the page title and LRU status (GO or NOGO).

b. Displays the bus status (GO, NOGO-A, NOGO-B, NOGO-AB, or NOGO-T) for the MDL's 1553B data bus interface.

c. Displays a 16-bit data word that displays the results of a CBIT, where a 1 indicates a fail state. The 16-bit data word displays dashes if the MDL experiences a bus terminal failure with no communication between the 1553B data bus and the CDU. Displays a count of MDL or bus failures. Selection resets failure counter to zero.

d. Displays a count of MDL or BUS failures. Selection resets the failure counter to zero.

e. Selection returns to the 1553B Status Page 2/2.

# FLIGHT GUIDANCE AND CONTROL SYSTEM

The flight guidance and control system combines the capabilities of guidance, flight controls, displays, and sensors into an integrated system. The system functions to provide the pilot with indications to manually fly the aircraft along a mission computer programmed route when in a coupled mode. In the coupled mode the pilot can assume manual control in the event of a system failure or, when desired, by fly-through inputs. The system operates in conjunction with the FDS, AFCS, and various displays and sensors to provide the following:

- Navigation position indications and commands provided by the CDU and SCC (STR).
- Coupled flight director operation and control in all four axes (pitch, roll, yaw, and collective assist) provided by the AFCS.
- Capability of following a mission computer programmed navigation profile executing an approach and transition-to-hover, and maintaining a stabilized rescue platform provided by the three axes (pitch, roll, and collective assist) Flight Director System.
- Access to all supporting subsystems and integration of data into a single display via dual CDUs and Multifuntion Displays (MFDs).

Pilot interface with the guidance and control system is diagrammed in Figure 1-139. The pilots input commands to the system via the CDUs and the MFD display control panel. Aircraft progress can be observed on the CDUs and MFDs if the appropriate page (progress) and mode (RNAV) are selected. The FDS control panel provides for selection of steering modes to direct the aircraft over the flight plan routes. The pilot can use the FD slew switch to change airspeed reference, change altitude references with the C SYNC (collective sync), and initiate automatic go-arounds with the go-around pushbutton. The AFCS is linked to the mission computer through the flight director computer. The FDS generates pitch, roll, and collective steering commands for coupled AFCS operation.

## AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS)

The AFCS (Figure FO-7) is an integral part of the avionics and provides automatic flight control in four axes (pitch, roll, yaw, and collective) of helicopter control. It is a stability and command augmentation system which provides attitude and heading hold capability, automatic sideslip preven-

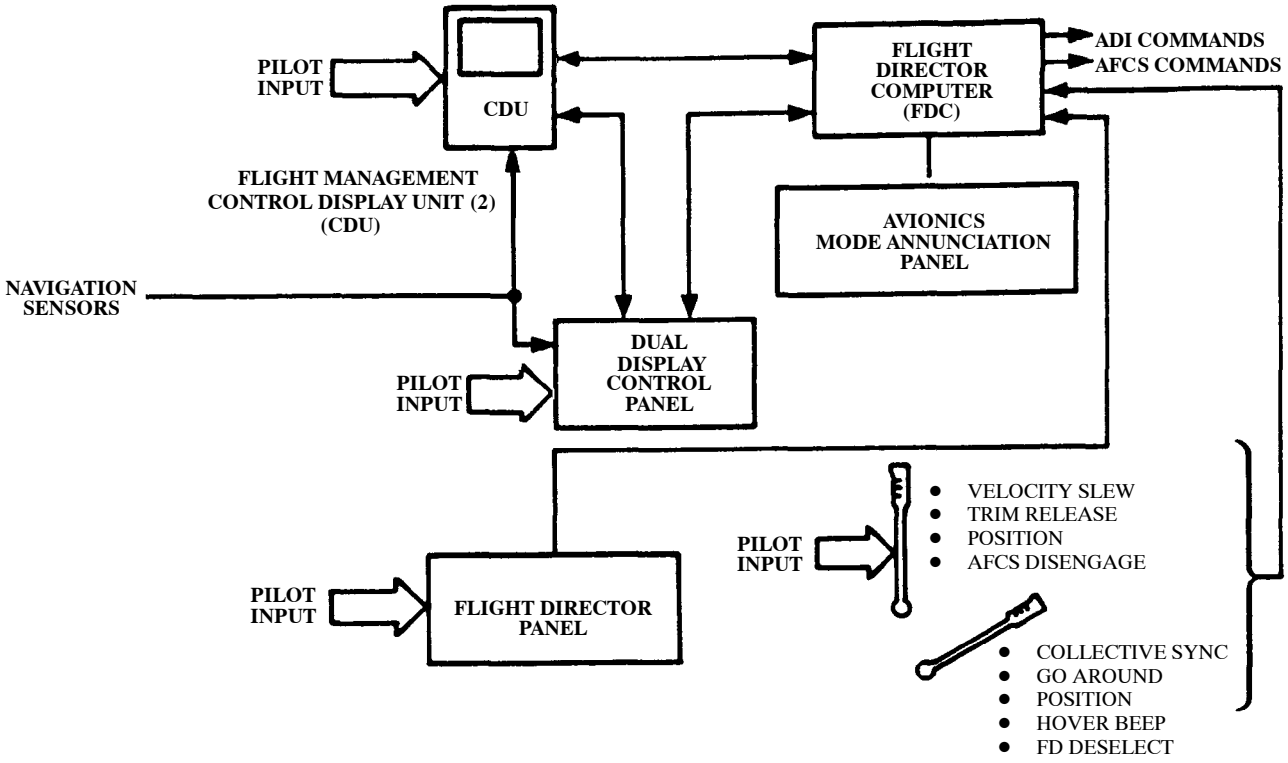



*Figure 1-139. Pilot Interface With Flight Guidance and Control System*

tion, and automatic trim. It incorporates fail-passive features which protect against the possibility of hard-over control movements or aircraft response by providing positive disengagement of the individual affected axis. The AFCS also executes commands received from the Flight Director System (FDS), when coupled. Refer to Flight Director System in this Section for information on how the FDS drives the AFCS.

## Major Components

The AFCS consists of the following major components: a computer, a control panel, four series actuators, two parallel trim/feel units, a yaw parallel servo, a collective parallel servo, a collective dual position transducer, two yaw rate gyros, and two vertical reference gyros.

The AFCS computer is located in the avionics rack and provides command outputs to the pitch, roll, yaw, and collective axes. The control panel (Figure 1-140) is located on the center console and provides control for all axes engagement, vertical reference gyro selection, trim control, and flight director couple selection. The series actuators; one in pitch, two in roll, and one in yaw, are attached to the flight controls and convert computer commanded inputs into mechanical positioning of the associated flight controls. The parallel trim/feel units are mounted on the airframe and are connected to the pitch and roll flight controls to provide trim control and force feel. A yaw parallel servo, connected to the yaw flight control, assists the yaw series actuator in controlling the yaw axis. A collective parallel servo, connected to the collective flight controls, converts AFCS computer commanded inputs to control the collective position. Refer to Figure 1-45 for component location. The dual position transducer is connected to the collective flight controls and returns collective position information to the ACFS computer. The yaw rate gyros, located in the avionics rack, and the attitude gyros, located in the baggage compartment, provide appropriate sensor inputs to the pitch, roll, and yaw axes.

## Associated Equipment

Associated support equipment consists of the avionics mode annunciator panel, a caution panel light, an Indicated Airspeed (IAS) transducer, an Omnidirectional Airspeed Data System (OADS), a directional gyro (copilot's), the Flight Director Computer (FDC), Attitude Director Indicators (ADI), and a lateral accelerometer. The avionics mode annunciator panel (Figure 1-140) displays amber, white, and green indicator lights to indicate active AFCS axes and modes, alert the crew of disengaged axes and out-of-trim conditions, provide trim-off condition warning, and display reversionary gyro and collective sync operation. Refer to Figure 1-141 for mode annunciator panel indicators and functions.

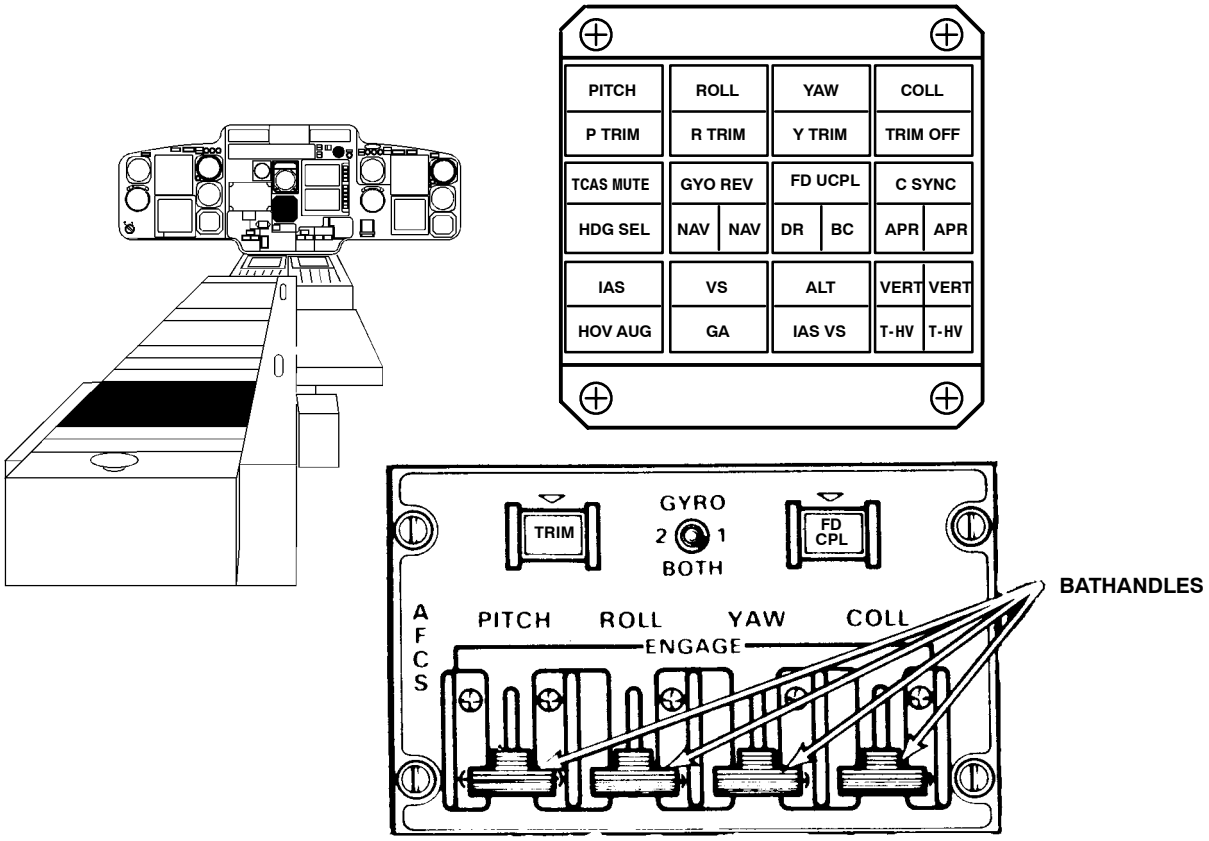



*Figure 1-140. AFCS Control Panel and Avionics Mode Annunciator Panel*

In addition to the advisory lights on the mode annunciator panel, the AFCS light on the warning-caution-advisory panel will illuminate when one or all AFCS axes disengage. The IAS transducer and the lateral accelerometer provide airspeed inputs for the yaw axis sideslip prevention function. The copilot's heading gyro provides heading information for the yaw axis heading hold function. A lateral accelerometer provides acceleration data for the yaw axis turn coordination function. Turn rate, received from the yaw rate gyros, is displayed on the ADIs. The FDC provides steering inputs to the pitch, roll, and collective axes when it is coupled to the AFCS.

## AFCS CONTROLS AND FUNCTIONS

### AFCS Control Panel

The AFCS control panel is redundantly powered by 28 volts DC through two circuit breakers marked AFCS located on the cockpit avionics circuit breaker panel. The yaw and collective axes are only powered from the pilot's bus. Depressing the TRIM pushbutton switch on the AFCS control panel enables the pitch and roll parallel trim motors, beep trim switches, and trim motoring circuitry in the AFCS computer. A chevron shaped indicator light above the TRIM pushbutton will illuminate to indicate trim on, and the amber TRM OFF light on the avionics mode annunciator panel (AMAP), will extinguish. Depressing the TRIM switch a second time will turn trim off. Trim is energized upon initial power application.

**NOTE**

The TRIM switch on the overhead panel does not turn the cyclic trim on or off. It merely engages or disengages the electromagnetic clutches that provide cyclic stick position holding.

Each axis of the AFCS is engaged by moving the corresponding bathandle forward. Positive system self-test and axis engagement is indicated if the bathandle remains in the forward position and the corresponding avionics mode annunciator light extinguishes. The AFCS caution light will go out when all four axes are engaged. The AFCS is coupled to, and uncoupled from the FDS with the FD CPL pushbutton switch. A chevron shaped indicator light, adjacent to the FD CPL pushbutton, will illuminate to indicate coupled status. A three-position GYRO select switch is used for selecting attitude inputs from both vertical reference gyros simulta-

| INDICATOR | FUNCTION |
|---|---|
| PITCH (amber) | Flashes when pitch axis disengages. Pressing the annunciator or the AFCS quick disengage switch causes steady illumination. Extinguishes when pitch axis is engaged. |
| P TRIM (amber) | Indicates that the pitch series actuator is displaced from its center position by more than 36 percent for longer than 4 seconds. |
| ROLL (amber) | Flashes when roll axis disengages. Pressing the annunciator or the AFCS quick disengage switch causes steady illumination. Extinguishes when roll axis is engaged. |
| R TRIM (amber) | Indicates the roll series actuators are displaced from their center positions by more than 57 percent for longer than 4 seconds. |
| YAW (amber) | Flashes when yaw axis disengages. Pressing the annunciator or the AFCS quick disengage switch causes steady illumination. Extinguishes when yaw axis is engaged. |
| Y TRIM (amber) | Indicates that the yaw series actuator is displaced from its center position by more than 56 percent for longer than 4 seconds. |
| COLL (amber) | Flashes when collective axis disengages. Pressing the annunciator or the AFCS quick disengage switch causes steady illumination. Extinguishes when collective axis is engaged. |
| TRM OFF (amber) | Indicates that the cyclic pitch and roll trim system is off/inoperative. |
| GYO REV (green) | Indicates that the AFCS is in single gyro reversionary operation. |
| FD UCPL (amber) | Indicates that the flight director is not coupled to the AFCS. |
| C SYNC (green) | Indicates that collective mode is being synchronized using the COLL SYNC pushbutton on the collective. |

*Figure 1-141. Avionics Mode Annunciator Indicator Functions*

neously, or one vertical reference gyro in the event of a gyro failure. Refer to AFCS Malfunction in Section III.

## Cyclic Switches

Each cyclic grip contains a TRIM REL (Synchronize/trim release) pushbutton switch, a beep trim switch marked TRIM, and a pushbutton switch marked AFCS. The TRIM REL button, when depressed, opens the electromagnetic clutches in the pitch and roll parallel trim/feel units and eliminates cyclic stick position holding. When the button is released, the magnetic clutches are re-engaged to hold the selected cyclic position and establish a new AFCS reference attitude. The overhead trim switch must be on to power the trim release button.

Activation of the beep TRIM switch forward/aft or left/right provides a change signal for the AFCS computer attitude reference, indirectly resulting in aircraft attitude change with AFCS pitch and roll channels engaged. With AFCS disengaged, the beep TRIM switch motors the parallel servos through the AFCS computer, repositioning the cyclic stick.

When depressed, the AFCS quick disengage switch immediately disengages all AFCS channels.

## Collective Switches

Each collective grip contains two switches used in AFCS operation. The C-SYNC (collective synchronization) switch, when depressed, causes the collective parallel trim/feel unit to temporarily declutch so the collective may be repositioned. Releasing the switch holds the collective in the new position. An FD DESELECT (flight director deselect) switch, located on the right side of the grip, provides an alternate means of deselecting the flight director from the AFCS.

## AFCS Operation

The AFCS control panel permits engaging or disengaging the roll, pitch, yaw, and collective axes individually. With an axis engaged, the AFCS computer provides the commands required for control of that axis. The electric series actuators and parallel servos mechanically control the main and tail rotor systems. Two attitude gyros, a directional gyro (copilot's compass system), OADS, IAS transducer, lateral accelerometer, and two yaw rate gyros sense attitude, heading, side slip and airspeed changes, then provide inputs to the AFCS computer. The AFCS computer sends signals to the electric series actuators and parallel servos which, in turn, cause the rotor systems to change or maintain attitude and heading as desired. Reduced performance is possible with certain system failures.

**NOTE**

The pitch and roll attitude hold mode is automatically released when the helicopter is on the ground, through actuation of the weight-on-wheels switch located on the nose landing gear. If the pitch or roll axis is engaged, the attitude hold mode will assume normal operation when the helicopter becomes airborne; holding the related attitude at the time of weight-on-wheels switch release. Movement of the collective by the parallel servo is also inhibited through activation of the nose weight-on-wheels switch.

Any axis may be manually disengaged by moving the associated bathandle aft, or all may be disengaged simultaneously by pressing the AFCS quick-disconnect switch on either cyclic. This action illuminates the AFCS caution light on the warning-caution-advisory panel and causes the related axis light on the avionics mode annunciator panel to flash. The AFCS computer then commands the applicable series actuator to return and remain at its center position. A second push of the AFCS quick-disconnect switch or depressing the applicable light segment on the avionics mode annunciator panel acknowledges the condition, extinguishes the AFCS caution light, and causes the annunciation light to stop flashing and remain illuminated.

Manual override of the AFCS is possible without disengagement. One half pound of cyclic pressure will activate the force-breakout switch and permit pilot induced "fly-through."

## REFERENCE ATTITUDE

The AFCS computer operates on the basis of reference attitude. All stability inputs are made in relation to the reference attitude determined from the attitude gyros. The AFCS computer "memorizes" this attitude and makes appropriate inputs to synchronize aircraft attitude with this reference. Changes to the reference attitude can be made with the beep trim switch, sync/trim release button, or with FDC modes when coupled. Cyclic pitch or roll fly-through by the pilot will not affect the reference attitude and the aircraft will return to the last selected attitude when the pressure is released.

## Roll Axis

The basic mode of the AFCS roll axis is attitude hold which will act to dampen helicopter roll rates. The AFCS will maintain the attitude selected by the pilot to a limit of 45 degrees left or right. Both attitude gyros are used to determine attitude information for the pitch and roll axes. The pilot and copilot vertical gyro positions are compared in the AFCS computer and, if within allowable tolerances, are combined into one valid attitude signal. If the roll related circuitry is operating properly and receiving the correct inputs, the bathandle will latch in the ENGAGE position.

In operation, the AFCS computer sends a roll signal to the two roll series actuators to hold the referenced roll attitude. If the helicopter roll attitude changes from the reference attitude, the AFCS computer sends a roll signal to the roll series actuators to return the helicopter to the reference roll attitude. If the helicopter is rolled to a bank angle of less than 45 degrees and the sync/trim release button is depressed and released, the helicopter will hold that bank angle. If the pilot rolls the helicopter to a bank angle greater than 45 degrees and the sync/trim release is depressed and released, the helicopter will return to and hold 45 degrees of bank. If the pilot increases the roll attitude to greater than 45 degrees and releases the cyclic without pressing the sync/trim release, the helicopter will initiate a rapid roll back toward the last reference attitude. Upon decreasing to 45 degrees of roll, the helicopter will slow to a predetermined, dampened, roll rate.

## Pitch Axis

Pitch axis control, normal and reversionary operation, is similar to the roll axis with the exception that the pitch axis

uses one series actuator and the roll axis uses two. The basic mode of operation of the pitch axis is to hold a pitch attitude selected by the pilot to a limit of 12 degrees up or down. If the pitch attitude changes from the referenced attitude, the AFCS computer sends a pitch signal to the pitch series actuator to return the helicopter to the referenced pitch attitude. If the pilot pitches the helicopter to an attitude of less than 12 degrees up or down and presses the sync/trim release, the helicopter will hold that pitch angle. If the pilot pitches the helicopter to an attitude greater than 12 degrees up or down and presses the sync/trim release, the helicopter will return to and hold 12 degrees of pitch. If the pilot increases the pitch to greater than 12 degrees up or down and releases the cyclic without pressing the sync/trim release, the helicopter will initiate a rapid pitch movement toward the last referenced attitude. Upon decreasing to 12 degrees, the helicopter will slow to a predetermined, dampened rate and return to the reference attitude. An additional input from the AFCS computer used in controlling the pitch axis is collective position using information sensed by the dual position transducer.

**NOTE**

If the Flight Director System (FDS) is coupled to the AFCS, attitude hold is released and the AFCS computer accepts pitch and roll steering commands from the flight director. The roll limit from flight director commands is 30 degrees left or right at a rate of 5° per second. The pitch limit from flight director commands is 12 degrees up or down at a rate of 9° per second.

## Reversionary Gyro Operation

Rev Gyro Operation is a degraded condition in which AFCS pitch and roll information is provided by reference to a single attitude gyro. In normal AFCS operation, both ATT gyros are referenced and compared to establish pitch and roll attitudes. If the attitude gyros disagree, the AFCS pitch and roll channels automatically disengage, since the AFCS computer cannot determine which ATT gyro has malfunctioned. If such an automatic disengagement occurs, the pitch and roll series actuators stop immediately without centering. This prevents unexpected transients with automatic disengagements. If the series actuators are beyond trim limits at that instant, the P TRIM and R TRIM (out of trim) lights on the AMAP remain illuminated.

AFCS pitch and roll channels can be regained by selecting the good gyro with the Gyro selector switch on the AFCS control panel. This restores attitude reference inputs to the AFCS computer but only from the selected gyro. This illuminates the GYRO REV (Gyro Reversionary Operation) indicator light on the avionics mode annunciator panel.

Hardover protection is not possible during GYRO REV operation (single gyro) because the second (failed) gyro is not available for comparison. Therefore, the AFCS will follow the referenced gyro even if it malfunctions. In addition, pitch and roll series actuator authority will be reduced by approximately 1/2 to decrease aircraft displacement in the event of an electrically generated series actuator hardover.

## TRIM

Three trim functions (automatic trim, manual trim, and sync/trim release) are available to provide aircraft trim. The purpose of trim is to center the flight controls to ensure full authority, to relieve cyclic pressure, or to permit incremental flight control inputs. The AFCS employs trim to perform its stabilization and command augmentation functions. The trim systems are affected differently by the AFCS depending on engaged or disengaged operation.

## Parallel Trim/Feel Units

The multi-purpose pitch and roll parallel trim/feel units consist of an output shaft with an artificial-feel load spring, an electromagnetic clutch, a drive motor, a force-breakout switch, and dual position potentiometers. The parallel trim/feel units are used for automatic flight control trim and artificial feel. With AFCS engaged, automatic trim is provided by the AFCS computer and uses all unit components. As long as the electromagnetic clutch is engaged, the AFCS automatically trims or centers the series actuators, as required, by motoring the parallel trim/feel unit output shaft. This action is perceptible by the pilot as slight cyclic movement.

With AFCS off or disengaged, the unit still provides artificial feel (clutch engaged), and manual beep trim capability.

Pilot fly-through activates the force-breakout switch and permits manual cyclic inputs to the flight controls. The dual position potentiometers provide feedback signals to the AFCS computer to relay parallel trim/feel unit position.

## Automatic Trim

Automatic trim is only available when AFCS is engaged. Automatic trim is a function of the AFCS and refers to the automatic centering of the series servos through parallel trim/feel unit adjustment to ensure maximum authority. (With AFCS off, the series servos remain centered.) Unless the AFCS input is very large, as in response to a significant external gust, the stick movement resulting from the parallel trim/feel unit movement, to recenter the series actuator, is very slight.

## Beep Trim Operation/Manual Trim

The cyclic beep TRIM switch (coolie-cap shape) operates differently depending on whether AFCS is engaged or disengaged. When AFCS is engaged, the beep trim switch adjusts, or trims, the AFCS computer reference attitude. A forward beep trim switch input readjusts the referenced attitude forward and the AFCS makes the appropriate nose-down adjustment through the series actuators. Since AFCS inputs are made at the series actuator, no cyclic movement is felt by the pilot unless parallel trim/feel unit movement is necessary to re-center the series actuator (refer to automatic trim above).

If the AFCS is disengaged, AFCS inputs are not possible. The beep TRIM switch, however, still motors the parallel trim/feel unit, causing perceptible cyclic movement and "manual trim." The cyclic will remain in the newly trimmed position until a new position is selected.

**NOTE**

With AFCS engaged, beep trim movement in roll is at a rate of 3 degrees-per-second to a maximum bank angle of 45 degrees left or right. Beep trim movement for pitch is at a rate of 2 degrees-per-second to a maximum pitch angle of 12 degrees up or down.

## Attitude SYNC/TRIM Release Operation

The TRIM/REL (sync/trim release) button on each cyclic and the TRIM switch in the overhead panel only control the electromagnetic clutch in the parallel trim/feel units. This provides stick position hold when the button is released and the switch is ON. During AFCS engaged operation, the trim release button also synchronizes AFCS computer attitude reference with actual aircraft attitude when the button is released. Once synchronized, the AFCS will maintain that selected attitude. While the button is depressed or the overhead switch is OFF, AFCS attitude reference is nulled and AFCS is ineffective in pitch and roll.

## AFCS Disengaged Operation

With AFCS disengaged, the sync/trim release button will trim the cyclic in any selected position by disengaging the magnetic clutches when the button is depressed and engaging the clutches when the button is released. The overhead TRIM switch must be on for normal sync/trim release operation.

## Fail Passive Trim Drive

Monitor circuits in the AFCS computer will detect an AFCS trim system fault (excluding the trim beep switch) and disable the pitch and roll motorized trim system, but not disengage the pitch or roll axis. The TRIM OFF light on the avionics mode annunciator panel will illuminate. If the fault clears itself, the TRIM switch must be manually positioned on again to return to normal operation. If the fault is not cleared, the pilot will need to maintain trim with the sync/trim release button.

## Yaw Axis

The yaw axis has two operational capabilities: heading hold and turn coordination. These capabilities cannot be selected individually and are automatically active with the AFCS engaged during various regimes of flight and configurations of the trim and flight control systems.

Yaw control commands are determined by the AFCS computer and executed by the yaw series actuator and the yaw parallel servo. Compass data from the copilot's directional gyro (HDG2), indicated airspeed, bank angle, collective position, lateral acceleration, and yaw rate gyros (both) are the inputs to the AFCS computer used to compute the yaw rate command. Heading hold is automatically active when forward airspeed is less than 40 knots as determined by the IAS transducer, or when a hover mode is captured and the AFCS is FD coupled. At speeds greater than 40 knots, heading hold is active whenever bank angle is less than 5 degrees, provided there is no roll fly-through input (manual cyclic displacement), TRIM REL (sync/trim) button activation, or roll beep trim switch activation. Whenever the forward airspeed is greater than 40 knots and heading hold is not active, the turn coordination mode is automatically active. In turn coordination, the AFCS computer commands the yaw series actuator to zero lateral airspeed as determined by the lateral accelerometer. In heading hold, the AFCS computer commands the yaw series actuator to hold a constant heading. In turn coordination, manual pedal movement adds to or subtracts from commanded yaw rate by an amount proportional to and in the direction of the pedal force. All yaw axis commands are sent to the series actuator. In addition, the yaw parallel servo accomplishes two complementary functions.

- Long term pedal trim. The yaw parallel servo moves in the commanded direction at a rate proportional to the series actuator command. The net result is to keep the yaw series actuator operating about its mid-position.

- Dynamic response. The yaw parallel servo also executes any commanded yaw response that exceeds the capability of the series actuator. This increases the total au-

thority of the yaw axis to hold heading with large wind gusts or collective torque changes.

In all regimes, a 10 degree-per-second yaw rate command limit is imposed by the AFCS computer. However, this rate may be exceeded by means of manual pedal motion. Manual pedal motion is sensed as a fly-through input and commands a yaw rate consistent with the pedal force. Releasing pedal force with a yaw rate of 2 degrees-per-second or less (left or right) causes the heading hold mode to hold the new heading. If pedal force is released with a yaw rate greater than 2 degrees-per-second (left or right), the AFCS computer will not command a heading hold mode until the yaw rate decreases to 2 degrees-per-second.

**WARNING**

Larger yaw demands, such as rapid collective movement or deceleration in a crosswind, can result in yaw requirements exceeding the AFCS command limit. The pilot must make pedal inputs to maintain heading.

**NOTE**

Loss of any of the valid computer signals will cause yaw axis disengagement. Loss of compass or lateral acceleration does not cause axis disengagement, but removes the respective input from the yaw circuits in the AFCS computer.

### Collective Axis

The collective axis holds the selected collective position with the parallel servo. The AFCS computer sends a collective hold command to the collective parallel servo to maintain collective position when not coupled to the flight director. After AFCS engagement, the collective position may be changed by pressing the C-SYNC (collective sync) switch on the collective grip, moving the stick to the desired position, and releasing the switch. Activating the C-SYNC switch causes the collective servo to declutch, allowing stick repositioning. The clutch is re-engaged when the switch is released. The collective may also be repositioned by overriding the servo forces (approximately 10 pounds). A dual position transducer connected to the collective flight control continuously sends collective position signals to the AFCS computer for pitch computations. If the AFCS is coupled to the FDS, the AFCS computer accepts collective commands from the flight director.

## FLIGHT DIRECTOR SYSTEM (FDS)

The FDS consists of a Flight Director Computer (FDC), a control panel containing mode select pushbuttons, control switches located on the cyclic and collective, two longitudinal/lateral accelerometers, and a normal (perpendicular to the longitudinal and lateral axes) accelerometer. The FDC receives signals from an altitude controller and Indicated Airspeed (IAS) sensor. The system generates steering commands in three axes; cyclic pitch and roll and collective for manual or coupled automatic flight control system operation. These steering signals are displayed on the Attitude Director Indicators (ADIs). The flight director system normally operates on signals from the navigation source, selected on the pilot's display control panel. A navigation data transfer pushbutton (NAV XFR) allows selection of the copilot's MFD for the navigation source. The FDS operates on 28 volt DC power from the copilot's manual shed bus with a circuit breaker marked FDS on the cockpit avionics circuit breaker panel.

### Flight Director Computer (FDC)

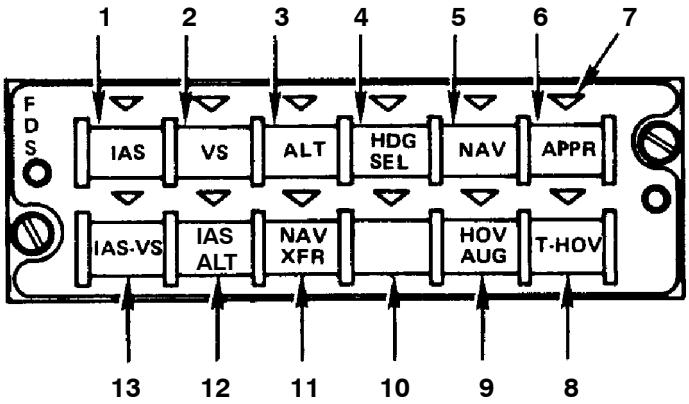
The FDC computes independent steering signals for cyclic pitch and roll, and collective control of the aircraft. During each mode of operation, validated steering signals from the navigation radios, data sensors, and status monitors within the FDC are processed and supplied to the pilot and copilot ADIs and, if coupled, to the AFCS.

### Flight Director Control Panel

The flight director control panel (Figure 1-142) contains 12 pushbuttons for FD mode selection and navigation transfer. Eleven of the buttons are operable and one is a spare. When a mode is selected, a chevron shaped annunciator light above each pushbutton will illuminate to indicate the mode has been activated. The selected mode can be deselected by: manually depressing the pushbutton a second time; selecting another mode which is not compatible with the previous selection, or by the arming of another mode which will drop the existing mode at capture.

### Flight Director Couple (FD CPL) Pushbutton

The flight director couple pushbutton, located on the AFCS control panel (Figure 1-140), allows the pilot to couple flight director signals to the AFCS. Depressing the pushbutton will cause the AFCS to couple to the mode of operation selected on the flight director control panel. When activated, an indicator light above the pushbutton will illuminate. Also, the FD UCPL indicator lamp on the AMAP will go out to indicate coupling.




1. Indicated Airspeed (IAS) Mode Pushbutton
2. Vertical Speed (VS) Mode Pushbutton
3. Altitude Hold (ALT) Mode Pushbutton
4. Heading Select (HDG SEL) Mode Pushbutton
5. Navigation (NAV) Mode Pushbutton
6. Approach (APPR) Mode Pushbutton
7. Mode Annunciator Indicator Lamps (12)
8. Transition-To-Hover (T-HOV) Mode Pushbutton
9. Hover Augmentation (HOV AUG) Mode Pushbutton
10. Spare
11. Navigation Transfer (NAV XFER) Mode Pushbutton
12. Indicated Airspeed-Altitude (IAS-ALT) Mode Pushbutton
13. Indicated Airspeed-Vertical Speed (IAS-VS) Mode Pushbutton

*Figure 1-142. Flight Director System Control Panel*

**WARNING**

When coupled to the AFCS, the flight director will command flight control movements without regard to aircraft limitations or operating altitude. Such control movements can result in engine, main rotor head, and MGB exceedances or positioning the helicopter outside of a safe operating envelope.

## Collective Synchronize (C-SYNC) Trigger

The collective synchronize C-SYNC trigger, located on the collective (Figure 1-46), is used to synchronize changes in altitude or vertical speed inputs to the flight director system as desired by the pilot when in the IAS-VS, APPR, T-HOV, HOV AUG, and GA modes. The button is a push-on, spring-loaded to off, type switch. The button must be depressed and held while the collective is used to establish a new altitude or vertical speed reference in the FDS for the AFCS to hold. The C-SYNC lamp, on the avionics mode annunciator panel, will illuminate while the button is depressed.

## Hover Beep Switch

The HOVER BEEP switch is a three position toggle switch mounted on the collective (Figure 1-46). The switch provides the means to change the hover altitude reference in the flight director by allowing the pilot or copilot to move the hover altitude up or down in incremental steps of approximately three feet. Spring-loaded to the center position, the hover altitude will be altered one step each time the switch is moved in either direction. Hover beep capability is operative only in the flight director modes of HOV AUG or T-HOV. If T-HOV selection directly captures and holds the existing altitude, hover beep operation is enabled immediately. However, if T-HOV captures the altitude from an armed state, hover beep operation is inhibited until after C-SYNC is activated. Once C-SYNC is activated, the hover beep switch may be used at any time thereafter. Hover beep operation is always enabled immediately upon selecting HOV AUG. Operating in a manner similar to collective sync, toggling the HOVER BEEP switch causes the radar altitude hover reference to change. Each time the hover altitude is beeped up or down, the low altitude warning circuit is reset by synchronizing the barometric altitude reference in the altitude controller. Refer to Low Altitude (LOW ALT) Warning Lights in this Section. No separate mode annunciation is provided to indicate hover beep operation.

## Go-Around (GA) Pushbutton

The go-around pushbutton is located on the collective (Figure 1-46). Depressing the button engages the go-around mode which provides commands to make a safe transition to climb out from any other mode. The GA lamp, located on the avionics mode annunciator panel, will illuminate to indicate that the mode is coupled. Selecting GA mode, which is not compatible with any other modes, will deselect any previously selected mode. Deselecting the GA mode is accomplished by selecting any other mode except APPR.

## Four-Position Slew Switch

The four-position slew switch, not to be confused with the TRIM (beep) switch, is located on the cyclic (Figure 1-46). The switch has four unmarked positions; forward, aft, left, and right and is spring-loaded to the center off position. With the flight director coupled to the AFCS, the switch provides a means of changing the airspeed reference. During operation in the IAS, IAS-VS, and GA modes, only the forward or aft positions of the switch are used to make changes to the FDS couple airspeed reference. During operation in the T-HOV mode, the airspeed reference can be changed in the forward, aft, left, or right directions.

## Flight Director Mode Deselect Pushbutton

The flight director mode deselect pushbutton is located on the collective (Figure 1-46). Depressing the button will deselect any flight director modes and uncouple the flight director.

## Navigation Data Transfer (NAV XFR) Pushbutton

The NAV XFR pushbutton is located on the flight director system control panel (Figure 1-142). On initial power application, the flight director system is connected to the navigation data source controlled by the pilot. Depressing the button will transfer the navigation data inputs to the flight director system from the pilot's to the copilot's position and illuminate the chevron above the button. When this occurs, the NAV CTL (navigation control) light on the pilot's side of the instrument panel will extinguish and the NAV CTL light on the copilot's instrument panel will illuminate. Depressing the button a second time will return the function to the pilot's station.

**NOTE**

When NAV XFR is activated, all flight director modes are deactivated.

## Navigation Control (NAV CTL) Lights

The navigation control lights (NAV CTL) are located on each pilot's instrument panel (12, Figure FO-2). The NAV CTL lights indicate which navigation data sources (pilot's or copilot's) are connected to the flight director system.

## Low Altitude (LOW ALT) Warning Lights

The low altitude warning lights (LOW ALT) are located on each pilot's instrument panel (12, Figure FO-2) and operate in conjunction with T-HOV and HOV AUG modes; flashing to warn the crew of an altitude deviation below an established reference hover altitude.

The LOW ALT warning function is completely independent of the HOV AUG and T-HOV radar altitude hold computations within the flight director computer. Instead, it operates with respect to a barometric pressure measurement to establish a fixed barometric altitude reference simultaneous with the fixed radar altitude hold reference established by the T-HOV or HOV AUG modes. The LOW ALT warning lights, operative at all times in the HOV AUG mode and conditionally in the T-HOV mode, flash whenever the helicopter descends to the LOW ALT warning trip point which is referenced to the barometric hover altitude. The nominal setting of the LOW ALT warning trip point is 20 feet below the altitude reference with an electrical tolerance of $\pm$ 10 feet. In addition, the pitot-static system of the helicopter experiences large perturbations during hover operations and can be expected to contribute an additional $\pm$ 5 feet to the overall tolerance of the function. Thus, the total allowable envelope of the LOW ALT warning function could cause the LOW ALT warning lights to flash at any altitude between 5 and 35 feet below the altitude reference.

As stated above, the LOW ALT warning function is operative at all times in the HOV AUG mode; flashing whenever the helicopter descends to the LOW ALT warning trip point. The altitude reference may be resynchronized to the existing pressure altitude at any time by using C-SYNC or hover beep. When T-HOV mode is selected directly or captures from an armed state, the LOW ALT warning function is delayed for approximately 2 minutes to allow ample time for the helicopter to become stabilized at the reference hover altitude. After 2 minutes, it operates in the same manner as HOV AUG, or the 2 minute delay can be defeated at any time by selecting HOV AUG. Using C-SYNC or hover beep will establish a new altitude reference, but will not defeat the delay.

The LOW ALT warning function is primarily intended to provide warning of altitude deviation from an established hover; for example, the LOW ALT warning will activate if a helicopter drifts slowly toward the water while the pilot is

| | | AXES | | | |
|---|---|---|---|---|---|
| MODE | LIMITS | PITCH | ROLL | COLL | REF SENSOR |
| IAS | ABOVE 40 KIAS | X | | | IAS SENSOR |
| VS | 70 KIAS MIN<br>0-3000 FPM | X | | | ALT CONTROL |
| ALT | 70 KIAS MIN | X | | | ALT CONTROL |
| IAS-VS | 40 KIAS MIN<br>0-3000 FPM<br>80% MCP | X | | X | IAS SENSOR<br>ALT CONTROL |
| IAS-ALT | 40 KIAS MIN<br>No altitude changes<br>Greater ± 150 FPM<br>80% MCP | X | | X | IAS SENSOR<br>ALT CONTROL |
| HDG SEL | 40 KIAS MIN | | X | | GYRO COMPASS W/NAV CONT |
| NAV | ABOVE 40 KIAS | | X | | VOR,TACAN,RNAV, LOC, BC LOC |
| APPR | ABOVE 40 KIAS<br>12° GLIDEPATH | X | X | X | VOR,TACAN,RNAV, ILS, LOC, BC LOC |
| T-HOV | BELOW 2500' RADALT | X | X | X | RADALT/OADS |
| HOV AUG | VISUAL, HOVER MANEUVERS | X | X | X | RADALT, LATERAL ACCEL |
| GA | ABOVE 25 FT AGL | X | X | X | IAS SENSOR, ALT CONTROL, GYRO COMP. |

*Figure 1-143. Flight Director Modes*

preoccupied with other duties. It cannot provide sufficient warning during the T-HOV capture maneuver (or during an erroneous, full authority collective command) to avoid contacting the surface.

**WARNING**

During the T-HOV capture maneuver, the pilot must monitor radar altitude for reasonableness of the transition. For erroneous collective commands, the pilot must respond immediately to any downward acceleration of the helicopter.

## Flight Director Modes of Operation

The FDS operates in conjunction with the AFCS in 11 separate and distinct modes. Ten modes are selected from the FD control panel and one (GA) is selected from either collective. Each FD mode, when coupled to the AFCS, provides commands to one or more axes of the AFCS as outlined in Figure 1-143.

INDICATED AIRSPEED (IAS) HOLD MODE

The selection of IAS hold mode couples the pitch axis to an airspeed reference originating from the IAS sensor at the moment of selection. After IAS has been selected, the pilot can change the airspeed (from 40 to 150 knots) using the four-position slew switch. Thumbing the switch forward or aft will increase or decrease the airspeed reference at a rate of 4 knots-per-second. The IAS mode is compatible with either the HDG SEL or NAV modes and will couple with either mode selected. The IAS mode can be deselected by depressing the IAS selector button a second time, selecting another pitch mode, or (when used with APPR mode) the IAS mode will automatically drop out at vertical capture. When the IAS mode is selected, the IAS light on the avionics mode annunciator will illuminate, and the airspeed display on the HSVD will appear as CMD (commanded airspeed). Simultaneously, pitch steering information will be sent to the pitch command bar on the ADIs.

VERTICAL SPEED (VS) HOLD MODE

The selection of VS hold mode couples the pitch axis to a constant vertical speed reference received from the altitude controller. If the vertical speed is greater than ± 150 feet–per–minute at engagement, the pitch axis will hold the value existing at the moment of mode activation. If the vertical speed is less than ± 150 feet–per–minute at activation, the pitch axis will act as in ALT hold mode, but the avionics mode annunciator will continue to show the VS mode as active. To change the established vertical speed reference, the pilot must deselect the mode, change the rate of climb or descent as desired, then recouple the mode. The VS mode is compatible with either the HDG SEL or NAV modes. The VS mode can be deselected by depressing the selector button a second time,

selecting another cyclic pitch mode, or (when used with the APPR mode) the VS mode will automatically drop out at vertical capture. When the VS mode is selected, the VS light on the avionics mode annunicator panel will illuminate and pitch steering information will be sent to the pitch command bar on the ADIs to represent the pitch attitude that will hold the climb or descent rate constant. For best handling qualities, the VS mode should only be used at vertical speeds ranging from 0 to ± 3000 feet–per–minute at airspeeds greater than 70 KIAS.

ALTITUDE (ALT) HOLD MODE

The selection of the ALT hold mode couples the pitch axis to a barometric reference received from the altitude controller at the moment of activation. The reference altitude can only be changed by deselecting the mode, establishing a new reference, then reselecting the mode. The ALT hold mode is compatible with the HDG SEL and NAV modes. The ALT hold mode is deselected by depressing the ALT select button a second time, selecting another cyclic pitch mode, or if the first two options are not taken, it will drop out automatically at APPR mode vertical capture. When the ALT mode is selected, the ALT light on the avionics mode annunciator panel will illuminate and pitch steering information will be sent to the pitch command bar on the ADIs to represent the pitch attitude that will hold the altitude constant. For best handling qualities, the ALT mode should only be used at barometric altitudes to 15,000 feet at airspeeds greater than 70 KIAS.

INDICATED AIRSPEED-VERTICAL SPEED (IAS-VS) HOLD MODE

Selection of the IAS-VS hold mode couples the pitch and collective axes. Pitch will be the primary axis for holding airspeed and collective for maintaining the vertical speed. If vertical speed is less than ± 150 feet-per-minute at activation, the collective will hold at a vertical speed of zero. The IAS mode functions the same as the separate IAS mode. The VS function is different from the separate VS mode in that vertical speed reference is maintained by the collective axis and the C-SYNC pushbutton can be used to change the vertical speed reference. The IAS-VS mode is compatible with the HDG SEL and NAV modes. The IAS-VS mode automatically arms T-HOV, will couple with APPR mode when selected, and will remain coupled until either mode captures altitude (vertical guidance). The IAS-VS mode can be deselected by depressing the IAS-VS selector button a second time, or selecting the HOV- AUG, IAS, VS, ALT, or GA mode. When the IAS-VS mode is selected, the IAS-VS light and the T-HOV arm light (amber) on the avionics mode annunciator panel will illuminate, and the airspeed display on the MFD will appear as CMD (commanded airspeed). Simultaneously, both pitch and collective steering information will be sent to the ADIs. The pitch command bar will represent the pitch attitude that will hold airspeed constant and the collective command pointer will indicate the collective action that will hold the vertical speed constant. For best handling qualities the IAS-VS mode should be used only at vertical speeds of from 0 to ± 3000 fpm at airspeeds greater than 40 KIAS. The IAS-VS mode should not be used above 80% Maximum Continuous Power (MCP), i.e., the limit above 75 KIAS in cruise flight would be 80% of 88% MGB torque or approximately 70% MGB torque.

INDICATED AIRSPEED -ALTITUDE (IAS-ALT) HOLD MODE

IAS-ALT is a low speed altitude hold mode. Selection of the IAS-ALT hold mode couples the pitch and collective axes. Pitch is the primary axis for holding airspeed and collective for maintaining the reference altitude. The IAS mode functions the same as the separate IAS mode. The ALT function is different from the separate ALT mode in that the ALT function of the IAS-ALT mode is maintained by collective axis and the C-Sync button can be used to make small altitude changes up to ± 150'. If altitude changes of greater than 150' are required, IAS-ALT shall be disengaged and the change in altitude should be established by using alternate modes such as HDG and IAS. Once the new altitude is achieved, the IAS-ALT can be reengaged. The IAS-ALT mode is compatible with HDG SEL and NAV modes. The IAS-ALT mode can be deselected by pressing the IAS-ALT button a second time, pressing the FD Mode Deselect Button on the collective, or by selecting the HOV-AUG, T-HOV, IAS, VS, IAS-VS, ALT, or GA modes. When the IAS-ALT mode is selected on the FD panel, both the IAS and ALT lights on the AMAP will illuminate and the airspeed display on the HSVD/MFD will appear as CMD (commanded airspeed). Simultaneously, both pitch and collective steering information will be sent to the ADIs. The pitch command will represent the pitch attitude and will hold airspeed constant and the collective command pointer will indicate the collective action that will hold the altitude. For ease of handling, the IAS-ALT mode shall only be used at airspeeds greater than 40 KIAS. The IAS-ALT Hold mode should not be used above 80% Maximum Continuous Power (MCP), i.e., the limit above 75 KIAS in cruise flight would be 80% of 88% MGB torque or approximately 7.0 FLI.

**WARNING**

Aircraft acceleration limits and MGB torque limits may be exceeded if IAS-ALT is engaged when the aircraft is established in a high rate of climb or descent.

HEADING SELECT (HDG SEL) MODE

The selection of HDG SEL mode couples the helicopter to magnetic heading selected on the MFD. The pilot selects the desired magnetic heading by simultaneous movement of the heading command bug on each MFD using the HDG select knob on the display control panel. The angular difference between the aircraft heading and the selected heading on the MFD produces a steering error signal which is used to generate the necessary roll command to steer the aircraft to the selected heading. The HDG SEL mode may be engaged with IAS, VS, ALT, or IAS-VS modes if previously selected. The HDG SEL annunciation on the avionics mode annunciator panel and the chevron light for HDG SEL on the FDS control panel will be illuminated whenever HDG SEL mode is selected. The HDG SEL mode can be deselected by depressing the mode button a second time or by selecting T-HOV, HOV AUG, or GA mode. The HDG SEL mode will remain coupled with NAV or APPR mode selected until the new mode capture conditions are met, at which time the HDG SEL mode will drop out.

NAVIGATION (NAV) MODE

The selection of NAV mode couples the helicopter to a selected navigation course. Figure 1-144 presents a typical NAV mode profile. During NAV mode operation, the flight director computer provides steering commands to the ADI roll steering bar. The NAV mode is compatible with all other modes except APPR, T-HOV, HOV AUG, or GA. HDG SEL mode, when coupled with the NAV mode, will drop out at course capture. When operating in NAV mode, the desired course is set in the MFD with the course (CRS) select knob. The chevron-shaped indicator light above the pushbutton will illuminate to indicate the NAV-source selected. Also, the NAV-source will be displayed in the lower right corner of the MFD (HSI, MAP, and RMAP displays). The NAV mode will enter an armed condition (indicated by an amber NAV light on the avionics mode annunciator panel), unless the aircraft is in close proximity to the selected course (HSI course deviation indicator within two deviation dots). In this case, NAV will capture the course. To intercept the course,

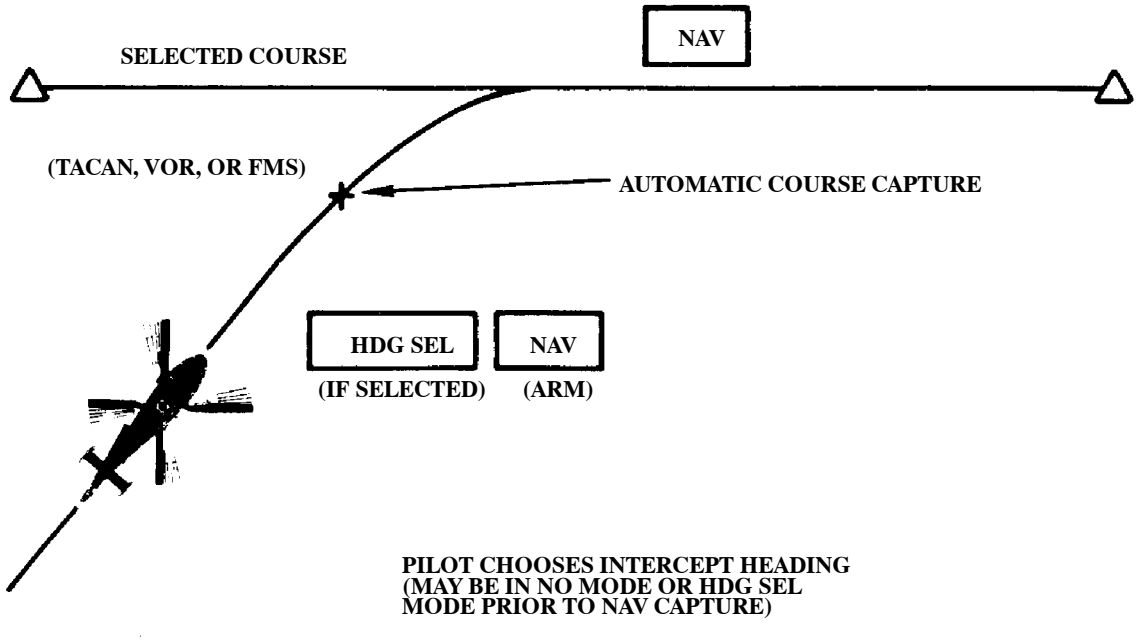



*Figure 1-144. Navigation Mode Operation*

the pilot must turn in the direction as indicated by the HSI course deviation bar to establish an intercept angle. The intercept angle may be up to 90 degrees. The intercept may also be performed manually by following the ADI steering commands, or by selecting the HDG SEL mode and setting in the intercept heading on the HSI display using the heading select knob on the display control panel. As the aircraft approaches the selected course, the beam sensor senses a capture condition. At course capture, the following occur simultaneously:

- The roll command bar on the ADI becomes active and indicates a steering command to intercept the course.

- If in HDG SEL mode, the HDG SEL mode drops out and a turn to a 50 degree course cut using a maximum bank angle of 25 degrees is initiated.

- The NAV mode annunciator light will change from amber to green.

After reaching the capture point, turn computations using bank angle, course datum, and deviation signals are used to determine the necessary lead point, and generate steering commands for intercepting the selected course. During course intercept, and when the course is established, automatic crosswind computation is provided to ensure course tracking. The operation with all four NAV- sources is essentially identical until establishing the course. Differences in the operation with each NAV source beyond that point are explained below:

- **NAV mode with VOR or TACAN NAV-source.** For the purpose of describing station passage, the operation of VOR and TACAN NAV-sources are identical and are discussed here as one source. In VOR or TACAN operation, a cone-of-confusion is encountered over the station and recognized by rapid course deviation indications. When this occurs, the DR (dead-reckoning) avionics mode annunciator light will illuminate to indicate station passage. The system will maintain the proper heading of the helicopter through the cone-of-confusion. When rapid course deviation indications have ceased for 1 minute, the system will revert back to the VOR or TACAN track. If a course change is entered by the pilot during station passage, the aircraft will turn to a wind corrected heading equivalent of the selected course. VOR or TACAN tracking guidance will not be supplied again until the DR light is extinguished.

- **NAV mode with localizer (LOC) NAV-source.** When the LOC NAV-source is selected with the NAV mode coupled, operation is the same as APPR mode except that sensitivity is reduced and there is no glide slope interception.

- **NAV mode with FMS NAV-source.** The operation with FMS NAV-source is identical to the other NAV sources except that navigational guidance to provide steering commands is generated by SCC 1.

**NOTE**

FMS is the only Nav-source that is capable of providing automatic course tracking along a flight plan route.

Initial capture of a course using FMS is described under INITIAL CAPTURE in this Section. Leg-to-leg capture occurs between the established course and the succeeding course. As the aircraft approaches a waypoint, the FMS examines the next navigation leg to determine if a course change is necessary. When a course change is required, the FMS computes the turning point and issues steering commands to smoothly intercept the new course. There are two methods for leg-to-leg captures:

COURSE CHANGE LESS THAN 150 DEGREES - As the helicopter tracks the present flight plan course, a capture initiation point (short of the fix) for each new leg is computed. When the helicopter reaches that point, it will initiate a turn to intercept and roll out on the new course. The maximum turn initiation distance is two miles from the fix and provides for minimum capture time. Prior to reaching the turn initiation point, a l0-second LNAV alert will flash on the MFD, followed at the turn initiation point by a switching of the flight plan (including MFD course and deviation bar) to the new course.

COURSE CHANGE EQUAL TO OR GREATER THAN 150 DEGREES - The helicopter will fly over the intersection of the two courses and initiate a standard rate turn toward the new course resulting in a teardrop interception outbound. The turn will be preceded by a l0-second LNAV alert followed at turn initiation by a switching of the flight plan (including MFD course and deviation bar) to the new course.

The NAV mode may be deselected by depressing the NAV mode select pushbutton a second time, or by selecting APPR, T-HOV, HOV AUG, or GA. The NAV mode will also deselect when the NAV mode is in a capture state and HDG SEL is selected.

APPROACH (APPR) MODE

The selection of APPR mode couples the pitch, roll, and collective axes. The roll axis provides commands to maneuver the aircraft to intercept a selected course and the pitch and collective axes provide commands to control airspeed and descent rate during the approach. Selecting APPR arms the T-HOV mode. When APPR is selected, the amber APPR, VERT, and T-HOV mode annunciators will illuminate. Until vertical capture, the operation of APPR mode is the same as the NAV mode except that steering tolerances are more restrictive for lateral tracking. When armed, the APPR mode is compatible with all other modes except NAV and HOV AUG. At vertical capture, any mode selected with APPR will uncouple. Refer to Radar Altimeter in this Section for a description of the indicator lights and aural intercom signals that will be encountered during the descent and transition to a hover.

### APPR mode with VOR-TACAN NAV-sources.

These NAV-sources can be used with the APPR mode to provide lateral guidance during coupled approaches. Vertical guidance will not be provided unless IAS, IAS-VS, or VS is also coupled.

**WARNING**

If vertical guidance is used during VOR or TACAN approaches, the descent must be manually arrested at the MDA.

### APPR mode with LOC (ILS) NAV-source.

The LOC NAV-source is selected by tuning the navigation receiver to a valid LOC frequency, depressing the APPR button on the FDS panel, and selecting the VOR/LOC receiver as the navigation source. When the localizer frequency is tuned, the flight director computer receives a LOC enable signal. If the difference between the selected localizer course and helicopter heading is less than 105 degrees at APPR capture, lateral steering commands are provided to intercept and track the front course. The commanded bank limit for capture is 25 degrees.

Course intercepts of the localizer back course are also possible by using LOC NAV-source. When a difference of more than 105 degrees exists (as sensed by the MFD) between the selected localizer front course and the aircraft heading, the flight director computer will automatically assume a back course configuration and reverse localizer deviation. When this occurs, the BC (back course) avionics mode annunciator light will illuminate and a "B/C" annunciation will appear on the HSI page to indicate this condition. The system will function in the same manner as front course localizer capture and tracking as long as the front course is selected on the HSI. The only exception is that intercepts to the back course localizer will be restricted to a 75 degree intercept angle versus 105 degrees for the front course.

At glide slope capture, any other mode coupled with APPR will drop out, a glide slope descent will be initiated, and the VERT avionics mode annunciator will switch from amber to green. As the descent continues to 100 feet radar altitude, the T-HOV mode will capture. At descent rates greater than 700 feet-per-minute, this will occur prior to 100 feet to prevent overshoot. At T-HOV capture, the following sequence of events occur:

- The T-HOV mode annunciator lamp switches from amber to green.
- Approach mode vertical guidance drops out and the VERT avionics mode annunciator lamp extinguishes.
- The helicopter initiates a transition from the descent rate and airspeed existing at capture to a commanded airspeed equal to the computed headwind (for zero airspeed if no headwind component exists) and zero vertical velocity at 50 feet radar altitude. This commanded airspeed is maintained unless changed by use of the slew switch.

**NOTE**

If the actual wind direction and/or velocity at 50 feet radar altitude is different from the headwind component computed at 100 feet radar altitude, the aircraft will not come to a zero groundspeed hover.

- The MFD, having navigational control, automatically switches to the HOVER display.

After T-HOV captures, approach mode roll inputs will continue to provide lateral steering commands. If the pilot makes a lateral speed input using the FD slew switch, the APPR mode will drop and the APPR mode avionics annunciator lamp will go out. While hovering, the pilot can change his hover airspeed using the four-position FD slew switch and adjust the altitude with the collective synchronize C-SYNC pushbutton.

## TRANSITION-TO-HOVER (T-HOV) MODE

**WARNING**

Radar altimeter fluctuations may induce large collective movements via the flight director and/or automatic flight control systems when using the T-HOV and HOV AUG operating modes. With these modes engaged, flight crews must be vigilant in monitoring collective movement as a primary means of quickly detecting and overcoming abnormal flight director and/or AFCS control inputs. Physical "hands-on" guarding of the collective is imperative.

Operation of the T-HOV mode depends on the existing mode selected at the time of T-HOV selection. Selecting T-HOV engages pitch, roll, and collective axes to maintain lateral position with signals from the Omnidirectional Airspeed Data System (OADS) and to maintain altitude with signals from the radar altimeter. Refer to Figure 1-145 for T-HOV mode profiles. If T-HOV is selected with no other mode or with any mode except IAS-VS or APPR selected, it will immediately capture the existing altitude (if below 2,500 feet radar altitude), and decelerate to zero forward speed. The T-HOV mode annunciator lamp will illuminate green at capture. While hovering, the pilot may change airspeed with the FD slew switch and the altitude reference using the collective synchronize C-SYNC pushbutton or HOVER BEEP switch.

**NOTE**

Commanded rearward speed, using the FD slew switch, is limited to a maximum of five knots.

T-HOV is automatically selected when IAS-VS mode is engaged and it will enter an armed state until the aircraft descends to 100 feet radar altitude. At this point the T-HOV mode annunciator lamp will switch from amber to green, the T-HOV mode will capture the altitude, and the IAS-VS mode will drop out. If another lateral mode (HDG SEL or NAV) is active, it will also drop out. T-HOV mode will continue the descent and decelerate the aircraft to a hover at 50 feet radar altitude. The pilot can change the hover airspeed and altitude reference as previously described. T-HOV mode automatically enters an armed state when APPR mode is selected. For detailed description of T-HOV operation with APPR, refer to approach mode operation. When the T-HOV mode is in the capture state it can only be deselected by depressing T-HOV, HOV AUG, or GA. When used in conjunction with IAS-VS or APPR, T-HOV will deselect when either of these modes is deselected prior to T-HOV capture.

### Hover Augmentation (HOV AUG) Mode

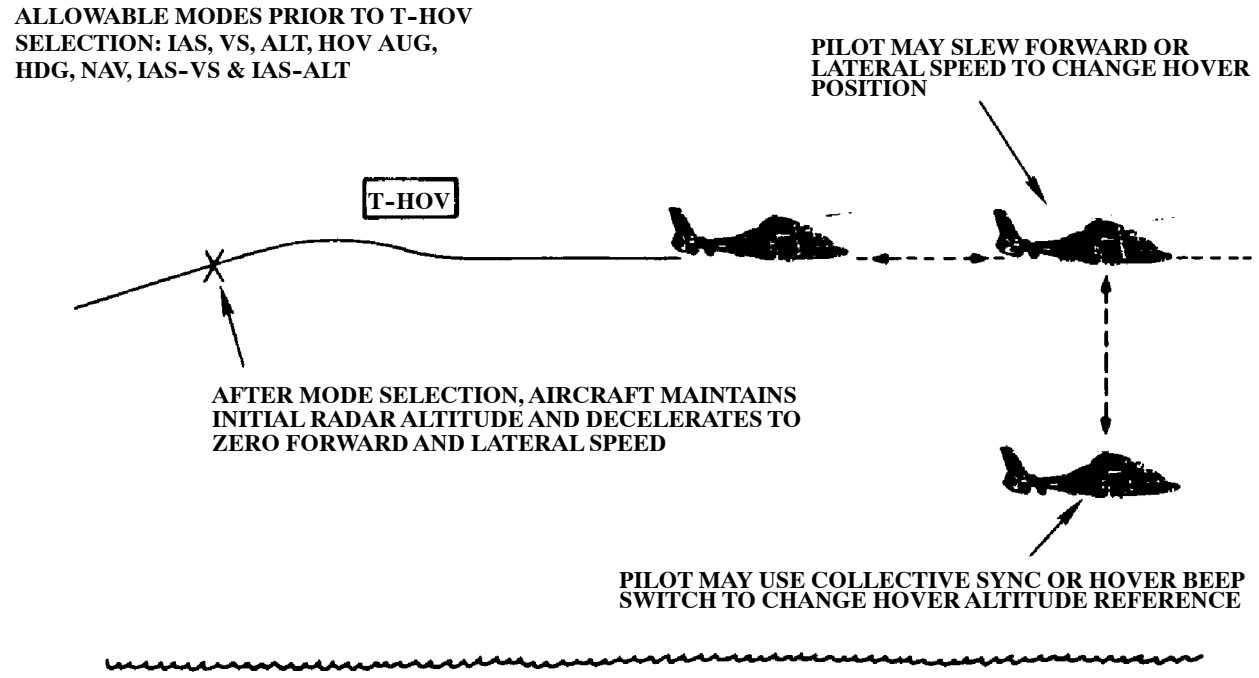
**WARNING**

Radar altimeter fluctuations may induce large collective movements via the flight director and/or automatic flight control systems when using the T-HOV and HOV AUG operating modes. With these modes engaged, flight crews must be vigilant in monitoring collective movement as a primary means of quickly detecting and overcoming abnormal flight director and/or AFCS control inputs. Physical "hands-on" guarding of the collective is imperative.

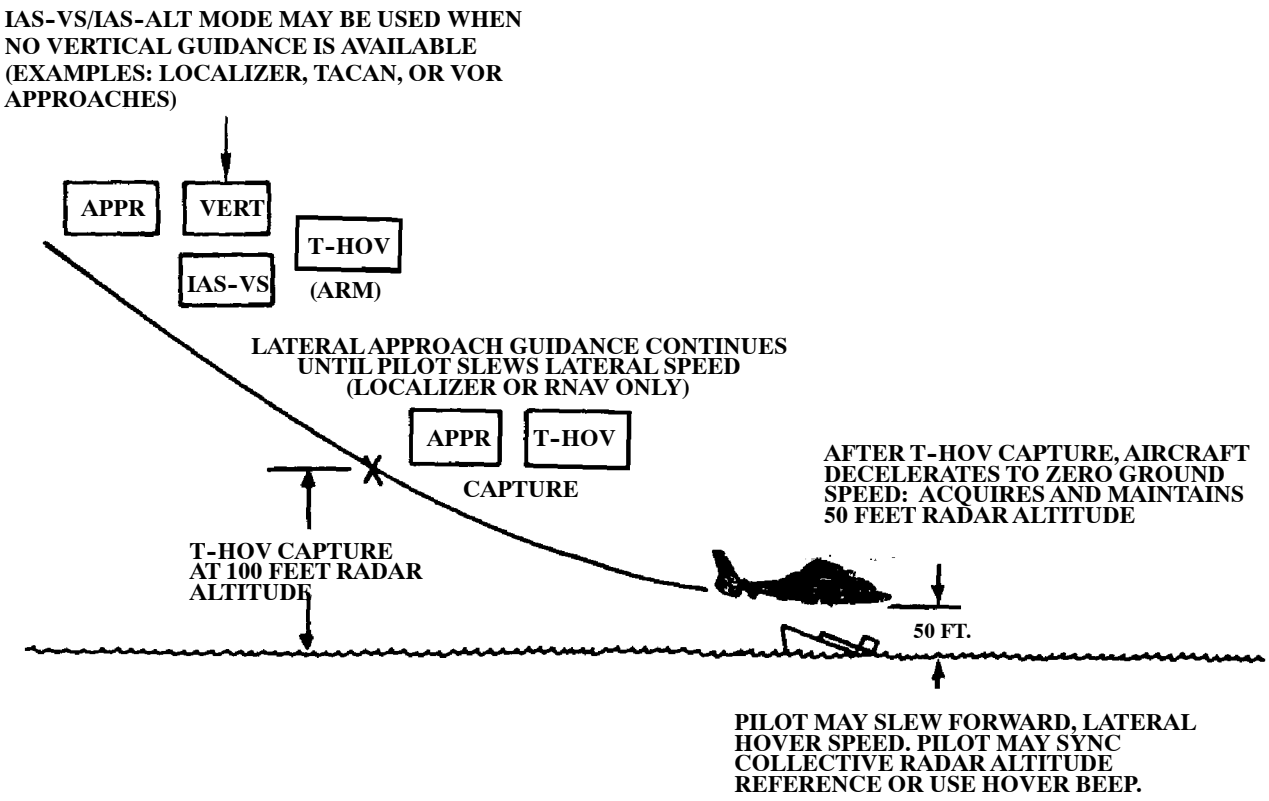
HOV AUG mode functions only when the flight director system is coupled to the AFCS. HOV AUG is not compatible with any other modes and can only be selected by depressing the HOV AUG pushbutton. Once coupled, HOV AUG can only be deselected by the selection of T-HOV, GA, or by depressing the HOV AUG pushbutton a second time. The selection of HOV AUG couples pitch, roll, and collective axes. The pitch and roll axes provide commands to maintain the aircraft in a stable hover; however, command bars on the ADI will not be in view. Aircraft position or velocity may be changed by flying-through or using the beep TRIM switch. The beep TRIM switch performs differently in HOV AUG than in other modes. When beeped, the aircraft attitude will change with a resultant change in airspeed. When released, the helicopter will resume a level attitude but retain the newly established airspeed. The four-position slew switch is inactive when HOV AUG is coupled. The collective axis provides the means of changing the hover altitude reference by use of the collective synchronized (C-SYNC) switch.

### Go Around (GA) Mode

The selection of GA mode couples the pitch, roll, and collective axes to provide commands for making a transition to climb-out from any flight director mode. GA mode is not compatible with any other mode and when selected, causes the deselection of any other mode. A typical GA profile is shown in Figure 1-146. Mode selection is accomplished by depressing the GA pushbutton located on the pilot's or copi-




T – HOV Mode Operation (Direct Capture)




T – HOV Mode Operation (Automatic Capture)

*Figure 1-145. T-HOV Mode Operation*

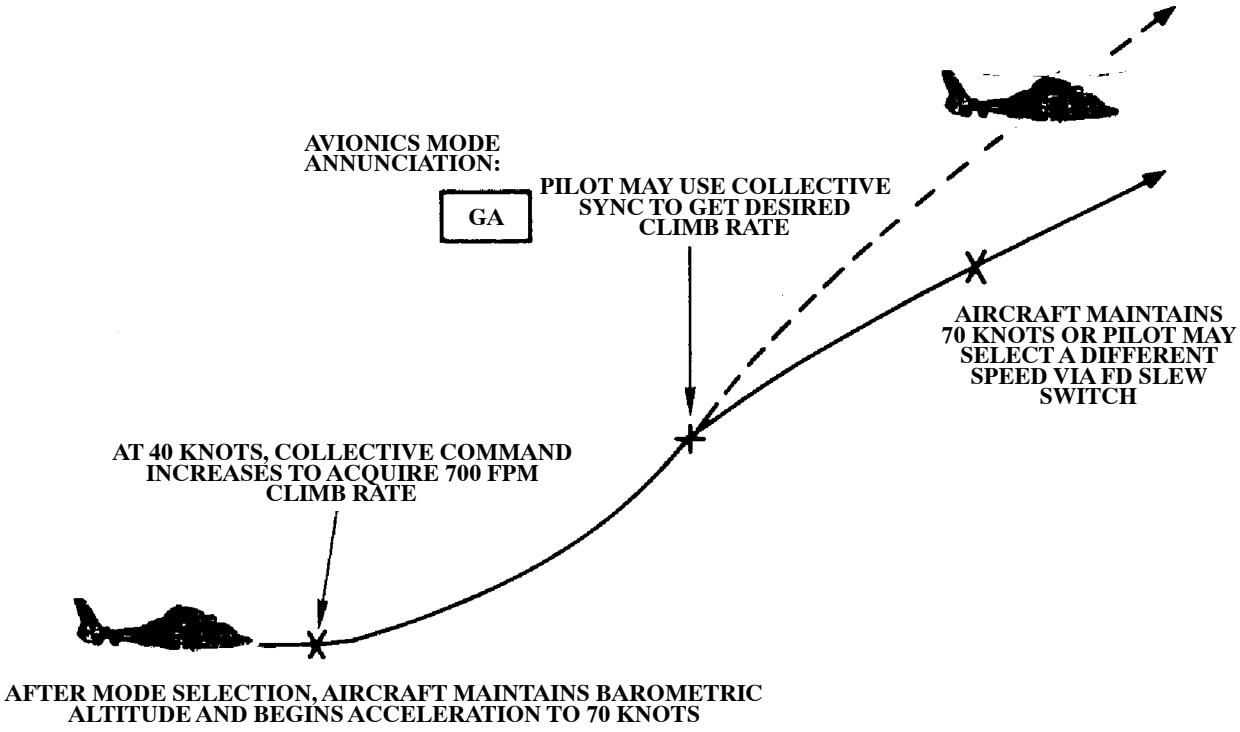



*Figure 1-146. Go-Around Mode Operation*

lot's collective (Figure 1-46). If the aircraft is hovering or if the indicated airspeed at mode selection is less than 40 knots, the collective axis maintains the existing barometric altitude and the pitch axis commands an airspeed acceleration to 40 knots. When 40 knots is obtained or if IAS was more than 40 knots at mode selection, collective will command a climb rate of 700 feet-per-minute and pitch will continue to accelerate the aircraft to 70 knots. If IAS at mode selection is more than 70 knots, pitch command will cause the helicopter to decelerate to 70 knots. The pilot has the capability at anytime in the go-around to change the airspeed reference with the FD slew switch on the cyclic, and the vertical speed reference with the collective synchronize C-SYNC pushbutton. The GA mode can be overridden and deselected by the selection of any other flight director mode.

## Flight Director Operating Procedure

The FDS may be operated in conjunction with three different navigational sources and any one of six different multifunction displays. On initial power application, the HSI display is automatically presented on both MFDs and the navigation data source is controlled from the pilot's position (NAV CTL). Normal operation is with flight director coupled to the AFCS.

1. Heading hold (HDG SEL):

   a. Heading select knob - Rotate to set heading command bug on the HSI to desired heading or depress the heading select knob to reset the bug to the current aircraft heading.

**NOTE**

Heading command bug will also appear on RADAR MAP, MAP, and CMAP mode presentations.

   b. HDG SEL pushbutton - Depress; mode annunciator HDG SEL light illuminates.

   c. ADI - Roll command bar will provide guidance to the selected heading. Aircraft will turn to center the command bar.

   d. HSI - Aircraft will turn to place heading command bug under lubber line.

To change heading reference:

   e. Heading select knob - Rotate to select new heading. ADI roll command bar will provide steering guidance and aircraft will turn to the new heading.

2. Vertical hold modes (IAS, VS, ALT, IAS-VS, IAS-ALT):

   a. Establish desired indicated airspeed, vertical speed, barometric altitude, or combination of indicated airspeed and vertical speed.

   b. Applicable mode pushbutton (IAS, VS, ALT, IAS-VS or IAS-ALT): Depress; associated mode annunciator lights illuminate.

   c. ADI - Pitch command bar becomes active and provides vertical guidance.

   d. HSI - IAS annunciator switches to CMD for IAS, IAS-VS or IAS-ALT modes.

To change airspeed reference:

   e. Use slew switch or deselect IAS mode, manually fly to a new airspeed and reselect IAS mode.

To change vertical speed reference:

   f. Deselect VS mode, manually fly to a new vertical speed and reselect VS mode, or if in IAS-VS mode, use C-SYNC to command new vertical speed.

To change altitude reference:

   g. Deselect ALT mode, manually fly to a new altitude and reselect ALT mode.

To change combination airspeed and vertical speed reference (IAS-VS mode):

   h. Use FD slew switch to change airspeed reference.

   i. Depress C-SYNC button on collective, establish new vertical speed reference and release C-SYNC.

3. Go-Around mode (GA):

   a. GA pushbutton (either collective) - Depress; mode annunciator GA light illuminates.

      (1) Less than 40 KIAS; aircraft will hold altitude and begin accelerating to 70 KIAS.

      (2) Above 40 KIAS; aircraft will climb at 700 fpm and accelerate to 70 KIAS.

      (3) Above 70 KIAS; aircraft will continue to climb at 700 fpm and decelerate to 70 KIAS.

   b. Change airspeed with slew switch.

   c. Change vertical speed with C-SYNC.

   d. Deselect GA mode with any FD mode.

4. NAV mode (Enroute VOR, TACAN, or FMS):

   a. CDU - Tune the applicable navaid.

   b. BDI - Select TACAN or VOR.

   c. Select navigation source on display control panel (VOR, TACAN, FMS).

   d. Course select knob (VOR and TACAN only)- Rotate to set desired course on HSI. Crosscheck with course pointer.

   e. HDG SEL mode - Check active; mode annunciator HDG SEL light illuminates.

**NOTE**

In FMS navigation source, course information to selected waypoint will be automatically displayed.

   f. Vertical hold mode - Select ALT, IAS-VS or IAS-ALT.

   g. Turn toward course deviation indicator on HSI to establish intercept angle (maximum of 90 degrees).

   h. NAV mode pushbutton - Depress; mode annunciator NAV amber (arm) light illuminates (green if course is already captured).

   i. Course capture:

      (1) ADI - Command bars will provide steering guidance.

      (2) HSI - Course Deviation Indicator (CDI) will display deviation from selected course.

      (3) HDG SEL mode will automatically deselect; mode annunciator light goes out.

      (4) NAV mode annunciator light switches from amber to green upon capture.

j. Holding:

(1) FMS - Call up patterns page via PAT access key on CDU and enter holding pattern requirements (refer to Flight Management System in this Section).

k. Station passage:

(1) In VOR and TACAN modes, mode annunciation DR (dead-reckoning) light illuminates for a minimum of 60 seconds.

(2) Course select knob (VOR and TACAN only) - Select VOR or TACAN outbound course; aircraft will turn to intercept new course. DR light extinguishes.

**NOTE**

With FMS selected as the NAV source the helicopter will turn immediately to new course for next waypoint.

5. APPR mode using published non-precision and precision approach criteria (VOR, TACAN, FMS).

To fly non-precision approach:

a. HDG SEL pushbutton - Depress; mode annunciator HDG SEL light illuminates.

b. Course select knob - Rotate to set VOR, LOC, or TACAN final approach course on HSI. Crosscheck with course pointer.

**NOTE**

In FMS mode, final approach course information presentation and lateral steering is automatic upon station passage, and is predicated on preselected flight plan data entered into mission computer via the CDU.

c. At Initial Approach Fix (IAF):

(1) Steer helicopter with heading select knob until procedure turn inbound.

(2) APPR mode pushbutton - Depress; mode annunciator APPR, VERT, and T-HOV amber lights illuminate. APPR light changes to green upon course capture.

d. At Final Approach Fix (FAF):

(1) Start clock.

(2) Establish desired descent airspeed and vertical speed to minimum descent altitude.

(3) IAS-VS mode pushbutton - Depress; mode annunciator IAS-VS light on. Helicopter will maintain selected indicated airspeed and vertical speed.

(4) Radar altimeter - Set altitude bug at Height Above Touchdown (HAT).

e. ADI:

(1) Command bars and collective pointer provide steering guidance.

(2) DH light - Illuminates when minimum descent altitude (HAT set on pilot's radar altimeter) is reached; aural warning sounds in headset.

f. HSI:

(1) Course pointer and course deviation indicator - Indicates final approach course and course deviation.

(2) IAS annunciation switches to CMD to indicate commanded airspeed.

(3) Lateral mode annunciation appears as VOR, TCN, LOC, or FMS depending on navigation source selected.

g. At Minimum Descent Altitude (MDA):

(1) ALT mode pushbutton - Depress; mode annunciator ALT light illuminates, IAS-VS mode annunciator light goes out.

(2) Execute missed approach when timing expires if landing area is not visible.

h. At missed approach point, either:

(1) Select GA mode,

(2) Allow helicopter to continue and execute T-HOV maneuver, or:

(3) Take over manually and land.

To fly precision approach:

a. HDG SEL pushbutton - Depress; mode annunciator HDG SEL light illuminates. Steer helicopter with heading select knob until procedure turn inbound.

b. CDU - Select localizer frequency for VOR.

**NOTE**

Glide slope tuning is automatic with localizer selection.

c. Course select knob - Rotate to set localizer course on MFD. Crosscheck with course pointer.

d. Navigation source select knob - Select ILS as the navigation source.

e. APPR mode pushbutton - Depress prior to crossing localizer course; mode annunciator APPR, VERT, and T-HOV amber lights illuminate.

f. If localizer course not captured, turn toward course deviation indicator on HSI to establish intercept angle. Manually fly or use HDG SEL.

g. Radar altimeter - Set altitude bug at Height Above Touchdown (HAT).

h. Mode annunciator panel:

(1) APPR light switches to green upon localizer course capture; HDG SEL light goes out.

(2) VERT light switches to green upon glide slope capture.

**NOTE**

Glide slope capture is inhibited until localizer course capture occurs.

(3) T-HOV light switches to green upon T-HOV capture (100 feet radar altitude); VERT light goes out; APPR light will extinguish if pilot applies lateral FD slew switch input.

i. ADI:

(1) Command bars provide steering guidance and airspeed control information. Collective pointer appears upon glide slope capture.

(2) Glide slope deviation pointer - Indicates helicopter deviation from glide slope.

(3) Localizer pointer - Indicates helicopter deviation from localizer course.

(4) Radar Altitude Pointer (rising runway symbol) - Comes into view at 200 feet radar altitude.

(5) DH light - Illuminates when decision height (HAT on pilot's radar altimeter) is reached; aural warning sounds in headset.

j. HSI:

(1) Course pointer and course deviation indicator - Indicates localizer course and course deviation.

(2) Vertical deviation pointer - Indicates helicopter deviation from glide slope.

(3) IAS designation changes to CMD upon glide slope capture to indicate a commanded airspeed.

(4) Vertical mode annunciation appears as GS.

(5) HSI presentation switches to HOVER presentation upon T-HOV mode capture at 100 feet radar altitude.

k. At Decision Height, either:

(1) Uncouple flight director and take over manually or:

(2) Engage Go-Around mode, or:

(3) Allow flight director to complete T-HOV maneuver; using FD slew switch as desired.

6. APPR mode in conjunction with RNAV rescue mission set-up (HDG SEL or NAV modes selected):

a. FMS NAV source selected and APPR mode pushbutton depressed prior to reaching desired HOVER AT fix; mode annunciator APPR, VERT, and T-HOV amber lights illuminate.

**NOTE**

HOVER AT fix may be a VOR or TACAN radial/DME, flight plan waypoint, radar, or visual target.

b. CDU:

(1) Depress MARK key when helicopter passes over fix/target.

(2) Depress FPLN access key to call up flight plan page.

(3) Depress HOVER AT flight plan line select key to enter MARK position. TURN and HOVER points are entered automatically as waypoints in the flight plan.

(4) Depress DIR access key to call up DIRECT TO data line.

(5) Depress TURN waypoint line select key. Helicopter will maneuver to fly directly to the TURN waypoint and commence the approach procedure.

The lateral profile followed during the approach to a hover is illustrated in Figure 1-147. The procedure turn executed at the TURN point will normally be from region 1. However, the DIRECT TO TURN function can result in the turn defined from region 2 or region 3 (no procedure turn).

c. Mode annunciator panel:

(1) APPR light switches to green when mission computer generated course is captured; HDG SEL or NAV light goes out.

(2) VERT light switches to green upon capture of mission computer generated glide slope.

(3) T-HOV light switches to green upon altitude capture (100 feet radar altitude); VERT light goes out; APPR light extinguishes if pilot applies lateral FD slew switch input.

d. ADI:

(1) Command bars provide course guidance and airspeed control information.

(2) Collective pointer appears upon glide slope capture.

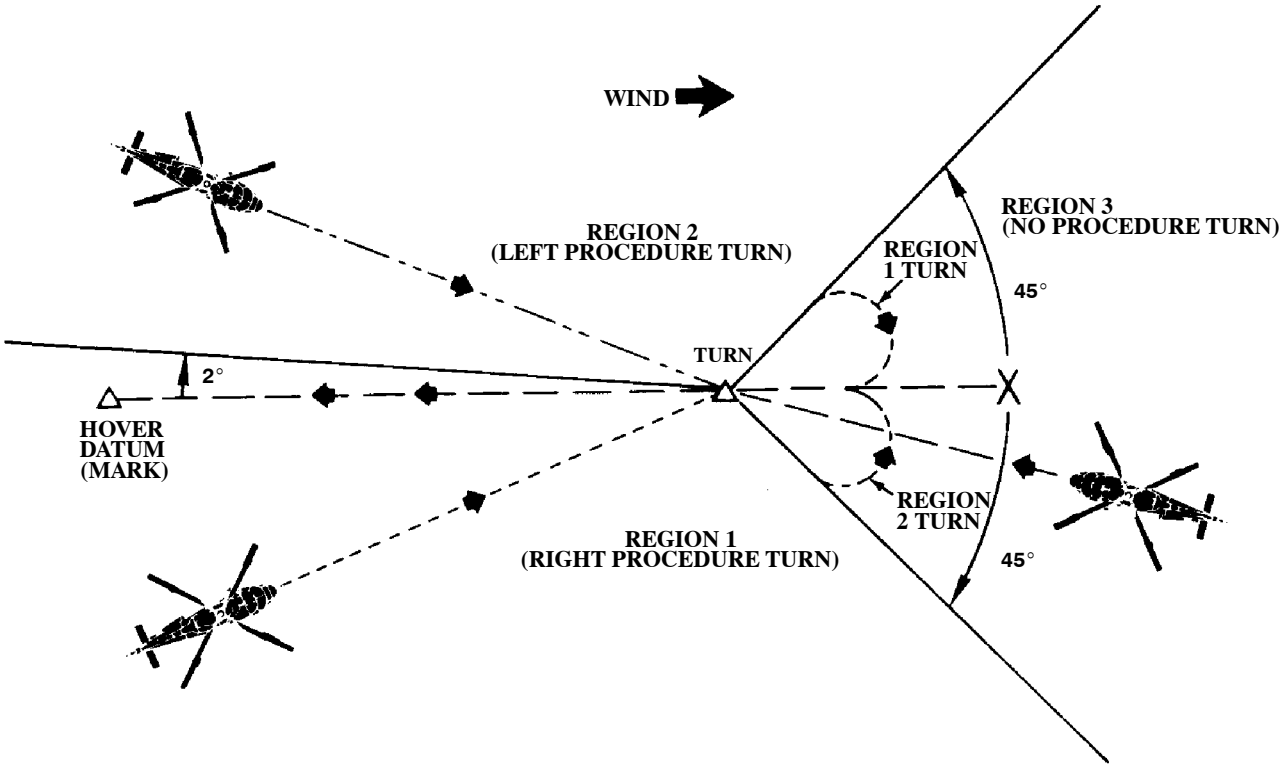



*Figure 1-147. Automatic Approach Lateral Profile*

(3) Radar Altitude Pointer (rising runway symbol) - Comes into view at 200 feet radar altitude.

e. HSI:

(1) Course pointer and course deviation indicator - Indicates localizer course and course deviation.

(2) Vertical deviation pointer - Indicates helicopter deviation from computer generated glide slope.

(3) IAS designation changes to CMD upon glide slope capture to indicate a commanded forward airspeed.

(4) Vertical mode annunciation appears as VNAV.

(5) Lateral mode annunciation appears as LNAV.

(6) HSI presentation switches to HOVER presentation upon T-HOV mode capture at 100 feet radar altitude.

f. T-HOV capture:

(1) Helicopter will transition to a 50 foot hover short of the target.

(2) Maneuver helicopter to target with FD slew switch.

(3) HOV AUG pushbutton (AFCS engaged and FD coupled only) - Depress (if desired); mode annunciator HOV AUG light illuminates, T-HOV and VERT lights go out.

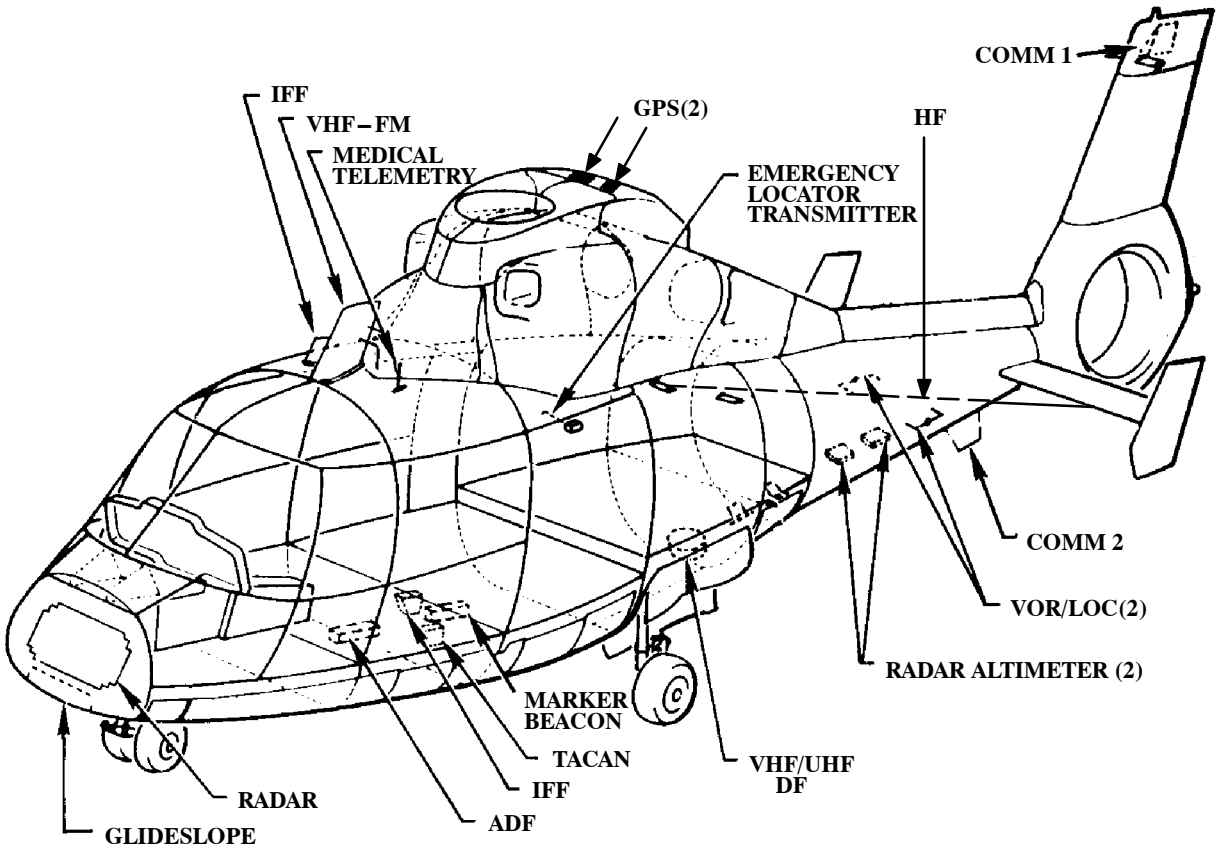



*Figure 1-148. Antenna Locations*

## COMMUNICATION SYSTEM

The communications system includes the following:

- An audio subsystem which provides intercommunications (ICS) between crew members, communications and navigation radio receiver monitoring, radio transmitter selection, and aural navigation and warning signal reception.
- Voice communications radios include COMM 1 and COMM 2 dual multiband VHF/UHF radios, a VHF FM radio, and a HF radio.
- Direction finding capability on the COMM 1, COMM 2, and VHF-FM radios when used with the DF-301E subsystem.
- Secure communications on COMM 2 radio when used with the KY-58.
- Digital Encryption Standard (DES) protected communications on VHF-FM radio.

Figure 1-149 provides a listing of communications and avionics equipment. Refer to Figure 1-148 for antenna locations. The communications system interfaces with the Flight Management System (FMS) to provide control of the communications radios via the COMM access pages on the CDUs. The FMS also provides Built-In-Test (BIT) circuitry for the COMM 1 and COMM 2 and HF radios via a COMM test page. Refer to CDU displays in this Section. The pilot's, copilot's, and hoist operator's audio control panels provide intercom or radio selection and volume control.

| TYPE | DESIGNATION | FUNCTION | OPERATOR | RANGE |
|---|---|---|---|---|
| HF | 718U-5 | Air-to-air, air-to-surface, D/F, data, and scrambled voice. | P, CP, HO* | Long Range |
| VHF/UHF COMM-1 | AN/ARC-182 | Air-to-air, air-to-surface, D/F, and data. | P, CP, HO* | Line of Sight |
| VHF/UHF COMM-2 | AN/ARC-182 | Air-to-air, air-to-surface, D/F, data, and scrambled voice. | P, CP, HO* | Line of Sight |
| VHF-FM | RT-9600-17 | Air-to-air, air-to-surface, D/F, data, and scrambled voice. | P, CP, HO* | Line of Sight |
| Comm/Audio | N/A | Provides intercom. | P, CP, HO | N/A |
| ELT | | Transmits distress signal in case of emergency landing or crash. | P, CP, Automatic | Line of Sight |
| UAB | | Transmits an underwater distress signal to aid in locating submerged aircraft. | Automatic | 2,000 to 4,000 yards (underwater) |
| IFF Transponder | AN/APX-100 | Identification, azimuth, and range. | P, CP | Line of Sight |
| VOR/ILS | AN/ARN-123 | VOR or ILS navigation. | P, CP | Line of Sight |
| Glide Slope | AN/ARN-123 | Glide Slope receiver azimuth and elevation. | ILS Receiver | Line of Sight, Short Range |
| Marker Beacon | AN/ARN-123 | Marker beacon receiver. | Automatic | |
| TACAN | AN/ARN-118 | Navigation. | P, CP | Line of Sight |
| LF/ADF | ADF 60A | LF receiver or automatic direction finder. | P, CP | Long Range |
| Radar Altimeter | HG7502AJ | Measures absolute altitude. | P, CP | 2,500 feet |
| Direction Finder | DF-301E | Provides relative bearing to transmitting station for VHF, UHF, and VHF-FM. | P, CP | 2,500 feet |
| RADAR | RT 1301/C (R/T CN 1306 Control) | Weather, search and navigation. | P, CP | 160 miles |
| GPS 1 and 2 | AN/ARN-151 | Provides long range navigation. | P, CP | 1,000 + miles |

* Transmits and receives on frequency/mode selected by pilot or copilot.

*Figure 1-149. Communication and Avionics Equipment*

## AUDIO SYSTEM

The Audio System is a centralized switching system consisting of:

1. Three (3) Audio Control Units.
2. Two (2) Auxiliary Audio Controls.
3. One (1) Audio Mixer.

The Audio System provides complete two-way communications between all crew members, provides the audio interface between the external communication and navigation receivers, and the audio switching for the DF function. There are three full capability crew stations of pilot, copilot, and hoist operator and two auxiliary observer stations.

The Audio Control units provide for the monitoring of up to ten separate communication/navigation receive audio signals and provide for selection of any one of six transmit channels. Each unit provides for master volume control to the headset, individual volume control of each monitor channel, and ON/OFF control of nine of the ten monitor channels (ICS monitor is on all the time). Three special functions are selectable on each Audio Control unit: ALTERNATE, which connects the user to alternate audio circuits; ICS HOT MIC, which allows continuous intercom use without Push-To-Talk (PTT); and ALL CALL, which permits the initiating station to transmit to all other stations regardless of selection at the other stations.

A data bus between the audio control units and the audio mixer provides control of the individual monitor audio levels and mode selection from the transmit selector switch.

The Audio Mixer provides the necessary impedance matching, audio amplification and compressing, and audio switching to interface crew members and COMM/NAV equipment audio.

The Auxiliary Audio Control unit provides the observer positions with the ICS transmit/receive and is interfaced with the crew audio through the audio mixer unit. The auxiliary audio unit transmits on ICS, and receives ALL CALL audio transmitted from the crew positions and the monitor audios selected on the hoist operator audio control unit. A volume control adjusts the headphone audio level.

### Audio Control

Guarded ICS HOT MIC - When energized, ICS HOT MIC enables continuous ICS communication without selecting ICS on the Transmit Selector switch or using the ICS push-to-talk (PTT) switch. The HOT MIC function is temporarily disabled and the system operates in the transmit selector mode during any interval the PTT is activated.

Guarded ALL CALL - When energized, ALL CALL enables the user, without activating his PTT or selecting ICS on the Transmit Selector switch, to be heard by all audio stations. The audio is at a level 6 dB above the master volume level of the individual stations. Selection of ALL CALL does not disable PTT or audio to any transmit/receive function selected on the Transmit Selector switch.

Master Volume - The Master Volume control adjusts all audio to the user headset.

Monitor and ON/OFF Volume Control - The Monitor and ON/OFF Volume provides for individual monitor selection and volume adjustment. Each monitor control, except ICS, provides eight discrete volume settings in approximately 2.25 dB steps, and also provides audio ON/OFF control. The ICS is always ON, but the last discrete volume step is large, thereby, providing low but always detectable ICS audio. Maximum volume is full clockwise (CW), minimum volume is full counterclockwise (CCW), pull ON, push OFF. The ICS monitor does not have an OFF position. The selection of a transmit function on the Transmit Selector switch automatically selects the corresponding receiver function at a level adjustable by the Master Volume control and the corresponding monitor control. Receive monitors are ICS, COMM 1, COMM 2, FM, HF, VOR 1, VOR 2, TACAN, MARKER BEACON, and ADF.

Transmit Selector - The Transmit Selector switch allows the user to select ALTERNATE, ICS, COMM 1, COMM 2, FM, HF, or Loud hailer. This selector, except for ALTERNATE, automatically routes the MIC audio to the selected function and sidetone and receive audio to the headset independent of the monitor ON/OFF setting. Monitor volume setting is still active. When in PTT the user hears only sidetone, down 5 dB from receive, and ICS audio at the selected monitor level. In receive, the user hears the selected audio at a level adjustable by the Master Volume control and the corresponding monitor control.

When the Transmit Selector switch is in the ALTERNATE position, the user's MIC, headset, and key lines are routed to bypass the electronics in the user's audio panel for connection to an alternate audio circuit. The pilot, when selecting ALTERNATE, is switched in parallel with the copilot's audio control panel and both the pilot and copilot have capability sharing the same audio control. Similarly, the copilot shares use of the pilot's audio control when ALTERNATE is selected on the copilot control. The hoist operator, when selecting ALTERNATE, is switched in parallel with the nearest auxiliary audio control and has intercom capability only.

External PTT input control functions - The external PTT inputs are ICS PTT and Transmit PTT.

When grounded, the ICS PTT input routes the MIC audio to ICS communications. The user hears sidetone, 6 dB below the fixed ICS audio level, the intercom and four comm receivers at the monitor settings. When the ICS PTT input is open, the user hears the audio as selected by the Transmit Selector switch and the monitor settings.

When grounded, the Transmit PTT input routes the MIC audio and key line to the unit selected by the Transmit Selector switch. The user hears sidetone, 6 dB below the receiver audio level, and the intercom at the monitor setting. When the Transmit PTT input is open, the user hears the audio selected by the Transmit Selector switch and the monitor settings.

### Auxiliary Audio Control

The Auxiliary Audio Control is limited to communication on the ICS only, monitoring ALL CALL ICS, and receiving any monitor audio as selected on the hoist operator's audio control unit.

1. Volume Control - The volume control adjusts the received audio to the user headset. ALL CALL audio is 6 dB above the volume control setting.

2. PTT Input - When grounded, the PTT input routes the MIC audio into ICS communication. The user hears sidetone and ICS communications. When the PTT input is open, the user hears ICS and monitor audios selected on the hoist operator's audio panel.

### Aural Warning

The system provides audio interface between the SIU (Signal Interface Unit) and the pilot and copilot stations for the aural warning tones generated in or processed by the SIU.

## AUDIO BYPASS

In the event of malfunction or failure of the audio mixer circuitry that provides normal audio system operation, a bypass capability permits continued, but limited, radio communication and intercom operation. Cockpit mounted switches permit the crew to select an audio bypass position for the pilot's and copilot's audio control panels. Positioning the pilot's audio bypass select switch in the BYPASS position provides continued radio communication on COMM 1 only. Positioning the copilot's audio bypass select switch in the BYPASS position also places the hoist operator in bypass ICS and provides continued radio communication on COMM 2 only. For the pilot and copilot to communicate, both switches must be in the BYPASS position. With both pilot and copilot in BYPASS, the hoist operator will hear all ICS traffic, but must go to ICS HOT MIC in order to communicate with either the pilot or copilot. The push-to-talk microphone switch will be inoperative; therefore, the hoist operator will not have radio transmit capability. The ICS volume control and all of the monitor and volume controls for the radios and navaids are inactive. Only the master volume control on each audio control panel remains active to adjust the volume level to the respective headset.

## COMMUNICATION SYSTEM CONTROLS

### Intercom System Volume Control Knob

The intercom system volume control knob, located on the audio control panel (1, Figure 1-150) is labeled ICS. The knob adjusts the volume of intercom audio to the headset.

### Monitor/Volume Control Knobs

Nine monitor/volume control knobs, located on the audio control panel (2, Figure 1-150) are provided to select and control the volume to the headset of audio received from the various radios. Each knob is a pull-on/push-off switch. Once a radio is selected by pulling the knob up, turning the knob will adjust the audio to the headset. The knobs are labeled as follows:

1-COMM-2 (COMM 1 and COMM 2 radios)

FM (VHF-FM radio)

HF (HF radio)

1-VOR

TCAS

TACAN

MKR (Marker Beacon Receiver)

ADF (Automatic Direction Finding)

**NOTE**

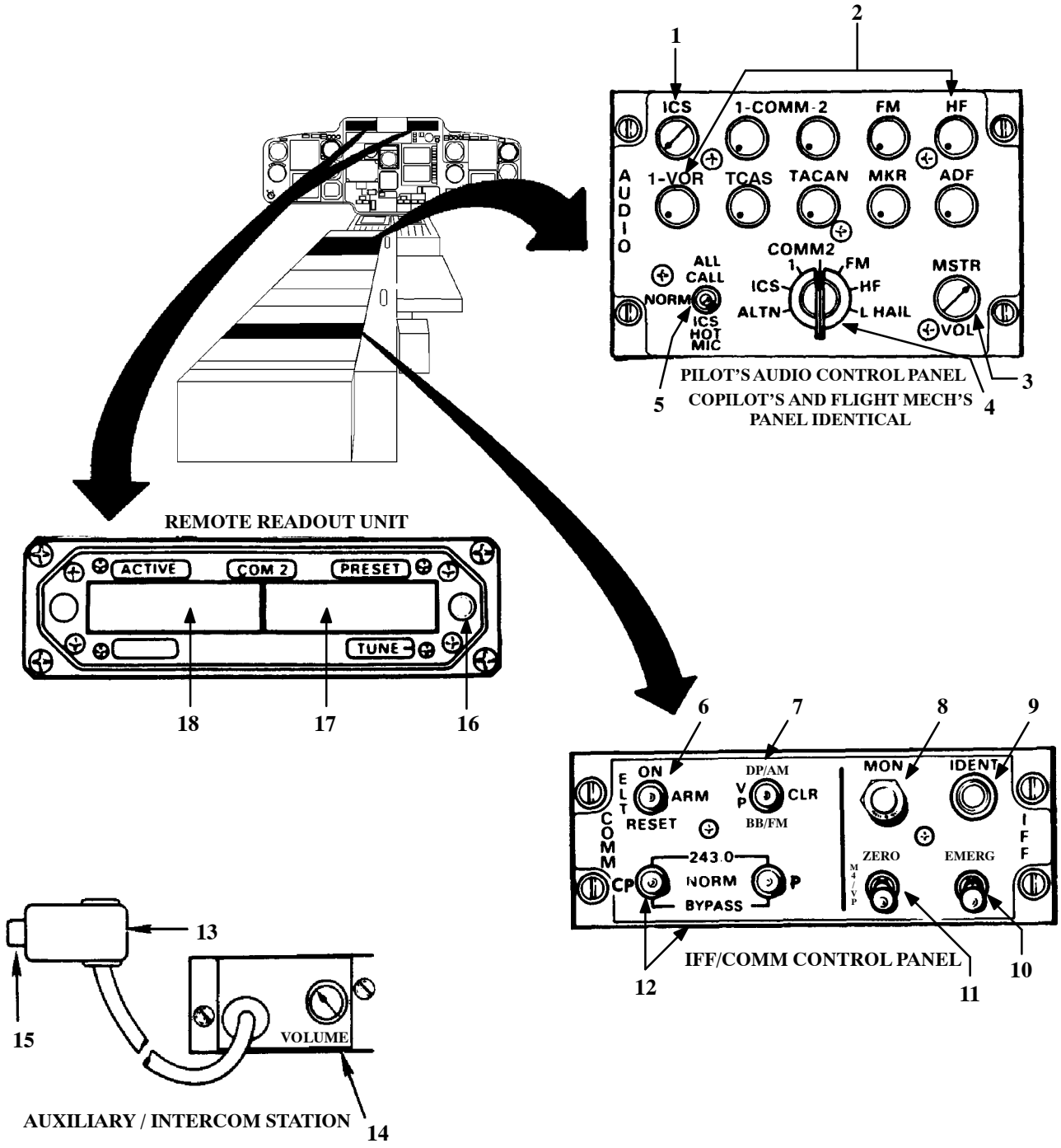
The TCAS Monitor/Volume control knob is disabled at the Pilot/Copilot station.

### Master Volume Control Knob

The master volume control knob, located on the audio control panel (3, Figure 1-150) is labeled MSTR VOL. The knob adjusts the volume level of audio to the headset from all sources.

### Transmit Selector Knob

The transmit selector knob, located on the audio control panel (4, Figure 1-150), has seven positions marked as follows:




1. Intercom System Volume Control Knob
2. Monitor / Volume Control Knobs (9)
3. Master Control Knob
4. Transmit Select Knob
5. Call / Hot MIC Select Switch
6. Emergency Locator Transmitter Switch
7. Voice Privacy Select Switch
8. IFF Monitor Lamp
9. IFF Ident Pushbutton
10. IFF Emergency Mode Switch
11. IFF Mode IV Zeroize Switch
12. Emergency Frequency and Audio Bypass Select Switches
13. Headset Receptacle
14. Intercom Station Volume Control Knob
15. Push-To-Talk Microphone Button
16. Tune Pushbutton
17. Present Frequency Readout
18. Active Frequency Readout

*Figure 1-150. Communications System Controls*

ALTN (alternate)

ICS (intercom system)

1 COMM 2 (COMM 1 and COMM 2 radios)

FM (VHF-FM radio)

HF (HF radio)

L HAIL (load hailer)

Selecting the ALTN position at either the pilot's or copilot's station switches all audio functions from one panel to the other to allow both pilots the use of a single panel in the event of a panel failure. Selecting ALTN at the hoist operator's station switches the hoist operator station to the No. 2 passenger station for ICS backup only. Selecting the ICS position at the hoist operator station allows the hoist operator to transmit on intercom using his push-to-talk switch. Selecting ICS at either pilot station provides intercom transmission on both positions (first and second detent) of the pilots transmit switch. Selecting COMM 1, COMM 2, FM, or HF positions enables transmission on the particular radio selected.

## ALL CALL/HOT MIC Select Switch

The ALL CALL/HOT MIC select switch, located on the audio control panel (5, Figure 1-150), is a three position lock/lever switch which locks in each position. The switch lever must be raised to move it from one position to another. The switch positions are marked ALL CALL in the forward position, NORM in the center position, and ICS HOT MIC in the aft position. When the ALL CALL position is selected, the microphone audio signal from that station is amplified to 6 decibels above the master volume control and allows the user to be heard at all other stations regardless of the position of their transmit selector switches. The NORM position of the switch provides normal intercom operation. Selecting ICS HOT MIC position bypasses the hand operated microphone switches and transmit selector switch (pilot and copilot only) and provides a keyed microphone for intercom transmissions from all stations as long as the switch is in that position. The ICS HOT MIC is disabled during a radio transmission.

## Cyclic Microphone Switches

Each pilot's cyclic is equipped with a trigger type microphone switch (Figure 1-46). The trigger switch has two detent positions. The first detent transmits on intercom regardless of other switch settings on the audio control panel. The second detent position of the switch transmits on the communications equipment selected with the transmit selector knob.

## Remote Microphone Switches

Each pilot's position is equipped with a remote microphone switch located outboard on each side of the main instrument panel glareshield (1, Figure FO-2). Each switch is marked ICS and XMIT and is spring loaded to an unmarked center off position. Holding the switch to ICS provides transmission on intercom. Holding the switch to XMIT transmits on the communication equipment selected with the transmit selector knob.

## Push-To-Talk Microphone Switches

The hoist operator and each passenger's intercom station is equipped with a push-to-talk microphone switch (15, Figure 1-150). The switch is molded into the headset cord receptacle. At the passenger intercom stations, the switch allows communications on intercom only. The hoist operator's switch allows communications on the communication equipment selected on the hoist operator's audio control panel.

## Passengers Intercom Volume Control Knobs

A volume control knob is provided at each passenger's auxiliary intercom station (14, Figure 1-150). Each knob controls the audio volume level received in the headset at that station.

## Pilot and Copilot Emergency Frequency and Audio Bypass Select Switches

The emergency frequency and audio bypass select switches, located on the IFF/COMM panel (12, Figure 1-150) are provided to select the UHF emergency frequency of 243.0 MHz on either pilot or copilot radio. Each switch is a three position lock/lever switch which locks in each position. The switch lever must be raised each time it is moved from one position to the other. The switch positions are marked 243.0 in the forward position, NORMAL in the center position, and BYPASS in the aft position.

## REMOTE READOUT UNIT

Two Remote Readout Units (RRUs), shown in Figure 1-153, are dedicated to the display of COMM 1 and COMM 2 active (ACTIVE) and alternate (PRESET) frequency display/selection. COMM 1 or COMM 2 frequency may be changed by actuation of the TUNE pushbutton on the respective RRU. COMM 1 or COMM 2 retunes to the alternate frequency selected on the RRU and the active frequency becomes the alternate frequency. The alternate frequency may be entered into the COMM 1 or COMM 2 RRU by entering a frequency or preset number into the CDU scratchpad and selecting the corresponding RRU TUNE pushbutton (pilot CDU for the COMM 1 RRU and copilot CDU for the COMM

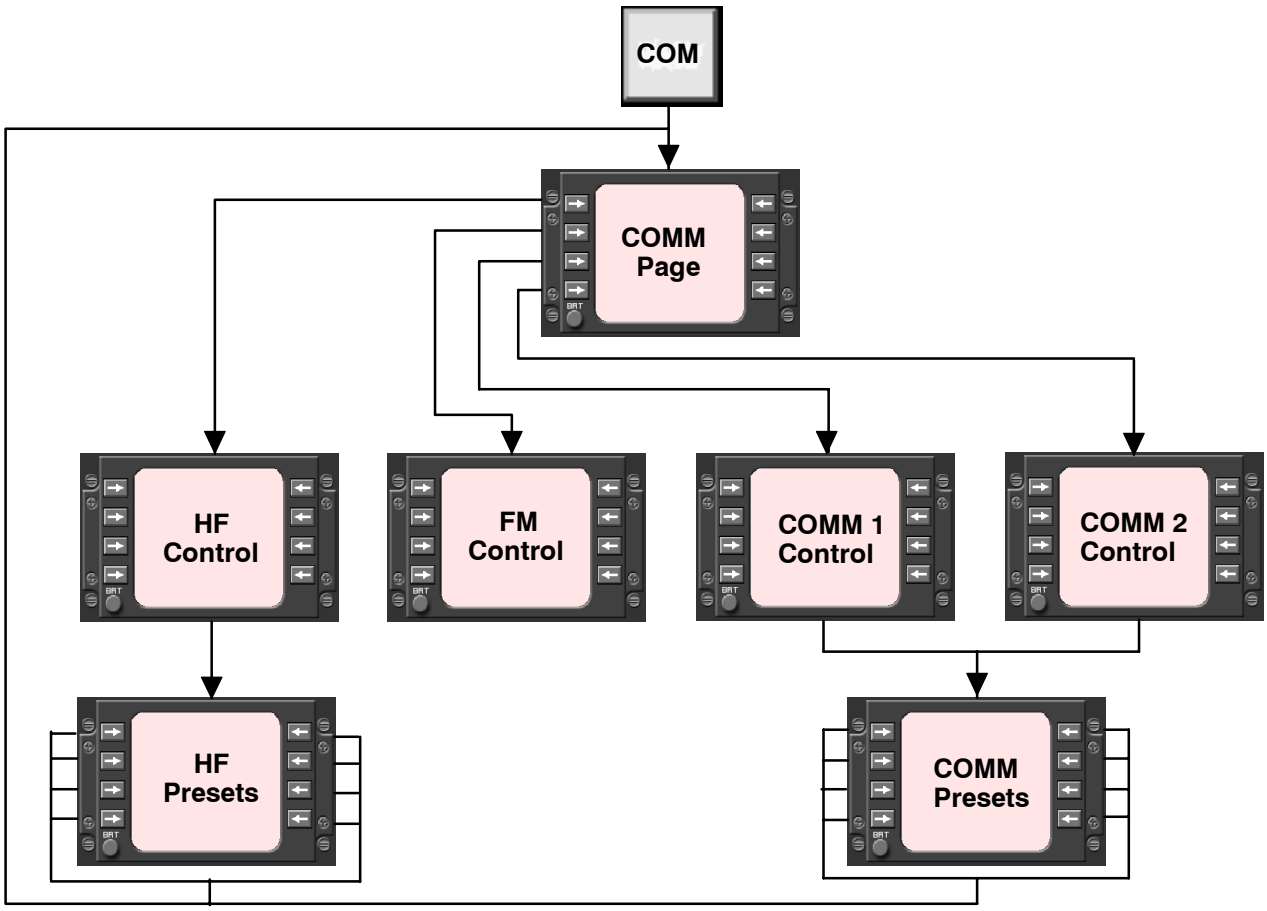



*Figure 1-151. COMM Page Access*

2 RRU). Entry of an alternate frequency is CDU Page independent.

## COMMUNICATION MANAGEMENT

Communication frequency and mode control is provided by the FCMS through two CDUs, two Remote Readout Units (RRUs) dedicated to the display of COMM 1 and COMM 2 active and alternate frequency display/selection and the quicktune toggle switch located on the Emergency IFF/ COMM panel.

### COMM PAGE

The Communication (COMM) Page is accessed by pressing the COM function key on the CDU (Figure 1-151) or by selection of a preset key on either the COMM or HF Presets Pages. The COMM Page allows access to additional pages permitting the crew to control all communications radios (Figure 1-152).

a. Selection accesses the HF Control Page. No changes occur if the HF is in IBIT. If the HF radio is in IBIT, ←HF TEST is displayed, and the frequency display field is dashed out. If the HF radio is failed, the frequency and preset displays are dashed out.

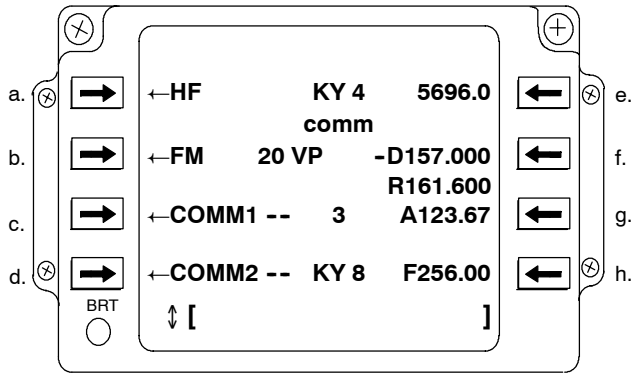



*Figure 1-152. COMM Page*

b. Selection with an empty scratchpad accesses the FM Control Page. Selection with a valid maritime channel in the scratchpad tunes the FM radio to the desired maritime channel. The channel frequency is displayed adjacent to LS6, the scratchpad tunes the FM radio to

the desired maritime channel and the preset number displays dashes. An ERROR message alternates with the data in the scratchpad if an invalid frequency is entered in the scratchpad and LS2 is pressed. "√STATUS" message flashes in the scratchpad if the FM radio is failed and the operator attempts to enter a frequency. "GRD ACTIVE" message alternates with the frequency entered in the scratchpad if the operator attempts to enter a frequency when the FM radio is set to XMIT GRD. If duplex mode is selected on the FM Control Page or if the FM radio is tuned to duplexed maritime frequency, "D" is displayed to the left of the FM frequency. If the FM radio is selected for the DF MODE on the DF Mode/TCAS Control panel, "DF" is displayed to the right of the maritime channel display. If the Digital Encryption Standard (DES) function is toggled to ON via the FM Control Page, "VP" is displayed to the right of the maritime channel display. The VP indication in the display field has priority over the DF mode indication. If the FM radio is failed, the frequency, preset, and maritime displays are dashed out. If duplex mode has been selected on the FM control page or if the FM radio is tuned to a duplexed maritime frequency, the receive frequency is displayed as "RXXX.XXX."

**NOTE**

If the FM radio mode is set to XMT GRD via the FM Control Page, the maritime channel display is dashed out, the preset number displays "G," the CDU displays 156.800 in the frequency field and the FM radio is forced into simplex mode. When a mode other than XMT GRD is selected, the previous maritime channel, preset number, frequency and simplex/duplex mode settings are restored.

c. Selection with an empty scratchpad accesses the COMM 1 Control Page. No changes occur if COMM 1 is in IBIT. Selection with a valid maritime channel in the scratchpad tunes the COMM 1 radio to the desired maritime channel, the channel frequency is displayed adjacent to LS7, and the preset number display is dashed out. An ERROR message alternates with the data in the scratchpad if an invalid frequency is entered in the scratchpad and LS3 is pressed. √STATUS message flashes in the scratchpad if the COMM1 radio is failed and the operator attempts to enter a frequency. "GRD ACTIVE" message alternates with the frequency entered in the scratchpad if the operator attempts to enter a frequency when the COMM1 radio is set to XMT GRD. If the COMM1 radio is tuned to a guard frequency either by setting the emergency switch on the IFF/COMM control panel or by selecting XMT GRD on the COMM 1 Control Page, the maritime channel display is dashed out, the preset number displays "G," and the maritime channel frequency is displayed in the frequency field. If the COMM 1 radio is selected for the DF MODE on the DF Mode/TCAS Control panel, "DF" is displayed to the right of the maritime channel display. If the COMM 1 radio is in IBIT, TEST is displayed to the right of the maritime channel display and all display fields are dashed out. If the COMM 1 radio is failed, the frequency, preset, and maritime displays are dashed out.

d. Operation is functionally identical to COMM1 operation described in "c." above.

e. Selection with an empty scratchpad tunes the HF to the last tuned frequency, including the preset number. Selection with a 0 in the scratchpad tunes the HF radio to the last manually tuned frequency. Selection with a valid frequency or preset number in the scratchpad tunes the HF radio to the desired manual frequency or preset frequency, respectively. If the HF is tuned to a manual frequency, the preset number displays 0. An "ERROR" message alternates with the data in the scratchpad if an invalid frequency is entered in the scratchpad and LS4 is pressed. "√STATUS" message flashes in the scratchpad if the HF radio is failed and the operator attempts to enter a frequency.

f. Selection with an empty scratchpad tunes the FM radio to the last tuned frequency (including the maritime channel or the preset number, and simplex/duplex mode). Selection with a 0 in the scratchpad tunes the FM radio to the last manually entered frequency and mode (i.e., simplex/duplex selection). Selection with a valid frequency in the scratchpad tunes the FM radio to the entered frequency, 0 is displayed adjacent to the frequency, the maritime channel displays dashes, and the FM radio is set to simplex mode. An "ERROR" message alternates with the data in the scratchpad if an invalid frequency is entered in the scratchpad and LS6 is pressed. "√STATUS" message flashes in the scratchpad if the FM radio is failed and the operator attempts to enter a frequency. "GRD ACTIVE" message alternates with the frequency entered in the scratchpad if the operator attempts to enter a frequency when the FM is set to XMT GRD.

g. Selection with an empty scratchpad tunes the COMM 1 radio to the last tuned frequency, including the maritime

channel of the preset number. Selection with a valid preset number in the scratchpad tunes the COMM 1 radio to the desired preset frequency. The preset number, type of modulation, and frequency are displayed adjacent to LS7. The maritime channel displays dashes. Selection with a 0 in the scratchpad tunes the COMM 1 radio to the last manually tuned frequency. Selection with a valid frequency in the scratchpad tunes the COMM 1 radio to the entered frequency. The frequency is displayed adjacent to LS7, the preset number displays 0, and the maritime channel displays dashes. If the entered frequency is in the range of 30.000-89.975 or 156.000-173.975, the modulation is FM. If the entered frequency is in the range of 118.000-155.975, the modulation is AM. If the entered frequency is in the range of 225.000-399.975 and the entry is preceded with A or F, the modulation is set to AM or FM, respectively, if no modulation is specified, the modulation is set to AM. The modulation type (A or F) precedes the frequency displayed adjacent to LS7.

h. Operation is functionally identical to COMM1 operation described in "g" above.

## GUARD TUNING

When COMM 1 or COMM 2 is tuned to a guard frequency, "G" is displayed as the preset number on the COMM Page. Tuning guard frequencies for COMM 1 or COMM 2 may be accomplished in the following ways:

1. Selection of XMT GRD on the COMM 1 or COMM 2 Control Pages disables the guard receiver and tunes the main receiver and transmitter to the appropriate guard frequency and modulation mode. The appropriate guard frequency is determined as a function of the current active frequency band as shown in Table 1-9. Selection of active frequencies via presets, maritime channels, or manual frequency entry is inhibited while in XMT GRD mode.

| Band | Guard Frequency |
|---|---|
| 30.0 to 87.975 MHz | 40.5 FM |
| 118.0 to 155.975 MHz | 121.5 AM |
| 156.0 to 173.975 MHz | 156.80 FM |
| 225.0 to 399.975 MHz | 243.0 AM |

*Table 1-9. COMM Radio Guard Frequencies*

2. Setting the emergency frequency select switch on the Emergency IFF/COMM Panel (Figure 1-154) to 243.0 for COMM 1 or COMM 2 performs the following for the respective COMM radio:

   a. Disables the guard receiver,

   b. Tunes the main receiver and transmitter to 243.0 MHz AM,

   c. Disables squelch, and

   d. Displays the tuned frequency on the COMM Page and the RRU as the active frequency.

Each emergency frequency select switch on the Emergency IFF/COMM Panel has a direct control line to the respective COMM radio, and control is independent of FCMS operation. Operation of the switches on the Emergency IFF/COMM Panel has priority over any other frequency selection method. Switching the emergency switches to OFF returns the COMM radios to the frequencies/mode that were selected prior to selection of emergency tuning. The UHF-AM guard frequency (243.00) is capable of being tuned even with an FCMS failure (Figure 1-154).

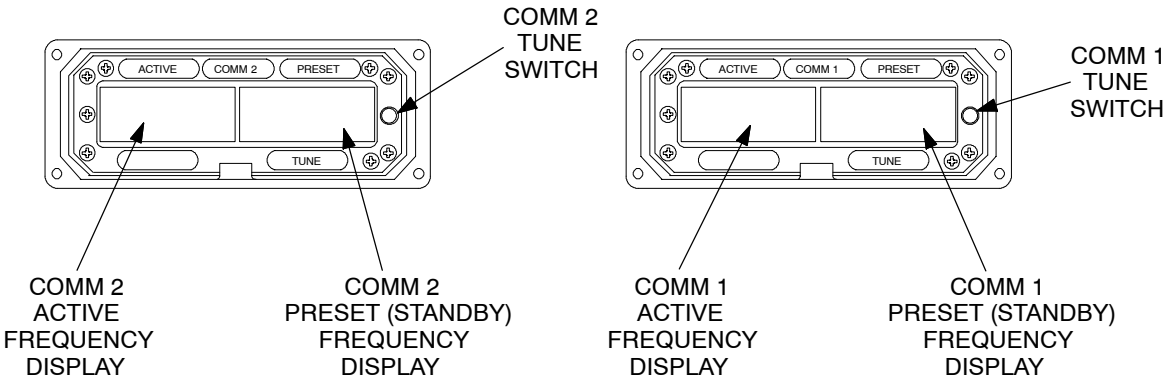



*Figure 1-153. Remote Readout Units*

h65a2380001a

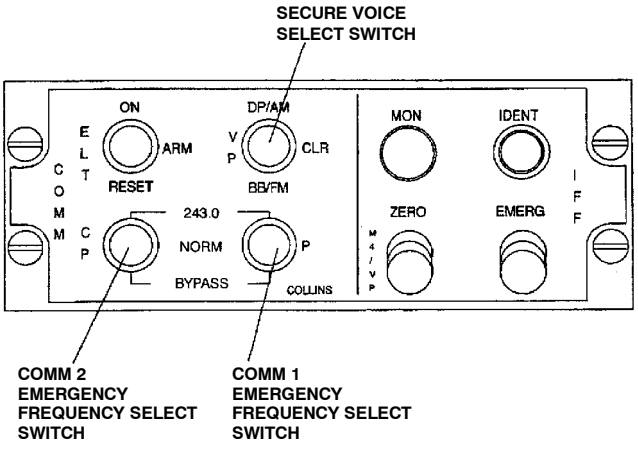



*Figure 1-154. Emergency IFF/COMM Panel*

## HF CONTROL

The pilot and copilot control HF mode and frequency through the FCMS. The pilot, copilot, and hoist operator can select HF via the audio control unit for transmitting, receiving or monitoring. The HF covers the frequency range from 2000.0 to 29999.9 kHz in 100 Hz tuning increments, with a power output of 100 watts PEP on average. Operating modes are USB (Upper Sideband), LSB (Lower Sideband), and AM (Amplitude Modulation).

### HF Control Page

Selecting LS1 key on the COMM Page accesses the HF Control Page (Figure 1-155).

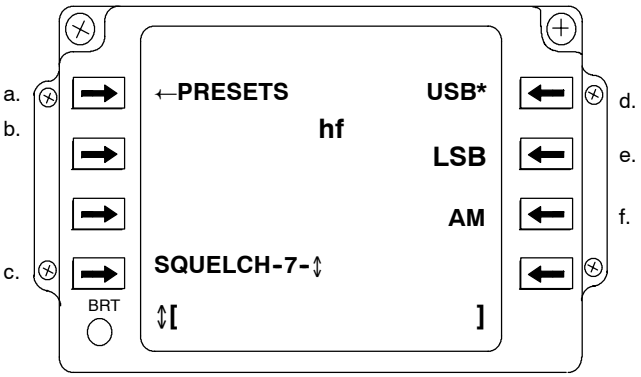



*Figure 1-155. HF Control Page*

a. Selection accesses the HF Presets Page.

b. Displays "TEST" to the right of "hf" if the HF radio is in IBIT.

c. Selecting the UP or DOWN arrow on the CDU adjusts the squelch. Holding an arrow key adjusts the squelch level once per 0.6 second. Squelch level ranges from 0 to 7 and does not wrap around (0=on, 7=off). The default squelch level is 0.

d. Selection activates Upper Side Band (USB) mode, deactivates a previously activated mode, and places an * adjacent to LS5.

**NOTE**

The default mode is USB. If the HF is tuned to a preset and the mode is changed on this page, the preset number on the COMM Page changes to 0.

e. Selection activates Lower Side Band (LSB) mode, deactivates a previously activated mode, and places an * adjacent to LS6.

f. Selection activates AM mode, deactivates a previously activated mode, places an * adjacent to LS7.

**NOTE**

When an arrow key is pressed, the "√STATUS" scratchpad message flashes when the HF radio is failed or the HF radio is in IBIT.

### HF Presets Page

Selecting PRESETS on the HF Control Page accesses the HF Presets Page. The HF Presets Page allows selection and entry of eight user defined frequency presets (Figure 1-156).

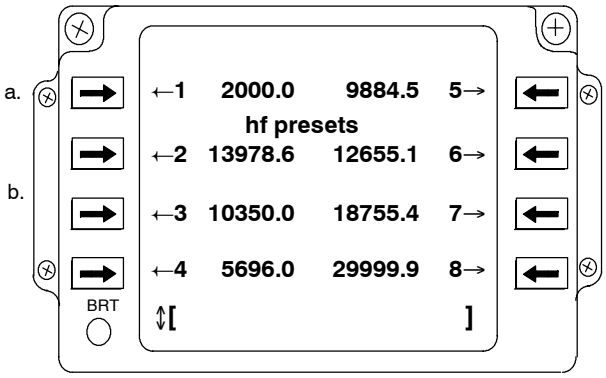



*Figure 1-156. HF Presets Page*

a. Selection of LS1-LS8 with a valid entry in the scratchpad enters the frequency into the preset list, and the frequency is displayed adjacent to the line select. If a preset is changed while it is currently tuned via the COMM Page, the HF radio remains tuned to the same frequency, and the frequency becomes a manually entered frequency. If invalid data is in the scratchpad, the "ERROR" message alternates with the data in the scratchpad when the line select is pressed. Selection

with an empty scratchpad tunes the HF radio to the corresponding preset frequency and accesses the COMM page. If the HF radio is already tuned to the selected preset, the frequency recall buffer is maintained (i.e., the last tuned frequency stays the same). If the HF radio is failed, the "√STATUS" message flashes in the scratchpad when the line select is pressed.

b. Display TEST center justified if the HF radio is in IBIT.

## FM CONTROL

The FM radio is the RT-9600 (ARC-513) system. This system consists of the RT-9600 transceiver, the IN-97 mount and the AT-960 antenna. The pilot and copilot control FM mode and frequency through the FCMS. The pilot, copilot and hoist operator can select FM audio via the audio control unit for transmitting, receiving or monitoring. The FM radio covers the frequency range from 150.0000 to 173.9975 MHz in 2.5 kHz tuning increments, with a high power output of 10 watts or a low power output of 1 watt. The FM radio is interfaced with the DF-301E for DF operation. Selection of DF mode for the FM radio is via a rotary switch selection on the DF MODE/TCAS Control panel (Figure 1-228). A Digital Encryption Standard (DES) is interfaced with the FM radio to provide privacy capability.

### FM Control Page

Selecting LS2 on the COMM Page accesses the FM Control Page (Figure 1-157).

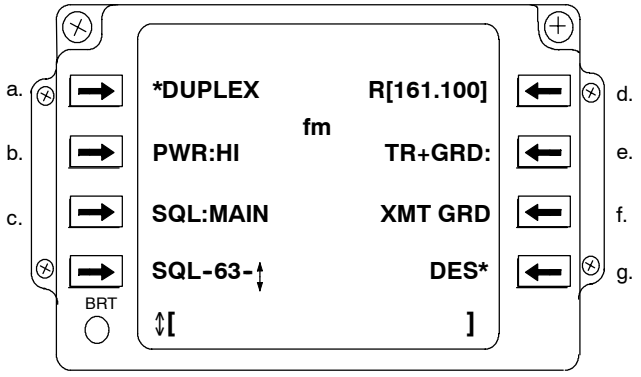



*Figure 1-157. FM Control Page*

a. Selection toggles the DUPLEX mode on and off (off is SIMPLEX mode). If DUPLEX mode is on, an "*" is displayed adjacent to LS1, and the receive frequency is set to a default of 4.6 MHz higher than the transmit frequency. Subsequent selections of Duplex from off to on sets the receive frequency to 4.6 MHz higher than the transmit frequency. DUPLEX mode is set to on if the FM radio is tuned to a duplexed maritime channel. The correct receive frequency for the duplexed maritime channel is tuned and attempted modifications to the receiver are not permitted. The default DUPLEX mode is off. DUPLEX mode is automatically forced to off if the currently tuned frequency of the FM radio is higher than 169.3975, or XMT GRD mode is active.

b. Selection toggles the transmitter power level between HI and LOW. The default transmitter power level is LOW.

c. Selection toggles the squelch control between MAIN and GRD (guard) receivers. The current squelch setting of the receiver selected is shown adjacent to LS4. The default squelch control toggle selection is MAIN.

d. When the Duplex is set to on, then "R[XXX.XXX]" is displayed. The XXX.XXX is the current receive frequency. As described in a. above, the default receive frequency is 4.6 MHz above the current transmit frequency from the COMM Page. Selection with a valid frequency in the scratchpad enters the frequency as the receive frequency in place of the default. When the Duplex is set to off, then "R[---.---]" is displayed. If the FM radio is tuned by a duplexed maritime channel selection using LS5, ERROR is displayed in the scratchpad.

e. Toggles between TR and TR+GRD. The mode is defaulted to TR at system power-up. When toggled to TR, the system activates the main transmitter/receiver and disables the guard receiver. When toggled to TR+GRD, the system activates the main transmitter/receiver and the guard receiver. When XMT GRD is selected, the ":" is removed and an "*" is displayed adjacent to LS7. To enable the toggle between TR or TR+GRD, LS6 must be pressed again.

f. Selecting XMT GRD activates the main transmitter/receiver and tunes the FM radio to 156.800 MHz (Channel 16) and disables the guard receiver. When XMT GRD is active, DUPLEX and DES are set to off, and attempts to change the FM tuning results in a GRD ACTIVE annunciation. Also, the Comm Page displays a G, to denote guard, and the frequency.

g. Selection toggles the Digital Encryption Standard (DES) function between on and off. An "*" is displayed when the DES function is on and "VP" is displayed on the Comm Page. The VP annunciation only indicates the DES is selected on the FM Control Page. The DES must be loaded with a code and the DES box (behind the copilot's seat) must also be set to PVT for secure communications to function. The default DES function

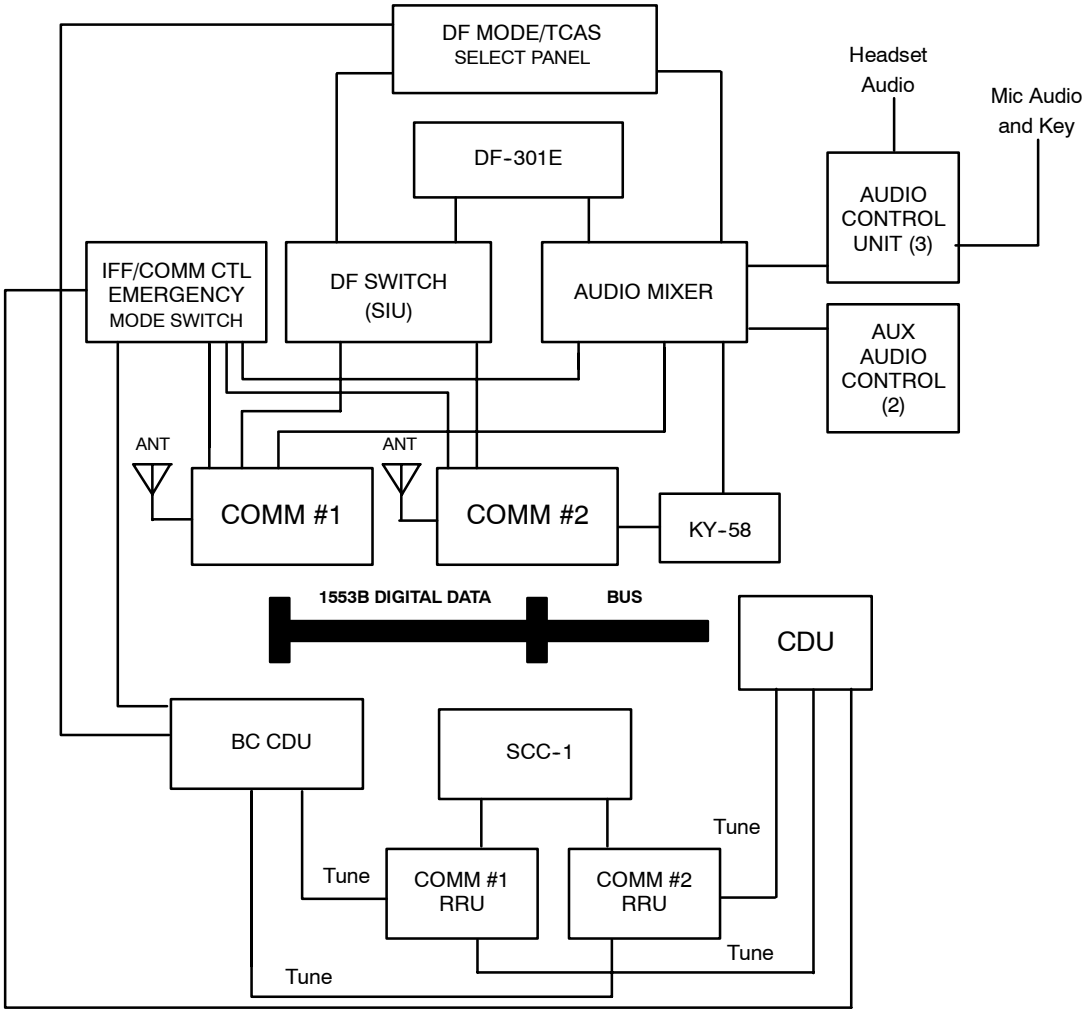



*Figure 1-158. COMM 1 and COMM 2 System Block Diagram*

setting is off. If XMT GRD mode is active, the DES function is forced off.

**NOTE**

Selecting the UP or DOWN arrow on the CDU adjusts the squelch. Holding an arrow key adjusts the squelch level once per 0.6 second. Squelch level ranges from 00 to 70 and does not wrap around (00=on, 70=off). The default squelch level (both receivers) is 00.

**NOTE**

The "√STATUS" message flashes in the scratchpad when any line select key or scroll arrow is pressed and the FM radio is failed.

## COMM 1 AND COMM 2 CONTROL

The COMM1 and COMM2 are AN/ARC-182 transceivers. Each COMM system consists of an RT-1250/A (V) transceiver, MT-4934 mount, and antenna. Control and tuning of the radios is through the FCMS via the MIL-STD-1553B Digital Data Bus. The active and preset frequencies are displayed on two dedicated RRUs. Comm 1 and Comm 2 systems are diagramed in Figure 1-158.

The pilot and the copilot control the mode and frequency through the FCMS. The pilot, copilot, and hoist operator can select COMM 1 or COMM 2 via the audio control unit for transmitting, receiving or monitoring. The COMM radios cover the following frequency bands in 25 KHz tuning increments, with a power output of 10 watts AM or 15 watts FM:

1. 30.000 to 87.975 MHz FM
2. 108.000 to 117.975 MHz AM ( Receive Only)
3. 118.000 to 155.975 MHz AM
4. 156.000 to 173.975 MHz FM
5. 225.000 to 399.975 MHz AM or FM

The COMM radios are also interfaced with the DF-301E for DF operation and described later in this Section. COMM 1

operates from the top blade antenna and COMM 2 operates from the bottom blade antenna. Selection of DF mode for the COMM radios is via a rotary switch selection on the DF Mode/TCAS Control panel. If the transmitter is keyed when DF mode is selected for COMM 1, the transmitter output is automatically switched to the top blade antenna. If the transmitter is keyed when DF mode is selected for COMM 2, the transmitter output is automatically switched to the bottom blade antenna. Emergency tune frequency of COMM 1 and COMM 2 is 243.0 MHz AM, and is provided by lever locked switches on the Emergency IFF/COMM panel. The KY-58 interfaces to the COMM 2 radio.

## COMM 1 And COMM 2 Control Page

Selecting LS3 on the Communication Page accesses the COMM 1 Control Page. Selecting LS4 on the Communication Page accesses the COMM 2 Control Page. The COMM 1 and COMM 2 Control Pages are functionally identical (Figure 1-159).

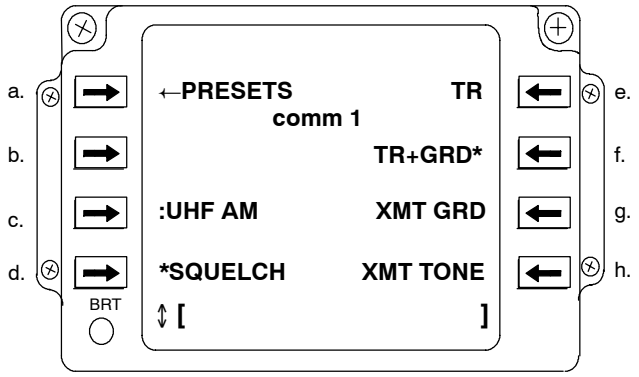



*Figure 1-159. COMM 1 and 2 Control Page*

a. Selection accesses the COMM Presets Page.

b. Displays the title “comm 1” or “comm 2,” indicating which COMM Control Page is displayed. TEST is displayed to the right of the title if the COMM radio is in IBIT.

c. Displays a colon adjacent to LS3 if the COMM radio is tuned to a UHF frequency and not tuned to a guard frequency. If the COMM radio frequency is in the UHF band, selection toggles the modulation between AM and FM. The default modulation setting is AM.

d. Selection toggles the squelch between on and off. If the squelch is on, an “*” is displayed adjacent to LS4. If the squelch is off, an “→” is displayed. The default squelch setting is on. If the emergency frequency select switch on the Emergency IFF/COMM Panel is set to 243.0, squelch is set to off.

e. Selection activates the main transmitter/receiver, disables the guard receiver, deactivates a previously activated mode, and places an “*” adjacent to LS5. TR is the default mode.

f. Selection activates the main transmitter/receiver and guard receiver, deactivates a previously activated mode, and places an “*” adjacent to LS6.

g. Selection activates the transmitter/receiver and tunes the COMM radio to the appropriate guard frequency, disables the guard receiver, deactivates a previously activated mode, and places an “*” adjacent to LS7. When in the XMT GRD mode, any attempt to change the COMM frequency results in the GRD ACTIVE annunciation in the scratchpad. On the COMM Page, the maritime channel is dashed out, the preset number displays “G,” and the guard frequency is displayed. Also, squelch is automatically set to off.

h. Selection toggles the tone-transmit on and off. If the tone is being transmitted, an “*” is displayed. Transmit tone is automatically turned off after 6 seconds (maximum allowable transmit time) or if another CDU page is accessed.

## Comm Presets Page

Selecting LS1 on either COMM 1 or COMM 2 Control Page accesses the COMM Presets Page. The COMM Presets Page (Figure 1-160) lists the frequencies for eight presets. COMM 1 and COMM 2 share the same eight preset frequencies.

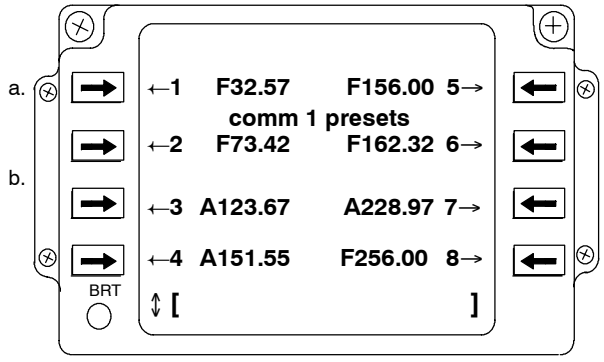



*Figure 1-160. COMM Presets Page*

a. Selection of LS1-LS8 with a valid entry in the scratchpad enters the frequency into the preset list, and the frequency is displayed adjacent to the line select. If the entered frequency is in the range of 30.000-87.975 or 156.000-173.975, the modulation is FM. If the entered frequency is in the range of 118.000-155.975, the modulation is AM. If the entered frequency is in the

range of 225.000-399.975 and entry is preceded with an A or F, the modulation is AM or FM, respectively, if no modulation is specified, the modulation is AM. The modulation type (A or F) precedes the frequency displayed. If a preset is changed while it is currently tuned via the COMM Page, the COMM radio remains tuned to the same frequency, and the frequency becomes a manually entered frequency. If invalid data is in the scratchpad, the "ERROR" message alternates with the data in the scratchpad when the line select is pressed. Selection with an empty scratchpad tunes the COMM radio to the corresponding preset frequency and accesses the COMM Page. If the COMM radio is already tuned to the selected preset, the frequency recall buffer is maintained (i.e., the last tuned frequency stays the same). The default COMM preset frequency is 121.5 MHz.

b. Displays TEST if the COMM radio is in IBIT.

## COMM Control Page Annunciations

The following annunciations warn the operator of a condition requiring their attention.

| Annunciation | Meaning |
|---|---|
| GRD ACTIVE | Failed attempt to change a Comm radio that is in guard mode. |
| VP MODE | When the FM Digital Encryption Standard (DES) is activated on the FM Control Page, VP is displayed to the right of the channel number. |
| DF MODE | When a radio is tuned to DF Mode, DF is displayed to the right of the channel number. |
| KY MODE (Comm 2) | When the KY-58 is used to encrypt/decrypt UHF, VHF and VHF-FM, KY is displayed for COMM 2. |
| TEST | If an IBIT Test is in progress, TEST is displayed next to the associated radio and the display fields are dashed out. |
| ↙STATUS | A radio has failed. |

| CHANNEL NUMBER | FREQ (XMT/RCV) | CHANNEL NUMBER | FREQ (XMT/RCV) |
|---|---|---|---|
| 06 | 156.300 | 28 | 157.400/162.000 |
| 07 | 156.350 | 65 | 156.275 |
| 08 | 156.400 | 66 | 156.325 |
| 09 | 156.450 | 67 | 156.375 |
| 10 | 156.500 | 68 | 156.425 |
| 11 | 156.550 | 69 | 156.475 |
| 12 | 156.600 | 70 | 156.525 |
| 13 | 156.650 | 71 | 156.575 |
| 14 | 156.700 | 72 | 156.625 |
| 15 | 156.750 | 73 | 156.675 |
| 16 | 156.800 | 74 | 156.725 |
| 17 | 156.850 | 77 | 156.875 |
| 18 | 156.900 | 78 | 156.925 |
| 19 | 156.950 | 79 | 156.975 |
| 20 | 157.000/161.600 | 80 | 157.025 |
| 21 | 157.050 | 81 | 157.075 |
| 22 | 157.100 | 83 | 157.175 |
| 23 | 157.150 | 84 | 157.225/161.825 |
| 24 | 157.200/161.800 | 85 | 157.275/161.875 |
| 25 | 157.250/161.850 | 86 | 157.325/161.925 |
| 26 | 157.300/161.900 | 87 | 157.375/161.975 |
| 27 | 157.350/161.950 | 88 | 157.425 |

## SECURE COMMUNICATIONS SYSTEM

The Secure Communications System provides for both "Secure" and "Protected" aircraft communications using the KY-58 VINSON secure voice system and the Digital Encryption System (DES) equipment, respectively.

**NOTE**

The KY-58 and associated fill devices are classified to the highest level of the stored codes. Operators must protect the equipment against unauthorized access in accordance with current directives.

### KY-58 VINSON Secure Voice System

The KY-58 is used to encrypt and decrypt UHF, VHF, and VHF-FM communications using the COMM 2 radio only. The KY-58 system is composed of a voice processor located behind the copilot seat. Control of plain/cipher operation and zeroization of the KY-58 can be done from either the IFF/COMM panel or the KY-58 itself. The KY-58 must be loaded with codes before secure communication is possible. Up to six different codes may be loaded at one time by either a KOI-18 Tape Reader or a KYK-13 Key Fill Device. The system is powered by the DC autoshed bus and protected by a circuit breaker marked VP on the avionics rack circuit breaker panel. A 6.5 volt mercury battery, installed in the processor, permits retention of stored codes when DC power to the system is removed. If the system is turned off or electrical power is removed from the KY-58, the COMM 2 radio will operate in plain text without secure capability. The KY-58 may be removed from the aircraft by installing a bypass cable enabling normal COMM 2 operation.

### Key Fill Equipment

Two common key fill devices are interchangeably used to load codes into the KY-58 VINSON: the KOI-18 General Purpose Tape Reader and the KYK-13 Key Fill Device.

### KOI-18, General Purpose Tape Reader

The KOI-18 (Figure 1-161) is a small, battery operated, hand carried device used to load the KYK-13 and/or the KY-58. The KOI-18 reads a code from an eight level punched tape and converts the code to an electronic serial output which is simultaneously transmitted to the receiving unit through a key fill adapter cable. The adapter cable connects to the fill connector on the KY-58 voice processor. A small 6.5v mercury battery provides power for converting tape information into electronic data. The KOI-18 has no memory capability and code information is not stored internally.

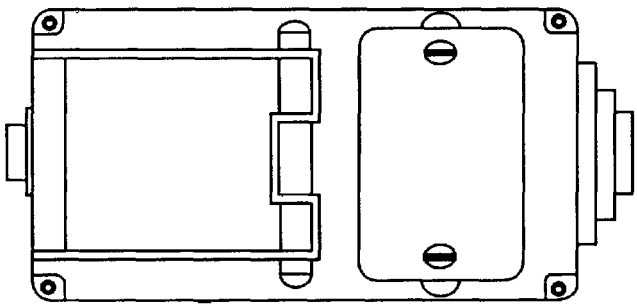


*Figure 1-161. KOI-18 Tape Reader*

### KYK-13, Key Fill Device

The KYK-13 (Figure 1-162) is a small, battery operated, hand carried device used to store up to six different codes. The device is filled by means of a KOI-18 Tape Reader. Codes can be stored indefinitely and transferred into the KY-58 upon request. Codes are retained in the KYK-13 until the storage registers are zeroized. A small 6.5 volt mercury battery provides power for loading, zeroizing and memory retention. The KYK-13 has a mode selector, a fill select switch, an initiate button, a parity indicator and a fill connector.

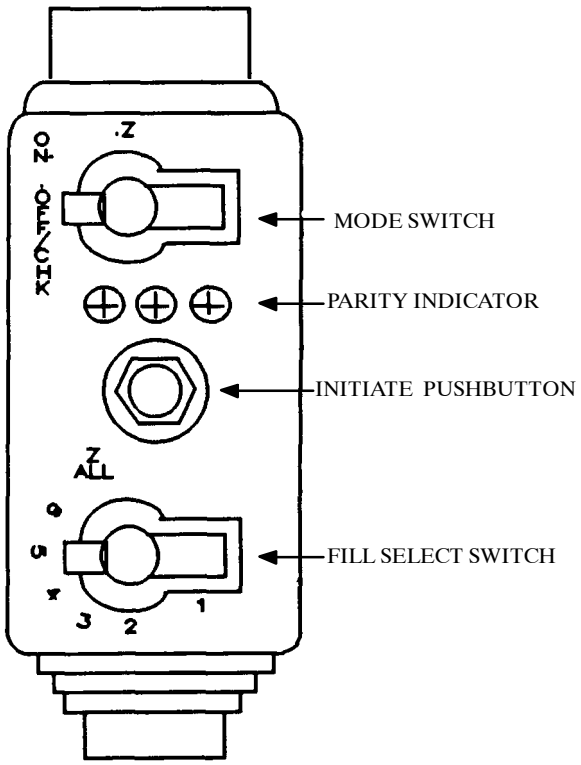



*Figure 1-162. KYK-13 Electronic Transfer Device*

a. Mode Selector - The mode selector is a three position rotary switch. The ON position is the

normal operating mode. The OFF/CHECK position is used to reset the device and to test the internal code of the selected register for parity when the initiate button is depressed. The Z position zeroizes code information in the selected register when the initiate button is depressed.

b. Fill Select Switch - The fill select switch is used to select one of six different fill registers. When loading the KYK-13, the position of the switch selects the register a code is loaded into. When loading the KY-58, the position of the switch selects the code to be transferred from the KYK-13. When zeroizing the KYK-13, the position of the switch selects the register to be zeroized. The Z-ALL position selects all six registers to be zeroized.

c. Initiate Button - The initiate pushbutton is used to activate code transfer from the KOI-18 into the KYK-13, and is also used to activate the zeroize function when the mode selector is held in the Z position. When the mode selector is in OFF/CHECK, the initiate button can be depressed to test a register for parity to determine if it is filled or empty.

d. Parity Indicator - The red parity indicator light will flash once during the fill process to indicate good data transfer. The light is also used in conjunction with the initiate button to determine whether a register is filled or empty.

e. Fill Connector - The fill connector is used during the fill process and connects to the KOI-18 or the KY-58 through a key fill adapter cable.

## Voice Processor Front Panel (Figure 1-163)

a. Power Switch - This three position rotary switch controls power to the KY-58 system. In the OFF position, all power is removed from the system. In the ON position DC power is applied to the system. However, the KY-58 must have a fill battery installed before it will turn on. The TD (Time Delay) position is used during remote keying operations. (Specialized ground equipment is required to execute the remote keying operation.)

b. Mode Selector - The mode selector is a four position rotary switch. The P (Plain) or C (Cipher) position selects the KY-58 operating mode. When in the plain mode, only plain text messages will be received. In cipher mode, both plain and cipher messages will be received. The LD (Load Data) position is used when loading codes into the system. The RV (Remote Variable) position is used during remote keying operations.

c. Fill Select Switch - The fill switch has eight positions. Positions 1-6 represent a register to be coded during secure operations. The Z 1-5 position is used to zeroize fills 1 through 5 only and the Z-ALL position zeroizes all 6 fills. A detent prevents the Fill Select Switch from being

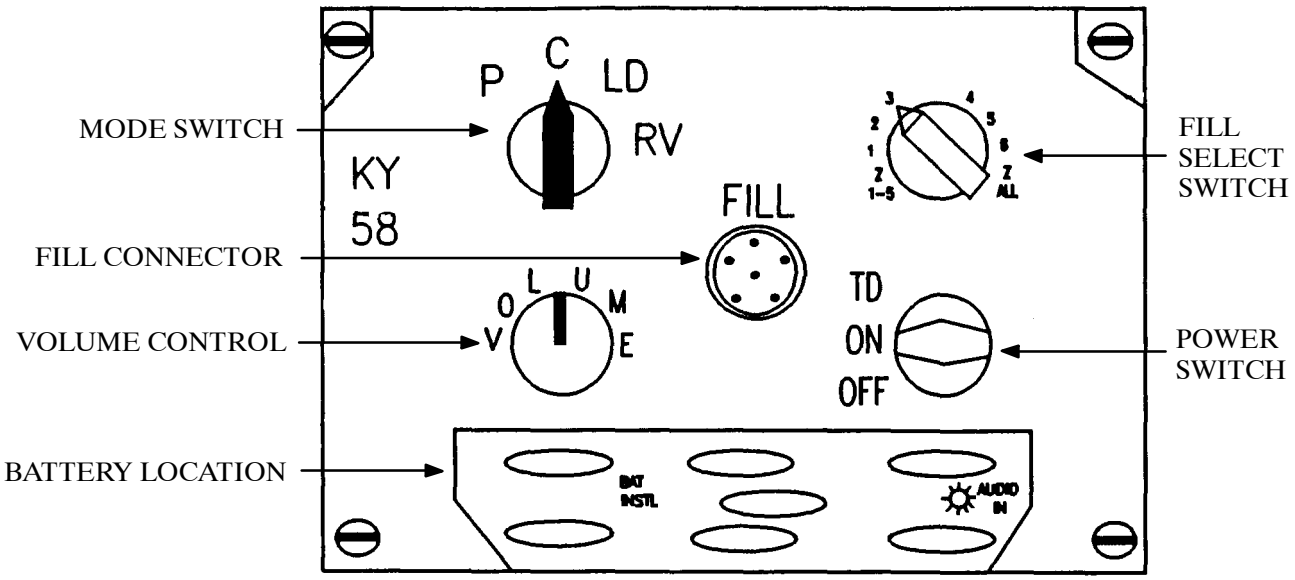



*Figure 1-163. KY-58 Voice Processor Front Panel*

inadvertently positioned to either zeroize position.

d. Volume Control - The volume control adjusts the audio level.

e. Fill Connector - The fill connector is used during the fill process to connect a KOI-18 or KYK-13 to the voice processor.

**NOTE**

A beeping alarm tone will be heard in the headset whenever the KY-58 is initially turned on or after the zeroize function is activated. The beeping alarm can be cleared by momentarily keying the ICS radio transmit switch, provided COMM 2 is selected on the audio control panel. During the loading process, a steady alarm tone will be heard when in the Load Data (LD) mode if the selected register is empty; a single beep will be heard if the selected register is filled. Additionally, while in the Cipher (C) mode, with COMM 2 selected, a single beep will be heard if the selected register contains a code during transmission. A steady alarm tone will be heard if the selected register is empty. The alarm will not be heard if Plain (P) mode is selected.

## IFF/COMM Control Panel (Figure 1-150)

The IFF/COMM control panel provides control of plain/cipher operation and zeroization of the KY-58. DP/AM (Diphase, AM operation), BB/FM (Baseband, FM operation) or CLR voice operation may be selected. When either cipher mode is selected, a VP annunciation will appear on the CDU COMM page indicating cipher mode has been enabled. When CLR is selected, the VP annunciation will disappear on the CDU. The IFF/COMM panel can also be used to zeroize the code in the KY-58 and the KIT-1C (Mode IV) computer. The switch has two positions, Zeroize and Normal, and must be kept in the normal position when not zeroizing. AC power is required to zeroize using the IFF/COMM panel. Zeroization may be accomplished at any time from the KY-58 Voice Processor front panel.

**NOTE**

Two way cipher communication is possible only when both the transmitting and receiving stations are using the same codes and type of modulation and KY-58 mode of operation (Diphase/Baseband). Deviation from a strict DP/AM or BB/FM operation may be warranted and will require coordination between the stations involved.

The DP/BB switch is kept in the BB mode on Coast Guard aircraft for secure comms, even if AM Modulation is selected with the UHF radio. Only use the DP mode if the other station is using DP mode.

## KY-58 Key Fill Procedures

a. KY-58 Power Switch - ON.

b. KY-58 Mode Selector - C. Adjust volume control as desired. A beeping alarm tone should be heard in the headset. With COMM 2 selected, momentarily key the Radio Transmit Switch to clear the alarm.

c. KY-58 Fill Select Switch - Turn to the register to be filled.

d. Connect the fill device to the KY-58 using a key fill adapter cable.

**CAUTION**

The KYK-13 must be in OFF/CHECK before connecting it to or disconnecting it from the KY-58 to prevent internal equipment damage and/or loss of stored codes.

e. KY-58 Mode Selector - LD. A steady alarm tone should be heard indicating that the selected register is empty. If a single beep is heard, it indicates that the register already contains a code.

**NOTE**

Finding a register unexpectedly loaded may indicate a compromise of classified material. The unit CMS custodian should be immediately notified.

Do not load a code into a filled register. To ensure a valid fill, the register must be empty before being loaded.

f. Load the KY-58.

(1) KOI-18 - Insert the tape reader through the KOI-18 slot marked IN, ensuring that the smaller holes in the tape are aligned with the white dots on the KOI-18.

(2) KYK-13 - Turn Mode Selector Switch ON. Turn Fill Select Switch to the register containing the code to be transferred.

g. With COMM 2 selected, momentarily key the Radio Transmit Switch and:

(1) KOI–18 – Within 7 seconds, pull the tape through the KOI–18 at a steady rate. A single beep should be heard indicating a valid fill.

(2) KYK-13 - Verify that the Parity Indicator flashes and a single beep is heard indicating a valid fill.

If the beep is not heard, repeat steps f. and g.

To load another code, repeat steps c., f., and g.

h. KY-58 Mode Selector - C. Momentarily key the Radio Transmit Switch. If a beep is heard, the KY-58 is keyed for cipher operation. If a steady tone is heard, reload. Leave the Mode Selector Switch in this position.

i. Disconnect the fill device.

(1) KOI-18 - Disconnect fill device.

(2) KYK-13 - Turn selector switch to OFF/ CHECK, then disconnect the fill device.

## KY-58 Operating Procedures

**NOTE**

Do not transmit secure information over ICS or over the KY-58 while other crewmembers make plain voice transmissions on any other radio.

a. To transmit and receive in PLAIN mode:

(1) KY-58 Mode Selector Switch - C. (Should already be in this position.)

(2) IFF/COMM Control Panel - VP/CLR. Ensure VP annunciation disappears on CDU COMM page. All transmissions will be in plain text. All plain voice signals will be received, but all cipher signals will be unintelligible.

b. To transmit and receive in CIPHER mode:

(1) KY-58 Mode Selector Switch - C. (Should already be in this position.)

(2) IFF/COMM Control Panel - DP/AM (UHF or VHF secure comms) or BB/FM (FM secure comms). VP annunciation appears on CDU COMM page. Operate COMM 2 radio normally. All transmissions will be in cipher text; however, both plain and valid cipher signals will be received.

**NOTE**

With the KY-58 loaded and cipher mode selected, a single beep will be heard in the headset when the transmit key is depressed. If a steady alarm tone is heard, the selected register does not contain a code and secure transmissions will not be possible.

- Two way cipher communication is possible only when both the transmitting and receiving stations are using the same codes and type of modulation (Diphase/Baseband). Deviation from a strict DP/AM or FM/BB operation may be warranted and will require coordination between the stations involved.

## KY-58 Zeroization Procedures

Zeroization may be accomplished in two ways. One is to use the Fill Select Switch on the front of the KY-58. This method does not require aircraft power. The second method is to use the ZERO switch on the IFF/COMM Control Panel. Use of this switch requires AC power in order to zeroize the KY-58 and will simultaneously zeroize the KIT-1C (Mode IV) computer.

**NOTE**

Operational necessity may require that the KY-58 remain keyed after shutdown (e.g., fuel stop). Until zeroized with the correct procedures, codes will remain stored in the KY-58 even with the power switch off. Unless all stored codes are zeroized, the KY-58 remains keyed, and is classified to the highest level of the stored codes. Operators must protect the equipment against unauthorized access in accordance with current directives.

a. KY-58 zeroize method:

(1) KY-58 Mode Selector Switch - C.

(2) KY-58 Fill Selector Switch - Turn to Z-ALL or Z/1-5, then back to the register used. A beeping alarm tone should be heard in the headset. With COMM 2 selected, momentarily key the Radio Transmit Switch to clear the alarm.

**NOTE**

All registers of the KY-58 may be zeroized without the aircraft or the COMM 2 powered. However, without power the alarm indicators cannot be monitored. Since the possibility exists that all stored codes may not be zeroized, the alarm indicators need to be verified to ensure that all registers have indeed been zeroized.

- The Z-ALL position will zeroize all six registers. The Z/1-5 position only zeroizes registers 1-5. If register 6 was filled, the Z-ALL position must be used to zeroize this register.

(3) KY-58 Fill Select Switch - Rotate through registers 1-6, pausing in each position to key the Radio Transmit Switch, with COMM 2 selected. A steady alarm tone should be heard in each position indicating that the register is empty. If the steady alarm is not heard in each position, repeat steps (1)-(3).

(4) KY-58 Power Switch - OFF.

b. IFF/COMM Control Panel zeroize method:

(1) IFF/COMM Control Panel - ZERO.

(2) IFF/COMM Control Panel - VP position. A beeping alarm tone should be heard in the headset. With COMM 2 selected, momentarily key the Radio Transmit Switch to clear the alarm.

(3) KY-58 Fill Select Switch - Confirm zeroization of applicable fills by keying the Radio Transmit Switch with the appropriate register (1-6) selected. A steady alarm tone should be heard. If the steady alarm is not heard in each position, repeat steps (1)-(3).

(4) KY-58 Power Switch - OFF.

## DIGITAL ENCRYPTED STANDARD (DES) VOICE PRIVACY SYSTEM

DES provides voice privacy for communication on the VHF-FM radio only. The DES system is composed of a voice processor located behind the copilot seat. Control of private/cipher operation is located on the voice processor control panel (Figure 1-164). The DES must be loaded with a code before protected communication is possible. A 15 VDC internal battery allows the code to be retained after power is secured. Only one code may be loaded at a time by the T3011AX Key Variable Loader. The system is powered by 28 volts DC from the auto shed bus and protected by a circuit breaker marked VHF-FM on the avionics rack circuit breaker panel.

**NOTE**

DES voice protected communication equipment, including the associated fill device, is classified to the highest level of the stored code. Operators must protect the equipment against unauthorized access in accordance with current directives.

### Key Fill Equipment

The T3011AX Key Variable Loader (KVL) is a handheld device where DES Variables can be assembled and stored. The operator can manually program the selected key variables into the KVL 16 digit keypad. The KVL is capable of storing up to 16 different key variables consisting of 8 pairs of hexadecimal digits. Key variable transfers to equipment are initiated by the Push-to-Transfer (P-T-T) switch located on the left side of the KVL. Controls for the KVL are shown in Figure 1-165.

**NOTE**

If no keystroke is made for 45 seconds after the unit is turned on, the KVL automatically shuts down to conserve power. Five seconds prior to shut down, the KVL emits a warning tone to alert the user. To abort the shut down, the user must press any button within 5 seconds of hearing this tone.

## DES Key Fill Procedures

1. Ensure AC and DC power is applied and both pilot's and copilot's avionics switches are on.

2. DES voice processor control panel:

   a. Rotate the operate key switch to the operate position.

   b. Activate the erase switch by toggling up momentarily.

   c. Insert the Keyload switch key and rotate to the Keyload position.

   d. Insert the KVL interface cable into the cable connection port.

   e. Push in the PVT switch ensuring the PVT light illuminates.

   f. Turn on the KVL by depressing the ON button located on the keypad.

   g. Select the desired Key Variable memory by depressing the SEQ button.

**NOTE**

If a valid code is entered into the memory location, "xrEAdY" will be displayed. A display of "xErASEd" indicates that a code has not been entered into the memory location.

   h. Depress the P-T-T switch located on the left side of the KVL. A 1 second tone will be heard on VHF-FM if the code has been properly transferred.

   i. Remove the KVL interface cable.

   j. Remove the Keyload and Operate switch keys.

## DES Operating Procedures

To transmit and receive in the plain mode:

1. Place PVT/STD switches to the STD position.

**NOTE**

Transmissions in the plain voice mode will be preceded by a 1 second tone upon keying the VHF-FM transceiver.

To transmit and receive in the cipher mode:

1. Place PVT/STD switches to the PVT position.

2. Toggle the DES function on the CDU to PVT.

**NOTE**

If both PVT and STD switches are deactivated or the PVT switch is activated without a valid code installed, plain voice transmissions will be inhibited, however, reception capability still exists.

## DES Zeroizing Procedures

Zeroizing may be accomplished with or without aircraft power using the erase switch on the front of the voice processor control panel.

**NOTE**

Operational necessity may require that the DES remain keyed after shutdown (e.g., fuel stop). Until zeroized with the correct procedures, the code will remain stored in the DES even with the power switch off. Unless the stored code is zeroized, the DES remains keyed, and classified to the highest level of the stored code. Operators must protect the equipment against unauthorized access in accordance with current directives.

1. DES zeroize method:

   a. Erase switch - Toggle up momentarily.

**NOTE**

The DES may be zeroized without the aircraft or VHF-FM powered. However, without power the alarm indicators cannot be monitored. Since the possibility exists that the stored code may not be zeroized, the alarm indicator needs to be verified to ensure the code has been zeroized.

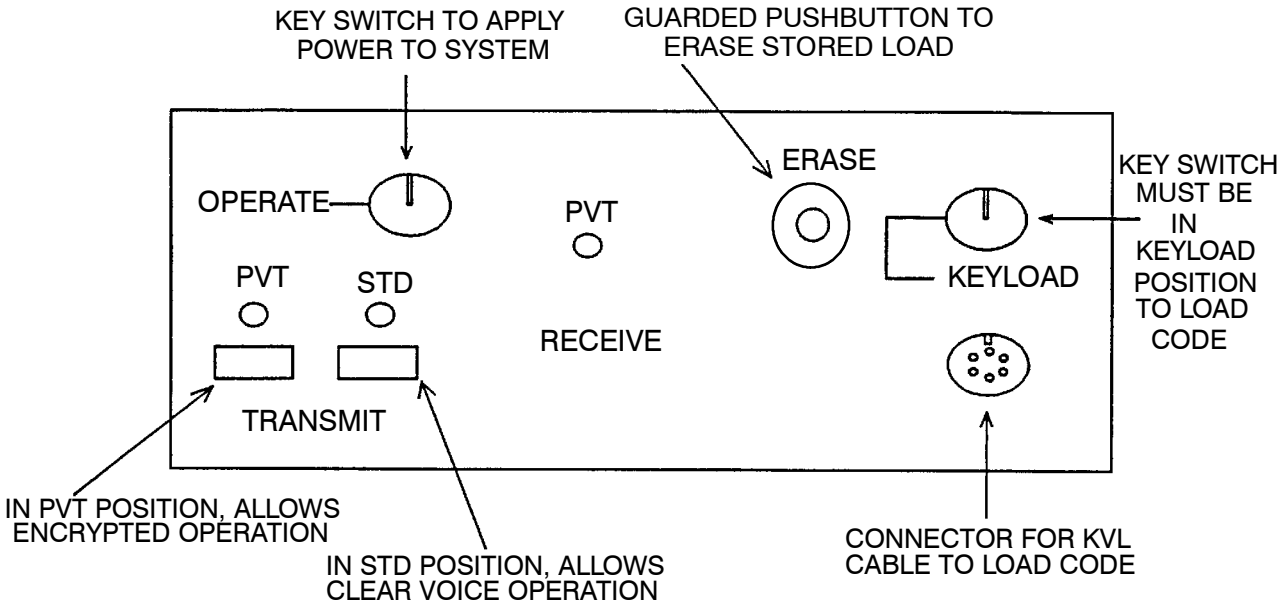



*Figure 1-164. DES Voice Processor Control Panel*

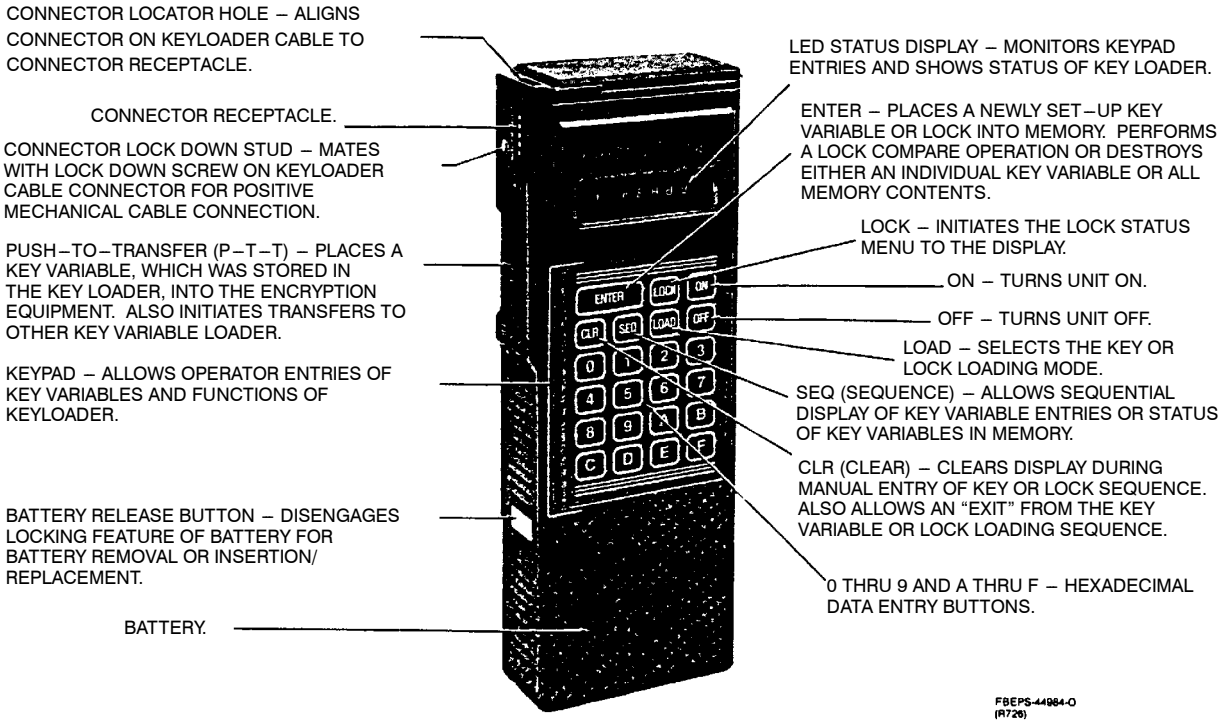



*Figure 1-165. DES Key Variable Loader*

# NAVIGATION SENSOR MANAGEMENT

Navigation sensor frequency, channel, and mode control are provided by the FCMS through two CDUs and by the emergency frequency select switch located on the Emergency Identification Friend or Foe (IFF) / Communications (COMM) Panel. Navigation sensors to manage include:

1. GPS
2. VOR/LOC
3. TACAN
4. Direction Finding
5. IFF
6. Radar Altimeter
7. Magnetic Heading Reference
8. Bearing Distance Indicator

## AREA NAVIGATION

Area navigation (RNAV) serves as a function of the FMS to provide the following navigational capabilities:

- To fly predetermined routes without the need to over fly specific navigational aids.
- To fly parallel offset routes to avoid adverse weather or fly around congested or hazardous areas.
- To change the flight plan by flying directly to a newly established waypoint and then returning to the flight plan route.
- To establish a holding pattern at any predetermined waypoint.
- To automatically compute and execute rendezvous, search pattern, and approach-to-hover maneuvers.
- To maintain a status of flight plan progress by calculating maximum range, fuel reserve, and estimated navigation position error.

## FLIGHT PLAN SEQUENCING

Automatic leg sequencing (AUTO) (Figure 1-166) is available at all times, except during Hover and Approach functions. When the flight plan sequencing is in the AUTO mode, waypoints will automatically go into history when passed. Prior to passing into history, a waypoint alert is indicated by flashing the active waypoint when the aircraft is within 10 seconds of the turn switching point. When the waypoint is passed, it is placed in history, and all other waypoints shift up on the Flight Plan Page. In AUTO mode, course editing is limited to +/- 90 degrees from the current course. The point at which the CDU changes active waypoints is a function of ground speed, wind and magnitude of course change. The turn initiation point is calculated based on a 30 second constant duration turn for a course change of 0-90 degrees and standard constant rate turn (3 deg/sec) for course changes > 90-150 degrees. A constant 25° bank teardrop turn is used for a course change of >150 degrees.

Automatic sequencing may be disabled at any time, except during Hover and Approach functions, by switching to Manual (MAN) (Figure 1-167). This suspends advancing of the flight plan and causes guidance computations to continue to reference the active waypoint at the point automatic sequencing was disabled. This is used for direct fly-over of waypoints (e.g., for marking position) or tracking a desired outbound course. 360-degree course editing is available in Manual Mode. The waypoint sequencing alert continues to be generated when manual sequencing has been selected, except that it now occurs 10 seconds prior to reaching the waypoint. The waypoint does not pass into history, though a “FROM” indication is generated when passing the waypoint. To advance the flight plan, the automatic flight plan-advancing mode may be selected, or a Direct To the next waypoint may be selected.

## HISTORY WAYPOINTS

The five most recent flight plan history waypoints are maintained by the CDU as they are passed. History waypoints cannot be edited or deleted but can be used with Direct To guidance to return to a recently passed point. When the flight plan is erased, present position at that time is placed as the first history waypoint. When automatically sequencing through pattern generated waypoints, the waypoints go into history normally, with the exception of executing a Ladder, Sector, or Expanding Square pattern. The CSP waypoint sequences only as far as the oldest history waypoint, where it is maintained until the pattern is no longer active.

## COURSE SELECTION

The following course types may be selected: To-To course for planned, automatic leg sequencing, Direct To course to interrupt the planned waypoint sequence and To-From course for course editing and manual leg sequencing.

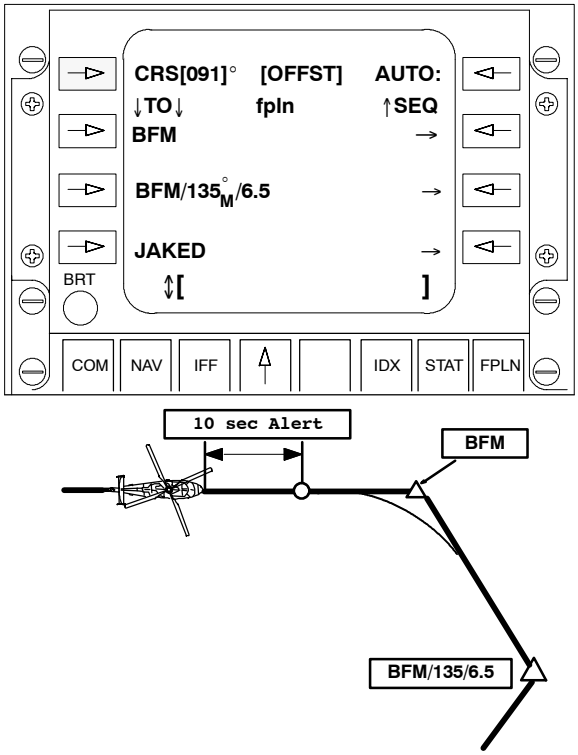



*Figure 1-166. Flight Plan - Auto Sequencing (sheet 1 of 2)*

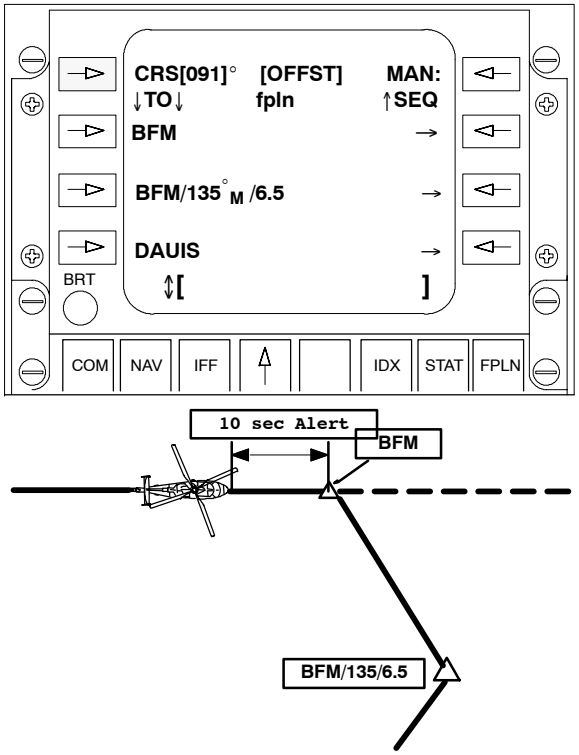



*Figure 1-167. Flight Plan - Manual Sequencing (sheet 1 of 2)*

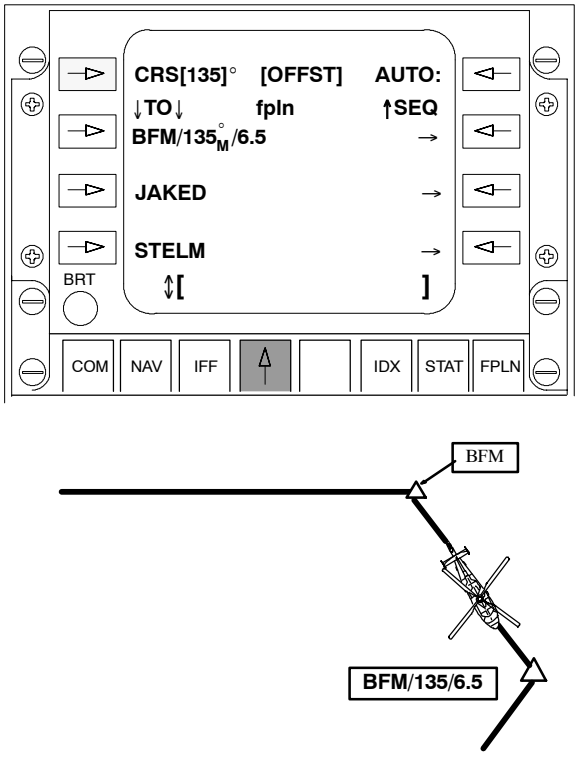



*Figure 1-166. Flight Plan - Auto Sequencing (sheet 2 of 2)*

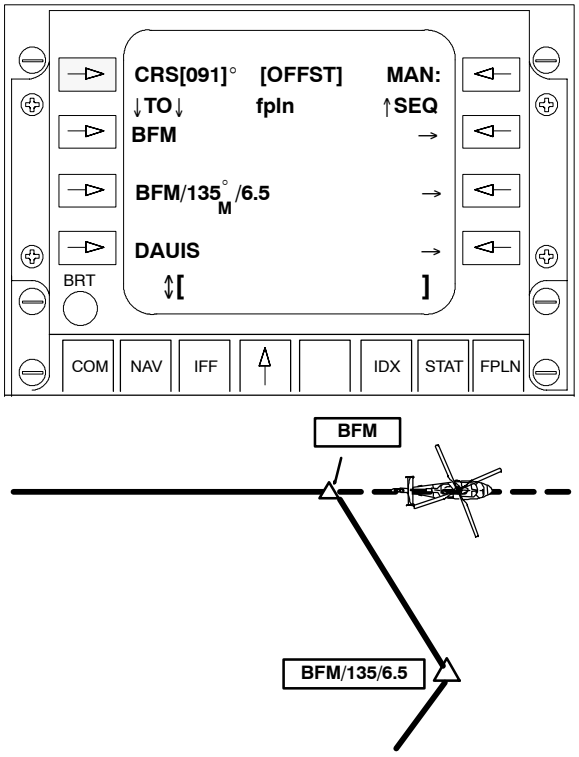



*Figure 1-167. Flight Plan -Manual Sequencing (sheet 2 of 2)*

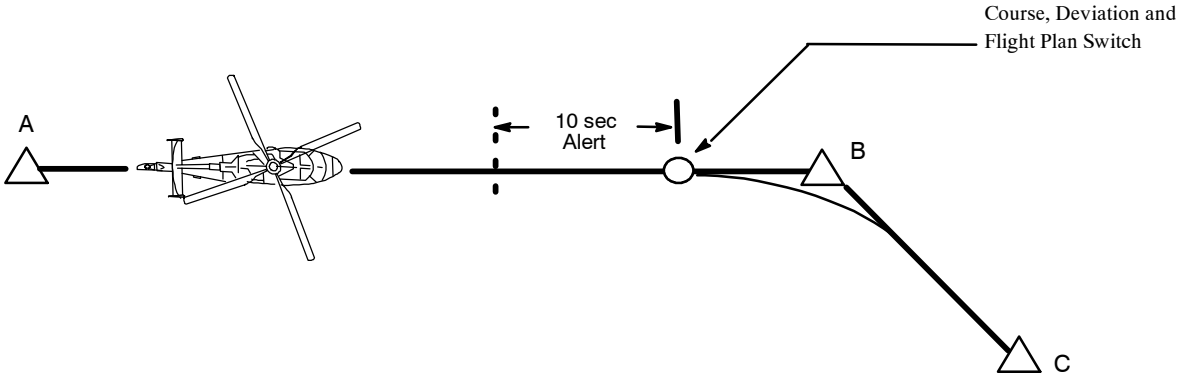



*Figure 1-168. Standard Lateral Capture*

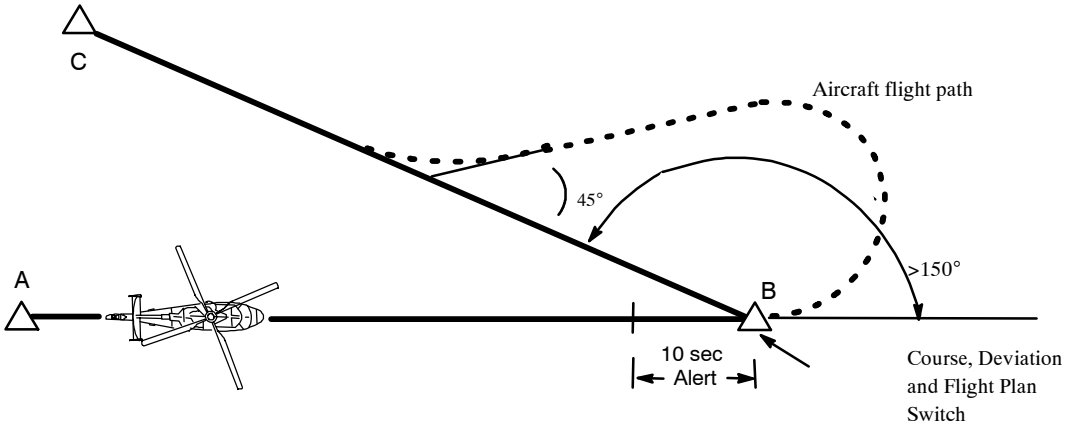



*Figure 1-169. Lateral Transition and Capture with Course Change Greater than 150 Degrees*

## TO-TO COURSE

To-To courses for planned leg transitions with automatic (AUTO) leg sequencing selected and switching computed to provide leg-to-leg capture is executed as shown in Figure 1-168. Turn point distance is determined by the along track distance to the TO waypoint and does not exceed two miles. When coupled to the FDS, bank command is limited to 25 degrees or the value that results in a four-degree/sec heading rate, whichever is smaller. When the course change is greater than 150 degrees, the turn point is the waypoint itself, and a teardrop maneuver with a 45° final course intercept is executed. Figure 1-169 details the teardrop course change.

## INITIAL COURSE CAPTURE

Initial NAV capture of an RNAV course is illustrated in Figure 1-170. To intercept the course, the FMS computes a capture initiation point that ensures NAV course capture when:

a. Present aircraft track is less than 90 degrees from the desired course.

b. Cross track deviation is less than 0.5 nautical mile.

The calculation of the capture initiation point includes the effects of estimated wind to allow a smooth transition to the course without overshoot.

**NOTE**

It is the responsibility of the flight crew to set up the intercept heading to the RNAV course, either manually or through the use of the HDG SEL mode. If the heading is such that course intercept is not made, the aircraft continues on heading.

The intercept may also be manually flown by following the ADI steering commands or by selecting the HDG SEL mode and setting in the intercept heading using the heading select knob on the MFD control panel.

The intercept may also be manually flown by following the ADI steering commands or by selecting the HDG SEL mode and setting in the intercept heading using the heading select knob on the MFD control panel.

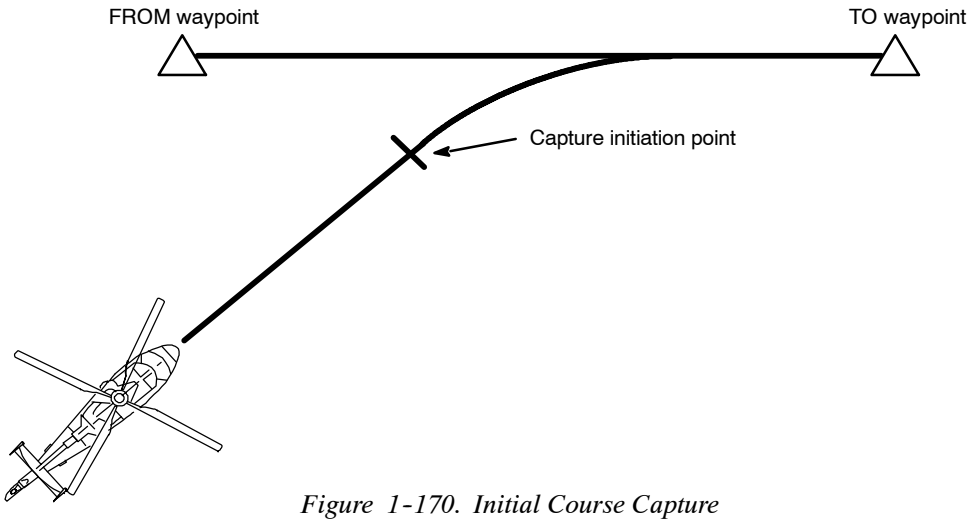



*Figure 1-170. Initial Course Capture*

## PARALLEL OFFSET

A parallel course, offset to the left or right of the flight plan course up to 99.9 nm in 0.1 nm increments, may be inserted into the flight plan. The annunciation "OFFSET" appears in the annunciation line to notify the crew of the offset, and cannot be cleared while the offset is in the flight plan. Figure 1-171 shows an example of an offset course. When an offset is applied, all displays (time and distance to go, TO/FROM flag) are referenced to the pseudo-waypoints along the offset course. Likewise, the leg switch point and the associated 10-second alert are computed relative to the offset course waypoints. In cases of large course changes coupled with large offsets (Figure 1-172), the CDU may compute a teardrop turn to change course in order to maintain flight plan continuity. Cross-track deviation displayed on the MFD is also computed relative to the offset course. Parallel course offsets may be applied or changed at any time the active waypoint is not identified as a Holding pattern, Circle pattern, Rendezvous, Approach or Hover. A parallel offset may be deleted at any time by entering "0," "-," "L0" or "R0" as the offset distance, or through the DIRECT TO and HOVER AT functions. If a waypoint identified as the Holding waypoint becomes the active waypoint while an offset is defined, the offset is also automatically cancelled. When cancelled, either automatically or by the operator, an "OFFSET CNCLD" annunciation appears, and the offset distance returns to the default setting "[OFFST]."

**NOTE**

If [OFFST] is selected with an invalid parallel offset entry in the scratchpad, the offset command is disregarded by the CDU and the flight plan sequencing toggles between AUTO and MAN. There is no annunciation to inform the crew of the failed offset entry.

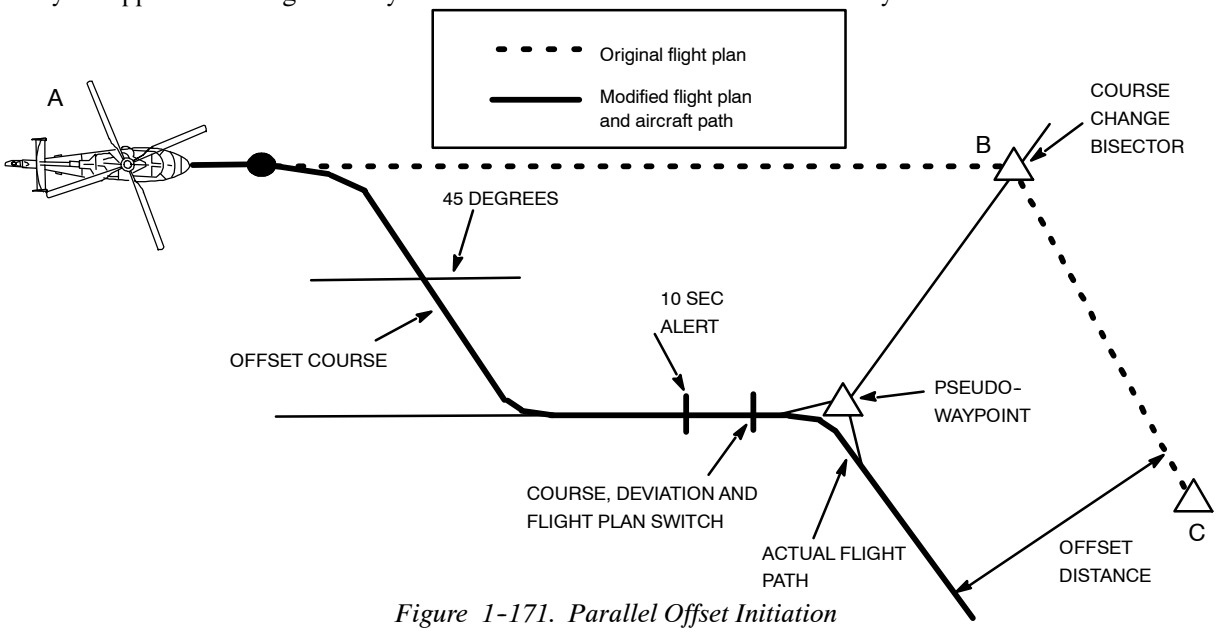



*Figure 1-171. Parallel Offset Initiation*

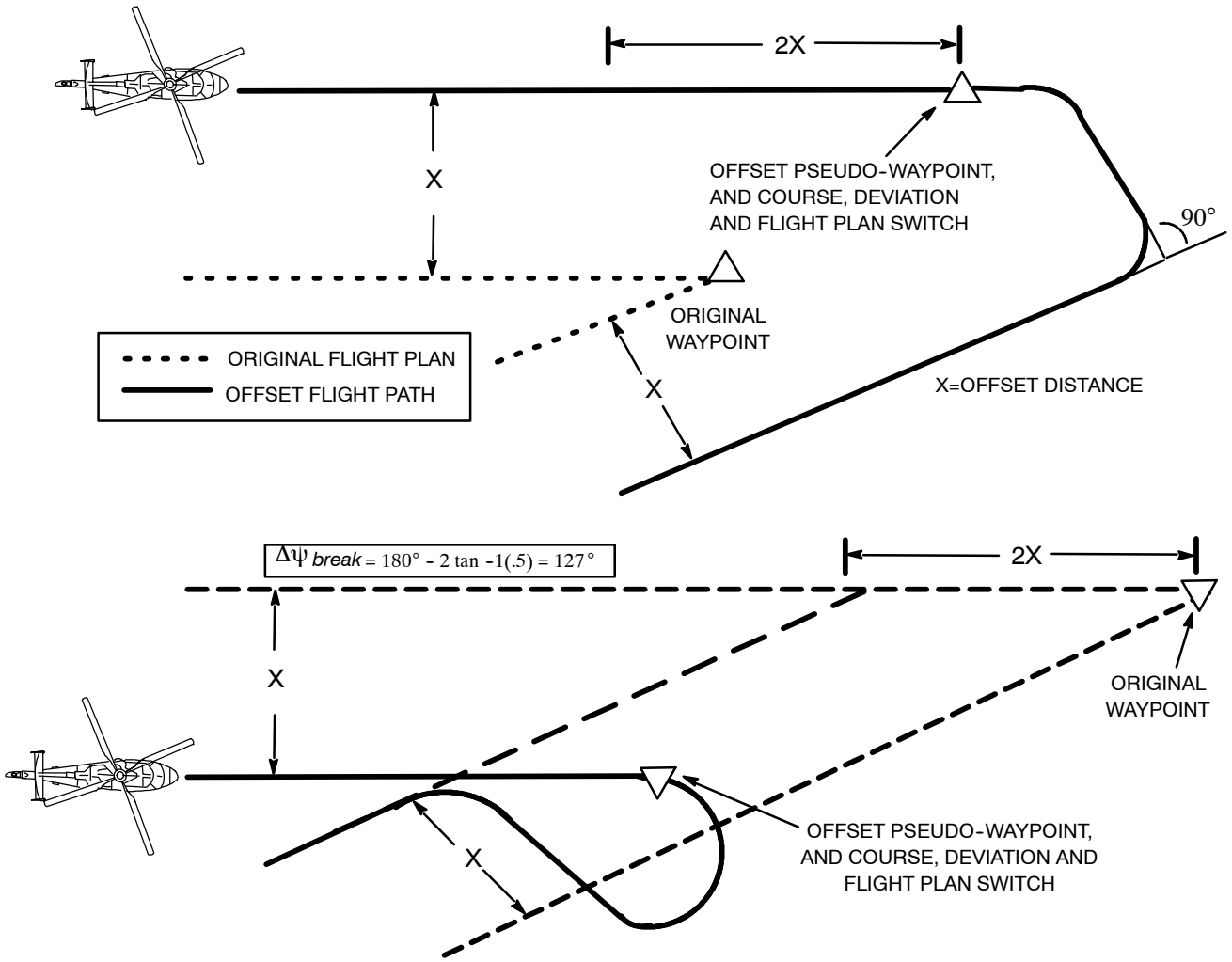



*Figure 1-172. Parallel Offset Transition with Large Course Change*

## DIRECT-TO

Direct-To courses are used to either bypass existing waypoints in the flight plan or insert an impromptu waypoint, interrupting the current leg. When Direct-To is commanded, a turn point is established ahead of the aircraft on its present track in order to provide turn anticipation for a smooth turn onto the direct path and prevent "S" turns during capture of the course. If the required course change is less than 150 degrees, the current aircraft speed and the course to the selected waypoint are used to create a turn point ahead of the aircraft. When the required course change is greater than 150 degrees, a teardrop course change is performed and the present aircraft position becomes the new "FROM" waypoint. Two direct-to modes are available to the operator: waypoint (WPT) and leg (LEG).

## WAYPOINT MODE

Direct-To mode may be executed to a non-flight plan waypoint, a waypoint in the active flight plan or a history waypoint. When a direct-to is performed in waypoint mode, a new course is created to proceed *directly* to the chosen waypoint. An additional Direct-To turn waypoint ("DIRECT-TURNPT") is inserted into the flight plan in order for the guidance to establish a new course with minimal overshoots. The CDU automatically generates this point and inserts it into the flight plan before the waypoint that the direct-to was performed upon. The waypoint is nearly unnoticeable by the crew and will essentially go into history after it is inserted.

To proceed direct-to a non-flight plan waypoint (Figure 1-173), select LS1 or 2 after pressing DIR with a valid way-

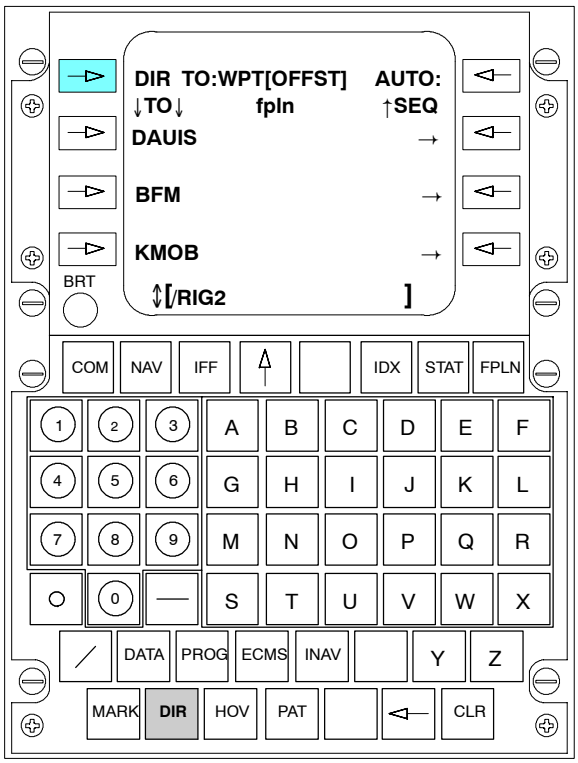



*Figure 1-173. Direct-To Non Flight Plan Waypoint (sheet 1 of 2)*

point (e.g., a non-flight plan waypoint) entry in the scratchpad. The CDU will:

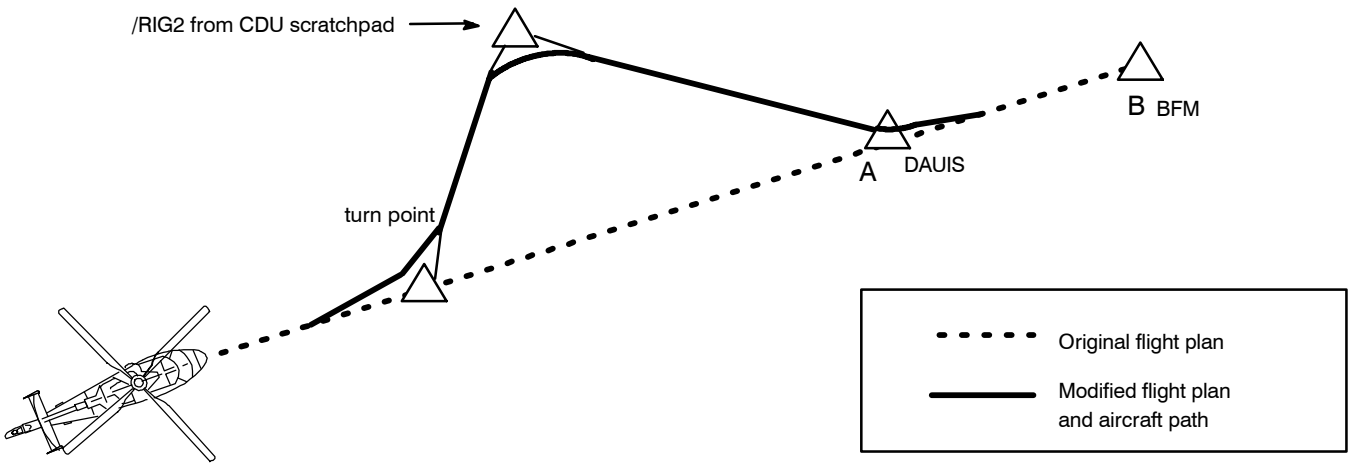
- insert the waypoint into the flight plan before all other waypoints,
- move all subsequent waypoints down in the flight plan,
- make the new waypoint the active waypoint,
- perform an immediate direct-to function course change to the new waypoint,
- display the Flight Plan Page,
- set the flight plan sequencing to AUTO, and
- cancel any offset currently in effect (except when Approach is active).

To proceed direct-to a non-flight plan waypoint (Figure 1-173) elsewhere in the flight plan:

a. Press DIR with a valid waypoint entry in the scratchpad, scroll through the future or history waypoints and select the line select key adjacent to the desired location, or

b. Scroll through the future or history waypoints then press DIR with a valid waypoint entry in the scratchpad. The CDU will:

- insert the waypoint into the desired location,
- make the new waypoint the active waypoint,
- perform an immediate direct-to function course change to the new waypoint,
- display the Flight Plan Page,




1. Depress DIR function key
2. Enter desired waypoint into scratchpad, (i.e., /RIG2)

**NOTE**

Steps 1 and 2 may be reversed

3. Select LS1 or 2 to insert waypoint as new active waypoint in flight plan.

*Figure 1-173. Direct-To Non Flight Plan Waypoint (sheet 2 of 2)*

- set the flight plan sequencing to AUTO,
- cancel any offset currently in effect (except when Approach is active).
- If the new waypoint is entered adjacent a future waypoint, all intervening points (between the previous active waypoint and the direct-to waypoint) are deleted, or
- If the new waypoint is entered adjacent a history waypoint, all intervening points (between the direct-to waypoint and the active waypoint) are removed from history and become, in order, part of the active flight plan.

To proceed direct-to an active flight plan waypoint (Figure 1-174):

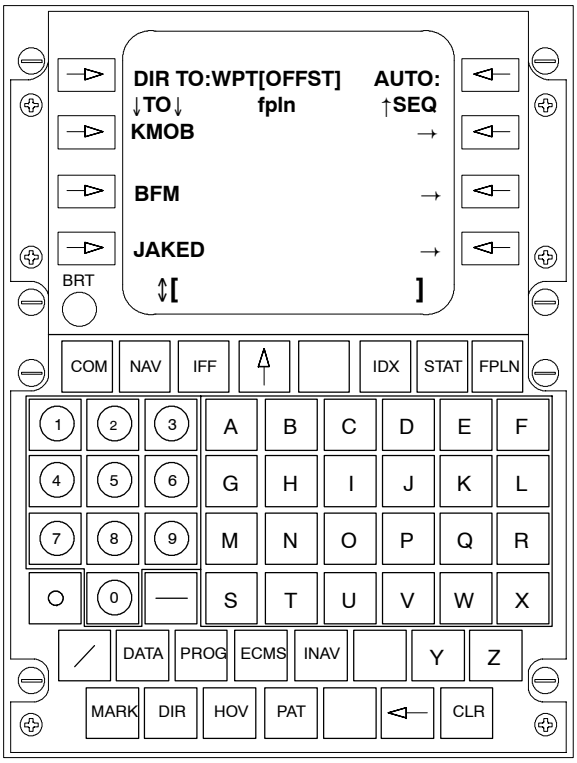



*Figure 1-174. Direct-To Waypoint*

a. Press DIR, scroll through the future waypoints and depress the line select key adjacent to the desired location, or

b. Scroll through the future waypoints, then press DIR, and depress the line select key adjacent to the desired location. The CDU will:

- insert the waypoint into the desired location,
- make the new waypoint the active waypoint,
- perform an immediate direct-to function course change to the new waypoint,
- display the Flight Plan Page,
- set the flight plan sequencing to AUTO,
- cancel any offset currently in effect (except when Approach is active), and
- delete all intervening points (between the previous active waypoint and the direct-to waypoint).

To proceed direct-to a waypoint in history:

a. Press DIR, scroll through the history waypoints and select the line select key adjacent to the desired location, or

b. Scroll through the history waypoints, then press DIR, and select the line select key adjacent to the desired location. The CDU will:

- insert the waypoint into the desired location,
- make the new waypoint the active waypoint,
- perform an immediate direct-to function course change to the new waypoint,
- display the Flight Plan Page,
- set the flight plan sequencing to AUTO,
- cancel any offset currently in effect (except when Approach is active), and
- remove all intervening points (between the direct-to waypoint and the previously active waypoint) from history and include them, in order, as part of the active flight plan.

**NOTE**

Deleting an Approach, Hover, Hold, Circle or Rendezvous waypoint that is active or part of an active Approach or Hover is not possible and results in an “xxx ACTIVE” annunciation (with “xxx” being APPROACH, HOVER, HOLD, CIRCLE or RENDZ, as appropriate). A waypoint or APPROACH, HOVER, HOLD, CIRCLE or RENDZ (active or inactive) may be deleted from a flight plan by performing a “direct to” function to a future waypoint not associated with the appropriate pattern.

## LEG MODE

Direct-To leg mode may be executed to any active flight plan waypoints or history waypoints. When a direct-to is

performed in leg mode, a new course is created to proceed to a point 1 nm from the chosen waypoint, on the original programmed course. Two additional waypoints are inserted into the flight plan in order for the guidance to establish a new course to the leg. The first is a Direct-To turn point that is identical to the waypoint mode direct-to turn waypoint. The CDU automatically generates this point and inserts it into the flight plan before the waypoint that the direct-to was performed upon. The waypoint is nearly unnoticeable by the crew and will essentially go into history after it is inserted. The second waypoint is the Leg Capture Point that appears in the flight plan as a latitude/longitude. The Leg Capture Point is 1 nm from the selected direct-to waypoint, on the original programmed course. The direct-to leg mode performed to non-flight plan waypoints is functionally identical to direct-to waypoint mode. Figure 1-175 illustrates the LEG direct-to functions.

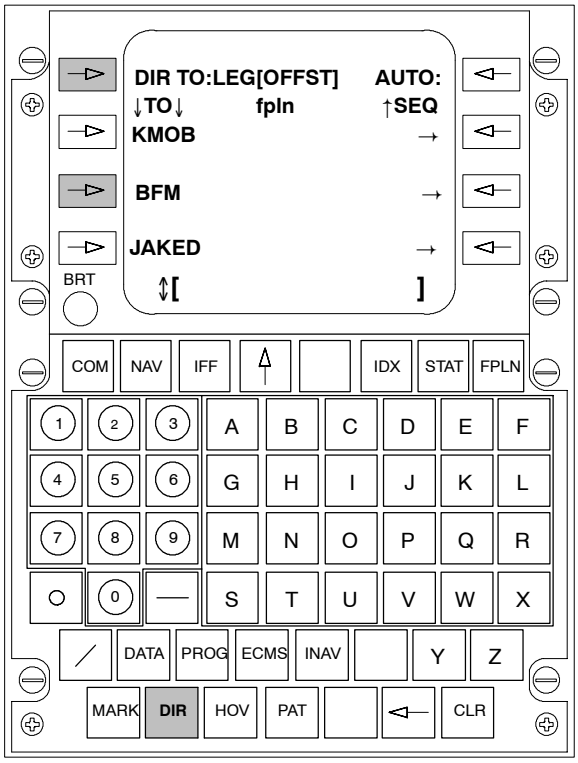



*Figure 1-175. Direct-To Leg (sheet 1 of 2)*

To proceed direct-to an active flight plan waypoint (Figure 1-175):

a. Press DIR, select LS1 to set LEG mode, scroll through the future waypoints and press the line select key adjacent to the desired location, or

b. Scroll through the future waypoints, then press DIR, select LS1 to set LEG mode and press the line select key adjacent to the desired location. The CDU will:

- Insert the Leg Capture Point as the active waypoint,
- insert the waypoint directly after the active waypoint,
- make the Leg Capture Point the active waypoint,
- perform an immediate direct-to function course change to the Leg Capture Point,
- display the Flight Plan Page,
- set the flight plan sequencing to AUTO,
- cancel any offset currently in effect (except when Approach is active), and
- delete all intervening points (between the previous active waypoint and the Leg Capture Point waypoint).

To proceed direct-to a waypoint in history:

a. Press DIR, select LS1 to set LEG mode, scroll through the history waypoints and press the line select key adjacent to the desired location, or

b. Scroll through the history waypoints, then press DIR, select LS1 to set LEG mode and press the line select key adjacent to the desired location. The CDU will:

- insert the waypoint into the desired location,
- make the new waypoint the active waypoint,
- perform an immediate direct-to function course change to the new waypoint,
- display the Flight Plan Page,
- set the flight plan sequencing to AUTO,
- cancel any offset currently in effect (except when Approach is active), and
- remove all intervening points (between the direct-to waypoint and the previously active waypoint) from history and include them, in order, as part of the active flight plan.

## SPECIAL DIRECT-TO CASES

Executing a Direct-To with a pattern active in the flight plan can present unique flight plan management situations. The following specific Direct-To conditions are amplified for user understanding:

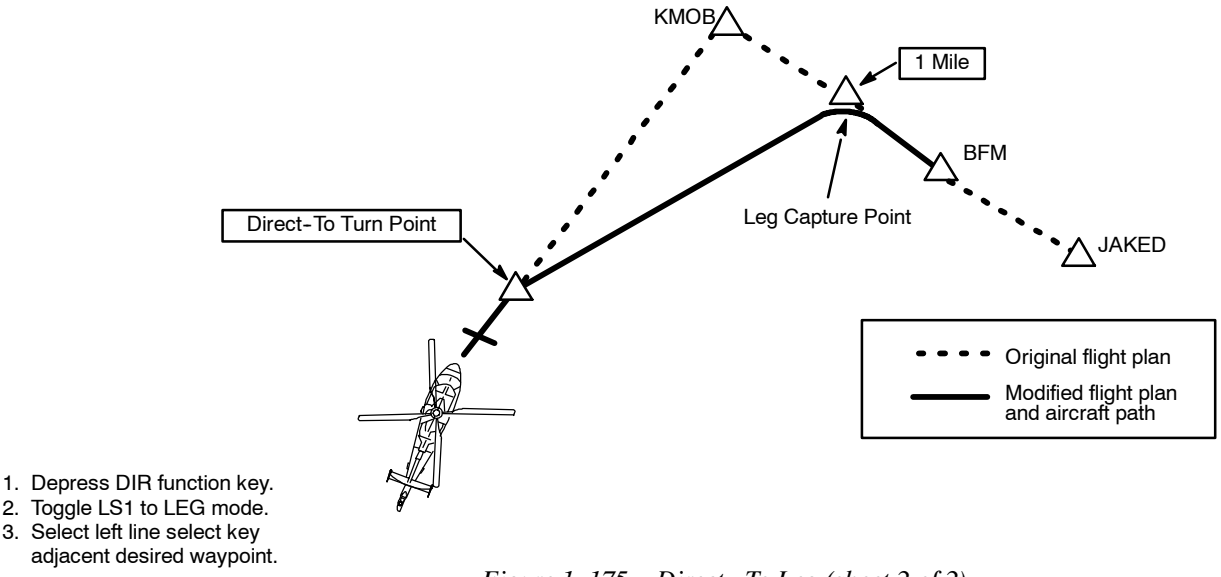



*Figure 1-175. Direct -To Leg (sheet 2 of 2)*

a. When a Direct-To is performed to a non-pattern future waypoint while inside a pattern, either by selection of an existing flight plan point or by inserting a new point, the pattern is exited and the Direct-To is performed as usual.

b. When a search pattern is active and a Direct-To is performed to the CSP in history, the current pattern is terminated and the pattern is restarted after passing the CSP.

c. When a search, circle or holding pattern is active and a Direct-To is performed to a non-pattern waypoint in history, the current pattern is terminated, the CSP moves into the future, and the search, circle or holding pattern is restarted after passing the CSP.

d. When a search pattern is active and a Direct-To is performed to a history pattern waypoint other than the CSP, the search pattern resumes the search at that waypoint. All waypoints between the selected waypoint and the previously active waypoint become future waypoints and remain in order.

e. When a Direct-to is performed to a point inserted between two pattern points, the pattern is not exited and the Direct-To is performed as usual.

f. When a Direct-To is performed to a future pattern point, or a point inserted between two pattern points, while the CSP or Datum is the active waypoint, the Direct-To will not function and the scratchpad displays an "ERROR" annunciation.

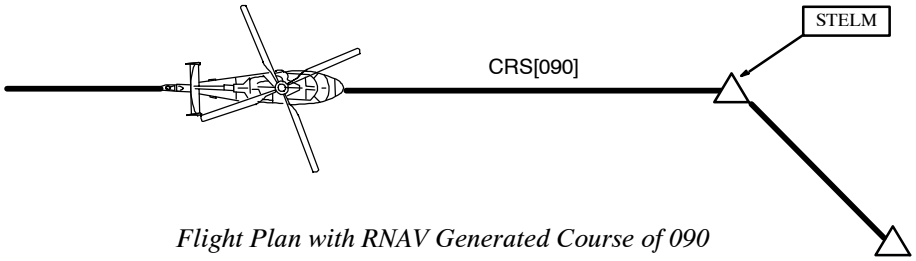
## TO-FROM COURSE EDIT

Normally courses to Flight Plan waypoints are automatically generated. To-From Course Edits (Figure 1-176) enable modification of the inbound course to the active waypoint. In AUTO sequencing mode, course changes are limited to +/- 90 degrees from the current course. The MAN mode allows 360 degree course editing. The following annunciations are provided to warn the user of an invalid course edit:

| ANNUNCIATION | CAUSE |
|---|---|
| ERROR | Invalid data in the scratchpad |
| CRS CHANGE >90 | Attempt to change the inbound course by +/- 90 with the flight plan sequencing in AUTO mode |
| APPROACH ACTIVE | Attempt to change inbound course with LOP or MAP of an approach active |
| CIRCLE ACTIVE | Attempt to change inbound course with circle pattern active |
| HOLD ACTIVE | Attempt to change inbound course with a holding pattern active |
| HOVER ACTIVE | Attempt to change inbound course with HOVER as the active waypoint |
| RENDZ ACTIVE | Attempt to change inbound course with a rendezvous as the active waypoint |

## HOVER AT

An automatic approach to a hover can be executed by using FMS as the NAV source with the APPR mode coupled.




*Flight Plan with RNAV Generated Course of 090*

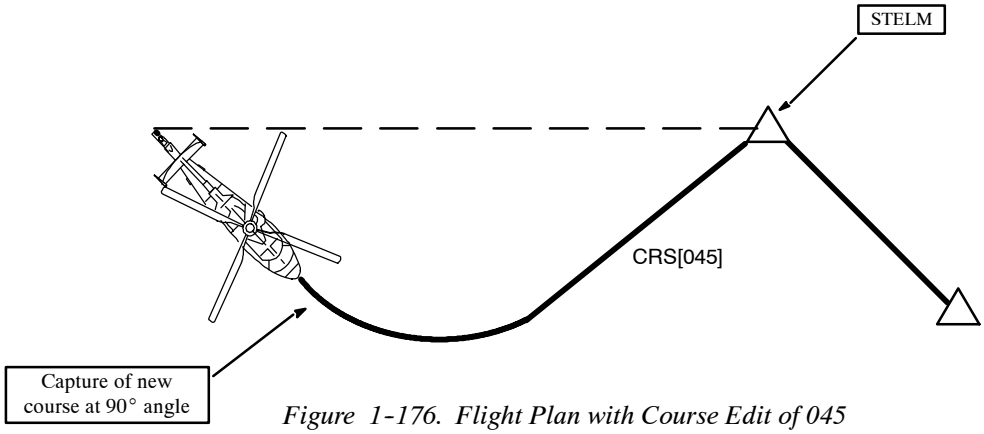



*Figure 1-176. Flight Plan with Course Edit of 045*

The automatic Approach-To-Hover maneuver provides a three-dimensional flight plan approach to a designated waypoint. The automatic approach procedure allows the helicopter to execute a precision approach to any point (fix) without any external navaids. The Approach-To-Hover pattern created consists of a CDU-generated TURN point, a user-defined HOVER point and glide slope. An Approach-To-Hover can be initiated at any flight plan waypoint or any waypoint entered via the scratchpad. Creation of the Approach-To-Hover flight path occurs when an Approach-To-Hover pattern is inserted into the flight plan or is attached to a non-pattern flight plan waypoint. All CDU Approach-To-Hover computations are based on a 70-knot true airspeed.

Pressing the HOV function key displays the Hover-At Page (Figure 1-179), enabling the crew to define the Approach-To-Hover pattern. Information required by the CDU to define an Approach-To-Hover includes hover position, glide slope (GLS) and inbound course (CRS IN). Wind (WND) information may also be edited on the Hover-At Page. To maintain an approach into the programmed wind, manually modifying automatically changes the course in (CRS IN) to the hover point.

Hover position may be defined on the Hover-At Page enabling the pattern to be inserted into the flight plan, or left blank to allow the pattern to be attached to an existing non-pattern flight plan waypoint.

When an Approach-To-Hover is inserted into or attached to the flight plan, the CDU generates a flight path that consists of a point 800 feet downwind of the defined HOVER point, a deceleration point downwind from the 800 foot point to allow for a deceleration from 70 KIAS to a wind corrected zero groundspeed, and a user-defined glide slope projecting from the deceleration point. A TURN point, defined as the intersection of the glide slope and helicopter's altitude, is automatically generated by the CDU and automatically entered into the flight plan. The TURN point is not a fixed point; rather, it changes relative to the helicopter's altitude to ensure intercept of the defined glide slope (i.e., climbing in altitude moves the TURN point farther from the HOVER point). Changes to the location of the TURN point caused by altitude changes are transparent to the operator. The TURN point is fixed when within 1 nm. Once the TURN and HOVER points are established in the flight plan, the FPLN course into the HOVER point cannot be manually modified, and a waypoint may not be inserted between them.

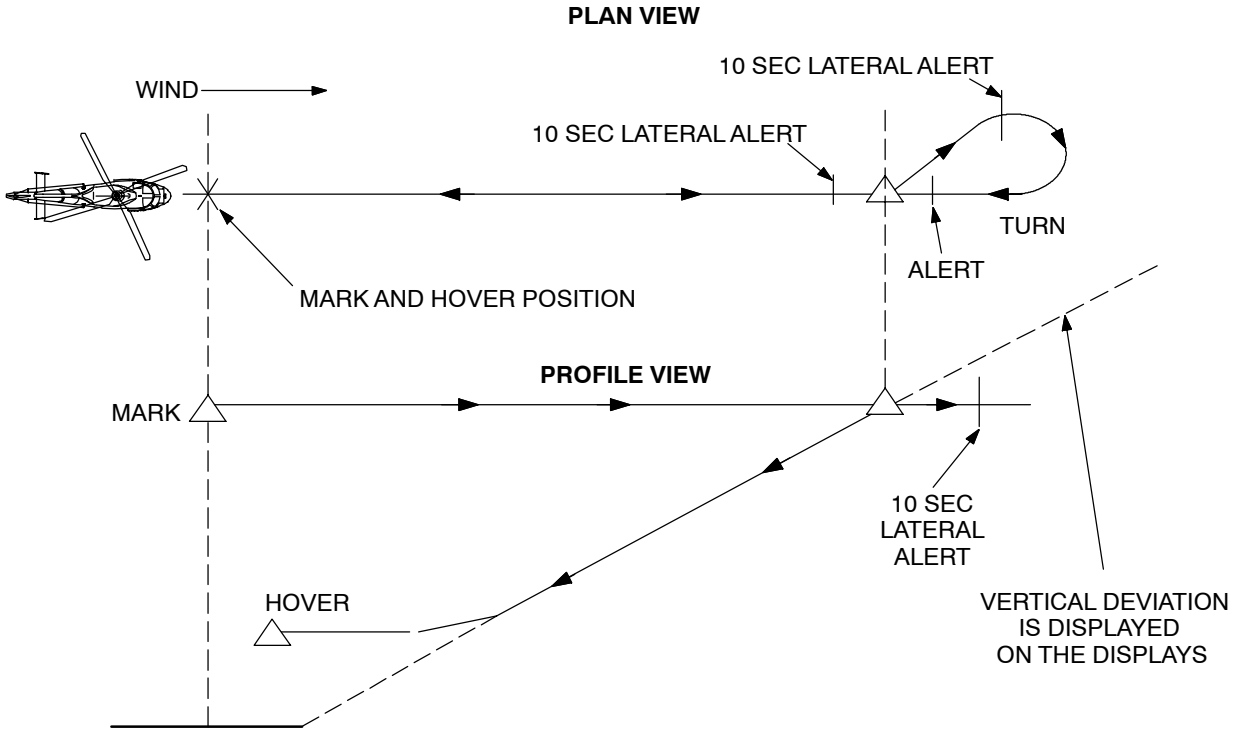



*Figure 1-177. Hover-Vertical Guidance*

The course from the TURN point, through the deceleration and 800 foot points, to the HOVER point is determined by the CDU using either the system default of the best estimate of the current wind, a crew edited wind direction, or a crew edited course (CRSE IN). The course between the TURN and HOVER points can only be changed on the Hover-At Page, and only prior to entering the Approach-To-Hover pattern. Modifying the wind, which automatically changes the CRSE IN, or changing the CRSE IN without changing the wind, changes the course between the TURN and HOVER. A "✓WIND LINE" scratchpad message appears to alert the crew that the manually entered course is greater than +/- 20 degrees from the wind on the Hover-At Page.

**NOTE**

Establishing a course into the Hover-At point which is appropriate for the current wind condition is the responsibility of the pilot/copilot.

**WARNING**

If the manual wind or course entry is significantly different than the actual wind, substantial over-runs and under-runs of the HOVER point will occur.

The CDU provides lateral guidance commands to the flight director to ensure a smooth transition from the TURN point to the HOVER point. If the aircraft's heading at the TURN point is not within 45 degrees of the CRSE IN, an automatic procedure turn is flown. The distance the helicopter travels while on the procedure turn is based on airspeed and current wind conditions. After passing the TURN point, flight plan sequencing automatically switches from AUTO to MAN, and remains in MAN until changed by the crew. As with standard flight plan sequencing, the TURN point flashes for

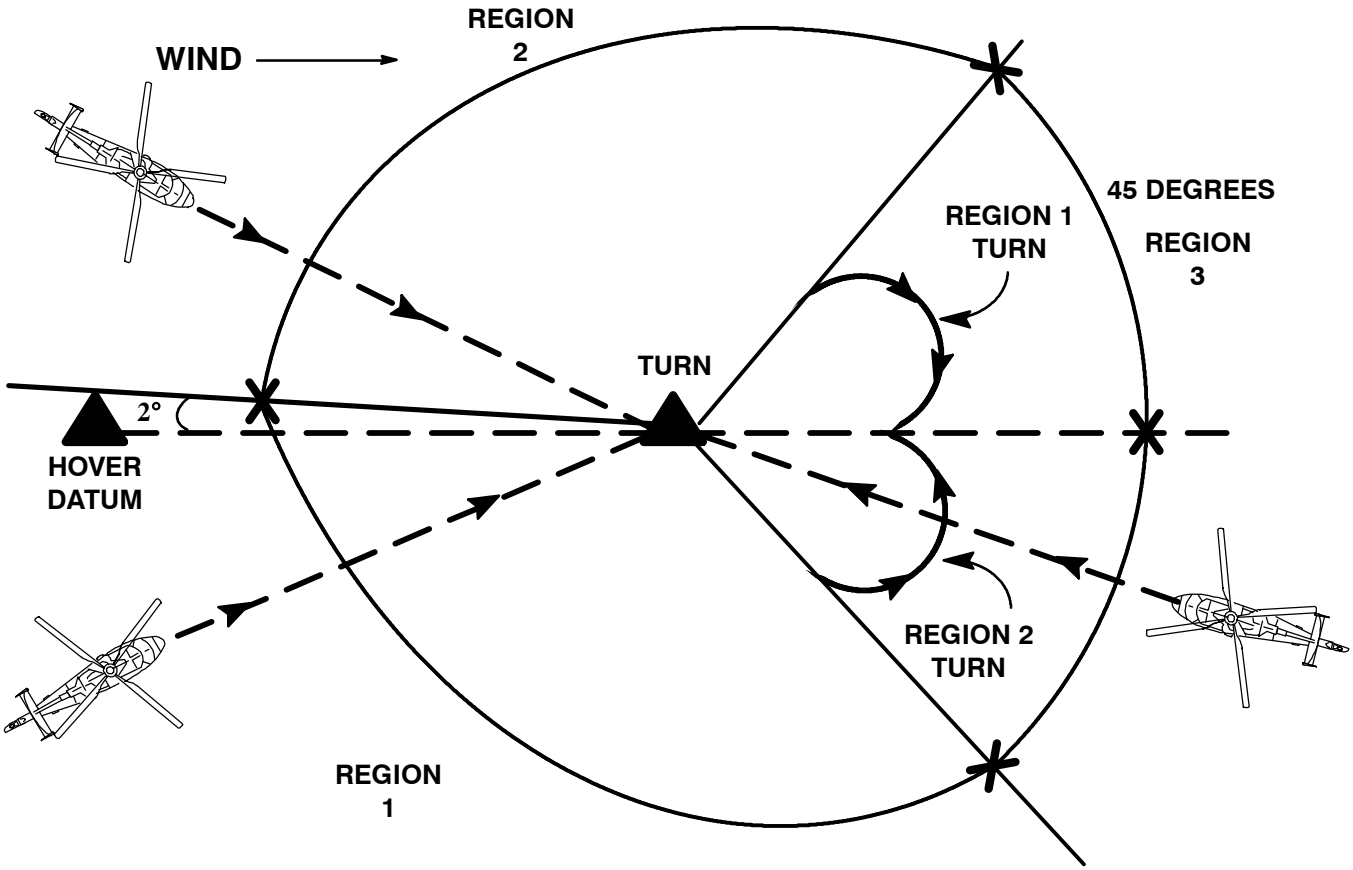



*Figure 1-178. Hover-Lateral Guidance*

10 seconds prior to passing into history. The HOVER point flashes for 10 seconds to indicate its passage.

Primarily referencing the radar altimeter, vertical deviation generated by the CDU is based on the operator-defined glide slope. Shortly after passing the TURN point, the helicopter commences a descent on the glide slope defined on the Hover Page. Vertical deviation scaling is 200 feet equals 2 dots deflection. At approximately 100 feet radar altimeter, the T-HOV mode (armed automatically when APPR was coupled) captures the altitude. The helicopter starts to decelerate and automatically transition to a 50 foot zero groundspeed hover.

**NOTE**

At descent rates greater than 700 fpm, T-HOV will automatically capture at an altitude greater than 100 feet to prevent altitude overshoot.

The vertical profile followed during the Approach-To-Hover is illustrated in Figure 1-177. The lateral profile followed during the Approach-To-Hover is illustrated in Figure 1-178.

There are five special annunciations designed to alert the operator of system degradations specific to the Approach-To-Hover pattern.

| Annunciation | Meaning |
|---|---|
| NO APPR TO HOVER | Radar Altimeter or Barometric Altitude rate invalid at the time the Hov function key pushed; an attempt is made to insert/attach an Approach-To-Hover pattern with an invalid barometric or radar altimeter, radar altitude is greater than 2500 feet, or the system calculated wind is invalid. |
| ⌐WIND LINE | Attempt to manually edit CRSE IN more than 20 degrees from the wind (WND). |
| HOVER IN FPLN | Attempt to insert an Approach-To-Hover pattern into the flight plan when one already exists. |

| | |
|---|---|
| ✓BARO ALT | Valid barometric altimeter data lost during an Approach-To-Hover pattern. |
| HOVER ACTIVE | Attempt to delete the active TO waypoint when it is a Hover waypoint, or if you attempt to perform a course (CRS) edit when Hover is active. |

Manual deletion of the TURN point deletes both the TURN and HOVER points. Manual deletion is accomplished via "-" in the scratchpad and pressing the adjacent left Line Select Key. Once the Approach-To-Hover is active, performing a Direct-To to a future waypoint other than the Hover point is the only method available to remove the pattern. Auto FPLN sequencing must be set by the crew after deleting an Approach-To-Hover pattern or passing the HOVER point. The HOVER point cannot be manually deleted and is not passed to history.

## HOVER-AT PAGE

The Hover-At Page (Figure 1-179) is used to define the Approach-To-Hover to be performed. The Hover Page is accessed by selecting the HOV function key or by selecting LS6 on the Flight Plan Data Page. Accessed from the Flight Plane Data Page, the parameters for the Hover in the Flight Plan are displayed. Once inserted into the FPLN, changes on the Hover-At Page have no affect on the Hover in the flight plan with the exception of CMD airspeed.

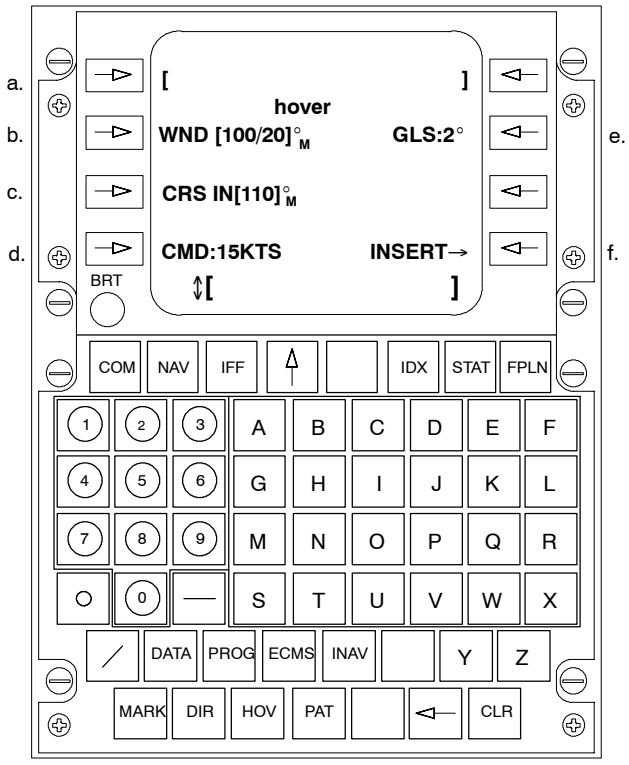



*Figure 1-179. Hover-At Page*

a. Selection with a valid position in the scratchpad enters the position as the Hover-At location. Entry of location is optional. Selection with a "-" in the scratchpad deletes the currently displayed position and the display blanks. Selection with a blank scratchpad and a valid waypoint on DL1 copies the waypoint and associated data to the scratchpad.

b. Displays the surface winds in the magnetic/true reference, selected on Start Page 1/3, to be used for the Hover-At function. If system calculated wind is invalid, the wind field displays dashes, regardless of the wind entry type (system calculated or manually entered). An attempt to enter displays "ERROR." If system wind is valid, selection with a valid wind entry in the scratchpad enters the value as the wind for the hover-at function (not for navigation and guidance functions). Entry of a manual wind on LS2 sets the "Course In" adjacent to LS3 to the same value. Selection with a "-" in the scratchpad will delete the currently displayed wind value and display the system calculated best estimate of wind, and set the Course In by LS3 to the same value.

c. Displays the course in the magnetic/true reference selected on Start Page 1/3, from the TURN point to the HOVER point. The default for the CRS IN is the same as the wind (to allow the hover to be aligned into the wind). Selection with a valid course entry enters the "COURSE IN." Selection with "-" in the scratchpad deletes the currently displayed "Course In" value and displays the system calculated best estimate of wind, if valid.

d. Selection toggles additional commanded airspeed (0,5,10,15 kts) when the Hover-At Point is the active flight plan waypoint. The airspeed is applied at T-HOV capture.

e. Selection toggles the descent angle between 2 and 3 degrees.

f. When Hover-At is not defined in the flight plan, and system calculated wind is valid, selection displays the Flight Plan Page. When DL1 is blank, the Flight Plan Page is displayed with the scratchpad message of "ATTACH HOVER?." The selected waypoint is used as the Hover point. When DL1 contains a position, the Flight Plan Page is displayed with the scratchpad message of "INSERT HOVER?." Selection of a waypoint inserts the Approach-To Hover pattern into the flight plan before the waypoint selected. Selection

with invalid system wind displays the scratchpad message of "NO APPR TO HOVER." With a Hover-At already in the flight plan, selection of LS8 displays the scratchpad message of "HOVER IN FPLN."

## SEARCH AND HOLDING PATTERNS

Search and holding patterns may be established in the flight plan by accessing pattern definition pages, defining pattern parameters, and inserting or attaching the pattern into the flight plan. The Patterns Page provides access to the individual pattern definition pages. The course orientation is specified by either a magnetic or true reference. When a pattern is established in the flight plan, a pattern attribute is assigned to the waypoint. These attributes appear on the right side of the waypoint display line and are assigned to the search and holding patterns provided in the FCMS:

| Pattern | Attribute |
|---|---|
| Ladder | C |
| Spot | D |
| Sector | D |
| Expanding Square | C |
| Circle | C |
| Holding | H |
| Impromptu | none |
| Sweep Width (normal and night vision goggle) | none |

This attribute also appears on the Flight Plan Data Page to indicate access to a pattern definition page. During any active search pattern, the deviation scaling to the MFD is set to Enroute.

The insertion of search and holding patterns into the flight plan is limited to three standard search patterns, one Spot Pattern and one Holding Pattern. An attempt to enter a pattern that exceeds these limits generates a MAX PATTERNS annunciation in the scratchpad. Commence Search Points (CSPs) remaining in history are counted against the MAX PATTERNS limit.

During a search, the CDU manages historical waypoints slightly different than during normal flight plan operation. In normal operations, the CDU maintains the last five waypoints passed as history waypoints. When executing Ladder, Sector and Expanding Square search patterns all pattern waypoints sequence into history until the Commence Search Point (CSP) is the oldest historical waypoint. At that point, the CSP remains in history as long as the pattern is active, and all other waypoints continue to sequence through history as before. Maintaining the CSP in history provides the ability to return to the CSP with the Direct-To function, effectively reactivating a search pattern.

### PATTERNS PAGE

The Patterns Page (Figure 1-180) is accessed via the PAT function key on the CDU. The page access diagram for the Patterns page is shown in Figure 1-181.

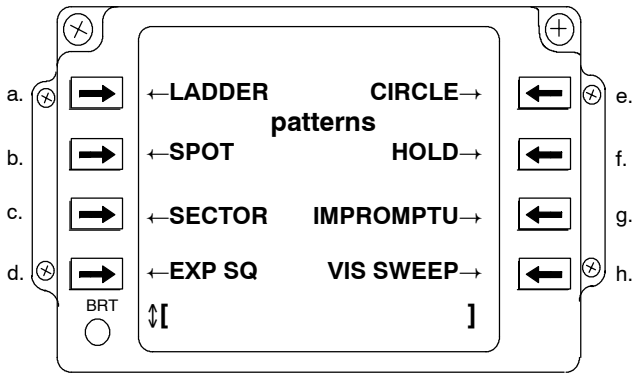



*Figure 1-180. Patterns Page*

a. Selection displays the Ladder search pattern definition page.

b. Selection with a valid position in the scratchpad accesses the Flight Plan Page and displays INSERT SPOT? in the scratchpad. The waypoint in the scratchpad is used as the Datum for calculating the Spot pattern to be inserted into the flight plan. The ERROR scratchpad message is displayed if either of the following conditions is met when the line select is pressed:

1. The scratchpad is empty.
2. Invalid data is in the scratchpad.

c. Selection displays the Sector search pattern definition page.

d. Selection displays the Expanding Square pattern definition page.

e. Selection displays the Circle definition page.

f. Selection displays the Holding pattern definition page.

g. Selection displays the Impromptu search pattern definition page.

h. Selection displays the Sweep-Width page.

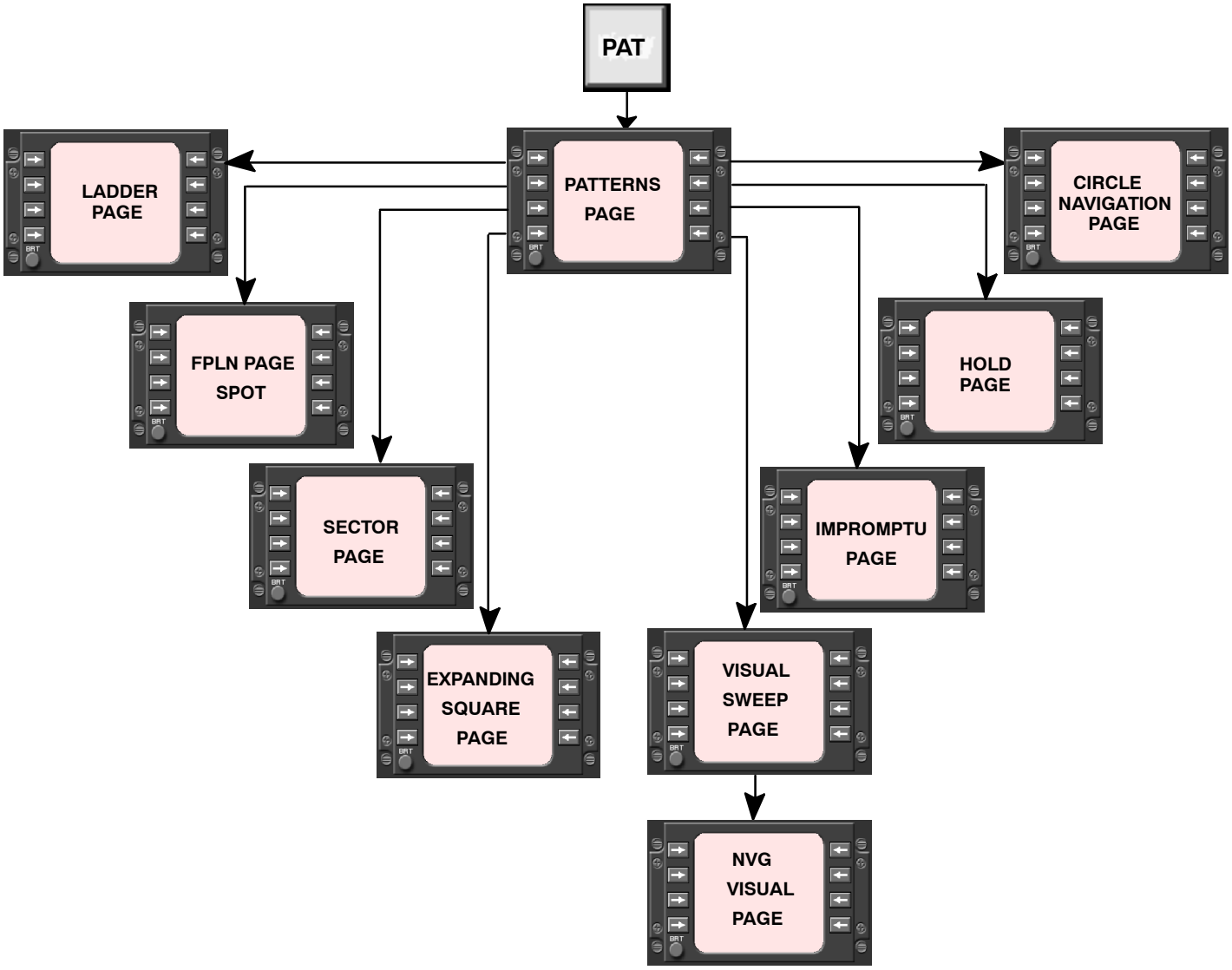



*Figure 1-181. Patterns Page Access Diagram*

## LADDER SEARCH PATTERN

The Ladder Search pattern is defined on the Ladder Page. Two different methods are included for defining the Ladder pattern: defining a Ladder pattern to a Commence Search Point (CSP) in the flight plan where the Ladder is defined to be either left or right of the pattern course from the CSP, and defining a Ladder pattern to a Center Point (CPT) inside a pilot defined search area, where the CDU calculates the CSP. The ladder patterns for a CSP are shown in Figure 1-182. The ladder pattern for a CPT is shown in Figure 1-183 and Figure 1-184.

When the CSP of a ladder search becomes the active waypoint, four system-generated waypoints are added to the Flight Plan Page. These waypoints are identified as BOL (Beginning of Leg) or EOL (End of Leg) points and are sequentially numbered on the right side of the Flight Plan Page display. As the aircraft passes each pattern point, additional BOL or EOL waypoints are automatically added to the Flight Plan. Past pattern waypoints, to include the CSP, move into history. While the pattern is active, the CSP remains in history to allow reactivation of the pattern using the Direct-To function. When the last waypoint is the active waypoint (determined by the CDU based on the defined dimensions of the pattern) the right side of the waypoint displays ADD LEG. Selecting the line select key adjacent to the ADD LEG adds one additional leg to the ladder pattern.

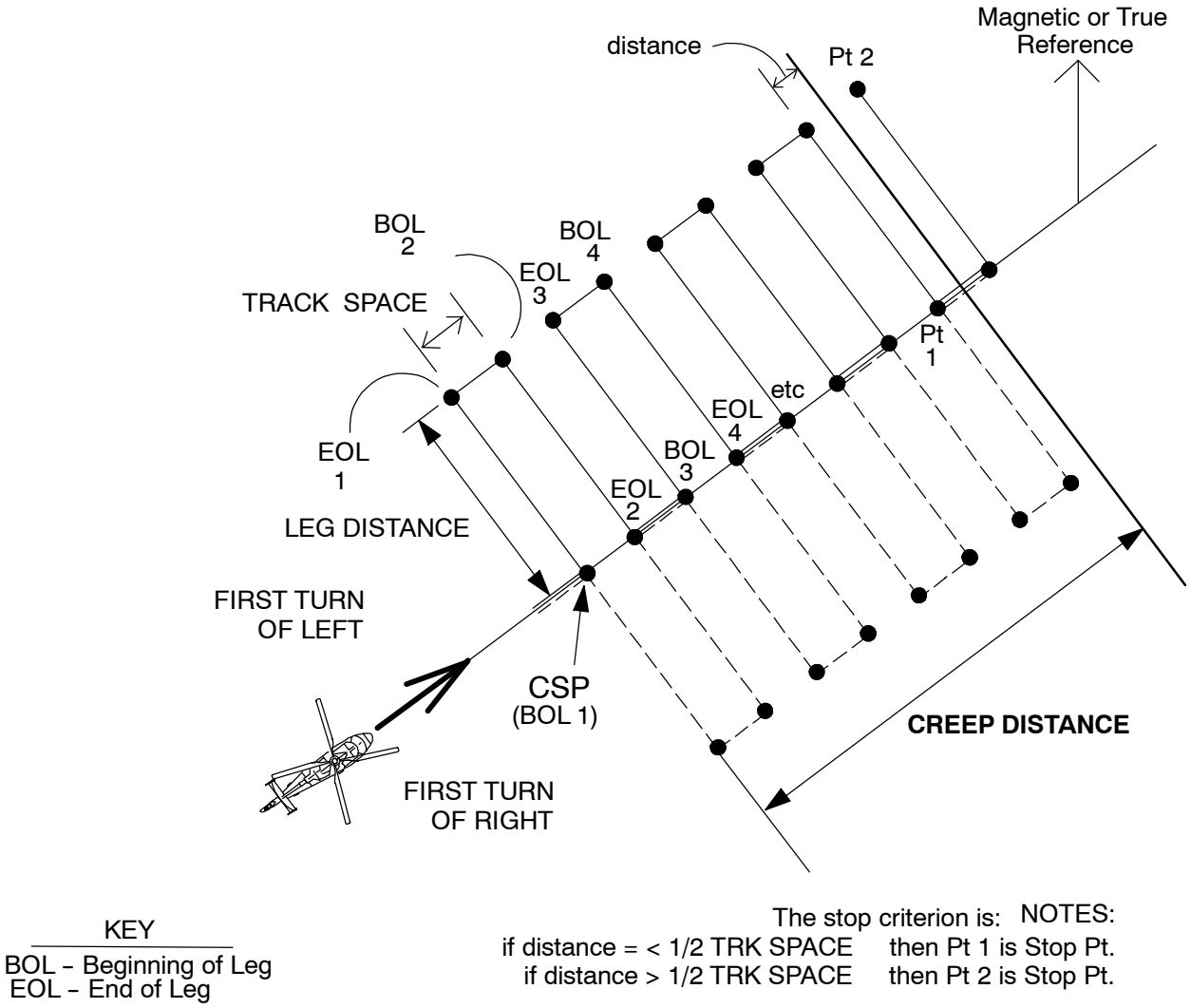



*Figure 1-182. Ladder Search Pattern Definition Attached to a CSP*

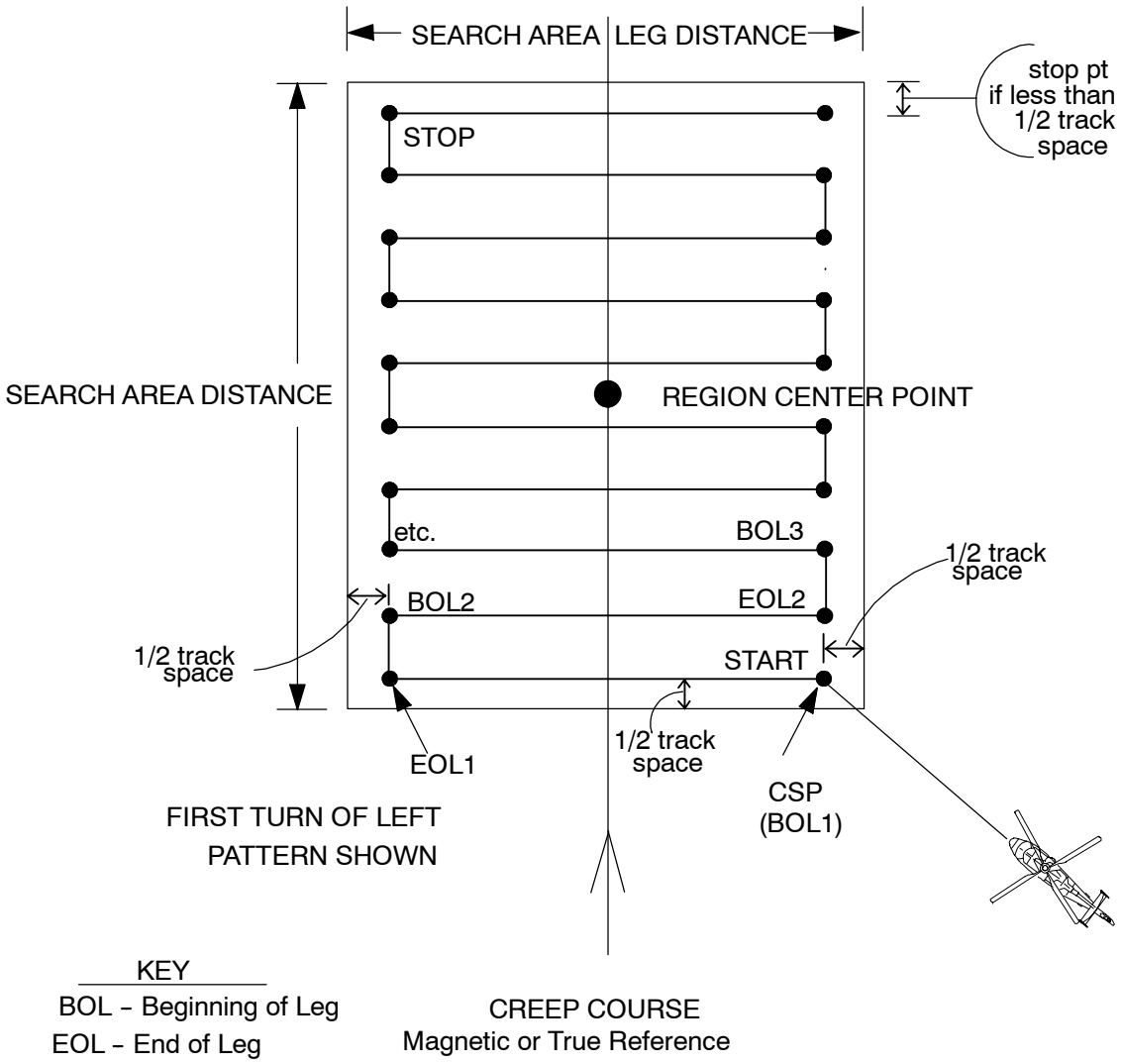



*Figure 1-183. Ladder Search Pattern Definition for a Search Area Center Point - Example 1*

Note: For this case the last leg is actually outside the search area in order to search the cross hatched area.

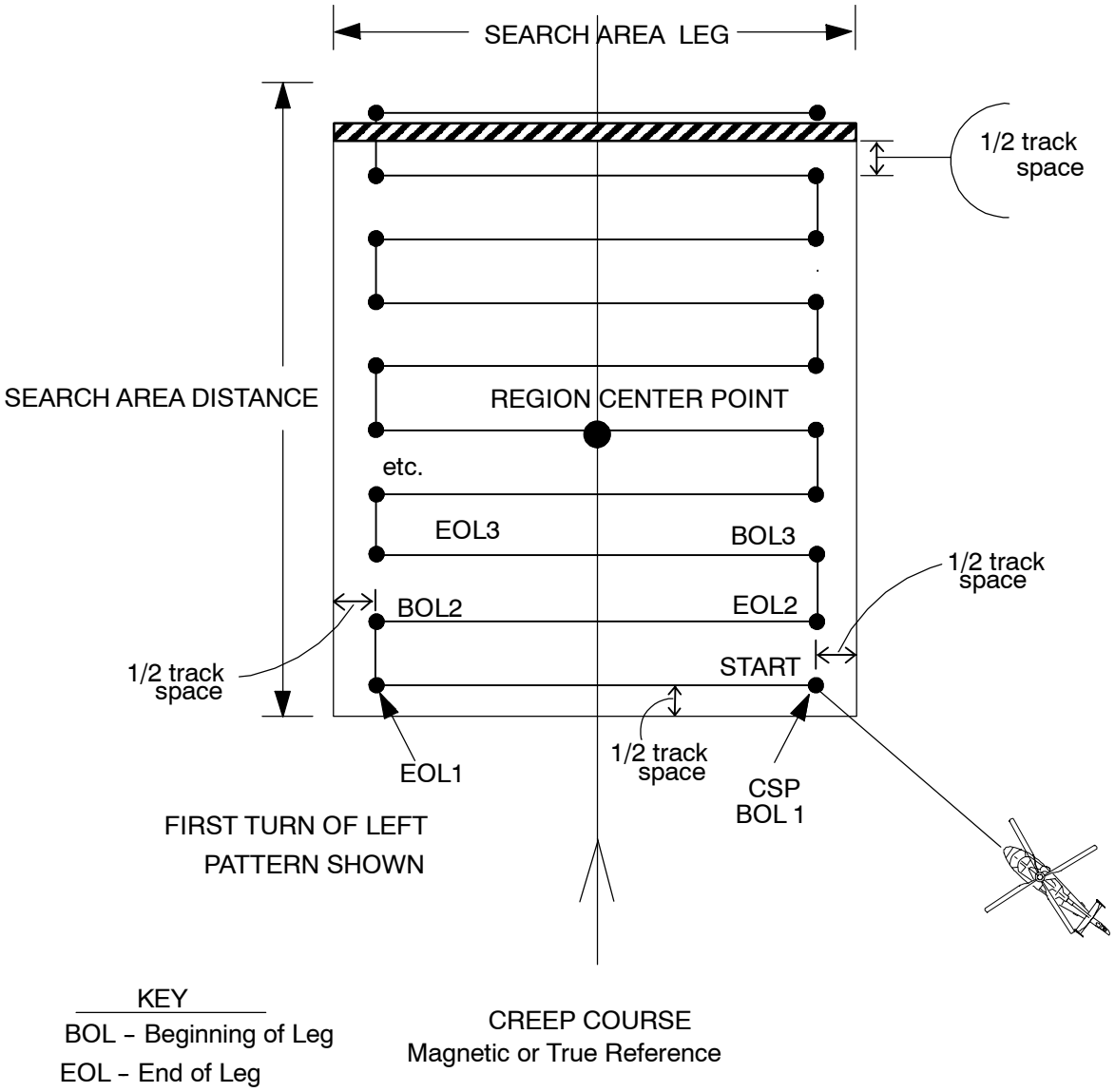



*Figure 1-184. Ladder Search Pattern Definition for a Search Area Center Point - Example 2*

## Ladder Page

Selecting LADDER on the Patterns Page or selecting LS6 next to the attribute C of a previously defined pattern (Datum/commence search point) on the Flight Plan Data Page displays the Ladder Page. When accessed from the Flight Plan Data Page, the parameters used to define the Ladder pattern in the flight plan are displayed. The Ladder pattern is inserted into the flight plan with either the CSP waypoint defined, or attached to a waypoint in the flight plan (Figure

1-185). Once inserted into the flight plan, changes to the pattern definition entries have no affect on the pattern being flown, and a new pattern must be inserted into the flight plan. See Table 1-10 for valid data ranges.

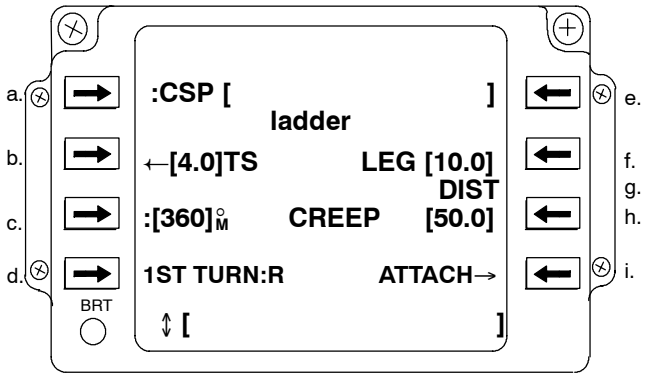



*Figure 1-185. Commence and Search Point (CSP) Display*

a. Selection with a blank scratchpad and a blank DL1 toggles the field between "CSP" and "CPT." Toggling to "CSP" causes the page to appear like the CDU Page in Figure 1-185. Toggling to "CPT" causes the page to appear like the CDU Page in Figure 1-186. Selection with a valid position entry in the scratchpad enters the position as the CSP or CPT for the pattern. Default at system power-up is blank. Selection with a "-" in the scratchpad deletes the displayed "CSP" or "CPT" waypoint.

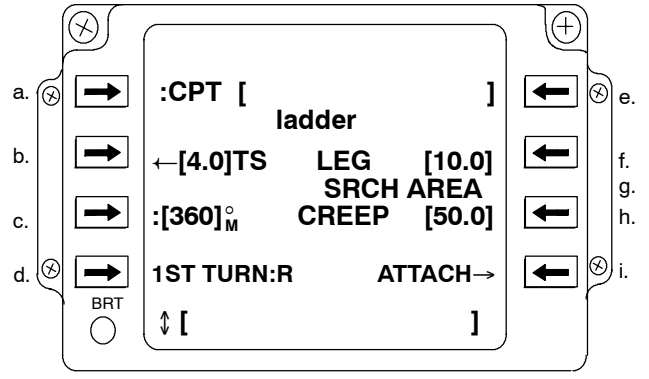



*Figure 1-186. Center Point (CPT) Display*

b. Enters the track spacing. With a blank scratchpad, selection displays the Sweep-Width Page.

c. Enters the search creep course for the pattern, magnetic or true reference. At power-up and when initially accessing the page for the initial pattern definition, the default magnetic or true reference for the creep input is determined by the Mag/True system selection on Start Page 1/3.

**WARNING**

Failure to ensure the correct magnetic or true reference for the defined search pattern can result in significant pattern misalignment. The misalignment may result in unplanned hazards to navigation along the flight plan route.

d. Toggles between L for left and R for right, for the direction of the first turn. The first turn is the turn at the end of the first leg. Defaults to Right at system power-up.

e. Selection with a valid position entry in the scratchpad enters the position as the CSP or CPT for the pattern. Selection with a blank scratchpad and a valid waypoint on DL1 copies the waypoint and the associated data into the scratchpad.

f. Enters the pattern leg length.

g. Displays DIST when LS1 is toggled to CSP, and SRCH AREA when LS1 is toggled to CPT.

h. Enters the pattern creep distance.

i. ATTACH → is displayed until a valid position is entered in DL1. Once a position is entered, INSERT → is displayed adjacent to LS8. Selection with DL1 empty displays the Flight Plan Page with ATTACH LADDER? displayed in the scratchpad. Selection with DL1 containing a position displays the Flight Plan Page with INSERT LADDER? displayed in the scratchpad. Without all the parameters for the Ladder pattern defined, "ENTER PARAMETERS" is displayed in the scratchpad. Selection with an entered creep distance, less than the track space, displays "ERROR" in the scratchpad.

| Data Type | Entry Range | Display Range |
|---|---|---|
| Track Space | 0.1-0.95 nm (by 0.05 only)<br>1.0 to 99.9 nm (by 0.1) | 0.1-0.95 nm (by 0.05 only)<br>1.0 to 99.9 nm (by 0.1) |
| Creep Space | 000-360 degrees | 001-360 degrees |
| Leg Length | 0.1-99.9 nm (by 0.1) | 0.1-99.9 nm (by 0.1) |
| Creep Distance or Search Area Length | 0.1-99.9 nm (by 0.1)<br>100-999 nm (by 1 only) | 0.1-99.9 nm (by 0.1)<br>100-999 nm (by 1) |

*Table 1-10. Ladder Page Valid Data Ranges*

## SPOT SEARCH PATTERN

The Spot search pattern is a special case of the Sector search pattern, and is defined as:

- Radius of 2 nautical miles
- Track Space of 2 nautical miles
- Sector Angle = 60 degrees

The Spot Search Pattern (Figure 1-187) provides for a one lap Sector Search Pattern. The Spot pattern can be within an active search pattern or within the normal flight plan. A valid position entry, used to generate the Spot pattern, must be displayed in the scratchpad at the time the Spot pattern is activated.

Selecting SPOT on the Patterns Page initiates the inserting of a Spot pattern by displaying the Flight Plan Page with "INSERT SPOT?" displayed in the scratchpad. The Spot pattern is inserted into the flight plan before the waypoint selected. If the Spot search pattern is inserted into the flight plan as the TO waypoint, a system generated turn point is inserted into

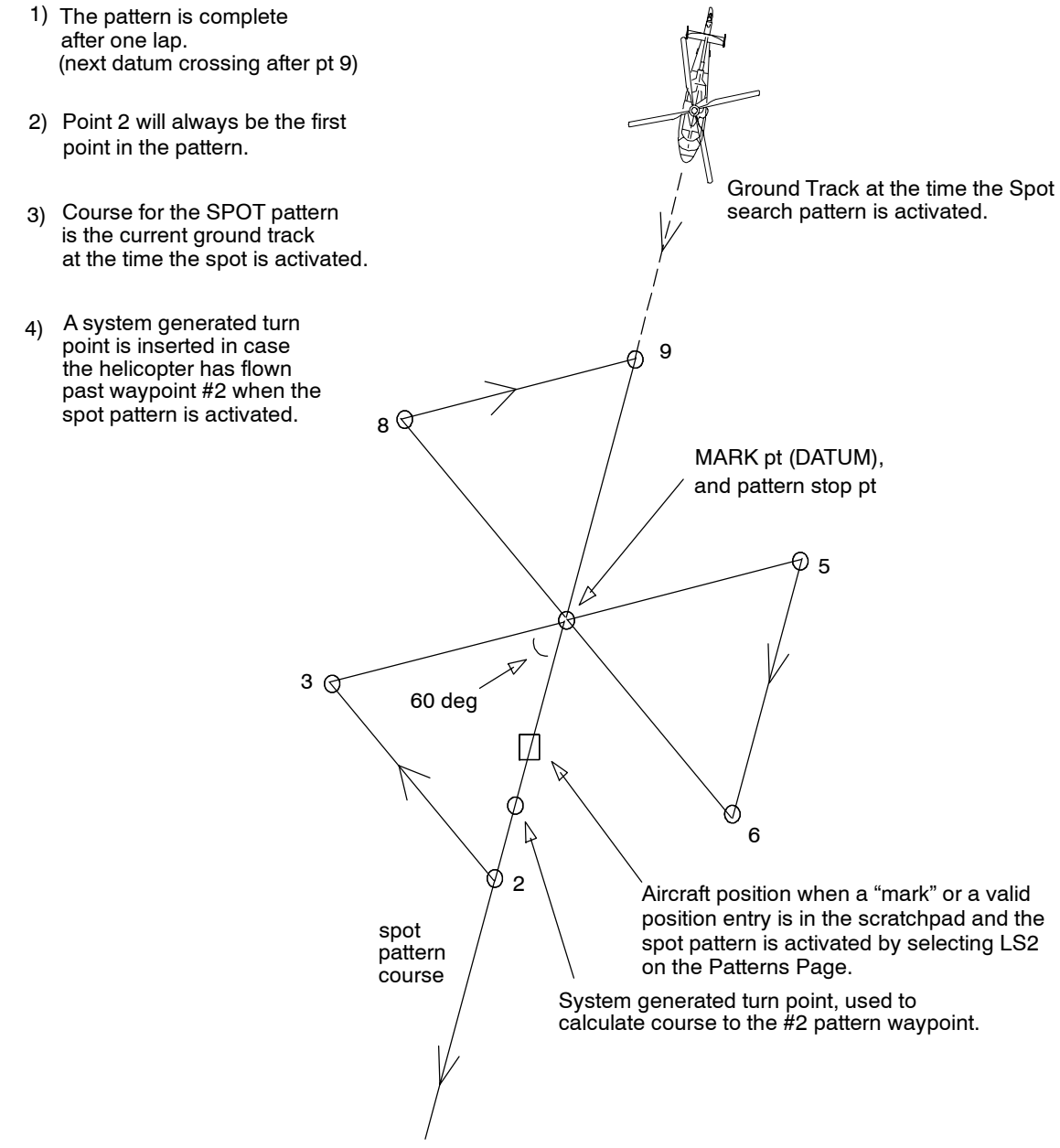



*Figure 1-187. Spot Search Pattern*

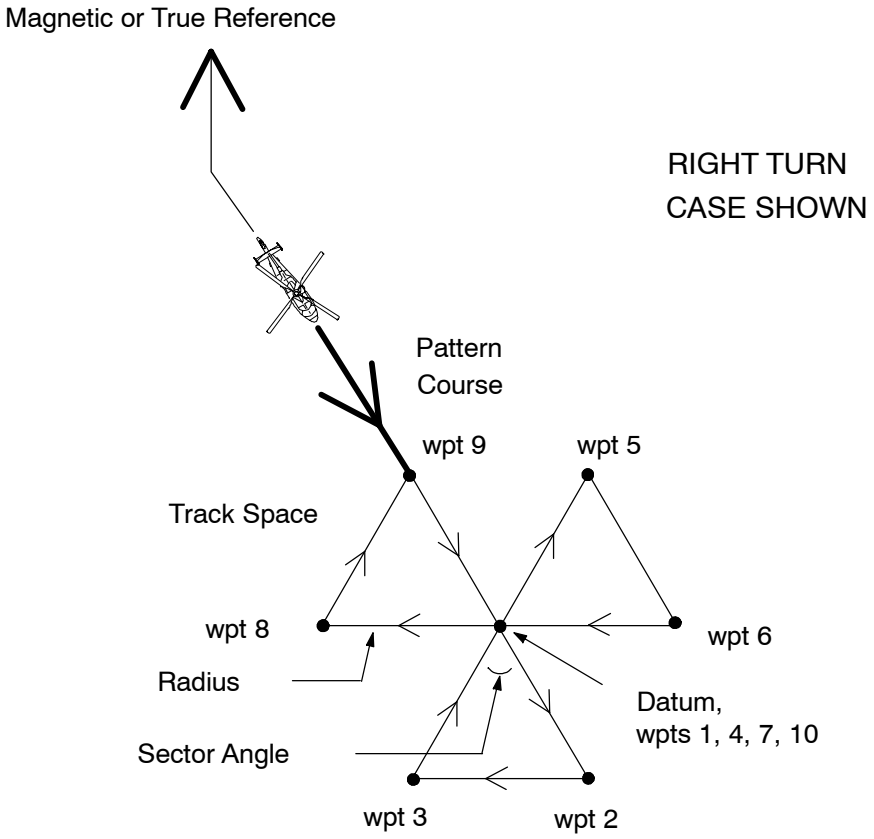
the flight plan to ensure a smooth transition to the Spot pattern. The turn point provides turn anticipation and prevents "S" turns during capture of the course to the pattern waypoint #2. Only one Spot pattern is allowed in the flight plan at any one time.

## SECTOR SEARCH PATTERN

The Sector search pattern (Figure 1-188) is defined by the Sector definition page. The CDU generates waypoints as shown for the Sector pattern until the pattern is terminated. The pattern has no defined stop waypoint, and may be terminated by either a DIR TO a waypoint outside the search pattern or by deleting the Datum.

### Sector Page

The Sector Page (Figure 1-189) is displayed by selecting SECTOR on the Patterns Page. When accessed from the Patterns Page, default values are displayed. Selection of the right line select key next to the attribute D (Datum/commence search point) on the Flight Plan Data Page accesses the Sector Page for the defined Sector Search. When accessed from the Flight Plan Data Page, the parameters used to define the Sector pattern in the flight plan are displayed. The Sector pattern is inserted into the flight plan when the CSP waypoint is defined, if the CSP Waypoint is not defined or attached to a waypoint in the flight plan. Once inserted into the flight plan, changes to the pattern definition entries have no affect on the pattern being flown. To change the current pattern, the pattern must be exited, and a new pattern with the updated pattern definitions must be inserted into the flight plan. See Table 1-11 for valid data ranges.




NOTE: The aircraft course into the Datum is defined by the flight plan course to the Datum.

*Figure 1-188. Sector Search Pattern*

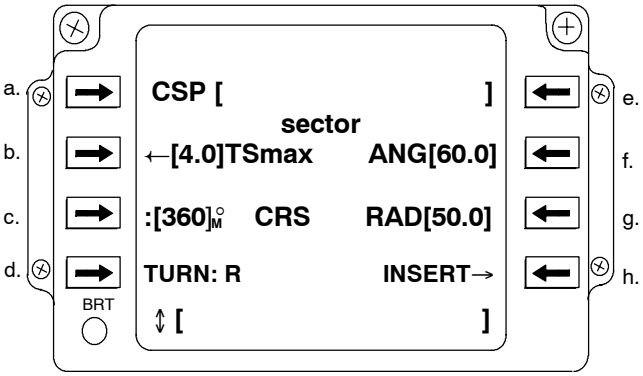



*Figure 1-189. Sector Page*

| Data Type | Entry Range | Display Range |
|---|---|---|
| Maximum Track Space | 1.1 to 99.9 nm (by 0.1) | 1.1 to 99.9 nm (by 0.1) |
| Course | 000-360 degrees | 001-360 degrees |
| Sector Angle | 1-90 degrees (by 1 degree) | 01-90 degrees (by 1 degree) |
| Sector Radius | 0.2-0.95 nm (by 0.05 only) 1.0-99.9 nm (by 0.1) | 0.25-0.95 nm (by 0.05) 1.0-99.9 nm (by 0.1) |

*Table 1-11. Sector Page Valid Data Range*

Upon initial entry of the parameters:

- Initial entry of maximum TRK SPACE computes RADIUS
- Initial entry of RADIUS computes TRK SPACE

Upon editing existing parameters:

- Editing the ANGLE computes the maximum TRK SPACE
- Editing the maximum TRK SPACE computes ANGLE
- Editing the RADIUS computes ANGLE

a. Selection with a valid waypoint in the scratchpad enters the position as the CSP for the pattern. Default at system power-up is blank. Selection with a "-" in the scratchpad deletes the displayed CSP position. Selection with a blank scratchpad and a valid waypoint on DL1 copies the waypoint and the associated data into the scratchpad.

b. Enters the maximum track spacing. With a blank scratchpad, selection displays the Sweep-Width Page.

c. Enters the search course orientation for the pattern, magnetic or true reference. Selection with a blank scratchpad toggles between magnetic and true reference. The default magnetic or true reference for the creep input is determined by the Mag/True system selection on Start Page 1/3.

d. Toggles between L for left and R for right, for the direction of the turns. Defaults to Right at system power-up.

e. Selection with a valid waypoint in the scratchpad enters the position as the CSP for the pattern. Default at system power-up is blank. Selection with a blank scratchpad and a valid waypoint on DL1 copies the waypoint and the associated data into the scratchpad.

f. Enters the sector pattern angle. Defaults to 60 degrees at system power-up.

g. Enters the sector pattern radius.

h. ATTACH → is displayed until a valid position is entered in DL1. Once a position is entered, INSERT → is displayed adjacent to LS8. Selection with the DL1 empty displays the Flight Plan Page with "ATTACH SECTOR?" displayed in the scratchpad. Selection with DL1 containing a position displays the Flight Plan Page with "INSERT SECTOR?" displayed in the scratchpad. Without all the parameters for the Sector pattern defined "ENTER PARAMETERS" is displayed in the scratchpad.

## EXPANDING SQUARE

The Expanding Square Search pattern is defined on the Expanding Square Page. The CDU generates waypoints until the stop criterion is satisfied. The Expanding Square Pattern is shown in Figure 1-190.

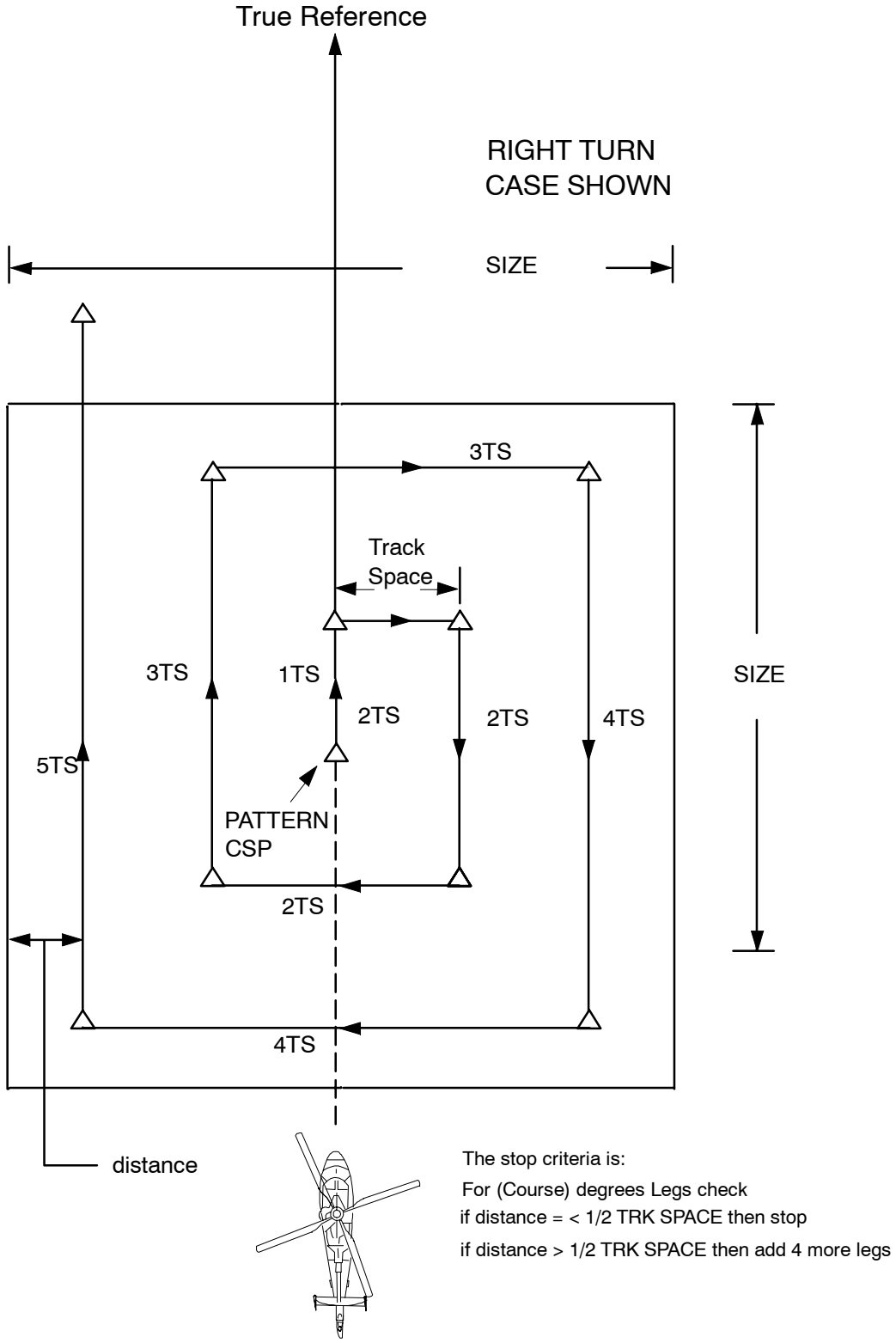



*Figure 1-190. Expanding Square Pattern*

## Expanding Square Page

The Expanding Square Page (Figure 1-191) is displayed by selecting EXPSQ on the Patterns Page. When accessed from the Patterns Page, the default values are displayed. Selection of the right line select key next to the attribute C (Datum/ commence search point) on the Flight Plan Data Page accesses the Expanding Square Page for a previously defined

Expanding Square Search. When accessed from the Flight Plan Data Page, the parameters used to define the Expanding Square pattern in the flight plan are displayed. The Expanding Square pattern is inserted into the flight plan when the CSP waypoint is defined, if the CSP waypoint is not defined or attached to a waypoint in the flight plan. Once inserted into the flight plan, changes to the pattern definition entries have no affect on the pattern being flown. To change the current pattern, the pattern must be exited, and a new pattern with the updates pattern definitions must be inserted into the flight plan. See Table 1-12 for valid data ranges.

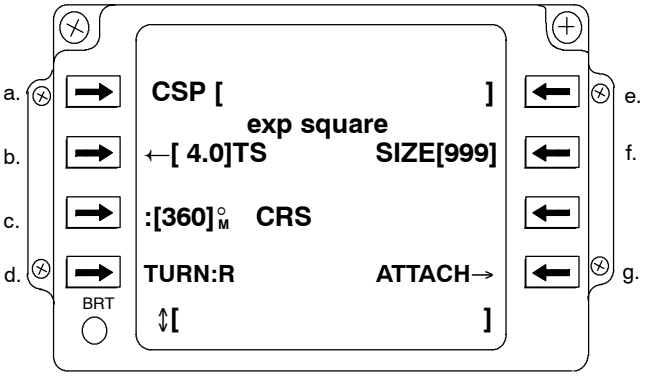



*Figure 1-191. Expanding Square Page*

| Data Type | Entry Range | Display Range |
|---|---|---|
| Track Space | 0.1-0.95 nm (by 0.05 only)<br>1.0-99.9 nm (by 0.1) | 0.1-0.95 nm (by 0.05)<br>1.0-99.9 nm (by 0.1) |
| Course | 000-360 degrees | 001-360 degrees |
| Expanding Square Size | 1-999 nm (by 1) | 1-999 nm |

*Table 1-12. Expanding Square Page Valid Data Ranges*

a. Selection with a valid waypoint in the scratchpad enters the position as the CSP for the pattern. Default at system power-up is blank. Selection with a "-" in the scratchpad deletes the displayed CSP position. Selection with a blank scratchpad and a valid waypoint on DL1 copies the waypoint and the associated data into the scratchpad.

b. Enters the track spacing. With a blank scratchpad, selection displays the Sweep-Width Page.

c. Enters the search course orientation for the pattern, magnetic or true reference. Selection with blank scratchpad toggles between magnetic and true reference. The default magnetic or true reference for the creep input is determined by the Mag/True system selection on Start Page 1/3.

d. Toggles between L for left and R for right, for the direction of the turns. Defaults to Right at system power-up. Selection with a blank scratchpad and a valid waypoint on DL1 copies the waypoint and the associated data into the scratchpad.

e. Selection with a valid waypoint in the scratchpad enters the position as the CSP for the pattern. Defaults to blank at system power-up. Selection with a blank scratchpad and a valid waypoint on DL1 copies the waypoint and the associated data into the scratchpad.

f. Enters the Expanding Square box size to be searched. Defaults to blank at system power-up.

g. "ATTACH →" is displayed until a valid position is entered in DL1. Once a position is entered, INSERT → is displayed. Selection with DL1 empty displays the Flight Plan Page with "ATTACH EXP SQ?" displayed in the scratchpad. Selection with DL1 containing a position displays the Flight Plan Page with "INSERT EXP SQ?" displayed in the scratchpad. Without all the parameters for the Sector pattern defined "ENTER PARAMETERS" is displayed in the scratchpad.

## CIRCLE SEARCH PATTERN

The Circle pattern generates a flight path that provides a constant radius circle around a fixed point. The fixed point of the Circle pattern is named the centered point (CPT). The Circle Pattern is shown in Figure 1-192.

The Flight Management System (FMS) provides steering data to maintain the helicopter on the constant radius Circle pattern. A "Direct-To" is required to terminate the Circle pattern. Two different entry scenarios are provided by the FMS: a straight in entry and an entry from within the radius of the circle pattern. The straight-in entry condition for the Circle pattern is shown in Figure 1-194. The entry for a helicopter position inside the Circle radius, or past the pattern activation waypoint, is shown in Figure 1-195. Edits to the pattern while in the Circle pattern are applied as shown in Figure 1-196. Circle Page data ranges are shown in Table 1-13.

| Data Type | Entry Range | Display Range |
|---|---|---|
| Circle Radius | 0.5-0.95 nm (by 0.05 only)<br>1.0 to 99.9 nm (by 0.1) | 0.50-0.95 mn (by 0.05)<br>1.0-99.9 nm (by 0.1) |

*Table 1-13. Circle Page Valid Data Ranges*

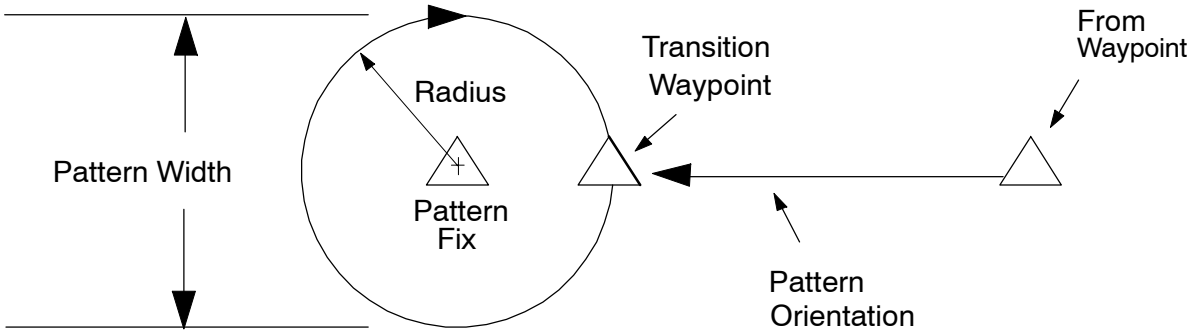



*Figure 1-192. Circle Pattern*

## Circle Pattern Page

The Circle Page (Figure 1-193) is accessed by selecting CIRCLE on the Patterns Page. When accessed from the Patterns Page, the default values are displayed. Selection of the right line select key next to the attribute C (Datum/commence search point) on the Flight Plan Data Page accesses the Circle Page for a previously defined Circle Pattern. The Circle pattern is inserted into the flight plan when the CPT waypoint is defined, if the CPT waypoint is not defined or attached to a waypoint in the flight plan. If the crew changes any of the Circle pattern definition parameters while in the pattern, selecting LS8 automatically applies the changes to the pattern being flown.

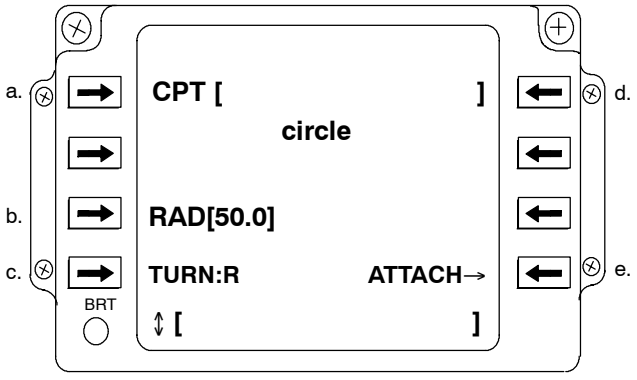



*Figure 1-193. Circle Page*

a. For a circle not in the flight plan:

- Selection with a valid waypoint in the scratchpad enters the position as the CPT for the pattern. Default at system power-up is blank.
- Selection with a "-" in the scratchpad deletes the displayed CPT position.

When modifying the circle pattern in the flight plan:

- Selection with a valid position in the scratchpad enters the position as the CPT.
- Selection with a "-" in the scratchpad displays "INVALID DELETION" in the scratchpad.

  Selection with a blank scratchpad and a valid waypoint on DL1 copies the waypoint and the associated data into the scratchpad.

b. Enters the Circle pattern radius in nm.

c. Toggles between L for left and R for right, for the direction of turn. Defaults to Right at system power-up.

d. Selection with a valid position entry in the scratchpad enters the position as the CPT for the pattern. Default at system power-up is blank. Selection with a "-" deletes the displayed CPT position. Selection with a blank scratchpad and a valid waypoint on DL1 copies the waypoint and the associated data into the scratchpad.

e. ATTACH → is displayed until a valid position is entered in DL1. Once a position is entered, INSERT → is displayed adjacent to LS8. Selection with the DL1 empty displays the Flight Plan Page with "ATTACH CIRCLE?" displayed in the scratchpad. Selection with DL1 containing a position displays the Flight Plan Page with "INSERT CIRCLE?" displayed in the scratchpad. Without all the parameters for the Sector pattern defined, "ENTER PARAMETERS" is displayed in the scratchpad. If the Circle pattern in the flight plan is being edited, the label adjacent to LS8 changes to APPLY, selection deletes the current Circle pattern, inserts the new Circle pattern, and displays the Flight Plan Page. If the Circle pattern was the active waypoint in the flight plan a Direct-To the new Circle pattern is completed.

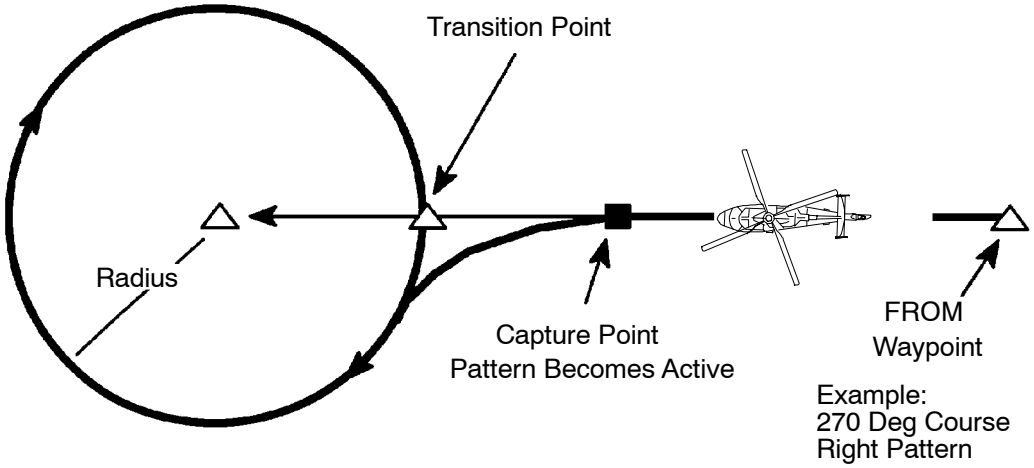



*Figure 1-194. Circle Pattern Straight-In Entry*

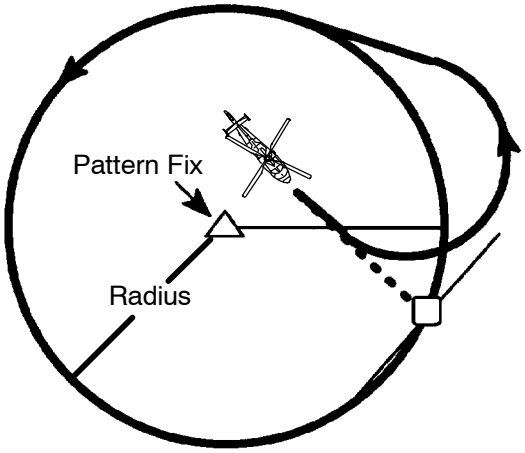



*Figure 1-195. Circle Pattern Inside Capture Entry*

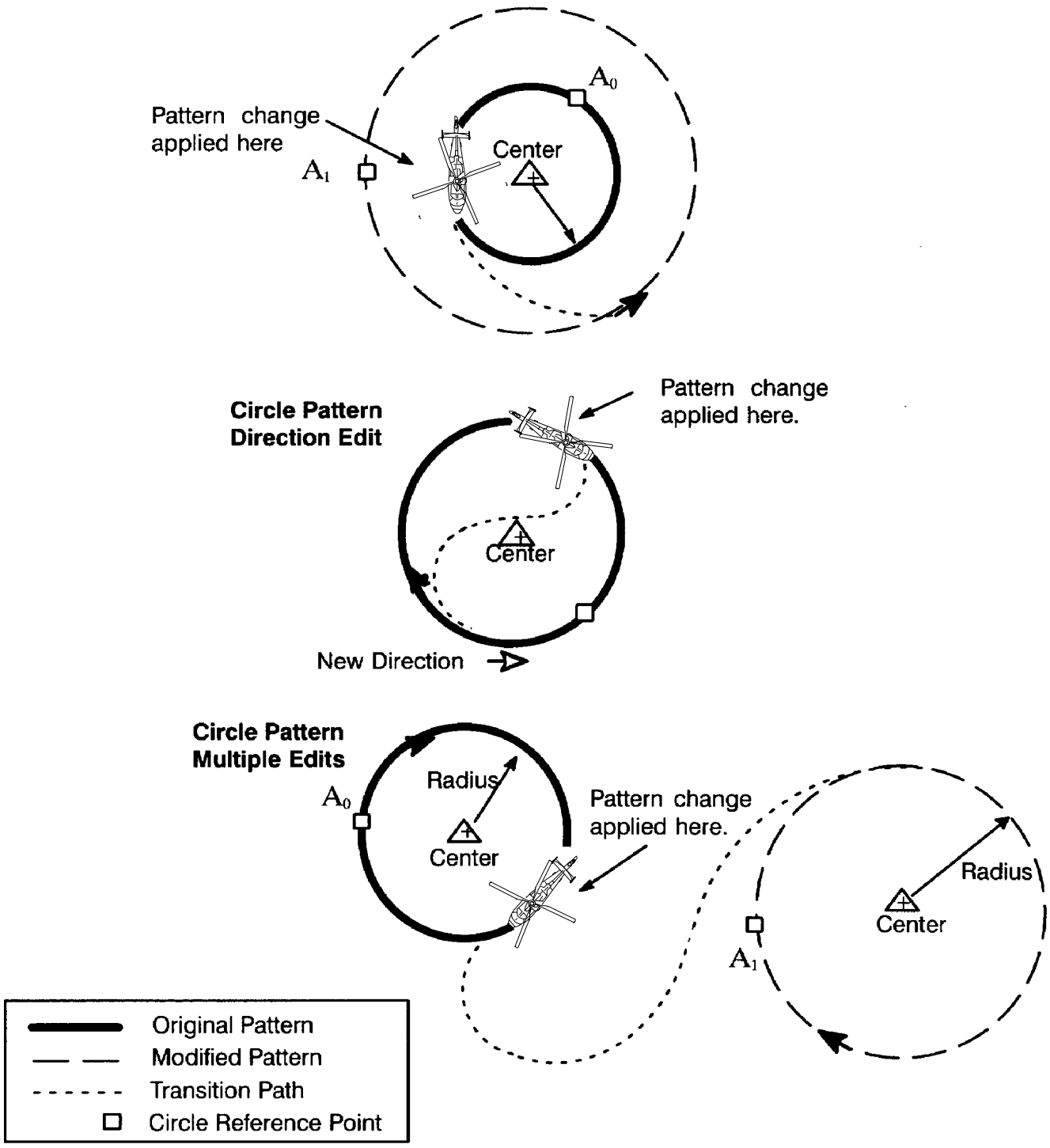



*Figure 1-196. Circle Pattern Edits*

## HOLDING PATTERNS

One holding pattern may be applied to a single fixed waypoint in the flight plan. A holding pattern may be inserted or attached to any waypoint, or may be assigned to the aircraft's present position using the HOLD PPSN feature. Holding guidance is activated when the waypoint identified as the holding fix is passed the first time. At that time, all displays reference the inbound course entered on the holding page and leg sequencing is suspended. While the Holding guidance is active, course editing on the Flight Plan Page is disabled. Additionally, the active waypoint may not be deleted nor may a different waypoint be inserted as the active waypoint. The lateral deviation distance and TO/FROM flag are computed with respect to the inbound holding course, regardless of the aircraft's location in the holding pattern. If the crew changes any of the holding pattern definition parameters while in the pattern, the changes are applied after the aircraft passes the holding fix (i.e., transition from "TO" to "FROM").

Holding patterns may be terminated in two ways by:

1. Cancellation, in which case a leg switch to the next flight plan waypoint occurs when the fix is crossed again (if automatic flight plan advancing is selected).

2. Direct-To to a future waypoint may be executed, removing the holding fix from the flight plan along with its associated waypoint.

Default values for holding patterns are as follows:

1. Inbound course from flight plan is inbound holding course.

2. Right-hand turn.

3. Pattern length is 3.0 miles.

Holding pattern entry and guidance are computed in accordance with standard Federal Aviation Administration (FAA) procedures as shown in Figure 1-197. Figure 1-197 illustrates the geometry for a standard (clockwise) holding pattern. For left-hand turns a mirror image of the entry and guidance applies.

### Hold Page

The Hold Page (Figure 1-198) is accessed by selecting HOLD on the Patterns Page or selecting the attribute H (commence hold point) on the Flight Plan Data Page. When accessed from the Patterns Page, the default values are displayed. When accessed from the Flight Plan Data Page, the parameters used to define the Hold pattern in the flight plan are displayed. Changes to the pattern definition entries have no effect on a pattern currently defined in the flight plan. Refer to Table 1-14 for valid data ranges.

a. Selection with a valid waypoint in the scratchpad enters the position as the CHP for the pattern. Default at system power-up is blank. With a CHP displayed, selection with a "-" in the scratchpad deletes the displayed CHP. When modifying the hold pattern that is in the flight plan, selection with data in the scratchpad displays the scratchpad message of "ERROR." Selection with a blank scratchpad and a valid waypoint copies the waypoint and the associated data into the scratchpad.

b. Enters the inbound course for use when holding guidance is activated. The current inbound leg course to the fix from the Flight Plan Page is used (either computed TO-TO or pilot entered course edit) for computing the entry advisory if the operator has not entered a value. Once holding guidance is activated, changes to the inbound course may only be made on this page. Magnetic (M) or True (T) reference for the course input is determined by the Mag/True system selection on Start Page 1/3. Prior to the hold pattern being inserted into the flight plan, selection with a "-" in the scratchpad deletes the displayed inbound course and sets the course display to blanks (default of inbound course per the flight plan). After the hold pattern has been inserted into the flight plan, selection with a "-" in the scratchpad displays "ERROR" in the scratchpad alternating with the data.

c. Enters pattern length. Defaults to 3.0 nm at system power-up.

d. Toggles between right or left turns. Defaults to right at system power-up.

e. Selection with a valid waypoint in the scratchpad enters the position as the pattern CHP. Default at system power-up is blank. Selection with a blank scratchpad and a valid waypoint copies the waypoint and the associated data into the scratchpad.

f. Selection with a blank scratchpad displays "CONFIRM HOLD PPSN" in the scratchpad. Confirmation is required within 3 seconds. Selection when the scratchpad is displaying "CONFIRM HOLD PPSN" uses the navigation best estimate of present position as a Commence Hold Point, current aircraft course for hold orientation, hold leg Length and Turn, and insert a hold as the TO event of the flight plan, display the Flight Plan Page, and clear the scratchpad. If a future Hold is in the

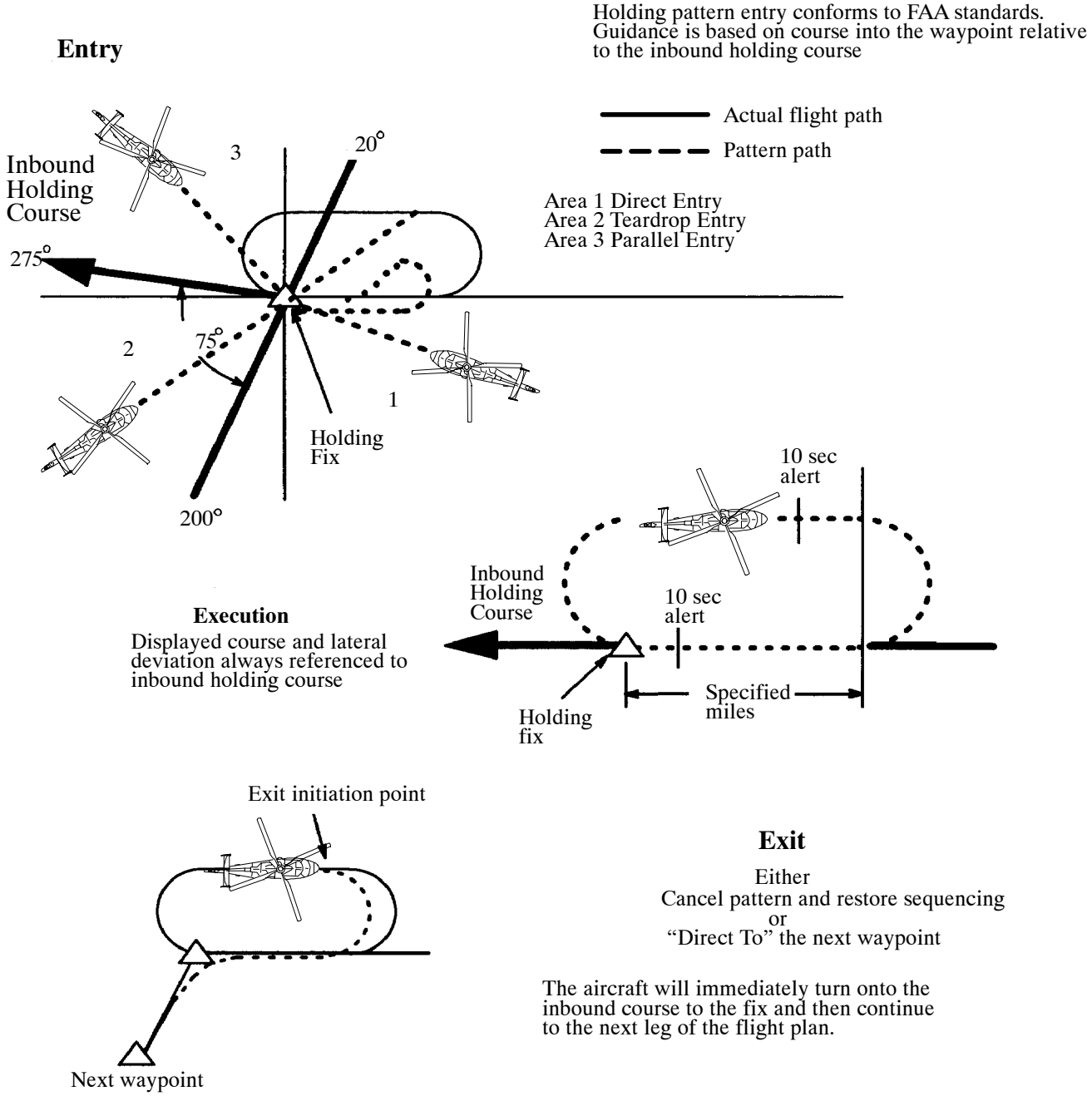



*Figure 1-197. Holding Patterns*

flight plan it is removed when the Hold at present position is inserted.

g. Displays the entry advisory ENTRY IS either DIRECT, TEARDROP or PARALLEL, based on the entry geometry, if the holding pattern is applied in the flight plan but is not yet active. HOLD IS ACTIVE is displayed if the holding pattern is active in the flight plan.

h. ATTACH → is displayed until a valid position is entered. Once a position is entered, INSERT → is displayed adjacent to LS8. Selection with the DL1 field empty displays the Flight Plan Page with "ATTACH

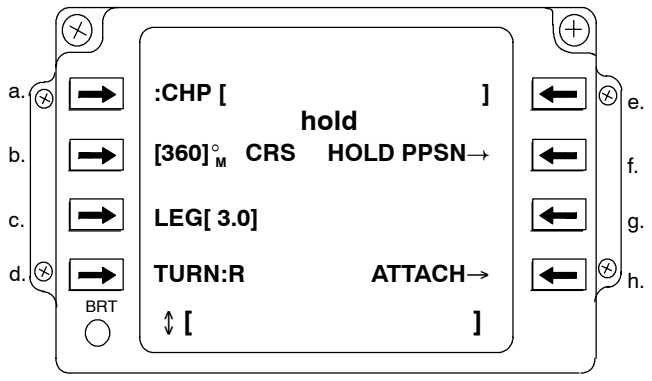



*Figure 1-198. Hold Page*

HOLD?" displayed in the scratchpad. Selection with DL1 containing a position displays the Flight Plan Page with "INSERT HOLD?" displayed in the scratchpad. Without all the parameters for the Sector pattern defined "ENTER PARAMETERS" is displayed in the scratchpad. If the Hold pattern in the flight plan is being edited, the label adjacent to LS8 changes to APPLY and selection modifies the current hold pattern being flown, and displays the Flight Plan Page.

Four advisory annunciations warn the operator of a rejected Hold Pattern:

| Annunciation | Meaning |
|---|---|
| FPLN FULL | The flight plan contains 50 way-points |
| PATTERN ACTIVE | A search pattern is already active in the flight plan |
| HOLD ACTIVE | A hold pattern is already active in the flight plan |
| HOVER ACTIVE | A Hover At is already active in the flight plan |

| Data Type | Entry Range | Display Range |
|---|---|---|
| Course | 000-360 degrees | 001-360 degrees |
| Length | 0.1-50.0 nm (by 0.1) | 0.1-50.0 nm (by 0.1) |

*Table 1-14. Hold Page Valid Data Ranges*

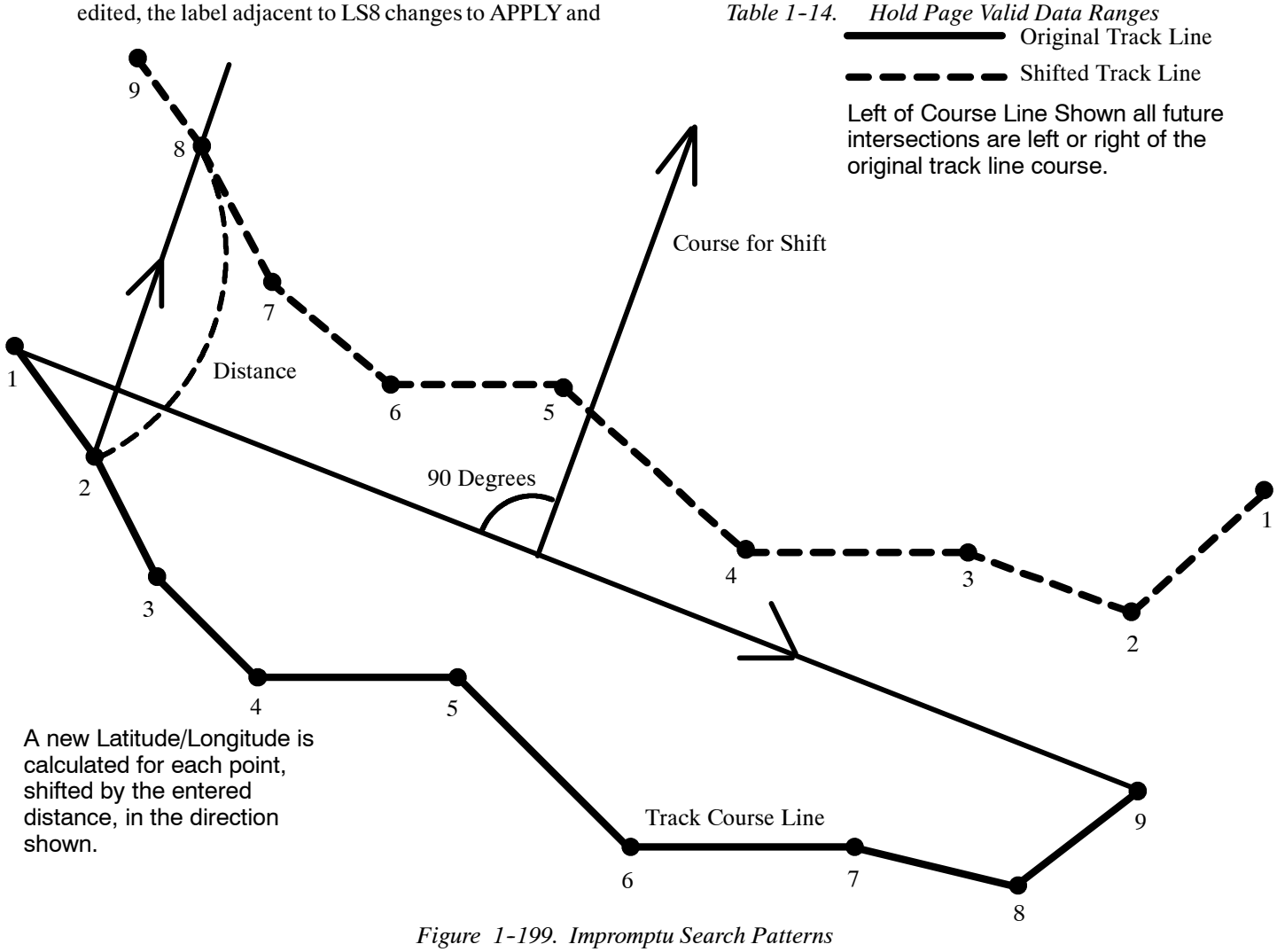



*Figure 1-199. Impromptu Search Patterns*

## IMPROMPTU SEARCH PATTERN

Figure 1-199 illustrates the Impromptu search pattern. The Impromptu Pattern represents a customized search pattern with a series of from two to nine waypoints. The Impromptu pattern provides a means to program searches for irregularly shaped search areas, such as a shoreline. Impromptu pattern waypoints may be created by inserting MARK points, manual entry, or by copying a waypoint to the Impromptu Points Page for insertion. When the pattern is inserted into the flight plan, the Impromptu Page may be used to shift the coordinates of the waypoints in a specified distance, direction, or order to offset the search area. If the first and last points are equal to or less than 0.1 nm apart, no shifting of the points is applied at the time of insertion into the flight plan.

### Impromptu Page

The Impromptu Page (Figure 1-200) is accessed by selecting IMPROMPTU on the Patterns Page. Once inserted into the flight plan, changes to the pattern definition entries have no effect on the pattern being flown.

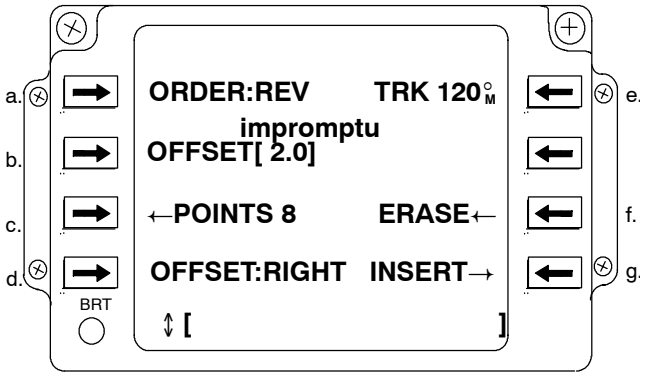



*Figure 1-200. Impromptu Page*

a. Toggles between FWD (forward) and REV (reverse) to specify the order to insert Impromptu Points into the flight plan. Defaults to FWD at system power-up.

b. Enters the Offset distance (nm) to shift the Impromptu Points. Offset distance may be between 0.0 and 99.9 nm in 0.1 nm increments. Defaults to 0.0 at system power-up.

c. Selection displays the Impromptu Pts Page. Displays the number of waypoints currently in the Impromptu Points Pages.

d. Toggles between LEFT and RIGHT for direction to shift points, always referenced to the original track line of the Impromptu Points. Defaults to RIGHT at system power-up.

e. Displays the calculated track (TRK) from Impromptu Point #1 to the last point in the Impromptu Points list. The magnetic/true reference is according to the system reference selected on the Start Page 1/3.

f. Selection displays the CONFIRM scratchpad message, a second selection erases the waypoints currently in the Impromptu Points Pages. After 3 seconds, if confirmation is not completed, the request for the erase is cancelled.

g. Selection displays the Flight Plan Page with "INSERT IMPROMPTU?" displayed in the scratchpad. Selection with fewer than two waypoints in the impromptu list is an error that causes the "ERROR" annunciation to appear in the scratchpad.

### Impromptu Points Page

The Impromptu Points Page can store a maximum of nine Impromptu waypoints (see Figure 1-201). The Impromptu Points Page is displayed when LS3 on the Impromptu Page is selected. Deletion of a waypoint causes the points after the selected waypoint to move up in the list. With no points entered, the page displays [...blank...] on DL1 and RETURN on DL7. With nine points entered, following point nine, point 1 is displayed (no blank waypoint fields are displayed). Wrap around scrolling enables viewing of the entire list.

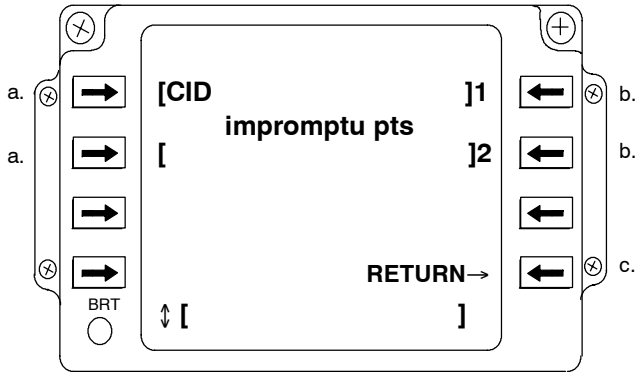



*Figure 1-201. Impromptu Points Page*

a. Selection with a valid waypoint entry enters the Impromptu Point (when brackets are displayed). If the waypoint was an insertion, the list shifts down. Selection with a blank scratchpad displays the Waypoint Data Page for the waypoint selected. Selection with a "-" in the scratchpad deletes the selected waypoint and moves the impromptu points below the deleted point up in the list.

b. Selection with a valid waypoint entry enters the Impromptu Point (when brackets are displayed).

c. Selection displays the Impromptu Page.

## VISUAL SWEEP FUNCTION

The Visual Sweep Width Pages provide a means to calculate the recommended sweep-width (in nautical miles) for a search pattern. The visual sweep-width calculator is derived from the National Search and Rescue Manual, Volumes 1 and 2, dated 1 February 1991. The Sweep-Width Page is used to calculate the recommended visual sweep-width to be used in the definition of a search pattern. Two Sweep Width functions are available: Visual Sweep Width (for unaided searches) and NVG Sweep Width.

### Sweep Width

To compute the Visual Sweep Width, the crew manually enters the visibility (nm), sea conditions (ft), and selects target type on the Visual Sweep Width Page. The sweep-width function automatically displays the system-captured present wind (knots), altitude (ft), and ground speed (knots) on the page. The crew may elect to manually edit values for wind, altitude, and ground speed. The CDU computes the sweep-width after any operator manual entry is performed. The uncorrected visual sweep-width is calculated based on altitude, visibility and target type.

### Sweep Width Page

The Sweep-Width Page (Figure 1-202) is accessed via LS2 (TS, track spacing) on the Ladder, Sector, or Expanding Square Search Pattern Pages, with a blank scratchpad, or by VIS SWEEP on the Patterns Page. The page shown is the format when the page is accessed from a Search Pattern Page. If accessed from the Pattern Page, the LS4 label and operation are omitted, as explained below.

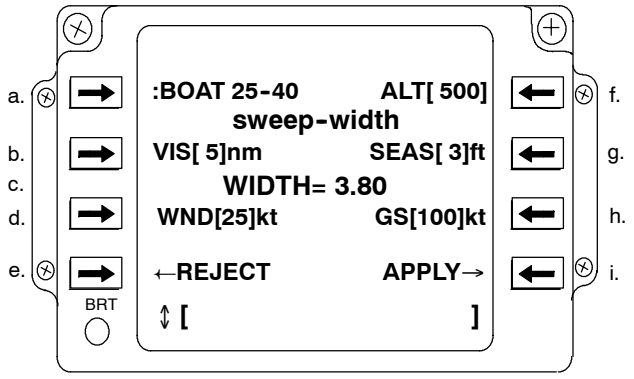



*Figure 1-202. Sweep Width Page*

a. Selection toggles between target types. Defaults to Raft (4) at system power-up. Order is:

1. RAFT (4) [Raft with 4 persons]
2. BOAT 15-25 [Boat 15 feet - 25 feet length]
3. BOAT 25-40 [Boat 25 feet - 40 feet length]
4. BOAT 40-65 [Boat 40 feet - 65 feet length]
5. SH 90-150 [Ship 90 feet -150 feet length]
6. SH 150-300 [Ship 150 feet -300 feet length]
7. SH 300 + [Ship > 300 feet length]

b. Enters the visibility in nm. Defaults to 0 at system power-up.

c. Displays the calculated visual sweep-width in nm. If the sweep-width is not computable, the display is dashed.

d. Enters manual wind magnitude. Automatically displays current wind magnitude, manual entry to replace the current wind may be entered. If present system wind is invalid, the display is blank. Defaults to current winds when page is accessed. Entering a "-" in the scratchpad, with a manually entered wind displayed, deletes the manual entry and displays the current calculated system wind.

e. When accessed from a Search Pattern definition page the ←REJECT label is displayed. Selection displays the Search Pattern Page that called the Sweep-Width Page. The displayed sweep-width is not automatically inserted into the Track Space field of the calling Pattern Definition Page, and must be manually entered. When accessed from the Pattern Index Page the ←REJECT label adjacent to LS4 is not displayed.

f. Enters the altitude. Automatically displays present altitude, manual entry to replace the present altitude may be entered. If present system altitude is invalid, blanks are displayed. Defaults to present altitude when page is accessed. Entering a "-" in the scratchpad, with a manually entered altitude displayed, deletes the manual entry and displays the current calculated system altitude.

g. Enters the wave height. Defaults to 0 at system power-up.

h. Enters the ground speed. Automatically displays present ground speed, manual entry to replace the

present ground speed may be entered. If present system ground speed is invalid, blanks are displayed. Defaults to present ground speed when page is accessed. Entering a "-" in the scratchpad, with a manually entered ground speed displayed, deletes the manual entry and displays the current calculated system ground speed.

i. When accessed from a Search Pattern definition page selection of APPLY → displays the Pattern Definition Page that called the Sweep-Width Page. The displayed sweep-width calculated value is automatically inserted into the Track Space field of the calling Pattern Definition Page if the value meets the entry validity criteria. If the calculated sweep width value is invalid, the calculated value displays dashes and the arrow adjacent to APPLY is removed. If the calculated sweep width is an invalid track space entry for the calling Pattern Definition Page, the arrow is also removed. When accessed from the Pattern Index Page the label changes to RETURN, and selection displays the Pattern Index.

**NOTE**

Selecting the UP or DOWN arrow on the CDU scrolls to the NVG Sweep Width Page.

## NVG Sweep Width

The night vision goggle (NVG) sweep width calculator was developed from USCG data. The NVG sweep width calculator is used to calculate the recommended NVG visual sweep width to be used in the definition of a search pattern during an NVG search operation. The CDU computes the NVG sweep width after any operator entry is performed. Unlike the Visual Sweep Width Page, data on the NVG Sweep Width Page is entered by the crew which manually toggles the selections to describe the current conditions. The system then calculates an uncorrected visual sweep width and applies the appropriate corrections to calculate the recommended NVG sweep width.

## NVG Sweep Width Page

The NVG Sweep-Width Page (Figure 1-203) is accessed by scrolling down, or up, from the Sweep Width Page.

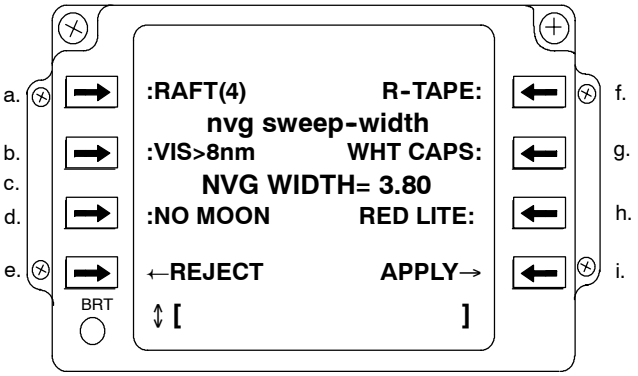



*Figure 1-203. NVG Sweep Width Page*

a. Selection toggles between target types. Defaults to PIW at system power-up. Order is:

1. PIW Person in the water with personal flotation device and reflective tape
2. RAFT (1) [Raft with 1 person]
3. RAFT (4) [Raft with 4 persons]
4. RAFT (6) [Raft with 6 persons]
5. RAFT (8) [Raft with 8 persons]
6. RAFT (10) [Raft with 10 persons]
7. RAFT (12) [Raft with 12 persons]
8. SKIFF 0-10 [Skiff 0 - 10 feet length]
9. SKIFF 15-25 [Skiff 15 - 25 feet length]
10. SKIFF 25+ [skiff > 25 feet length]
11. SAIL 0-10 [Sail 0 -10 feet length]
12. SAIL 15-25 [Sail 15 -25 feet length]
13. SAIL 25+ [Sail > 25 feet length]

b. Toggles between VIS>8nm and VIS<=8nm. Defaults to visibility less than 8.0 nm at system power-up.

c. Displays the calculated NVG visual sweep-width in nm. If the NVG sweep-width is not computable, the display is dashed.

d. Toggles between NO MOON and MOON. MOON means a moon lighted situation. Defaults to NO MOON at system power-up.

e. If the Sweep Width Pages were accessed from a Search Pattern Definition Page the ←REJECT label is displayed. Selection displays the Search Pattern Page that called the Sweep-Width Pages. The displayed sweep-width is rejected and therefore not automatically inserted into the Track Space field of the calling Pattern Definition Page. If the Sweep-Width Pages were accessed from the Pattern Index Page the ←REJECT label is NOT displayed.

f. If the target type is any RAFT(x) then LS5 displays and toggles between R-TAPE (reflective tape applied to the Raft) and NO TAPE (no reflective tape). If toggled to R-TAPE, the correction factor of 1.1 is applied. If the target type is not any raft, the label and ":" are not displayed. Defaults to NO TAPE at system power-up.

g. If the target type is PIW, RAFT(1), RAFT(4), or SKIFF 0-10, then LS6 displays and toggles between SEAS> 2.5:, WHT CAPS:, and CALM:. If toggled to SEAS>2.5: or WHT CAPS: the correction factor of 0.75 is applied. If the target type is not PIW, RAFT(1), RAFT(4), or SKIFF 0-10, the label and colon are not displayed. Defaults to CALM at system power-up.

h. Toggles between RED LITE: (red colored chemical light) and NO LITE:. If RED LITE is selected, the calculated NVG Sweep Width is the larger of 1) the corrected table value, 2) 1.3 nm for a no moon light condition or 3) 0.3 nm for moon lighted situation. Defaults to NO LITE at system power-up.

i. When accessed from a Search Pattern definition page, selection displays the Pattern Definition Page that called the Sweep-Width Page. The displayed sweep-width calculated value is automatically inserted into the Track Space field of the calling Pattern Definition Page if the value meets the entry validity criteria. If the calculated sweep-width value is invalid, the calculated value displays dashes, and the arrow is removed. When accessed from the Pattern Index Page, the label changes to RETURN, and selection displays the Pattern Index.

**NOTE**

Selecting the UP or DOWN arrow on the CDU scrolls to the Sweep Width Page.

## Model Aircraft Page

The Model Aircraft Page is accessed by pressing LS5 on Index Page 2/2. It controls execution of an internal aircraft model which replaces the navigation sensor inputs to the flight plan. This feature is only available when the aircraft is on the ground (Figure 1-81).

a. Toggles between "RUN" and "STOP." Defaults to STOP at system power-up. When Running, all navigation quantities are supplied by the model aircraft rather than the system navigation solution. Speed and altitude remain constant, but the heading/track are automatically adjusted by a guidance control law simulating execution of the horizontal flight plan.

b. Enters heading or ground track as appropriate, with associated label change between "HDG" and "STR." Defaults to 360 degrees (True reference), and Steer at system power-up. If True reference is selected on the Start Pages, a "T" is displayed after the entry field. If magnetic reference is selected on the System Start Page, magnetic variation is applied, and the heading or ground track display is referenced to magnetic north.

c. Enters true airspeed. Defaults to 70 kts at system power-up.

d. Enters wind. Entry is referenced to True North (irrespective of the True/Magnetic discrete selection), followed by an "I," followed by wind velocity in knots. Defaults to 360 degrees (True reference) at 0 kts at system power-up. If magnetic reference is selected on the System Start Page, magnetic variation is applied, and the wind display is referenced to magnetic north.

e. Enters the fuel quantity. Model assumes a fixed fuel burn rate of 550 1bs/hr. Defaults to 1,500 lbs at system power-up.

f. Enters corrected barometric altitude. Defaults to 1,000 feet at system power-up

# MULTIFUNCTION DISPLAY

The Multifunction Display (MFD) provides electronic data processing, display processing, and display control to both pilots. The system provides the following functionality.

1. Horizontal Situation Indicator (HSI):

    a. Full 360° compass which displays deviation data and selected course information to the aircrew for navigation (Figure 1-204).




*Figure 1-204. HSI Page*

2. MAP:

    a. A compass rose with an 80° arc (expanded compass rose segment) displaying a pictorial of the current flight plan (Figure 1-205).

3. Weather Radar with Map (RMAP):

    a. The same as the Map mode with the addition of a weather radar video overlay (Figure 1-206).

4. Circle Map (CMAP):

    a. Provides a 360° top-down pictorial of the current flight plan (Figure 1-207).




*Figure 1-205. MAP Page*




*Figure 1-206. RMAP Page*

5. Hover:

    a. Provides flight director visualization and indications to attain and control the aircraft at designated hover points (Figure 1-208).

6. Video:




*Figure 1-207. CMAP Page*

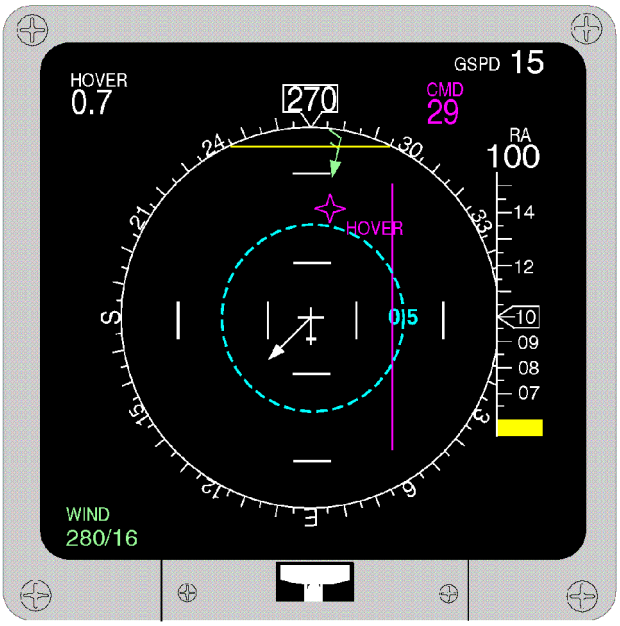



*Figure 1-208. HOVER Page*

a. Displays the selected video source, WXR, FLIR or Video Camera (CAM) (Figure 1-209).

7. System Failure Flags:

a. MFD and aircraft sensor failure/validity flags are displayed on all MFD pages (Figure 1-210). Fail Flags Displayed are as follows:

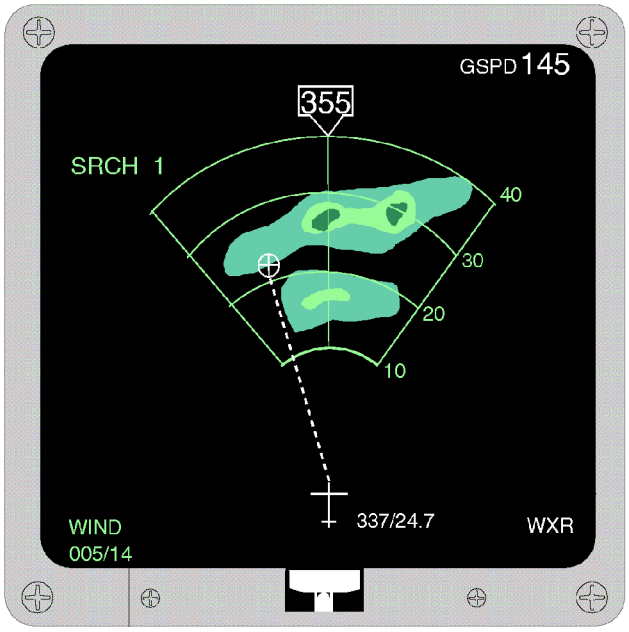



*Figure 1-209. VIDEO Page*

(1) Internal MFD Failure - DU is displayed.

(2) Navigation source failure - the selected source failure flag is displayed (TCN, FMS, VOR or ILS).

(3) Heading source failure - heading readout is removed and HDG is displayed.

(4) Glide slope source failure - glide slope failure flag is displayed.

(5) Bearing #1 source - bearing #1 failure flag is displayed (FMS, TCN, VOR, DF or ADF), bearing pointer is removed.

(6) Bearing #2 source - bearing #2 failure flag is displayed (FMS, TCN, VOR, DF or ADF), bearing pointer is removed.

b. Hover Display failure flags are the same as the HSI failure flags with the following exceptions (Figure 1-211).

(1) RA - The Radar Altimeter flag will be displayed

(2) FD - The Flight Director flag will be displayed

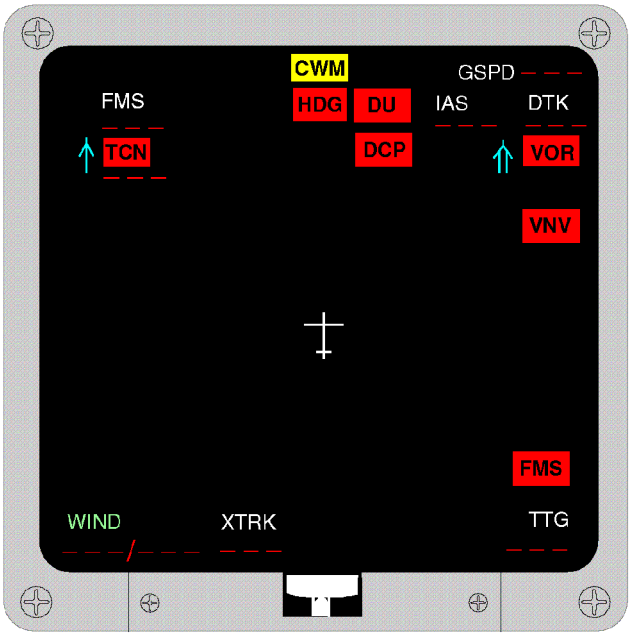



*Figure 1-210. HSI System Failure Flags*

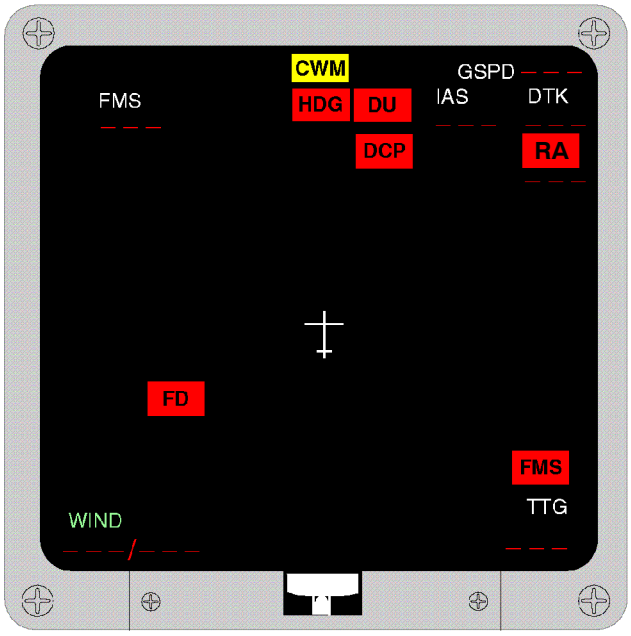



*Figure 1-211. Hover Display Failure Flags*

(3) CMD/IAS - The CMD/IAS readout will be displayed as three red dashes

(4) Bearing #1 and #2 - The bearing failure flags will not be shown

(5) Bearing distance - The bearing distance failure will not be shown.

8. Diagnostics:

a. The MFD reports Built In Test (BIT) results via the Status Page (Figure 1-212). Failures are annunciated in red.

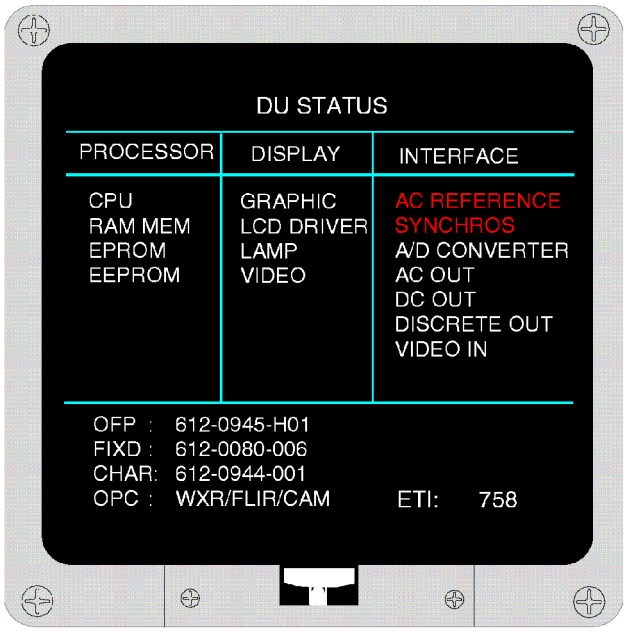
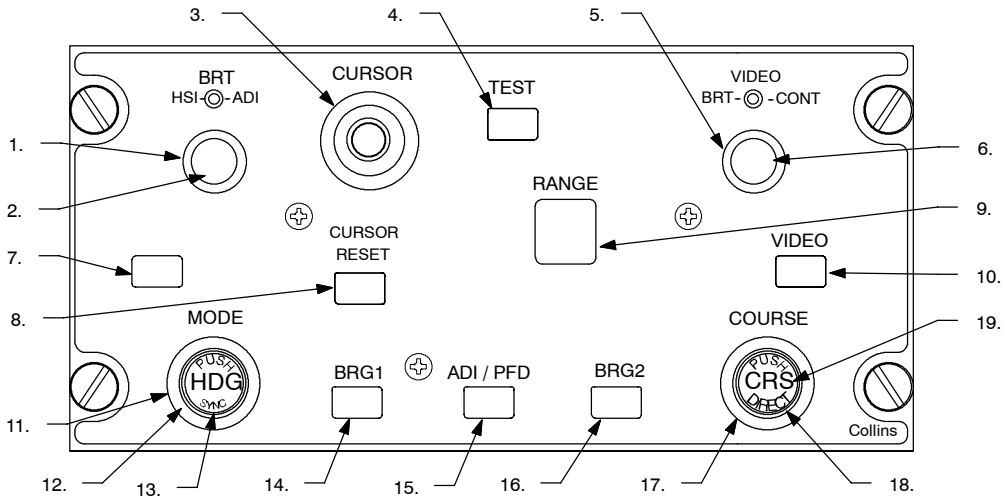



*Figure 1-212. MFD Status*

## MFD CONTROL PANEL

The Multifunction Display Control Panel (CP - 255K) provides integrated display management via the controls described in Figure 1-213. The display control panels are powered by 28 VDC and protected by the pilot and copilot DCP circuit breakers located on the cockpit avionics panel.




1. Not used
2. MFD brightness
3. Cursor control (joystick)
4. Test Button
5. Video contrast control
6. Video brightness control
7. Push button (future growth)
8. Cursor reset button
9. Range select knob
10. Video select button
11. Display mode selector
12. Heading select knob
13. Heading sync push knob
14. #1 bearing pointer source select
15. Not used
16. #2 bearing pointer source select
17. Nav source select knob
18. Course select knob
19. Course direct pushbutton

*Figure 1-213. MFD Control Panel*

## BRIGHTNESS CONTROL

MFD brightness is adjusted using the inner BRT knob. The outer BRT knob is not used.

## CURSOR CONTROL

The RMAP page and VIDEO (WXR) page have a cursor (crosshair symbol) available to calculate bearing and distance information on the display. The cursor is moved using the joystick cursor control. The latitude and longitude of the current cursor position can be displayed in the CDU scratchpad by selecting the DATA pushbutton on the CDU.

## CURSOR RESET

Pressing the CURSOR RESET pushbutton will reset the cursor location to the aircraft symbol. The cursor is also reset to the aircraft symbol following a 30-second cursor timeout or anytime a different display is selected.

## VIDEO BRIGHTNESS CONTROL

The VIDEO BRT knob (inner knob) is used to change the brightness of the video currently being displayed on the MFD. The control knob is active only when RMAP or Video (WXR) are being used.

## VIDEO CONTRAST CONTROL

The VIDEO CONT knob (outer knob) is used to change the contrast of the video currently being displayed on the MFD. As with brightness control, the knob is only active when RMAP or Video (WXR) are displayed.

## RANGE SELECT

The RANGE knob allows selection of display ranges at 2.5, 5, 10, 20, 40, 80 and 160 nautical miles. The control knob is designed to “wrap around.” This means that the knob can be rotated clockwise or counterclockwise without reaching a physical stop. Clockwise rotation increases the range value and counterclockwise rotation decreases the range value.

## VIDEO CONTROL

The VIDEO pushbutton allows for sequential selection of the Weather Radar (WXR) video, FLIR video and Video Camera (CAM). The pushbutton is active only when the display mode is “VIDEO.” Video modes that are not available will be skipped in the selection order. For example, if the FLIR and Video (hoist) Camera are not installed, the only mode available is WXR.

## MODE/HEADING CONTROLS

The MODE and HDG (heading) knobs are designed with a “wrap around” feature. The HDG knob also allows for push-

button activation. These knobs perform the following functions:

### Mode Selector

The outer knob is used to select the desired MFD display and "wraps" in both directions (see MFD Description section for example pages).

### Selected Heading

The inner knob adjusts the associated heading bug. This knob has rate sensitivity meaning that the movement of the heading bug varies depending on the speed in which the knob is rotated.

### Heading Sync

Pressing the heading sync pushbutton (inner knob) sets the heading bug to the current aircraft heading.

## BEARING #1 SELECTION

The BRG1 (bearing #1) pushbutton selects the source displayed on the MFD bearing pointer #1 (single needle). The selections in order are:

1. OFF (no bearing display)
2. FMS
3. VOR
4. TACAN (TCN)
5. ADF
6. DF

## BEARING #2 SELECTION

The BRG2 (bearing #2) pushbutton selects the source displayed on the MFD bearing pointer #2 (double needle) and is functionally identical to the BRG1 pushbutton.

## ADI/PFD

The ADI/PFD pushbutton is not used.

## COURSE CONTROLS

The inner and outer knobs are designed with a "wrap around" feature and the outer knob is designed to allow for pushbutton activation. These knobs perform the following functions:

### Navigation Source Selector

The outer knob cycles through the navigation sources listed below:

1. FMS (Flight Management System Integrated RNAV)
2. VOR/ILS/BC
3. TCN (TACAN)

### Course Selection

The inner knob is used to select the desired course. This knob has rate sensitivity meaning that course changes are dependent on the speed in which the knob is rotated.

### Course Direct-To (Sync) Button

The center pushbutton is a CRS sync button. If the primary source is VOR or TCN, pressing the CRS Sync pushbutton will set the active course to the current bearing of the VOR or TCN navigation source. If the primary navigation course source is FMS, pressing the CRS Sync pushbutton will generate a Direct-To course to the active waypoint. This function is the same as pressing the DIR key on the CDU.

## TEST BUTTON

Pressing the TEST pushbutton will display the MFD Status pages and initiate a built in test (BIT).

## GROWTH BUTTON

The control panel has one pushbutton that is not labeled. This pushbutton is provided for future growth requirements.

# MULTIFUNCTION DISPLAY DESCRIPTION

Two Multifunction Displays (MFD-255) are installed in the cockpit and replace the previously installed HSVD Multifunction displays. The MFD serves three primary functions:

- Provides multifunction displays of tactical situation and aircraft sensor data
- Acts as a source of pilot inputs to the FDS (navigation source, heading/course selections)
- Acts as an analog/digital converter of flight data for displays and inputs to the FMS

  Flight data from the pilot's MFD is sent to the pilot's CDU. Flight data from the copilot's MFD is sent to the copilot's CDU.

Pilots MFD converts signal from the radar into a picture for both MFDs.

The MFD is NVG compatible and displays bearing and course information with a magnetic north or true north reference as selected on the CDU. The MFDs operate as two independent systems. The pilot and copilot MFD, and associated control panels, are electrically independent and operate independent of the MIL-STD-1553B data bus. Both the pilot and copilot MFD communicate independently with their respective CDU. Refer to Figure 1-72 (HH-65 Avionics System Architecture) for the system diagram.

Primary operating power for the MFDs is 28 VDC. The MFDs are protected by the EHSI circuit breakers located on the cockpit avionics panel. In addition to 28 VDC electrical power, 26 volt AC power is utilized by the MFDs as a reference voltage anytime there are synchro type inputs and outputs to the MFD. The AC reference voltage ensures that all bearings within a given system are pointing in the right direction. There are multiple 26 volt AC inputs to the MFD including: DF/ADF, VOR, pitch/roll, and compass. Each 26 volt AC circuit breaker on the cockpit avionics panel feeds all equipment associated with that specific system. For example, NAV feeds both MFDs, the BDI and the NAV receiver. When the NAV receiver sends out a bearing, each component that displays that bearing must operate on the same phase AC to ensure the indicators point in the same direction, the equipment is synched. If 26 volt AC power is lost to a display, the associated item will blank or red flag because the reading will be unreliable.

Two cooling fans located behind the center console are powered by 115 VAC power and protected by the P/FDS Fan and CP/FDS Fan circuit breakers located on the pilots forward panel. The cooling fans circulate air through the MFDs to prevent an overheat condition of the video card.

## HORIZONTAL SITUATION INDICATOR (HSI)

The HSI page displays a full 360° compass card and is automatically displayed when the aircraft is initially powered up or when the Go-Around mode is selected.

The following navigation sources are available for display on the HSI:

1. FMS
2. VOR/ILS/BC
3. TCN (TACAN)

Selecting VOR, ILS or B/C transforms the HSI into a VOR/ILS display. Selecting TCN transforms the HSI into a TACAN display. Selecting FMS transforms the HSI into an area navigation display using the flight plan data inserted in the CDU. An annunciation in the lower-right corner of the HSI indicates which NAV source is selected (Figure 1-214).

### Heading Readout Box

The aircraft heading is read against the triangular portion of the heading readout box that points to the edge of the compass rose. The heading is also displayed digitally, between 0 and 359 degrees, in the heading readout box. Figure 1-214 illustrates a heading of 325° .

### True Heading Reference

Normally headings are displayed as magnetic. However, if a true heading is manually selected on the CDU, a label titled "TRU" will appear in white next to the heading readout. No label is displayed if magnetic is selected.

### Navigation Source Annunciation

The navigation source (FMS, VOR/ILS/BC or TCN) is selected using the outer Course Control Knob on the MFD Control Panel (see Figure 1-213) and displayed in the bottom-right corner of the MFD. Navigation source annunciations are normally displayed in white.

**NOTE**

When both pilots have selected the same navigation source, a yellow box will appear around the annunciation and the annunciation is yellow.

Figure 1-214 displays FMS as the navigation source.

**NOTE**

Because the Course Control Knobs (pilot and copilot) work independently, the pilot's MFD will display the source selected on the pilot-side MFD Control Panel and the copilot's MFD will display the source selected on the copilot-side MFD Control Panel.

### FMS Mode

The current FMS MODE or "phase of flight" is displayed immediately below the navigation source annunciation. If FMS is not the current source, this display will blank. The FMS modes each provide different lateral deviation scaling indications.

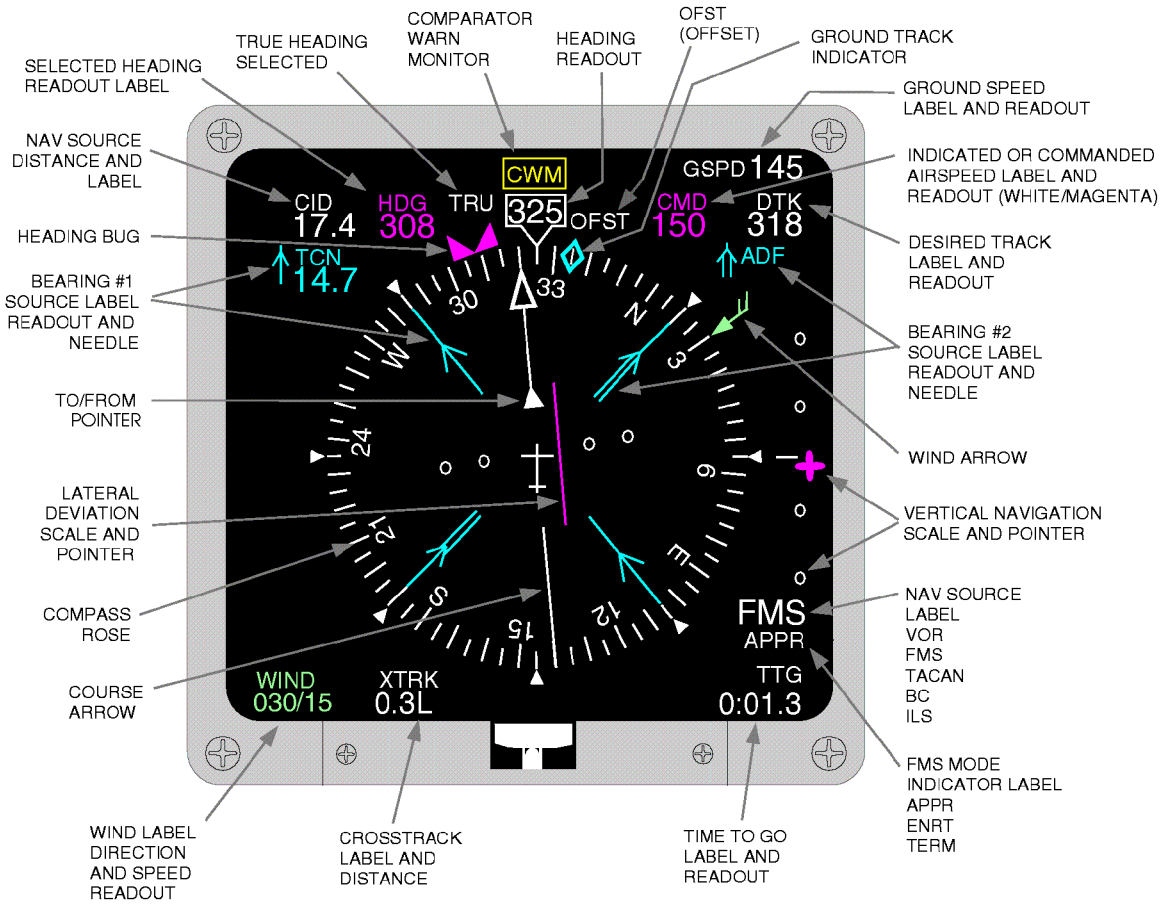



*Figure 1-214. Horizontal Situation Indicator (HSI)*

| Phase of Flight | Lateral Deviation Per Dot | Lateral Deviation Full Scale |
|---|---|---|
| ENRT (En route) | 2.0 nm | 5.0 nm |
| TERM (Terminal Area) | 0.5 nm | 1.25 nm |
| APPR (Approach) | 0.15 nm (300 yds) | 0.375 nm (750 yds) |

ENRT is the only mode displayed unless an FMS approach has been programmed in the CDU and the aircraft is within 30 nm of the FAF and the FAF is the active "TO" waypoint.

Figure 1-214 displays APPR as the current FMS Mode.

## Glide Slope Deviation Scale

A glide slope deviation scale and pointer are displayed on the right side of the MFD. Glide slope deviation is represented by a magenta triangle moving beside a four-dot scale with a maximum movement of +/- 2.5 dots. When the difference between an ILS course and the aircraft's current course is >105°, the navigation source annunciation will change from ILS to back course (BC) causing the glide slope scale and pointer to disappear.

## Vertical Navigation Scale And Pointer

When FMS is the navigation source and is capable of providing vertical guidance, the VNAV scale and pointer are displayed on the right side of the MFD. Vertical deviation is indicated by the position of the "snowflake" shaped deviation pointer against the VNAV scale. One dot deviation equals 150' (FMS approach) or 100' (HOVER-AT).

## FMS Waypoint/TCN ID And Distance

When distance information is available for the selected navigation source (i.e., FMS, TCN, or VORTAC), the source and distance are displayed in the top-left corner of the MFD.

If FMS is the selected navigation source, the distance readout represents the distance to the next CDU flight plan waypoint. For example, Figure 1-214 indicates that waypoint CID is 17.4 nm from the aircraft.

When distance information associated with a navigation source is not available, the distance readout is blanked. If distance information is associated with a navigation source but is not available due to a failure, the distance readout will display three red dashes.

## Selected Course

The selected course is displayed in the top-right corner of the MFD.

When the navigation source is VOR, ILS or TCN, a digital course readout appears directly below a "CRS" label. When the navigation source is FMS, the course readout is labeled "DTK" and is interpreted as the desired track.

Figure 1-214 displays a desired track of 318°.

## Track Indicator

The track indicator is a blue diamond that is displayed on the compass rose. This indicator shows the ground track of the aircraft. The ground track displayed in Figure 1-214 is 335°.

## Ground Speed (GSPD)

Ground speed is displayed in the top-right corner of the MFD. Figure 1-214 illustrates a ground speed of 145 knots.

## Time–To–Go (TTG)

Time-To-Go is displayed in the bottom-right corner of the MFD. TTG is only displayed when FMS is the navigation source and represents the time to the active flight plan waypoint. Figure 1-214 illustrates a Time-To-Go of 1.3 minutes.

## Cross-Track Distance

When the navigation source is FMS, a digital cross-track (XTRK) distance is displayed in the bottom-left corner of the MFD. This number represents the lateral distance between the aircraft current position and the desired FMS flight path. An "L" or "R" follows the distance to indicate that the aircraft is either Left or Right of desired track. For example, Figure 1-214 displays a XTRK distance of 0.3 nm left of course.

The XTRK readout is blanked when FMS is not the selected NAV source.

## Selected Heading

The selected heading is represented by a magenta heading bug on the outside of the compass rose and a digital heading readout (three digits) on the top-left corner of the MFD. The readout is displayed only when the heading bug is being moved and will remain displayed until 5 seconds after the heading bug stops moving.

Figure 1-214 shows a selected heading of 308°.

## Bearing Pointers

Two bearing pointers can be displayed on the MFD, BRG1 (#1 bearing pointer) and BRG2 (#2 bearing pointer). BRG1 is a blue single-bar pointer and BRG2 is a blue double-bar pointer.

A distance readout for BRG1 is displayed in the top-left corner of the MFD and BRG2 distance is displayed in the top-right corner of the MFD. Other than the location of the readout, operation of both bearing pointers is identical.

Six source selection options are available for both bearing pointers.

1. OFF
2. FMS
3. VOR
4. TACAN
5. ADF
6. DF

Figure 1-214 illustrates that the source for BRG1 is a TACAN station at a distance of 14.7 nm. The source for BRG2 is an ADF station.

## Wind Display

Wind information is displayed in two ways:

1. A green digital readout of wind direction and speed is located on the bottom-left corner of the MFD.
2. A Beaufort wind arrow is displayed on the outside of the compass rose.

The Beaufort wind arrow represents the wind azimuth by the position of the arrow on the compass. If wind speed drops below 4 knots, the wind arrow will disappear from the display and reappear when the speed climbs above 6 knots.

The wind speed is displayed on the wind arrow with fins. Below 50 knots of wind, speed is presented in 5 knot increments

with half a fin representing 5 knots and a whole fin representing 10 knots. Above 50 knots, a pennant (▶) appears on the end of the arrow.

Figure 1-214 illustrates a wind direction of 030° and a wind velocity of 15 knots.

## Dead Reckoning (DR) Annunciation

A "DR" annunciation will appear to the right of the heading box to indicate that the GPS is disabled and the position is being computed by dead reckoning. This annunciation is only displayed when FMS is the selected navigation source.

## Offset (OFST) Annunciator

"OFST" annunciation will appear to the right of the heading box to indicate that an offset is active in the FMS flight plan. This annunciation is only displayed when FMS is the selected navigation source. Figure 1-214 displays this annunciation.

## Commanded (CMD) and Indicated Airspeed (IAS)

"CMD" airspeed and "IAS" airspeed are functions related to the Flight Director. When flight director modes, capable of setting specific airspeeds (IAS/VS, IAS, GA, T-HOV, APPR) are selected, "CMD" is displayed to the right of the heading box to indicate that the FD Button on the cyclic is active. Directly below "CMD" is the commanded airspeed. Flight director modes that do not have this capability (ALT, VS, HOV-AUG) will display "IAS" to the right of the heading box. Directly below "IAS" is the indicated airspeed.

Three red dashes are displayed when airspeed data is invalid.

Figure 1-214 illustrates a commanded airspeed of 150 knots.

## MAP PAGE

The MAP page consists of a partial HSI (80° arc) that shows the flight plan route of the aircraft. The flight plan route consists of a series of waypoints connected by magenta lines.

Information displayed on the MAP page is similar to the information displayed on the HSI page with the exception of the following items that are not displayed (Figure 1-215).

1. Course Pointer
2. To/From Arrow
3. Course Deviation

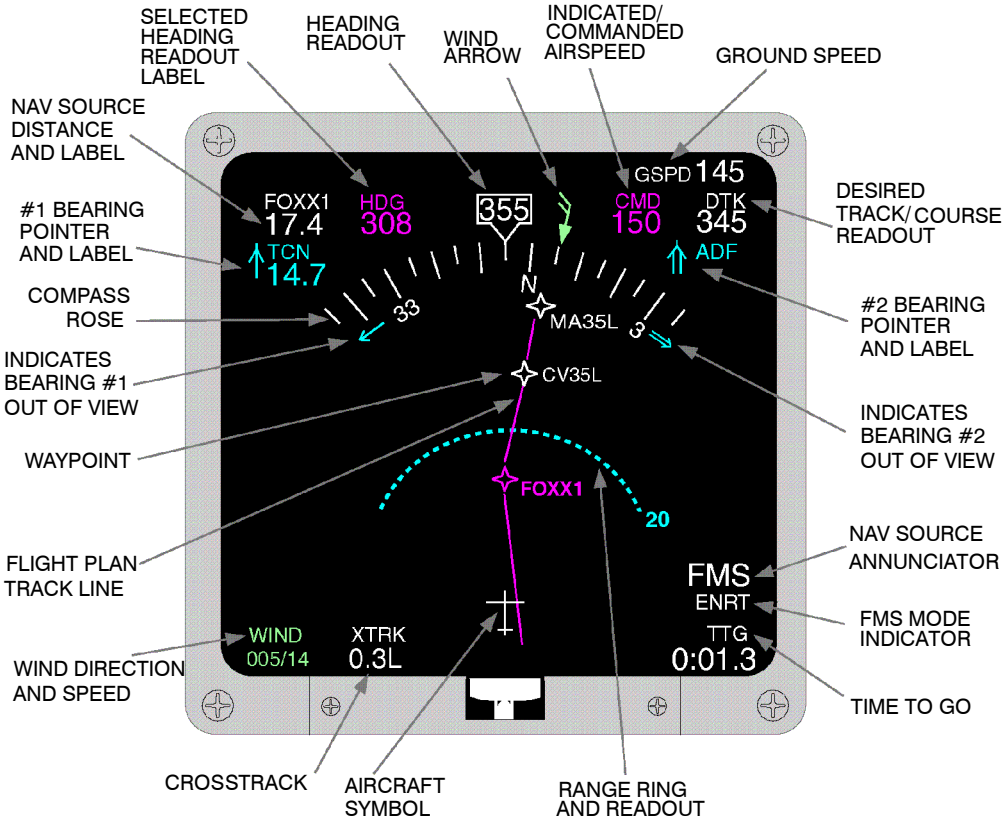



*Figure 1-215. MAP Page*

4. Glide Slope

The HDG readout always remains in view when the heading bug is set outside of the 80° ARC.

## Range Rings

The Range Knob on the MFD Control Panel is used to select the following ranges:

- 2.5, 5, 10, 20, 40, 80, 160

Figure 1-215 shows a Map Page display with a selected range of 40 nm.

Adjustment of the pilot or copilot Range Knob changes the MAP range display on both MFDs. If both the pilot and copilot are adjusting the range simultaneously, the pilot's selection overrides the copilot's selection.

## MAP Symbology

Refer to Figure 1-216 for MAP symbology.

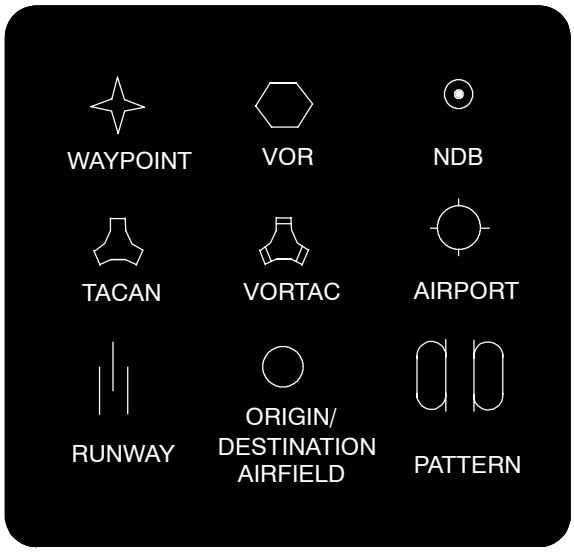



*Figure 1-216. MAP Symbology*

## FMS As Navigation Source

The MAP page, with FMS as the navigation source, displays the flight plan track as a magenta line. The active waypoint is displayed in magenta and all other waypoints/symbols are displayed in white.

## VOR Or TACAN As Navigation Source

The MAP page, with VOR or TACAN as the navigation source, displays a white line from the aircraft symbol to the corresponding VOR or TACAN station.

**NOTE**

The VOR/TACAN station is not displayed if it is outside the selected display range.

## RMAP PAGE

The RMAP page consists of a video display of weather radar data overlaid on the MAP display. The flight plan route displayed consists of a series of waypoints connected by magenta lines along with weather inside the viewable 80° arc.

Information displayed on the RMAP page is similar to the information displayed on the HSI with the exception of the following items that are not displayed (Figure 1-217).

1. Course Pointer
2. To/From Arrow
3. Course Deviation
4. Glide Slope

The HDG readout always remains in view when the heading bug is set outside of the 80° ARC.

## Weather Radar Range Grid Display

The Range Knob on the MFD Control Panel is used to select the following ranges:

- 2.5, 5, 10, 20, 40, 80, 160

Figure 1-217 shows a RMAP Page display with a selected range of 2.5 nm.

## Cursor Control

A cursor, controlled by a joystick on the MFD Control Panel, is used to calculate bearing and distance information on the RMAP Page and the VIDEO (WXR) Page. The cursor is a crosshair symbol that can be moved on the display by moving the joystick in the desired direction. A dashed line connects the aircraft symbol at the bottom of the display and the cursor symbol. The bearing and distance from the aircraft's present position to the cursor position is displayed to the right of the aircraft symbol.

For example, Figure 1-217 displays a cursor position at 351° and 2 nm.

In addition, the latitude and longitude of the current cursor position can be displayed in the scratchpad by selecting the DATA button on the CDU.

## Cursor Reset Button

Pressing the CURSOR RESET pushbutton will reset the cursor location to the aircraft symbol. The cursor is automati-




*Figure 1-217. RMAP Page*

cally reset to the aircraft symbol following a 30-second cursor timeout or anytime a different display is selected.

## CMAP PAGE

The CMAP Page consists of a full 360° compass rose that shows the flight plan route of the aircraft. The route consists of a series of waypoints connected by magenta lines.

Information displayed on the CMAP is similar to the information displayed on the HSI page with the exception of the following items that are not displayed (Figure 1-218).

1. Course Pointer
2. To/From Arrow
3. Course Deviation
4. Glide Slope

## HOVER PAGE

The HOVER Page shows a top-down display of the aircraft relative to a hover datum point. This page is useful for providing flight cues to hover during periods of reduced visibility (Figure 1-219).

Information displayed on the HOVER page is similar to the information displayed on the HSI with the exception of the following items that are not displayed.

1. Course Pointer
2. To/From Arrow
3. Course Deviation
4. Glide Slope
5. Heading Bug and Heading Readout
6. Bearing #1 and #2 information
7. Track Indicator
8. Cross Track Distance

### Range/Velocity Symbols

The rings and tic marks on the HOVER page are dual purpose. These Symbols represent both range (distance) and velocity. The range/velocity setting is fixed and cannot be changed. Each tic mark represents 0.25 nautical mile distance. The dashed ring represents a distance of 0.5 nautical

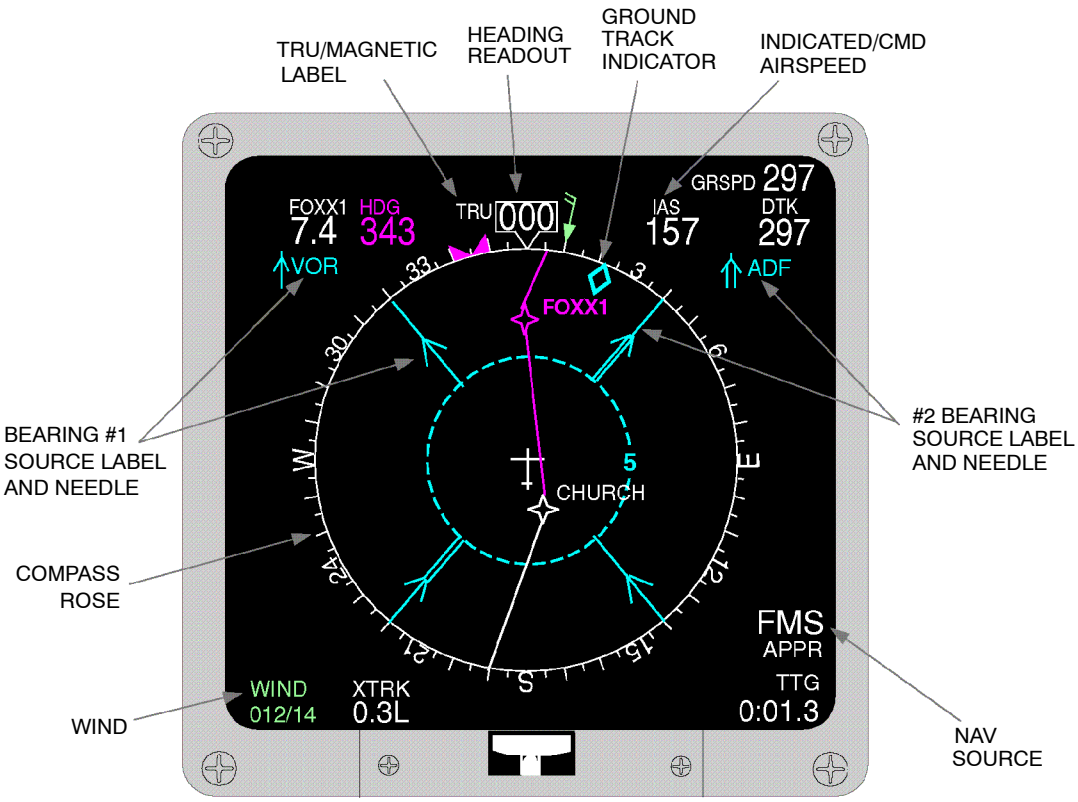



*Figure 1-218. CMAP Page*

mile and the solid ring represents a distance of 1.0 nautical mile.

Each tic mark represents 10 knots of velocity. The dashed ring represents 20 knots velocity and the solid ring represents 40 knots velocity. The dashed ring represents a distance of 0.5 nautical mile and 20 knots velocity. The solid ring represents a distance of 1.0 nautical mile and 40 knots velocity.

## Longitudinal and Lateral Velocity Command Bars

Longitudinal and lateral command bars appear on the HOVER page at T-HOV capture. The command bars indicate longitudinal and lateral velocity error and provide a fly-to command. The bars are referenced to the range/velocity rings with each ring representing 20 knots of speed error.

**NOTE**

The velocity bars turn yellow when the speed is above 34.5 knots and turn white when the speed drops below 33 knots.

## Hover Datum Symbol

The Hover Datum Symbol represents the hover-at position established when the HOV pushbutton is depressed. The distance to the Hover Datum is determined using the range rings/tic marks. If the hover datum distance is beyond 1.0 nautical mile, the symbol will remain in view at the edge of the display at the appropriate bearing.

Figure 1-219 shows the Hover Datum Symbol on a bearing of 285° at 0.6 nautical mile.

## Airspeed Vector

An arrow indicates the direction and magnitude of the aircraft airspeed. The arrow head points in the direction of aircraft movement and the length of the arrow shaft indicates airspeed. The airspeed is determined using the velocity rings and tic marks.

## Radar Altimeter Tape

Between 0’ and 300’ AGL/AWL, a nonlinear Radar Altimeter (Radalt) Tape appears on the right side of the Hover display.

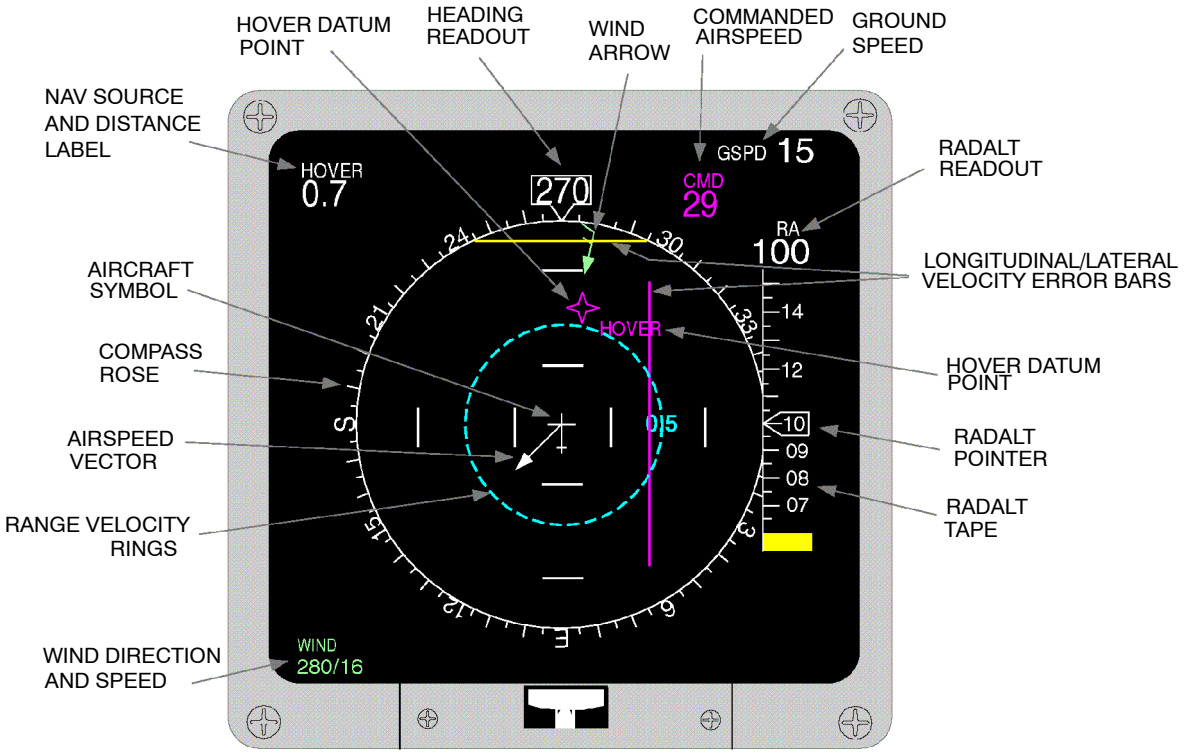



*Figure 1-219. HOVER Page*

From 0’ to 100’ the altitude is labeled in 10’ intervals. From 100’ to 300’ the altitude is labeled in 20’ intervals. Both altitude scales are divided in 5’ increments.

As the aircraft altitude changes, the tape will move vertically and the current altitude will be displayed in the altitude pointer window. When the aircraft altitude is over 100’, the tape will be yellow crosshatched from 1’ to 100’. If the aircraft descends below 100’, the crosshatch will disappear until the aircraft climbs above 120’. 0’ is depicted as solid yellow.

A digital altitude readout is displayed just above the Radalt Tape. Above 300’ the tape and pointer are blanked, but the digital readout remains displayed.

Figure 1-219 shows a radar altitude of 100’.

**NOTE**

With HDG select engaged, the aircraft will not respond to heading bug inputs when the Hover Page or Video Page is selected for display on the MFD.

## VIDEO PAGE

The VIDEO Page is capable of displaying video from three sources.

1. Weather Radar (WXR)
2. Forward Looking Infrared (FLIR)
3. Hoist Cam (CAM)

The source for the video display is selected using the VIDEO pushbutton on the MFD Control Panel. The lower-right corner of the VIDEO page will display the selected mode as “WXR,” “FLIR,” or “CAM.” The default display is the last displayed source (Figure 1-220).

**NOTE**

With HDG select engaged, the aircraft will not respond to heading bug inputs when the Hover Page or Video Page is selected for display on the MFD.

# DATA PAGE

The CDU Data Pages allow for the management and display of non-flight plan data on the MFD MAP, RMAP, and CMAP pages. To effectively manage the display of non-flight plan data on the MFD, the CDU provides two unique functions: Mission Identifier Database Load function and MFD Data Display function.

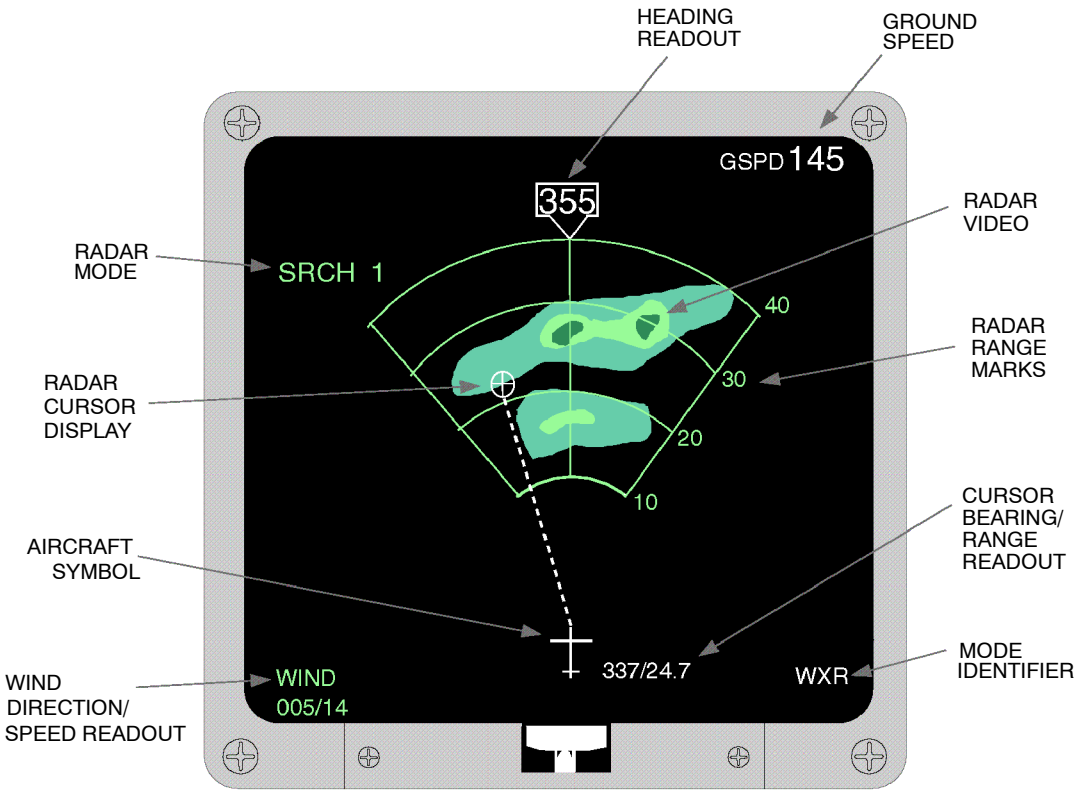



*Figure 1-220. VIDEO Page*

## MISSION IDENTIFIER DATABASE LOAD FUNCTION

The Mission Identifier Database Load function provides the operator the capability to build a mission specific database containing up to 1,200 points within a defined radius around a user-defined position. The user-defined position is referred to as the anchor fix. The Mission Identifier Database is created by searching the Primary Identifier Database on the MDL to determine which of the 20,004 identifiers fall within an area defined by a grid pattern that encompasses the radius around the anchor fix. Depending upon the radius, 250 nm or 350 nm, the Mission Grid can be either 500 nm X 500 nm, or 700 nm X 700 nm. Refer to Figure 1-221 for Mission Grid patterns. Once created, the Mission Identifier Database is stored in the CDU's long-term memory.

The following Identifiers can be used as anchor fixes.

a. VOR

b. VORTAC

c. TACAN

d. VOR-DME

e. NDB

f. Airports

g. Latitude/Longitude

The following information is stored in the Mission Identifier Database for each identifier:

1. Identifier
2. Grid Location, A1, A2, …B1, B2, etc.
3. Latitude/Longitude
4. Identifier Type

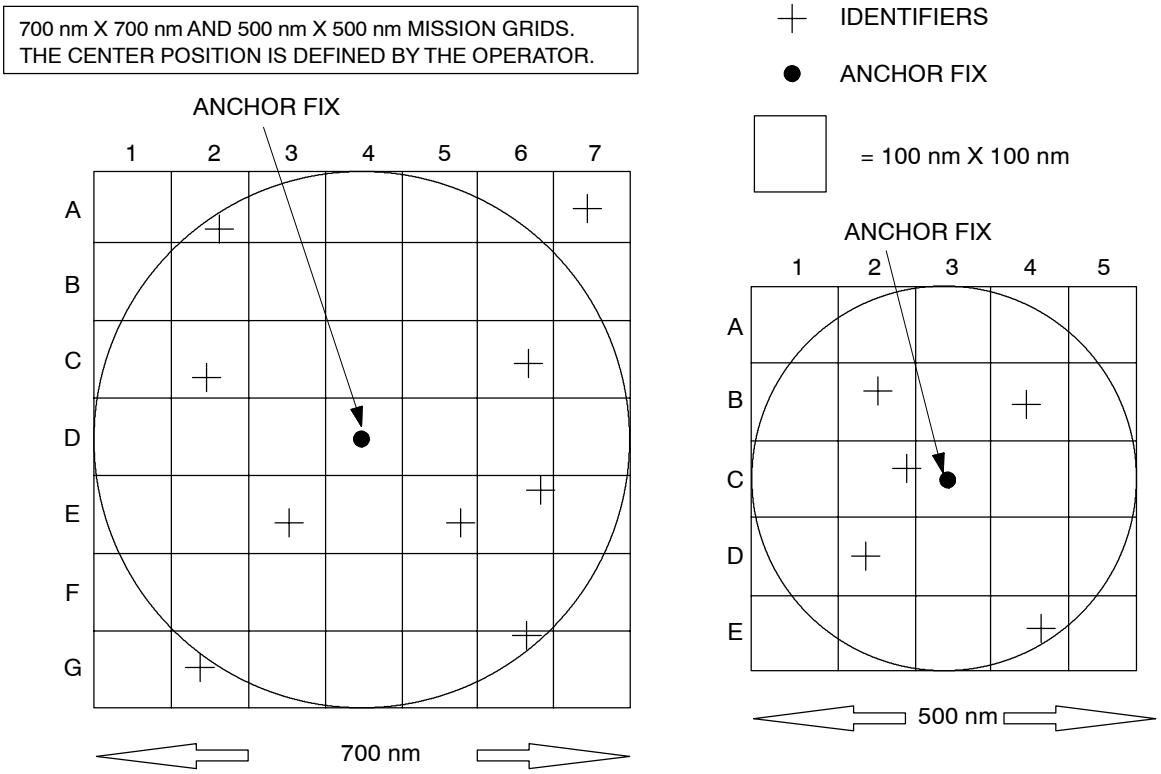



*Figure 1-221. Mission Grids*

## MFD DATA DISPLAY FUNCTION

Dedicated CDU pages are provided for the MFD Data Display function and are used to control the display of non-flight plan waypoints on the MFD. Waypoints available for display on the MFD include: Mission Identifier Database (airports and Navaids, up to 1,200 points), Reversionary Site Data (200 points), Waypoint List (48 points), and Mark List (10 points). All non-flight plan waypoints are displayed using standard MFD symbology. The MFD is only capable of displaying 35 identifiers. Therefore, the data must be filtered to determine the closest identifiers, waypoints, and markpoints that are sent from the CDU for display on the MFD.

System limitations prevent the simultaneous display of Mission Identifier Database points and Reversionary Site Data. Since the MFD MAP/RMAP pages have a maximum range of 320 nm, the Mission Identifier Database is filtered to those points that fall within a 300 nm X 300 nm grid centered on the aircraft's present position (Figure 1-222). Following this initial filtering, the Mission Identifier Database is further filtered to the 35 closest airports and Navaids, if selected for display via the MFD Data Page, before combining with any other data selected for display (markpoints and/or waypoints).

If Reversionary Site Data is chosen for display, Mission Identifier Database points cannot be displayed. The 200-point Reversionary Site is filtered to the 35 closest points before combining with any other data for display (markpoints and/or waypoints).

If markpoints and/or waypoints are selected for display along with either Mission Identifier Database points or Reversionary Site Data points, the FMS checks the points in those lists to see if they are closer than any of the points in the selected list of 35 Mission Identifiers or 35 Reversionary Data. Only the closest 35 points are displayed on the MFD.

## MFD DATA DISPLAY PAGES

There are three MFD Data Display Pages in the CDU: MFD Data Page, Mission Database Page, and Mission Data Load Page. The MFD Data Page is used to choose which off route flight plan waypoints to send from the CDU for display on the MFD. The Mission Database Page provides information for the currently stored Mission Identifier Database. The Mission Data Load Page is used to create the Mission Identifier Database. Pressing the DATA function key on the CDU when the cursor is not active accesses the MFD Data Display Pages (Figure 1-223, Figure 1-224, Figure 1-225, and Figure 1-226).

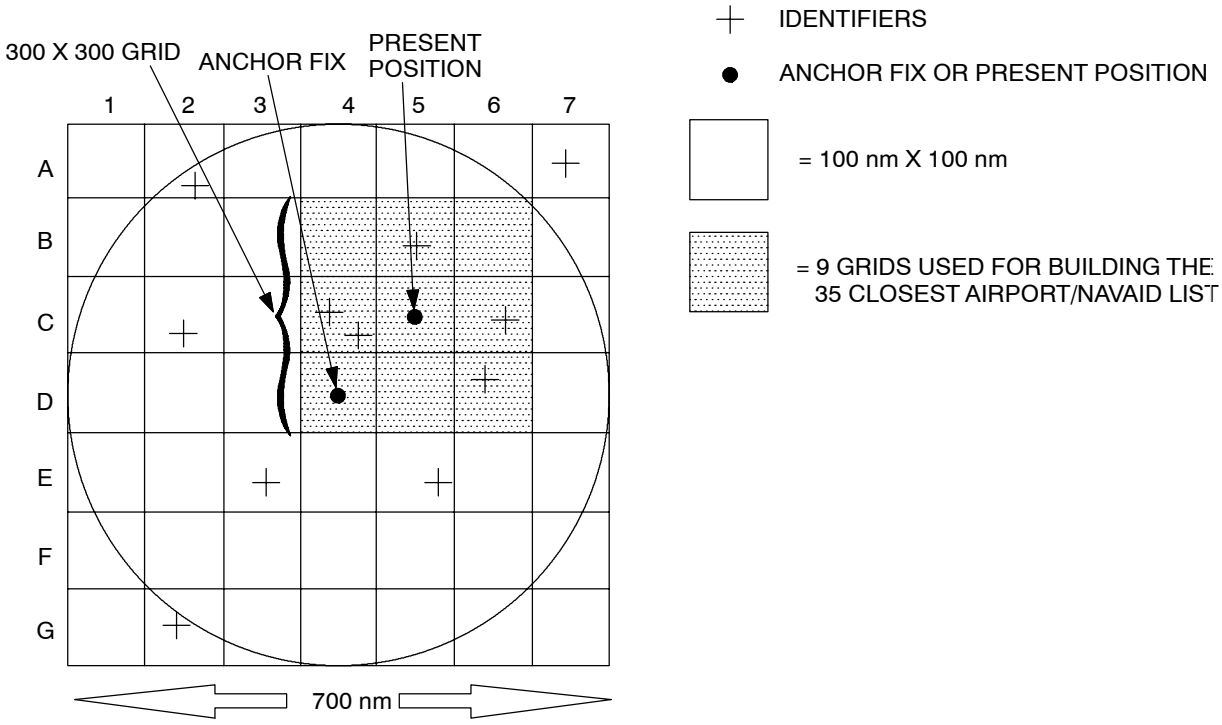



*Figure 1-222. 700 X 700 Grid within the Mission Database Region*

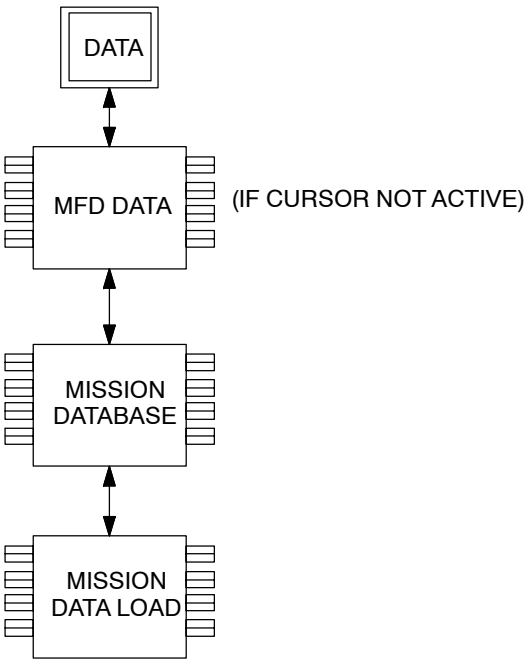



*Figure 1-223. MFD Data Page Access*

## MFD Data Page

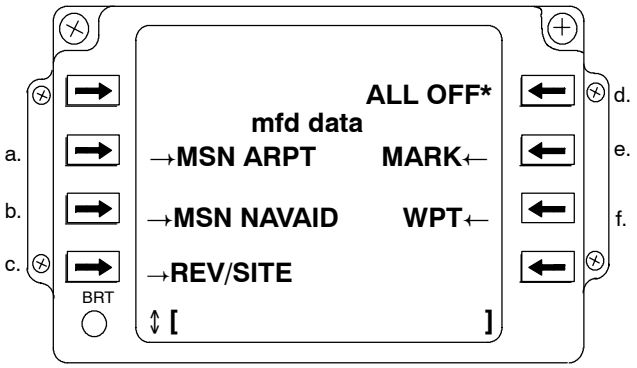



*Figure 1-224. MFD Data Page*

a. Selects Mission Identifier Database airports for display on the MFD. REV/SITE points, if selected, are turned off.

b. Selects Mission Identifier Database Navaids for display on the MFD. REV/SITE points, if selected, are turned off.

c. Selects Reversionary Site Data points for display on the MFD. MSN ARPT and/or MSN NAVAID, if selected, are turned off.

d. Selection removes all airports, Navaids, Site Reversionary, markpoints, and waypoints from the MFD display.

e. Selects the Mark List for display on the MFD.

f. Selects the Waypoint List for display on the MFD.

## Mission Database Page

The Mission Database Page (Figure 1-225) is a view only page and provides information for the stored Mission Identifier Database.

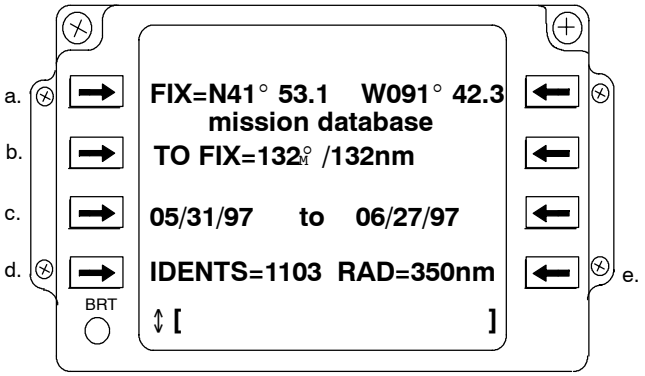



*Figure 1-225. Mission Database Page*

a. Displays the anchor fix. Dashes are displayed if no Mission Identifier Database is available.

b. Displays bearing and distance from present position to the anchor fix. The bearing is set to the system True/Mag selection. Dashes are displayed if no Mission Identifier Database is available.

c. Displays the effective date for the Mission Identifier Database. The line is blank if no Mission Identifier Database is available.

d. Displays the total identifiers stored in the Mission Identifier Database. Dashes are displayed if no Mission Identifier Database is available.

e. Displays the radius of the stored search.

## Mission Database Load Page

The Mission Database Load Page (Figure 1-226) is used to establish and store an anchor fix.

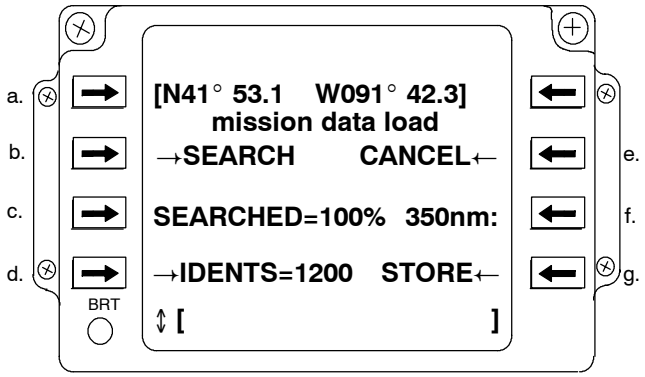



*Figure 1-226. Mission Database Load Page*

a. Selection enters a valid position from the scratchpad to be used as the anchor fix. Attempts to modify the anchor fix while a search is in progress results in the scratchpad message "SEARCH IN PROGRESS." Attempts to modify the anchor fix following a search and prior to storing the database results in the scratchpad message "DB NOT STORED." Selection with an empty scratchpad and a valid position for the anchor fix copies the anchor fix to the scratchpad.

b. Initial selection results in a "CONFIRM SEARCH" scratchpad message. SEARCH must be pressed a second time to initiate a search of the Primary Identifier Database for airports and Navaids. An "ENTER PARAMETERS" scratchpad message results if no anchor fix is defined.

c. Displays the percentage of the Primary Identifier Database searched. Dashes are displayed if the search is cancelled.

d. Incrementally displays the number of identifiers in the Mission Identifier Database. Dashes are displayed if the search is cancelled.

e. Initial selection results in a "CONFIRM CANCEL" scratchpad message. Selecting CANCEL a second time commands the search to stop.

f. Toggles between 250 nm and 350 nm.

g. Initial selection results in a "CONFIRM STORE" scratchpad message. Selecting STORE a second time stores the Mission Identifier Database in the CDUs long-term memory replacing any previously stored Mission Identifier Database.

## VOR/LOC NAVIGATION RADIO (AN/ARN-123)

The aircraft is equipped with a VOR/LOC radio receiver which processes VOR, localizer, glide slope, and marker beacon signals to provide full visual omnidirectional range and instrument landing system capabilities in the frequency range of from 108.00 to 117.95 MHz. Glide slope and marker beacon tuning is automatic with localizer frequency selection. The TACAN may be paired with the VOR for use by the CDU when the VOR is tuned to collocated VORTAC stations. Control of the VOR radio is accomplished through the CDUs via the NAV page. The receiver is separately powered by 28 volts DC and 26 volts AC, 400 Hz. Two circuit breakers, both labeled NAV (one for DC and one for AC), protect the VOR and are located on the PILOT section of the cockpit avionics circuit breaker panel.

The receiver can be operated in one of two modes; manual or localizer, as selected on the CDU NAV radio page. The modes are displayed on the CDU as; MAN or LOC.

- MAN mode. In the manual mode, the VOR station must be selected via identifier or frequency entries in the scratchpad. Manual mode is selected as follows: If the existing mode is AUTO, depressing the respective line select key will switch the mode to MAN. The station identifier and frequency will remain unchanged. Entering a new station, either by station identifier or frequency via the scratchpad, will also switch the mode from AUTO to MAN or from LOC to MAN. When entering a new identifier, the SDB will be searched for the station and, if found, both the identifier and its corresponding frequency will be tuned and displayed. If the station is not in the data base, a NOT STORED annunciation will appear in the scratchpad. When entering a new frequency, the system will again search the SDB for the corresponding identifier and if found, display the identifier as well as the frequency. However, if the tuned station identifier is not in the SDB, the ident field will display (--) dashes and no annunciation will occur. This will also occur if a frequency is entered and the mission computer has failed.

- LOC mode. The localizer mode is entered from the automatic or manual mode by inserting a localizer frequency via the scratchpad. The station ident display will be (--) dashes and the mode is displayed as VOR: LOC when the mode is entered. Localizer mode can be cancelled by entering a VOR frequency, which will switch to manual mode, or by depressing the line select key twice, which will switch the VOR to automatic mode.

- Marker Beacon Operation. Each VOR/LOC radio receiver is set up to receive marker beacon signals anytime power is applied. Two selectable levels of sensitivity are provided to enable the pilot to shorten or lengthen the indication time over a marker beacon. The sensitivity level for both receivers is controlled by the HI or LO lighted switch located on the pilot's instrument panel and is selected by depressing the appropriate switch which will illuminate to display the desired level. The marker beacon tone, heard in the crewmember's headset, is controlled by the associated MKR monitor/volume control knob on each audio control panel.

### VOR Radio Operational Procedure

1. NAV page access key - Depress to access the NAV page display on the CDU.
2. VOR line select key
   a. For VOR mode: Enter desired VOR frequency or three letter identifier.
   b. For LOC mode: Enter the desired localizer frequency.
3. DCP - Select VOR as NAV source.
4. DCP - Select HSI page for the MFD.
5. BDI - Select VOR for bearing and distance display on BDI.
6. HI - LO light switch - Select desired marker beacon sensitivity level.

## TACAN (AN/ARN-118)

The TACAN consists of a single transceiver which provides continuous bearing and distance information from any selected station within range of the equipment. Although the range of the equipment is governed by line of sight considerations, the maximum range possible is 350 nm. There are 252 TACAN channels available; 126 in each of the X and Y modes.

**NOTE**

The Y channels were developed to alleviate congestion of the X channels. Use of the Y channels in the A/A mode is encouraged to eliminate possible interference with ground stations using the X band.

Tuning and control of the TACAN is accomplished through the CDUs via the NAV page. For a detailed presentation of

the NAV page, refer to Figure 1-119. The TACAN can be operated in two modes; MAN (manual) which requires that TACAN channels be manually entered via the scratchpad, or PAIR which means the TACAN will be automatically tuned to stations collocated with VOR 1. Selection of MAN or PAIR is made via the left line select key and is displayed as TACAN: MAN or TACAN: PAIR. Manual mode is also achieved by: manual entry of a TACAN channel via the scratchpad, manually changing the TACAN transmit-receive functions (TR, R, AAR, or AATR), or by tuning VOR to a localizer frequency. The right line select key of the CDU is used to manually enter or change TACAN channels. With the scratchpad empty, the right line select key is used to select the TACAN operating functions R, TR, AAR, and AA TR.

TACAN operating functions are:

- R - TACAN receives bearing and audio identification from selected surface station. MFD and BDI TACAN DME displays are blank.
- TR - Transmit and receive. TACAN interrogates ground station DME and determines range to station. Also receives bearing and audio identification. Range is displayed on MFD and BDI.
- AAR - Receives bearing (if station has bearing transmit capability) and audio identification from selected airborne TACAN station. MFD and BDI DME displays are blanked.
- AATR - TACAN interrogates cooperating aircraft TACAN and calculates range. Also receives bearing (if station has bearing transmit capability ) and audio identification. Range is displayed on MFD and BDI.

**NOTE**

Operation in the air-to-air mode requires prearrangement with a cooperating aircraft. The second aircraft must be equipped with an air-to-air TACAN which is set to the air-to-air mode of operation and to a channel 63 channels away from the channel setting of the TACAN in the first aircraft. One aircraft may reply to as many as five others, but it will only display the distance to the nearest aircraft.

- This aircraft does not have bearing transmit capability.

The TR function will be selected automatically from whatever function is being used when the TACAN is paired with VOR.

The TACAN is powered by 115 volts AC, 400 Hz and is protected by a circuit breaker labeled TCN located on the cockpit avionics circuit breaker panel.

## TACAN Radio Operational Procedure

1. NAV page access key - Depress to access the NAV page display on the CDU.
2. TACAN line select key - Select PAIR or MAN. If TACAN is to be used with a collocated VOR station (VORTAC), select PAIR. If TACAN is to be tuned to a station that is not paired with a VOR, select MAN (manual).
3. TACAN mode line select key - Select R, TR, AAR, or AATR, as required.
4. TACAN channel - Enter the desired TACAN channel number via the scratchpad and depress the right line select key.
5. DCP - Select TACAN as NAV source.

## RADAR ALTIMETER SYSTEM

Radar altitude data is made available to the CDUs via the MFD for use in navigation and approach-to-hover computations. The Radar Altimeter system provides altitude above ground level (AGL) flight below 2,500 feet AGL for display on the radar altitude indicators, ADI, MFD, and altitude data for use by the Flight Control and FMS systems. Separate radar altitude indicators are provided for pilot and copilot with independent selectable decision height (DH) controls.

Decision height control on each indicator provides the following:

1. Radar altitude visual annunciation on the ADI.
2. Aural annunciation from the pilot's DH control only.

The Radar Altimeter consists of a receiver-transmitter, antenna system and panel mounted Radar Altitude indicators. This unit provides altitude and validity output to the indicators, flight director computer, and MFD. When below the selected DH, an annunciator light on the Attitude Director Indicator (ADI) is illuminated. When below the pilot's set DH, the altitude aural warnings are enabled. An indicator warning flag is provided on the indicators to indicate power failure or self test. Self test is initiated when the self test button on the indicator is pressed. The self test is inhibited if the Radar Altimeter is coupled to the Flight Director Computer. Figure 1-70 is a block diagram of the Radar Altimeter system as integrated into the flight management system.

## MAGNETIC HEADING REFERENCE

Compass data and validity are made available to the CDUs via the MFD for use in navigation computations. Dual magnetic heading references and validity flags are provided. The number one heading system drives the pilot's MFD and the VOR, while the number two system provides magnetic heading information to the copilot's MFD, BDI and Flight Control System (YAW channel). Compass information for the FMS and Flight Director Computer are processed from the FDC SIM and either of the MFDs (as determined by NAV CTRL). Latitude compensation is provided to prevent apparent gyro drift in the DG MODE during polar operations. Inputs for SLAVE mode of compass system operation are processed by the FDC SIM and routed to the CDU via the 1553B data bus.

## BEARING DISTANCE INDICATOR

The BDI is a Radio Magnetic Indicator (RMI) with digital distance display. The BDI receives bearing information from the VOR, TACAN or ADF/DF systems. A 2-position pushbutton is associated with each pointer and permits selection between two inputs. Either the VOR or ADF/DF relative bearing may be selected on the double-bar pointer, while the VOR or TACAN relative bearing may be selected on the single-bar pointer. Copilot compass heading information is presented on an azimuth card that is read against a fixed lubber line. A HDG flag is displayed whenever a) compass information is invalid, b) internal power is lost, or c) excessive servo error exists.

TACAN slant range distance is presented on the digital distance display. When TACAN is paired with the VOR, and VOR bearing is selected on the single Bar Pointer, the distance is displayed on the VOR (right) side of the display. When TACAN is unpaired or TACAN BRG is selected on the single bar pointer, the distance is displayed on the TACAN (left) side of the display.

## AUTOMATIC DIRECTION FINDING SYSTEM (ADF-60A)

The ADF system provides automatic direction finding or low frequency broadcast band reception in the 190 to 1749.5 kHz frequency band (Figure 1-227). The system consists of a receiver and a combined loop and sensor antenna. Refer to Figure 1-148 for antenna location. Frequency and mode of operation are selected via the NAV radio access page on the CDUs. Refer to Figure 1-119 for a detailed presentation of the NAV radio access page display. ADF mode is selected on the CDU by depressing the ADF line select key with the scratchpad empty. This will select ADF for automatic direction finding, or ANT for antenna broadcast band or low frequency homer audio reception. Frequencies are entered or changed via the scratchpad by depressing either the ADF or TONE line select keys. Depressing the TONE line select key, with the scratchpad empty, enables or disables a 1000 kHz CW tone signal with each actuation. The ADF mode select button on the DF mode control panel on the center console selects ADF bearing information for display on the MFD (BRG 1 and BRG 2) and BDI. The ADF system operates on 28 volts DC power from the pilot's shed bus and 26 volts AC power from the No. 1, 26 volt AC transformer. Two circuit breakers marked ADF are located on the cockpit avionics circuit breaker panel.

### ADF Mode Select Button

A DF mode rotary select switch (Item 1, Figure 1-228) is located on the DF mode control panel. Selection of the ADF mode will provide relative bearing information to the MFD and BDI. ADF bearing information is available on the MFD BRG 1 and BRG 2 needles. On the BDI the relative bearing is displayed on the double bar pointer (Item 6, Figure 1-228) as selected by the BDI double bar pointer selector switch (Item 5, Figure 1-228).

### ADF Operational Procedure

1. Audio control panel:
   a. ADF monitor/volume control knob - Pull out and adjust volume to a comfortable level.
2. Control display unit:
   a. NAV radio control access page key - Depress to access NAV radio page display on CDU.
   b. Enter frequency of radio station in scratchpad.
   c. ADF or TONE line select key - Depress to tune the ADF receiver to frequency entered in scratchpad. Scratchpad will clear and frequency will appear on ADF data line.
   d. ADF line select key - Select ADF mode or antenna (ANT) mode for low frequency homer or broadcast band reception.
   e. TONE line select key - Depress TONE line select key if receiving a low frequency homer to enable station CW identifier reception. Arrow beside TONE will be replaced with an asterisk to indicate tone is enabled.
3. DF mode control panel:

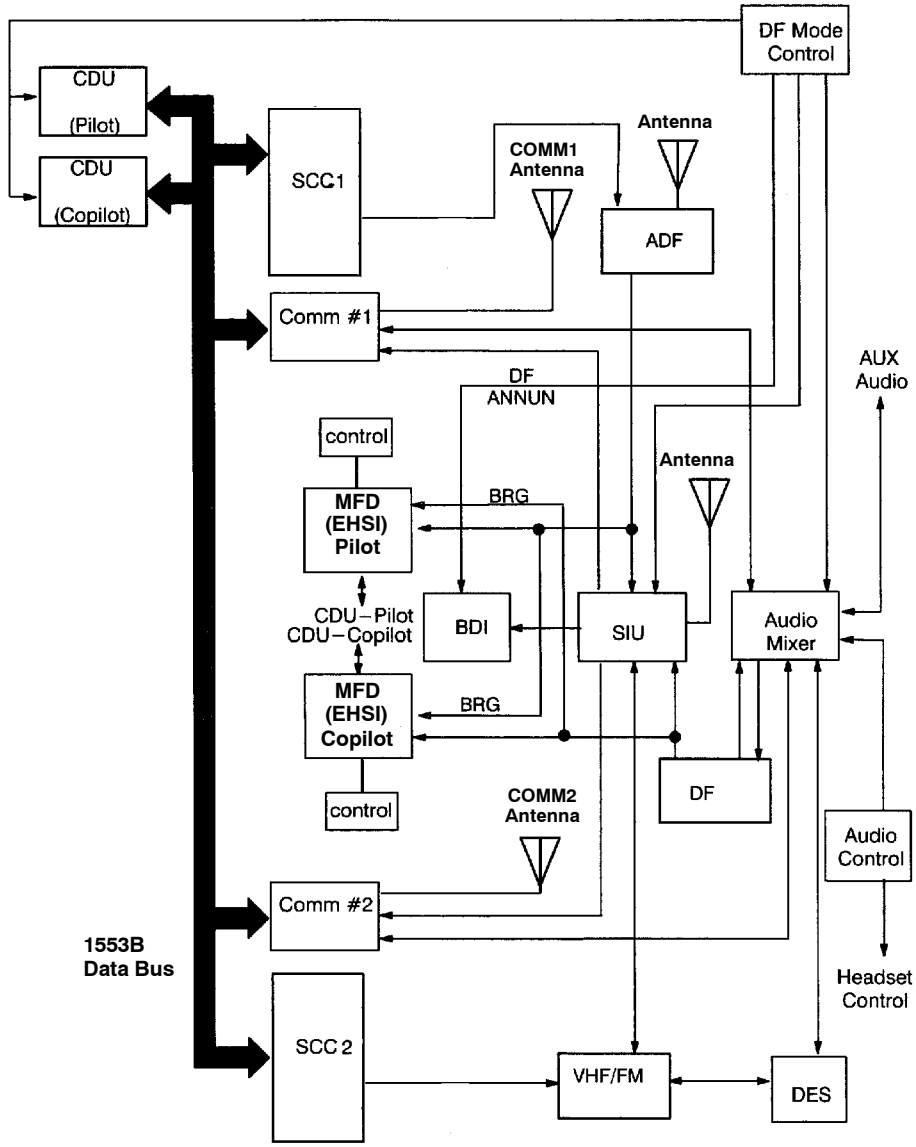



*Figure 1-227. ADF/DF Block Diagram*

a. DF mode rotary switch - Rotate to select ADF.

4. Display control panel:

   a. BRG 1 or BRG 2 needles - Select DF.

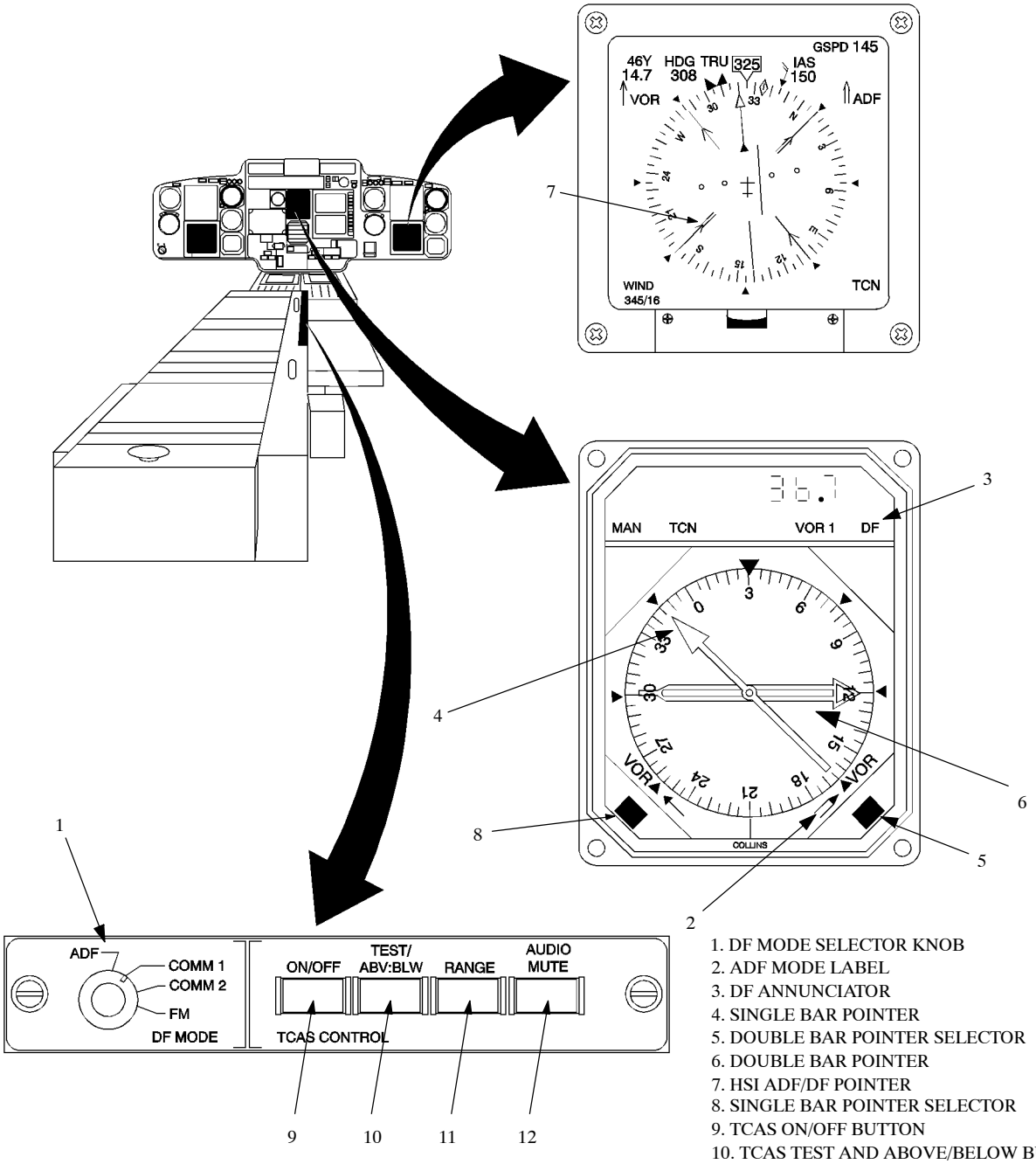
   b. Display mode selector - Select HSI, MAP, RMAP, or CMAP. Selected needle will display DF bearing.

5. Bearing distance indicator:

   a. BDI double bar pointer switch - Push in to select ADF. ADF flag adjacent to switch will appear to indicate double bar pointer is displaying ADF relative bearing.

## DIRECTION FINDING SYSTEM (DF-301E)

The DF system provides direction finding capability in the VHF/UHF and VHF-FM radio frequency band from 100 to 400 MHz. The DF- 301E consists of a single unit which contains two sections; a solid state VHF/UHF antenna with preamplifier and an audio processing section. Refer to Figure 1-148 for antenna location. Frequency, mode selection, and radio receiver for DF operation are selected via the COMM radio control page on the CDUs. Refer to Figure 1-152 for a detailed presentation of the COMM radio control page display. COMM 1, COMM 2, or FM may be selected to operate in conjunction with the DF-301E to provide DF steering to a transmitting station.




1. DF MODE SELECTOR KNOB
2. ADF MODE LABEL
3. DF ANNUNCIATOR
4. SINGLE BAR POINTER
5. DOUBLE BAR POINTER SELECTOR
6. DOUBLE BAR POINTER
7. HSI ADF/DF POINTER
8. SINGLE BAR POINTER SELECTOR
9. TCAS ON/OFF BUTTON
10. TCAS TEST AND ABOVE/BELOW BUTTON
11. TCAS RANGE BUTTON FROM 6, 12, OR 24 NM
12. TCAS MUTE BUTTON PILOT/COPILOT

*Figure 1-228. ADF/DF System Controls and Indicators*

**NOTE**

- HF radio transmissions are not recommended during DF operation as this will cause the BDI relative bearing pointer to swing.
- Voice transmission on the selected radio may be accomplished when operated in conjunction with the DF-301E; however, DF steering signals will be preempted.

## DF Mode Rotary Switch

A DF mode rotary switch, (1, Figure 1-228), located on the TCAS/DF MODE panel, is provided to select COMM 1, COMM 2, or FM radios for operation with the DF-301E antenna. Selecting the desired radio will provide relative bearing information to the HSVD and BDI, and a DF annunciator lamp on the BDI will illuminate to indicate DF information is being supplied to the instrument. With the HSVD in the HSI mode, the relative bearing is displayed on the ADF/DF bearing pointer (7, Figure 1-228). On the BDI, the relative bearing is displayed on the BDI double bar pointer (6, Figure 1-228) as selected by the BDI double bar pointer selector (5, Figure 1-228). Audio reception of the radio selected for DF operation can be monitored at the pilot's, copilot's, and hoist operator's stations. The DF-301E operates on 28 volt DC power from the auto shed bus and 26 volt AC power through a circuit breaker labeled DF on the avionics rack circuit breaker panel.

## DF Operational Procedure

1. Audio Control Panel:
   a. COMM 1, COMM 2, or FM monitor/volume control knob - Pull out and adjust to comfortable level.
2. DF MODE Select Panel:
   a. DF mode select switch - As desired. Rotate to select the radio to be used in DF operation.
3. Control display unit:
   a. Tune the COMM 1, COMM 2, or FM radio to the frequency to be used in DF operation.

**NOTE**

Audio reception will be degraded when operating radios in DF mode.

4. Display control panel:
   a. BRG 1 and BRG 2 needle - Select DF.
   b. Display mode selector - Select HSI, MAP, RMAP or CMAP. Selected needle will display DF bearing.
5. Bearing distance indicator:
   a. DF annunciator in upper right corner of BDI will illuminate.
   b. BDI double bar pointer switch - Push in to select ADF. ADF flag beside switch and DF annunciator will indicate that double bar pointer is displaying DF bearing.

## IFF TRANSPONDER (AN/APX 100)

The IFF transponder provides automatic aircraft identification, location, and altitude reporting in response to surface or airborne IFF interrogation (Figure 1-229). An emergency mode is also available which, when selected, will transmit a signal without being interrogated. The IFF system consists of a transponder, two antennas (upper and lower), and controls on the IFF/COMM control panel. Refer to Figure 1-148 for antenna locations. The IFF is controlled by the CDU via the IFF control page. Mode selection, code entry, and antenna selection are provided and are discussed in the IFF Page subsection. The IFF/COMM panel provides guarded switches for IFF emergency selection and for zeroizing of the secure codes from the Mode IV computer (KIT-1C). Identifier control and a monitor annunciator are also provided on the IFF/COMM panel. The IFF block diagram is shown in Figure 1-229. The IFF control page on the CDUs provides mode selection, code entry, and antenna selection. Refer to Figure 1-120 and 1-121 for a detailed presentation of the IFF control page. Self-test capability of the IFF is provided by an IFF test page on the CDUs (Figure 1-120 and 1-121). Operating modes of the IFF are as follows:

- Mode 1 - Security identification - 32 possible codes available
- Mode 2 - Personal identification - 4,096 possible codes available to identify aircraft
- Mode 3A - Traffic identification - 4,096 possible codes available to denote flight status
- Mode IV - Special encrypted military code identification-requires KIT-lC computer for operation. A Mode

IV monitor on the CDU IFF display and an audio signal alerts the crew to a Mode IV challenge and reply.

- Mode C - Altitude interrogation - 4,096 codes available to report altitude information furnished by encoding altimeter.

- Emergency (EMER) mode - Selected by positioning IFF emergency mode switch to EMERG position. Selecting EMERG will: switch IFF operation from STBY or NORM to EMER, enable all modes (as indicated by an asterisk), and switch mode 3A to the emergency code 7700.

The pilot may select either the TOP, BTM (bottom), or BOTH IFF antennas as desired via the CDU IFF control page ANT line select key. When the BOTH antenna position is selected, an antenna switching unit contained in the transponder unit will automatically select the best antenna for interrogation replies. The IFF operates on 28 volts DC power from the copilot's shed bus and 115 volts AC from the No. 2 main AC bus. Circuit breakers, marked IFF, are located on the cockpit avionics and avionics rack circuit breaker panel.

## IFF Emergency Mode Switch

The IFF emergency mode switch, located on the IFF/COMM control panel (10, Figure 1-150) is a two position lock/lever switch marked EMERG with an unmarked normal position. The switch lever must be raised out of the lock detent each time it is moved from one position to the other. The normal (down) position of the switch provides normal operation of the IFF transponder. Positioning the switch to EMERG will:

- Switch IFF operational mode from STBY, or NORM to IFF: EMER

- Enable all IFF modes 1, 2, 3A, and C, with provisions for Mode IV, if not already selected

- Cause the CDUs to display IFF EMERG on pages 1 and 2 of the IFF page and the IFF test page

- Cause the mode 3A code in use to switch to the distress code 7700

- Enable Mode IV; but no additional pulses are added to M-4 replies.

Returning the switch to the normal position will return the IFF to its configuration prior to selecting EMERG.

## IFF IDENT Pushbutton

The IDENT (identification-of-position) pushbutton is located on the IFF/COMM control panel (9, Figure 1-150). Depressing the button will cause the IFF transponder to transmit an additional position identification pulse on modes 1, 2, or 3A to distinguish between aircraft with transponders on the same code. The additional pulse will be transmitted for approximately 20 seconds.

## IFF Mode 2 Operation

Mode 2 codes must be manually entered using the four rotary switches located on the face of the RT-1157A IFF receiver/transmitter located in the avionics rack. The IFF receiver/transmitter may be accessed through a door in the upper right corner of the avionics rack upper panel. Mode 2 will then respond to interrogation when mode 2 is selected on IFF page 2 of the CDU.

## IFF Mode IV Zeroize Switch

The IFF Mode IV zeroize switch, located on the IFF/COMM control panel (11, Figure 1-150) is a two position lock/lever switch marked ZERO with an unmarked normal position. The switch lever must be raised out of the lock detent each time it is moved from one position to the other. Positioning the switch to ZERO will change the Mode IV encrypted code entries to zero. The normal position of the switch allows normal operation of the transponder in Mode IV.

## IFF Monitor Lamp

The IFF monitor lamp, located on the IFF/COMM control panel (8, Figure 1-150), is a push-to-test, turn-to-dim lamp which, when illuminated, indicates a malfunction in the IFF transponder. The lamp will also illuminate steady when the IFF is in standby or flash when interrogated by Mode IV Air Traffic Control.

## IFF Operational Procedure

1. Preflight - Enter mode 2 codes into the IFF receiver/transmitter located in the avionics rack access panel.

2. IFF control page access key - Depress to access the IFF page.

3. IFF line select key - Depress to select NORM.

4. Mode line select keys - Select modes 1, 3A, or C as desired. Depress mode line select key to select desired modes for operation. An asterisk by the line key indicates mode is active.

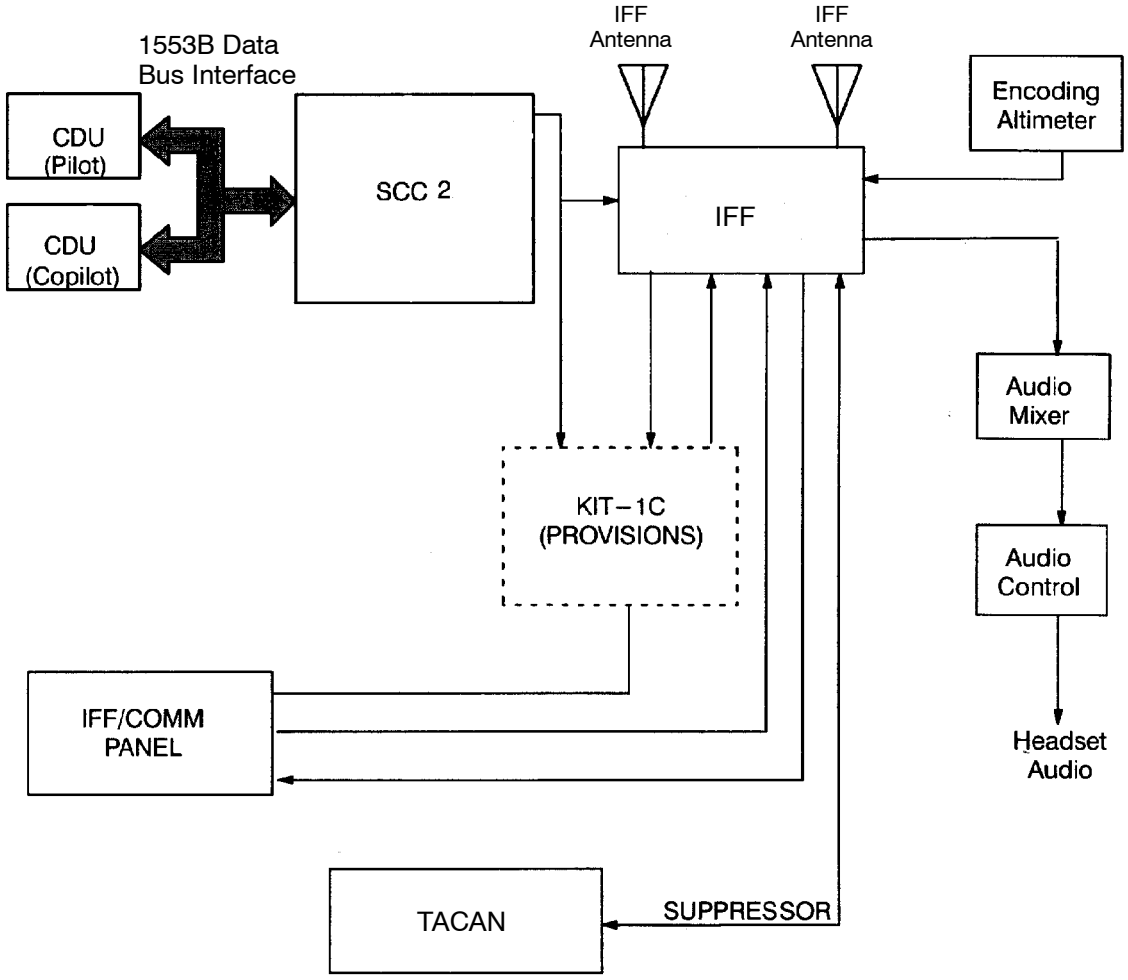



*Figure 1-229. IFF Block Diagram*

**NOTE**

Mode C is activated when mode 3A is selected. However, mode C can be deselected without effecting mode 3A.

5. Enter mode 1 or mode 3A codes via scratchpad and right line select keys.

6. ANT line select key - Select TOP, BTM, or BOTH. "BOTH" shall be selected when using Mode IV.

7. Vertical scroll keys - Actuate up or down to access IFF page 2.

8. Mode line select keys - Select modes 2, 4A, or 4B as desired. Depress mode line select key to select desired mode.

9. Mode IV monitor line select key - Depress to select REPLY : LIGHT. Depress Mode IV monitor line select key to activate Mode IV. REPLY : OUT indicates Mode IV off, REPLY : LIGHT indicates Mode IV on. "TONE" shall be selected when using Mode IV.

10. The M 4 REPLY in the right annunciator line indicates Mode IV is making encoded replies.

11. Vertical scroll keys-Actuate up or down to return to IFF page 1.

## MODE IV CODE – "M-4A" AND "M-4B"

M-4A or M-4B allows the selection of the A or B Mode IV operational code. A Mode IV operational code loaded into the transponder computer consists of codes for two consecutive crypto periods. The current day's period is M-4A, while the subsequent period is M-4B. Use the appropriate A or B position to select the desired period. Deselecting both A and B puts the KIT-1C Mode IV Computer to Standby.

## "M4 HOLD" FUNCTION

## MODE IV CODE HOLD FUNCTION

The HOLD function of the IFF system enables the KIT-1C transponder computer to retain Mode IV codes without the need to reload codes when power is restored. If the landing gear is cycled during the sortie (detected via right main cylinder downlock switch) and power is later removed from the transponder computer (via shutdown or emergency procedure) all codes will be deleted unless the HOLD button is selected on the CDU IFF page during SHUTDOWN procedures. Proper shutdown procedures will enable the KIT-1C computer to retain codes without the need to reload codes when power is restored and will remain protected until the landing gear is again cycled. The KIT-1C HOLD function relies on two 3 volt batteries installed in the KIT-1C to operate correctly.

If Mode IV codes need to be saved (gear cycled or GEAR INDICATOR circuit breaker pulled/reset during flight), depress the HOLD button on the IFF page. An asterisk will appear for approximately 15 seconds, and then the word HOLD changes to HELD, indicating that the codes have been saved.

**WARNING**

Securing or resetting the landing gear indicator circuit breaker located on the copilot's forward breaker panel at any time will have the same affect on the KIT-1C as cycling the landing gear. Securing aircraft power with this circuit breaker pulled will result in the loss of Mode IV codes regardless if the HOLD function was activated or not.

## USE OF MODE IV CODE HOLD FUNCTION

Mode IV code holding procedures are only required when the crypto computer is in the electrical hold condition. This occurs when power is applied and the landing gear has been cycled.

On the CDU, select HOLD before shutting down power. Once this is accomplished, the Mode IV code is protected until the landing gear interlock line is again ungrounded (either through cycling gear or via circuit breaker).

## "ANT"

This selects TOP, BTM or BOTH IFF antennas. With both antennas operating correctly, BOTH shall be selected. BOTH is the default position in the HH-65 aircraft.

**WARNING**

Failure to select BOTH could result with no reply signal.

## "REPLY"

This is used to enable the M4 Reply Annunciation, Mode IV Warning Light and the Mode IV audio tone.

1. In the TONE position, the M4 Reply Annunciation, Mode IV Warning Light and Mode IV Audio Tone are enabled; this is the default position in the HH–65 aircraft.

2. In the OUT position, the M4 Reply Annunciation, IFF Warning Light, and the Mode IV audio tone are disabled.

3. In the LIGHT position, the M4 Reply Annunciation and IFF Warning Light are enabled and the Mode IV audio tone is disabled. TONE shall always be selected.

**WARNING**

Failure to select TONE could result in interrogation without replying to the proper day's code; TONE must be selected to ensure all interrogation capabilities are operational.

## MODE IV REPLY ANNUNCIATION ("M4 REPLY")

The Mode IV Reply Annunciation provides a visual indication to the transponder operator that Mode IV replies are being transmitted. To enable this annunciation to function, the REPLY select must be placed in the LIGHT or TONE position. M4 REPLY will be displayed on the lower right corner of all pages on both of the CDUs (TONE shall always be selected).

**Mode IV Audio Tone.** A tone is heard when the aircraft is being interrogated by a VALID code, but not the code se-

lected on the CDU. This is called cross coding and alerts the pilot to check the crypto code (A or B) selected. Audio is heard at both pilot's and copilot's position.

The term **Compatible** indicates a code that matches that of your transponder; **Valid** indicates a code that is theoretically possible but not necessarily the correct Mode IV code for the crypto period.

## MODE IV WARNING LIGHT ("IFF/M4")

Illumination of the Mode IV Warning Light**,** located on the Caution Advisory Panel, will indicate one of the following conditions:

1. The transponder computer is installed with power applied but is not loaded with a valid Mode IV code.

2. The transponder computer has failed its Mode IV self–test cycle.

3. A compatible Mode IV interrogation was received but no Mode IV reply was transmitted. This condition occurs if:

   a. The transponder system is in standby.

   b. A malfunction in the IFF transponder will not allow the Mode IV reply to be transmitted or transmits the reply at very low power.

   c. Neither 4A or 4B is selected on the CDU.

In the event of a. and b. above, the Mode IV Warning Light will be on steadily. In the event of c., the Mode IV Warning Light may cycle on and off depending on the recurrence of Mode IV interrogations. In any event, the Mode IV Warning Light is an indication to the transponder system operator that the Mode IV function is not operating. The IFF MON light on the IFF/COMM Panel will illuminate when the M4/IFF Warning Light on the WCA Panel is lit.

## MODE IV CODE CHANGING AT THE END OF THE CURRENT CRYPTO PERIOD

**The Crypto Period.** Currently, the Mode IV crypto period is 24 hours long. Daily Mode IV operational codes are replaced by new operational codes at the end of the crypto period. System operators must know exactly when the Mode IV crypto period ends and change to the new period's code at that time via reloading the crypto computer or using the code A/B switch. Failure to change to the new code at the end of the crypto period will make the system's Mode IV function incompatible with other Mode IV systems. Operators must be sensitive to the fact that not everyone, due to human factors, will complete the change to the new Mode IV code at precisely the same time.

**Using the 4A and 4B Select Switch.** The crypto computer is loaded with two consecutive crypto periods. Sometimes operational requirements make it impossible to reload the Mode IV code at the end of the first crypto period. In this case, the new Mode IV code may be chosen by selecting 4B on the IFF page.

## MODE IV CODE ZEROIZE FUNCTION

**Methods of Zeroizing-Crypto Computers.** Several methods are described in the paragraphs that follow for zeroizing or clearing the Mode IV codes in the crypto computer.

**Removing Power from the KIT-1C Crypto Computers.** The Mode IV code will zeroize when power to the computer is removed for approximately 15 seconds, but only if the landing gear had cycled and the Mode IV code hold function was not activated. The Mode IV code will not zeroize on removal of power if the landing gear is down and has not been cycled since power was first applied. This permits multiple power applications to an aircraft after code insertion without the need to activate the Mode IV code hold switch.

**WARNING**

Securing or resetting the landing gear indicator circuit breaker located on the copilot's forward breaker panel at any time will have the same affect on the KIT-1C as cycling the landing gear. Securing aircraft power with this circuit breaker pulled will result in the loss of Mode IV codes regardless if the HOLD function was activated or not.

**Using the Mode IV Zeroize Switch on the KIT-1C.** Pushing the zeroize button on the front of the KIT-1C will zeroize the Mode IV codes. Power does not need to be applied to the system to operate and is independent of the position of the landing gear or the status of the Mode IV code hold circuits.

**Using the Mode IV Zeroize Switch on the IFF/COMM Panel.** If the Mode IV zeroize switch is used while power is applied to the computer, the codes to the Mode IV and the KY-58 will be zeroized. This is independent of the position of the landing gear or the status of the Mode IV code hold circuits. (See Figure 1-230.)

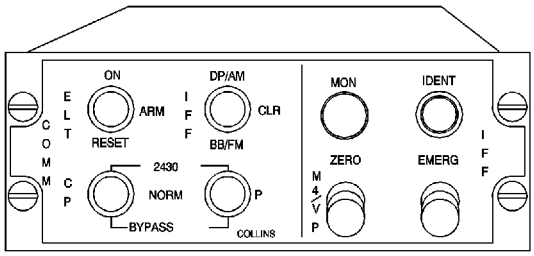



*Figure 1-230. 373C-1 IFF/COMM Control*

**Indication of Mode IV Code Zeroize.** The Mode IV warning light will light steadily to indicate that the Mode IV codes in the KIT-1C computer have been zeroized.

## MODE IV VERIFY BIT 1 (RAD TEST)

Verify Bit 1 is a test feature of the KIT-1C equipment. When RAD is selected on the IFF test page, the Mode IV code in the computer is altered to make it compatible with other systems that have also selected Verify Bit 1 only. This enables over-the-air loop testing while ensuring that no outside system will reply to these interrogations. If this loop-back test is conducted in Mode IV on a crowded flight line without Verify Bit 1 enabled, the number of close range replies would make it impossible to see the intended reply. Enable RAD Test by selecting IDX, then Test on the CDU. On the IFF Test Page select RAD.

**Possible Uses of Verify Bit 1.** Verify Bit 1 provides a unique Mode IV interrogation and reply. This function can be used to specifically identify an individual target much like the identification of position (I/P) function used in SIF operation. This requires direct cooperation, in most cases voice communication, between the interrogator and transponder operators. Verify Bit 1 can also be used to increase the identification confidence of a target. For example, a target's reply to a Mode IV interrogation may be questionable; that is, it may not present a clear video presentation. With RAD TEST enabled, verification can be made of a questionable target.

## IN SUMMARY

The M4 REPLY Annunciation, located on the bottom right-hand corner of the CDU, advises the pilot that it is replying to a compatible Mode IV interrogation. The Mode IV Warning Light – Labeled M4/IFF, located on the Caution Advisory Panel, advises the pilot that: the KIT-1C is not loaded properly (steady light), the KIT-1C has failed the self test (steady light), or the Compatible Mode IV code was received but no Mode IV reply was generated (may cycle on/off). The following items are important to remember: the KIT-1C requires two code fills; **BOTH** shall be selected on the Antenna Select, if both antennas are operating correctly; and **TONE** shall be selected in Reply to ensure both light and audio warnings are presented. The KIT-1C receives 28 VDC power from the DC IFF circuit breaker located on the Cockpit Avionics Circuit Breaker Panel. This circuit breaker receives its power from the Copilot's Avionics Bus, in turn, powered from the #1 DC Bus. Failure of either the IFF circuit breaker, CP Avionics Bus, or respective DC Bus will result in the loss of Mode IV capability.

## PRE-FLIGHT

1. Verify with FM/AVT that Mode IV has been properly loaded in the aircraft.
2. After AC power is online, check CDU IFF page to ensure that:
   a. ANT: BOTH is selected to use both antennas.
   b. M-4A is asterisked.
   c. IFF REPLY: TONE is selected for light and audio warnings.
3. Prior to launch, validate Mode IV pre-flight test with Ramp Tester:
   a. Select IFF: NORM.
   b. Ramp Tester will interrogate aircraft with code of the day.
   c. M4 REPLY should illuminate on lower right corner of CDU, indicating proper system operation. No tone heard indicates a COMPATIBLE code.
   d. Communicate proper system operation to Ramp Tester.
4. The following items are optional and should be completed if time permits:
   a. With M-4A code selected in the ramp tester's IFF test set, switch to M-4B on the IFF page and listen for a Mode IV audio tone. An audio tone should be heard, which indicates a valid but incompatible code.
   b. Ramp Tester switch to M-4B.
   c. Repeat steps 3.a.- 3.d., but switch back to M-4A at end of step 3.d.

d. Select IFF: NORM/STBY as appropriate.

## IF TEST PASSES

Inform controlling unit that aircraft passed Mode IV preflight test.

## IF TEST FAILS

Don't launch without specific approval of the Commanding Officer or controlling agency.

## IN-FLIGHT

M4 REPLY may not illuminate on the CDU while operating in areas where air traffic controllers don't have the capability to interrogate or are not attempting to interrogate. The IFF MON light on the IFF/COMM panel will also illuminate when the M4/IFF WCA light illuminates. A distinct audio tone will be heard in the pilot's and copilot's headset when the aircraft is interrogated and a valid non-current code is being used. It is imperative that all crews be aware of keymat cryptal periods. If a crew forgets to switch to next crypto period, i.e., M-4B, and remains on M-4A, the tone will sound as previously described; vice versa, if the interrogating source has failed to switch to the proper cryptal period and aircraft is squawking the proper code, an IFF tone will sound.

## POST-FLIGHT

The Mode IV Code will zeroize after approximately 15 seconds when power to the computer is removed and the landing gear has been cycled, if the M-4 HOLD function was not activated. The Mode IV code will not be zeroized on removal of power if the landing gear was down when power was first applied and remained down thereafter. The easiest way to zeroize the KIT-1C IFF computer is to switch the M4/VP switch on the center console to ZERO, but be aware, the KY-58 code will also be zeroized using this technique. Mode IV codes shall be zeroized after each flight unless another mission is scheduled during the same crypto-day. After selecting M4/VP switch – ZERO, crew should observe a steady illumination of M4/IFF WCA light, indicating the computer code is zeroized. Aircraft security is a top priority, all crewmembers shall comply with COMDTINST M3710.1 (series) for proper security measures.

**WARNING**

Securing the landing gear indicator circuit breaker located on the copilot's forward breaker panel during the flight will have the same affect as cycling the landing gear.

If Mode IV codes need to be saved (gear cycled or GEAR INDICATOR circuit breaker pulled/reset during flight), depress the HOLD button on the IFF page. An asterisk will appear for approximately 15 seconds, and then the word HOLD changes to HELD, indicating that the codes have been saved.

## COMPASS SYSTEM

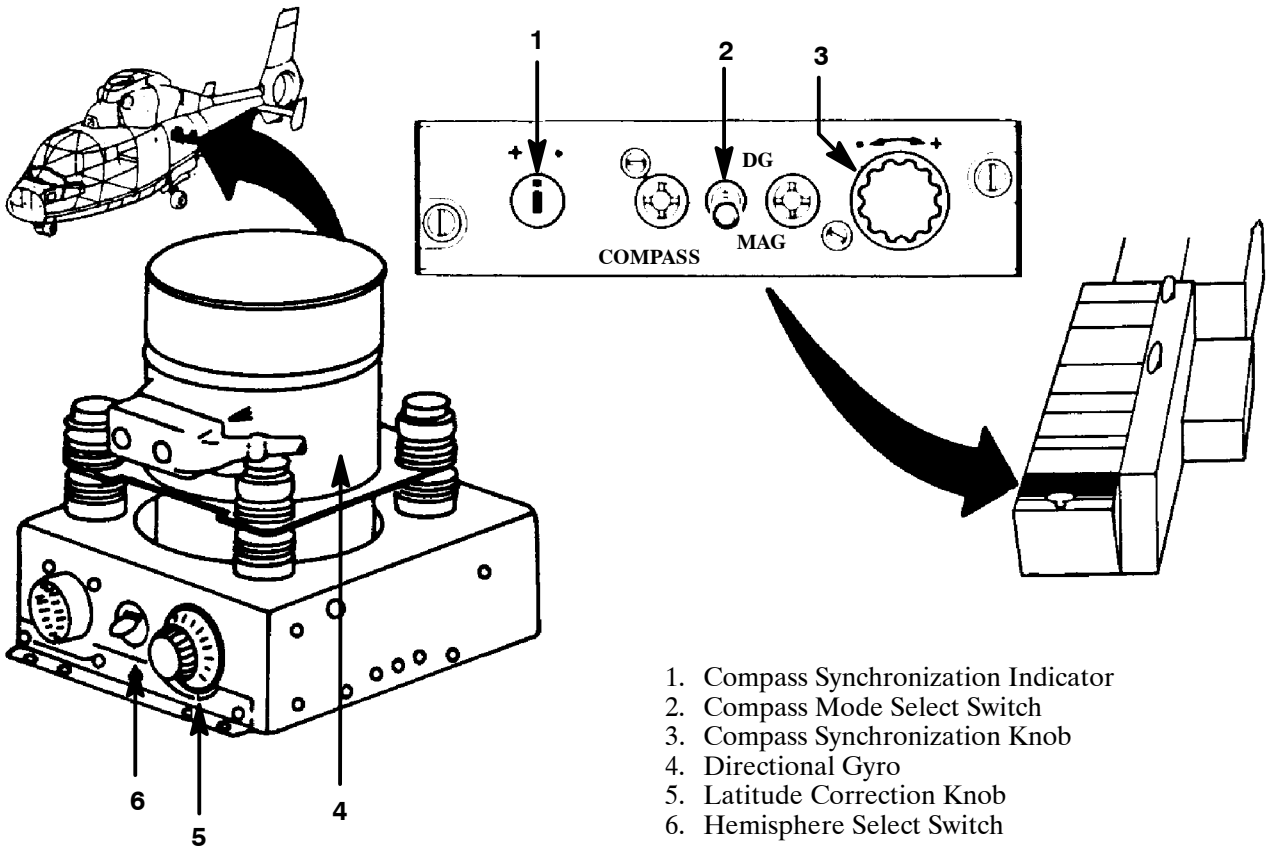
The compass system consists of two identical and independent compass systems; one for each pilot, and an independent standby magnetic compass. The pilot's compass system provides heading information to the pilot's VOR/ILS receiver and MFD. The copilot's system provides heading information to the copilot's VOR/ILS receiver and MFD, the BDI, and the AFCS. Each system consists of a compensator, flux valve, controller, and directional gyro. The directional gyros are mounted on the floor of the baggage compartment. Each system can operate independently of the other in either MAG (magnetic) mode or DG (directional gyro) mode. Both compass systems are powered by 115 volts 400 Hz AC power and are protected by separate circuit breakers labeled HDG located on the cockpit avionics circuit breaker panel.

### Compass Mode Select Switch

The compass mode select switch, located on the compass control panel (2, Figure 1-231), is a two position lock/lever switch marked DG and MAG. The switch lever must be raised each time it is moved from one position to the other. In the DG position, the directional gyro operates independently of the magnetic flux valve as a free running gyro and is referenced to the heading at the time the magnetic input was lost. In the MAG position, the directional gyro is slaved to the earth's magnetic field by signals from the flux valve.

### Compass Synchronizer Knob

The compass synchronizer knob, located on the compass control panel (3, Figure 1-231) provides a means of rapidly synchronizing the directional gyro with the magnetic flux valve when operating in the MAG mode and to set in desired heading when operating in the DG mode. When operating in the MAG mode, the knob is adjusted to center the synchronization annunciator.




1. Compass Synchronization Indicator
2. Compass Mode Select Switch
3. Compass Synchronization Knob
4. Directional Gyro
5. Latitude Correction Knob
6. Hemisphere Select Switch

*Figure 1-231. Compass System Controls*

## Hemisphere Select Switch

The hemisphere select switch, located on the directional gyro (6, Figure 1-231), is a two position switch marked N (north) and S (south). The switch must be positioned to the correct hemisphere in which the aircraft is operating to provide proper polarity to the gyro drift correction for the earth's rotation.

## Latitude Correction Knob

The latitude correction knob, located on the directional gyro (5, Figure 1-231) is marked with latitudes from 0 to 90 degrees. The knob must be set for the latitude for the area where the aircraft is based to provide gyro drift correction when operating in the DG mode.

## Compass Synchronization Indicator

The compass synchronization indicator, located on the compass control panel (1, Figure 1-231) indicates whether or not the directional gyro and the magnetic flux valve are synchronized when operating in the MAG mode. During operation in the MAG mode, the pointer will fluctuate slightly to either side of center when the system is synchronized. Should the system get out of synchronization, the pointer will deflect toward the plus or the dot on the face of the indicator. Adjusting the compass synchronization knob will center the pointer. The indicator is deactivated in the DG mode.

## Compass System Operational Procedure

1. Compass mode select switch - Select MAG or DG as required. Normal mode is MAG.

**NOTE**

Select DG if flux valve is unreliable or when operating in areas where magnetic lines of force are unreliable or vary rapidly.

2. Compass synchronization indicator - Centered. Using compass synchronization knob, center compass synchronization indicator.

3. Compass synchronization knob - In DG mode, set heading. In MAG mode, center sync indicator.

**NOTE**

When synchronizing compass, cross check heading against the standby magnetic compass or a known heading. The compass can be synchronized 180 degrees out of phase.

# SPECIAL SENSORS

Special sensors enhance the capabilities of the flight management system. The special sensors consist of:

- Omnidirectional Airspeed Data System (OADS)
- Search/Weather Radar System
- Engine Condition Monitoring System (ECMS)
- Voice Flight Data Recorder (VFDR)
- Traffic Alert and Collision Avoidance System (TCAS)

## OMNIDIRECTIONAL AIR DATA SYSTEM (OADS)

The OADS consists of an Omnidirectional Airspeed Sensor (OAS) mounted above the main rotor, where it is free from the effects of high rotor downwash, and an Air Data Converter (ADC) located in the avionics rack. The OAS is made up of two rotating venturi-like sensors mounted on hollow arms driven by a self-contained electric motor at a constant 720 rpm. An outside air temperature sensor is mounted on the rear of the OAS body. The OAS provides airspeed data by sensing the airspeed magnitude, side slip angle, and free stream air temperature; converts these data into electrical signals, and sends them to the ADC for processing. The ADC receives AC and DC power from the helicopter and provides power to the OAS. It processes the data from the OAS into true airspeed signals using, in addition, the ambient pressure signal from a static pressure transducer housed inside the ADC, as well as the IAS signal from an indicated airspeed transducer. The ADC sends these signals to the CDUs, Flight Director Computer, AFCS computer, and both MFDs.

### OADS Operation

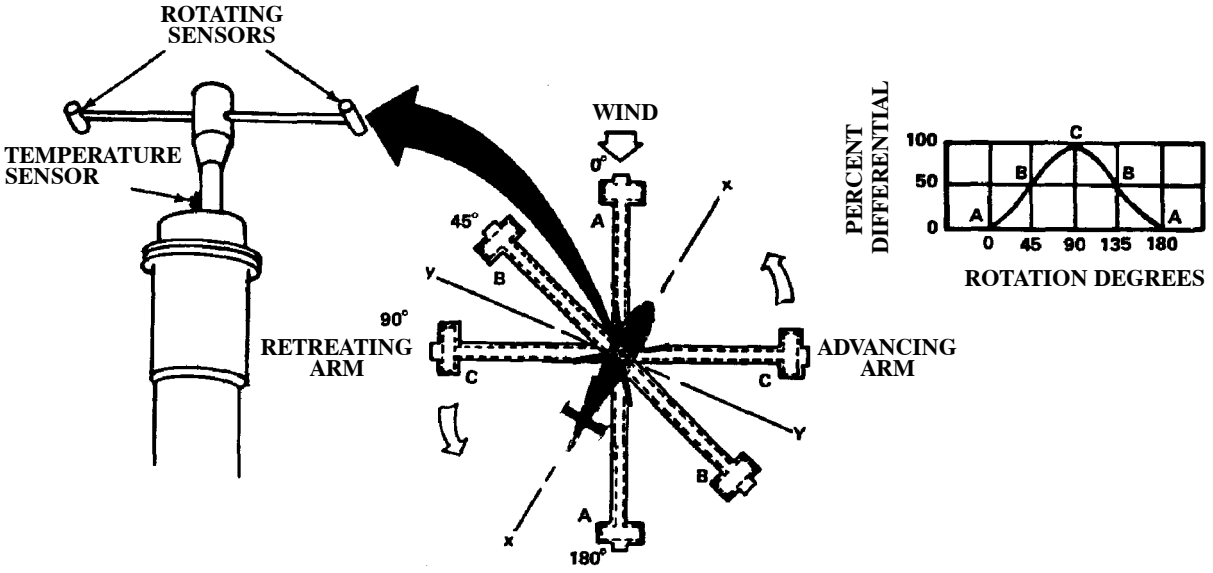
Figure 1-232 describes how the OAS determines airspeed values. When the wind shifts away from the helicopter heading, the rotating sensors note the shift in wind which is resolved by the ADC into the two airspeed components of longitudinal true airspeed and lateral true airspeed. A total true airspeed signal is also provided. Graphically plotted on a waveform, amplitude is directly proportional to airspeed and phase is related to relative wind direction. The longitudinal airspeed output is a combination of a true airspeed conversion of the pitot static airspeed transducer output signal and the OADS resolved longitudinal airspeed. At pitot static true airspeeds above 45 knots, the longitudinal airspeed output is derived solely from the IAS signal. At pitot static true airspeeds below 30 knots, the longitudinal airspeed output is the OADS resolved longitudinal airspeed output. Between 30 and 45 knots the longitudinal airspeed output is a combination of IAS and OADS signals. If a failure indication of the IAS transducer is received by the ADC, the output is transferred to the OADS longitudinal airspeed. The output does not change at greater than three knots per second during a transition from the IAS signal to the OADS signal. The ADC continuously monitors the OAS and in the event of a system failure, provides an AIRSPEED FAIL annunciation on the MFD hover mode presentation, and an OADS fail annunciation on the CDU status page. The OADS receives 28 volts DC power from the battery bus and 115 volts AC from the No. 2 main AC bus. Two circuit breakers labeled OADS are located on the avionics rack circuit breaker panel.

## RADAR SYSTEM

The radar system is an x-band radar that provides detection of small surface targets at short range, ground mapping to enhance navigation, and long range weather surveillance for storm avoidance or penetration. The radar incorporates scan-to-scan integration to enhance target detection in high sea clutter. The system consists of a receiver/transmitter (R/T) unit, an interface unit, antenna with drive assembly, and a control panel located on the center console. Refer to Figure 1-148 for antenna location. The antenna is stabilized in pitch and roll $\pm$30 degrees with reference to the copilot's vertical gyro. Antenna tilt is manually adjusted $\pm$15 degrees. The system can be operated in three search modes, two weather modes, and a test mode. Radar video is displayed on the pilot's and copilot's MFDs when the RADAR or RMAP (radar map) modes are selected. Radar ranges of 2.5, 5.0, 10.0, 20.0, 40.0, 80.0, and 160.0 nautical miles can be selected with either a 60 or 120 degree sector scan presentation. The radar R/T unit operates on 28 volts DC power from the auto shed bus. The antenna drive assembly operates on 115 volts AC power from the No. 2 main AC bus. Two circuit breakers labeled RDR are located on the avionics rack circuit breaker panel.

### Radar Modes

The radar can be operated in a test mode, three search modes (SRCH 1, 2, and 3), and two weather modes (Wx and WxA) as selected on the radar control panel. All of the radar modes can be operated at any of the ranges available from 2.5 to 160




**In the diagram the velocity of the advancing arm is equal to the sensor speed plus the aircraft speed and conversely the retreating arm velocity is equal to sensor speed minus aircraft speed. Therefore, in a no wind condition there will be zero pressure differential between the sensors. When operating in a wind, the pressure differential between the sensors will be zero when parallel to the wind as shown at (A). As the arms rotate past the parallel point a differential pressure will be sensed at (B) and increase to a maximum value when the arms are perpendicular to the wind at (C). The higher the wind value, the greater the pressure differential between sensors. Components of x and y are resolved to determine the wind direction relative to the aircraft heading.**

*Figure 1-232. OADS Theory of Operation*

nm. However, search 1 and 2 modes are tailored for short range operation at ranges from 2.5 to 10 nm while search 3 mode and the weather modes are best suited for long range operation of 20 nm or greater. Search 1 and 2 modes will act as search 3 if a range greater than 10 nm is selected.

## Test Mode

The test mode is provided for checking the radar for proper operation. When TEST is selected: the transmitter is inhibited, the MONITOR lamp will illuminate, and a test pattern consisting of selectable range and azimuth marks, and five bands of video, is generated for display on the MFD when the radar range select knob is set at 80 (Figure 1-233).

## Search (SRCH 1) Mode

Search 1 (SRCH 1) mode is provided primarily for target search when operating in a high sea state environment at selected ranges of 10 nm or less. Scan integration is available when selected to enhance target detection in high sea clutter.

## Search 2 Mode

Search 2 (SRCH 2) mode is primarily for high resolution target search in low sea states or precision ground mapping. Scan integration is not available.

## Search 3 Mode

Search 3 (SRCH 3) mode is designed for maximum clutter returns as required for mapping oil slick areas. Scan integration is not available.

## Weather Mode

The weather (Wx) mode provides long range weather detection. Iso-echo contouring techniques are employed to distinguish storm centers or areas of most intense weather activity on the radar display as the brightest video returns.

## Weather Alert Mode

The weather alert (WxA) mode operates the same as weather mode. However, when selected, the brightest returns on the radar display will flash at a rate of 1.25 CPS. This will emphasize the most intense weather so that it may be avoided.

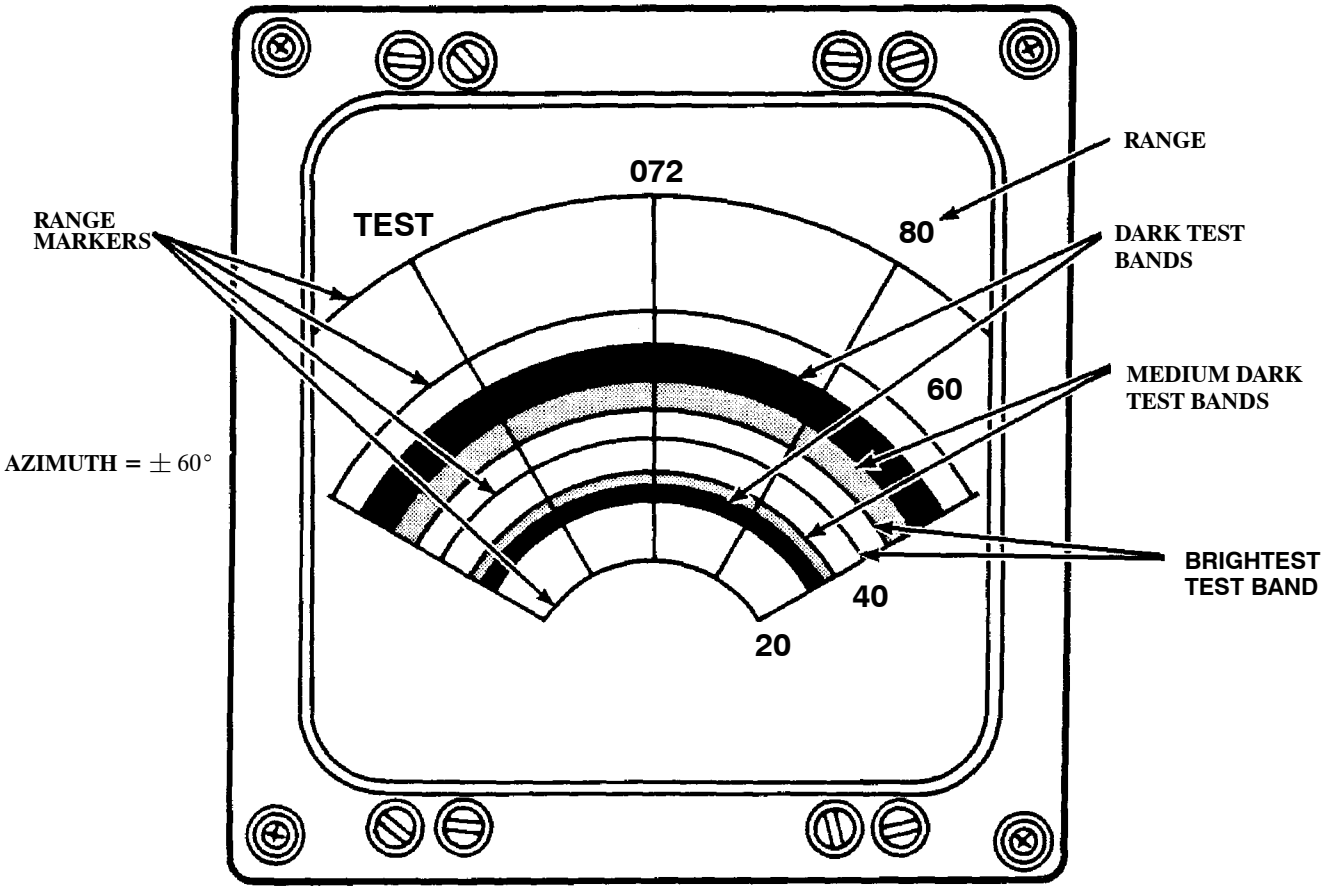



*Figure 1-233. Radar Test Pattern*

## Radar Mode Select Knob

The radar mode select knob, located on the radar control panel (4, Figure 1-234), has eight detents marked OFF, STBY (standby), TEST, SRCH 1 (Search 1), SRCH 2, SRCH 3, Wx (weather), and WxA (weather alert). The knob positions provide the following functions:

- The OFF position removes all power from the radar system.
- STBY position places the system in standby condition during the warm-up period. The MONITOR lamp will illuminate while the switch is in STBY.
- The TEST position and the five radar mode positions are used to select functions described above.

**NOTE**

A radar on caution light is mounted on the instrument panel adjacent to the MGB fire detector indicator. The light circuit is wired through the weight-on-wheels switch and will illuminate anytime the helicopter is on the deck and the radar mode select knob is in any position other than OFF.

## Gain Control Knob

The gain control knob, located on the radar control panel (5, Figure 1-234), adjusts video gain when operating in the search 1, 2, or 3 modes. Clockwise rotation of the knob increases video gain. The knob has no effect on the radar displays in the test or weather modes. Video gain is preset at maximum in these modes.

## Scan Integration Switch

The scan integration switch, located on the radar control panel (6, Figure 1-234), is a two position switch marked ON and OFF. Positioning the switch to ON selects scan integration to enhance target detection in high sea clutter. The switch is only active when operating in search 1 mode at range settings of 10 nm or less.

## Antenna Tilt Control Knob

The antenna tilt control knob, located on the radar control panel (7, Figure 1-234), is used to adjust the tilt of the antenna up or down 15 degrees in each direction. A scale on the knob is graduated in one degree increments. The 0, 5, 10, and 15 degree marks are labeled.

## Antenna Stability (STAB) Select Switch

The STAB switch, located on the radar control panel (9, Figure 1-234), is a two position switch marked ON and OFF. Positioning the switch to ON stabilizes the antenna in pitch and roll up to ±30 degrees with reference to the copilot's vertical gyro.

**NOTE**

If the copilot's vertical gyro fails, the antenna will no longer be stabilized in relation to the horizon and may tilt to an undesired angle. The STAB switch shall be placed in the OFF position which will slave the antenna attitude to the helicopter attitude.

## Scan/Hold Select Knob

The scan/hold select knob, located on the radar control panel (10, Figure 1-234) has three positions marked 60, HOLD, and 120. The 60 and 120 positions provide 60 degree or 120 degree scan presentations, respectively, on the MFD radar display. In the HOLD position, the weather or ground map image last presented is retained on the radar display for longer evaluation. The antenna will continue to scan but display updating will not occur until the HOLD position is deselected.

## Radar Map and Radar Pages

The diplay mode selector knobs, located on the display control panels (1, Figure 1-234), are provided for selecting the radar and radar map displays on the pilot's and copilot's MFDs.

## Radar/Map Range Select Knob

There are two range select knobs, located on each display control panel (3, Figure 1-234) for selection of various ranges for radar operation. Range settings and range mark spacing for each setting are as follows:

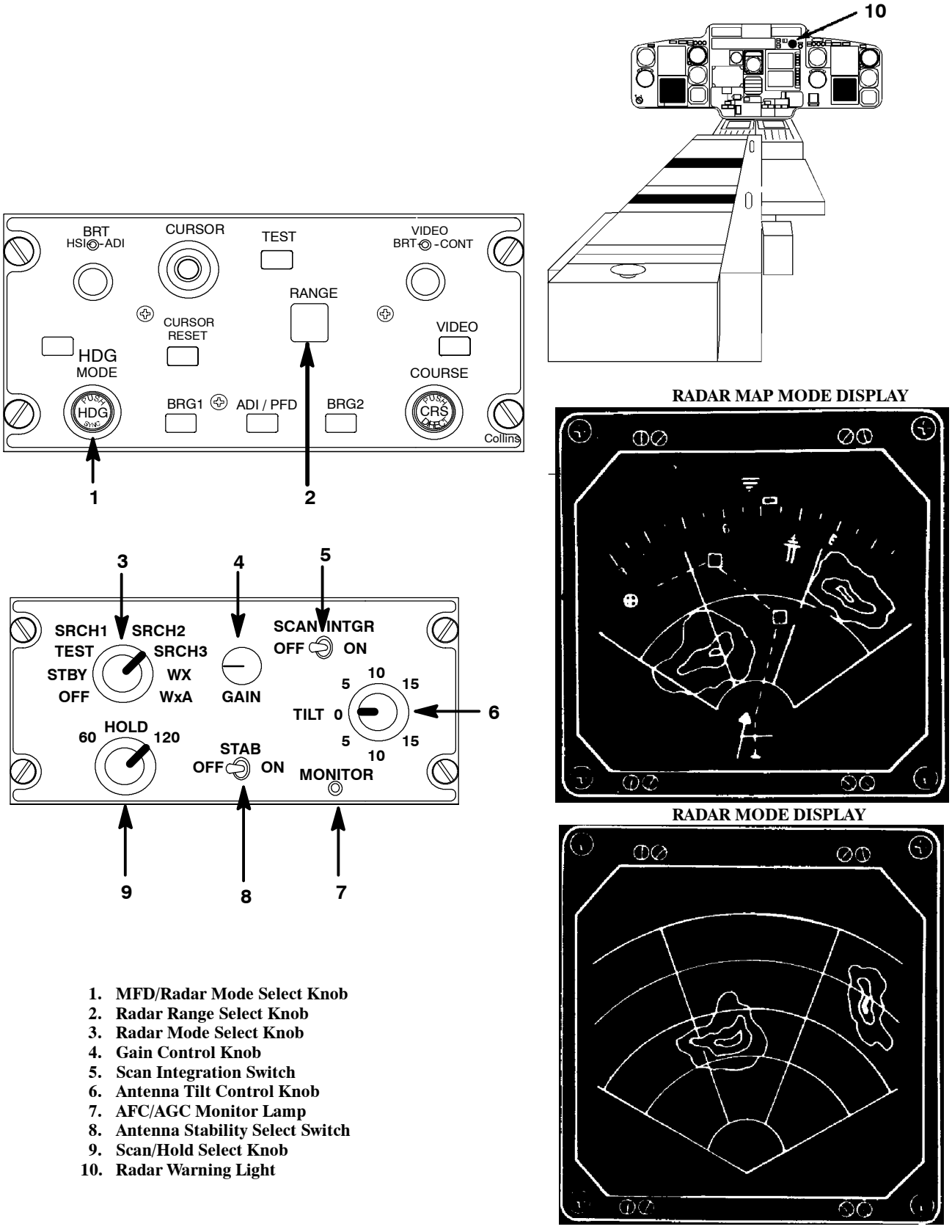
| Range (NM) | Range Mark Spacing (NM) |
|---|---|
| 2.5 | 0.5 |
| 5.0 | 1.0 |
| 10.0 | 2.0 |
| 20.0 | 5.0 |
| 40.0 | 10.0 |
| 80.0 | 20.0 |
| 160.0 | 40.0 |

## AFC/AGC Monitor Lamp

The AFC/AGC monitor lamp is located on the radar control panel (8, Figure 1-234). The lamp is illuminated when the radar mode select knob is in the STBY or TEST position. With the radar mode select knob in SRCH 1, 2, 3, Wx, or WxA positions, illumination will indicate a malfunction in the Automatic Frequency Control (AFC) or Automatic Gain Control (AGC) circuits. This will be accompanied by loss of radar video or abnormal radar display. There is no corrective action the crew can take to extinguish the light.

## Search/Weather Radar Operational Procedure

1. Radar mode select knob - STBY. With mode switch in STBY the MONITOR lamp will be illuminated.
2. Gain control knob - Set mid-range.
3. Scan integration switch - ON.
4. Antenna tilt control knob - As desired.
5. Antenna stability select switch - ON.
6. Scan/hold select switch - As desired. Select 60 or 120 degree scan.
7. Display control knob (pilot or copliot) - Select Radar or Radar Map.
    a. Brightness (BRT) controls - Set mid-range.
    b. Contrast (CONT) controls - Set mid-range.
8. Radar system check:
    a. Range select knob - 80 nm.
    b. Radar mode select knob - TEST. Test pattern will be displayed on HSVD. MONITOR lamp will be illuminated.




1. **MFD/Radar Mode Select Knob**
2. **Radar Range Select Knob**
3. **Radar Mode Select Knob**
4. **Gain Control Knob**
5. **Scan Integration Switch**
6. **Antenna Tilt Control Knob**
7. **AFC/AGC Monitor Lamp**
8. **Antenna Stability Select Switch**
9. **Scan/Hold Select Knob**
10. **Radar Warning Light**

*Figure 1-234. Radar Controls and Indicators*

9. Range select knob - As desired. If SRCH 1 or 2 operation is anticipated, set range to 10 nm or less. For other modes, any range may be selected, but 20 nm or greater is recommended.
10. Radar mode select knob - Desired mode. Set radar mode select knob to desired operating mode: SRCH 1, 2, 3, Wx, or WxA.
11. Antenna tilt control knob - Adjust for best presentation.
12. Gain control knob - Set gain for optimum display.

## ENGINE CONDITION MONITORING SYSTEM

The Engine Condition Monitoring System (ECMS) allows flight and ground crews to monitor engine parameters through the CDUs. There are three "top-level" pages which provide engine parameters, performance calculations, and engine information.

The ECMS has no hardware components. ECMS functions are executed via the CDU, and tie together four major subsystems:

1. Engine sensors, transmission sensors, OADS, and aircraft sensors
2. ECMS data-set resident in the CDU
3. VFDR
4. Caution advisory panel annunciator

The CDU performs the data processing associated with the ECMS. Engine / power train parameter exceedences are annunciated on the CDUs. The CDU stores the 10 most recent exceedances. If the limit for exceedances has been surpassed, the numbering scheme for these events restarts at 1. New exceedances replace the oldest in memory. Refer to Figure 1-235 for an illustration of the system components interfacing with the ECMS capability.

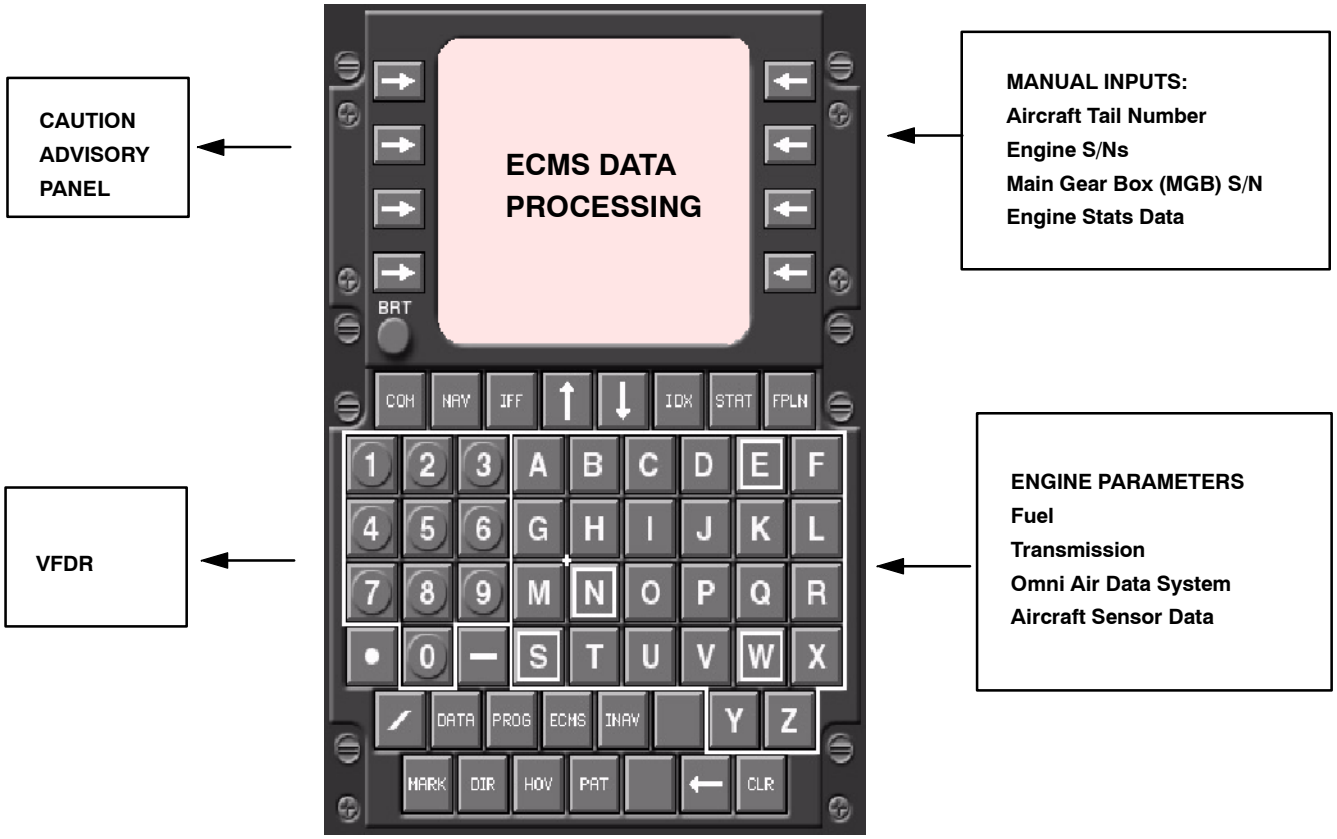



*Figure 1-235. ECMS Data Processing*

## "REAL-TIME" PARAMETER READOUT

The CDU ECMS has the capability of providing a "real-time" digital display on the CDU Engine Parameters Page for the purpose of providing a highly accurate, high resolution readout of those parameters required for engine trim procedures. The following "real-time" engine parameters are displayed on the CDU Parameters Page:

1. Gas Turbine Generator Speed (NG) (for each engine)
2. Power Turbine Speed (NP) (for each engine)
3. Measured Gas Temperature (MGT) (for each engine)
4. Torque (Q) (for each engine)
5. Fuel Flow Rate (WF) (for each engine)
6. Outside Air Temperature (OAT)
7. Main Rotor Speed (NR)
8. Total Torque (QT)

# SYSTEM INITIATED BUILT IN TEST (IBIT)

The CDU controls execution of subsystem Initiated Built in Tests (IBIT) upon operator command (Figure 1-236). IBITs are initiated by the operator on a TEST page and can only be commanded when the CDU determines the helicopter is on the ground.

As Test Pages do not constantly monitor status of the Line Replaceable Units (LRUs) their displays are latched, displaying the latest IBIT results received from the LRU or to the system power-up defaults if no IBIT is performed. Therefore, the LRU test results displayed on the test pages may not correspond to that on the status pages, which are continuously monitored and updated. For example, the Status Page could indicate a NOGO for a sub-system failure (i.e., CDU1), while the CDU1 Test Page shows the result of the last IBIT, which indicates a GO condition. If an IBIT has not been requested since the last application of power, all test result fields display dashes, with the exception of the CDUs which display the results from the power-up BIT.

## SYSTEM TEST PAGE

The System Test Page (Figure 1-237) is accessed by pressing the TEST key on the Index Page 2/2 or by vertically scrolling from the COMM Test or NAV Test Page. The System Test Page provides access to the CDU 1/2, GPS 1/2, IFF and MDL detailed test pages. From the System Test Page selecting the DOWN arrow scrolls to the NAV Test Page, while selecting the UP arrow scrolls to the COMM Test page.

a. Selection accesses the CDU2 Test Page.
b. Selection accesses the GPS2 Test Page.
c. Selection accesses the IFF Test Page.
d. Selection accesses the CDU1 Test Page.
e. Selection accesses the GPS1 Test Page.
f. Selection accesses the MDL Test Page.

## CDU Test Page

Pressing LS1 or LS5 on the System Test Page accesses the CDU2 or CDU1 Test Pages (Figure 1-238). CDU IBITs can only be commanded when the CDU determines the helicopter is on the ground. Any attempt to initiate an IBIT while airborne results in the "GROUND ONLY" scratchpad annunciation. Selecting LS1 (INITIATE TEST) from the CDU 1 or 2 Test Page initiates the IBIT. During the test DL2 displays TEST, an asterisk replaces the arrow adjacent to LS1, and the IBIT (16 bit data word) displays dashes (-). When the test is complete, DL2 displays a GO or NOGO annunciation. If a NOGO occurs, the IBIT data word on DL5 places a 1 in the position representing the cause for failure, (i.e., IBIT 00000100 00000000). Recording the failure for maintenance personnel aids in the expeditious repair of the system. Table 1-15 shows the definitions of each of the 16 bits. The CDU1 and CDU2 Test Pages are functionally identical with the title on DL2 reflecting which CDU test page is displayed.

| BIT | Definition |
|---|---|
| 1 | Subsystem Status |
| 2 | Terminal Status |
| 3 | Expansion I/O Status 1 |
| 4 | Expansion I/O Status 2 |
| 5 | Expansion I/O Status 3 |
| 6 | Display Status |
| 7 | 1553B CD Status |
| 8 | 1553B AB Status |
| 9 | Serial Address |
| 10 | Discretes Status |
| 11 | Power Supply Status |
| 12 | Flash Memory Status |
| 13 | NVM Status |
| 14 | ROM Status |
| 15 | RAM Status |
| 16 | CPU Status |

*Table 1-15. CDU IBIT Status Word Definitions*

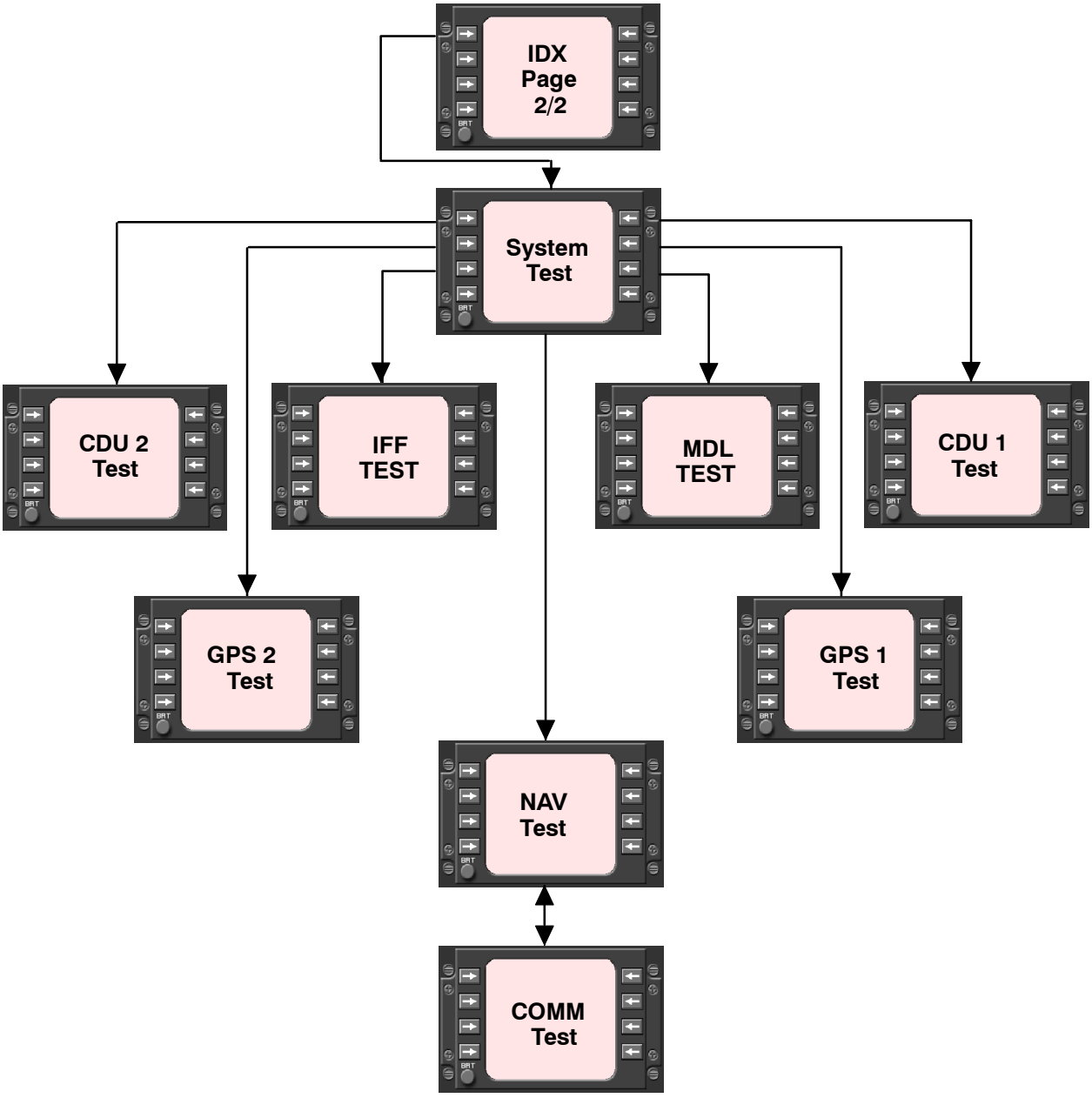



*Figure 1-236. Test Pages*

a. Selection initiates the IBIT for indicated CDU. An asterisk replaces the arrow when IBIT is in progress.

b. Displays a 16-bit data word which indicates the results of the last IBIT, where a "1" indicates a fail state. The 16-bit data word displays dashes when an IBIT is in progress or the BC CDU cannot establish communication with the CDU under test. BIT 1 is displayed on the left side of the display, if the BC CDU cannot establish communication with the CDU.

c. Displays the latest IBIT results. Displays GO, NOGO, TEST (in progress) or dashes (- -). Dashes are displayed if the BC CDU cannot establish communication with the CDU under test.

d. Selection returns to the System Test Page.

## GPS Test Page

Pressing LS2 or LS6 on the System Test Page accesses the GPS Test Page (Figure 1-239). GPS IBITs can only be commanded when the CDU determines the helicopter is on the ground. Any attempt to initiate an IBIT while airborne results in the "GROUND ONLY" scratchpad annunciation. The GPS Test Pages permit initiation of off-line testing and display of the detailed status results from these tests for the

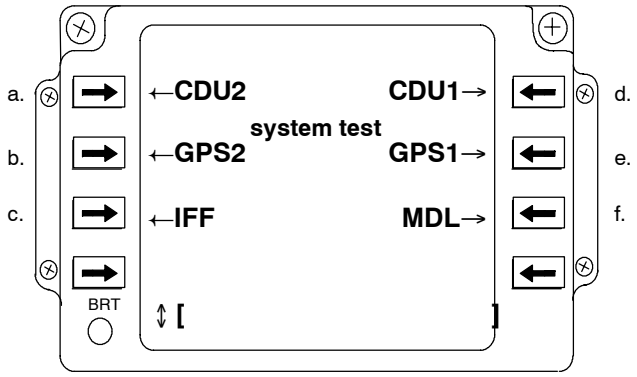



*Figure 1-237. System Test Pages*

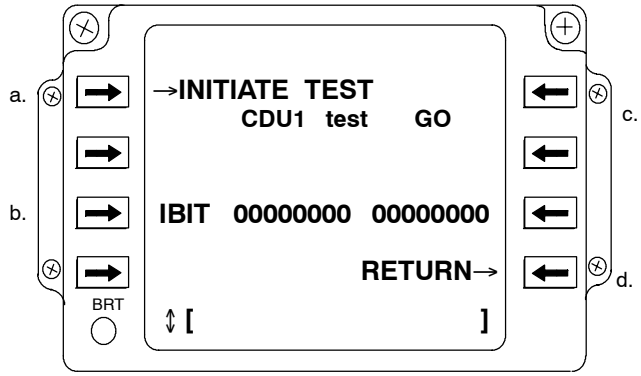



*Figure 1-238. CDU Test Page*

GPS components. Selecting LS1 (INITIATE TEST) from the GPS 1 or 2 Test Pages initiates the IBIT. During the test DL2 displays TEST, an asterisk replaces the arrow, and Receiver/Processor Unit (RPU) and battery (BATT) status annunciations display dashes (- -). When the test is complete display lines 2, 3 and 5 display a GO or NOGO annunciation. The GPS1 and GPS2 Test Pages are functionally identical with the title on DL2 reflecting which GPS Test Page is displayed.

a. Selection initiates the GPS IBIT. An asterisk replaces the arrow when IBIT is in progress.

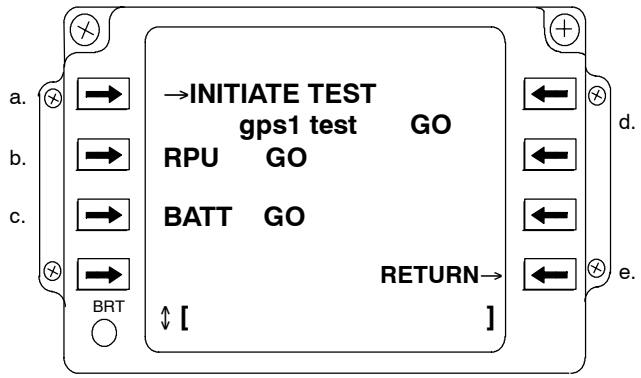



*Figure 1-239. GPS Test Page*

b. Displays the latest Receiver/Processor Unit (RPU) IBIT results. Displays GO, NOGO, or dashes (- -). The test result field displays dashes if IBIT is in progress, the BC CDU cannot establish communication with the GPS, or IBIT has not been requested since the last power cycle.

c. Displays battery (BATT) test results. Displays GO, NOGO, or dashes (- -). The test result field displays dashes if IBIT is in progress, the BC CDU cannot establish communication with the GPS, or IBIT has not been requested since the last power cycle.

d. Displays the latest IBIT results. Displays GO, NOGO, TEST (in progress) or dashes (- -). Dashes are displayed if the BC CDU cannot establish communication with the GPS, or IBIT has not been requested since last power cycle.

e. Selection returns to the System Test Page.

## IFF Test Page

Pressing LS3 on the System Test Page accesses the IFF Test Page (Figure 1-240). The IFF Test Page performs initiation of off-line testing and display of the IFF test results. With the IFF in NORM mode, and the helicopter on the ground, selecting LS1 through 5 on the IFF Test Page initiates the test for the associated IFF Mode. Any attempt to initiate an IFF IBIT while airborne results in the "GROUND ONLY" scratchpad annunciation. During the test, the GO/NOGO annunciations are replaced by dashes (- -) and the arrow is replaced by an asterisk. When the test is complete, the mode tested displays a GO or NOGO annunciation. With the IFF in NORM mode, selecting LS7 initiates the Mode IV radiation test, which can be performed in flight.

**NOTE**

IFF must be in NORM mode for all IFF IBITs.

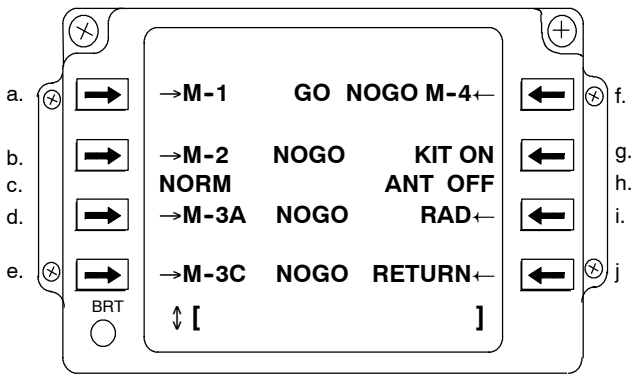



*Figure 1-240. IFF Test Page*

a. Selection initiates Mode 1 IBIT and displays the IBIT results as GO, NOGO, or dashes (- -). An asterisk replaces the arrow when IBIT is in progress.

b. Selection initiates Mode 2 IBIT and displays resulting BIT status as GO, NOGO, or dashes (- -). An asterisk replaces the arrow when IBIT is in progress.

c. Displays IFF control mode as either STBY or NORM.

d. Selection initiates Mode 3A IBIT and displays resulting IBIT status as GO, NOGO, or dashes (- -). An asterisk replaces the arrow when IBIT is in progress.

e. Selection initiates Mode 3C IBIT and displays resulting IBIT status as GO, NOGO, or dashes (- -). An asterisk replaces the arrow when IBIT is in progress.

f. Selection initiates Mode IV IBIT and displays resulting IBIT status as GO, NOGO, or dashes (- -). An asterisk replaces the arrow when IBIT is in progress.

g. Displays KIT-1 C computer fault ball status as either KIT ON or KIT OFF. KIT ON indicates a KIT-1C failure.

h. Displays antenna voltage standing wave ratio (VSWR) status as either ANT ON or ANT OFF. ANT ON indicates an antenna VSWR failure.

i. Selection initiates Mode IV Radiation Test. An asterisk (*) replaces the arrow when radiation test is active. Subsequent selection of LS7 deactivates the test, removes the asterisk (*) and restores the arrow. The test is deactivated if another page is selected.

**NOTE**

The Mode IV Radiation Test is allowed while airborne.

j. Selection returns to the System Test Page.

## MDL Test Page

Pressing LS7 on the System Test Page accesses the MDL Test Page (Figure 1-241). The MDL Test Page permits initiation of an off-line test and displays the detailed status results from these tests for the MDL. With the helicopter on the ground, selecting LS1 initiates the MDL testing process. Attempts to initiate an IBIT while airborne result in the "GROUND ONLY" scratchpad annunciation. During the test, DL2 displays TEST and an asterisk replaces the arrow adjacent to LS1. The IBIT (16 bit data word), TOP CARD and BOT CARD (lines 3, 5 and 7) also display dashes (-) to indicate a test in progress. When the test is complete, display lines 2, 5 and 7 display a GO or NOGO annunciation. If NOGO occurs on line 2, the IBIT data word places a 1 in the position representing the cause for failure (i.e., IBIT 00000100 00000000). Recording the failure for maintenance personnel aids in the expeditious repair of the system. Table 1-16 shows the definitions of each of the 16 bits.

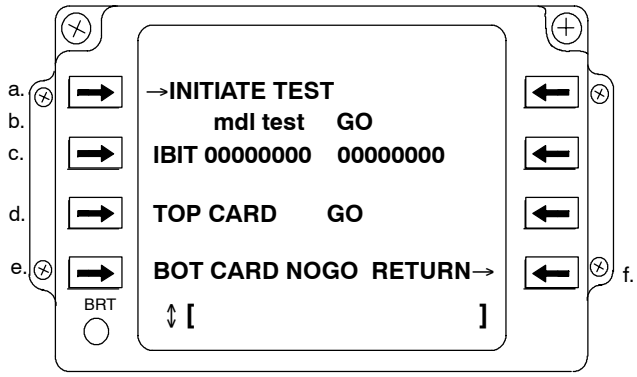



*Figure 1-241. MDL Test Page*

| BIT | Definition |
|---|---|
| 1 | 1553B data bus Subsystem Flag |
| 2 | 1553B data bus Terminal Flag |
| 3 | SRA–CPU & Memory board, 1= failed |
| 4 | SRA–Power Supply, 1= failed |
| 5 | SRA–Bulk Memory, 1= failed |
| 6 | SBIT Test Results, 1= failed |
| 7 | PBIT Test Results, 1= failed |
| 8 | IBIT Test Results, 1= failed |
| 9 | Reserved, set to "0" |
| 10 | Reserved, set to "0" |
| 11 | Reserved, set to "0" |
| 12 | Reserved, set to "0" |
| 13 | Reserved, set to "0" |
| 14 | Reserved, set to "0" |
| 15 | Reserved, set to "0" |
| 16 | Reserved, set to "0" |

*Table 1-16. MDL IBIT Status Word Definition*

a. Selection initiates MDL IBIT. An asterisk replaces the arrow when IBIT is in progress.

b. Displays the latest IBIT results. Displays GO, NOGO, TEST (in progress) or dashes (- -). Dashes are displayed if the BC CDU cannot establish

communication with the MDL or IBIT has not been requested since last power cycle.

c. Displays a 16-bit data word which indicates the results of the last IBIT, where a "1" indicates a fail state. The 16-bit data word displays dashes if IBIT is in progress or the BC CDU cannot establish communication with the MDL or IBIT has not been requested since last power cycle.

d. Displays the label TOP CARD followed by GO, NOGO, or dashes (- -), test results from the Top Card write/read test.

e. Displays the label BOT CARD followed by GO, NOGO, or dashes (- -), test results from the Bottom Card write/read test.

**NOTE**

On display lines 5 or 7, when dashes (- -) are displayed, this indicates that no card is installed, or a card is installed but the test results are not available.

f. Selection returns to the System Test Page.

## NAV Test Page

The NAV Test Page (Figure 1-242) is accessed by vertically scrolling from the System Test Page or from the COMM Test Page. The NAV Test Page permits initiated tests for the NAV LRUs. Whenever a NAV Test is initiated, the arrow associated with the system being tested (VOR1/MKB, TACAN or ADF) changes to an asterisk. Selection of the associated line select key, or accessing a different CDU page terminates the test. NAV tests can only be performed when the CDU determines that the helicopter is on the ground. Any attempt to initiate a NAV test while airborne results in the "GROUND ONLY" scratchpad annunciation.

a. Selection initiates VOR/MKB IBIT. An asterisk replaces the arrow when IBIT is in progress. The operator must select LS1 a second time to deselect IBIT. To perform a self-test the VOR must be receiving a valid VOR signal and must be in VOR mode. After receiving the IBIT command the VOR1/MKB unit provides outputs to perform the following functions:

1. Illuminates all the marker beacon lights.

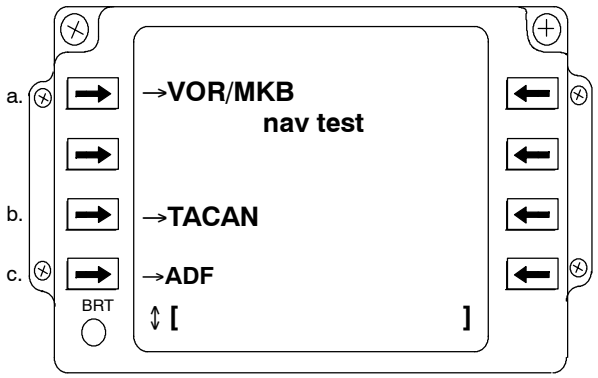



*Figure 1-242. NAV Test Page*

2. Rotates the BDI needle to 315 degrees with a TO indication.

b. Selection initiates TACAN IBIT. An asterisk replaces the arrow when IBIT is in progress. The operator must select LS3 a second time to deselect IBIT. After receiving the IBIT command the TACAN unit provides outputs to perform the following functions:

1. Within 7 seconds the following sequence of events occurs:

   a. BDI distance blanks

   b. HSI DIST readouts are dashed

   c. HSI TCN flag is dashed

   d. BDI pointer parks at 90 degrees

2. Within 15 seconds, the following indications occur:

   a. BDI and HSI distance displays 0 +/- 0.5 nm

   b. BDI and HSI pointers indicate 180 +/- 3 degrees

   c. HSI deviation bar centers at +/- 1/2 dot

   d. HSI TO-FROM is relative to selected course

c. Selection initiates ADF IBIT. An asterisk replaces the arrow when an IBIT is initiated. The operator must select LS4 a second time to deselect IBIT. To perform a self-test the TACAN must be receiving a valid TACAN or DME signal and must be in TACAN mode. After receiving the IBIT command, the BDI and HSI pointers rotate and park 90 degrees counterclockwise from the selected course.

**NOTE**

Selecting the DOWN arrow scrolls to the COMM Test Page while selecting the UP arrow scrolls to the System Test Page.

## COMM Test Page

The COMM Test Page (Figure 1-243) is accessed by vertically scrolling from the NAV Test Page or the System Test Page. The COMM Test permits initiation of off-line testing and display of the detailed status results from the COMM LRU TESTS. COMM tests can only be performed when the CDU indicates the helicopter is on the ground. If an attempt to initiate a test is made while the helicopter is airborne, the scratchpad displays "GROUND ONLY."

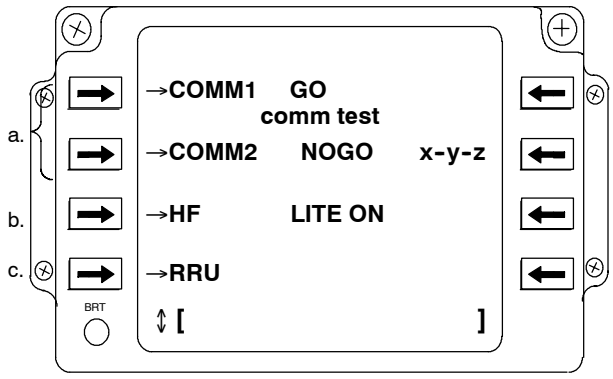



*Figure 1-243. COMM Test Page*

a. Selection initiates COMM IBIT. An asterisk replaces the arrow when IBIT is in progress. Results are displayed as GO (with x-y-z blanked) or NOGO x-y-z, where x, y and z represent respectively the first, second and third most likely causes of the detected error as reported by the COMM unit. x, y and z may be any of the following numbers:

0 - GO

1 - Control

2 - Synthesizer

3 - Guard Receiver

4 - Main Receiver

5 - Power Supply

6 - Transmitter

7 - Chassis Interconnect

b. Selection initiates HF IBIT. An asterisk replaces the arrow when IBIT is in progress. Displays LITE ON or LITE OFF during test per following criteria:

System Unkeyed:

LITE ON - RF test circuit working

LITE OFF - RF test circuit failure

System Keyed:

LITE ON - HF Failure

LITE OFF - Test OK

c. Selection initiates RRU IBIT. An asterisk replaces the arrow when IBIT is in progress. This test causes both RRUs to display all 8s in both the ACTIVE and PRESET frequency fields for 5 +/- 2 seconds before timing out.

**NOTE**

Selecting the DOWN arrow scrolls to the System Test Page while selecting the UP arrow scrolls to the NAV Test Page.

# VOICE AND FLIGHT DATA RECORDER (VFDR)

The VFDR is located in the avionics rack and weighs approximately 8 pounds. It is fitted with an Underwater Acoustic Beacon (UAB) that is capable of withstanding a high "g" impact and deep water immersion down to 20,000 feet. It records up to 4 hours of data from the 1553 data bus and 37 minutes of audio monitored by the pilot's audio panel only and an area microphone located on the 4630 bulkhead. A microswitch has also been installed in the fenestron section to record full application of right pedal.

Commandant G-WKS has restricted VFDR downloading capabilities at the unit level. Downloading can only be accomplished by Commandant (Safety), ARSC (Projects), or the Mishap Analysis Animation Facility (MAAF) located at Kirtland AFB. Cockpit/cabin conversations and radio communications are "safety privileged" under COMDTINST M5100.47 (series).

Circuit breakers associated with the VFDR are the VFDR CB located on the Avionics Rack Circuit Breaker panel (Figure 1-252) and the EHSI CBs located on the Cockpit Avionics Circuit Breaker panel (Figure 1-253). The VFDR FAIL light is located on the Avionics Rack Circuit Breaker panel. The VFDR FAIL warning light will illuminate if the system is malfunctioning and the appropriate emergency procedure should be completed.

# TCAS SYSTEM DESCRIPTION

TCAS791 SYSTEM COMPONENTS.

TRC791A Transmitter Receiver Computer

Pilot VSI–TCAS Display

Copilot VSI–TCAS Display

DF Mode/TCAS Control Panel

L Band Directional Antenna

VHF/UHF/L Band Omnidirectional Antenna

Associated Wiring

## TRANSMITTER RECEIVER COMPUTER UNIT (TRC791A)

The microprocessor based TRC791A controls all surveillance, data acquisition, tracking, advisory, and traffic alert functions in the TCAS system. It generates 1030 MHz interrogation pulses and receives 1090 MHz reply data from both directional and omnidirectional antennas. It also generates display data to the VSI-TCAS Displays, generates audio advisories, monitors the system status through continuous Built-In-Test (BIT) routines, and executes the functional self test when initiated from the control unit. The TRC791A is mounted in the Avionics Rack.

### VSI-TCAS Displays

Airspace traffic conditions within the traffic display range and altitude volume limits are displayed on the VSI-TCAS (see Figure 1-246). The following information is displayed:

1. Standard symbology consisting of an own aircraft symbol, and on the 6 nm and 12 nm range displays an inner-range ring representing 2 nm made up of white dashes. A middle-range ring made up of white dots representing 6 nm is displayed when the 12 nm range is selected. The aircraft symbol is displayed at the lower center of the screen which results in an asymmetrical display area. The maximum possible target ranges with this offset are approximately:

- 115% of selected range at the 12 o'clock position;
- 92% of selected range at the 10 o'clock and 2 o'clock positions;
- 62% of selected range at the 9 o'clock and 3 o'clock positions, and
- 42% of selected range at the 6 o'clock position.

2. Traffic Alert (TA), Proximity Advisory (PA), and Other Traffic are the three categories of aircraft traffic symbols that are depicted on the VSI-TCAS display (see Figure 1-244 and 1-246). The range and relative bearing to the target aircraft is depicted by the location of each symbol on the display field. Associated information on the intruder's relative altitude and whether it is climbing, descending, or maintaining a constant altitude will also be displayed.

3. A "No Bearing" TA will be displayed when the bearing for traffic cannot be determined and lies within the Traffic Alert range (see Figures 1-246 and 1-247).

4. TAs that are off the selected range scale are displayed as a one half yellow circle at the outer edge of the traffic display field.

5. Display operating mode.

6. System failure annunciations.

### DF MODE/TCAS Control Panel

The control panel (Figure 1-245) is located in the center console. Four pushbuttons are provided on the right side of the panel to select TCAS system power, initiate the system self test, control display range functions, and mute aural annunciations. The DF Mode select knob consists of a single rotary switch located on the left side of the TCAS control panel.

## AURAL ANNUNCIATIONS

1. The aural annunciation - "Traffic! Traffic!" will accompany the TA symbol when an intruder poses a collision threat to your aircraft. The aircrew position must have audio control panel TCAS knob pulled out to hear the annunciations.

2. At the completion of the TCAS self-test, either the "TCAS TEST PASSED" or "TCAS TEST FAILED" aural annunciation, as appropriate, will be heard.

3. The MUTE pushbutton on the TCAS Control Panel toggles the TCAS audio on and off to the pilot, copilot and aircrew positions. The green "TCAS MUTE" advisory capsule on the Avionics Mode Annunciator Panel will illuminate whenever TCAS audio is muted (see Figure 1-245).

### Look up - Look Down Capability

The Look Up - Look Down capability is a display feature only, it does not affect the volume of airspace which TCAS

monitors for intruder traffic. This feature only affects the on screen display of Other Traffic. All PAs and TAs will be displayed whether or not they are within a selected display mode airspace.

1. **Normal Mode.** Other Traffic intruders are displayed within ±2,700 feet altitude relative to your own aircraft.

2. **Above Mode (ABV).** Other Traffic intruders are displayed from +9,000 feet to -2,700 feet relative to your own aircraft.

3. **Below Mode (BLW).** Other Traffic intruders are displayed from +2,700 feet to -9,000 feet altitude relative to your own aircraft.

4. **Ground Mode.** The display can be set to only the 6 nm or 12 nm ranges and all intruders are displayed up to +9,000 feet AGL. When first selected on the ground the display will be automatically set to the 12 nm ABV scale.

**NOTE**

Selecting the DOWN arrow scrolls to the System Test Page while selecting the UP arrow scrolls to the NAV Test Page.

| Symbol | Color | Title | Description |
|---|---|---|---|
| ● | Solid Yellow | Traffic Alert (TA) | Traffic which will intercept your own aircraft's track within approximately 15–30 seconds, or when an intruder is within 0.55 nm and ±800 feet vertically.<br>Traffic Alert aircraft outside the selected display range are shown as a half–circle at the outer edge of the display field until they are within the selected range and can be completely displayed.<br>An aural warning "Traffic, Traffic" will accompany a TA appearing on the display.<br>Increase visual outside scan and search for intruder. |
| ◆ | Solid Cyan (Blue) | Proximity Advisory (PA) | Traffic is within 4 nm and ±1,200 feet vertically, but is not generating a TA.<br>Monitor for future development.<br>Increase visual outside scan. |
| ◇ | Hollow Cyan (Blue) | Other Traffic | Traffic which is within the selected display range but is not generating a PA or TA.<br>Monitor for future development. |
| ↑↓ | Same as the associated traffic symbol | Trend Arrows | Indicate intruder is either climbing or descending at or greater than 500 fpm. |
| "+10" or "–10" | Same as the associated traffic symbol | Relative Altitude Indication | Symbol and number indicate the target's relative altitude above or below own aircraft in hundreds of feet. It will appear above or below the traffic symbol as appropriate. "00" will appear if the target is at the same altitude as own aircraft. |

*Figure 1-244. VSI-TCAS Traffic Display Symbology*

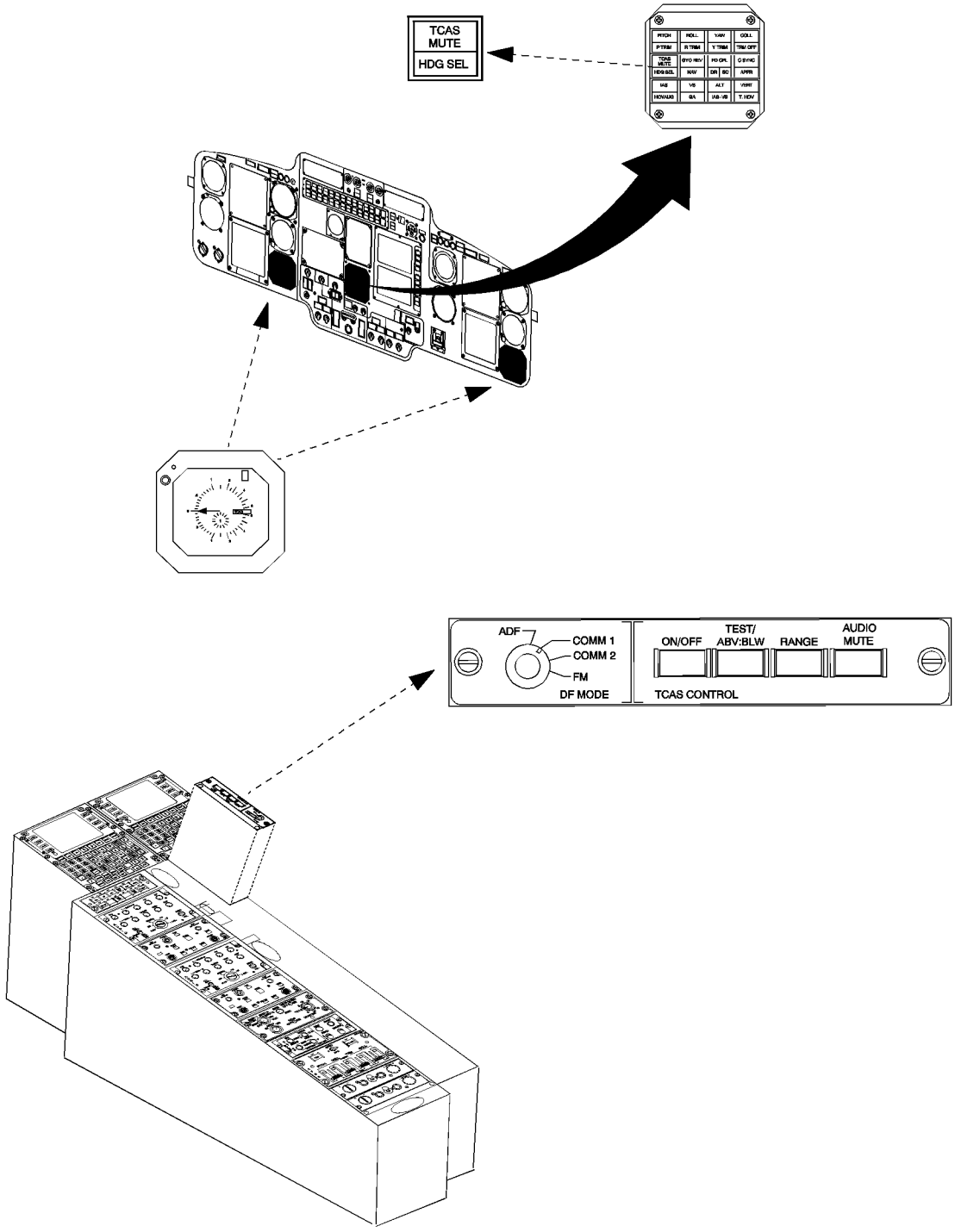



*Figure 1-245. TCAS Control Panel and Indicators*

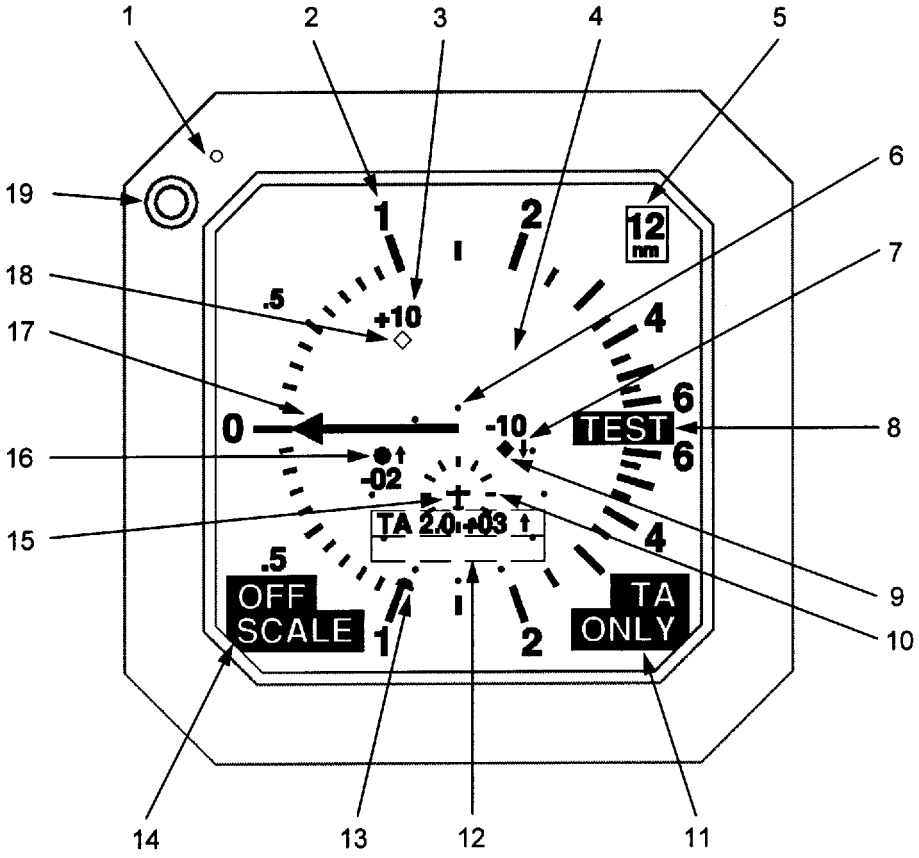



*Figure 1-246. VSI-TCAS Display Controls and Indicators*

| Index No. | Control/Indicator | Function |
|---|---|---|
| 1 | Test Button (Recessed) | Activates self–test of VSI–TCAS display. |
| 2 | Vertical Speed Scale | A graduated scale to show, in thousands of feet per minute, the vertical speed of the aircraft. |
| 3 | Intruder Altitude Display | Indicates intruding aircraft altitude relative to own aircraft in hundreds of feet. Positive and negative values indicate above and below respectively. |
| 4 | TCAS Display Field | TCAS information is shown on the face of the display inside the vertical speed scale. |
| 5 | TCAS Range Display | Indicates TCAS range in nautical miles. TCAS ranges are 6, 12, and 24 nautical miles. Range is selected on the TCAS Control Panel. |
| 6 | 6–Mile Range Ring | Aircraft appearing within range ring are within 6 miles of own aircraft. Ring present only on the 12 nm range display. |
| 7 | Trend Arrow Display Symbol | Down arrow indicates descent of intruder aircraft ≥500 fpm. Up arrow indicates ascent of intruder aircraft ≥500 fpm. |

| Index No. | Control/Indicator | Function |
|---|---|---|
| 8 | TCAS Status Display | **Annunciation** / **Indicates**<br>TCAS FAIL (Yellow) — TCAS failure or TCAS is off.<br>TCAS Off (White) — TCAS is in standby mode.<br>TEST (White) — TCAS is in self−test mode.<br>TD (Yellow) — TCAS display has failed.<br>(Blank) — TCAS is in operating mode. |
| 9 | Proximity Advisory Symbol | A closed cyan diamond. (See Figure 1−244.) |
| 10 | 2−Mile Range Ring | Ring represents 2 nm on the 6 nm and 12 nm range displays. |
| 11 | TA ONLY Display | TA ONLY (White) annunciation indicates TCAS I system is in normal operating mode. Annunciation changes to yellow when a traffic advisory (TA) is present on the display. |
| 12 | No Bearing TA Traffic Display | TA traffic information is displayed as text below the Own Aircraft Symbol (Index No. 15) when the bearing for that traffic cannot be determined. Relative altitude and the climbing or descending trend arrow will be displayed. |
| 13 | Off Scale TA Traffic Symbol | A one−half TA traffic symbol will be displayed at the Maximum Range Border of the TCAS Display Field on the bearing of the traffic when it is beyond the selected display range of the VSI−TCAS. Accompanied by a separate “Off Scale” annunciation (see Index No. 14). |
| 14 | Off Scale, Above/Below Display | **Annunciation** / **Indicates**<br>OFF SCALE (White) — Indicates TA Traffic is off−scale. A partial TA symbol will be displayed at the edge of the display field.<br>ABV (White) — Other Traffic (open cyan diamond) within +9,000 ft to −2,700 ft of your own altitude is displayed.<br>BLW (White) — Other Traffic (open cyan diamond) within +2,700 ft to −9,000 ft of your own altitude is displayed.<br>(Blank) — Normal operating mode. Other Traffic (open cyan diamond) within ±2,700 ft of your own altitude is displayed. |
| 15 | Own Aircraft Symbol | Symbol of Own Aircraft offset from the geometric center of the display. |
| 16 | Traffic Alert Symbol | A solid yellow circle. (See Figure 1−244.) |
| 17 | Vertical Speed Pointer | Indicates instantaneous vertical speed of the aircraft on the vertical speed scale. |
| 18 | Other Traffic Symbol | An open cyan diamond represents any traffic within the selected display range that is not proximate traffic or traffic generating a TA. |
| 19 | Light Sensor | Automatically adjusts display brightness, depending on ambient lighting changes. |

*Figure 1-247. VSI-TCAS Display Controls and Indicators*

## Aircraft Detection

TCAS operates as an air-to-air interrogation device which detects transponder equipped aircraft that reply to Mode A, Mode C and Mode S interrogations. Once the presence of an intruder is confirmed, TCAS monitors the bearing, range, track and speed of the intruder aircraft. TCAS is capable of tracking up to a total of 35 targets and displaying up to eight at a time.

**NOTE**

TCAS will not track or display any information from a military intruder aircraft using an AN/APX-72 transponder set to only Mode 3A.

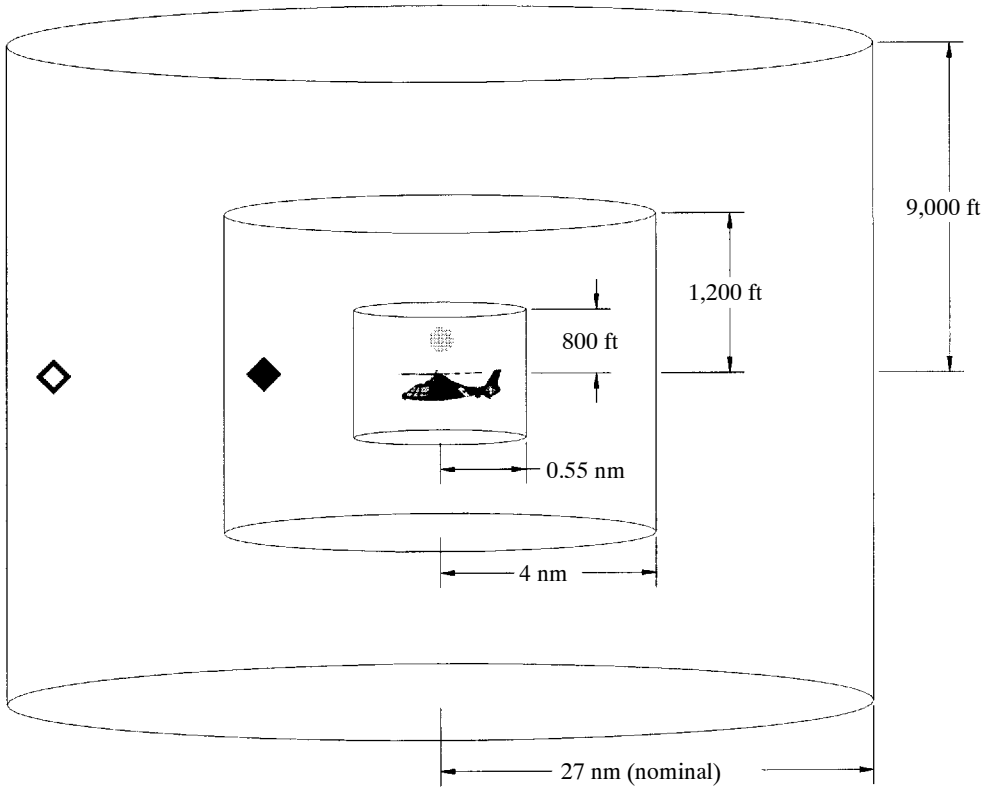



*Figure 1-248. TCAS Surveillance Airspace*

## Operating Frequencies

TCAS equipment operates at the same transmit (1030 MHz) and receive (1090 MHz) frequencies as ATC ground radar stations (ATCRBS). TCAS interrogates only in Mode C by transmitting 1030 MHz messages via the bottom directional TCAS antenna. TCAS receives 1090 MHz messages from Mode S and ATCRBS Mode A or Mode C transponders via the top omnidirectional and bottom directional antennas.

## Altitude Tracking

TCAS tracks other transponder-equipped aircraft that are within a relative altitude range of ±9,000 feet (see Figure 1-248).

## Aircraft Tracking

Tracking is performed by repetitious TCAS interrogations in Mode C format. When interrogated, transponders reply after a fixed delay. Measurement of time between interrogation transmissions and reply reception allows TCAS to determine the range of the intruder. If the intruder transponder is supplied with an altimeter input, TCAS will receive intruder altitude reports in the replies and will be able to determine the relative altitude of the intruder. Transmission and reception techniques used by the TCAS directional antenna allow TCAS to determine the bearing of an intruder. Based on closing rates and relative position computed from the reply information, TCAS classifies intruders as Other Traffic (non-intruding), Proximity Advisory (PA), or Traffic Alert (TA) threat category aircraft and provides visual and aural aids to the pilots.

**NOTE**

- TCAS system may not display targets which are within ±8° aft and above own aircraft.
- The relative bearing accuracy of targets displayed by the TCAS is ±30° from the 7:30 position clockwise to the 4:30 position, and ±45° from the 4:30 position clockwise to the 7:30 position (see Figure 1-249). The largest bearing errors will normally occur when the aircraft altitude is within 500 ft of the surface of the water.
- Target losses can occur during turns utilizing >20° angle of bank, but the target will be quickly reacquired after resuming level flight.

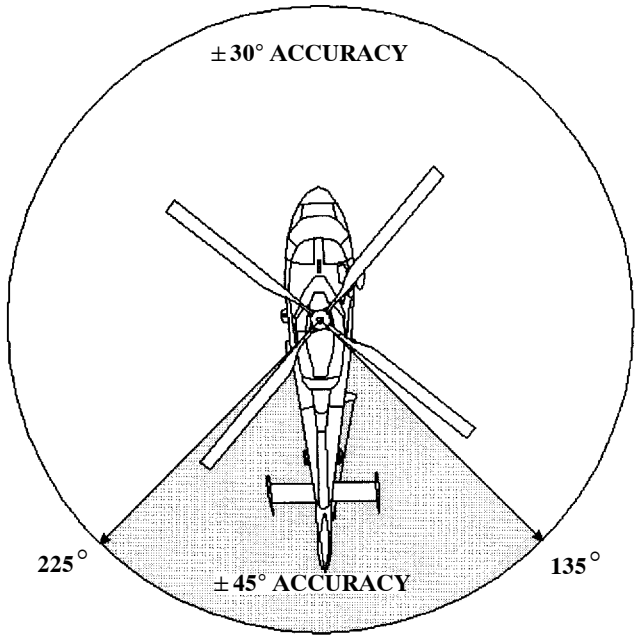



*Figure 1-249. TCAS Relative Bearing Accuracy*

## Visual Alerting

When TCAS is tracking an intruder on the directional antenna, a traffic display symbol will be displayed on the VSI-TCAS (see Figures 1-244 and 1-246). The symbol position on the display depicts relative range and bearing of the intruder. The symbol shape and color identify whether the aircraft has been categorized as an Other Traffic, Proximity Advisory, or Traffic Advisory threat (see Figure 1-244). If the intruder is reporting altitude, intruder relative altitude and a vertical trend arrow indicating a climb or descent greater than or equal to 500 fpm are also displayed.

## Aural Alerting

If the intruder is categorized as a TA, TCAS provides an aural warning "Traffic, Traffic" alert to the pilot and copilot positions. The aircrew position must have audio control panel TCAS knob pulled out to hear the aural warnings.

## Traffic Alerts

The VSI-TCAS display alerts the flight crew to the relative position of nearby aircraft that are, or could become, collision threats. Aircraft is considered a Traffic Alert when it will intercept your own aircraft's track within approximately 15-30 seconds, or when an intruder is within 0.55 nm and ±800 feet vertically. This assists and improves the ability of the flight crew to visually acquire intruder aircraft that represent a mid-air collision danger.

# OPERATIONAL PROCEDURES

## Start-Up

The TRC791A receives power from the No. 1 Main DC Bus through the Avionics Bus, which is an auto shed bus. It is ready for operation after a required 30-60 second warm-up period. The VSI-TCAS displays are also powered from the No. 1 and No. 2 Main DC Buses, but are on manual shed buses and independent of the TRC791A (see Figures 1-251 and 1-252). Power to all TCAS system components is routed through the appropriate (pilot or copilot) avionics master switches. The system is checked during the Systems/Equipment Check and placed in the appropriate operating mode as required.

## Ground Mode

1. Momentarily depress the ON/OFF button to turn the TCAS "ON."

**NOTE**

FAR 91.221 requires that the PIC of an aircraft equipped with an operable TCAS shall have that system on and operating.

2. The TCAS system is automatically in standby when "ON" while the aircraft is on the ground. When airborne, the aircraft weight-on-wheels switch automatically commands the TCAS system to

operate in normal modes, as selected by the pilot. Similarly, the weight-on-wheels switch will automatically place the TCAS system into standby 24 seconds after landing.

3. To put the TCAS into ground mode:

   a. Momentarily depress the RANGE button. TCAS is now in the ABV mode with the 12 nm scale selected on the VSI-TCAS.

   b. Select Normal, ABV, or BLW modes as desired by depressing the TEST/ABV:BLW button to cycle through the options.

   c. Depress and release the RANGE button to change the VSI-TCAS range as desired.

   d. To return TCAS to standby, depress the RANGE button for 2 or more seconds.

## Normal TCAS I Operations

To put the TCAS into operation:

1. Depress the ON/OFF button to turn the TCAS "ON."
2. Select Normal, ABV, or BLW modes as desired by depressing the TEST/ABV:BLW button to cycle through the options.
3. Select TCAS Range as desired.

**WARNING**

Maneuvers based solely on the TCAS traffic display are prohibited. Information shown on the VSI-TCAS is provided to the pilot as an aid to visually acquiring traffic. Do not use TCAS to attempt to maneuver based solely on the use of TA information, displayed traffic, or other TCAS traffic information.

**NOTE**

Intruder splits (duplicated targets) may occur while flying in an area near large reflective surfaces (buildings), over large bodies of water, or when maneuvering the aircraft below 2,500 ft AGL. Normally these will reappear as a single target within 30 seconds.

4. The MUTE pushbutton on the TCAS Control Panel toggles the TCAS audio on and off to the two cockpit positions and the flight mechanic's station. The green "TCAS MUTE" advisory capsule on the Avionics Mode Annunciator Panel will illuminate whenever TCAS audio is muted.

**NOTE**

It is left to the PIC's discretion whether to activate AUDIO MUTE. Consideration should be given to ambient traffic conditions, demanding maneuvers (requiring sterile cockpit conditions), and ATC traffic advisory capabilities. It is recommended that TCAS audio not be muted at airports without control towers.

## TCAS Self-Test

1. The TCAS system should be tested prior to flight.

**NOTE**

Self-test is inhibited in flight and when operating in the ground mode.

2. To self-test the TCAS:

   a. Momentarily depress and release the TEST/ABV:BLW button to initiate the "TEST." If on the ground and the RANGE button has been previously depressed, the TCAS is in the ground mode and can not be tested. To test the system, depress the RANGE button for 2 or more seconds to place TCAS in standby, then depress the TEST/ABV: BLW button.

   b. Verify the following:

      (1) The proper test patterns are displayed on the pilot and copilot VSI-TCAS (see Figure 1-250).

      (2) "TCAS TEST PASSED" is annunciated on the VSI-TCAS and aurally through the ICS system.

**NOTE**

- If the "TCAS TEST PASSED" message is received aurally without the test screens being displayed, the VSI–TCAS has failed and the TCAS shall be turned off.
- If "TCAS FAILED" is displayed on the VSI–TCAS and "TCAS TEST FAILED" is annunciated aurally, the TCAS shall be turned "OFF." The VSI portion of the VSI–TCAS display will not be secured.

## Standby Mode and Shut-down

The TCAS automatically reverts to the standby mode 24 seconds after the aircraft weight-on-wheels switch senses

that the aircraft has landed. The TCAS system does not need to be shut down or placed in standby manually following landing. To shutdown the TCAS, depress the ON/OFF button.

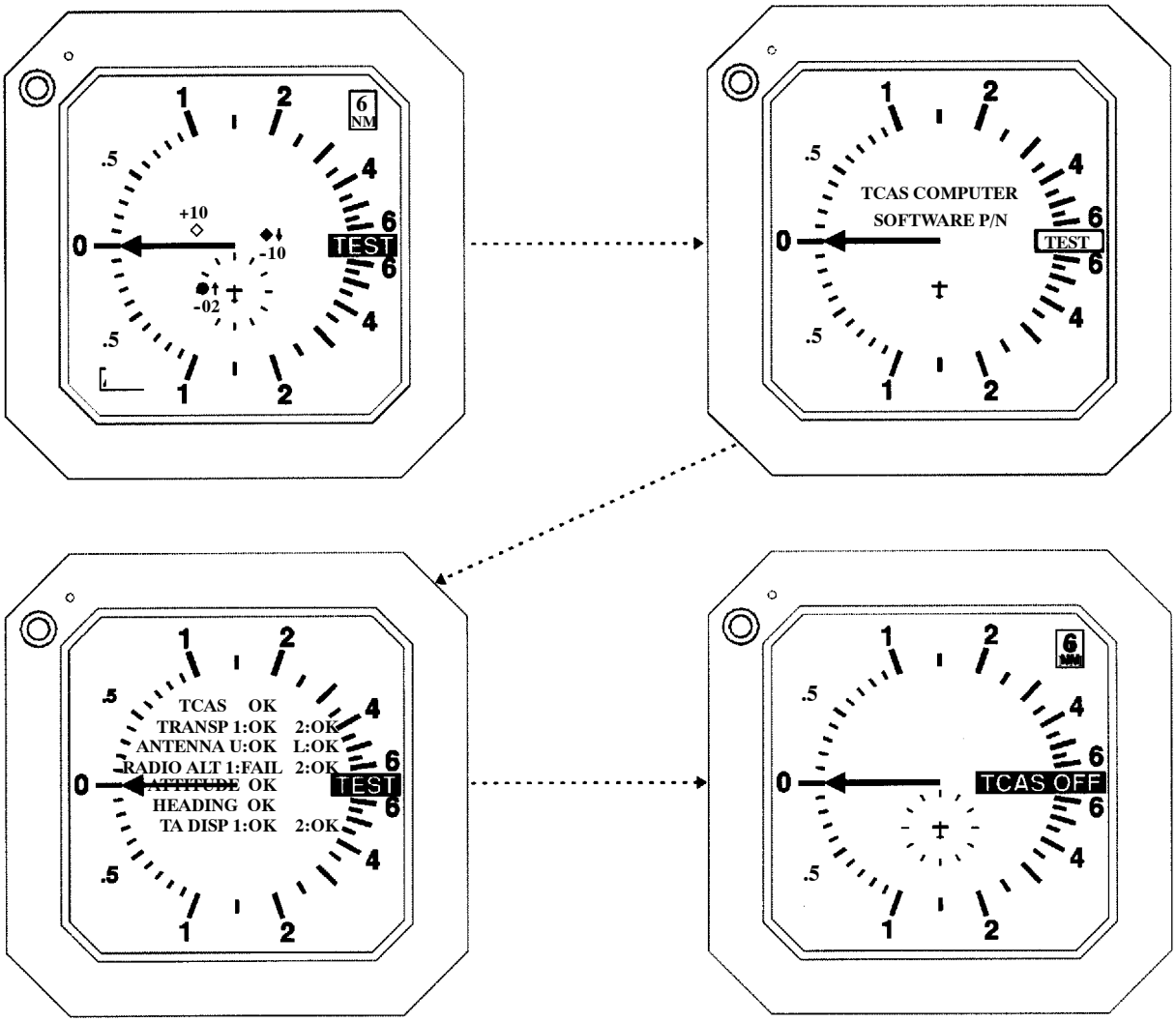



*Figure 1-250. VSI-TCAS Self-Test Displays*

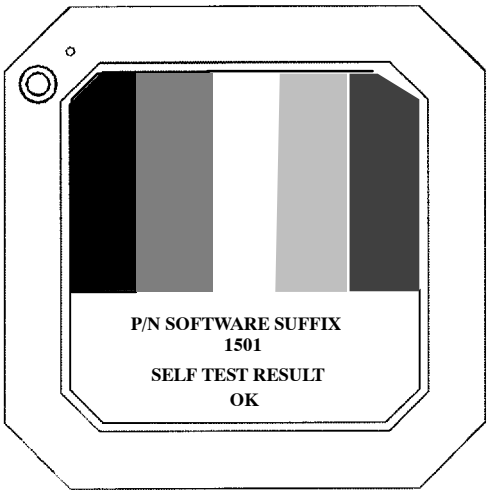



*Figure 1-251. VSI-TCAS Display Self-Test Display*

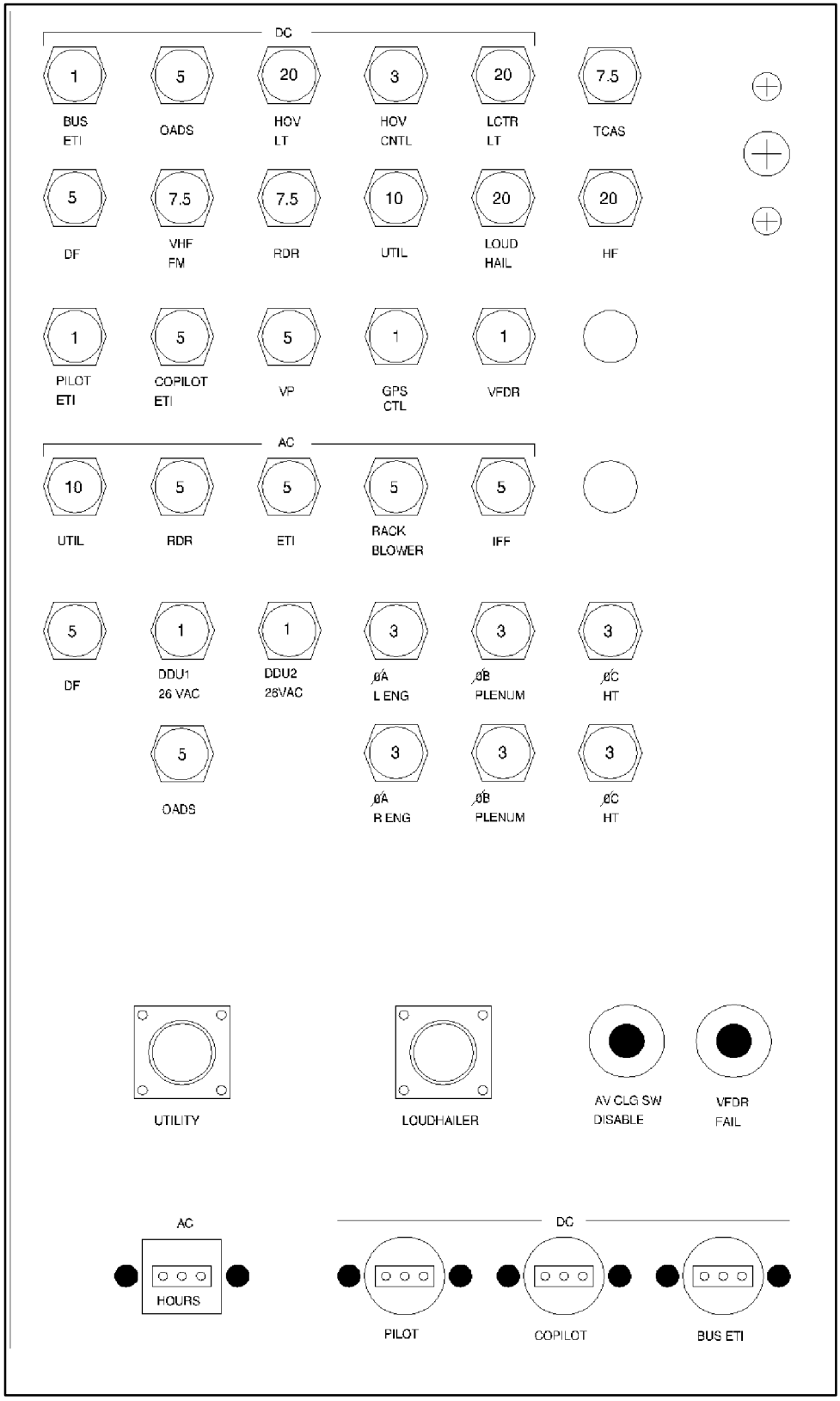



*Figure 1-252. Avionics Rack Circuit Breaker Panel*

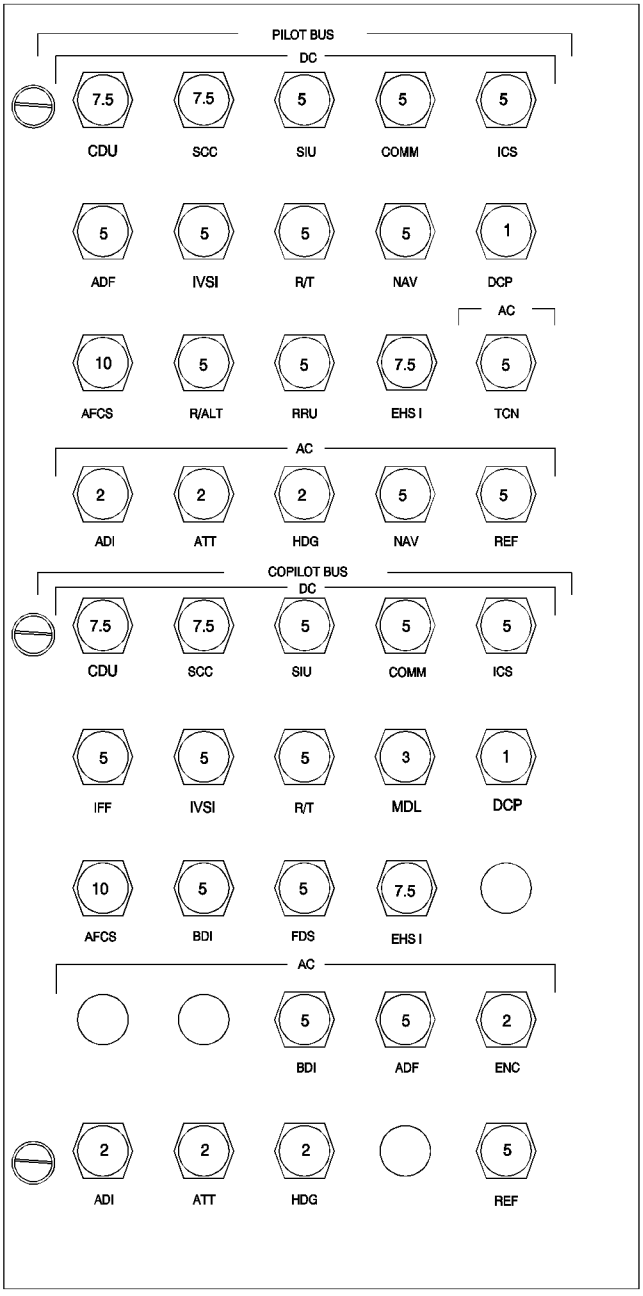



*Figure 1-253. Cockpit Avionics Circuit Breaker Panel*

# SECTION II

# NORMAL PROCEDURES

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## PREPARATION FOR FLIGHT

Fuel requirements and weight and balance will be determined for each flight. Standard computations are acceptable when filed in accordance with the requirements of COMDTINST M3710.1 (series).

## CHECKLIST AND BRIEFING EXECUTION/COCKPIT PROTOCOL

## CHECKLIST

Referencing a written checklist is a proven countermeasure to human errors that may occur during any flight regime. Failure to accurately complete aircraft checklists presents a significant risk to safe aircraft operations. Whether dual or single piloted, the employment of sound crew resource management practices is essential to the safe completion of assigned missions. Specific protocols for dual and single piloted operations are listed below. Written checklists have been provided for use by all aircrews. Checklist use is mandatory for the following: Before Starting Engines, Engine Start, Systems/Equipment, Taxi, Takeoff, Level Off, Landing, After Landing, Secure, Letdown, and Hot Refueling. Written checklists for the Rescue Check are posted in the cabin for use by FMs. FMs complete these checklists silently and verbalize their completion. Normally, the Landing/Hover checklist will not be completed while rescue checks are in progress.

Checklists direct aircraft configuration. The majority of checklist items direct a specific action to occur (e.g., Batteries - On). If an item is listed as "As Required," the specific action is based on operational requirements (e.g., Hoist Check-As Required). If an item is listed as "As Desired," the specific action is based on the discretion of the PIC (e.g., TCAS Audio/Mute Switch - As Desired).

Standard flight crewmember definitions and abbreviations listed in Section IV are used to delineate checklist responsibilities. Changes in aircraft configuration **or** checklist execution will be verbalized over the ICS. Verbalization is defined as stating a checklist requirement or mode selection request, followed by a statement of the condition in which the item has been placed (e.g., Landing Gear Handle-Down). Verbalization assists the crew in maintaining situational awareness with respect to the aircraft's current status.

### ASTERISKED ITEMS

Asterisks "*" have been placed by items in several checklists to allow omission when doing subsequent checklists in the same aircraft with the same pilot/copilot during the same duty day cycle. This is designed to take advantage of efficiencies gained by not having to re-check systems which were previously tested. To ensure consistency, asterisked items are not skipped, but are still challenged with the accompanying response "completed." Omitting asterisk items will not be appropriate for all flight regimes at all times and shall not be omitted if maintenance has been performed on the system during a stop. The PIC must use discretion in determining when to allow items to be omitted.

Double asterisks "**" have been placed by items in the checklists to mandate PAC to verbalize the required step, execute, and verbalize completion (e.g., "Trim - ON").

Static checklists (Before Starting Engines, Systems/Equipment, etc.) - Asterisked items may be omitted as above on subsequent starts at the discretion of the PIC if completing multiple sorties on the same day. All items must be completed on the initial start.

Taxi checklists - Asterisked items may be omitted as above on subsequent taxi checks at the discretion of the PIC if completing multiple taxi checks during the same flight. All items must be completed for the initial taxi after any shutdown and restart.

Letdown checklists - Asterisked items may be omitted as above at the discretion of the PIC on subsequent approaches when conducting multiple practice instrument approaches to the water, (CATCH, MATCH, IAS-VS Letdown, NATCH) in the same location. All items must be completed if the configuration of the aircraft or location of the approaches is changed. Note the brief is not an asterisked item and must be completed for each approach.

## BRIEFING GUIDES

Briefing Guides are useful tools to ensure concise and accurate crew and vessel briefs, and execution of instrument letdowns to the water. General instrument approach setup guidelines have been included in the Instrument Approach Brief to assist crews in setting up instrument approaches.

## DUAL PILOT PROTOCOL

Under dual pilot ops, cockpit duties such as checklist management, Instrument Approach setup, briefings, commu-

nications, CDU operations, and flight director mode selection should be completed by the SP, allowing the PAC to focus on aircraft control. The SP should verbalize over the ICS engagement or disengagement of the flight director modes at the request of the PAC (e.g., PAC - "Engage ALT HOLD." SP - Selects ALT HOLD, confirms engagement, and states "ALT HOLD engaged.") Checklists will be completed using the team concept of challenge and response, whereas the SP or FM will verbalize the required step, and the responsible aircrew will execute, then verbalize completion of the step. The pilot occupying the right seat will respond as "pilot" and the pilot occupying the left seat will respond as "copilot" to avoid confusion in the cockpit. This will be without regard to seniority or PIC designation. All other crew members will respond by using their respective crew position.

## SINGLE PILOT PROTOCOL

Under single pilot operations, the pilot must carefully balance and prioritize cockpit management duties with flight control operations. When executing checklists, the PAC will complete checklist items listed as the responsibility of the SP. In certain flight regimes, the Aircrewman should be tasked with assisting checklist execution, relieving overall workload on the pilot. When the aircraft is static, the PAC or Aircrewman will reference the Checklist and verbalize the following: Before Starting Engines, Engine Start, Systems/Equipment, Taxi, Secure, and Hot Refueling. During aircraft movement or flight, the Aircrewman should conduct the challenge portion of the following using the Checklist: Takeoff, Level Off, Landing/Hover Checklist, After Landing Checklist. Certain flight regimes (SAR, external load operations) may preclude the Aircrewman from assisting with checklist execution. During these situations, the PAC will execute and verbalize the checklist. The PAC will execute and verbalize FD mode engagement for the benefit of the other crewmembers.

## FLIGHT CREW INSPECTION

The PIC (or a representative) will provide the crew with an appropriate brief prior to takeoff to ensure all crewmembers understand the mission and their responsibilities in the conduct of safe flight operations. Refer to Figures 2-5 and 2-6 for aircraft danger areas. A qualified pilot or Aircrewman will make a walk-around inspection, checking all visible fluid levels and clogging indicators; all cowlings and latches for proper security; covers, plugs, and flags removed; main and tail rotor blades and tires for condition; presence of ice, snow, or frost; all antennae; cabin area; cabin exits and emergency release handles in position and wired; all break–away wired items intact. In addition, the following specific items will be checked.

1. Pilot's side of cockpit:
    a. Parking brake/Nose gear lock set appropriately.
    b. Adjust seat, set weight.
    c. Circuit breaker panels (3).
    d. Pubs and charts.
    e. Landing gear safety pin removed.
    f. FADEC safety guards removed.
2. Cabin sliding door/hatch:
    a. Smooth operation.
    b. Roller assemblies secure.
    c. Rescue hatch security.
    d. Jettison handle.
3. Pressure refueling cap secure and selector centered.
4. Baggage compartment:
    a. Cargo properly secured.
    b. ELT armed.
    c. Circuit breaker panels (2).
5. Right wheel well:
    a. Actuator lock/strut collar removed.
    b. Flotation bottle pressure.
    c. Chocks, as desired.
6. Tail skid.
7. Left wheel well:
    a. Actuator lock/strut collar removed.
    b. Flotation bottle pressure.

c. Chocks, as desired.

8. Gravity refueling caps.

9. Landing gear blow down bottle pressure.

10. Cabin interior:

a. Circuit breaker panels (3). Ensure main AC bus tie contactor circuit breakers (2) are pulled.

b. SAR gear.

c. Locator light, pendant disconnected.

d. Cargo properly secured.

**WARNING**

Any item not secured in the cabin is likely to become a missile hazard in the event of a mishap. All cargo and/or personal gear should be properly secured to the aircraft prior to transition to forward flight whenever possible.

11. Copilot's side of cockpit:

a. Adjust seat, set weight.

b. Circuit breaker panel.

c. Pubs and charts.

d. Total/static press switches on and break-away wire intact.

e. Fuel jettison switches covers down and break-away wire intact.

f. Emergency electrical cutoff up and break-away wire intact.

g. Emergency fuel shutoff levers forward.

h. Overhead static pressure switch on and break-away wire intact.

i. Harness, as required.

12. Battery compartment door secured.

13. ADU probe.

14. Nose wheel well:

a. Actuator lock/strut collar removed.

b. Locking indicator.

## BEFORE STARTING ENGINES

1. Seat - "SET." (PAC/SP/FM)

a. Check seat weight set properly. (PAC/SP/FM)

b. Confirm harness and pedals adjusted. (PAC/SP)

2. Center console - "CHECKED." (PAC)

**a. TCAS - ON.

**b. Training switch - FLT.

**c. Parking brake - SET.

**d. Radar - OFF.

3. Electrical Control Panel - "CHECKED." (PAC)

**a. Pilot and copilot avionics switches - OFF.

**b. Shed bus switch - OVERRIDE.

**c. Emergency T/R - ON.

**d. Battery relay switches - ON.

(1) Conduct ICS checks.

**e. Generator switches - ON.

**f. Voltmeter selector - AS REQUIRED.

(1) Battery start - BATT.

(2) External power start - EXT (If DC external power is used for the start, place the spike suppression switch in the "START PROTECTION" position prior to connecting DC external power. Ensure that the BATT RLY 2 OPEN light has extinguished to ensure proper operation.)

**g. AC panel - CHECKED. (PAC)

(1) Alternator switches - ON.

(2) 26 VAC transformer XFER switch - NORMAL.

(3) AC EXT power switch - OFF.

*4. LIMIT light/brake pressure check - "CHECKED." (PAC)

**NOTE**

Secondary hydraulic pressure shall stay in the normal operating range throughout the check to avoid undue stress on the standby pump.

a. Electric pump - TEST.

b. Collective - UNLOCK.

c. Cyclic fore and aft, check LIMIT light - ON.

d. Collective up, check LIMIT light - ON.

**WARNING**

Ensure the down-lock stem of the collective does not contact the collective down-lock flexible blade. If the stem contacts the flexible blade or engages the down-lock stem, the flexible blade must be adjusted prior to flight.

**WARNING**

Movement of the tail rotor pedals while the main rotor is below 266 RPM is prohibited.

e. Collective - LOCKED.

f. Parking brake accumulator gauge - 700 psi min. (If below 700 psi, place electric pump in BKP.)

g. Electric pump - OFF.

5. Floats - "CHECKED." (PAC)

a. ARM - LIGHTS ON.

b. OFF.

6. Fuel management panel check - "CHECKED." (PAC)

a. Fuel quantity indicator - CHECK. Depressing TEST button decreases displays to zero, releasing returns to normal reading. Note quantity.

b. Transfer pump - CHECK. Both directions, then off.

*7. Clock - "CHECKED." (PAC)

a. Time and Date set.

8. WCA panels - "CHECKED." (PAC)

a. Check WCA panel for normal indications. Normal indications are: ENG 1 and ENG 2 OIL P, ENG 1 and ENG 2 FUEL P, PRI SERVO P, SEC SERVO P, SERVO JAM, SEC HYD LO PRES, MGB PRES, MGB PMP MAIN, MGB PMP AUX, AFCS, ROTOR BRAKE, PARKING BRAKE, HORN, L PITOT and R PITOT.

**NOTE**

If GOV light on WCA Panel is flashing, scroll VEMD to the system status page and check the displayed failure message. If the message reads TO.DISC A or TO.DISC B, and there is a difference of more than 5 °C between the two FADEC thermal probes due to sun exposure, the start may be continued. Prior to takeoff the temperature differential must be less than 15 °C, otherwise takeoff is not authorized.

9. FIRE/FAIL lights - "CHECKED." (PAC)

a. ENG 1 and ENG 2 FIRE/FAIL lights - CHECKED.

(1) Red fire light on Emergency Fuel Shutoff Levers illuminate.

b. MGB FIRE/FAIL lights - CHECKED.

10. Overhead Panel - "CHECKED." (PAC)

    **a. Trim - ON.

    **b. Servo jam - CHECKED.

    **c. Chip detector - CHECKED.

        (1) GB position - MGB CHIP and TGB CHIP message on VEMD fuel page illuminates.

        (2) ENG postion - ENG 1 CHIP and ENG 2 CHIP message on VEMD fuel page illuminates.

    **d. Nr switch - NORMAL.

    **e. Lighting - AS REQUIRED.

        (1) Lighting rheostats - SET.

        (2) Lighting switch - AS REQUIRED.

    **f. Position lights - AS REQUIRED.

    **g. Anti-collision light - AS REQUIRED.

    **h. Cabin lights - AS REQUIRED.

        (1) Day - ARM.

        (2) Night - ON/ARM.

    **i. Avionics fan - AUTO.

    **j. HEAT/COOL switches - OFF.

11. Overhead quadrant - "CHECKED." (PAC)

    **a. FADEC backup switch - NORMAL.

    **b. OVHD heat rheostat - OFF.

## ENGINE START/ROTOR ENGAGEMENT

On odd calendar days the #1 engine should be started first. On even calendar days the #2 engine should be started first. This alternating start will ensure appropriate rotor load sharing.

1. Fire guard - "POSTED/AREA CLEAR." (FM)

2. Rotor brake - "OFF." (PAC)

3. Boost pumps - "ON."

    a. Place boost pumps for first engine start ON.

**CAUTION**

Both engines must be started using the same DC power supply (battery or GPU).

**CAUTION**

Engine start must not be performed if the red pie symbol (OEI HI used) is displayed on the FLI page.

4. First engine start - "COMPLETED." (PAC)

    a. FADEC control switch - Idle.

        (1) Battery voltage ≥ 17 volts.

        (2) Engine oil temperature > 0 °C. Remain in Idle position until EOT > 0 °C.

    b. FADEC control switch - Flight.

        (1) Start on VEMD flashes when N1 > 3%.

        (2) Horn ON at 300 rpm.

**CAUTION**

Abort the start by placing the FADEC control switch to OFF if any of the following conditions occur:

1. An increase in N1 and TOT values are not observed within 10 seconds.

2. The TOT digital value is underscored in red.

3. The main rotor does not turn prior to 25% N1.

4. The ENG # OIL P warning light does not extinguish prior to 70% N1.

5. The FADEC # FAIL caution light illuminates.

6. The N2 needle passes the Nr needle on the pilot's triple indicator (freewheeling failure).

7. When engine has not reached 45% N1 within 30 seconds and is no longer accelerating.

5. OEI - "CHECKED." (PAC)

   a. Check HI illuminated on the FLI.

   b. Select LO using HI/LO switch on collective. LO appears on FLI OEI message line.

   c. Select CT using the continuous switch on the collective. CT appears on the FLI.

6. Voltmeter - "CHECKED." (PAC)

   a. Select GEN for engine started.

   b. Ensure loadmeter is < 100%.

   c. Select BATT or EXT.

7. Boost Pumps - "ON."

   a. Place boost pumps for second engine start ON.

8. Second engine start - "COMPLETED." (PAC)

   a. FADEC control switch - Idle.

      (1) Battery voltage ≥ 17 volts.

      (2) Engine oil temperature > 0 °C. Remain in Idle position until EOT > 0 °C.

   b. FADEC control switch - Flight.

      (1) START on VEMD flashes when N1 > 3%.

**CAUTION**

Abort the start by placing the FADEC control switch to OFF if any of the following conditions occur:

1. An increase in N1 and TOT values are not observed within 10 seconds.

2. The TOT digital value is underscored in red.

3. The ENG # OIL P warning light does not extinguish prior to 70% N1.

4. The FADEC # FAIL caution light illuminates.

5. The N2 needle passes the Nr needle on the pilot's triple indicator (freewheeling failure).

6. When engine has not reached 45% N1 within 30 seconds and is no longer accelerating.

9. FCS Safety Locks - "LOCKED." (PAC)

10. External power - AS REQUIRED. (PAC or FM)

11. Avionics - "ON." (PAC)

12. Heat/Cool switches - AS REQUIRED. (PAC) For avionics cooling purposes, the COOL switch must be on when cabin temperatures are 20 °C or above.

13. Chocks - "REMOVED." (FM)

## SYSTEMS/EQUIPMENT CHECKLIST

1. Overhead Panel - "CHECKED." (PAC)

   **a. Pitot heat L/R - ON.

   **b. W/S anti-ice L/R - AS REQUIRED.

   **c. Servo jam - CHECKED.

      (1) Depress servo jam. Warning light should illuminate.

   **d. Hoist check - AS REQUIRED.

(1) If a hoist check is required, select hoist power to crew and direct FM to begin hoist check.

(2) If a hoist check is not required, select hoist power OFF.

2. Warning-Caution-Advisory panel - "CHECKED." (PAC)

a. Depress Test button. Check that all WCA and Master Warning, Avionics Annunciator, Fuel Management, Electrical, and FDS panel VEMD test display lights illuminated.

3. Landing gear indicator - "CHECKED." (PAC)

4. PTT lights - "CHECKED." (PAC/SP)

a. Radar caution light - CHECKED.

b. Marker beacon lights - CHECKED.

5. Radar altimeter - "CHECKED/SET AS DESIRED." (PAC/SP)

a. Bug - SET AS DESIRED.

b. Press-to-test - 400 ($\pm$40) ft.

6. BARALTs - "SET AND COMPARED." (PAC/SP)

7. Voltmeter selector - "CHECKED." (PAC)

a. Observe GEN 1/2 for load. If a generator is not carrying a load, investigate the cause prior to flight. Do not leave in BATT position.

8. Boost pumps - "CHECKED." (PAC)

a. Boost pump #1 - OFF. Ensure normal fuel pressure on engine #1.

b. Boost pump #3 - OFF. Ensure engine #1 remains running.

c. Boost pump #2 - OFF. Ensure normal fuel pressure on engine #2.

d. Boost pump #4 - OFF. Ensure engine #2 remains running.

e. Boost pump #1 - ON. Ensure normal fuel pressure on engine #1.

f. Boost pump #3 - ON.

g. Boost pump #2 - ON. Ensure normal fuel pressure on engine #2.

h. Boost pump #4 - ON.

9. Center Console - "CHECKED." (PAC)

**a. IVSI display - CHECKED.

(1) DF mode/TCAS control panel - TEST/ABV;BLW - TEST.

(2) Observe normal indications of first TCAS screen (traffic positions).

**b. Gyro compasses - SET. (PAC)

(1) Select MAG or DG.

(2) Synchronize heading compasses. Compare both MFDs, BDI, and magnetic compass.

**c. Automatic Flight Control System (AFCS) Control panel - CHECKED. (PAC)

(1) TRIM - ON.

(2) GYRO - BOTH.

(3) FD CPL - COUPLE.

(4) AFCS - ENGAGE. The ATT flags on the ADIs must be out of view.

(5) Avionics mode annunciator panel - ALL LIGHTS OUT.

(6) AFCS quick disconnect - DEPRESS.

(a) All channels disengage.

(b) AFCS channel disengaged lights flash.

(c) AFCS caution light on.

(7) AFCS quick disconnect - DEPRESS.

(a) AFCS channel disengaged lights on steady.

(b) AFCS caution light extinguished.

**d. DF mode/TCAS control panel - CHECKED. (PAC)

(1) DF rotator knob - ADF.

(2) Note the "TCAS TEST PASSED" audio annunciation and "TCAS OFF" message on the VSI-TCAS display.

**e. Radar control panel - CHECKED. (PAC)

(1) Mode - STBY.

(2) STAB - ON.

**f. COMM/IFF (Identification friend or foe) panel - CHECKED. (PAC)

(1) ELT - ARM.

(2) VP - CLR.

(3) CP/P - NORM.

(4) EMER - AFT.

(5) ZERO - AFT.

(6) IFF MON light - ON. If off, place transponder to STBY.

**g. Flight director system (FDS) - CHECKED. (PAC)

(1) IAS/VS mode - SELECT.

T-HOV captures (below 100 ft. RADALT).

Normal indications are:

(a) Command bars centered.

(b) Command pointer indicating up collective. (Pointer in lower position.)

(2) Slew switch - ACTIVATE. Observe command bars and CMD airspeed move in conjunction with slew switch.

(3) Depress C-SYNC button. Collective command pointer centers.

(4) NAV XFR - TRANSFER.

(a) All FD modes deselect.

(b) NAV CTL - COPILOT.

(b) Second actuation returns NAV CTL to PILOT.

(5) MFD - AS DESIRED.

**NOTE**

Step 10 may be completed by the SP. Steps 9 and 10 may be conducted concurrently at the discretion of the PIC.

10. Control Display Unit (CDU) - "CHECKED." (PAC or SP)

a. INDEX page - Enter Start Data;

(1) START 1/3 - Verify posn, date, time. Normally it is not necessary to initialize either GPS. However, if the display posn differs significantly from the known posn (e.g., shipboard ops), satellites are not acquired within approximately 1 minute, enter the known posn and initialize GPS1 and GPS2.

(2) START 2/3 - Verify aircraft basic weight, enter crew weight, payload weight, and desired fuel reserve.

(3) START 3/3 - Verify dates of primary database (automatically transferred from MDL). Verify dates and name of reversionary database (manually transferred from MDL). Load/Enter Flight Plan as necessary.

b. STATUS page - CHECK FAIL line.

(1) Check SATS/GPS IDX and FAIL line.

(2) STATUS 1/2 and 2/2 - Check "GO/NO GO" of LRUs. Review "check marked" LRU items to acknowledge failures.

c. FPLN page - As Required.

d. COMM page - Ensure VHF or UHF GUARD monitored. Enter frequencies as required.

e. NAV page - As Required.

f. IFF page - As Required.

g. DATA page - Select desired database points/identifiers.

(1) MISSION DATABASE page: Review mission identifier database information and effective date.

(2) MISSION DATA LOAD page: Enter anchor fix, select radius and perform search to create new mission identifier database as required.

11. Hoist check - AS REQUIRED. (PAC/FM)

a. FM report completion of hoist check.

b. Pilot - ACKNOWLEDGE.

c. Hoist master switch - OFF.

12. Maintenance checks - AS REQUIRED. (FM)

13. First flight of the day checks - "CHECKED." (PAC)

**NOTE**

First Flight of the Day checks may be delayed until the next start for Urgent Missions. Any noted discrepancies should be entered on Form CG-4377 at the end of the flight.

a. Heating Shutoff Valve (SOV) Check - CHECK.

(1) Heat selector - ON. FLI heat ON symbol illuminates.

(2) OVHD heat rheostat - OVERRIDE. Ensure heat flow.

(3) SOV test pushbutton - PUSH. Ensure heat flow stops and FLI heat ON symbol disappears.

(4) Heat selector - Reset, ON. FLI heat ON symbol illuminates.

(5) SOV test pushbutton - PUSH. Ensure heat flow stops and FLI heat ON symbol disappears.

(6) Heat selector - OFF.

(7) OVHD heat rheostat - OFF.

b. P2 Valve Test - CHECK.

See Interim Change 1 dated 25 May 06.

**NOTE**

Prior to commencing the P2 check, airflow from the heater vents should be at or near zero or TOT rise will be less than expected. On colder days, heater air will flow until cabin temperature reaches approximately 68 °F.

(1) Heat selector - ON.

(2) OVHD heat rheostat - OFF.

(3) Training switch - IDLE 1.

(4) Collective - INCREASE to close engine #2 bleed valve. If TOT reaches 700° prior to the bleed valve closing then maintain 700°.

(5) OVHD heat rheostat - OVERRIDE. TOT on engine #2 should increase approximately 30° - 50°.

(6) Collective - DOWN.

(7) OVHD heat rheostat - OFF.

(8) Training switch - FLIGHT.

(9) Training switch - IDLE 2.

(10) Collective - INCREASE to close engine #1 bleed valve. If TOT reaches 700° prior to the bleed valve closing then maintain 700°.

(11) OVHD heat rheostat - OVERRIDE. TOT on engine #1 should increase approximately 30° - 50°.

(12) Collective - DOWN.

See Interim Change 1 dated 25 May 06.

(13) OVHD heat rheostat - OFF.

(14) Training switch - FLIGHT.

(15) Heat selector - OFF.

**NOTE**

If TOT does not increase, the idling engine side of the P2 double check valve may be seized in the open position.

## TAXI CHECKLIST

1. Crew and passengers - "READY." (FM)
2. Parking brake - "OFF." (PAC)
3. Nose gear - "UNLOCKED." (PAC)

*4. Brakes - "CHECKED." (PAC)

   a. Ensure collective is full down prior to applying brakes.

   b. Ice chocks as required.

*5. Compass cards/turn and slip indicators - "CHECKED." (PAC or SP)

   a. Magnetic compass checked for correct turn indications.

   b. MFDs and BDI checked for proper turn indications.

   c. R/T needles checked for proper turn indications.

   d. Slip indicators checked for freedom of movement.

## TAXIING

Forward taxiing can be accomplished with the cyclic slightly forward of the neutral position and taxi speed regulated by amount of collective used.

**NOTE**

Minimum collective should be used in the vicinity of light aircraft or other areas where rotor wash must be minimized.

## TAKEOFF CHECKLIST

1. Crew and passengers - "READY." (FM)

   a. Seats facing forward.

   b. Harnesses fastened.

   c. Hoist boom stowed.

2. Doors - AS REQUIRED. (PAC/SP/FM)

   a. Pilot/copilot/left cabin - SECURED.

   b. Sliding door - OPEN for shipboard ops
   - AS DESIRED for other ops.

3. AFCS - "ENGAGED." (SP)
4. Radar - AS REQUIRED. (SP)
5. Parking brake - AS REQUIRED. (SP)

   a. Shipboard/slope ops - ON.

   b. Other operations - AS DESIRED.

6. Nose gear - AS REQUIRED. (SP)

   a. Shipboard/slope ops - ON.

   b. Other operations - AS DESIRED.

7. TCAS - AS DESIRED. (SP)
8. IFF - "NORM." (SP)
9. Floats - AS REQUIRED. (SP)
10. Talon - AS REQUIRED. (SP) (shipboard operations only)
11. Nr switch - AS REQUIRED. (SP)

    a. Hovering ≥ 10 ft. - HI.

12. Center instrument panel - "CHECKED." (SP)

    a. WCA panel.

    b. Engine, transmission, hydraulic, and fuel indications on VEMD (note fuel).

    c. Wheel position as required.

    d. Avionics mode annunciator panel.

    e. Electrical panel.

# FLIGHT REGIME DEFINITIONS

(1) HOVER FLIGHT - Any zero or near zero ground speed operation in winds of 35 knots and below, or any steady state hover operation where the relative wind does not exceed 35 knots. During HOVER FLIGHT, maximum continuous power is 10.0 on the FLI. Transient power spikes are limited to a maximum of 10.3 on the FLI (maximum of 10.7 on the FLI if pedal induced). Hover operations in relative winds in excess of 35 knots must be considered as transition flight for the purpose of determining power limitations.

(2) TRANSITION FLIGHT - Flight from zero to 75 knots indicated air speed (KIAS). This flight regime is intended for the purpose of transitioning from a hover to cruise flight or cruise flight to a hover. The maximum continuous power during TRANSITION FLIGHT is 10.0 on the FLI. Transient power spikes are limited to a maximum of 10.3 on the FLI.

(3) CRUISE FLIGHT - Flight above 75 KIAS. The maximum continuous power is 8.8 on the FLI.

# TAKEOFF

Factors that will determine the type of takeoff to be performed are: power available/power required; obstacles, and characteristics of the takeoff area. Regardless of the type takeoff used, a safe single engine airspeed and altitude should be attained as soon as possible. This is accomplished by coordinating the flight controls to achieve a climb speed of 70 to 80 KIAS as soon as practicable after takeoff. The Minimum Airspeed (for level flight) charts and Height Velocity Diagram, One Engine Inoperative chart in APPENDIX A should be used to determine acceptable takeoff profiles. If an aborted takeoff could result in water landing, the floatation system must be armed during the BEFORE TAKEOFF CHECK. The first objective during takeoff is to clear obstacles, then establish a safe single engine climb profile. The best rate-of-climb airspeed will also produce best single engine performance.

Always scan the instruments, particularly N1 and Nr, to confirm normal operation prior to committing to takeoff.

During normal takeoffs and landings with the helicopter light on the wheels, bank angle, side drift, or crosswind may cause the helicopter to begin pivoting or rolling laterally. Under these conditions, lateral cyclic stick inputs are less effective in generating a rate of roll than for a free hovering helicopter.

**WARNING**

If a rolling tendency commences, take immediate corrective action with lateral cyclic input. Depending on the situation, either reduce collective to stop the rolling tendency or raise collective to lift off. Reduction of collective is most effective and is the recommended procedure if conditions permit. Raising collective and lifting off is acceptable, but be prepared for an abrupt roll in the opposite direction. If possible, re-attempt the maneuver heading into wind.

## VERTICAL TAKEOFF

A vertical takeoff is accomplished by increasing collective pitch to establish a hover.

**NOTE**

If pedal force is released while the helicopter is turning at a rate faster than 2 degrees-per- second in either direction, the AFCS does not hold heading until the yaw rate decreases to 2 degrees-per-second.

## TRANSITION TO FORWARD FLIGHT

From a hover, apply forward cyclic to slowly accelerate and adjust collective, as necessary, to prevent settling. After translational lift is achieved, adjust attitude to 8-10° nose

down, accelerating to 70-80 KIAS climb. Below 200 feet above ground level (AGL) sideslip (wing down/top rudder) as required to maintain desired takeoff alignment. Adjust collective as required to maintain power within Takeoff Limits.

### NO HOVER TAKEOFF

This maneuver is used when departing a foreign object debris/damage (FOD) environment, i.e., snow, sand, leaves or other debris. The purpose of the maneuver is to depart the FOD environment expeditiously, thereby keeping the FOD material from obscuring the pilot's vision and out of the engines and rotors. Although it is not a jump takeoff, once the collective pull is initiated, there should be a steady, positive power increase to climb power. As the helicopter lifts off in a level attitude, ease the cyclic forward to accelerate. Once clear of the FOD environment and obstacles and translational lift is attained, adjust attitude to 8-10° nose down, accelerating to a 70-80 KIAS climb. Adjust collective as required to maintain power within Takeoff Limits.

### RUNNING TAKEOFF

Running takeoffs are used under conditions when the power available is not sufficiently higher than the power required to hover. Under these conditions, it is necessary to achieve translational lift through forward motion on the ground, prior to becoming airborne. Running takeoffs shall only be attempted from smooth surfaces, and into prevailing winds if practicable.

Align the helicopter on the desired takeoff heading. Increase collective to 3-5 FLI power, ensuring that both engines are responding, while simultaneously applying forward cyclic. Adjust cyclic as required to maintain LIMIT light extinguished. Slight right cyclic may be required to offset tailrotor thrust.

Accelerate using the wing-down technique with a crosswind. When the helicopter has solidly attained translational lift, move the cyclic slightly aft towards the neutral position, observing the tip path plane of the main rotor, and smoothly increase collective to climb power. Once airborne, smoothly adjust attitude to 8-10° nose down, accelerating to a 70-80 KIAS climb. Adjust collective as required to maintain power within Takeoff Limits.

**CAUTION**

Avoid abrupt collective and/or cyclic movements to prevent lift off in a nose low attitude and possible nosewheel contact with the surface after takeoff.

## LEVEL OFF CHECKLIST

Upon LEVEL OFF:

1. RADALT/BARALT - AS DESIRED. (PAC/SP)
   a. Set RADALT.
   b. Set BARALT to local altimeter setting.
2. Landing gear handle - AS REQUIRED. (SP or PAC)
3. Floats - AS REQUIRED. (SP)
4. NR switch - "NORMAL." (SP)
5. Center instrument panel - "CHECKED." (SP)
   a. WCA panel.
   b. Engine, transmission, hydraulic and fuel indications on VEMD (note fuel).
   c. Wheels as required.
   d. Avionics mode annunciator panel.
   e. Electrical panel.
6. Sliding door - AS REQUIRED. (SP or FM)
7. TCAS audio/mute switch - AS DESIRED. (SP)

## LANDING/HOVER CHECKLIST

1. Landing gear handle - "DOWN." (PAC or SP)

**NOTE**

Wheels shall be down during over water operations unless a landing is not reasonably foreseeable due to the distance from a suitable landing spot or when the Pilot in Command determines that operation with the landing gear extended would present possible interference with or obstacle to the next flight evolution.

2. Crew and passengers - "READY." (FM)
   a. Harnesses/gunner's belt fastened.
3. TCAS audio/mute switch - AS DESIRED. (SP)
4. Radar - AS REQUIRED. (SP)

**WARNING**

It may be necessary to have the radar operating during the approach. Radar must be placed in STBY prior to operating in close proximity of vessels/personnel.

5. Parking brake - AS REQUIRED. (SP)
   a. Shipboard/slope ops - ON.
   b. Other operations - AS DESIRED.
6. Nose gear - AS REQUIRED. (SP)
   a. Shipboard/slope ops - LKD.
   b. Other operations - AS DESIRED.
7. Wheels - CONFIRMED DOWN. (PAC/SP/FM)
8. NR switch/OEI - AS REQUIRED. (SP)
   a. Hovering ≥ 10 ft. - NR HI.
   b. OEI stop selection - AS REQUIRED.
9. Floats - AS REQUIRED. (SP)
10. Talon - AS REQUIRED. (SP)
11. Center instrument panel - "CHECKED." (SP)
12. Sliding door - AS REQUIRED. (SP or FM)
    a. Sliding door - OPEN for shipboard and water ops. - AS DESIRED for other operations. Prior to opening the sliding door in flight:
       (1) Speed - Within limits.
       (2) Rescue hatch - SECURE.
       (3) Jettison handle - SECURE.

**NOTE**

When below 200 ft AWL and below 40 KIAS, the sliding door must be open over water.

    b. Seat(s) facing forward.

**Prior to 200 ft RADALT:**

The following checks shall be accomplished and verbalized over the ICS prior to 200 ft during all transitions to hover or land.

1. Wheels - CONFIRMED DOWN. (PAC/SP/FM)
2. Nr switch/OEI - AS REQUIRED. (SP)
   a. Hovering ≥ 10 ft. - NR HI.
   b. OEI stop selection - AS REQUIRED.
3. Floats - AS REQUIRED. (SP)
4. Sliding door - AS REQUIRED. (SP/FM)

**Prior to touchdown:**

5. Wheels - CONFIRMED DOWN. (PAC or SP)

## NORMAL APPROACH

This maneuver is used to transition to landing or hover over land or water, day or night, aided or unaided. Latitude in selecting the exact approach angle and closure rate has purposely been left to the judgment of the pilot depending on specific operational requirements. High rates of descent and/or fast closure rates should be avoided. The approach is normally entered on downwind at 500 feet AGL or higher; however, it may be successfully executed from any position prior to the TRANSITION POINT. This is a visual maneuver and cockpit instruments should be used as secondary aids. The pilot should plan his course of action in the event

of engine failure prior to commencing the approach. Depending on the airspeed at the time of engine failure, it may be possible to abort the approach (continue flight) or be committed to a landing. The approach angle used should always allow touchdown at the originally intended point, even after engine failure. In conditions where maximum performance will be required in the event of engine failure, the NR switch should be placed in the HI position prior to arriving at the transition point. Similarly, if the approach is over water and could possibly result in water landing, arm the floatation system.

1. Pattern:
   a. Designated pattern altitude.
   b. Airspeed - 80-100 KIAS; maintained as prebriefed.
2. Prior to the abeam position -
   a. Landing/Hover Checklist - COMPLETE.
3. Approximately 1500 feet downwind of the abeam position -
   a. Commence decelerating, descending turn to final.
4. Altitude should be approximately 500 to 700 feet AGL passing the 90° position.
5. Continue to arrive aligned on final PRIOR to the TRANSITION POINT. Crab as required for drift correction.

   TRANSITION POINT:

   - 200 feet AGL

   - 50-70 KIAS

   - Approximately 1500 feet straightaway
6. At TRANSITION POINT:
   a. Adjust collective and cyclic to decelerate and maintain the desired angle of approach.
   b. Sideslip (rudder) required to maintain desired alignment.
7. Coordinate collective and cyclic to decrease airspeed, control closure rate, maintain approach angle to arrive at/over the intended point of landing or hover.

## ELEVATED HELIPAD/PINNACLE APPROACH

This maneuver is used to transition to a landing over an elevated helipad/pinnacle or whenever necessary to clear obstructions. Initially, the maneuver is flown in the same manner as a normal approach until arriving on final to establish the transition point. High rates of descent and/or fast closure rates should be avoided. This is a visual maneuver and cockpit instruments should be used as secondary aids. The pilot should plan a course of action in the event of an engine failure prior to commencing the approach. Depending on the airspeed at the time of an engine failure, it may be possible to abort the approach (continue flight) or be committed to the landing. The approach angle should always allow touchdown at the originally intended spot, even after an engine failure. The NR switch should be placed in the HI position prior to arriving at the transition point. Similarly, if the approach is to a pad over water and could possibly result in water landing, arm the floatation system.

1. Pattern:
   a. Designated pattern altitude.
   b. Airspeed - 80-100 KIAS; maintained as prebriefed.
2. Prior to the abeam position:
   a. Landing/Hover Checklist - COMPLETE.
3. Approximately 1200 feet downwind of the abeam position -
   a. Commence decelerating, descending turn to final.
4. Altitude passing the 90 degree position should be the height of the landing spot plus 500 to 700 feet.

5. Continue to arrive on final PRIOR to the TRANSITION POINT. Crab as required for drift correction.

   TRANSITION POINT:

   - 200 feet above the height of the landing spot

   - 50 - 60 KIAS

   - Approximately 1200 feet straightaway

6. At TRANSITION POINT:

   a. Adjust collective and cyclic to decelerate and maintain the desired angle of approach.

   b. Sideslip (rudder) as required to maintain desired alignment.

7. Coordinate collective and cyclic to decrease airspeed, control closure rate and maintain approach angle to arrive at/over the intended point of landing or hover.

# LANDING

## VERTICAL LANDING

The helicopter normally hovers 3° right wing down and 4° nose up; therefore, the right landing gear will normally contact the surface first. If an unusual vibration or unbalanced condition during touchdown is experienced, execute an immediate takeoff to a hover.

**CAUTION**

Due to tail rotor control limitations, landing in crosswind components exceeding 35 knots is prohibited.

## NO HOVER LANDING

This is the most practical technique of landing on smooth surfaces, particularly when a FOD environment is present or the power available is not sufficiently higher than the power required to hover. A safe landing, using between 5 and 10% less power than that required to hover, can be accomplished. Minimum snow, sand, and other debris will be circulated. The same transition-to-hover procedures are used except that the approach terminates on the surface, with 0 to 5 knot ground speed, depending on the surface. The vertical descent rate should be the minimum necessary and still prevent snow, sand, or other debris from building in the rotor downwash prior to touchdown. Landing attitudes of less than 4° nose up will normally result in acceleration.

**NOTE**

At a 7° nose up attitude, the tail skid and main landing gear (fully compressed struts) will contact simultaneously.

**CAUTION**

Excessive aft cyclic movement on touchdown or after landing can cause rotor head to cowling contact and/or main rotor blade contact with the vertical stabilizer.

## RUNNING LANDING

At the TRANSITION POINT, establish and maintain the desired approach angle and rate of descent and dissipate speed as required throughout the approach so as to touch down at 60 knots groundspeed (GS) maximum. Assume a landing attitude that allows the main landing gear to touch down prior to the nosewheel. Running landings should only be attempted on a smooth, firm surface with all drift eliminated. Translational lift should be maintained throughout the maneuver.

# AFTER LANDING CHECKLIST

After landing checks may be completed, then verified via the checklist once clear of the landing area.

1. AFCS - "DISENGAGED." (PAC)
2. Radar - "STANDBY." (SP)
3. IFF - "STANDBY." (SP)
4. Floats - "OFF." (SP)
5. NR switch - "NORMAL." (SP)

## SECURE CHECKLIST

1. Collective - "LOCKED." (PAC)
2. Parking brake - "SET." (PAC)
3. Radar - "OFF." (PAC)
4. Chocks - "INSTALLED." (FM)
5. Landing lights - AS REQUIRED. (PAC/SP)
6. COMM 1 - "SET." (PAC)
7. IFF/COMM control panel M4/VP-HOLD/ZERO - AS REQUIRED. (PAC)
8. KY-58-Z ALL - AS REQUIRED. (FM)
9. Maintenance checks - "CHECKED." (PAC or FM)
   a. Any ARSC requirements or locally directed maintenance actions such as recording zone times or stat data.
10. Overhead panel - "CHECKED." (PAC)
    **a. Horn- OFF.
    **b. Pitot heat L/R - OFF.
    **c. W/S anti-ice L/R - OFF.
    **d. Position lights - OFF.
    **e. Cabin lights - OFF.
    **f. Heat/Cool switches - OFF.
11. Electrical panel - "CHECKED." (PAC)
    **a. Pilot and copilot avionics switches - OFF.
    **b. Shed bus switch - AUTO.
    **c. EMER T/R switch - OFF.

After 30 seconds flat pitch (the taxi duration can be subtracted from the 30 seconds):

12. ENG 1 and ENG 2 - "OFF." (PAC)
    a. ENG 1 FCS - Idle.
    b. ENG 2 FCS - Idle.
    c. ENG 1 FCS - Off.
    d. ENG 2 FCS - Off.

**CAUTION**

If the engine does not stop immediately (solenoid valve failure), the FADEC will shut down the engine 5 to 6 seconds later. Do not move the Fuel Shutoff Lever to the shutoff position before 10 seconds have elapsed.

**NOTE**

Movement of the tail rotor pedals to slow the main rotor is prohibited due to the stress placed on the tail rotor spar and tension straps.

13. Boost pumps - "OFF." (PAC)
14. Rotor brake - AS REQUIRED. (PAC) (NR below 170 rpm)

**CAUTION**

Rotor brake application is prohibited prior to engine shutdown.

15. Lighting - "OFF." (PAC)
16. Anti-collision light - "OFF." (PAC)
17. VEMD FLIGHT REPORT - "CHECKED." (PAC or SP)
    a. Record the following Flight Report information.
       (1) Flight Number
       (2) Duration
       (3) Cycle N1
       (4) Total

(5) Cycle N2

(6) Total

(7) Failures

(8) OEI LO

(9) OEI HI

(10) Usage

b. If the GOV light on the WCA panel is flashing, record the failures on the VEMD system status page.

(1) Scroll to the system status page.

(2) Select the failure line.

(3) Scroll through the failures.

18. Battery relay switches - "OFF." (PAC)

19. FADEC safety guards - "AS REQUIRED." (PAC or SP)

## ABBREVIATED CHECKS

When remaining in the touch and go pattern, the following abbreviated checks may be used at the discretion of the pilot in command (PIC).

Abbreviated checks may be performed from memory and should be performed by the SP when dual pilot. Checks shall be verbalized on ICS. A complete Landing/Hover checklist shall be completed if the aircraft configuration is changed while in the touch and go pattern or if the aircraft departs the pattern for any reason.

### TAKEOFF

1. NR switch - AS REQUIRED. (SP)

2. Center instrument panel - "CHECKED." (SP)

### LANDING

1. Wheels - CHECKED DOWN. (PAC or SP)

2. NR Switch/OEI - AS REQUIRED. (PAC/SP)

3. Center instrument panel - "CHECKED." (SP)

**Prior to 200 feet AGL -**

1. WHEELS RECHECKED DOWN. (PAC or SP)

2. NR Switch/OEI - AS REQUIRED (PAC/SP)

**Prior to Touchdown -**

1. WHEELS CONFIRMED DOWN. (PAC or SP)

### LEVEL OFF

Abbreviated level off checks may be used at the discretion of the PIC when conducting multiple practice approaches to the water, (CATCH/MATCH/NATCH/IAS-VS Letdown), in the same location or multiple IFR approaches in the same general area. The check may be performed from memory and falls under the same guidelines as the abbreviated checks in the pattern. A complete Level Off checklist shall be completed if the aircraft configuration is changed or if the aircraft departs the vicinity where the approaches are being conducted.

**Upon level off:**

1. RADALT bug - AS DESIRED. (PAC/SP)

2. Center instrument panel - "CHECKED." (SP)

## ENGINE WASH PROCEDURES

Engines will normally be washed daily after the last flight of the day. Additionally, engines should be washed as soon as practical after low level salt water operations or flights in dirty/dusty environments. The following procedures apply.

**CAUTION**

Use only distilled, demineralized, or filtered water.

**CAUTION**

Allow engines to stabilize for at least 5 minutes prior to engine wash (the taxi duration may be subtracted from the 5 minutes).

1. Place 6 liters (1.6 gallons) of distilled, demineralized, or filtered water into the spraying equipment and tank assembly. (FM)
2. Heat switch - OFF. (PAC)
3. FCS ENG 1 - IDLE. (PAC)
4. Connect the spraying device hose to the #1 engine wash fitting. (FM)
5. When TOT and N1 parameters for the idled engine are stable, open the cock of the spraying device to empty water into the aircraft washing system at a flow rate of 2-3 liters/minute (0.5-0.8 gallons/minute) - "RINSE STARTED." (FM)
6. Start clock and monitor N1 of idled engine to ensure decrease does not exceed 10%. (PAC)
7. After 30 seconds - "RINSE COMPLETE." (PAC)
8. Disconnect the spraying device hose from the #1 engine wash fitting. (FM)
9. FCS ENG 1 - FLIGHT. (PAC)
10. FCS ENG 2 - IDLE. (PAC)
11. Connect the spraying device hose to the #2 engine wash fitting. (FM)
12. When TOT and N1 parameters for the idled engine are stable, open the cock of the spraying device to empty water into the aircraft washing system at a flow rate of 2-3 liters/minute (0.5-0.8 gallons/minute) - "RINSE STARTED." (FM)
13. Start clock and monitor N1 of idled engine to ensure decrease does not exceed 10%. (PAC)
14. After 30 seconds - "RINSE COMPLETE." (PAC)
15. Disconnect the spraying device hose from the #2 engine wash fitting. (FM)
16. FCS ENG 2 - FLIGHT. (PAC)

**CAUTION**

During the engine wash, the maximum N1 decrease of the idled engine is 10%.

**CAUTION**

An engine must run for a minimum of 30 seconds following an engine wash.

## INSTRUMENT FLIGHT PROCEDURES

The aircraft is equipped with an integrated avionics system which provides the flight crew with extensive instrument flight capabilities. The CDU can be programmed with the instrument flight plan and the aircraft automatically flown along the route in the various modes of flight director operation from takeoff through climb, cruise, letdown, and approach to a hover.

The capability of performing area navigation (RNAV) enables the aircraft to fly an instrument flight plan without the need to over fly specific navigation aids. Parallel offset routes can be added to the flight plan to avoid adverse weather or to fly around congested or hazardous areas. The flight plan can also be readily changed inflight. Holding patterns can be established at waypoints along the route. The progress of the aircraft along the route is continuously monitored to provide the crew with pertinent information relative to the next waypoint and the destination waypoint. The search/weather radar enhances instrument flight by providing some navigation capabilities, particularly around weather, and early detection of severe weather. In the event these automatic features should fail, the aircraft can be flown manually to perform most mission requirements. Both pilot positions are equipped with a complete set of flight instruments and

controls for operating the communications, navigation, and flight director systems so that either pilot can safely fly the aircraft under instrument conditions. The instrument flight speed range is 45-145 KIAS. Speeds below 45 KIAS should only be used during transition to hover.

**CAUTION**

When coupled to the AFCS, the flight director will command flight control movements without regard to aircraft limitations or operating altitude. Such control movements can result in exceedance of airframe or engine limitations.

## PREFLIGHT PLANNING

Complete and accurate preflight planning is essential if the instrument flight capabilities of the aircraft are to be fully utilized. Ensure the Site Data Base (SDB) used covers the geographic area of intended mission operation.

Additional pilot responsibilities associated with flight planning include minimum enroute altitude determination and clearance through restricted airspace.

Flight planning must also include performance calculations, particularly in case of engine failure.

## INSTRUMENT TAKEOFF (ITO)

In addition to those conditions which normally require an instrument takeoff (precipitation, low ceiling, poor visibility, or lack of reference), helicopter induced restrictions to visibility due to blowing dust, snow, or water caused by rotor downwash may also require an instrument takeoff. There are two recommended procedures: the coupled and the manual.

## COUPLED INSTRUMENT TAKEOFF

With the AFCS engaged and coupled to the flight director, establish a hover and check for normal indications. Smoothly increase collective to establish a climb, while setting a wings level, nose on the horizon, accelerating attitude. This attitude will provide the airspeed necessary to preclude a descending, nose low takeoff profile. Activate Go-Around (GA) at no less than 25 feet, ensuring cyclic is in a trimmed condition and avoiding fly-through. The helicopter will level and accelerate to 40 KIAS. At 40 KIAS it will establish a 700 fpm climb and accelerate to 70 KIAS. Once established in this climb, select non-collective modes of the flight director such as indicated airspeed (IAS) and HDG SEL or NAV. With the GA mode selected, the collective synchronize (C-SYNC) function is the same as during IAS-VS operations.

**WARNING**

If the collective synchronize (C-SYNC) pushbutton is depressed after the GA mode is selected, the rate of climb current at that moment will be maintained. This may be zero fpm if C-SYNC is depressed prior to the flight director induced collective pull at 40 KIAS.

## MANUAL INSTRUMENT TAKEOFF

A manually executed ITO may be accomplished whenever the PIC desires. From a hover, check for normal indications. Disengage all FDS modes and smoothly increase collective to establish a climb, while setting a wings level and nose on the horizon attitude. Monitor RADALT and vertical speed for positive climb indications. After a climbing acceleration to 40 KIAS, lower the nose five degrees and continue accelerating until achieving a 70 to 80 KIAS climb profile. Once established, continue with a normal climb and engage non-collective FDS modes as desired.

## INSTRUMENT APPROACH OPERATIONS

Standard instrument approaches may be performed manually or with the aid of the flight director. ILS, LOC, FMS, VOR, and TACAN approaches may be performed coupled, with the FDS providing commands to the AFCS for automatic signal following. The navigation source selected will determine the navigation display in each MFD. In addition, the navigation source of the side with NAV CONTROL will be used by the flight director to provide steering commands. Prior to commencing any instrument approach, the pilot will brief the crew.

## INSTRUMENT APPROACH BRIEF

The following items shall, as a minimum, be covered as they apply:

1. Approach (ex. *ILS RWY 14 to Mobile Regional*).
2. Communications/Navaids/Courses (outbound, inbound, etc.).

3. IAF/Turn Point/FAF.

4. Altitudes.

5. Airspeed(s)/Groundspeed and Timing.

6. Intentions at DH/MAP.

Briefing "standard brief" at decision height or missed approach point is appropriate with the concurrence of both pilots if the following are acceptable for the current approach being flown:

**Standard calls: a. I am visual, I have the controls.**

Indicates the safety pilot requests the controls and is visual with the runway environment (FAR 91.175) and the aircraft will continuously be in a position from which a descent to a landing on the intended runway or landing zone can be made at a normal rate of descent, using normal maneuvers.

**b. Not visual, execute missed approach.**

Indicates the pilot cannot comply with the requirements of FAR 91.175 above and desires the flying pilot to execute the missed approach procedure.

**c. Descend to (TDZE + 100 ft)(if appropriate for approach).**

Indicates the pilot is visual with the approach lighting system (as defined by FAR 91.175) and requests the flying pilot to descend to an altitude no lower than 100 ft above the touchdown zone elevation (TDZE). The safety pilot does not take the controls until the requirements for the call of "I am visual, I have the controls" (see para a. above) are met. (TDZE + 100 ft) above shall be replaced with the actual altitude to which the pilot should descend.

7. Nav Control/Flight Director Use.

8. RADALT Bug Use.

9. NVG Usage.

10. Crew Duties.

    a. Pilot controlled lighting.

    b. RWY orientation at MAP.

11. Complete Landing/Hover Checklist.

# INSTRUMENT LANDING SYSTEM (ILS) APPROACH PROCEDURE

An ILS approach may be flown by following conventional course deviation indicator (CDI) displays, by following FD command bars, or may be fully coupled using APPR mode. During coupled operation, the pilot must intervene to execute a missed approach if sufficient visual cues are not available at Decision Height. If uninterrupted, the APPR mode will provide commands to fly the approach to 100 ft AGL, at which time T-HOV will capture and command the helicopter to a nearly stationary 50–foot hover over the ILS runway.

## ILS CATEGORY I PROCEDURE

CAT I approaches normally have a decision height of 200 feet AGL.

1. CDU
    a. NAV Page: LOC - TUNED
       TAC - AS REQUIRED
       ADF - AS REQUIRED
    b. FPLN Page - AS DESIRED
    c. COM Page - AS DESIRED
2. MFD CONTROL PANEL
    a. NAV source - ILS
    b. MFD display - HSI
    c. MFD course - SET
    d. BRG1/BRG2 - AS REQUIRED
3. AUDIO CONTROL PANEL
    a. Marker Beacon - MONITOR
4. BDI -AS DESIRED
5. INSTRUMENT APPROACH BRIEF - COMPLETE

# GROUND CONTROLLED APPROACH (GCA) PROCEDURE

Ground controlled approaches may be PAR (precision approach radar) or non-precision ASR (airport surveillance ra-

dar). PARs may have decision heights as low as 100 ft AGL. Although no coupled approach capability exists, the FDS may be used to maintain stable horizontal and vertical profiles. If published procedures are issued for lost comms, setup prior to commencing the approach.

1. CDU
   a. NAV Page: VOR - AS DESIRED
      TAC - AS DESIRED
      ADF - AS DESIRED
   b. FPLN Page - AS DESIRED
   c. COM Page - AS DESIRED
2. MFD CONTROL PANEL
   a. NAV source - AS DESIRED
   b. MFD display - AS DESIRED
   c. MFD course - AS DESIRED
   d. BRG1/BRG2 - AS DESIRED
3. BDI - AS DESIRED
4. INSTRUMENT APPROACH BRIEF - COMPLETE

## LOC, VOR, OR TACAN APPROACH PROCEDURE

These non-precision approaches may be flown by following conventional CDI displays, either manually or using FDS modes such as HDG SEL and pitch modes; by manually following FD command bars; or they may be coupled in azimuth using the APPR or NAV modes of the FDS. Refer to the FMS Approach Procedure for guidance to execute a fully coupled non-precision approach.

1. CDU
   a. NAV Page: VOR - AS REQUIRED
      TAC - AS REQUIRED
      ADF - AS REQUIRED
   b. FPLN Page - AS DESIRED
   c. COM Page - AS DESIRED
2. MFD CONTROL PANEL
   a. NAV source - VOR/ILS/BC or TCN
   b. MFD display - AS REQUIRED
   c. MFD course - SET
   d. BRG1/BRG2 - AS REQUIRED
   e. INAV Page - CONFIRM GPS MODE IN AUTO

**CAUTION**

To execute the FMS approach, you must have an operable altitude controller and the INAV Page GPS Mode must be set to "AUTO."

3. BDI - AS DESIRED
4. INSTRUMENT APPROACH BRIEF - COMPLETE

**WARNING**

Illumination of the DR (dead reckoning) light in the Avionics Mode Annunciator panel during the approach will indicate that NAV or APPR steering commands have ceased. Outside the NAVAID cone of confusion, disengaging and reengaging NAV or APPR may restore FDS steering.

## LOCALIZER BACK-COURSE APPROACH PROCEDURE

Automatic FDS APPR mode intercepts to the localizer back course are restricted to an intercept angle of less than 75 degrees.

1. C D U
   a. NAV Page LOC - TUNED
      TAC - AS REQUIRED

ADF - AS REQUIRED

b. FPLN Page - AS DESIRED

c. COM Page - AS DESIRED

2. MFD CONTROL PANEL

a. NAV source - VOR/ILS/BC

b. MFD display - HSI

c. MFD course - SET FRONT COURSE

d. BRG1/BRG2 - AS REQUIRED

3. BDI - AS DESIRED

4. INSTRUMENT APPROACH BRIEF - COMPLETE

## RNAV APPROACH PROCEDURE

RNAV approach procedures are not normally found in DOD FLIP approach publications. All waypoints enclosed in a rectangle must be programmed into the RNAV flight plan. The NAVAID from which the approach is derived should be tuned (manual) in the CDU NAV Page. An RNAV approach is a non-precision approach. If executed coupled, the vertical profile must still be controlled by the pilot, either manually or by using appropriate FDS modes.

1. CDU

a. NAV Page: VOR - AS REQUIRED

TAC - AS REQUIRED

ADF - AS REQUIRED

b. FPLN Page - ENTER WAYPOINTS

c. COM Page - AS DESIRED

d. PAT Page - HOLDING IF REQ

2. MFD CONTROL PANEL

a. NAV source - FMS

b. MFD display - AS DESIRED

c. MFD course - AS DESIRED

d. BRG1/BRG2 - AS DESIRED

3. BDI - AS DESIRED

4. INSTRUMENT APPROACH BRIEF - COMPLETE

## NON DIRECTIONAL BEACON (NDB) APPROACH PROCEDURE

With the exception of the MFD Hover and Video Pages, NDB navigation information is displayed on all pages of the MFD through use of either the BRG1 or BRG2 pointer. NDB information is also displayed on the BDI (double-bar pointer). The FDS may be used to maintain stable lateral and vertical profiles.

1. CDU

a. NAV Page: VOR - AS DESIRED

TAC - AS DESIRED

NDB - TUNED

b. FPLN Page - AS DESIRED

c. COM Page - AS DESIRED

2. MFD CONTROL PANEL

a. NAV source - AS DESIRED

b. MFD display - AS DESIRED

c. MFD course - AS DESIRED

d. BRG1/BRG2 - ADF (only one pointer required)

3. BDI - AS DESIRED

4. INSTRUMENT APPROACH BRIEF - COMPLETE

## FMS APPROACH

The APPROACH feature of the CDU provides a means to define a non-precision instrument approach with lateral and

vertical guidance capability. Non-precision approaches defined using the APPROACH feature may be flown by following conventional CDI displays, by following the FD command bars, or may be fully coupled using the APPR mode. When fully coupled in the APPR mode, the aircraft must be within 25 feet of the FAF altitude as displayed on the CDU, otherwise VERT may not capture. Additionally, the maximum angle of intercept for the final approach course should be limited to 45 degrees.

**CAUTION**

Due to the accuracy of the Alt Controller being +/- 22 feet, slight descents below MDA may occur, especially on fast, steep approaches, or in turbulence. IAW AIM requirements, if the aircraft descends or appears to be descending more than 50 feet below the MDA, the PAC shall override the Flight Director to maintain MDA.

The FMS APPROACH is designed as a supplemental navigation system for non-precision approaches. Therefore, the appropriate NAVAID from which the non-precision approach is derived shall be tuned on the NAV Page and monitored throughout the approach. Use of the FMS APPROACH is not authorized if the NAVAID is out of service. The FMS APPROACH is not authorized for ILS/Localizer approaches.

**NOTE**

A NO RAIM or RAIM WARN annunciation will appear on the CDU when RAIM or GPS is unavailable, or the GPS position integrity is degraded. When this occurs, the lateral course guidance provided by the FMS may become unreliable. The primary NAVAID for the approach shall be referenced for course guidance.

1. CDU
   a. APPROACH Page - ENTER APPROACH PARAMETERS
   b. NAV Page: VOR - AS REQUIRED
      TAC - AS REQUIRED
      ADF - AS REQUIRED
   c. FPLN Page - AS DESIRED
   d. COM Page - AS DESIRED
2. MFD CONTROL PANEL
   a. NAV source - FMS
   b. MFD display - HSI
   c. MFD course - SET
   d. BRG1/BRG2 - AS REQUIRED
3. BDI – AS DESIRED
4. INSTRUMENT APPROACH BRIEF - COMPLETE

## INSTRUMENT APPROACHES TO THE WATER

For instrument letdowns over water to a specific point (with no published procedures), three types of procedures are available. THESE PROCEDURES DO NOT PROVIDE OBSTACLE CLEARANCE. The CATCH (Computer Approach to a Coupled Hover) is designed for fully coupled operation, the MATCH (Manual Approach to a Controlled Hover) is designed for manual operation, at least in the final phase and the IAS-VS LETDOWN to T-HOV capture which uses the FDS IAS-VS mode and delayed T-HOV function.

**CAUTION**

Chart A6 computes a weight, for current environmental conditions, that ensures a 10% power reserve prior to reaching Maximum Continuous Power. When the current aircraft weight exceeds the A6 weight, maneuvers become very demanding and may result in the exceedance of aircraft limitations.

# LETDOWN CHECKLIST

**NOTE**

Operational necessity may require the completion of the Letdown Checklist (rescue checklist part 1, brief, etc.) early. PIC shall verify the procedure is completed by conducting a full checklist using "completed" as the response for those steps which were finished early.

1. Performance calculations - CHECKED.

*2. Rescue checklist part 1 - AS REQUIRED.

*3. Instrument comparison check:

   a. Airspeed indicators - COMPARED.

   b. Attitude indicators - COMPARED.

   c. RADALTs/BARALTs - MATCHED.

   d. IVSIs - COMPARED.

4. NAV control - SELECT APPROPRIATE SIDE.

*5. Landing/Hover Checklist :

   a. Landing gear handle - "DOWN." (PAC or SP)

   b. Crew and passengers - "READY." (FM)

   c. TCAS - AS REQUIRED. (SP)

   d. Radar - AS REQUIRED. (SP)

   e. Parking brake - AS REQUIRED. (SP)

   f. Nose gear - AS REQUIRED. (SP)

   g. Wheels - CONFIRMED DOWN. (PAC/SP/FM)

   h. NR switch/OEI - AS REQUIRED. (PAC/SP)

   i. Floats - AS REQUIRED. (SP)

   j. Talon - AS REQUIRED. (SP)

   k. Center instrument panel - "CHECKED." (SP)

   l. Sliding door - AS REQUIRED. (SP or FM)

6. Exterior lights - AS REQUIRED.

7. LETDOWN brief - CONDUCT.

   a. Altitude.

   b. Course(s).

   c. Airspeed/CMD airspeed at 100 ft AWL.

   d. Determination of gate (radar/CDU/timing).

   e. Radar.

   f. Target hover altitude/intentions at 50 ft AWL.

   g. Obstacles.

   h. Missed approach/ITO/waveoff.

   i. NVGs.

   j. Emergencies.

   k. RADALT bug.

Prior to 200 ft RADALT (by memory):

1. Wheels - CONFIRM DOWN. (PAC/SP/FM)
2. NR switch/OEI -AS REQUIRED. (PAC/SP)
3. Floats - AS REQUIRED. (SP)
4. Sliding doors - OPEN. (SP/FM)

Prior to Touchdown:

1. Wheels - CONFIRM DOWN. (PAC or SP)

**CAUTION**

During night operations, it may take up to 15 minutes for eyes to adjust from NVG aided to unaided.

# CATCH

**CAUTION**

A Computer Approach To a Coupled Hover can be executed by using FMS as the navigation

source with the APPR mode coupled. Indications in the cockpit are identical to those displayed during a coupled ILS, except that the attitude director indicator (ADI) will not display glide slope or localizer information. The automatic approach procedure allows the helicopter to execute a precision approach to any waypoint, utilizing the FMS capability. The ability of the FMS to accurately return to a specific waypoint is directly related to the GPS INDEX displayed in the CDU STATUS Page. The GPS index should be very low (50 ft-0.6 nm) to ensure accuracy in waypoint definition.

**WARNING**

This procedure does not provide obstruction clearance. Use of the radar is recommended to assist in obstacle avoidance.

**WARNING**

Radar altimeter fluctuations may induce large collective movements via the flight director and/or automatic flight control systems when using the T-HOV and HOV AUG operating modes. With these modes engaged, flight crews must be vigilant in monitoring collective movement as a primary means of quickly detecting and overcoming abnormal flight director and/or AFCS control inputs. Physical "hands-on" guarding of the collective is imperative.

The pilot is only required to enter a Hover At point into the CDU for the approach pattern to be generated. The Hover At point may be entered on the Hover At Page and inserted into the flight plan, or by attaching a hover to a waypoint in the flight plan. The CDU will generate the pattern to place the helicopter approximately 800 feet short of the Hover At point. The CDU interprets the crew entered course (or system calculated wind), crew entered winds, and selected glide slope on the Hover At Page to generate the automatic approach-to-hover profile. The procedure should be flown at 70 KTAS or less.

**WARNING**

If the airspeed is greater than 70 KTAS or the surface wind is significantly different than the computer captured wind at T-HOV capture, the helicopter may overshoot datum.

## CATCH PROCEDURE

1. AT DATUM - Enter MARK or VERIFY WAYPOINT.
2. CDU HOV Page
   - Enter position as required
   - CHECK/EDIT wind
   - CHECK/EDIT course
   - Select CMD airspeed
   - Select glide slope
   - Insert/Attach Hover into flight plan

**NOTE**

A CATCH requires an operating CDU, OADS, SCC1, RADALT and FDS coupled to the AFCS.

3. NAV source – FMS.
4. FDS - APPR Mode armed.
5. CDU - DIRECT TO TURN waypoint.
6. MFD
   - Monitor the approach
   - CMAP for orientation
   - MAP/RMAP during pattern
   - HSI (PAC monitor on final)
7. PAC – Speed – Adjust to 50-70 KIAS.
8. SP – Report "VERT captured."
9. PAC – AT VERT capture – MONITOR THE DESCENT.
10. SP – MONITOR DESCENT – call out every 100 ft.
11. SP – AT/PRIOR TO 200 ft – SELECT HOT MIKE.
12. SP – Report "T-HOV captured."
13. PAC – AT T-HOV capture – MONITOR DECELERATION AND HOVER. CMD AIRSPEED – ADJUST AS NECESSARY.

**NOTE**

If desired final hover altitude is greater than 50 ft due to high sea state or obstacle avoidance, depress C-SYNC at the desired altitude after T-HOV capture.

14. PAC continue monitoring the instruments until the SP reports one of the three following calls:

    **"I am visual, I have the controls."** This call is made when the SP (either NVG aided or unaided) has acquired sufficient visual cues to maintain a hover and takes the flight controls.

    **"I am visual, target in (not in) sight, continue."** This call is made when the SP (either NVG aided or unaided) has acquired visual contact with the surface, has the target in sight or is satisfied with the stability of the aircraft, and desires to provide conning commands to the PAC to move the aircraft closer to the target to improve hover references. Conning commands by the SP should be based upon desired heading and airspeed. When the SP is satisfied with the aircraft position in relation to the target, the SP takes the flight controls.

    **"Not visual, ITO."** This call is made when the SP determines (either NVG aided or unaided) that sufficient visual cues do not exist to report "I am visual, I have the controls," or "I am visual, target in sight, continue." The PAC immediately executes a coupled or manual ITO.

**CAUTION**

Due to degradation of depth perception below 50 ft while wearing NVGs, the SP must continue to scan instruments, particularly RADALT, to prevent inadvertent descent and water contact.

15. If unable to establish a visual hover reference at 50 ft RADALT, and PAC pre-briefs desire to descend to 30 ft RADALT:

    SP - Reports "**Not visual, descend to 30 ft.**"

    PAC - Begin a gradual descent to 30 ft RADALT.

**NOTE**

The C-SYNC BUTTON must be depressed to enable the hover beep switch when T-HOV captures from an armed state.

**WARNING**

It is possible to descend to the surface using the FDS collective hover beep switch.

SP - Reports **"I am visual, I have the controls," "I am visual, target in sight, continue,"** or **"Not visual, ITO."**

# MATCH

The Manual Approach To a Controlled Hover provides positive control of the airspeed and altitude as the helicopter decelerates to a hover. The pattern depicted in Figure 2-1 is recommended. If the GATE can be identified by using the CDU or RADAR, the pattern may be modified as required. Operable Flight Director modes may be used throughout the pattern to the GATE.

## MATCH PROCEDURE

1. CDU – MARK datum AS APPROPRIATE and display WPT DATA.

2. RADALT bug - SP SET 250 FT.
   PAC AS DESIRED, NO LOWER THAN 30 FT.

3. Over DATUM:

   PAC - Cross DATUM from the upwind side at 300 feet RADALT and 70 KIAS.

   SP - START TIMING; CONFIRM MARK.

4. PAC - TURN RIGHT or LEFT 20° from downwind heading.

5. At 1-minute 45 seconds after DATUM:

   PAC - Commence a standard rate turn to the windline, opposite the direction of entry turn.

   SP - Reset the clock.

6. After rollout on heading:

   SP - Start timing; set RADALT BUG to 125 ft.

   PAC – Descend to 150 feet RADALT.

**WARNING**

Do not exceed 400 FPM rate of descent at any time.

7. SP – AT/PRIOR TO 200 ft – SELECT HOT MIKE.

8. SP - Monitor descent and advise the pilot when approaching 150 feet radar altitude.

The GATE is established at a range of 1.0 nm from DATUM if the CDU or RADAR is used.

If determined by time alone, the GATE is arrived at 60 seconds after rollout on the windline in no-wind conditions. An additional 20 seconds is added for each 5 knots of wind. When the gate is determined solely by timing, stabilized hover in excess of 1 nm short of DATUM can be expected in winds above 30 knots.

9. Prior to the GATE:

   SP – Select HOVER display for PAC, if requested; set RADALT BUG as DESIRED, no lower than 30 ft.

10. At the GATE:

    PAC - Torque - Decrease 10-15% to initiate a descent.

    Attitude - Decelerating, wings level.

    Attitude - Wind up to 10 knots; +4-5°.
    Wind over 10 knots; +2-3°.

11. During deceleration:

    PAC - CHECK altitude vs. speed. Recommended airspeed equals approximately one half altitude, i.e.:

    140 ft / 70 KIAS

    100 ft / 50 KIAS

    80 ft / 40 KIAS

    SP – Monitor the descent, assist PAC with ALT/AIRSPEED CROSS CHECKS, and advise PAC when approaching 70 ft RADALT.

The MFD HOVER display provides wind and slow speed (below 40 kts) information if the OADS and CDU are operating.

12. At 70 feet:

    PAC - Slowly increase collective, predicated on the rate of radar altimeter needle movement, to control the descent and establish a 50–foot hover. Some forward groundspeed should be maintained to preclude backing down. In no wind conditions, the helicopter hovers 3° right wing down and 4° nose up. If operable, T-HOV may be used to assist in maintaining altitude. With OADS inoperative, only altitude hold is operable in T-HOV.

**NOTE**

If OADS airspeed information is unavailable, the maneuver becomes very demanding due to the possibility of backing down. Consideration should be given to maintaining at least 25 KIAS (IAS indicator is unreliable below 25 KIAS).

13. At 50 feet RADALT: The PAC will continue monitoring the instruments until the SP reports one of the three following calls:

    **"I am visual, I have the controls."** This call is made when the SP (either NVG aided or unaided) has acquired sufficient visual cues to maintain a hover (Section II of the HH-65C flight manual), and takes the flight controls.

    **"I am visual, target in (not in) sight, continue."** This call is made when the SP (either NVG aided or unaided) has acquired visual contact with the surface, has the target in sight or is satisfied with the stability of the aircraft, and desires to provide conning commands to the PAC to move the aircraft closer to the target to improve hover references. Conning commands by the SP should be based upon desired heading and airspeed. When the SP is satisfied with the aircraft position in relation to the target, the SP takes the flight controls.

    **"Not visual, ITO."** This call is made when the SP determines (either NVG aided or unaided) that

sufficient visual cues do not exist to report "I am visual, I have the controls," or "I am visual, target in sight, continue." The PAC immediately executes a coupled or manual ITO.

**CAUTION**

Due to degradation of depth perception below 50 ft while wearing NVGs, the SP must continue to scan instruments, particularly RADALT, to prevent inadvertent descent and water contact.

14. If unable to establish a visual hover reference at 50 ft RADALT, and PAC pre-briefs desire to descend to 30 ft RADALT:

    SP - Reports "**Not visual, descend to 30 ft.**"

    PAC - Begin a gradual descent to 30 ft RADALT.

**WARNING**

It is possible to descend to the surface using the FDS collective hover beep switch.

SP – Reports "**I am visual, I have the controls**," "**I am visual, target in (not in) sight, continue**," or "**Not visual, ITO**."

## IAS-VS LETDOWN TO T-HOV CAPTURE

The IAS-VS letdown to T-HOV capture provides the pilot with flight director assistance for a letdown to the water. The radar, a "MARK" position, or a DME will assist the pilot in determining an approximate point to initiate the letdown.

**WARNING**

This procedure does not provide obstruction clearance. Use of the radar is recommended to assist in obstacle clearance.

**WARNING**

Radar altimeter fluctuations may induce large collective movements via the flight director and/or automatic flight control systems when using the T-HOV and HOV AUG operating modes. With these modes engaged, flight crews must be vigilant in monitoring collective movement as a primary means of quickly detecting and overcoming abnormal flight director and/or AFCS control inputs. Physical "hands-on" guarding of the collective is imperative.

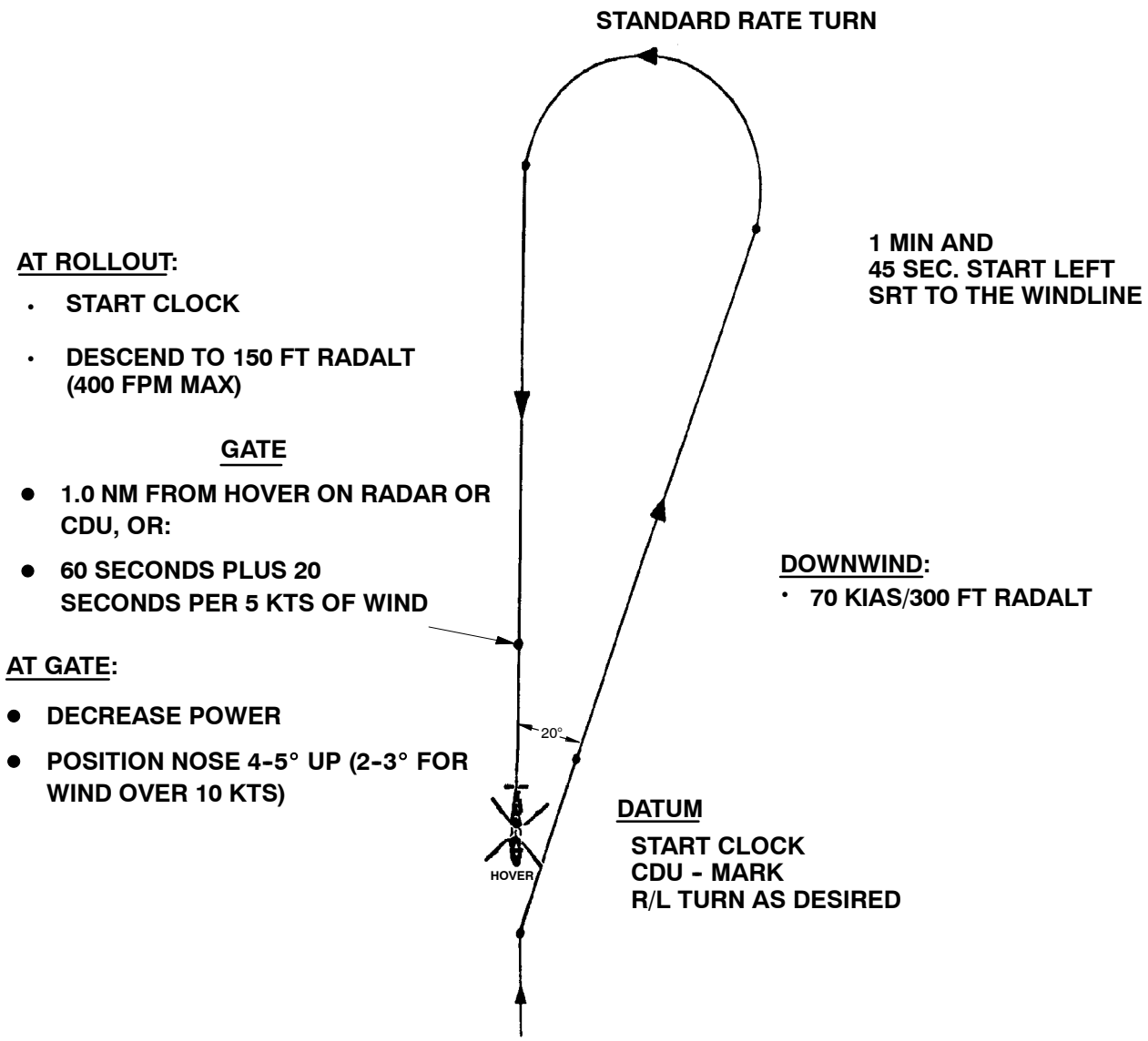
### IAS-VS LETDOWN PROCEDURE

1. FDS - HDG SEL and IAS - VS.
2. PAC – INITIATE/MONITOR DESCENT.

**WARNING**

Do not exceed 400 FPM rate of descent at any time.

3. PAC – Speed adjust to 50-70 KIAS.
4. SP – MONITOR DESCENT – call out every 100 ft.
5. SP – AT/PRIOR TO 200 ft – SELECT HOT MIKE.
6. SP – Report "T-HOV captured."




**CAUTION**

Chart A6 computes a weight, for current environmental conditions, that ensures a 10% power reserve prior to reaching Maximum Continuous Power. When the current aircraft weight exceeds the A6 weight, maneuvers become very demanding and may result in the exceedance of aircraft limitations.

*Figure 2-1. Manual Approach to a Controlled Hover*

7. PAC – AT T-HOV capture – MONITOR DECELERATION AND HOVER. CMD AIRSPEED – ADJUST AS NECESSARY.

**NOTE**

If desired final hover altitude is greater than 50 ft due to high sea state or obstacle avoidance, depress C-SYNC at the desired altitude after T-HOV capture.

8. PAC continue monitoring the instruments until the SP reports one of the three following calls:

**"I am visual, I have the controls."** This call is made when the SP (either NVG aided or unaided) has acquired sufficient visual cues to maintain a hover (Section II of the HH-65C flight manual), and takes the flight controls.

**"I am visual, target in (not in) sight, continue."** This call is made when the SP (either NVG aided or unaided) has acquired visual contact with the surface, has the target in sight or is satisfied with the stability of the aircraft, and desires to provide conning commands to the PAC to move the aircraft closer to the target to improve hover references. Conning commands by the SP should be based upon desired heading and airspeed. When the SP is satisfied with the aircraft position in relation to the target, the SP takes the flight controls.

**"Not visual, ITO."** This call is made when the SP determines (either NVG aided or unaided) that sufficient visual cues do not exist to report "I am visual, I have the controls," or "I am visual, target in sight, continue." The PAC immediately executes a coupled or manual ITO.

**CAUTION**

Due to degradation of depth perception below 50 ft while wearing NVGs, the SP must continue to scan instruments, particularly RADALT, to prevent inadvertent descent and water contact.

9. If unable to establish a visual hover reference at 50 ft RADALT, and PAC pre-briefs desire to descend to 30 ft RADALT:

SP - Reports "**Not visual, descend to 30 ft.**"

PAC - Begin a gradual descent to 30 ft RADALT.

**NOTE**

The C-SYNC BUTTON must be depressed to enable the hover beep switch when T-HOV captures from an armed state.

**WARNING**

It is possible to descend to the surface using the FDS collective hover beep switch.

SP - Reports "**I am visual, I have the controls," "I am visual, target in (not in) sight, continue,"** or **"Not visual, ITO."**

## NATCH

An NVG - Aided Approach to a Controlled Hover may be executed when aided with NVGs, if positive visual contact with the surface can be maintained at or above 150 ft AWL. This procedure is recommended when illumination levels, light sources, and environmental conditions preclude a safe normal approach to a hover.

### NATCH PROCEDURE

1. CDU - MARK datum AS APPROPRIATE and display WPT DATA.

2. PAC - Navigate the aircraft to the transition point for the approach, utilizing the CDU and/or RADAR as appropriate. A transition point 1.0 nm downwind of datum at 300 ft AWL and 70 KIAS is recommended.

3. Prior to the transition point:

SP - Select HOVER display for PAC, if requested; set RADALT BUG as DESIRED.

4. At the transition point:

PAC - Commence decelerating, descending approach to arrive at target hover altitude.

**WARNING**

Do not exceed 400 FPM rate of descent at any time.

SP - Monitor the descent, assist PAC with ALT/AIRSPEED CROSS CHECKS, and advise PAC when approaching target hover altitude.

## GO AROUND/MISSED APPROACH

The pilot announces "GO AROUND" or "MISSED APPROACH" on the intercom system (ICS). The maneuver may be performed coupled, by using the FDS GA mode or manually by increasing power and establishing a climb. Best rate of climb speed is 70-75 KIAS dual or single engine. If performance coupled, once the climb is established at 70 KIAS and 700-fpm rate of climb, select a non-collective FDS mode (IAS) to continue the climb. With the GA mode selected, the C-SYNC function is the same as during the IAS-VS operation.

**WARNING**

If the collective synchronize (C-SYNC) pushbutton is depressed after the GA mode is selected, the rate of climb current at that moment will be maintained. This may be zero fpm if C-SYNC is depressed prior to the flight director induced collective pull at 40 KIAS.

## NIGHT FLYING

Night flying presents some of the same problems as instrument flying, and additional problems are introduced by illumination of the instruments and cockpit and exterior reflections. Disorientation, due to diminished visual cues, physiological factors and reflections, is also possible. Night approaches into unlighted areas over smooth, featureless terrain such as water, snow, dry lake beds, etc., can result in complete loss of depth perception.

Use of Night Vision Goggles (NVGs) and the installation of NVG compatible cockpit lighting minimizes many of the problems associated with cockpit and instrument lighting reflections. However, pilots must be cognizant of the limitations of these devices. NVGs do not magnify images. An object viewed through the NVGs will be the same size as if it were seen in the day without the NVGs. Objects that are difficult to see during the day are also difficult to detect with NVGs. NVG performance is directly related to the amount of ambient light. Typically, during periods of high ambient light, resolution is improved and objects can be identified at greater distances; however, visual acuity with NVGs will never be as good as it is with the unaided eye during daylight conditions.

Depth perception and distance estimation are also affected by NVGs. Depth perception is reduced at distances less than 50 feet and greater than 500 feet. Between 50 and 500 feet, depth perception is roughly equal to that of the unaided eye. Distance viewing is also reduced with the NVGs. This is due mainly to reduced visual acuity and lack of peripheral cues. Flight techniques and visual cues used during unaided night flight also apply to NVG aided night flight. The primary advantage of NVG use is improved ground and/or water reference; however, the field of view is significantly reduced. To compensate for this, pilots must use a continuous scanning pattern. Because eye movement alone will not change the viewing perspective with NVGs, pilots should make slow, smooth head movements until the NVGs point in the desired direction. Rapid head movement should be avoided as it can induce vertigo.

**NOTE**

- Whenever possible, the flight crew (flight mech, RS, etc.) should be NVG aided when the pilots are NVG aided to ensure the entire crew has the same visual perspective.

- Refer to the Air Operations Manual, COMDTINST M3710.1 (series) for specific NVG operations in the HH-65.

During start and shutdown, instrument lighting will not be available when the alternators are not on line. An alternate means of lighting, such as the overhead spotlights, is required.

The landing/hover lights should be positioned for immediate use when not on. Securing the lights to the OFF position, without going to the AUTO RETR position, will ensure this. The copilot landing/hover light and the searchlight are powered from the auto-shed bus.

# WATER OPERATIONS

The following procedures cover normal water operations as they differ from land operations. The helicopter is not designed for amphibious operations. Watertight compartments and inflatable floatation bags provide egress time in case of emergency water landing (ditching).

## SALT WATER EFFECTS

Prolonged operation in salt water spray may result in engine parameter divergencies due to salt ingestion by the engines. Some rotor roughness may also be experienced due to salt accumulation on the rotor blades.

## LOW ALTITUDE FLIGHT OVER WATER

Numerous operations require flying over the water at low altitudes and slow airspeeds. Search patterns are the most frequently performed operation in this environment. Flight director modes are highly recommended to assist the pilot in maintaining altitude. IAS-VS is commonly used during low altitude flight over the water because it provides an altitude hold function at slower airspeeds and arms the T-Hov mode.

**WARNING**

Vertical speed must be less than ±150 feet per minute at activation of IAS-VS for the collective to hold a vertical speed of zero. The RADALT and VSI should be used to confirm desired altitude is being maintained.

## NORMAL APPROACH TO A HOVER

**CAUTION**

Chart A6 computes a weight, for current environmental conditions, that ensures a 10% power reserve prior to reaching Maximum Continuous Power. When the current aircraft weight exceeds the A6 weight, maneuvers become very demanding and may result in the exceedance of aircraft limitations.

The procedure for a normal approach to a hover over water is the same as for land, except that hover altitude will be predicated upon sea state and operational factors. The floatation system is armed during the LANDING/HOVER CHECKLIST. A safe altitude in case of engine failure is recommended. The rotor downwash will ripple the surface and may aid in drift and depth perception; however, continuous reference to the RADALT should be made. When positive visual contact with the surface cannot be maintained by 150 ft AWL, or conditions hinder depth perception (IMC, glassy water, haze, etc.) execute a CATCH, a MATCH, or an IAS-VS LETDOWN.

## HOVERING OVER WATER

Maintaining position over open water is difficult and aids such as debris, seaweed, foam, rotor downwash, and smoke float signals must be used. Pilots must become familiar with and use the rotor downwash patterns. When transitioning into a hover with no wind, the rotor wash will be equal, and as the speed of the helicopter and/or wind increase(s), the wash pattern retreats downwind.

**WARNING**

Hovering operations when little or no visual reference is available may induce pilot disorientation, particularly at night, due to downwash spray. This spray may be encountered to an altitude of approximately 40 feet at heavy gross weights and no wind.

Do not deploy smoke floats from a steady hover due to the possibility of valve plug FOD after ignition.

## TRANSITION TO FORWARD FLIGHT

Transition to forward flight by applying forward cyclic to accelerate and collective as necessary to prevent settling. Cross-check the radar altimeter and other flight instruments to aid in establishing a wings-level, positive climb attitude. Climb and accelerate to 70-80 KIAS and avoid turns below 200 feet, if possible. If insufficient reference is available for a visual transition, execute an ITO. Complete the LEVEL OFF CHECK.

# HOISTING PROCEDURES

**CAUTION**

Chart A6 computes a weight, for current environmental conditions, that ensures a 10% power reserve prior to reaching Maximum Continuous Power. When the current aircraft weight exceeds the A6 weight, maneuvers become very demanding and may result in the exceedance of aircraft limitations.

The following procedures cover vessel and water hoists and are adaptable to land hoists. Most hoists will be performed to/from a vessel. An initial evaluation and briefing should be completed prior to commencing the approach to a hover. Include on scene conditions; performance factors (such as fuel state, power available/required): a review of normal and emergency procedures during hoisting (engine malfunction, egress, lost comms, fouled cable/shear); and, if possible, rescue method/device to be used. The objective is to minimize the time spent in a hover due to the inherent risks associated with a single engine failure below 30 KIAS. The Height Velocity diagram and 30 second OEI Capability charts in Appendix I provide guidance in planning the best course of action. The pilot must complete the final crew briefing prior to commencing the hoist to include those items that could not be covered at altitude, such as delivery point and hover altitude. Simulated emergencies shall not be conducted during live hoists. The entire briefing shall, as a minimum, cover these items:

## HOIST BRIEF

1. Performance calculations. (Power required to hover out of ground effect (HOGE) may be significantly affected by the presence of down drafts or burbles. If altitude is increased to avoid effects of down drafts/burbles, hover reference may be reduced making the evolution extremely demanding.)
2. Crew duties/EPs (emergency procedure). (Engine failure; egress; lost comm; fouled cable/shear; runaway; lost target; who will be PAC.)
3. Rescue method/device to be used. (Consider the effect of rotor wash on the survivor.)
4. Delivery point for rescue equipment. (For land hoists, include route to be taken by swimmer. Traverse direction should consider aircraft fly out direction in the event of an aircraft emergency. For vertical surface rescues, swimmer should not approach survivor from directly above.)
5. Horizontal/vertical clearance, set specific clearance in feet, all crew members in addition to individual duties are responsible for monitoring clearances.
6. Altitudes.
7. Exit direction.

**NOTE**

Full activation of the hoist control may cause a momentary flicker of the SEC HYD LOW PRESS warning light.

## RESCUE BASKET

The rescue basket is the primary device for hoisting individuals in most situations. It affords a measure of protection for the individual being hoisted from vessel rigging, etc., particularly for an untrained person.

**CAUTION**

Due to the center of gravity of the basket, survivors must be brought into the cabin head first.

## LITTER

In rescue situations where the survivor is not ambulatory, the rescue litter is used. The litter is more difficult to use in a hoist, primarily due to its larger size and sail area. The trail line method of hoisting is normally used. Often, it is advisable to have the boat crew disconnect the litter and advise the

helicopter when ready for pickup. This procedure will minimize hover time.

**NOTE**

Recommend bringing litter into cabin head first, however, situation may dictate otherwise.

## SLING

The sling is an efficient method to deliver and pickup personnel trained in its use. Due to the danger of falling out, it is not recommended for use with those not specifically trained to use it.

**NOTE**

The chest strap must be used by all personnel with the exception of the rescue swimmer.

**NOTE**

The sling should be delivered open to reduce possibility of snag hazard.

## RESCUE SWIMMER

The rescue swimmer is trained to be deployed from the helicopter and act independently while preparing survivors for pickup. When the rescue swimmer is used, the swimmer will participate in the on-scene evaluation, advise the pilot if deployment is feasible and recommend the best method of deployment. Rescue swimmer hoists are the same as standard hoists except as noted in this section. The rescue swimmer has the authority to decline deployment if the situation is beyond the swimmer's capabilities. The rescue swimmer is a trained Emergency Medical Technician (EMT) and may be a useful member of the search and rescue (SAR) crew, even in situations where their swimming ability is not required.

## RESCUE CHECK

The flight mechanic's RESCUE CHECK is divided into three parts. This organization minimizes the time required in a hover. PART 1 should be accomplished at altitude and PART 2 completed once the hover is established. PART 3 is accomplished at the end of all hoisting evolutions.

PART 1

1. Portable Recording Unit (PRU) (if used) - ON

**NOTE**

When the PRU is turned on, it will record all selected audio from the flight mechanic station. To prevent unintentional recording of sensitive or classified information, the flight mechanic should secure radios over which such transmissions might be received.

2. Helmet visor - DOWN. (If NVGs not used)
3. ICS cord - ATTACH TO CLIP.
4. Rescue swimmer - ENSEMBLE DONNED/SECURED IN SEAT HARNESS.
5. Cable cutters - READIED IN CABIN.
6. Hoist glove - ON.
7. RS COMM check - AS REQUIRED.

If PART 1 is done at altitude report -"**RESCUE CHECK PART 1 COMPLETE."** The flight mechanic will open the cabin door during the LANDING/HOVER CHECKLIST. Observe speed limits.

PART 2 (When established in a hover)

1. NVGs and battery pack (If used) - REMOVE and STOW.
2. Visor - DOWN.
3. Seat - FULL LEFT, FACING FORWARD.
4. Safety harness - ON AND ADJUSTED.
5. Hatch - OPEN.
6. Hoist power - "REQUEST HOIST POWER." (FM)
7. Rescue device/swimmer - READIED AT DOOR.
8. Audio control panel:
   a. HOT MIC - ON/CHECK/OFF.
   b. COMM/NAV monitors - AS DESIRED.
9. Report - "RESCUE CHECK PART 2 COMPLETE, READY AFT FOR _____." (FM)

**NOTE**

The flight mechanic may elect to keep the COMM/NAV monitor switches ON until the boat briefing is complete or for the entire evolution.

When hoisting is completed and rescue device with survivor(s) are in cabin, the flight mechanic completes Part 3 as follows:

PART 3

1. Hoist boom - STOW.
2. Hatch - CLOSE AND LATCH.
3. Cabin door - AS REQUIRED.
4. Report - "BOOM STOWED, READY FOR FORWARD FLIGHT." (FM)

**WARNING**

The Flight Mechanic must stand by the cabin door until a safe single engine speed (40 KIAS) and a positive rate of climb are achieved.

5. Radio monitor switches - ON.
6. Request - "SECURE HOIST POWER." (FM)
7. Cabin - SECURE.
   a. Rescue device.
   b. Cable cutters.
   c. Hoist glove.
   d. Safety harness.
   e. PRU - off, disconnect, and secure (if used).
   f. FM/RS/PAX seated and secured.
8. Report - "PART 3 COMPLETE." (FM)

## VESSEL BRIEF

The pilot should establish communications with the vessel as early as possible to expedite the rendezvous and hoist, and brief the ship's personnel as follows:

1. If possible, have the vessel assume a heading 35° to 45° right of the wind line.
2. Vessel speed underway or maintain steerageway.
3. Radar (Vessel and Helo).
4. Have the vessel lower, stow or secure all antennas, booms, rigging, flag staffs, and secure loose gear around the hoist area.
5. The rescue device to be utilized will be provided by the helicopter.
6. Discharge static electricity before handling the hoist device.
7. Have the vessel's personnel disconnect the hoist cable if the rig is to be moved away from the hoist location. Emphasize that the hook is not to be attached to any part of the vessel.
8. Pass additional information as required. Advise vessel of the number of persons on board. In the event of a mishap to the helicopter, the vessel may be able to assist.

**WARNING**

Do not use the vessel's equipment except as a last resort. Litters which are specially stressed and rigged for hoist operations must be used for maximum safety.

The crew must evaluate the characteristics and rigging of the vessel, select the safest hoisting location and establish horizontal and/or vertical clearance criteria. It is normally more effective to show the flight mechanic the hoisting altitude than to state its value. When the flight mechanic has reported "RESCUE CHECK COMPLETE, READY AFT FOR ___," the pilot directs the flight mechanic to "GO ON HOT MIC." At this time the flight mechanic should go on hot mic, start the hoist device down and commence giving ADVISORY REPORTS. The pilot directs the flight mechanic to "CONN ME IN" when conning commands are desired, and the flight mechanic commences giving COMMANDS to position the helicopter over the hoisting area as previously briefed. The running flow of ADVISORY RE-

PORTS keeps the pilot informed as to the progress of the hoist. The hoist device should be dipped or grounded before being touched by the vessel's crew.

**WARNING**

If spilled fuel is present, caution must be exercised when discharging static.

**WARNING**

If at any time during the hoist the flight mechanic loses sight of the vessel, the flight mechanic (FM) must immediately inform the pilot. If possible, hoisting should be discontinued and the helicopter maneuvered for another approach.

Once the device is clear of the vessel, the pilot must be advised accordingly so he can move the helicopter clear. When clear of the vessel, the pilot may move the helicopter to a safe hovering altitude as the hoisting device is raised. When the pilot can maintain position relative to the vessel he shall report "CEASE COMMANDS;" the flight mechanic continues hoisting and giving ADVISORY REPORTS. At the completion of the last hoist the flight mechanic performs Part 3 of the RESCUE CHECK. A transition to a safe single engine speed should be accomplished as soon as the flight mechanic reports "BOOM STOWED, READY FOR FORWARD FLIGHT," indicating the hoisting device is inside the cabin, the boom stowed, and the cabin door closed (to prevent loose gear from flying out). The flight mechanic will stand by the door until a safe single engine speed is attained (minimum of 40 KIAS) and a climb established.

## TRAIL LINE HOIST

If executed properly, the pilot should be able to maintain visual contact with the vessel at all times. However, the combination of boat size, mast or rigging obstructions, antennae, little or no relative wind or dead in the water (DIW) vessel may result in a hoist during which the pilot will be unable to see the vessel during some portions of the hoist. An unstable rescue device, such as the litter, may also present problems. In these situations the trail line hoist can be used to simplify the hoist operation. The trail line can also be considered as an expendable device to make contact with the vessel's crew. In very rough conditions, attempting to deliver the hoist device directly may result in the cable fouling in the rigging and the necessity to shear the cable; whereas the trail line, if fouled, can be discarded and another used in a second attempt. The use of the trail line reduces the time the pilot must maintain a precise hover with little or no reference. It also prevents sailing and swinging of the rescue device during a high hoist or when the rescue device must be lowered to a restricted location.

The weak link is a safety device used between the trail line and the hoist hook which protects the helicopter by not allowing more than 300 pounds of force to be applied to the hoist. If more is applied, the weak link will part. To facilitate delivery, weights should be attached to the end of the trail line, without the use of a weak link.

The procedures for a trail line hoist are exactly the same as a direct hoist through the approach and hover downwind of the vessel. The weighted trail line is passed to the vessel using standard hoist procedures. If the rescue device is placed outside the cabin door, the weak link may be connected prior to delivering the trail line. If the device is in the cabin, the trail line must not be secured in any way until the device is ready to be delivered. The weak link of the trail line is fastened to the hoist hook (small eye).

**WARNING**

Extreme care must be taken to preclude fouling the trail line on persons and/or the aircraft.

In a situation where the vessel is dead in the water (DIW), the rotor wash may move the vessel, making the hoist much more difficult. To minimize the effects of rotor wash, the recommended method in this situation is to position the aircraft downwind of the vessel after delivering the trail line or rescue device. During the hoist, however, it may become necessary to follow the vessel's turn to maintain visual contact if wind and power available allow. The vessel will nearly always turn clockwise as viewed from the aircraft. If this is anticipated, a right pedal turn (to confirm power required and control authority) should be completed prior to commencing the hoist.

**WARNING**

When approaching small boats and rafts, particularly DIW, the rotor downwash may capsize the vessel.

Once the trail line is on the vessel and being tended, the flight mechanic will report "TRAIL LINE ON DECK," and give COMMANDS so the pilot can maintain reference. When the pilot is able to maintain position relative to the vessel he will report "CEASE COMMANDS," and the flight mechanic will continue hoisting and provide ADVISORY REPORTS. The boat crew should use the trail line to guide the rescue device into the desired location.

When the flight mechanic advises that the survivor is ready for hoisting, the pilot will direct "CONN ME IN." While it is desirable to make a vertical pickup, it may not always be possible.

As soon as the survivor is clear of the vessel, the flight mechanic will give COMMANDS enabling the pilot to maintain position. When the pilot can maintain position relative to the vessel and reports "CEASE COMMANDS," the flight mechanic continues hoisting and ADVISORY REPORTS. Once the trail line is clear of the vessel, the pilot may move clear as the flight mechanic completes the hoist and prepares for forward flight.

**WARNING**

To prevent the device (and survivor) from being pulled out, disconnect the trail line from the hook as soon as possible.

## DEWATERING PUMP DELIVERY

Dewatering or salvage pumps may be delivered to a vessel by one of two methods. The DIRECT METHOD is a standard hoist with or without trail line as the situation dictates. If environmental conditions or mast and rigging obstructions do not permit direct delivery of the pump, the INDIRECT METHOD may be utilized. This method is predicated upon the ability of the vessel's crew to lift the pump aboard. A standard dewatering pump weighs approximately 85 pounds. With this method, the 300 - pound weak link end of the trail line, with weight bag, is lowered to the vessel. The helicopter is moved left and a low hover established clear of the vessel. The non-weak link end of the trail line is then clipped to the two pump bridle d-rings and the pump is dropped into the water. The vessel's crew must pull the pump alongside and lift it aboard.

## RAFT DELIVERY

The LRU-20 raft may be delivered to a vessel or persons in the water if required. The raft weighs 65 pounds and will float when deployed to the water uninflated.

**WARNING**

- If deploying the aircrew's raft, the 75' tether line that attaches the raft to the floor must be disconnected. A thorough "risk vs gain" assessment should be made before deciding to deploy the aircrew's raft.

- Do not attach the hoist hook or trail line to the raft inflation handle as this may cause an inadvertent raft inflation inside the aircraft.

**To a Vessel:** The procedures for a raft delivery to a vessel are exactly the same as the Dewatering Pump delivery except the hoist hook is attached to one of the raft case handles for a direct delivery. For an indirect delivery, the non-weak link end of a trail line is tied to one of the raft case handles and the 300 - pound weak link end of the trail line with weight bag is lowered to the vessel.

**To People in the Water (PIW):** To deliver the raft to PIW an indirect method is used. Tie the non-weak link end of the trail line to the raft case handle and attach a float strobe and weight bag to the other end. Attach additional floatation such as a sling on the trail line. Deliver the trail line to the survivors, then reposition the aircraft a safe distance from the survivors. With the raft in position at the cabin door, pull the inflation handle while simultaneously pushing the raft out. The survivors can then use the trail line to aid in their approach to the inflated raft.

**NOTE**

The raft inflation handle and approximately 4 feet of inflation lanyard will separate from the raft upon activation.

## 20-PERSON MASS RESCUE (IBA) RAFTS

The purpose of the mass rescue operations raft is to provide emergency floatation for large numbers of survivors prior to rescue by vessel or helicopter. The intent is to deploy a number of rafts to groups of survivors as rapidly as possible. This will help survivors get out of cold water and stay alive long enough for rescue assets to recover them. Aircrews must use their best judgement in maximizing the number of survivors that benefit from deployed rafts, as there may not be enough rafts available to accommodate all PIWs.

There are currently three authorized rafts, the CONAX 20-person IBA raft, the Air Cruisers 20-person VPLR raft, and the Switlik 10-person raft pod system, which consists of three 10-person pods that are connected by line and packaged together in one deployable container.

The CONAX IBA raft is pre-rigged with a 105' inflation lanyard (trail line). Prior to deployment, the flight mechanic shall remove the D-Ring end of the 105' inflation lanyard from its attachment point on the raft and pay out approximately five feet of line. The flight mechanic will then attach a weight bag to the D-Ring end of the inflation lanyard, position the raft in front of the cabin door, and report "rescue checklist Part two complete for deployment of the mass casualty raft."

The Air Cruisers VPLR raft and the Switlik raft pod system are not pre-rigged with an inflation lanyard. When deploying these rafts, the flight mechanic will obtain a trail line from the SAR board and pay out approximately three feet from each end. The weak link end of the trail line shall be attached to the inflation cable on the raft. A weight bag shall be attached to the other end. The flight mechanic will then position the raft in front of the cabin door and report, "rescue checklist Part two complete for deployment of the mass casualty raft."

The purpose of the weight bag is to carry the inflation lanyard below the surface after deployment to prevent fouling rescue vessels propellers. The flight mechanic shall maintain a secure handhold on the raft, and especially the bitter-end of the trail line.

**WARNING**

Inadvertent raft inflation inside the cabin may cause injuries, interfere with pilot mobility, and cause loss of aircraft control. The trail line must never be wrapped around the flight mechanic's hand or attached to any part of the aircraft. Extreme care should be taken not to pull on the raft's activation lanyard during handling. Aircrews shall have a survival knife immediately available in the event of inadvertent activation.

**WARNING**

- Aircrews must balance the risk to the survivors from aircraft rotor wash, with the risk that the survivors may not be able to reach the raft unless it is very close. Factors such as wind, seas, water temperature, and indications of survivor strength should be considered.

- Using rotor wash to position the raft near survivors is not recommended. Testing has indicated rotor wash may cause the raft to become airborne and tumble. Should the raft become airborne and land atop survivors, death or serious injury may result from the raft's inflation cylinder striking survivor(s).

After the flight mechanic reports ready for deployment, the pilot commands, "CONN ME IN." The helicopter should be positioned upwind of survivors and the raft deployed as close as possible to survivors from an altitude less than 25 feet. Because survivors may be unable to swim, the raft must be placed such that survivors can reach it with minimal effort. After the aircraft is conned into position, the pilot commands "deploy the raft." The flight mechanic will then push the raft out and immediately conn the aircraft back and left, paying out line. As the line becomes taught, the flight mechanic will inflate the raft by pulling sharply on the line. Once the raft begins to inflate, the flight mechanic shall discard the deployment line.

CAUTION

Due to a lack of ballast, hoisting of survivors from the raft is not recommended.

## HOIST FROM THE WATER

The pilot executes an approach to a hover with the survivor(s) at the one to two o'clock position, outside the rotor wash. The number and condition of the survivors and the on-scene conditions will dictate the rescue method to be used: a direct hoist or use of the rescue swimmer (when available).

The following factors should be considered in selecting the best method of survivor recovery:

1. Number and condition of survivors.
2. Location and dispersal of survivors.
3. Visible injuries.
4. PFDs.
5. Parachute.
6. Sea state/temperature/wind.
7. Fuel or other debris.
8. Sea predators.

If the rescue swimmer is available, the swimmer should participate in the on-scene evaluation, advise the Pilot in Command if deployment is feasible, and recommend the best method of deployment. The rescue swimmer has the authority to decline deployment if the swimmer feels the situation is beyond his/her capabilities.

Once the method of survivor recovery has been determined, the pilot will direct the flight mechanic to complete RESCUE CHECK part 2.

Utilize standard hoist procedures for hoisting from the water. Lack of a hover reference for the pilot may make position keeping difficult and it may be necessary to drop suitable markers upwind, to provide a reference during the hoist. Other aids that may be used for reference are water foam, debris, and rotor wash patterns. The HOVER display and FDS T-HOV or HOV-AUG modes may assist in keeping a steady hover.

**WARNING**

Do not deploy smoke floats from a steady hover, due to the possibility of valve plug FOD after ignition.

Rotorwash may capsize small rafts or boats and may cause a survivor difficulty in breathing and result in subsequent drowning.

If a parachute is present in the water, do not approach to a point where the rotor wash can have an effect on it. Sinking the parachute may result in drowning the survivor.

# RESCUE SWIMMER PROCEDURES

CAUTION

Chart A6 computes a weight, for current environmental conditions, that ensures a 10% power reserve prior to reaching Maximum Continuous Power. When the current aircraft weight exceeds the A6 weight, maneuvers become very demanding and may result in the exceedance of aircraft limitations.

Only the PIC has the authority to deploy the rescue swimmer. Five methods are available for deploying the rescue swimmer; FREE FALL, SLING, HARNESS, DIRECT, and DISEMBARK DEPLOYMENT TO ICE. Free fall is used only in daylight. A sling, harness or direct deployment is always used at night or anytime a free fall deployment is not feasible, e.g., debris in water, low visibility, questionable water depth, sea state, or high winds. Direct deployments are specifically used when it is desirable for the swimmer to remain attached to the hoist hook, such as in surf, ice, swift water, or vertical surfaces, or when predators are present. Disembark procedures are used when touchdown on ice is possible. Night deployments require chemical lights on the swimmer, hoist hook, and rescue device.

Except for the direct or disembark deployments, the preferred method for recovery is the rescue basket for both survivor and rescue swimmer. Normally, only one person at a time is hoisted in the basket. Double recovery methods are available with the Military Aviator Double Pick-Up (MADPU), for properly equipped military survivors, and the Sling Augmented Double Pick-Up (SADPU). When using the MADPU, the rescue swimmer (RS) connects to the aviator and is hoisted by connecting the hoist hook to the lifting V-ring of the RS harness. For the SADPU, the RS places the survivor into the sling, then connects to the hoist hook via the RS's lifting V-ring and is simultaneously hoisted with the survivor. When using either of these methods, the Flight Mechanic attaches one end of the sling to the hook to provide visibility, floatation of the hook, and to prevent snag hazards. For the SADPU, the chest straps must be unsnapped prior to delivery.

In the direct deployment, the RS remains attached to the hoist cable throughout the evolution and in most instances utilizes the Quick Strop to recover the survivor. Two alternate means of recovery may be used during a direct deployment. For a severely hypothermic survivor, the double lift recovery can be used to keep the survivor in a more horizontal position. The double lift utilizes the sling around the survivor's torso and the Quick Strop under the survivor's knees. A physical grip pickup is used only in an emergency when the RS is unable to control a panicked survivor or possibly used to recover a small child. For ice operations where touchdown is possible, the RS assists survivor across the ice and back to the helicopter.

The rescue swimmer is equipped with a radio for communication and emergency use. A pre-briefed frequency must be monitored by the crew when the rescue swimmer is deployed. The rescue swimmer hand signals are depicted in Figure FO-9.

Once the decision has been made to deploy the rescue swimmer, the following procedures are used (pilot=pilot at the controls; FM=Flight Mechanic; RS=Rescue Swimmer):

**For FREE FALL, SLING, and HARNESS deployments:**

1. When the RESCUE CHECK is complete, the FM reports "RESCUE CHECK PART 2 COMPLETE, READY AFT FOR (free fall/sling/harness) DEPLOYMENT."

2. The pilot directs "GO ON HOT MIC," "CHECK SWIMMER."

3. The FM responds "ON HOT MIC," "CHECKING SWIMMER" and;

   a) FM holds RS's harness.

   b) FM taps RS once on chest.

   c) RS disconnects gunner's belt.

   d) RS indicates "thumbs up" when ready.

   e) For harness deployment, FM completes a load check of the RS to ensure harness is properly donned.

**WARNING**

To prevent inadvertent RS deployment, FM must maintain hold on RS harness. During free fall deployments, if flight conditions permit, remain at or below 30 feet RADALT once "GO ON HOT MIC, CHECK SWIMMER" has been given.

4. The FM reports "SWIMMER READY."

5. The pilot directs "CONN ME IN." The FM provides COMMANDS to establish a steady hover, placing the survivor at the one to two o'clock position, just outside the rotor wash in a no-wind condition. In higher wind conditions the rotor wash will be displaced aft, allowing closer placement of the swimmer. In any event, do not deploy RS closer than 5 feet from survivor.

6.a) FREE FALL DEPLOYMENT. With the aircraft in the desired position and altitude, the pilot commands "DEPLOY SWIMMER." Maximum hover altitude for free fall deployment is 15 feet RADALT. The FM checks to ensure that area is clear of debris and taps the RS three times on the shoulder, simultaneously releasing his handhold on the RS harness. The RS jumps and the FM reports "SWIMMER AWAY," then "SWIMMER IN THE WATER."

**WARNING**

The pilot MUST maintain altitude until "SWIMMER AWAY" report is heard.

6.b) SLING DEPLOYMENT. Once the pilot has directed "CONN ME IN," the FM lowers the RS using standard hoist advisories and reports "SWIMMER IN THE WATER." When the RS is clear of the sling, the FM reports "SWIMMER AWAY."

6.c) HARNESS DEPLOYMENT. Once the pilot has directed "CONN ME IN," the FM lowers the RS using standard hoist advisories and reports "SWIMMER IN THE WATER." When the RS is clear of the hook, the FM reports "SWIMMER AWAY."

7. After water entry, the RS signals "I AM ALL RIGHT" and the FM reports "SWIMMER OK."

8. The FM directs the pilot left and back to place the RS outside the rotor wash. The FM must maintain visual contact with RS until pilot regains sight of RS and reports "CEASE COMMANDS."

9. The pilot must maintain visual contact with RS while FM secures HOT MIC (if desired) and completes rescue check for recovery device. When rigged, the FM will report "READY AFT FOR _____." The RS will prepare the survivor for hoisting and give the "MOVE IN FOR PICKUP" signal.

10. The pilot directs "GO ON HOT MIC" (if required), "CONN ME IN" and the FM conns to place the hoisting device in the water 5 to 10 feet from RS. The pickup of survivor and RS is essentially a water hoist. (If recovery is with a litter, FM delivers litter to within 5 to 10 feet of the RS. When the litter is in the water, the RS disconnects the litter from the hoist hook. After delivering the litter, the FM conns the helicopter back and left as in step 8. above. When RS signals ready, pilot directs to begin the hoist as above.)

**WARNING**

To prevent static electric shock, allow device to contact water prior to being touched.

11. The RS places the survivor in the device and gives the "READY TO BE HOISTED" signal. When ready, FM hoists and directs the pilot left and back to place the RS outside the rotor wash. The pilot reports "CEASE COMMANDS" when visual with RS or whenever pilot no longer needs conning commands. The procedure will be repeated until all survivors and RS are aboard.

**CAUTION**

Due to the survivor's position during pickup, the survivor must be brought into the cabin first.

**NOTE**

Precise commands and a steady hover during this phase of the rescue are essential to a timely recovery.

**WARNING**

The hoist shall be accomplished at an altitude that will enable the pilot to maneuver the helicopter clear of the survivor and RS in the event of an engine malfunction.

12. With RS aboard, FM reports "SWIMMER IN CABIN, GOING OFF HOT MIC," and begins RESCUE CHECK Part 3. The pilot maintains position or air taxies until FM reports "BOOM STOWED, READY FOR FORWARD FLIGHT."

**For DIRECT Deployments to water:**

In a direct deployment, the RS remains attached to the hoist cable throughout the evolution. The RS is placed near the survivor, applies the Quick Strop and indicates ready for

pickup. The swimmer and survivor are hoisted together. The survivor may be hoisted facing towards or away from the swimmer.

1. When the RESCUE CHECK is complete, the FM reports "RESCUE CHECK PART 2 COMPLETE, READY AFT FOR DIRECT DEPLOYMENT."

2. The pilot directs "GO ON HOT MIC," "CHECK SWIMMER."

3. The FM responds "ON HOT MIC," "CHECKING SWIMMER" and;

   a. FM holds RS's harness.

   b. FM taps RS once on chest.

   c. RS disconnects gunner's belt.

   d. RS indicates "thumbs up" when ready to be hoisted.

   e. FM performs load check of RS to ensure seat harness is properly donned.

   f. RS indicates another "thumbs up" when ready.

**WARNING**

To prevent inadvertent RS deployment, FM must maintain hold on RS harness.

4. The FM reports "SWIMMER READY."

5. The pilot directs "CONN ME IN." The FM lowers the swimmer to a safe point approximately 5 feet above the water and provides COMMANDS to establish a steady hover, so as to place the RS approximately 2 to 3 feet from the survivor. The RS may give desired movement hand signals to the FM.

**NOTE**

If RS begins spinning during deployment, momentarily dip fins to stabilize RS.

6. When the helicopter is in position, the FM lowers the RS into the water, reports "SWIMMER IN THE WATER," conns the helicopter to remain in position over the RS and survivor, and prepares to take the load.

7. After water entry, the RS approaches the survivor and applies the Quick Strop.

**WARNING**

To prevent the RS from becoming entangled in cable, the FM must pay out only enough slack so the RS can move freely. The cable must not be allowed to coil in the water.

8. Once the survivor is safely secured in the Quick Strop, the RS gives the "READY TO BE HOISTED" signal. When ready, FM hoists the RS and survivor into the aircraft. The survivor should always be brought into the cabin first. The pilot reports "CEASE COMMANDS" when conning commands are no longer required.

**NOTE**

For unconscious survivors, the Quick Strop crotch strap is strongly recommended. Failure to connect the crotch strap on an unconscious or incapacitated survivor may result in survivor slipping out of the Quick Strop.

9. With RS and survivor aboard, FM reports "SWIMMER IN THE CABIN, GOING OFF HOT MIC," and begins SECURE CHECK. The pilot maintains position or air taxies until FM reports "BOOM STOWED, READY FOR FORWARD FLIGHT."

**For DIRECT Deployments to vertical surface:**

The direct deployment method may also be used to perform rescues on vertical surfaces such as cliffs or towers. Recovery is accomplished by hovering above the object and maneuvering the aircraft to hold the RS in positive contact with

the face of the object. The RS uses the seat harness and remains attached to the hoist cable throughout the evolution with the cable supporting the RS's weight. The RS can then traverse the face, rappelling fashion as necessary, to reach the survivor.

Good crew coordination and thorough planning are paramount to a successful vertical rescue operation. Pilots, FM, and RS should collectively determine the feasibility and plan the rescue. The final decision to perform the rescue must be made by the pilot in command.

Site evaluation is accomplished using high and low reconnaissance techniques and considering effects such as orographic turbulence and loss of wind behind obstacles. These factors and techniques are described in the ROUGH/CONFINED AREA OPERATIONS and MOUNTAIN FLYING sections of this chapter.

A thorough review of the hoist brief is critical to a successful evolution. The entire briefing should cover these items:

1. Power available/required for existing conditions. (Power required to HOGE may be significantly affected by the presence of down drafts or burbles. If altitude is increased to avoid effects of down drafts/burbles, hover reference may be reduced making the evolution extremely demanding.)

2. Crew duties/EPs. (Engine failure; egress; lost comm; fouled cable/shear; lost target; who will be PAC.)

3. Rescue method/device to be used. (Consider the effect of rotor wash on the survivor.)

4. Delivery point for rescue equipment. (For land hoists, include route to be taken by swimmer. Traverse direction should consider aircraft flyout direction in the event of an aircraft emergency. For vertical surface rescues, swimmer should not approach survivor from directly above.)

5. Horizontal/vertical clearance, altitude, and person responsible to monitor all clearances.

6. Exit direction.

PROCEDURES:

1. When the RESCUE CHECK is complete, the FM reports "RESCUE CHECK COMPLETE, READY AFT FOR DIRECT DEPLOYMENT."

2. The pilot directs "GO ON HOT MIC," "CHECK SWIMMER."

3. The FM responds "ON HOT MIC," "CHECKING SWIMMER" and;

   a) FM holds RS's harness.

   b) FM taps RS once on chest.

   c) RS disconnects gunner's belt.

   d) RS indicates "thumbs up" when ready to be hoisted.

   e) FM performs load check of RS to ensure seat harness is properly donned.

   f) RS indicates another "thumbs up" when ready.

**WARNING**

To prevent inadvertent RS deployment, FM must maintain hold on RS harness.

4. The FM reports "SWIMMER READY."

5. The pilot directs "CONN ME IN." The FM provides COMMANDS to establish a steady hover, so as to place the RS at the pre-briefed position on the surface.

**WARNING**

It is essential that the RS arrives at the pre-briefed position in a safe, controlled, and positive fashion. To establish initial positive contact, it is preferred to have the RS hoisted down from a stable hover over the pre-briefed position. Conning the helicopter in horizontally with the RS at the end of the cable could cause a swing to develop and cause uncontrolled RS contact with the surface.

6. When the helicopter is in position, the FM lowers the RS using standard hoist advisories and reports "SWIMMER IN CONTACT WITH THE SURFACE."

7. Once secure footing has been established, the RS approaches the survivor via walking/rappelling along the vertical surface. The RS gives desired movement hand signals to the FM while moving about the surface. The FM gives conning commands to keep the helicopter in a stable hover above the RS and keep the RS in positive contact with the surface. The RS may, upon reaching the survivor, request a small amount of slack in the hoist cable to allow the RS to prepare the survivor for pickup.

**WARNING**

The FM should keep slack to a minimum and be prepared to take the load immediately should the situation dictate.

**WARNING**

If the RS should lose positive contact with the vertical surface, the FM should advise the pilot and begin recovery of the RS to a safe position and begin the delivery again.

8. Once the survivor is safely secured in the Quick Strop, the RS gives the "READY TO BE HOISTED" signal. When ready, FM hoists the RS and survivor into the aircraft. The survivor should be brought into the cabin first. The pilot reports "CEASE COMMANDS" when conning commands are no longer required.

9. With RS and survivor aboard, FM reports "SWIMMER IN THE CABIN, GOING OFF HOT MIC" and begins SECURE CHECK. The pilot maintains position or air taxies until FM reports "BOOM STOWED, READY FOR FORWARD FLIGHT."

**For CATENARY HOISTING deployments:**

The catenary hoisting method may be used with any rescue swimmer deployment and/or survivor recovery. The catenary method is ideal for situations which may require an extended period of time for survivor preparation. An excellent example of this would be a hypothermic victim recovery. The rescue swimmer may require up to 20 minutes to place both strops around the victim and prepare the survivor for the hoist. The catenary method is also ideal for direct deployments in heavy sea/surf. It gives the pilot a hoisting reference and allows the pilot, copilot, and flight mechanic to time the period between consecutive wave crests. The rescue swimmer should be lowered to an altitude which places him approximately 5 feet above the highest wave. Only after the approaching wave crest has passed should the rescue swimmer be lowered into the water to the survivors position. The optimal area of deploying the rescue swimmer is on the backside of the passing wave crest down to the wave trough.

**WARNING**

Avoid deploying the rescue swimmer into the face of an approaching wave. Attempt to deploy the rescue swimmer immediately on the backside of the preceding wave crest down to the wave trough.

While the rescue swimmer is preparing the survivor for pickup, the flight mechanic will conn the pilot to a position where the rescue swimmer/survivor are just outside the rotor wash and at the pilots 2-3 o'clock position while simultaneously paying out cable and creating a catenary. The pilot will announce "CEASE COMMANDS" once the survivor and the rescue swimmer are in sight. In high sea/surf conditions, the pilot and flight mechanic will be able to move the aircraft in the same direction that the approaching wave will push the rescue swimmer/survivor.

**WARNING**

To prevent the rescue swimmer from becoming entangled in the hoist cable, the flight mechanic must pay out only enough slack for the rescue swimmer to move freely. Hoist cable must not be allowed to coil in the water.

When the rescue swimmer gives the "READY FOR PICK-UP" signal, the pilot will announce, "CONN ME IN." The flight mechanic will give standard conning commands to the pilot to place the rescue swimmer and the survivor directly underneath the helicopter. Once in position, the flight mechanic takes the load and completes the hoist. The intent is to minimize the time that the rescue swimmer and survivor are underneath the helicopter.

**For TRAIL LINE deployments:**

The trail line deployment procedure of the rescue swimmer may be used as an alternative to the conventional methods of delivering the rescue swimmer. The RS shall wear the flight helmet when deployed. It is not to be used for water deliveries/recoveries. The trail line procedure is ideal for situations when stability of the rescue swimmer is desired for delivery to an unstable vessel or platform. This procedure may be used with the harness deployment only, in conjunction with the trail line quick release. Disposition of the trail line following a RS deployment should be prebriefed.

Proper aircraft position is critical for ensuring a safe trail line deployment of the RS. Unlike a conventional trail line delivery of a rescue device when the trail line is used to guide the device into or through potential hazards while the aircraft maintains a "stand-off" position, a trail line deployment of the RS will require the aircraft to remain nearly vertical over the hoisting reference. The deployment should be executed in the same manner as a direct hoist, using the trail line only as a method of stabilizing the RS during descent to the target, not as a method of guiding the RS through potential hazards. Pilots must minimize lateral separation from the hoisting reference while maintaining proper altitude to ensure a near vertical deployment of the RS. Failure to maintain proper position may result in an inadvertent deployment of the RS to the water prior to the RS reaching the hoisting reference.

**WARNING**

This procedure shall not be attempted without the use of the trail line quick release. The fixed eye of the quick release device shall be attached to the lifting snap hook on the RS TRI-SAR harness. The trail line weak link is attached to the gated eye on the quick release. RS shall be connected to the hoist hook prior to trail line connection.

1. When the RESCUE CHECK is complete, the FM reports "RESCUE CHECK PART 2 COMPLETE, READY AFT FOR HARNESS DEPLOYMENT WITH TRAIL LINE."

**NOTE**

Disposition of the trail line following a RS deployment should be pre-briefed with the RS, via ICS, during the hoist brief.

2. The pilot directs "GO ON HOT MIC," "CHECK SWIMMER."
3. The FM responds "ON HOT MIC," "CHECKING SWIMMER" and;
   a. FM holds RS harness.
   b. FM taps RS once on chest.
   c. RS disconnects gunner's belt and ICS cord.
   d. RS indicates "thumbs up" when ready to be LOAD CHECKED.
   e. FM performs LOAD CHECK of RS to ensure seat harness is properly donned.
   f. RS indicates "thumbs up" when LOAD CHECK is complete READY TO BE HOISTED.
4. FM reports "SWIMMER READY."

**NOTE**

Once the load check is complete, the swimmer may be left hanging in the door or boomed out. Attachment of the weak link end of the trail line to the gated eye of the quick release may be done now or prior to lowering RS to vessel.

5. The pilot directs "CONN ME IN." The FM lowers the trail line and once the trail line is on the hoisting reference and being tended, the flight mechanic will report "TRAIL LINE ON DECK," and give COMMANDS so the pilot can maintain reference. The weak link end of the trail line is then connected to the gated eye of the quick release.

6. When the pilot is able to maintain position relative to the hoisting reference, the flight mechanic will continue hoisting and provide the pilot conning COMMANDS to remain vertical or nearly vertical over the hoisting reference until the swimmer is on deck.

7. When the swimmer is on deck, the FM will report "SWIMMER ON DECK." When the swimmer is clear of the hook, the FM reports "SWIMMER AWAY." When the swimmer signals OK, FM reports "SWIMMER OK."

8. The FM clears the pilot left and back to maintain visual with the hoisting reference.

9. The pilot will look for the RS request for a recovery device and call for "RESCUE CHECK PART 2 FOR _____ pickup of the survivor," or "RESCUE CHECK PART 2 FOR TRAIL LINE RECOVERY OF THE SWIMMER FROM THE _____."

**NOTE**

The trail line recovery method may not be used when recovering the RS from the water.

10. The RS places the survivor in the device and gives the "READY TO BE HOISTED" signal. When ready, FM hoists and directs the pilot left and back to maintain visual with the target. The pilot reports "CEASE COMMANDS" when visual with the RS or whenever pilot no longer needs conning commands. The procedure will be repeated until all survivors and RS are aboard.

11. With RS aboard, FM reports "SWIMMER IN CABIN, GOING OFF HOT MIC," and begins RESCUE CHECK Part 3. The pilot maintains position or air taxies until FM reports "BOOM STOWED, READY FOR FORWARD FLIGHT."

## ICE OPERATIONS

Operations over icy water and ice can be safely accomplished, provided careful attention is paid to the ice thickness and quality of ice. Of equal concern is the effect that ice and water in the rotor wash will have on a rescue swimmer and survivors if air temperatures are below freezing and hoisting is to be accomplished.

As is the case with slope and rough area landings, the pilot's on scene evaluation of conditions is critical to the safety and success of ice operations. Some of the factors to consider are:

- Visible thickness of the ice.
- Presence of equipment, or vehicles, already on the ice.
- If people or equipment have broken through the ice.
- Period of the ice season (early, late).
- Ice condition (honeycombed, cracks, leads).
- Recent air temperature trend.
- Effect the aircraft's rotor wash is having on the ice (rippling, breaking, cracking).
- If the rotor wash is blowing the ice.
- Cracking of ice as each aircraft wheel is placed on it.

When operating on ice covered water, ROTOR PITCH SHALL BE MAINTAINED allowing minimal weight of aircraft on the wheels to safely accomplish the deployment and recovery of personnel or equipment. The PILOT AT THE CONTROLS SHALL CONTINUE TO "FLY THE AIRCRAFT" the entire time the aircraft is in contact with the surface of the ice. Exception: If the ice is free of cracks, voids, or melt ponds and is a minimum of 12 inches thick, the aircraft may be operated without restriction. The flight mechanic, rescue swimmer, or basic aircrewman may be used to confirm ice integrity and thickness with an auger if doubt exists.

Recovery of the rescue swimmer, survivor, or an object from the water when air temperatures are below freezing will normally cause free running water on the cabin deck to freeze, creating hazardous footing. The water in the aircraft will normally freeze in the lower rail of the sliding cabin door. This could prevent the door from closing before transitioning to forward flight, or opening again once it is closed. Also, the exiting water may freeze on the extended landing gear.

**WARNING**

Vertical landings should normally be made whenever freezing air temperatures exist and water from hovering, taxiing through water, or braking in snow has possibly frozen the wheel brakes. If the wheel brakes are frozen and a running, or rolling landing is completed, the frozen brakes may cause the tires to blowout. Normally after a vertical landing, attempting a slow ground taxi will free frozen brakes.

**WARNING**

Smooth ice provides an almost frictionless surface. The rotor downwash from the HH-65C helicopter can easily blow a 230 pound RS off his/her feet, across the surface of the ice, and into the water. Downwash also makes returning to the helicopter difficult for the RS and survivor. RSs should be deployed to the ice with ice cleats.

The following procedures apply to all deployments to ice:

The RS shall wear the standard aircrew flight helmet, visor down, when conducting disembark or hover over solid ice.

The safety line is NOT to be attached to the aircraft in any way.

If the safety line is used, the webbing cutter shall be placed adjacent to the cable cutters in the event that an emergency condition arises requiring an immediate severing of the safety line.

To avoid having the hoist cable or safety line blown into the rotor arc, the FM must tend the hoist cable or safety line at all times. The flight mechanic should minimize the slack in the hoist cable or safety line. When necessary, the flight mechanic should tug the hoist cable or safety line to get the attention of the rescue swimmer.

The hoist cable or safety line should not be used to pull the RS across the ice due to the risk of possible injury to the RS.

While on the ice, the RS should periodically view the aircraft in order to enhance his situational awareness.

The survivor and the RS should be kept at the one-to-two o'clock position of the aircraft to minimize the effect that the rotor wash will have on them.

**For DISEMBARK Deployment to ice:**

Disembarking is used only when the helicopter has touched down. Utilizing this method (if it is determined that the hoist cable or safety line is necessary), the RS disembarks from the helicopter with the hoist cable or safety line attached and tended by the FM. The primary function of the hoist cable or safety line is to prevent the RS from being swept under the ice in the event he falls through. The hoist cable will permit a more expedient and safer recovery of the RS in the event the RS falls through the ice, or is injured. Secondary functions include retrieval and guide for survivors. Units to which this procedure is applicable will carry the required additional SAR equipment.

PROCEDURES:

1. The pilot establishes the helicopter in a stable hover placing the survivor at the one-to-two o'clock position, well outside the rotor wash; then touches down, remaining light on the wheels. If unable to touch down, use the DIRECT deployment procedures or hover over solid ice procedures.

**NOTE**

Rescue check part II may be performed in a hover or after landing.

2. When the RESCUE CHECK PART II is complete, the FM reports "RESCUE CHECK PART II COMPLETE, READY AFT FOR DISEMBARK DEPLOYMENT TO THE ICE."

3. The pilot directs "GO ON HOT MIC," "CHECK SWIMMER."

4. The FM responds "ON HOT MIC," "CHECKING SWIMMER" and;

   a) FM removes end of safety line with carabiner and safety belt attached from storage bag and attaches to RS (only if using the safety line). (If using the hoist cable, it was attached in Rescue Check Part 2.)

   b) FM holds RS's harness.

   c) FM taps RS once on chest.

   d) RS disconnects gunner's belt.

   e) RS indicates "thumbs up" when ready.

5. The FM reports, "SWIMMER READY."

6. The pilot commands, "DEPLOY SWIMMER." The FM checks the connection of the hoist cable or safety line and taps the RS three times on the shoulder, simultaneously releasing his/her hand hold on the RS harness. The RS steps clear of the aircraft and the FM reports, "SWIMMER ON THE ICE, TENDING (SAFETY LINE OR HOIST CABLE, AS APPROPRIATE)."

7. The RS will retrieve the survivor(s) back to the aircraft as required.

8. Once the rescue is complete with the RS aboard, FM reports, "SWIMMER IN CABIN, GOING OFF HOT MIC," and begins SECURE CHECK. The pilot maintains position until FM reports "BOOM STOWED, READY FOR FORWARD FLIGHT."

**For DIRECT Deployments to ice:**

Direct deployment to the ice uses the same commands and procedures as a direct deployment to the water. It is used when the ice is too thin to support the weight of the RS, the survivor has fallen through the ice, or any other time deemed necessary by the aircrew. Special attention should be given to the effect of rotor wash on the survivor. Care should be taken not to blow the survivor from their handhold or under the ice edge. A higher than normal hover may be required to minimize rotor wash effect and missile hazards. Once the RS and survivor are clear of the water or ice, pilots should consider lowering the hover altitude to maintain the RS and survivor no more than ten feet above the surface, conditions permitting.

**For HOVER over solid ice deployment:**

Hover over solid ice is used when the ice will not support the weight of the helicopter but will support the weight of the RS and a direct deployment is undesirable due to rotor wash effect or other concerns. During the hover over solid ice deployment, the RS remains attached to the hoist cable at all times.

**NOTE**

If survivors are ambulatory and the rotor wash will not have an adverse effect, a basket hoist may be used in lieu of the procedure listed below. However, the RS should be ready to deploy in the event a survivor falls through the ice, becomes injured, or the rotor wash blows the survivor away from the basket.

**NOTE**

In a no wind situation, as little as a 10–foot change in altitude can dramatically change the rotor wash effect on survivors.

PROCEDURES:

1. The pilot establishes the helicopter in a stable hover placing the survivor at the one–to–two o'clock position, well outside the rotor wash.

2. When Rescue Check Part II is complete, the FM reports, "RESCUE CHECK PART 2 COMPLETE, READY AFT FOR HOVER OVER SOLID ICE DEPLOYMENT."

3. The pilot directs, "GO ON HOT MIC, CHECK SWIMMER."

4. The FM responds, "ON HOT MIC, CHECKING SWIMMER," and after completing the load check announces, "SWIMMER READY."

5. The pilot directs, "DEPLOY THE SWIMMER." The FM lowers the swimmer to the ice. Once the RS is on the ice, the FM reports, "SWIMMER ON THE ICE," the RS signals "I AM ALRIGHT" and the FM reports, "SWIMMER OK." If the rotor wash isn't effecting the RS, he begins walking toward the

survivor while the FM pays out slack and tends the hoist cable. If the rotor wash is effecting the RS, making walking difficult, he may lay face down on the ice while the FM conns the helicopter back and left. Once the helicopter is clear of the RS, he stands up and begins walking toward the survivor.

6. After the RS has reached the survivor(s) he will have them lay on the ice, face down, head toward the helicopter. The RS will give the "MOVE IN FOR PICKUP" signal at which time the pilot will direct, "CONN ME IN." The FM will conn the helicopter into position for a vertical pickup. Once the helicopter is vertical, the RS will secure the survivor with the quick strop and give the "READY TO BE HOISTED" signal when ready to be hoisted. When the RS and survivor are clear of the ice, the FM clears the pilot to move back and left. The pilot reports "CEASE COMMANDS" when conning is no longer needed. In the case of multiple survivors, the procedure is repeated as necessary to recover all survivors.

7. With the RS aboard, the FM reports "SWIMMER IN CABIN, GOING OFF HOT MIC," and begins RESCUE CHECK PART 3. The pilot maintains position or air taxies until the FM reports "BOOM STOWED, READY FOR FORWARD FLIGHT."

## HOIST PHRASEOLOGY

The pilot and flight mechanic must perform as a team to make a safe hoist recovery. To prevent confusion and misunderstanding, the flight mechanic will use two types of standardized voice reports: COMMANDS and ADVISORY REPORTS. A COMMAND is given to direct the pilot to position the helicopter. All COMMANDS are given in reference to the longitudinal axis of the helicopter. All distances given will be in feet. HOLD COMMANDS are used when changing direction (i.e., "Forward 10," "Hold," "Right 5," "Hold," "Forward and Right Easy."). Hold is also used when maintaining the aircraft in a position relative to the target. (Example: "Forward and Right Easy," "Hold," "Trail Line on Deck.") ADVISORY REPORTS keep the pilot informed of everything else that is occurring during the hoist. An ADVISORY REPORT is information, not a command.

The following is a list of COMMANDS and ADVISORY REPORTS utilized during hoisting, including specific ones for employment of the rescue swimmer.

| COMMAND | MEANING |
|---|---|
| GO ON HOT MIC (given by PAC) | FM begins ADVISORY REPORTS and can begin lowering the trail line or device. |
| CONN ME IN (given by PAC) | FM begins giving COMMANDS to position helo over the hoist site and continues advisories. |
| FORWARD _____ | Move helicopter forward ___ feet. |
| BACK_____ | Move helicopter back ____feet. |
| LEFT____ | Move helicopter left ____feet. |
| RIGHT____ | Move helicopter right ____feet. |
| UP | Increase helicopter altitude. |
| DOWN | Decrease helicopter altitude. |
| HOLD | Hold the helicopter position relative to the target. |
| EASY (LEFT, RIGHT, etc.) | Move helicopter very slowly in direction indicated. |
| FORWARD AND RIGHT____ | Combination COMMAND. |
| CEASE COMMANDS (given by PAC) | Cease giving COMMANDS but continue ADVISORY REPORTS. |

| | |
|---|---|
| ABORT | Discontinue present evolution. |
| SHEAR! SHEAR! SHEAR! | FM and pilot activate their respective shear switches. |

| ADVISORY REPORT | MEANING |
|---|---|
| (Basket hoist example) | |
| ON HOT MIC, HAVE TARGET IN SIGHT, BASKET BOOMING OUT | FM is beginning the hoist. The hoist boom is moving out. |
| BASKET BELOW AIRCRAFT | Self-explanatory. |
| BASKET HALFWAY DOWN/UP | Self-explanatory. |
| BASKET HOLDING ____FEET OFF THE WATER | Basket has been lowered to a safe distance from the water and will not be lowered further until over the hoist area. |
| BASKET ON DECK | Self-explanatory. |
| MAN GETTING IN THE BASKET | Self-explanatory. |
| MAN IN THE BASKET | Man in the basket and ready to be hoisted. |
| PREPARE TO TAKE THE LOAD | FM is taking in slack and preparing to lift the basket clear of the deck. |
| TAKING THE LOAD | FM is lifting the basket off the deck with the hoist. |
| BASKET CLEAR OF VESSEL, CLEAR TO MOVE ____ (as briefed) | Basket is well clear of deck and rigging. Move (as briefed) so the pilot has visual contact. Continue COMMANDS. |
| BASKET OUTSIDE DOOR | Self-explanatory. |
| BASKET BOOMING IN/OUT | Hoist boom is moving in/out. |
| BASKET IN CABIN GOING OFF HOT MIC | Basket is in the cabin and being disconnected from the hoist. FM is going off hot mic. |
| HOIST BOOM STOWED, READY FOR FORWARD FLIGHT | All rescue gear is in cabin, hatch and door are closed. FM standing by the door. |
| CABIN SECURE | All rescue gear is stowed; all passengers and crew are strapped in. |
| BASKET (CABLE) FOULED | Basket (cable) has fouled on the vessel. |
| BASKET (CABLE) FREE | Basket (cable) no longer fouled on the vessel. |
| LOST TARGET | Pilot or FM has lost sight of the hoisting reference, (RS is not considered a hoisting reference). |
| COMMITTED | Committed to the hoist evolution as defined on pg. 3-47. |

If a trail line hoist is performed, the following additional ADVISORY REPORTS are utilized:

| ADVISORY REPORT | MEANING |
|---|---|
| TRAIL LINE GOING OUT THE DOOR | FM is beginning to deliver trail line to the vessel. |
| TRAIL LINE HOLDING _____ FEET OFF THE WATER | Self-explanatory. |
| TRAIL LINE SAILING AFT | Trail line is sailing aft in the wind. Extra effort will be required to deliver it. |

| | |
|---|---|
| TRAIL LINE ON DECK | Self-explanatory. |
| TRAIL LINE TENDED | Trail line is being tended by vessel personnel. |
| PAYING OUT TRAIL LINE | FM is paying out extra trail line. |
| WEAK LINK CONNECTED TO HOIST HOOK | Basket is ready to go out, and FM is making last-minute connection of weak link. |
| BASKET CLEAR OF VESSEL, TRAIL LINE STILL ON DECK, CLEAR TO MOVE____ (as briefed) | Self-explanatory. |
| BASKET IN CABIN, DISCONNECTING WEAK LINK, RETRIEVING TRAIL LINE | Self-explanatory. |
| TRAIL LINE IN CABIN, GOING OFF HOT MIC | Basket and trail line are in cabin, FM is going off hot mic to prepare cabin for forward flight. |
| SECURE HOIST POWER | Self-explanatory. |

When hoisting is complete and rescue device with survivor(s) is in the cabin, complete SECURE portion of RESCUE CHECK.

## RESCUE SWIMMER COMMANDS AND ADVISORY REPORTS

These are additional COMMANDS or ADVISORY REPORTS to be used in addition to normal reports:

| COMMAND | MEANING |
|---|---|
| CHECK SWIMMER | The pilot wants the FM to perform the swimmer check:<br>a) FM holds RS harness.<br>b) FM taps RS once on chest.<br>c) RS disconnects gunner's belt.<br>d) RS indicates "thumbs up" when ready. |
| DEPLOY SWIMMER | Swimmer is cleared to leave the aircraft. |

| ADVISORY REPORT | MEANING |
|---|---|
| CHECKING SWIMMER | Performing swimmer check. |
| SWIMMER READY | Swimmer's gunner's belt disconnected; swimmer indicates ready. Rescue sling hooked to hoist cable (if appropriate). |
| SWIMMER AWAY | Swimmer is no longer in aircraft or connected to the hoist cable. |
| SWIMMER IN THE WATER | Self-explanatory. |
| SWIMMER OK | Swimmer has given "I Am All Right" signal. |
| LOST SWIMMER | Pilot or FM has lost visual contact with the RS. Advisory used to initiate lost swimmer emergency procedure. |

RESCUE SWIMMER SIGNALS -- (Figure FO-9)

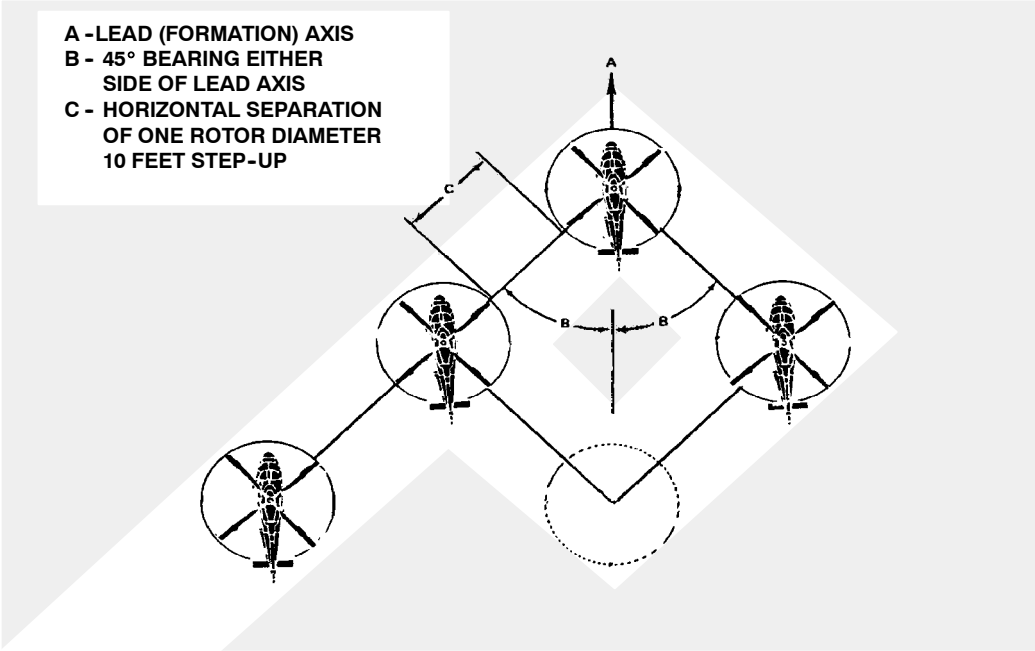



*Figure 2-2. Finger Tip Parade*

# TOWING WITH THE AIRCRAFT

Towing with the helicopter is prohibited except with a line held by the flight mechanic. Towing in this manner should be undertaken with great caution. Under no circumstances shall the line be attached to any part of the aircraft or flight mechanic. The pilot must ensure that the line is firmly secured to the vessel and that the bitter end is hand-held by the flight mechanic.

# FORMATION FLIGHT

Prior to formation flight an appropriate briefing will be completed. The Air Operations Manual, COMDTINST 3710.1 (series), outlines the circumstances under which formation flying may be conducted. When flying formation, it is imperative the flight leader fly as smoothly as possible with a minimum of attitude and power changes. The flight leader must allow his wingman at least 10 percent torque and airspeed margin for maneuvering. Radio communications between units of the formation are mandatory. No changes in the formation will take place until all aircraft in the formation understand and acknowledge the transmitted intent. Lead should be the only aircraft with the transponder code set to normal. The last aircraft in the formation should be the only one with its anti-collision light on. Formation flight may only be conducted during daylight visual meterological conditions (VMC). It is essential that basic fundamentals of formation flying be practiced in preparation for missions requiring formation flight. The procedures and positions contained herein are intended to provide a foundation for formation flying.

## ELEMENTS OF A FORMATION

The number of aircraft required to accomplish a mission varies. A section will consist of two aircraft, and a division will consist of three or four aircraft (two sections). Two or more divisions constitute a flight. The disposition of members within a formation is at the discretion of the leader.

## BASIC FORMATIONS

The two basic types of formations are parade and tactical. Parade is used primarily when there is a requirement of aircraft to fly a fixed bearing position in close proximity to each other and maximum maneuverability is not essential.

Parade is most frequently employed during arrival at or departure from ships or airfields, or during flight demonstrations. Power is varied to assist maintaining position. Tacti-

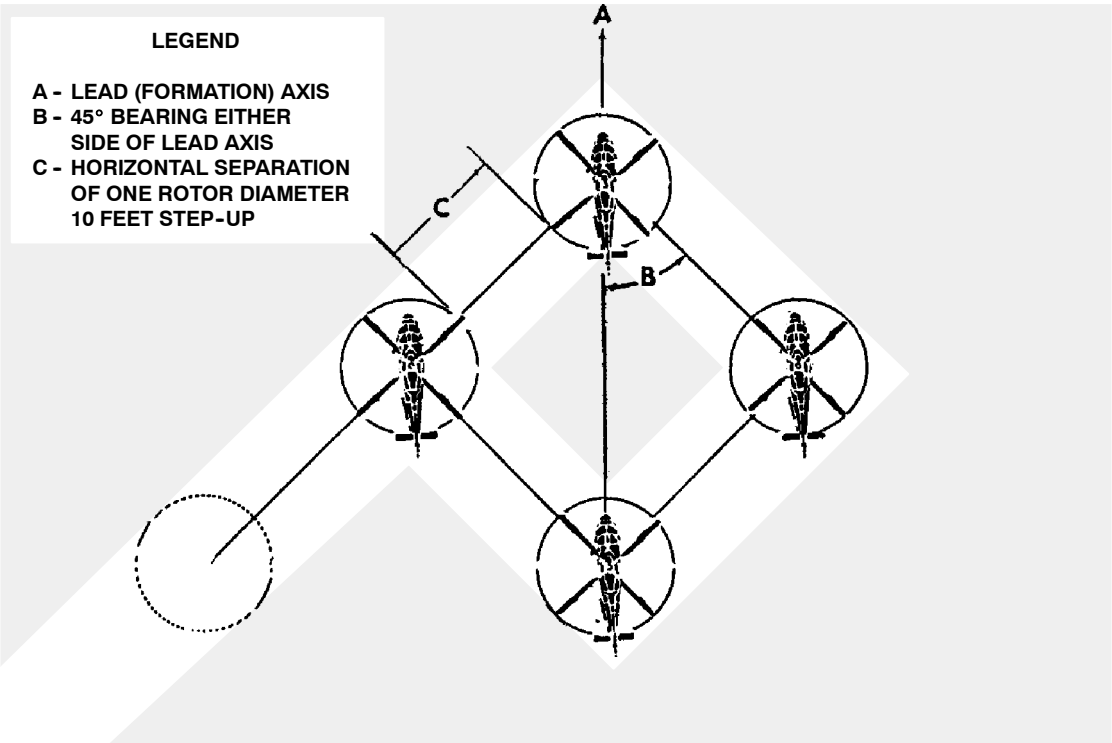



*Figure 2-3. Diamond Parade*

cal formations afford flexibility of maneuvering. This maintains the formation as an integral unit and allows freedom to turn, climb, and dive the formation with few restrictions. Radius of turn is varied rather than power to maintain position.

## PARADE FORMATIONS

**Types.** The four basic types of parade formations are: echelon, fingertip (Figure 2-2); diamond (Figure 2-3); and column.

**Positions.** The parade position for echelon, fingertip, and diamond is on a 45 degree bearing either side of lead axis with 10 feet of step-up, and one rotor diameter diagonal clearance. This position provides adequate longitudinal and lateral clearance between aircraft. In fingertip and diamond, the section leader will fly the same position on the leader as the number two man. The column position is on a 0 degree bearing with 10 feet of step-up and two (2) rotor diameters longitudinal clearance.

### Parade Turns

**Echelon and Fingertip**. Wingmen will rotate about the leader's longitudinal axis during a turn into them, and on their own longitudinal axis on turns away from them.

**Diamond and Column.** Wingmen will maintain a fixed position and roll about the leader's longitudinal axis on all turns.

## TACTICAL FORMATIONS

**Types.** The three basic types of tactical formations are: cruise (Figure 2-4), tail chase, and scouting line.

**Cruise.** The cruise position is on a 45° bearing off the tail with 10 feet of step-up, and two (2) rotor diameters diagonal clearance. This position will provide adequate longitudinal and lateral clearance between aircraft for maximum maneuverability. Number three will fly a position to allow room for number two between himself and the leader. When the leader initiates a turn, aircraft will maintain longitudinal clearance on the aircraft directly ahead by sliding and utilizing the radius of turn created by the leader. To decrease distance, increase bank; to increase distance, decrease bank. As

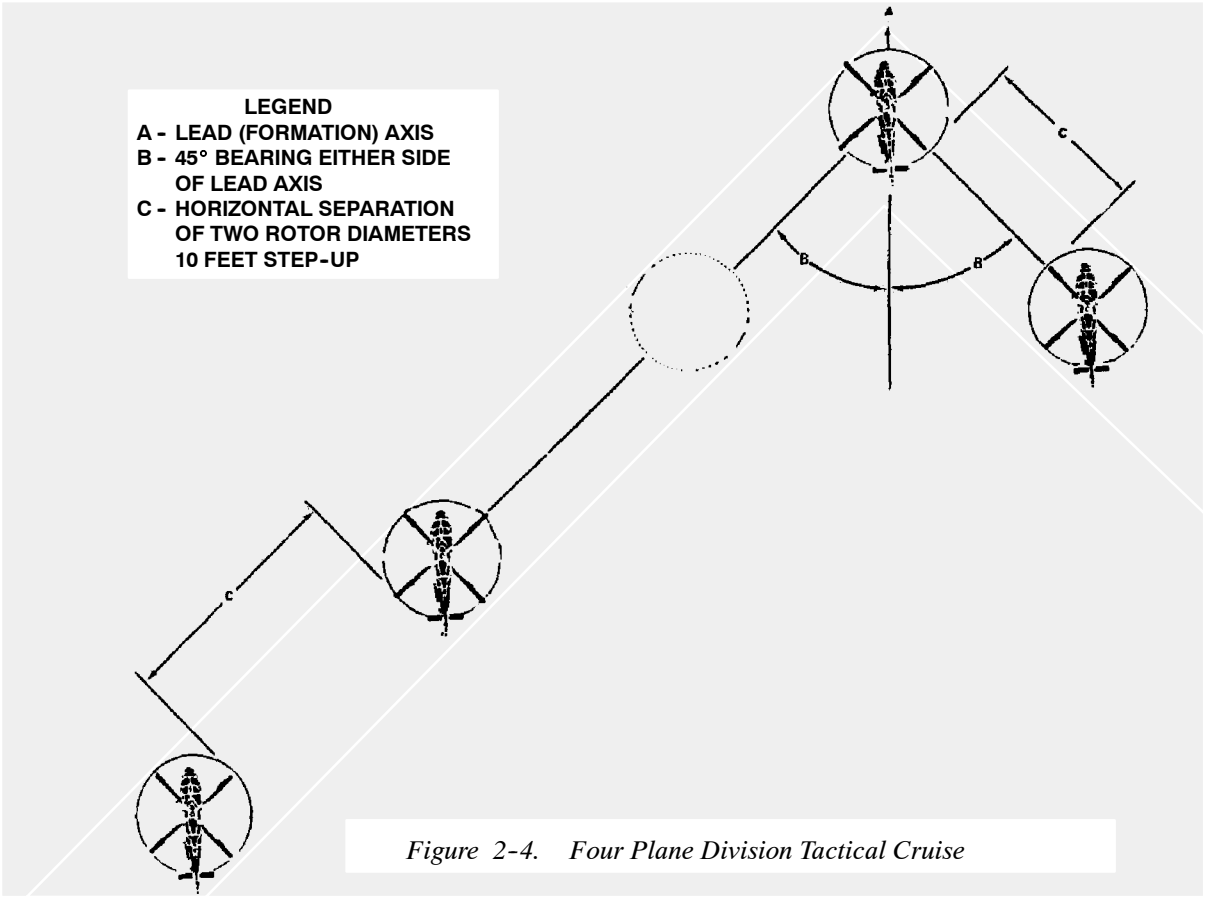



*Figure 2-4. Four Plane Division Tactical Cruise*

soon as the leader rolls level, the normal cruise position will be resumed with the No. 2 aircraft balancing the formation.

**Tail Chase.** The tail chase formation is flown in a loose column and all wingmen will use basic cruise-turn principles to maintain longitudinal clearance between aircraft. This formation is most commonly used in conjunction with the basic cruise formation when the leader is required to maneuver extensively through climbs, dives, and turns. When the need for tail chase ceases, the leader should return the formation to normal cruise formation.

**Scouting Line.** During flights that require increased doctrine, greater lateral separation, and where a high degree of maneuverability is not required, a formation leader may desire to move his wingmen forward and out from the normal cruise position. The degree of maneuverability required and situation will dictate the bearing and distance between aircraft in the formation. The more forward the bearing, the greater the ease of maintaining position and the less maneuverable the flight. This type of formation is generally employed on routine flights over extended distances.

**CROSSOVERS.** Crossovers will be accomplished by individual wingmen, or by sections when directed by the leader. The leader must ensure all helicopters in his formation are aware of the change in formation. The following procedures will be followed:

1. When a wingman is required to crossover, he/she will move to the corresponding position on the opposite side maintaining longitudinal blade tip clearance constant. The section leader will slide out on bearing to allow room for the number two aircraft, when applicable.

2. When the section is required to crossover, it shall be accomplished by the section moving across to the appropriate position on the opposite side. The section leader's wingman will not affect his crossover on the section leader until the section leader is in his new position.

**LEAD CHANGES**. All changes of the lead position in a formation will be acknowledged by the recipient in such a manner as to preclude the possibility of misunderstanding by

any member of the formation. Preferably, a lead change will be executed from level flight and in such a manner as to allow the old leader time to assume his new position before maneuvering flight is commenced.

## RENDEZVOUS

The two types of basic rendezvous are the running rendezvous and the cutter type rendezvous. A combination of the principles of these two is most commonly employed to join aircraft after takeoff.

**RUNNING RENDEZVOUS.** The leader will depart maintaining a prebriefed airspeed and will allow wingmen to use an airspeed differential and/or radius of turn that will enable them to overtake the leader and join as briefed.

**Cutter Type Rendezvous.** This is a join-up executed while the division leader makes a 180 degree level turn, using a 10 - 15 degree angle of bank and 90 KIAS airspeed. Joining helicopters will assume a rendezvous bearing on the division leader using the cut-off vector to affect the join-up. The final phase of the rendezvous will be on a 45 degree rendezvous bearing. Join-ups will be made to the inside of the turn. After relative motion is stopped, affect a crossover.

When practicing cutter type rendezvous, break-ups will be executed from an echelon. The leader will break first maintaining altitude and a 30 degree bank throughout his turn. Each succeeding wingman breaks at a prebriefed interval with 30 degrees of bank, adjusting his bank to be in an extended column position when the leader completes his turn.

**Formation Takeoffs and Landings.** Power availability, size of zone, obstacles to flight, wind direction and velocity, terrain features, rotor turbulence, and other considerations will determine the positions to be assumed by members of a formation. In crosswind conditions the wingman should position himself on the upwind side. A recommended procedure for takeoff entails the wingman lifting into a 10 foot hover and advising lead. The lead aircraft may then depart with a no-hover takeoff or transition to forward flight from a 5 foot hover as pre-briefed.

**Responsibilities.** Section and division leaders must endeavor to fly as smoothly and as steadily as possible, maintaining constant altitudes, headings, and power settings. Section and division leaders are responsible for maintaining positions within the formation as instructed. The leader is responsible for briefing, conduct, and discipline of the flight. He/she normally handles radio transmissions for the flight, including takeoff and landing clearance. All section leaders must be prepared to assume lead of the division.

# ROUGH/CONFINED AREA OPERATIONS

## LANDING SITE EVALUATION

On the spot evaluations may be made by circling and making passes, into the wind, over the intended landing site at various altitudes and airspeeds. The final analysis of the situation and the decision to land must be made by the pilot in command. Sand erosion may cause significant damage to the engine compressors. Landings to sandy areas may only be made when operational requirements dictate it. The prime factors to be considered are:

1. Wind direction, velocity, and consistency. The pilot must pay special attention to aerological effects (down drafts, turbulence, up drafts). Expect to lose beneficial effects of wind when below the obstructions.
2. Rough terrain. The flight mechanic should guide the pilot to a safe landing spot.
3. On slippery areas, such as wet or icy surfaces, due caution must be exercised. Brake action may induce skidding.

**CAUTION**

Hovering/landing in sandy or similar abrasive environments may cause excessive engine compressor erosion and is limited to urgent operational missions.

## HIGH RECONNAISSANCE

Fly the high reconnaissance at approximately 300 feet above the landing site obstacles to permit observation of the intended landing area and all possible approach and takeoff routes. Accomplish the following:

1. BEFORE LANDING / HOVER CHECK - COMPLETE.
2. Select approach, departure, and escape routes. Consider the terrain features and select the most

desirable course to approach and depart in the event of emergency. Consider wind, obstructions, and long axis of the area.

3. Site elevation. Estimate the elevation of the landing area by reference to barometric and radar altimeters.

4. Ensure that power required to HOGE allows a 10% margin from power available.

**CAUTION**

Chart A6 computes a weight, for current environmental conditions, that ensures a 10% power reserve prior to reaching Maximum Continuous Power. When the current aircraft weight exceeds the A6 weight, maneuvers become very demanding and may result in the exceedance of aircraft limitations.

## LOW RECONNAISSANCE

The low recon is used to confirm observations and finalize plans made during the high recon. The low recon may be conducted separately or as part of the final approach to the area.

## APPROACH AND TERMINATION

Prior to initiating the approach the pilot will brief the crew. Horizontal/vertical clearance, set specific clearance in feet, all crew members in addition to individual duties are responsible for monitoring clearances. The approach should be a normal approach if possible. Arrive at the Transition Point (200 feet above the obstacles) and select an approach angle which will clear all obstacles and result in a termination point as far forward in the landing area as conditions permit. As the approach progresses, the pilot must continue to evaluate the factors considered in the high and low recons. The approach is terminated in either a hover or no hover landing depending on power available, FOD and terrain. Determine the stability of the helicopter after touchdown prior to reducing power.

**WARNING**

If insufficient clearance is provided, the tail skid can become embedded in the ground or other obstruction, providing a pivot point for possible dynamic rollover or pitch over.

## TAKEOFF

The takeoff should be made over the lowest obstacle, consistent with other factors such as wind and utilization of the long axis of the area. Based on new information, the takeoff position may be different from that determined during the high and low recons. The takeoff may be initiated from the surface or a hover. Power is applied to establish a straight line climb angle that will clear the obstacle. The wind cannot be depended on for early attainment of translational lift. Plan the course of action in case of engine failure.

## LOW ALTITUDE OPERATIONS

Prior to descending below safe obstacle clearance altitude, the pilot should evaluate and plan the operation using the HIGH and LOW recon procedures listed above. This is particularly important when operating in unfamiliar areas. Certain obstacles, particularly wires, may not appear on aeronautical charts and may be very difficult to detect visually when operating at low altitudes. All crew members must be briefed to keep a constant lookout for obstacles. Ground speed must be adjusted so that obstacles may be seen and avoided. Horizontal/vertical clearance, set specific clearance in feet, all crew members in addition to individual duties are responsible for monitoring clearances.

# ELEVATED HELIPAD AND PINNACLE OPERATIONS

Approaches to elevated helipads or pinnacle landing sites (roof tops, oil rigs, aids to navigation platforms, mountains, ridgelines, etc.) present unique hazards. Execution of the approach is very demanding due to lack of visual cues for judging closure rate and approach angle. A known visual illusion tends to make the pilot perceive that the aircraft is high and slow during the initial phase of the approach. This phenomenon becomes more pronounced the higher the landing site is in respect to the surrounding terrain or water. If the approach path overflys water or nondescript terrain, the

illusion is magnified. The level of difficulty is greatly compounded during night operations. If the pilot does not adequately compensate by referencing instruments, the helicopter will approach the landing site on a shallow and fast profile. The increase in nose attitude and power required to correct for this undesirable state can destabilize the approach and place the aircraft in danger of striking the near edge of the structure or pinnacle.

**Prior to commencing the approach.** Determine power available and power required to HOGE for the existing conditions and configuration. Complete the BEFORE LANDING and HOVER CHECKS with emphasis on the following:

If conditions permit, consider opening the cabin door so the crew can provide advisories for obstacle clearance.

The parking brake and nose wheel lock should be set to prevent the helicopter from rolling after landing.

OEI should be armed.

Floats shall be armed if over water.

**WARNING**

When maximum power available is not at least 10 percent greater than that required to HOGE, the maneuver becomes very demanding and should not be attempted unless mission urgency dictates.

**Landing Site Evaluation.** Determine the following during site reconnaissance prior to initiating the approach:

Elevation of landing site. This can be obtained through charted means if available or by flying abeam the site and noting its altitude.

Location of landing site. Use aircraft navigation systems to mark a position overhead or abeam the landing spot. This can be a valuable means of gauging a suitable transition point for the approach.

Size and shape of pad. If the pad is rectangular, consider the orientation of the long axis in relation to wind and obstacles. Most oil rig pads have numbers painted on the surface that indicate maximum gross weight allowed and size of the pad. This number should be painted in the corner and appear as a fraction (i.e., 20/50). The top number is the max gross weight for the pad in thousands of pounds and the bottom number is the size of the pad. If the pad is not symmetrical, the bottom number will indicate length and width in feet (i.e., 20/60x40).

Wind and wind effects. Utilize all available means to determine local winds. Consider the likelihood of updrafts (upwind) and downdrafts (downwind) in the vicinity of the structure or pinnacle. Be prepared to encounter turbulence in the landing area if portions of the structure, cranes, trees, etc., are located upwind and extend above the height of the landing spot. Note any large air conditioning units or exhaust fans located near the approach/departure path as they can produce an enormous amount of hazardous vertical airflow.

Obstructions. Identify vertical obstructions, landing gear hazards, rotor wash considerations and personnel ingress/egress concerns. Horizontal/vertical clearance, set specific clearance in feet, all crew members in addition to individual duties are responsible for monitoring clearances.

Pad lighting. Necessary for night visual cues to determine closure rate and approach angle.

Best approach and orientation for landing. Determine the approach which makes best use of wind, affords best allowance for obstructions and provides the best escape route from the approach should a power loss occur. Consider the view afforded of obstructions and references when determining which pilot should fly the approach.

**Approach Procedures.** Conduct an Elevated Helipad/Pinnacle Approach to an IGE hover at the landing spot. The position marked during the reconnaissance may be used as an aid to identify a transition point approximately 0.2 nm (1200 ft) from the landing spot. Altitude at the transition point should be the height of the helipad or pinnacle plus 200 feet. Attempt to keep the aircraft at or above translational lift as long as possible, but be slow enough to require only minimal flare over the landing spot to terminate in a hover. Ensure the aircraft is at least 10 feet above the height of the deck or pinnacle edge as the aircraft crosses it. After stabilizing in a hover, recheck obstructions and wheel positioning over the spot, then land vertically.

**WARNING**

If the approach angle becomes shallow at any time during the approach, execute a waveoff. Do not terminate in a hover short of the pinnacle or structure. Turbulence and downdrafts on the downwind side of the structure/terrain can have substantial effects on the aircraft and can cause an overtorque or impact with the structure/terrain.

**Takeoff Procedures.** Before takeoff, select a departure path that will provide the best headwind component and escape route away from the obstacles. Perform the BEFORE TAKEOFF CHECK and brief the crew on specific duties. If fuel, passengers or equipment have been added, hover and check power required.

**WARNING**

The large amount of ferrous material present in man-made structures may interfere with aircraft compasses. To ensure navigational information is valid, it may be necessary to re-synchronize compasses prior to or immediately after takeoff from such sites.

Depending on pad height, the aircraft may depart ground effect as the deck edge is cleared. Utilize maximum power available for the transition to forward flight. During operations with high gross weight, aircraft settling may be encountered prior to fully clearing the deck edge. Smoothly lowering the nose will simultaneously aid in clearing the tail and accelerate the achievement of translational lift. Once clear of obstructions, lower the nose to 8-10 degrees nose down and accelerate to normal climb airspeed. If taking off at night and/or low visibility, transition to an instrument takeoff as soon as pad obstructions are cleared.

## SLOPE OPERATIONS

Slope operations are conducted either upslope or sideslope. Slope operations can be safely accomplished, provided careful consideration and attention is paid to the loss of a percentage of ground effect and the increased risk of dynamic rollover.

**WARNING**

To prevent rotor blade contact with the fuselage or terrain, avoid any excessive or abrupt control inputs.

### UPSLOPE

Landing with the nose of the helicopter pointed upslope is the most desirable procedure. The parking brake and nose wheel lock are set during the BEFORE LANDING/HOVER CHECK. When over the desired landing spot, commence a slow vertical descent. Depending on the slope angle, the nosewheel may touch down first. Regardless of which wheel touches first, continue to carefully and slowly lower the collective, while coordinating upslope cyclic, until the weight of the helicopter is resting firmly on the surface. If the LIMIT light illuminates before reaching minimum collective, return to a hover and select a position with a lesser degree of slope. To take off, coordinate cyclic and collective to bring the aircraft to a level attitude with the upslope wheel still on the ground, then continue increasing collective to effect a vertical takeoff.

### SIDESLOPE

Due to the normal right-wing-down hover attitude, landing left side upslope is preferable. Execute the landing by heading the aircraft parallel to the slope with the brakes and nosewheel locked. Descend slowly, placing the upslope wheel on the ground. Coordinate reduction of collective with lateral cyclic into the slope. Reduce collective pitch until the nosewheel and the downslope main wheel touch the ground. Continue coordinating cyclic into the slope until all the weight of the aircraft is resting firmly on the ground. If 10° roll is reached prior to minimum collective, return to a hover and select another site. Once the helicopter is firmly on the surface and there is no danger of downslope movement, place the cyclic in the neutral position. This will reduce stress on the main rotor and provide maximum upslope rotor-to-surface clearance.

To take off, coordinate cyclic and collective to bring the aircraft to a level attitude with the upslope main wheel still on the ground. After attaining a level attitude, continue increasing collective to bring the aircraft to a hover.

**CAUTION**

When landing to a right upslope, it is possible for the right vertical fin to contact the surface.

## MOUNTAIN FLYING

Helicopter missions may require flight and landings in mountainous terrain. Refined flying techniques with complete and precise knowledge of the individual problems to be encountered are required. The effects of mountains and vegetation can greatly vary wind conditions and temperatures. Helicopter pilots must be constantly alert to evaluate and avoid areas of severe turbulence. If encountered, immediate steps must be taken to avoid continued flight through it to preclude exceeding the structural limits of the helicopter.

The most frequently encountered type of turbulence is orographic turbulence. It can be dangerous if severe and is normally associated with updrafts and downdrafts. It is created by moving air being lifted by natural or man-made obstructions. It is most prevalent in mountainous regions and is always present in mountains if there is a surface wind. Orographic turbulence is directly proportional to the wind velocity. It is found on the upwind side of slopes and ridges near the tops and extends down the downwind slope. It will always be found on the tops of ridges associated with updrafts on the upwind side and downdrafts on the downwind side. Its extent on the downwind slope depends on the strength of the wind and the steepness of the slope. If the wind is fairly strong (15 to 20 knots) and the slope is steep, the wind will have a tendency to blow off the slope and not follow it down; however, there will still be some tendency to follow the slope. In this situation, there will probably be a severe turbulence several hundred yards downwind of the ridge at a level just below the top. Under certain atmospheric conditions, a cloud may be observed at this point. On more gentle slopes the turbulence will follow down the slope but will be more severe near the top. Orographic turbulence will be affected by other factors. The intensity will not be as great when climbing a smooth surface as when climbing a rough surface. It will not follow sharp contours as readily as gentle contours.

When the wind blows across a narrow canyon or gorge it will often veer down into the canyon. Turbulence will be found near the middle and downwind side of the canyon or gorge. When the helicopter is being operated at or near its service ceiling and a downdraft is encountered, the helicopter may descend, or exceed power limitations. Although the downdraft does not continue to the ground, a rate of descent may be established to such magnitude that the helicopter will continue descending and crash, though no longer affected by the downdraft. Therefore, the procedure for transiting a mountain pass is to fly close aboard that side of the pass or canyon which affords an upslope wind. This procedure not only provides additional lift, but also provides a readily available means of exit in case of emergency. Maximum turning space is available and a turn into the wind is also a turn to lower terrain. The middle of a pass is frequently the area of greatest turbulence and provides little opportunity to turn back in case of emergency. If an uncontrollable downdraft is encountered, adjust airspeed to best rate of climb and power to maximum allowable.

Rising air currents created by surface heating cause convective turbulence. This is most prevalent over bare areas. Convective turbulence is normally found below 2000 feet above the surface, and may be encountered up to 8000 feet. Turbulence can be anticipated when transiting from bare areas to areas covered by vegetation or snow. Convective turbulence is seldom severe enough to cause structural damage.

When flying in and around mountainous terrain under adverse weather conditions, it should be remembered that the possibility of inadvertent entry into clouds is ever present. Air currents are unpredictable and may cause cloud formations to shift rapidly. Since depth perception is poor with relation to distance from cloud formation and to cloud movement, low clouds and scud should be given a wide berth at all times.

### SUMMARY

The following guidelines are considered to be most important for mountain terrain flying:

1. Make a continuous visual check of wind direction and estimated velocity. Check against the MCU estimate.
2. Be alert for Nr surges during turbulent conditions. Updrafts will increase rotor rpm, while downdrafts will decrease it.
3. Fly as smoothly as possible and avoid steep banks.
4. Cross mountain peaks and ridges high enough to stay out of downdrafts on the lee side of the crest.

5. Avoid downdrafts prevalent on leeward slopes.

6. Fly to one side of a valley. Plan your flight to take advantage of the updrafts on the windward slopes.

7. Whenever possible, approach ridges parallel, rather than perpendicular.

8. Know your route and brief well for flying in these areas.

9. Calculate performance data for the flight. Power available decreases with altitude, while power required increases.

# EXTERNAL LOAD OPERATIONS

The mechanical and electrical operation of the external cargo hook is explained in Section I. Operating limitations with external loads are explained in Section V. Before commencing operations the pilot must obtain information on load weights. Operating areas and weather should be checked and aircraft performance computed. Due to the location of the cargo hook, external loads shift the center of gravity towards the rotor mast. Compute weight to ensure that maximum gross weight limits are not exceeded. External load operations may be divided into preflight, hookup, transition to forward flight, cruise, and approach phases.

## PREFLIGHT

Prior to flight the pilot must ensure that the following items are inspected:

1. Cargo hook for proper installation and security.

2. Electric (both cyclics) and Manual release (T-handle and external release knob) for proper operation. Manual release capability using the emergency release handle is mandatory.

   a. Cargo hook power - ON.

   b. Check operation of electrical release, both cyclics.

   c. Cargo hook power - OFF.

   d. Manual release - CHECKED. (An operating manual release is mandatory.)

3. Conduct a briefing for hookup personnel. State intentions in case of emergency.

**WARNING**

The landing gear shall be left down whenever the cargo hook is installed. This precludes the possibility of a fuel cell puncture in the event of an inadvertent wheels-up landing.

## HOOKUP

1. Brief the flight mechanic.

2. Cargo hook switch - ON.

3. Hot mic - CHECK.

4. FM use hoist voice procedures to position helicopter over cargo.

5. FM monitor hookup and check ground personnel clear of cargo. Report hookup and ready for liftoff.

6. Pilot smoothly increase power until pendant is under tension and when vertical, lift load. Monitor power.

7. FM report cargo clear of deck.

8. Stabilize load, note power required to hover and RADALT reading.

## TRANSITION TO FORWARD FLIGHT

Transition to forward flight and establish a positive rate of climb as soon as translational lift has been attained. Do not descend during transition. Acceleration and maximum airspeed will be dependent upon the type of load carried. Some loads will require airspeeds as low as 10 knots to maintain stability. Turns should be coordinated and shallow (5-10° bank). Do not exceed 30° bank. The FM should monitor the load for oscillation and other unsatisfactory indications. Be ready to release the load, if required.

## CRUISE

Do not fly over populated areas or buildings that could be endangered by inadvertent cargo release. Place cargo switch to OFF position.

**WARNING**

External loads which have aerodynamic characteristics may cause the load to oscillate into the rotor blades and/or fuselage.

Oscillation of the load can cause oscillation of the airframe. The pilot should keep control movements small to avoid aggravating the oscillation. Reducing speed may reduce oscillations.

Gusty wind conditions, actions of the load, or aircraft malfunction may cause or require unplanned release.

## APPROACH

1. Use a normal approach angle, not exceeding 300 feet-per-minute on final.
2. Flight mechanic on hot mic.
3. Cargo hook switch - ON.
4. FM conn helicopter into position.
5. FM report load on deck and released.

## COMMAND/ADVISORY REPORTS FOR EXTERNAL LOAD OPERATIONS

The standard hoist procedures apply, with the following additional reports:

| REPORT | MEANING |
|---|---|
| CARGO IS _____FEET OFF THE DECK. | Self-explanatory. |
| DOWN . | Repeated until cargo is on deck. |
| CARGO ON DECK. | Self-explanatory. |
| CLEAR TO RELEASE. | Self-explanatory. |
| CARGO STILL CONNECTED. | Pendant is still on the hook. |
| CARGO RELEASED. | Self-explanatory. |
| READY FOR . | FM is ready for . |
| SECURING CABIN. | Self-explanatory. |
| GROUND CREW APPROACHING. | Self-explanatory. |
| GROUND CREW ATTEMPTING HOOKUP. | Self-explanatory. |
| CARGO CONNECTED, GROUND CREW DEPARTING. | Self-explanatory. |
| AREA CLEAR, READY TO LIFT. | Self-explanatory. |
| **REPORT** | **MEANING** |
| UP ____. | Repeated as required. |
| PICKLE. | Jettison load. |
| PREPARE TO TAKE THE LOAD. | Self-explanatory. |
| TAKING THE LOAD. | Self-explanatory. |
| CARGO IS ____ FEET OFF THE DECK AND (STEADY, SWINGING, etc.). | Self-explanatory. |

# SEARCHLIGHT OPERATIONS

## OPERATION

1. LCTR LT circuit breaker - IN.
2. Junction box circuit breakers - IN.
3. Searchlight master OFF-ON-START switch - ON.

**NOTE**

When first starting the searchlight in flight, point it away from the cockpit area to avoid excessive glare for the pilot.

4. Searchlight master OFF-ON-START switch - START (hold in START position until lamp starts, 3-5 seconds). Check gimbal movement and focus operation.

**CAUTION**

Holding the switch in the start position after ignition or during a prolonged series of "strobes" may cause premature failure of some of the starting circuit components and/or the xenon lamp.

5. Focus beam as desired.

**NOTE**

Beam focusing mechanism is unidirectional. If the switch is held in the closed position, the searchlight beam will continuously cycle from large to small to large again until the switch is released.

6. Adjust light beam direction as desired.

**NOTE**

The 8-way directional control switch has no electrical travel limits. If, for example, the light is pointed toward the extreme "UP" position and the switch is held in this position after the mechanical limit of upward travel has been reached, the elevation motor continues to rotate while the motor torque is absorbed in a friction clutch. The same applies to the other three positions of the switch when the light has reached a mechanical limit of travel.

## SECURING

1. Prior to landing, raise the light to horizontal position.

**CAUTION**

If light is not placed in horizontal position, ground contact/damage is possible during slope landings, landings to unprepared surfaces or shipboard landings.

2. OFF-ON-START switch - OFF.

## OPERATING TECHNIQUES

Techniques for use of the searchlight will vary with the object of the search area being searched, and with the meteorological conditions. General guidelines for its use are listed below:

1. Search Airspeed: 50-100 KIAS is recommended as required by the type of object being searched for and the area to be covered. The searchlight has been designed to operate at all airspeeds corresponding to helicopter limitations.

2. Altitude: The operator can select either a small diameter, high-intensity beam which may be more useful when operating at highter altitudes, or a larger-diameter beam of less intensity when operating closer to the ground. The beam may be stopped at any position between wide and narrow. The best target identification will be at 500 to 1000 feet AGL.

**CAUTION**

Avoid operation of the searchlight below 10 feet AGL as it can ignite flammable material or dry vegetation at the focal point. The focal point is variable and can be as close as one meter from the light.

3. Search Stations: The port side of the helicopter is the recommended search side and can be used effectively by the copilot and flight mechanic. The copilot or flight mechanic can maintain directional control of the searchlight with the searchlight control box. It is recommended that the searchlight not be used to search on the starboard side of the helicopter due to the possibility of the light striking the helicopter.

**WARNING**

The heat generated by the light is capable of melting a tire or igniting paint or fiberglass.

4. Safety Considerations: Care should be taken when operating the searchlight during fog, haze, or snow,

when visibility may be reduced to zero. If these conditions are encountered, secure the light and fly the helicopter entirely by reference to instruments at a safe instrument altitude.

The searchlight may be used to assist in position holding during hovering by shining it down toward the water. However, when the light is used in this manner, caution should be used since the light will shine down into water (below the surface), possibly creating a false altitude sensation, which may increase the potential for disorientation.

**WARNING**

When operating close to personnel, the light beam should never be directed towards them since the high intensity of the beam may cause burns or eye injuries.

## HOT REFUELING OPERATIONS

The following describes hot refueling procedures for land based and shipboard operations. Hot refueling presents safety concerns which are not normally encountered in other fueling operations. For more specific information regarding shipboard hot refueling operations, see chapter 9 of the Coast Guard Shipboard-Helicopter Operational Procedures Manual, COMDTINST M3710.2 (series).

Personnel supervising and conducting hot refueling must have a thorough knowledge of the fueling equipment, helicopter fuel system, operational procedures and appropriate safety precautions. The pilot in command is responsible for maintaining obstacle clearance in the fueling area and complying with the following procedures. The flight mechanic or basic air crewman will supervise the hot refueling operation. They will ensure compatibility of the pressure refueling system, proper type of fuel, and proper grounding of the helicopter and single point refueling nozzle.

**WARNING**

NVG or gravity hot refueling shall not be conducted.

**CAUTION**

Repetitive hot refueling should be carefully considered. By lengthening the interval between thru-flight inspections, the risk of experiencing an undetected aircraft component problem increases. This interval should not routinely exceed 6 hours.

Minimum resources required:

1. Ground crew - At least three which can be air crew, ground crew or a combination. One shall be posted as fire guard, one at the fuel source, and one at the nozzle (fueler).

2. Fire protection - Ensure local unit fire fighting requirements or local standard operating procedures are adhered to. A twin-agent fire fighting unit is the preferred protection.

IF THESE MINIMUMS CANNOT BE MET, HOT REFUELING SHALL NOT BE ATTEMPTED.

**NOTE**

On land, position the helicopter and/or the refueling source so that the entire evolution is conducted on the right side of the helicopter. Place as much distance between the refueling source and the helicopter as the hose will permit. This should be at least 50 feet. If the physical layout of the refueling site prevents orienting the aircraft into the wind, select the best heading available that will place the wind off the aircraft's nose and move engine exhausts and fuel vapors away from the refueling source and refueling receptacle.

### HOT REFUELING PROCEDURES

1. Chocks/TALON/Tiedowns - AS REQUIRED.

2. Collective - DOWN AND LOCKED.

3. Parking brake - SET.

4. NVGs - ALL AIRCREW UNAIDED. (NVG hot refueling is prohibited.)

5. Radar - OFF or STBY.

**NOTE**

During hot refueling operations at night, deck light intensity shall be increased to 100% illumination.

**WARNING**

Because of possible injury to personnel, radar operation and HF transmissions shall not be conducted during hot refueling.

6. All transmit selector knobs - SELECT ANY OTHER THAN HF.

**CAUTION**

All radio communications should be kept to a minimum.

7. Passengers - DISEMBARK.
8. Flight Mech/BA - HOT MIC.
9. Doors - ALL CLOSED.

**CAUTION**

All doors must be closed in case of flash fire.

10. Refueling source ground wire - BOND TO HELICOPTER.
11. Pressure fuel nozzle to helicopter - CONNECT.
12. Lock nozzle - CHECK.
13. Fire guard, fueler, safety observer - POSTED.
14. Flight Mech/BA - INFORM PILOT "READY TO REFUEL."

**CAUTION**

Refuel flow rate shall not exceed 150 gpm or 55 psi.

15. Fuel flow - COMMENCE.
16. Fuel flow shutoff check - COMPLETE.

**CAUTION**

The fuel flow shutoff valve must be operating properly to continue with hot refueling. If the fuel flow does not stop when checked, it indicates a fuel system malfunction and hot refueling operations shall be terminated. In any case, limit fuel load to 1500 pounds to preclude the chance of fuel venting if the pressure shutoff valve fails.

The pilot shall monitor the fuel quantity indicator for signs of uneven tank filling. If necessary, the FM can make adjustments with the three-way valve.

17. Fuel flow - STOP.
18. Pressure fueling nozzle - DISCONNECT.
19. Fueling hose - STOW.
20. Ground wire - DISCONNECT.
21. Refueling source - CLEAR.
22. Radar - STBY.
23. Passengers - EMBARK.
24. Chocks - REMOVED.
25. Taxi/Takeoff/Secure checks - AS REQUIRED.

## FUEL JETTISON PROCEDURE

Fuel may be jettisoned when required by an inflight emergency or urgent rescue operation. If the situation allows, fuel should be jettisoned from one system at a time. Simultaneous jettison from both systems is at the rate of approximately 270 pounds per minute. When securing fuel jettison,

check fuel flow stopped. Fuel will continue to flow for several minutes after the jettison valves are closed. If not manually secured, fuel will jettison to approximately 150 pounds remaining in the left system and approximately 170 pounds in the right system.

1. Crew - BRIEF.
2. Communications - TRANSMIT INTENTIONS.
3. Anti-collision light - OFF.
4. Airspeed - 40 to 120 KIAS (wheels down if below 60 KIAS).
5. Fuel jettison valve(s) - OPEN.
6. Fuel quantity gauge - MONITOR.
7. SECURE JETTISON - AS REQUIRED.
8. Anti-collision light - ON.

# SHIPBOARD HELICOPTER OPERATIONS

Shipboard helicopter operations require a great deal of coordination between the crew of the helicopter and the ship's personnel. Pilots contemplating ship-helicopter operations must refer to Shipboard-Helicopter Operational Procedures Manual (COMDTINST M3710.2 (series)). This section covers flight procedures for shipboard operations.

## EQUIPMENT

The following minimum equipment must be installed/ operating properly in order to conduct shipboard operations:

1. AFCS - pitch/roll/yaw channels are required. An operating collective channel is not required.
2. Nose wheel lock.
3. Parking/wheel brakes.
4. Rotor brake.
5. Floatation system.
6. RADALT.
7. Tiedown rings.

This is a minimum, and some missions may require additional equipment such as radar, MCU, etc.

## RECOVERY PROCEDURES

The pilot must ascertain that flight deck motion and relative wind are acceptable for landing.

**CAUTION**

A port relative wind should be used whenever possible as this will provide maximum helicopter/flight deck clearance during takeoff and landing evolutions.

## TRAFFIC PATTERN

A 500 ft AGL racetrack pattern is recommended. Prior to reaching the downwind abeam position, complete the BEFORE LANDING/HOVER CHECK.

**NOTE**

If use of the Talon decklock system is anticipated, it should be turned ON during the before landing checklist. Refer to Section 1 for a description of the Talon system.

## APPROACH

Normally, a landing clearance is obtained prior to commencing the approach. Plan the approach to arrive at a point astern of the vessel approximately 50 ft above the deck and at a distance and airspeed that will provide sufficient visual cues of flight deck movement, wave period and deck lighting to execute a safe landing. Landing signal officer (LSO) signals to assist the pilot in the approach are advisory except the WAVEOFF, which is mandatory. When approaching the aft edge of the flight deck, ensure sufficient height to preclude unintentional deck contact and make a final evaluation of deck motion and other existing conditions to determine if a landing should be attempted. During the approach phase, the flight mechanic should use the following advisory reports to assist the pilot in positioning the helicopter over the landing spot:

1. "WHEEL OVER THE DECK."
2. "IN THE CIRCLE."
3. "IN THE GRID."

**WARNING**

The tail skid may become embedded in a raised mushroom deck fitting during shipboard operations, providing a pivot point for possible dynamic rollover or pitch over.

## WAVEOFF

A waveoff should be executed at any time doubt exists as to the safe conclusion of an approach. It may be initiated by the pilot, helicopter control officer (HCO), or LSO. If sight of the LSO is lost while over the flight deck, a pilot waveoff is mandatory. Waveoff will normally be performed into the wind and away from the vessel, ensuring a safe flight path. Ensure waveoff condition is resolved prior to commencing another approach.

## HOVER

Using the LSO's signals for assistance, position the helicopter over the landing spot in the touchdown circle, aligned with the flight deck line-up line.

**NOTE**

Prolonged hovering in the disturbed air mass over the flight deck may result in reduced aircraft stability and pilot induced oscillations.

## LANDING

From a hover over the landing spot, the pilot must note the vessel's movement cycle and attempt to land with the vessel at the horizontal (level). Descend, eliminating drift and maintaining alignment heading. A positive touchdown should be made to prevent multiple contacts which could result in excessive stress on the landing gear. As deck contact is made, continue lowering the collective to the full down position and simultaneously center the cyclic. No further control inputs should be made. Cyclic movement on deck may have an adverse effect on aircraft stability, and can be dangerous to flight deck personnel. If the cyclic is placed full forward, the main rotor blades will dip to a height of approximately 5 feet. In the event of landing without all the wheels inside the touchdown circle, obstacle clearance is not guaranteed and a secure tiedown may not be possible. The helicopter should be repositioned in the landing circle.

**WARNING**

The flight mechanic's seat should be centered in the cabin away from the open cabin door at touchdown to ensure the flight mechanic remains protected inside of the cabin in the event of a mishap. This position also allows a clear egress route for anyone seated in the aft part of the cabin.

**CAUTION**

Flight deck contact of the vertical fins on the horizontal stabilizer may occur during landing or takeoff. The fins can contact the deck prior to the tail skid and main mounts if excessive pitch/roll angles occur.

**CAUTION**

Excessive aft cyclic movement on touchdown or after landing can cause rotor head to cowling contact and/or main rotor blade contact with the vertical stabilizer.

## PRIMARY TIEDOWNS

After landing, give the TIEDOWNS - ON signal. Once the signal is given, the aircraft is considered to be attached to the deck. Further attempts at flight are prohibited. Complete the AFTER LANDING checklist. Should the helicopter become unstable to a point where a mishap is imminent, prior to or during tiedown, the appropriate action is to secure both engines, apply the rotor brake, and secure the battery. The primary high tiedowns attach to the aft upper tiedown rings (Frame 4630) and are led aft. The primary low tiedowns attach to the lower forward tiedown rings (Frame 2000) and are led forward.

**WARNING**

To avoid ground resonance, secondary tiedowns and strut collars shall not be installed until engine and rotor shutdown is complete.

## SHUTDOWN

The following shutdown procedures apply for the conditions outlined:

1. Light winds (relative winds less than 20 kts) and minimum flight deck motion (flight deck motion pitch and roll combined less than 8°). Complete the SECURE CHECKLIST with rotor brake application at 20% Nr (one red segment). Position blades at 45°.

2. High winds (in excess of 20 kts) or moderate flight deck motion (pitch and roll combined 8° or greater). Complete the SECURE CHECKLIST with rotor brake application at or below 170 Nr. Position blades at 45°.

All tiedown personnel must be outside the rotor disc during shutdown.

**WARNING**

Main rotor blades may dip below 5 feet during shutdown.

## LAUNCH PROCEDURES

Ensure preflight planning is completed with the following minimum items: Mission briefing with ship's personnel, flight deck limits, aircraft power requirements, flight crew briefing, FLIGHT CREW INSPECTION (ensure secondary tiedowns and strut collars removed), and flight deck checked for FOD and obstacles.

## ENGINE START AND ROTOR ENGAGEMENT

Normal procedures apply.

**WARNING**

Secondary tiedowns and strut collars shall be removed prior to engine start to avoid ground resonance.

## SHIPBOARD TAKEOFF

After receiving takeoff clearance from the HCO and when ready for takeoff, signal the LSO to remove tiedowns. Observe all tiedowns removed and flight deck is clear. If the TALON Decklock System is in use, it should be released at this time.

**WARNING**

Applying collective pitch prior to releasing the TALON probe may cause the nose of the helicopter to pitch up, striking the tail on the deck.

Signal LSO for takeoff when ready. LSO will signal TAKEOFF. Use of HOT MIC is recommended to allow rapid flow of information (TRQ, TOT, position, clearance). Execute a vertical takeoff when flight deck is at the horizontal/level attitude. Maintain heading aligned with the flight deck lineup line, and slide laterally clear of the flight deck at sufficient height to ensure adequate clearance from the deck and nets for the existing pitch and roll conditions. Ensure nose of the helicopter does not cross the forward peripheral line until rotor disc is clear of the vessel. Apply forward cyclic to slowly accelerate and adjust collective, as necessary, to prevent settling. After translational lift is achieved, adjust to 8°-10° nose down, accelerating 70-80 KIAS. Adjust collective as required to maintain power within takeoff limits. A Coupled or Manual ITO may also be performed, as appropriate. After takeoff is executed and single engine fly out assured, make the "OPS Normal" call to HCO and complete the AFTER TAKEOFF CHECK.

**WARNING**

Dynamic rollover may occur on takeoff or landing if excessive angular momentum about a wheel in contact with the deck (pivot point) is allowed to develop.

**CAUTION**

Overrotating the nose in excess of 8°-10° during transition to forward flight will cause aircraft to settle, possibly resulting in inadvertent surface contact or MGB overtorque.

## NIGHT PROCEDURES

Night pitch, roll, and relative wind limits are less than those for day operations due to reduced visual cues. Depth perception is impaired and closure rate is more difficult to determine at night. Anti-collision light, searchlight and landing/hover lights must be secured while over the vessel during night takeoffs and landings.

## NIGHT TAKEOFF

The night takeoff will be the same as day takeoff until the aircraft is laterally clear of the ship. From that point, an instrument takeoff (Manual or Coupled) is required, unless performing "box pattern" landings and maintaining visual contact with the ship.

## NIGHT RECOVERY

Although CATCH/MATCH procedures are highly recommended, visual approaches at night are only recommended when the ceiling is 500 ft or higher, the visibility 1 mile or greater, and the pilot can maintain positive visual contact with the cutter and either the stabilized glide slope indicator (SGSI) (if available) or the water surface. Vessels equipped with SGSI can provide glide slope information out to 3 nm. SGSI procedures are described in COMDTINST M3710.2 (series). The night visual pattern is the same as the day. Due to the difficulty in discerning deck motion at night, the helicopter should cross the stern of the vessel at a slightly higher height than during daylight to ensure adequate clearance. The pilot must monitor the LSO signals closely as they may be his only source of information on position, altitude, and height.

# HELICOPTER IN-FLIGHT REFUELING (HIFR)

Helicopter in-flight refueling (HIFR) is a method of extending the flight duration of the HH-65, when normal refueling is not feasible due to time or other constraints. As in any refueling operation with the engines running, HIFR assumes a certain amount of risk. It consists of hovering beside a HIFR capable vessel; performing a standard hoist to retrieve the HIFR rig; pressure refueling and then lowering the HIFR rig to the vessel. The HH-65 is compatible with all HIFR rigs currently in use aboard U.S. Coast Guard and U.S. Navy vessels. The operation requires specific planning and coordination. If a HIFR mission is planned prior to the helicopter's departure from the air station, the pilot should review the applicable section of the Shipboard-Helicopter Operational Procedures Manual (COMDTINST M3710.2 (series)), for detailed shipboard and aircraft procedures; and the requirements of the Air Operations Manual (COMDTINST M3710.1 (series)). Additionally, the helicopter pressure refueling system should be checked for proper operation.

**CAUTION**

Repetitive inflight refueling should be carefully considered. By lengthening the interval between thru-flight inspections, the risk of experiencing an undetected aircraft component problem increases. This interval should not routinely exceed 6 hours.

## PREPARATIONS FOR HIFR

1. Consider power available versus power required to hover at 50 ft (after refueling), and allowing a 10% MGB Q reserve margin, determine amount of fuel to be received.

2. Establish communications with the refueling vessel and:

   a) Provide estimated time of rendezvous.

b) Request vessel's numbers and fuel test results (Limits: 2.0 MG/L max sediment; 5 ppm of water; 0.03% - 0.20% FSII; clear and bright).

c) Advise amount of fuel required and 55 psi limit at the nozzle.

3. Brief aircrew on procedures and duties. The standard hoist brief should be conducted, with the following additional items:

a) Special advisories desired: Ground wire attached; nozzle attached; etc.

b) Flight mechanic monitors ship/helo comms to ensure breakaway command is heard.

c) Emergency breakaway procedures.

d) HF radio transmissions prohibited.

e) Helmet visors down.

## HIFR PROCEDURES

1. RESCUE CHECK, PART 1.

2. LANDING/HOVER CHECK - COMPLETE.

3. When vessel advises ready for HIFR, perform shipboard approach to a hover.

4. Complete RESCUE CHECK, PART 2 and confirm fuel requirement. Advise ship if different from briefed amount.

5. Set: RADAR/IFF-STBY; TACAN-REC (only).

6. Open HIFR refueling receptacle door and remove receptacle cover.

7. Perform hoist of refueling rig and hose from aft port side of flight deck.

8. Remain over the HIFR H until the HIFR rig is two-blocked. When HIFR rig is in position for hook-up, FM advises pilot.

**WARNING**

Ensure the fuel hose is not pressurized when connecting and disconnecting the refueling nozzle.

9. Connect grounding wire to refueling receptacle first, then HIFR nozzle to refueling receptacle, ensure "flow valves" are in line with the refueling hose and nozzle flow handle is in the open position; FM advises pilot.

10. Hoist Master Switch (cockpit overhead panel) - OFF.

**CAUTION**

To prevent damage to the aircraft, the hoist cable should not be sheared while the HIFR nozzle is connected. Use the HIFR Emergency Quick Disconnect Handle for Emergency Breakaway.

11. Position the helicopter off the port side of the vessel with rotors clear of the deck edge. Maintain an altitude of approximately 10-15 feet above the level of the flight deck, which will be approximately 30-35 feet above the water for U.S. Coast Guard vessels. Maintain a position that is aft of the VERTREP Ts and forward of the aft edge of the flight deck. Ensure the LSO is visible throughout the refueling operation and that the refueling hose does not enter the water or become taut.

**WARNING**

Due to the location of pumping stations on some cutters, the length of usable fuel hose from the edge of the flight deck to the aircraft may be as little as 100 feet. The fuel hose must not be allowed to become taut as separation is possible.

12. FM advise vessel by visual signal to commence fueling.

13. Monitor MGB Q; fuel quantity; and engine performance. Fuel quantity indicated in hover

attitude can be as much as 10 percent less than actual fuel aboard.

14. When desired fuel quantity is aboard, or upon reaching power limit (10% reserve), FM advise vessel by visual signal to cease fueling.

15. Upon receiving HAVE STOPPED PUMPING FUEL signal from LSO, begin disconnect procedures:

    a. Ensure the nozzle flow handle is in the closed position.

    b. Disconnect HIFR nozzle.

    c. Disconnect grounding wire.

    d. Replace the HIFR fueling adapter cover and close receptacle door.

    e. Hoist Master Switch (Cockpit Overhead Panel) - ON.

    f. Use standard hoisting procedures to lower hose and HIFR rig to flight deck. Do not allow fuel hose to trail into the water or HIFR rig to contact deck edge safety nets.

16. Secure for forward flight, reset RADAR/IFF/TACAN - AS REQUIRED, and execute transition to forward flight.

# PRACTICE EMERGENCY PROCEDURES

Practice emergencies may only be initiated with the pilot in command's consent. Malfunctions may be practiced by disabling or securing equipment. It is desirable to practice emergency procedures often, however, the PIC must exercise sound judgment to ensure practice procedures do not result in an actual emergency or high- risk maneuver. Simulated emergencies shall not be conducted during live hoists and are not recommended during practice DIW hoists, when committed.

## PRACTICE EMERGENCY MANEUVERS

The maneuvers required to deal with engine and tail rotor malfunctions should be practiced frequently to maintain the skills necessary to deal with an actual malfunction. These practice emergency maneuvers require two pilots in the cockpit, one an Aircraft Commander. The abbreviations used are: **PAC** = **P**ilot **A**t the **C**ontrols and; **SP** = **S**afety **P**ilot.

**NOTE**

It is left to the PIC's discretion whether to activate TCAS AUDIO MUTE. Consideration should be given to ambient traffic conditions, demanding maneuvers (requiring sterile cockpit conditions), and ATC traffic advisory capabilities. It is recommended that TCAS audio not be muted at airports without control towers.

## PRACTICE SINGLE ENGINE MANEUVERS

All practice single engine maneuvers are initiated by moving the Training Switch from Flight to the Idle 1 or Idle 2 position. Practice single engine flight may be initiated with the pilot in command's consent any time at or above 30 KIAS. Below 30 KIAS, initiation is prohibited unless a smooth, hard surface is available with crash equipment.

Movement of the Training Switch from Idle to Flight should only be performed when the FLI is at or below 8.0 during power reduction and the Nr is stabilized at 355 rpm (or 365 rpm if the Nr Switch is set to HI). The bleed air HEAT should be secured prior to initiating practice engine failures.

**WARNING**

Use of the FADEC Backup Switch is prohibited when the Training Switch is in the Idle 1 or Idle 2 position.

**CAUTION**

Demanding single engine maneuvers can cause excessive Nr droop. When Nr droops to 320 rpm, the N1 of the idled engine will begin to increase, providing additional power to maintain Nr at 320 rpm. The power provided by the idled engine is limited only by the actual OEI rating that corresponds to the OEI rating stop selected for the "good" engine.

**CAUTION**

Movement of the training switch back to flight with the FLI above 8.0 should only be done in extreme circumstances when aircraft damage is likely to result if the training switch is left in Idle 1/2. If the training switch is placed to flight at power settings above 8.0, actual OEI time may be accrued which shall be annotated on the CG–4377.

**CAUTION**

If greater than a 600 fpm rate of descent is exceeded and/or the aircraft emergency lighting system illuminates upon touchdown, the aircraft shall be secured. Further flight shall not be attempted until maintenance personnel complete a hard landing inspection.

## DURING FORWARD FLIGHT

CONTINUED FLIGHT PROCEDURE

This procedure is used any time an immediate landing is not appropriate.

SP 1. Select Idle 1 or Idle 2 position with Training Switch.

PAC 2. Nr - Maintain above 345 rpm (low Nr horn extinguished).

PAC 3. AIRSPEED/ALTITUDE - CONTROL. Adjust attitude to maintain altitude and accelerate/decelerate as required. Excess altitude may be exchanged for airspeed.

PAC 4. Collective - Adjust to maximum power while, maintaining Nr (minimum continuous limit = 345 rpm).

PAC 5. AIRSPEED - CLIMB 70-75 KIAS - CRUISE 70-110 KIAS.

PAC 6. OEI Rating Stop - Observe limits associated with the 30-second (HI) and 2-minute (LO) rating stops. Select continuous (CT) as soon as possible.

**CAUTION**

Do not allow rotor rpm to droop below 320 rpm.

To resume two engine operation:

PAC 1. Smoothly lower collective to reduce power on the FLI to at or below 8.0 while maintaining Nr at 355 rpm (or 365 rpm if the Nr Switch is set to HI).

SP 2. Select Flight (FLT) position with the Training Switch.

## ON TAKEOFF

Engine failures may be practiced on takeoff anytime there is sufficient clear area in front to accomplish a safe landing or continued flight.

LANDBACK PROCEDURE (Rejected takeoff).

This procedure is used anytime conditions allow immediate landing.

SP 1. Select Idle 1 or Idle 2 position with Training Switch.

PAC 2. Nr - Maintain above 345 rpm (low Nr horn extinguished).

PAC 3. Airspeed/Altitude - Control. Adjust attitude to obtain required groundspeed for touchdown.

PAC 4. Wheels/Floats - Wheels down.

PAC 5. Assume landing attitude, eliminating yaw and drift prior to touchdown.

**CAUTION**

Excessive aft cyclic movement on touchdown or after landing can cause rotor head to cowling contact and/or main rotor blade contact with the vertical stabilizer. Do not apply aft cyclic at or after touchdown.

PAC 6. After landing, smoothly lower collective with cyclic centered.

SP 7. Select FLT position with the Training Switch.

## ON APPROACH TO LANDING

Engine failures may be initiated during approach to landing, as long as airspeed is a minimum of 30 KIAS. Below 30 KIAS, a smooth, hard surface with crash equipment shall be available for a landing.

PRACTICE SINGLE ENGINE LANDING

Upon reaching a suitable landing area, in a simulated single engine profile:

SP 1. BEFORE LANDING/HOVER CHECK - COMPLETE.

PAC 2. OEI Rating Stop - Ensure 30-second (HI) rating stop selected.

PAC 3. Adjust pattern to arrive at the Transition Point.

PAC 4. Maintain translational lift until landing is assured.

PAC 5. Assume landing attitude, eliminating yaw and drift prior to touchdown.

**CAUTION**

Excessive aft cyclic movement on touchdown or after landing can cause rotor head to cowling contact and/or main rotor blade contact with the vertical stabilizer. Do not apply aft cyclic at or after touchdown.

PAC 6. After landing, smoothly lower collective with cyclic centered.

SP 7. Select Flight position with the Training Switch.

## FROM A LOW HOVER

Engine failures may be practiced from a hover over a smooth, hard surface when the wind is within 45° of the nose. Practice single engine failures above 5-foot wheel height can be particularly demanding in calm, high density altitude conditions. Increasing initiation hover height in increments (from the basic 5 ft. hover height) to determine handling and Nr droop is recommended.

**CAUTION**

High density altitude, calm winds or high gross weights may cause excessive Nr droop (Nr <320 rpm).

LOW HOVER SINGLE ENGINE PROCEDURE

PAC 1. Establish stable hover.

SP 2. Select Idle 1 or Idle 2 with Training Switch.

PAC 3. Adjust collective as required.

PAC 4. Assume landing attitude, eliminating yaw and drift.

PAC 5. Cushion the landing with collective.

PAC 6. Smoothly reduce collective to the down position with the cyclic centered.

SP 7. Select Flight position with the Training Switch.

## FROM A HIGH HOVER

The hover out-of-ground-effect (HOGE) single engine maneuver may be practiced over a smooth, hard surface with a relative wind of at least 5 knots up to 45° either side of the nose. The maneuver is initiated from an altitude at, or above, the calculated Height Loss After Engine Failure Hover OGE figure (chart A-12).

Upon entry, the PAC simultaneously maintains Nr > 345 rpm and adjusts pitch attitude to increase airspeed. The nose attitude should be lowered between 15 degrees and 20 degrees depending on the current headwind component. The higher

the headwind component the less pitch attitude required. To minimize excessive altitude loss, maintain the current collective setting until the low Nr aural horn sounds. Collective pitch should then be adjusted to extinguish the Nr horn. As the aircraft approaches 45 KIAS, decrease the pitch attitude to set a nose on the horizon attitude. Maintain attitude until achieving 75 KIAS. Observe limits associated with the 30-second (HI) and 2-minute (LO) rating stops. Select continuous (CT) rating stop as soon as possible.

## HIGH HOVER SINGLE ENGINE PROCEDURE

SP 1. Reference Figure A-12 to determine height loss after engine failure.

PAC 2. Establish stable OGE at predetermined altitude with enough usable runway to allow for completion of maneuver, or landing if necessary.

PAC 3. Use the airspeed vector arrow on the Hover page to ensure a minimum of 5 knots relative wind within 45° of the nose.

**WARNING**

Failure to establish a minimum 5 knots relative wind may result in power settling in a no wind, high density altitude or high gross weight condition. Power available may be insufficient to arrest the excessive rate of descent prior to ground impact.

SP 4. Select Idle 1 or Idle 2 position with Training Switch.

**NOTE**

The immediate goal is to achieve translational lift. Too little nose down will result in insufficient acceleration, while too much will unnecessarily increase the rate of descent.

PAC 5. Establish a 15° - 20° pitch attitude for acceleration.

PAC 6. Adjust collective to maintain Nr >345 RPM (low Nr audio horn extinguished).

PAC 7. Approaching 45 KIAS, adjust pitch attitude to nose on the horizon. Maintain pitch attitude until achieving 75 KIAS.

PAC 8. OEI Rating Stop - Observe limits associated with the 30-second (HI) and 2-minute (LO) rating stops. Select continuous (CT) as soon as possible.

**CAUTION**

Do not allow rotor rpm to droop < 320 rpm.

To resume two engine operation:

PAC 1. Smoothly lower collective to reduce power on the FLI to at or below 8.0 while maintaining Nr at 355 rpm (or 365 rpm if the Nr Switch is set to HI).

SP 2. Select Flight (FLT) position with the Training Switch.

## PRACTICE TAILROTOR MALFUNCTIONS

Tailrotor malfunctions may be practiced simulating complete loss of thrust or jammed pedals. Landings must be made under day VMC to a hard surfaced runway and with crash equipment available. The touchdown limit is 60 knots ground speed (KGS). Yaw is dependent on torque applied to the rotor and airspeed. In a partial-power situation (such as an approach), it is often possible to eliminate yaw as low as 50 KIAS without tailrotor thrust. A right cross wind (30° - 45° from the nose) helps to reduce yaw and touchdown groundspeed at a constant airspeed. A constant airspeed approach (resulting in right yaw once the collective is lowered to maintain glidepath) is recommended. Airspeeds of 70-80 KIAS are common for no-thrust approaches. When low over the runway, a level deceleration will result in the nose swinging left (due to decreasing horizontal lift). Reductions in collective will swing the nose right. Once touchdown is achieved, coordinate cyclic and collective to maintain directional control and reduce ground speed (collective down - moves the nose right; up - moves the nose left). The maximum brake application speed is 38 KGS. For practice, avoid heavy application of brakes.

## SIMULATED LOSS OF THRUST

At a speed of 120-125 KIAS in straight and level flight, the permanently offset vertical fins and the cambered vertical

stabilizer provide sufficient horizontal lift to maintain balanced flight without tailrotor thrust. Maintaining this pedal setting will simulate loss of thrust. Landing is facilitated at light gross weights (less torque applied to rotor). The final approach angle should be as shallow as possible, while maintaining a right yaw (left sideslip) during the approach.

## SIMULATED FIXED PITCH SETTING

With jammed pedals, the approach angle is predicated upon tailrotor thrust. In most situations, a shallow approach angle will produce best results. With right pedal forward, the touchdown speed to align the aircraft to the runway will be slow (high power demand, a left crosswind may help here). With left pedal forward, a high touchdown speed is required (possibly above 60 KGS). Due to the high speeds required to eliminate yaw in left-pedal-forward jammed pedals, it is often not possible to simulate these to a touchdown.

## PRACTICE TAILROTOR MALFUNCTION POWERED LANDING PROCEDURE

SP 1. Yaw pedals - Assume control.

2. AFCS yaw channel - Disengage.

3. BEFORE LANDING/HOVER CHECK - Complete.

PAC 4. Approach angle/speed - As required to maintain right yaw.

5. By 200 ft RADALT - Wheels down.

6. Touchdown - Eliminate yaw and drift.

7. Rollout - Coordinate cyclic and collective to maintain directional control and reduce groundspeed.

8. Brakes - Apply as required (38 KGS maximum).

**WARNING**

Rapid lowering of collective after touchdown may result in uncontrollable yaw.

**CAUTION**

Excessive aft cyclic movement on touchdown or after landing can cause rotor head to cowling contact and/or main rotor blade contact with the vertical stabilizer.

**CAUTION**

With the collective up and little weight on the tires, light brake application may be sufficient to lock the wheels and cause tire blowout.

When rollout completed;

SP 9. AFCS yaw channel - Reengage.

PAC 10. Flight controls - Reassure control of the yaw pedals.

## PRACTICE AUTOROTATION PROCEDURES

In the HH-65C the chance of a dual FADEC failure is 10-10 (1:10,000,000,000). Due to accuracy and sensitivity of the FADEC system, practice autorotation procedures in the aircraft cannot accurately reflect actual autorotation characteristics. Nr cannot be split from N2 because when the collective is raised to control Nr, FADEC matches Nr/N2. Furthermore, practice procedures for flare, rock out, and termination are artificial due to both engines running at 100%. At termination during a practice autorotation the nose yaws left due to power being applied to the rotor head. In actual autorotation the nose will yaw right during the collective pull to cushion the landing. Therefore, practice autorotations are not required in the H-65C. Autorotations will be practiced in the H-65 simulator because other situations could cause engine failures, i.e. mechanical failures or fuel starvation/contamination.

When all of the above items are considered together it makes the attempt at practice autorotations in the H-65C Model very unrealistic and would develop negative pilot habits in the event of an actual autorotation. Rather than require unrealistic practice autorotations each semi-annual period, the simulator will be used to conduct more realistic autorotations for H-65C Model pilots.

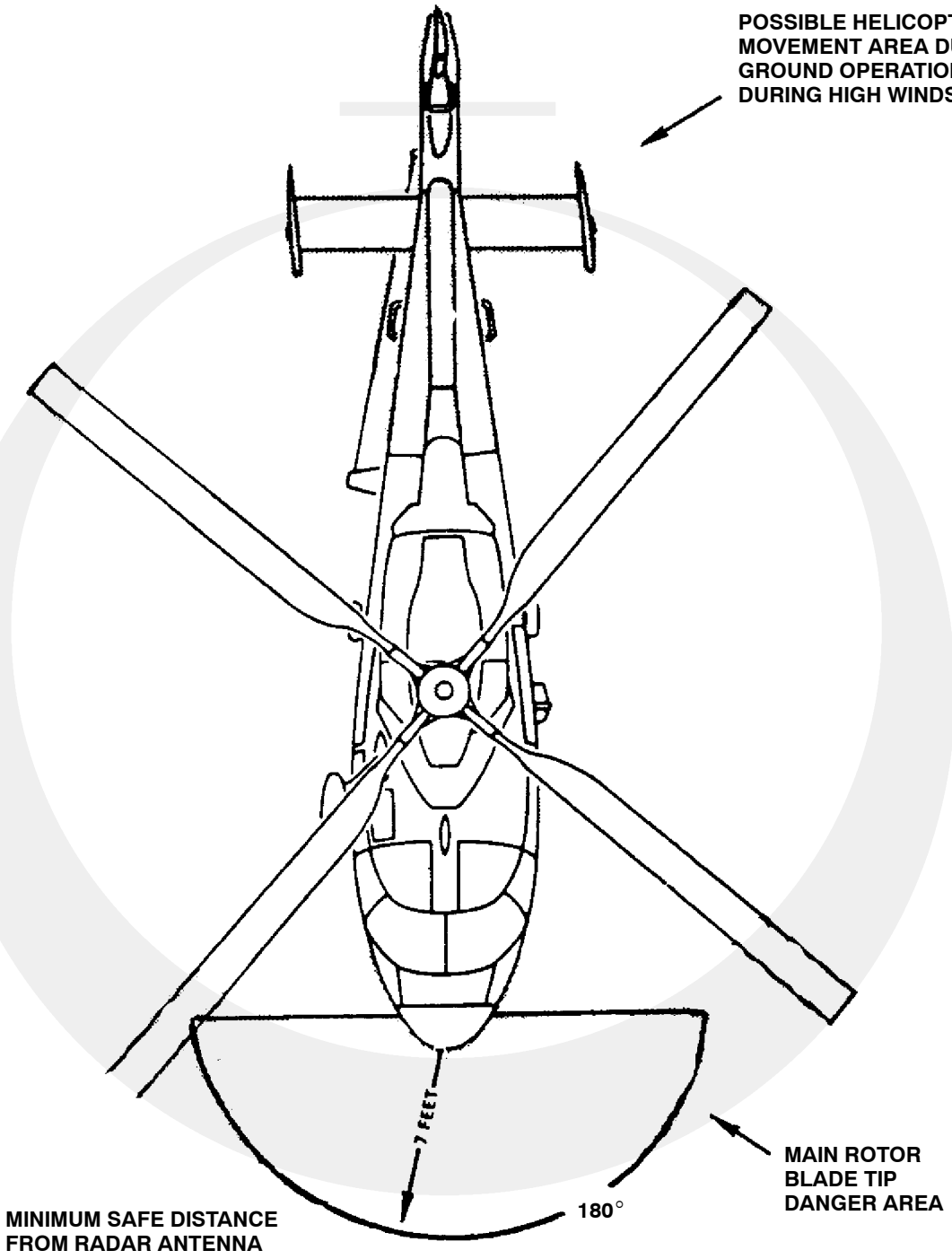



*Figure 2-5. Danger Areas*

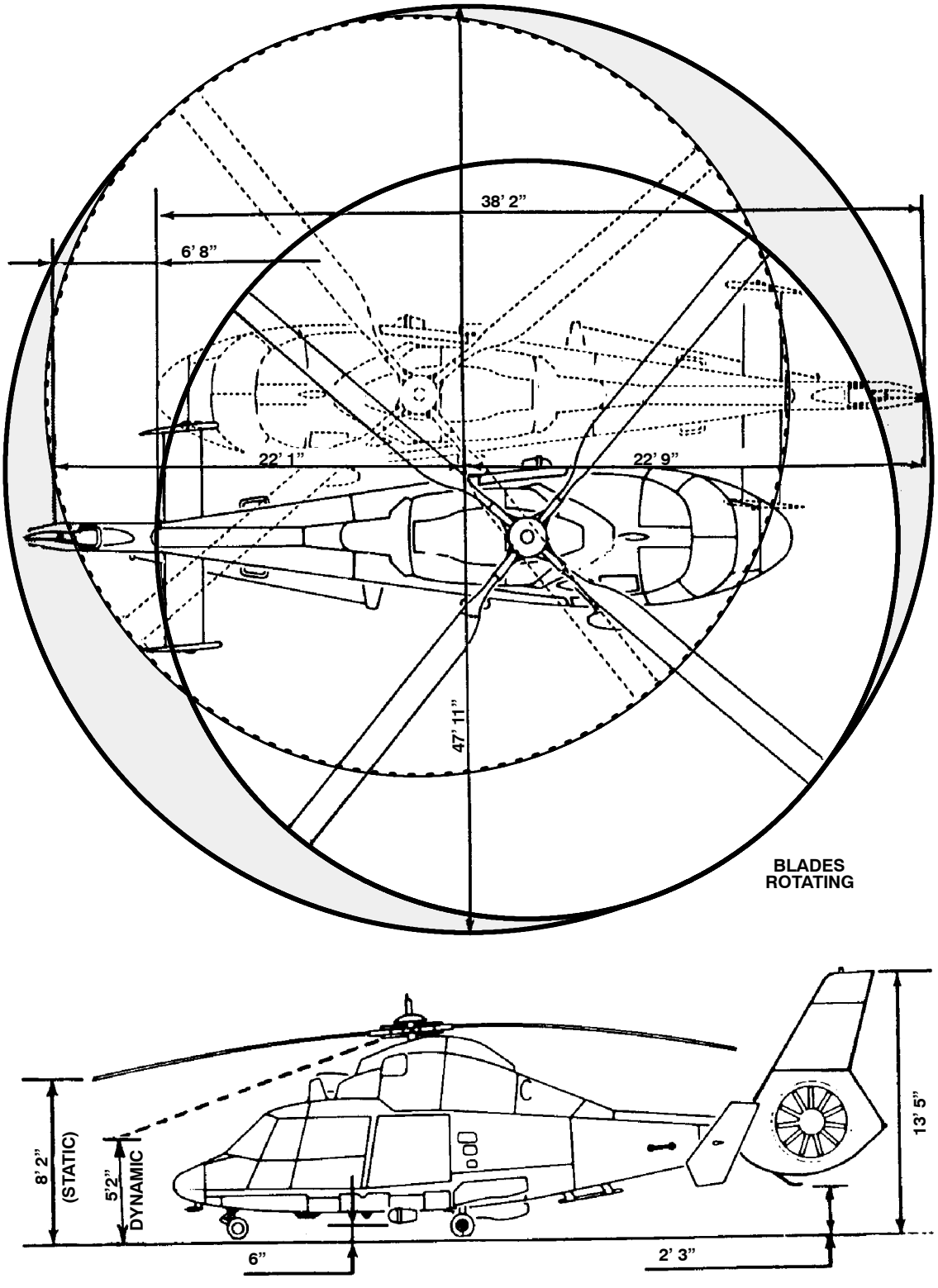



*Figure 2-6. Turning Radius and Ground Clearance Diagram*

# SECTION III

# EMERGENCY PROCEDURES

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# INTRODUCTION

Due to the varied types of equipment installed, pilots and aircrewmen must be thoroughly familiar with the emergency procedures in the succeeding paragraphs. The emergency situations and procedures outlined in this section cover the general types of emergencies encountered; however, the procedures in an actual emergency must result from consideration of the complete situation.

The corrective actions for each emergency are divided into critical and noncritical items.The critical items are those actions which must be performed immediately to preclude aggravating the condition and/or to avoid further damage or injury. The critical items in this section are in **BOLD FACE TYPE** and **MUST BE COMPLETED FROM MEMORY**.

**NOTE**

The lack of bold face type associated with the less critical items does not relieve the pilot of the responsibility to maintain the appropriate aircraft systems knowledge required to correctly identify the malfunction and understand the relationship of the malfunctioning component/system to other components/systems. It is recommended that the 1H-65C-1-CL1, Emergency Procedures handbook be referred to when completing non-critical corrective actions.

Regardless of the nature and severity of the emergency, the overriding consideration must be to:

1. MAINTAIN AIRCRAFT CONTROL.
2. ANALYZE THE SITUATION.
3. TAKE APPROPRIATE ACTION.

Compound emergencies may require departure from normal corrective procedures for any specific emergency. Four standard terms are used in this section for the purpose of standardizing phraseology.

1. LAND/DITCH IMMEDIATELY - Due to the seriousness of the malfunction, the aircraft must be landed or ditched without delay. If extreme sea/terrain conditions seriously jeopardize aircrew survivability, the aircraft may be air taxied to the nearest suitable site and landed or ditched immediately.

**WARNING**

The potential loss of the airframe after aircrew egress is not sufficient cause to continue flight.

2. LAND AS SOON AS POSSIBLE - Aircraft shall be landed at the first site at which a safe landing can be made.
3. LAND AS SOON AS PRACTICABLE - Extended flight is not recommended. The landing site and duration of flight is at the discretion of the pilot in command.
4. ABORT MISSION - The aircraft shall not proceed on its assigned mission. Allows for continued flight to the DESIRED RECOVERY BASE.
5. CONTINUE FLIGHT AS APPROPRIATE - Allows continuation of the mission if the failed component is not required to accomplish the mission and airframe or component limitations have not been exceeded.

When the aircraft is damaged away from home station, the pilot in command shall ensure compliance with the inspection requirements of M3710.1(series).

**NOTE**

The ECMS has the capability to record multiple exceedances that occur simultaneously. When the “Engine Exceed” annunciation comes on, the pilot should scroll through the exceedance pages to confirm the presence of all exceedances with the associated event. “CHECK CDU” and “ENGINE EXCEED” annunciations DO NOT constitute secondary indications of a malfunction.

The phrase “PULL, RESET” in relation to circuit breakers means to reset a popped circuit breaker, or to pull and reset a circuit breaker that controls power to an individual item. Circuit breakers should only be reset once.

# MAIN GEARBOX/OVERTORQUE

A combination of abnormal pressure indications and/or temperature indications should NOT be treated as an indicating malfunction, but rather as a Main Gearbox malfunction. The VEMD should be used to verify whether a GB Chip warning light is associated with the Main gearbox or the Tail Rotor gearbox.

## MAIN GEARBOX FAILURE IMMINENT

If an immediate landing/ditching seriously jeopardizes aircrew survivability, i.e., extreme sea/terrain conditions, air taxi to the nearest suitable site and land/ditch immediately.

**WARNING**

The potential loss of the airframe after aircrew egress is not sufficient cause to continue flight.

Symptoms:

1. Loss of XMSN lubrication **OR** illumination of a GB CHIP warning light with an MGB CHIP annunciation on the VEMD CAUTION/FUEL page in conjunction with any one of the following:
   - Yaw kicks
   - Abnormal transmission noises
   - Unusually high power requirements
2. LOSS of XMSN lubrication **AND** illumination of a GB CHIP warning light with an MGB CHIP annunciation on the VEMD CAUTION/FUEL page.

Corrective Action:

1. **BEFORE LANDING/HOVER CHECK - COMPLETE.**
2. **LAND/DITCH IMMEDIATELY (POWER ON).**

## MAIN GEARBOX MALFUNCTION

Any **ONE** of the following conditions constitutes an indication of a single malfunction. Several symptoms may be evident in a single malfunction. The loss of XMSN lubrication, for instance, will be indicated by illumination of the MGB press warning light; MGB PMP MAIN, and MGB PMP AUX caution lights; **and** XMSN oil pressure at zero. While serious, a single malfunction does not indicate that a Main Gearbox failure is imminent. Flight without Main Gearbox oil lubrication should be sustainable for approximately 25 minutes. In the event of high temperature indications, minimize hovering and ground operations due to loss of cooling airflow.

Symptoms:

Any **ONE** of the following:

1. Loss of XMSN lubrication.
2. GB CHIP warning light illuminated with an MGB CHIP annunciation on the VEMD CAUTION/FUEL page.
3. Abnormal transmission noises.

Corrective Action:

1. MONITOR ENGINE AND TRANSMISSION INSTRUMENTS, CAUTION PANEL AND TORQUE INDICATIONS.
2. FLY AT MINIMUM SAFE ALTITUDE.
3. MAINTAIN AIRSPEED BETWEEN 75 AND 100 KIAS.
4. AVOID HIGH POWER MANEUVERS.
5. LAND AS SOON AS PRACTICABLE.

**NOTE**

In order to determine whether or not power requirements have increased for an MGB problem, the pilot should note flight regime, airspeed and current power setting at the onset of the malfunction to establish a baseline for later comparison.

## MGB PUMP MAIN ELEMENT FAILURE

The MGB oil pump main element may cease to operate due to partial loss of MGB oil supply or failure of the element itself. MGB lubrication will continue to be provided by the auxiliary element of the pump. The auxiliary element operates at a lower pressure and bypasses the oil cooler.

Symptoms:

1. Illumination of MGB PMP MAIN caution light.
2. Decrease in XMSN oil pressure.
3. Increase in XMSN oil temperature.

Corrective Action:

1. MONITOR XMSN OIL PRESSURE and TEMPERATURE.
2. LAND AS SOON AS PRACTICABLE.

## MGB PUMP AUXILIARY ELEMENT FAILURE

During normal operation, the auxiliary element of the MGB oil pump is not used for lubrication. A failure will indicate loss of redundancy in case of main element failure.

Symptoms:

1. Illumination of MGB PMP AUX caution light.

Corrective Action:

1. MONITOR XMSN OIL PRESSURE and TEMPERATURE.
2. ABORT MISSION.

## MAIN GEARBOX INDICATING SYSTEM FAILURE

Symptoms:

Any **ONE** of the following conditions:

1. MGB PRESS warning light illuminated.
2. XMSN oil pressure in red or zero. (May be accompanied by MGB exceedance in CDU due to shared transducer.)
3. XMSN oil temperature in red or zero.

Corrective Action:

1. MONITOR FOR SECONDARY INDICATIONS.
2. ABORT MISSION.

## MGB OVERTEMP

High power settings may increase operating temperatures. Operation at slow speeds (below 120 KIAS) may not provide sufficient airflow through the oil cooler for effective cooling. This failure may not be evident at airspeeds above 120 KIAS.

Symptoms:

1. OIL TEMP warning light illuminated.
2. Abnormal rise in MGB oil temperature.

Corrective Action:

1. CRUISE AIRSPEED - 120 KIAS MINIMUM.
2. LAND AS SOON AS PRACTICABLE.

## MAIN GEARBOX HIGH PRESSURE

Symptoms:

1. Transmission oil pressure greater than 80 psi.

Corrective Action:

1. LAND AS SOON AS PRACTICABLE.

## MGB OVERTORQUE

All overtorque conditions must be recorded on CG Form 4377. Note flight regime, maximum MGB torque value, and duration. If the overtorque occurred in hover flight, annotate whether or not pedal input caused the overtorque condition. (See Figure 3-1.)

## HOVER FLIGHT AND TRANSITION FLIGHT BETWEEN 0 AND 75 KIAS

Symptom:

1. MGB Q greater than 100% but less than 107%.

Corrective Action:

1. **REDUCE TORQUE TO WITHIN LIMITS, WHEN ABLE.**

Symptom:

1. MGB Q greater than or equal to 107% but less than 110%.

Corrective Action:

1. ABORT MISSION. URGENT MISSION MAY BE COMPLETED.

Symptom:

1. MGB Q greater than or equal to 110%.

Corrective Action:

1. LAND AS SOON AS PRACTICABLE.

## CRUISE FLIGHT (ABOVE 75 KIAS)

Symptom:

1. MGB Q greater than 88% but less than 103.4%.

Corrective Action:

1. **REDUCE TORQUE TO WITHIN LIMITS, WHEN ABLE.**
2. EXCEEDANCE AND DURATION ABOVE 94% SHOULD BE RECORDED ON CG Form 4377.

Symptom:

1. MGB Q greater than or equal to 103.4% but less than 110%.

Corrective Action:

1. ABORT MISSION. URGENT MISSION MAY BE COMPLETED.

Symptom:

1. MGB Q greater than or equal to 110%.

Corrective Action:

1. LAND AS SOON AS PRACTICABLE.

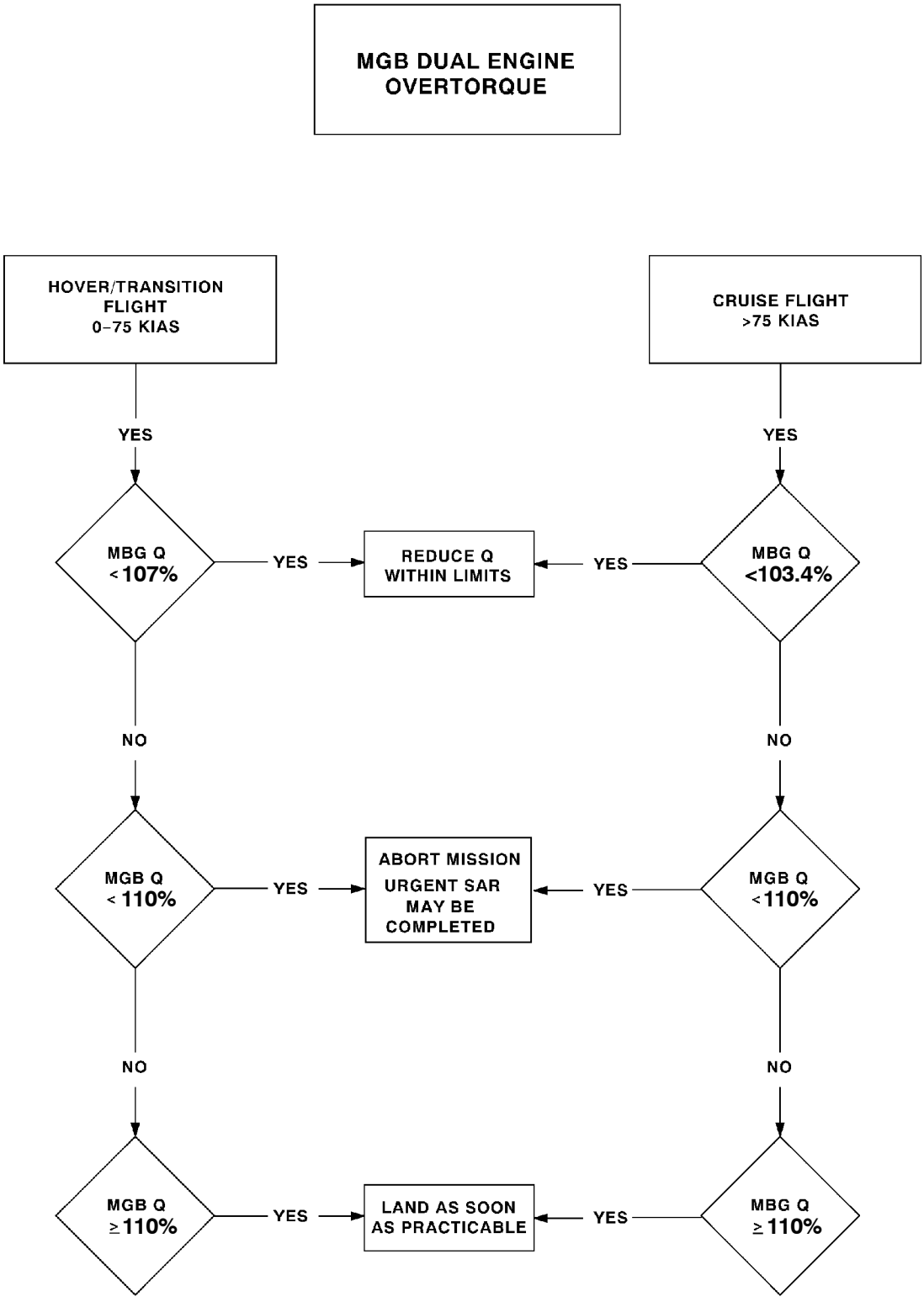



*Figure 3-1. MGB Dual Engine Overtorque*

# FIRES

## MAIN GEARBOX FIRE

Illumination of the MGB fire detector may indicate a fire or overheat condition in the main gearbox compartment, or a short circuit in the detection system. Since no fire extinguishing system is provided for the main gearbox compartment, immediate action should be taken to confirm the presence of fire.

**WARNING**

Due to the potential for fire damage to the flight control servos and/or the associated hydraulic lines, a fire in this compartment may result in complete loss of aircraft control.

Symptoms:

1. MGB fire warning light illuminated.

Additional possible symptoms:

2. Illumination of MGB related warning and caution lights.
3. Loss of MGB oil pressure and/or rise in temperature.
4. Drop in fuel or hydraulic pressure.
5. Electrical system malfunctions.

Corrective Action:

1. **ATTEMPT TO CONFIRM PRESENCE OF FIRE (alert crew).**
2. **BEFORE LANDING/HOVER CHECK – COMPLETE.**

If fire confirmed:

3. **LAND/DITCH IMMEDIATELY.**

If fire NOT confirmed:

3. LAND AS SOON AS POSSIBLE.

## ENGINE COMPARTMENT FIRE IN-FLIGHT

Due to engine location, confirming a fire in-flight may be difficult. It may be necessary for an aircrew member to open one of the cabin doors to observe the engines. Ensure a gunner's belt is utilized for this evolution.

Symptoms:

1. FIRE warning light illuminated on the instrument panel.
2. Red warning light illuminated on the corresponding Emergency Fuel Shutoff Lever (EFSL).
3. Flames and/or smoke coming from engine compartment.

Corrective Action:

1. **ATTEMPT TO CONFIRM PRESENCE OF FIRE (alert crew).**
2. **SINGLE ENGINE FLIGHT PROFILE – ESTABLISH.**

If fire confirmed;

3. **FADEC CONTROL SWITCH (affected engine) – CONFIRM; IDLE; CONFIRM; SHUT OFF.**
4. **EMERGENCY FUEL SHUTOFF LEVER – CONFIRM; SHUT OFF.**
5. **BOOST PUMPS – (affected engine) – OFF.**
6. **PRI FIRE EXTINGUISHER BUTTON (affected engine) – CONFIRM; PUSH.**
7. **SEC FIRE EXTINGUISHER BUTTON (affected engine) – PUSH.**

If fire still persists:

8. **BEFORE LANDING/HOVER CHECK – COMPLETE.**
9. **LAND/DITCH IMMEDIATELY.**

If fire no longer evident:

8. **LAND AS SOON AS POSSIBLE.**

## ENGINE COMPARTMENT FIRE ON DECK

Symptoms:

1. FIRE warning light illuminated.
2. Possible hand or voice signals from ground crew.
3. Red warning light illuminated on the corresponding Emergency Fuel Shutoff Lever (EFSL).

Corrective Action:

1. **ATTEMPT TO CONFIRM PRESENCE OF FIRE (alert crew).**
2. **FADEC CONTROL SWITCHES – BOTH OFF.**
3. **EMERGENCY FUEL SHUTOFF LEVERS – SHUT OFF.**
4. **BOOST PUMPS – ALL OFF.**

If fire confirmed:

5. **PRI FIRE EXTINGUISHER BUTTON (affected engine) – CONFIRM; PUSH.**
6. **SEC FIRE EXTINGUISHER BUTTON (affected engine) – PUSH.**
7. **EMERGENCY ELECTRICAL CUTOFF – OFF.**
8. **ROTOR BRAKE – ON.**
9. **EVACUATE AIRCRAFT.**

## INTERNAL FIRE (CABIN, ELECTRICAL, AND/OR AVIONICS)

**CAUTION**

A popped circuit breaker should only be reset once. Repeated resetting or holding in may result in an electrical fire.

Corrective action:

1. **DESIGNATE CREWMAN TO FIGHT FIRE.**
2. **AFFECTED EQUIPMENT – OFF.**
3. **HEAT/COOL SWITCHES – OFF.**
4. **RAM AIR – CLOSED.**
5. **CABIN SLIDING DOOR – CLOSED.**
6. **PILOT'S WINDOWS – CLOSED.**
7. **RACK BLOWER CIRCUIT BREAKER – PULL (for avionics rack fire only).**
8. **CIRCUIT BREAKERS – PULL (for affected circuits).**

**NOTE**

An avionics fire will be fought by disconnecting enough camlocks on the avionics rack panel to allow access for the fire extinguisher nozzle. Short blasts are advised to preserve extinguishing agent in case of a reflash. Close rack panel and monitor for reflash.

**NOTE**

All communication, both internal and external, and all aircraft system lighting will be lost after activating Emergency Cut-Off switch.

**WARNING**

The severity of the fire and actual flight conditions (night/instrument) will dictate the immediate procedures to be followed. It may not be advisable to secure all electrical power, thus losing AFCS and flight instruments, prior to achieving VMC.

If electrical or avionics fire persists:

9. **LANDING GEAR HANDLE – DOWN.**
10. **EMERGENCY ELECTRICAL CUTOFF SWITCH – OFF.**

If electrical or avionics fire persists:

11. **LAND/DITCH IMMEDIATELY.**

If fire goes out:

11. **LAND AS SOON AS POSSIBLE.**

## SMOKE AND FUME ELIMINATION

Corrective Action:

1. **HEAT/COOL SWITCHES – OFF.**
2. **RAM AIR – OPEN.**
3. **CABIN SLIDING DOOR – OPEN.**
4. **PILOTS' WINDOWS – OPEN.**
5. **LAND AS SOON AS PRACTICABLE.**

**WARNING**

If fuel fumes are present, limit radio transmissions to a minimum. Due to antenna location, COMM 1 is the best choice.

**CAUTION**

To avoid the possibility of rotor blade or structural damage, do not jettison any window or door unless deemed absolutely essential for smoke or fume removal.

Normally, no toxic quantities of carbon monoxide gas or other gases are present from the engine exhaust. Objectionable odors from the ECS are sometimes experienced due to internal oil leaks in the engine(s). These fumes may be noxious to the crew and should be entered on CG Form 4377 ("pink sheet"). Opening the sliding door and the pilots' windows in-flight will assist in removing objectionable fumes and odors.

### ENGINE POST-SHUTDOWN FIRE

Symptom:

1. TOT rises or does not decrease within 5 to 6 seconds after the FADEC control switch has been placed in the OFF position.

Corrective Action:

1. **FADEC CONTROL SWITCHES – CHECK OFF.**
2. **BOOST PUMPS – CHECK OFF.**
3. **EMERGENCY FUEL SHUTOFF LEVERS – SHUT OFF.**

**CAUTION**

Operation of the crank button with the EFSL pulled will cause severe damage to the engine fuel pump.

4. **CRANK BUTTON – DEPRESS UNTIL TOT DECREASES.**

If high TOT persists:

5. **EMERGENCY ELECTRICAL CUTOFF SWITCH – OFF.**
6. **ROTOR BRAKE – ON.**
7. **EVACUATE AIRCRAFT.**

### FIRE DETECTOR FAILURE

An open circuit in the fire detection system will result in "FAIL" light illumination, while a short circuit will result in a false "FIRE" light and EFSL light illumination.

Possible Symptoms:

1. Fire detector FAIL light illuminated.
2. FIRE light illuminated without other indications of fire.
3. Fire detection light on the EFSL illuminated without other indications of fire.

Corrective Action:

1. LAND AS SOON AS PRACTICABLE.

### FIRE SUPPRESSION FAILURE

L and/or R EXT Caution Lights illuminate when the bottle(s) have been expended.

Symptom:

1. L or R EXT caution light illuminated.

Corrective Action:

1. ABORT MISSION.

## AIRCRAFT DAMAGE

Any known or suspected aircraft damage should be considered serious. What appears minor on the surface may in fact involve structural or flight control components. If a precautionary landing is made for suspected aircraft damage, the pilot in command shall ensure that a proper inspection of the aircraft is conducted by competent maintenance personnel. If the damage is determined by the engineering officer, or other qualified maintenance officer, to be non-structural or cosmetic, the commanding officer may clear the aircraft for further flight. Refer to COMDTINST M3710.1 (series) for more complete details on clearance of damaged aircraft.

### ROTOR BLADE DAMAGE

If the main/tail rotor blades have been damaged by a foreign object, the helicopter shall not be flown until a thorough in-

spection has been accomplished by qualified maintenance personnel and maintenance release obtained.

If accompanied by strong medium frequency vibrations or abnormal noise from the tail section, plan your approach for the possible loss of tail rotor thrust. If an immediate landing/ditching seriously jeopardizes aircrew survivability, i.e., extreme sea/terrain conditions, air taxi to the nearest suitable site and land/ditch immediately.

**WARNING**

The potential loss of the airframe after aircrew egress is not sufficient cause to continue flight.

**NOTE**

A reduction in airspeed may reduce vibrations and improve flight characteristics (weather, flight conditions, and distance from landing area permitting).

Symptom:

1. Rotor blade damage is known or suspected, with or without secondary indications of up to mild.

Corrective Action:

1. **LAND AS SOON AS POSSIBLE.**

Symptoms:

1. Rotor blade damage is known or suspected.

**AND**

2. Secondary indications (such as vibrations) are more than mild, flight characteristics are drastically altered.

Corrective Action:

1. **BEFORE LANDING/HOVER CHECK COMPLETE.**
2. **LAND/DITCH IMMEDIATELY.**

### ABNORMAL VIBRATIONS

An unusual vibration should be investigated to determine its cause. The perceived severity of the vibration will determine whether continued flight is appropriate.

Corrective Action:

1. CRUISE AIRSPEED - 75-120 KIAS.
2. AVOID ABRUPT MANEUVERS.
3. LAND AS SOON AS PRACTICABLE.

**NOTE**

A reduction in airspeed may reduce vibrations and improve flight characteristics (weather, flight conditions, and distance from landing area permitting).

### WINDSCREEN CRACKS

Symptom:

1. Either inner or outer pane on windshield cracked.

Corrective Action:

1. CRUISE AIRSPEED 70 KNOTS MAXIMUM.
2. IF ARCING ON WINDSCREEN IS NOTICED, SECURE WINDSCREEN ANTI-ICE.
3. ABORT MISSION.

Symptom:

1. Both inner and outer panes on windscreen cracked.

Corrective Action:

1. CRUISE AIRSPEED 70 KNOTS MAXIMUM.
2. IF ARCING ON WINDSCREEN IS NOTICED, SECURE WINDSCREEN ANTI-ICE.
3. LAND AS SOON AS PRACTICABLE.

## MAIN/TAIL ROTOR

### MAIN ROTOR OVERSPEED

Symptom:

1. Nr 395 RPM to less than 420 RPM.

Corrective Action:

1. ABORT MISSION.

Symptom:

1. Nr 420 RPM or greater.

Corrective Action:

1. LAND AS SOON AS PRACTICABLE.

## NR 365 RPM SYSTEM MALFUNCTION

Symptom:

1. RPM HI caution light illuminated with Nr High switch off.
2. Nr ≥ 365 RPM with the Nr High switch off.

Corrective Action:

1. Nr SWITCH - NORMAL.

If failure persists:

2. AIRSPEED - LESS THAN 135 KIAS.
3. ANGLE OF BANK 40 DEGREES MAXIMUM.
4. CONTINUE FLIGHT AS APPROPRIATE.

## NR INDICATING SYSTEM FAILURE

Symptom:

1. One or both Nr gages fluctuates abnormally or indicates zero.

Corrective Action:

1. **COMPLETE THE "BIG 4."**
2. MONITOR OTHER NR INDICATOR (IF OPERABLE) OR N2.
3. AVOID ABRUPT MANEUVERS.
4. ABORT MISSION.

**NOTE**

The Low Nr audio will still function even when the Nr indicator fails.

## UNCOMMANDED LEFT YAW (ULY)

Uncommanded Left Yaw (ULY) is the occurrence of any unanticipated left yaw rate which does not subside of its own accord and is not caused by a mechanical failure of the tail rotor drive system. If timely corrective actions are not applied, this left yaw rate may accelerate and result in loss of aircraft control. Such yaw rates may appear benign at initial onset; however, if the aircraft does not instantaneously respond to corrective control inputs, the pilot must take immediate action for a ULY condition. A ULY condition can normally be differentiated from a loss of tail rotor thrust by the rate of yaw acceleration experienced. A loss of tail rotor thrust will result in an immediate, rapid yaw acceleration. ULY will generally begin with a gradually accelerating yaw rate when operating in flight regimes known to be conducive to uncommanded yaw. Operation of the Nr Hi system greatly increases tail rotor authority. Consideration should be given to having the non-flying pilot switch the Nr to Hi while the flying pilot executes the initial corrective actions.

Symptom:

1. Any uncommanded left yaw not attributable to mechanical failure of the tail rotor drive system.

Corrective Action:

1. **IMMEDIATE FULL RIGHT PEDAL, MAXIMUM DEFLECTION.**
2. **ALTITUDE/OBSTACLES PERMITTING, SMOOTHLY APPLY FORWARD CYCLIC TO INCREASE FORWARD AIRSPEED.**
3. **ALTITUDE PERMITTING, REDUCE COLLECTIVE.**
4. **NR HI SWITCH – 365 RPM.**

**CAUTION**

Gradual pedal input will not arrest increasing rates of yaw. Recovery will lag pedal input. During flight testing, up to 300 degrees of lag has been experienced between pedal application and yaw stabilization. This must not be mistaken for a loss of thrust situation.

**WARNING**

Rapidly lowering the collective can initiate or increase an undesirable descent rate. If a large descent rate develops close to the ground/water, the subsequent large collective increase required to arrest the descent prior to ground/water contact may aggravate or re-initiate ULY.

## TGB CHIP DETECTED

If accompanied by strong medium frequency vibrations or abnormal noise from the tail section, plan your approach for the possible loss of tail rotor thrust.

Symptom:

1. Illumination of the GB CHIP warning light and a TGB CHIP annunciation on the VEMD CAUTION/FUEL page.

Corrective Action:

1. **ESTABLISH SAFE ALTITUDE AND AIRSPEED FOR POSSIBLE LOSS OF TAIL ROTOR THRUST.**

2. **LAND AS SOON AS POSSIBLE.**

## LOSS OF TAIL ROTOR THRUST WHILE HOVERING

Symptoms:

1. A loss of tail rotor thrust will result in an IMMEDIATE, rapid left yaw acceleration.

2. Tail rotor pedals movable but with no apparent effect.

3. Abnormal vibration or noise from the tail section.

4. Illumination of the GB CHIP warning light and a TGB CHIP annunciation on the VEMD CAUTION/FUEL page.

Corrective Action:

1. **EMERGENCY FUEL SHUTOFF LEVERS – BOTH OFF.**

2. **MAINTAIN LANDING ATTITUDE.**

3. **CUSHION LANDING WITH COLLECTIVE.**

## LOSS OF TAIL ROTOR THRUST IN FORWARD FLIGHT OR FIXED TAIL ROTOR PITCH

With loss of tail rotor thrust, the permanently offset lateral fins and the cambered vertical fin provide sufficient horizontal lift to maintain balanced flight at airspeeds above 120-125 KIAS in straight and level flight. Landing is facilitated at light gross weight and with right crosswind. The final approach angle should be as shallow as possible while producing a right yaw (left sideslip) during the approach. Changing the Nr switch from its current setting may exacerbate a tail rotor malfunction based on a high or low fixed pitch setting. Changing the existing setting is not recommended.

With a fixed tail rotor pitch (jammed pedals), the approach angle will be predicated upon tail rotor thrust. With right pedal forward, the touchdown speed to align the aircraft to the runway will be slow (high power demand). With left pedal forward, a high touchdown speed (possibly above 60 KGS) will be required to align the aircraft (high lateral/vertical fin lift). Relative wind can be used to assist with runway alignment and to minimize ground speed (left crosswind for stuck pedal positions above that required for stable hover power; right crosswind for stuck left). With the pedals jammed, the AFCS may assist in maintaining balanced flight through the YAW series actuator.

**WARNING**

If a suitable surface is not available, a power-off autorotative landing to the best available area is required.

Possible Symptoms:

1. Uncommanded yaw to the left or right (loss of thrust).

2. Tail rotor pedals movable without effect (loss of thrust).

3. Abnormal vibration or noise from the tail section (loss of thrust or fixed pitch).

4. Possible illumination of the GB CHIP warning light (loss of thrust) with a TGB CHIP annunciation on the VEMD CAUTION/FUEL page.

5. Cannot move pedals either left or right (fixed pitch).

Corrective Action:

1. **DIRECTIONAL CONTROL – MAINTAIN USING CYCLIC AND COLLECTIVE.**

2. LAND AS SOON AS PRACTICABLE. UTILIZE PROCEDURE FOR LANDING WITH TAIL ROTOR MALFUNCTION.

## POWERED LANDING WITH TAIL ROTOR MALFUNCTION

1. BEFORE LANDING/HOVER CHECK - COMPLETE.
2. APPROACH ANGLE/SPEED - AS REQUIRED TO MAINTAIN RIGHT YAW (left sideslip).
3. TOUCHDOWN - ELIMINATE YAW AND DRIFT.
4. ROLLOUT - COORDINATE CYCLIC AND COLLECTIVE TO MAINTAIN DIRECTIONAL CONTROL AND REDUCE GROUND SPEED.

**CAUTION**

With the collective up and little weight on the tires, light brake application may be sufficient to lock the wheels and cause tire blowout. Rapid lowering of collective after touchdown may result in uncontrollable yaw to the right.

5. BRAKES - APPLY AS REQUIRED.

## AUTOROTATIVE LANDING WITH TAIL ROTOR MALFUNCTION

An autorotation with no tail rotor thrust will result in increasing left sideslip (right yaw) as airspeed increases above 50 KIAS. At 75 KIAS, bank angles of 10-15 degrees left-wing-down will be required to maintain heading. As airspeed decreases in the flare, the aircraft will yaw left with a constant collective setting. A right crosswind component of 20-45 degrees is desirable. More crosswind will increase groundspeed without alleviating the sideslip. As the collective is increased to cushion the landing, the aircraft will yaw right.

**NOTE**

Placing the engine in the IDLE DETENT position allows the option to abort the maneuver, at least until the flare.

If the engines are left at IDLE, the aircraft will yaw left as the collective is increased to cushion the landing and Nr droops below 345 (torque applied to the rotor). This will aggravate the left yaw already existing due to low airspeed at the end of the flare.

In summary, the aircraft will initially be in a right yaw as the auto is established. During the flare it will yaw left. With increased collective to cushion the landing, the aircraft will yaw right again. This should all result in close to zero sideslip at touchdown.

1. BEFORE LANDING/HOVER CHECK - COMPLETE.
2. AIRSPEED - 75 KIAS.
3. COLLECTIVE - DECREASE TO ESTABLISH AUTOROTATION.
4. FADEC CONTROL SWITCHES - IDLE.
5. AT 200 FT RADALT - WHEELS AS REQUIRED.

If satisfied that the approach will permit successful completion of the autorotation to the desired area:

6. FADEC CONTROL SWITCHES - OFF.
7. AT 125 FT RADALT - INITIATE FLARE. INFLATE FLOATS AS REQUIRED.
8. ASSUME LANDING ATTITUDE, ELIMINATING DRIFT PRIOR TO TOUCHDOWN.
9. COLLECTIVE - CUSHION THE LANDING.

# ENGINES

## ENGINE EMERGENCIES IN-FLIGHT - GENERAL

FOR ANY SUSPECTED ENGINE MALFUNCTION, THE FOLLOWING BASIC PROCEDURES APPLY AND WILL BE REFERRED TO AS THE “BIG 4:”

1. **Nr – MAINTAIN.**
2. **AIRSPEED/ALTITUDE – CONTROL AND SET LIMITS.**
3. **WHEELS/FLOATS – AS REQUIRED.**
4. **ANALYZE.**

Corrective action should be based on a careful analysis of all engine indications, i.e., Nr, Torque, N1, and TOT. In addition, after completing the initial analysis, pilots must maintain situational awareness by continuously monitoring the appropriate instruments.

**CAUTION**

Any operation of the engines in the 30 Second power range will require major engine maintenance. The helicopter shall be landed as soon as practicable. Further flight shall not be attempted until a thorough inspection has been accomplished by qualified maintenance personnel and a maintenance release obtained.

## DUAL ENGINE FAILURE IN-FLIGHT - GENERAL

Without the engines driving the rotor, Nr will decrease rapidly. With Nr in the desired range (optimum 360 RPM ), some collective will be required to prevent overspeed. In order to minimize ground speed for landing, autorotative landings should be performed into the wind. For water landings, the flotation should be inflated prior to water contact.

MAXIMUM GLIDE

A speed of 105 KIAS and 360 RPM will result in maximum glide distance.

MINIMUM RATE OF DESCENT

A speed of 75 KIAS and 360 RPM will result in the minimum rate of descent. Any increase in rotor RPM will result in a greater rate of descent.

**LANDING ON WATER OR UNPREPARED SURFACE**

This type of landing will require a minimum ground speed touchdown. Zero ground speed is desirable, but may be difficult to attain due to lack of wind, high gross weight, or high density altitude. Prior to touchdown, set a landing attitude of 5° nose up to prevent noseover. Increase collective to cushion, reaching maximum as the helicopter contacts the surface. Reduce collective to zero pitch. Rotor brake should not be used after water landings. Slight collective loading may decrease rotor deceleration time. The helicopter floats with the tailrotor partially submerged.

**LANDING ON TREES**

A power-off landing into a heavily wooded area should be accomplished by executing a normal autorotative approach and flare to achieve minimum ground speed. The flare and subsequent application of collective pitch should be executed so as to reach zero rate of descent and zero ground speed in a 5° nose up attitude as close to the top of the trees as possible. Increase collective to maximum as helicopter descends vertically through the trees.

Symptoms:

1. Low Nr horn - ON.
2. Nr - DECAYING.
3. Engine parameters - BOTH ENGINES DECREASING.
4. Possible right yaw.

Additional symptoms will become evident as the engines spool down.

Corrective Action:

1. **Nr – MAINTAIN.**
2. **PERFORM AUTOROTATION PROCEDURE.**

## VISUAL AUTOROTATION PROCEDURES

Corrective Action:

1. **COMPLETE THE "BIG 4" (airspeed 75–105 KIAS).**
2. **TURN TOWARD DESIRED LANDING AREA AND/OR INTO THE WIND.**
3. **AT 200 FT RADALT – WHEELS RECHECK.**
4. **AT 125 FT RADALT – INITIATE FLARE; INFLATE FLOATS AS REQUIRED.**
5. **ASSUME LANDING ATTITUDE, ELIMINATING YAW AND DRIFT PRIOR TO TOUCHDOWN.**
6. **COLLECTIVE - CUSHION THE LANDING.**

The following items should be completed if time and altitude permit:

a) CABIN DOOR - OPEN.

b) SHOULDER HARNESS - LOCKED.

c) DISTRESS - TRANSMIT.

d) IFF - EMERGENCY.

e) FADEC CONTROL SWITCHES - BOTH OFF.

f) ENGINE RESTART - CONSIDER ATTEMPT.

g) LANDING LIGHTS - AS REQUIRED.

## INSTRUMENT AUTOROTATION PROCEDURES

A dual engine failure during flight in Instrument Meteorlogical Conditions (IMC) or night over water conditions may require the autorotation to be executed by reference to instruments only.

Corrective Action:

1. **COMPLETE THE "BIG 4" (airspeed 75 KIAS).**
2. **TURN TOWARD DESIRED LANDING AREA AND/OR INTO THE WIND.**
3. **AT 200 FT RADALT – WHEELS RECHECK.**
4. **AT 125 FT RADALT – INITIATE FLARE. CONTROL THE RATE TO ARRIVE AT 20 DEGREES NOSE – UP AT 75 FT RADALT; INFLATE FLOATS AS REQUIRED.**
5. **MAINTAIN FLARE UNTIL DESIRED AIRSPEED IS REACHED – 30 KTS PLUS HALF THE WIND SPEED.**
6. **ASSUME 5° NOSE UP, WINGS–LEVEL LANDING ATTITUDE.**
7. **AT 25 FT RADALT – COLLECTIVE – CUSHION THE LANDING.**

The following items should be completed if time and altitude permit:

a) CABIN DOOR - OPEN.

b) SHOULDER HARNESS - LOCKED.

c) DISTRESS - TRANSMIT.

d) IFF - EMERGENCY.

e) FADEC CONTROL SWITCHES - OFF.

f) ENGINE RESTART - CONSIDER ATTEMPT.

g) LANDING LIGHTS - AS REQUIRED.

# SINGLE ENGINE FAILURES

The altitude, airspeed, and gross weight at which an engine failure occurs will dictate the action to be followed to effect a safe landing. Most likely, level flight can be maintained at low pressure altitude and maximum gross weight during standard day conditions. As altitude increases during forward flight, single engine performance decreases.

IN ANY SINGLE ENGINE SITUATION, THE MAXIMUM POWER AVAILABLE IS ATTAINED AT THE 30 SEC. OEI RATING AND 355 RPM. OVERALL, POWER DECREASES AS NR DROPS BELOW 355 RPM. When one engine fails, the power output of the other engine automatically increases (with some acceleration delay). If the required power exceeds the OEI setting, the rotor speed will droop and may activate the low Nr aural warning (345 RPM). 30 Second OEI is automatically selected by the FADEC upon any of the following malfunctions: major FADEC failure, BACK-UP mode selected on one engine, N1 difference between the two engines is > 6%, or there is an engine failure. When the aural warning activates, the rate and degree of Nr droop should be checked to determine the need to lower collective to preserve Nr.

**NOTE**

Where continued flight is hindered by gross weight, consideration should be given to jettisoning fuel.

Descending to a lower altitude, if terrain clearance will allow, and selecting the airspeed for minimum power required (70-75 KIAS) may allow single engine flight to be continued. Maintaining altitude or a climb to a safe autorotation altitude (while preserving the remaining engine) should be considered if sufficient power is available. During single engine flight, the remaining engine's life can be preserved by maintaining power settings at or below the 30 second OEI limits whenever conditions permit. The following aircraft situations represent areas where immediate action is required by the pilot due to either time or operating limitations.

## SINGLE ENGINE FAILURES IN FLIGHT TO INCLUDE: LOW HOVER, HIGH HOVER, AND TAKEOFF/LANDING TRANSITION

The procedures to be followed depend on hovering height, gross weight, indicated airspeed/wind, and other environmental conditions. The ability of the aircraft to fly out from an engine failure in a hover must be predetermined. The TODD card is a useful tool to predetermine aircraft single engine capabilities.

Symptoms:

1. Possible Nr droop.

2. Abnormal engine parameters.
3. DIF N1 warning light illuminated.
4. Low Nr horn.
5. Torque, TOT, N1, N2, fuel pressure decreasing.
6. As engine spools down, additional symptoms will become evident such as Generator Failure, Eng Oil P light.
7. FLI switches to single engine display.
8. ECS disengages.
9. Bleed air shuts off.

Corrective Action:

1. **Nr – MAINTAIN.**
2. **AIRSPEED/ALTITUDE – CONTROL**
3. **WHEELS/FLOATS – AS REQUIRED.**
4. **LAND BACK OR CONTINUE FLIGHT.**

LANDBACK PROCEDURE:

5. **ASSUME LANDING ATTITUDE, ELIMINATE YAW AND DRIFT PRIOR TO TOUCHDOWN.**

CONTINUED FLIGHT PROCEDURE:

6. **COLLECTIVE – ADJUST TO MAXIMUM POWER, MAINTAINING MINIMUM Nr (at or above 345 RPM).**
7. **AIRSPEED – CLIMB AT 70–75 KIAS.**
8. **OEI – SET AS NECESSARY.**
9. **ANALYZE**

**WARNING**

Do not allow rotor RPM to decrease below 300 RPM Nr.

## FLAMEOUT

Symptoms:

1. Possible Nr droop.
2. Abnormal engine parameters.
3. DIF N1 warning light illuminated.
4. Low Nr horn.
5. Torque, TOT, N1, N2, fuel pressure decreasing.
6. As engine spools down, additional symptoms will become evident such as Generator Failure, Eng Oil P light.
7. FLI switches to single engine display.
8. ECS disengages.
9. Bleed air shuts off.

Corrective Action:

1. **COMPLETE THE "BIG 4."**
2. **OEI – SET AS NECESSARY.**
3. **ENGINE SHUTDOWN PROCEDURE – COMPLETE.**

If the situation warrants and time permits, an ENGINE RE-START may be attempted.

**NOTE**

If the engine can not be restarted, ECS may still be recovered by resetting the COOL switch.

## ENGINE CHIP DETECTED

Symptoms:

1. ENG # CHIP warning light illuminated.
2. Corresponding ENGINE CHIP annunciation on the VEMD CAUTION/ FUEL page.

Corrective Action:

1. **COMPLETE THE "BIG 4."**
2. **FADEC CONTROL SWITCH (AFFECTED ENGINE) CONFIRM; IDLE.**
3. **ENGINE – MONITOR.**

If NORMAL indications:

4. LAND AS SOON AS PRACTICABLE. (If additional power is required for landing, affected FCS may be switched to FLT position.)

If ABNORMAL indications:

4. ENGINE SHUTDOWN PROCEDURE - COMPLETE.

## ENGINE GEARBOX/OUTPUT SHAFT FAILURE

Symptoms:

1. N2 significantly above Nr.
2. Zero torque on malfunctioning engine.
3. Possible loud noises from the engine area.

Corrective Action:

1. **COMPLETE THE "BIG 4."**
2. **ENGINE SHUTDOWN PROCEDURE – COMPLETE.**

## N1 DIVERGENCE/PARTIAL POWER LOSS

Symptoms:

1. DIF N1 Warning Light illuminated.
2. Single engine FLI display.
3. N1 difference between both engines is greater than 6%.

Corrective Action:

1. **COMPLETE THE "BIG 4."**
2. ENGINE PARAMETERS – MONITOR.
3. LAND AS SOON AS PRACTICABLE.

## MAJOR FADEC/GOVERNOR FAILURE

FADEC logic is designed to cancel the Training Mode in the event of an actual engine failure. However, if the failure is in the form of a Level 3 FADEC failure, EBCAU operation, if selected, will conflict with Training Mode logic and FADEC operation will be unpredictable.

**WARNING**

The backup mode shall not be used when an engine is at training idle.

Symptoms:

1. FADEC # FAIL caution light illuminated.
2. Red ENGINE STATUS light on the overhead quadrant illuminated.
3. DUAL ENGINE FLI DISPLAY with OEI.
4. Affected engine will not respond to collective movement due to Fuel Flow metering being frozen at the rate present when the FADEC failed.

**NOTE**

In back-up mode, FADEC will match the N1 of the affected engine to the N1 of the good engine. While N1 matching is assured, there will be some acceleration delay on the engine in back-up mode.

Corrective Action:

1. **COMPLETE THE "BIG 4."**
2. **TRNG/FLT MODE – FLT.**
3. ENGINE BACK-UP SWITCH (affected engine) - BACK-UP.
4. OEI - SET AS NECESSARY.
5. LAND AS SOON AS PRACTICABLE.

## MINOR FADEC/GOVERNOR FAILURE

Symptom:

1. GOV caution light illuminated (steady or flashing).

Corrective Action:

1. ABORT MISSION. URGENT MISSION MAY BE COMPLETED.

## VEMD FAILURES

The following symptoms indicate various minor failures of the VEMD.

Symptoms:

Any ONE of the following symptoms on the VEMD:

1. LANE 1 FAILED > PRESS OFF 1.
2. LANE 2 FAILED > PRESS OFF 2.
3. CROSS TALK FAILED > PRESS OFF 1.

4. CROSS TALK FAILED > PRESS OFF 2.
5. Loss of one screen.
6. FLI DEGR annunciation on the VEMD with BLANK N1 TOT and/or TRQ parameters.

Corrective Action:

1. CONTINUE FLIGHT AS APPROPRIATE.

**NOTE**

A loss of one VEMD screen will cause a loss of the engine torque indication from the respective engine, i.e., a loss of the top screen will cause a FLI DEGR annunciation on the VEMD and a loss of the torque indication on the number one engine.

**NOTE**

When one VEMD screen fails, the EPC and STATUS pages will not be available.

## DUAL VEMD SCREEN FAILURE

Symptoms:

1. Both VEMD screens off or failed.
2. GOV caution light illuminated.

Corrective Action:

1. SHUT OFF SCREEN 1 OR 2 AS DIRECTED BY VEMD.
2. AVOID HIGH POWER SETTINGS, REFERENCE PLACARD FOR COLLECTIVE PITCH SETTINGS.
3. ABORT THE MISSION.

## LUBRICATION SYSTEM FAILURE

Possible Symptoms:

1. ENG # OIL P warning light illuminated.
2. Engine oil pressure fluctuates, increases or decreases abnormally.
3. Engine warning light illuminated on the overhead control quardrant.
4. Engine oil pressure less than 22 psi.

**CAUTION**

A combination of the engine oil pressure gage decreasing or reading zero AND illumination of the OIL P warning light must not be treated as an indicating malfunction, but rather as a lubrication system failure. Pilots shall not wait for additional symptoms before completing the engine shutdown procedure.

**NOTE**

Oil pump failure resulting in the above symptoms may be preceded by an initial increase in oil pressure above 100 psi, accompanied by a CHECK CDU annunciation.

Corrective Action:

1. **COMPLETE THE "BIG 4."**
2. **ENGINE SHUTDOWN PROCEDURE – COMPLETE.**

## ENGINE SURGE OR COMPRESSOR STALL IN FLIGHT

Possible Symptoms:

1. Popping or rumbling noises.
2. TOT increases.
3. Torque and N1 decreases.
4. Airframe vibration.

Corrective Action:

1. **COMPLETE THE "BIG 4."**

If NORMAL engine parameters or affected engine cannot be identified:

2. LAND AS SOON AS PRACTICABLE.

If ABNORMAL engine parameters and affected engine can be identified:

2. FADEC CONTROL SWITCH (affected engine) - CONFIRM; IDLE.

3. ENGINE - MONITOR.

If NORMAL IDLE parameters:

4. LAND AS SOON AS PRACTICABLE.

**NOTE**

If additional power is required for landing, the engine may be switched to FLT mode. A surge may reoccur at any time.

If ABNORMAL IDLE parameters:

4. ENGINE SHUTDOWN PROCEDURE - COMPLETE.

## ENGINE SURGE OR COMPRESSOR STALL ON DECK

Possible Symptoms:

1. Popping or rumbling noises.
2. TOT increases.
3. Torque and N1 decreasing.
4. Airframe vibration/shuddering.

Corrective Action:

1. **FADEC CONTROL SWITCH (affected engine) – OFF.**
2. **FUEL BOOST PUMP – (affected engine) – OFF.**
3. **TOT – MONITOR FOR POST–SHUTDOWN FIRE.**

## ENGINE OIL COOLER FAN FAILURE

High power settings may increase temperatures. Operation at speeds (below 120 KIAS) may not provide sufficient airflow through the oil cooler for effective XMSN cooling. This failure may not be evident at airspeeds above 120 KIAS.

Symptoms:

1. OIL TEMP warning light illuminated.
2. Abnormal rise in ENG OIL TEMP.

Corrective Action:

If BOTH engines overheated;

1. Cruise airspeed - 120 KIAS min.
2. LAND AS SOON AS PRACTICABLE.
3. SHUT DOWN AS SOON AS POSSIBLE.

If ONE engine overheated, IAS ≥ 75KTS:

1. FADEC CONTROL SWITCH (Affected Engine) - CONFIRM; IDLE.
2. Engine Oil temperature - Monitor.

On approach to landing; if additional power required:

2. Affected engine - FLT.

## ENGINE SHUTDOWN PROCEDURE IN FLIGHT

1. **SINGLE ENGINE FLIGHT PROFILE – ESTABLISH.**
2. **FADEC CONTROL SWITCH (Affected Engine) – CONFIRM; IDLE; CONFIRM; OFF.**
3. **BOOST PUMPS (affected engine) – OFF.**
4. **TOT – MONITOR FOR POST–SHUTDOWN FIRE.**
5. **OEI – SET AS REQUIRED.**
6. **FUEL – TRANSFER/JETTISON AS REQUIRED.**
7. **LAND AS SOON AS PRACTICABLE. (Single engine landing procedure.)**

## RESTARTING ENGINE IN FLIGHT

The cause of engine flameout will dictate whether an in-flight restart should be attempted. If time allows, wait 30 seconds with the FADEC CONTROL SWITCH in the shut off position before attempting a restart to purge the engine of fumes and fuel. If a start is initiated with N1 above 17%, the FADEC will not initiate the start sequence until N1 drops below 17%.

Corrective Action:

1. **HEAT – OFF.**
2. **BOOST PUMPS – ON.**
3. **EMERGENCY FUEL SHUTOFF LEVER – ENSURE FORWARD.**
4. **CHECK N1 LESS THAN 17%.**
5. **PERFORM NORMAL START PROCEDURE.**

If engine start successful:

6. **LAND AS SOON AS PRACTICABLE.**

If engine fails to light off:

6. **ENGINE SHUTDOWN PROCEDURE - COMPLETE.**

## ENGINE START EMERGENCIES

Before attempting another start, investigate and analyze the conditions requiring the abort. After the fifth attempt, a 20 minute cooling period is required.

Possible Symptoms:

1. Insufficient voltage to start.
2. Voltage drops below 17 VDC.
3. TOT rises rapidly and/or appears that it will exceed 750 °C (Hot start).
4. The rotor system does not turn by 25% N1.
5. No rise in TOT or N1 within 10 seconds after FADEC CONTROL SWITCH is moved to the IDLE position.
6. Engine does not reach 45% N1 by 30 seconds and is no longer accelerating.

**NOTE**

The FADEC will automatically shut the engine down during start if the TOT exceeds 840 °C. The pilot shall initiate a shut down if it appears that the TOT will exceed 750 °C.

Corrective Action:

1. **FADEC CONTROL SWITCH – OFF.**
2. **TOT – MONITOR FOR POST–SHUTDOWN FIRE.**

**CAUTION**

If engine start fails and OAT is less than 20 °C with TOT greater than 120 °C, crank engine for 20 seconds prior to subsequent start.

**CAUTION**

Do not crank the engines with the EFSLs secured as significant fuel pump damage will occur.

# ENGINE INDICATION FAILURES

Depending on the failed component, the ECMS engine parameters page may or may not provide correct values.

## TORQUE, TOT or N1 INDICATING SYSTEM FAILURE

Possible Symptoms:

1. FLI DEGR annunciation on the VEMD.
2. TRQ, TOT or N1 value missing with TRQ, TOT, or N1 label in boldface yellow type.
3. GOV caution light (TOT failure).
4. All other engine parameters normal.

Corrective Action:

1. **COMPLETE THE "BIG 4."**
2. MONITOR OTHER ENGINE PARAMETERS.
3. AVOID HIGH POWER SETTINGS.
4. ABORT MISSION. URGENT MISSION may be completed.

## VEHICLE PAGE INDICATION FAILURES

VEMD vehicle page indicators get their information from various sources. A failure will manifest itself as a single, blank indicating scale that turns amber without a numeric value.

Symptoms:

1. VEMD Vehicle page indicator blanked without numerical values.
2. VEHICLE PARAMETER OUT OF LIMIT annunciation on the VEMD.

Corrective Action:

1. Monitor for secondary indications.

2. Abort Mission.

**NOTE**

Additional symptoms such as a corresponding WCA panel light constitute secondary indications of a more serious malfunction and the appropriate emergency procedure should be followed.

# HYDRAULICS

FAILURE OF BOTH HYDRAULIC SYSTEMS WILL RESULT IN LOSS OF AIRCRAFT CONTROL. After any hydraulic system failure it is desirable to reduce the dynamic load on the flight controls. This is achieved by cruising at speeds between 75 and 100 KIAS.

## PRIMARY HYDRAULIC SYSTEM FAILURE

The limit light system is powered by the primary system and will be inoperative, but illuminated. It may not illuminate during reduced power flight.

Symptoms:

1. PRI SERVO P warning light illuminated.

2. SERVO JAM warning light illuminated.

3. LIMIT lights illuminated.

4. HYD2 PRESS < 720 psi.

5. SERVO LIMIT annunciation on the VEMD CAUTION/FUEL page.

Corrective Action:

**1. CRUISE AIRSPEED - 75-100 KIAS.**

**2. AVOID ABRUPT MANEUVERS.**

3. LAND AS SOON AS PRACTICABLE.

## SECONDARY HYDRAULIC SYSTEM FAILURE

Symptoms:

1. SEC SERVO P warning light illuminated.

2. SEC HYD LO PRESS warning light illuminated.

3. SERVO JAM warning light illuminated.

4. HYD1 PRESS < 720 psi.

5. SEC HYD ISOLATE warning light illuminated. (Only if failure is due to a loss of hydraulic fluid.)

Possible symptoms:

6. High-pitched noise from transmission area.

7. Stiffness in flight controls.

Corrective Actions:

**1. CRUISE AIRSPEED - 75 TO 100 KIAS.**

**2. AVOID ABRUPT MANEUVERS.**

3. TAIL HYD ISOLATE SWITCH - CUT-OFF.

4. EMERGENCY LANDING GEAR EXTENSION HANDLE - PULL.

**NOTE**

When wheels are blown down a burning electrical smell, accompanied by possible residual gas, may be detected in the cockpit and should not be confused with a possible electrical malfunction or fire.

**CAUTION**

Leave the Emergency Landing Gear Extension handle in the UP (extended) position.

5. LANDING GEAR HANDLE - DOWN

6. SAFETY PIN - INSTALL (if available).

If wheels fail to extend:

7. CONSIDER EXTERNAL ACTIVATION OF LANDING GEAR BLOW DOWN BOTTLE TO EXTEND LANDING GEAR - ACTIVATE FROM THE GROUND BY REMOVING FLAGGED SAFETY PIN AND ACTUATOR PIN (located in chine panel forward of the left main mount).

If wheels still fail to extend:

8. CONSIDER USE OF EXTERNAL NITROGEN CANISTER VIA THE LANDING GEAR

NITROGEN LINE "T" FITTING TO EXTEND LANDING GEAR (located in chine panel forward of the left main mount).

**NOTE**

Emergency extension of the wheels via the Landing Gear nitrogen "T" fitting requires specific tools and equipment which may not be readily available.

9. LAND AS SOON AS PRACTICABLE. (If loss of fluid situation exists or is suspected - PERFORM VERTICAL LANDING.)

**NOTE**

During an isolate condition, the fluid level in the secondary hydraulic reservoir is below the level of the electric pump suction line. The electric pump will only be capable of pumping the trapped volume of hydraulic fluid that is still in the suction line. The electric pump should only be used to charge the accumulator if brake pressure is absolutely necessary, and then only after the landing gear is down and locked. When using the electric pump to charge the accumulator, closely monitor the accumulator pressure gage. Secure the pump immediately after accumulator pressure levels off.

**WARNING**

When using the electric pump to charge the accumulator, it is possible to overheat the electric pump and start a fire before the ELEC PMP warning light activates at 1377 psi.

**WARNING**

The TALON manifold block incorporates a check valve that prevents the TALON accumulator from pressurizing the landing gear and brake circuits. TALON accumulator pressure should not be lost when lowering the gear in an isolate condition. For shipboard operations with TALON installed, a TALON landing will provide the safest means of stopping aircraft motion after landing.

## SECONDARY HYDRAULIC SYSTEM LOW FLUID LEVEL

In addition to the hydraulic isolation of the landing gear, wheel brakes, TALON and left body of the tail rotor servo, normal electrical power to the rescue hoist will be isolated.

Symptoms:

1. SEC HYD ISOLATE warning light illuminated.
2. SERVO JAM warning light illuminated.

Possible symptoms:

3. High-pitched noise from transmission area.
4. Stiffness in flight controls.

Corrective Actions:

1. TAIL HYD ISOLATE SWITCH - NORM.
2. SEC HYD CIRCUIT BREAKER - RESET ONLY IF POPPED (pilot's aft panel).

**CAUTION**

Pulling the SEC HYD circuit breaker secures power to the 2000 psi isolation valve, and returns it to the open position which may result in the loss of additional hydraulic fluid. The tail rotor isolation valve will not be affected and will remain closed.

If system is restored:

3. CONTINUE FLIGHT AS APPROPRIATE.

If failure persists:

4. TAIL HYD ISOLATE SWITCH - CUT-OFF.

**NOTE**

Placing the isolate switch in the isolate position serves several functions: it prevents further fluid loss in other than straight and level flight, it prevents the low fluid probe from opening the isolation valves should residual fluid from emergency blow down rise above 1 gallon in sump, and it prevents accidental gear retracting during emergency gear extension procedures.

5. EMERGENCY LANDING GEAR EXTENSION HANDLE - PULL.

**CAUTION**

Leave the Emergency Landing Gear handle in the UP (Extended) position. Failure to follow the procedure could result in a full or partial gear retraction.

**NOTE**

When the wheels are blown down a burning electrical smell, accompanied by a residual gas, may be detected in the cockpit and should not be confused with a possible electrical malfunction or fire.

**NOTE**

Secondary Hydraulic Fluid serviced above mid level may vent secondary hydraulic fluid when the main landing gear blow-down system is activated.

6. LANDING GEAR HANDLE - DOWN.

7. SAFETY PIN - INSTALL (if available).

**NOTE**

Electrical power to the landing gear handle is isolated by activation of the emergency blow-down system. Placing the gear handle to the down position assures gear down "if" the emergency landing gear handle is accidentally returned to the down position. Although the system is isolated via the Tail Hyd isolate switch, residual pressure from the brake accumulator could allow the down locks to unlock, resulting in a partial gear up landing.

If wheels fail to extend:

8. CONSIDER EXTERNAL ACTIVATION OF LANDING GEAR BLOW DOWN BOTTLE TO EXTEND LANDING GEAR - ACTIVATE FROM THE GROUND BY REMOVING FLAGGED SAFETY PIN AND ACTUATOR PIN (located in chine panel forward of the left main mount).

If wheels still fail to extend:

9. CONSIDER USE OF EXTERNAL NITROGEN CANISTER VIA THE LANDING GEAR NITROGEN LINE "T" FITTING TO EXTEND LANDING GEAR (located in chine panel forward of the left main mount).

**NOTE**

Emergency extension of the wheels via the Landing Gear nitrogen "T" fitting requires specific tools and equipment which may not be readily available.

10. LAND AS SOON AS PRACTICABLE - PERFORM VERTICAL LANDING.

**NOTE**

During an isolate condition, the fluid level in the secondary hydraulic reservoir is below the level of the electric pump suction line. The electric pump will only be capable of pumping the trapped volume of hydraulic fluid that remains in the suction line. The electric pump should only be used to charge the accumulator if brake pressure is absolutely necessary, and then only after the landing gear is down and locked. When using the electric pump to charge the accumulator,

closely monitor the accumulator pressure gage. Secure the pump immediately after accumulator pressure levels off.

**WARNING**

When using the electric pump to charge the accumulator, it is possible to overheat the electric pump and start a fire before the ELEC PMP warning light activates at 1377 psi.

**WARNING**

The TALON manifold block incorporates a check valve that prevents the TALON accumulator from pressurizing the landing gear and brake circuits. TALON accumulator pressure should not be lost when lowering the gear in an isolate condition. For shipboard operations with TALON installed, a TALON landing will provide the safest means of stopping aircraft motion after landing.

## SECONDARY HYDRAULIC PRESSURE HIGH/LOW

Rescue hoist response will be decreased with a reduction in system pressure. Pressure available for braking will be indicated on the accumulator pressure gage.

Symptoms:

1. SEC HYD HI PRES warning lights illuminated. (HYD1 pressure above 3480 psi.)
2. SEC HYD LO PRES warning lights illuminated. (HYD1 pressure below 2450 psi.)

Corrective Action:

1. **LANDING GEAR HANDLE – DOWN (check wheels down).**
2. SAFETY PIN - INSTALL (if available).
3. SEC HYDRAULIC PRESSURE - MONITOR.
4. LAND AS SOON AS PRACTICABLE.

## SERVO JAM

With normal hydraulic pressure to the servos, a SERVO JAM warning indicates seizing of a servo distributor valve. Subsequent seizing of the backup distributor valve will result in control lockup or uncontrollable hardover (pitch, roll, or yaw).

Symptoms:

1. SERVO JAM warning light illuminated.
2. Flight control loading may increase.

Corrective Action:

1. S C JAM CIRCUIT BREAKER - PULL, RESET (pilot's aft panel).
2. LAND AS SOON AS PRACTICABLE.

## HYDRAULIC INDICATING SYSTEM FAILURE

Symptoms:

Any **ONE** of the following conditions:

1. HYD 1 pressure indication goes to full scale, zero or is blanked.
2. HYD 2 pressure indication goes to full scale, zero or is blanked.
3. PRI SERVO P warning light illuminated.
4. SEC SERVO P warning light illuuminated.

**NOTE**

Illumination of the MASTER WARNING light in conjunction with a SERVO JAM, LIMIT LIGHT, PRI SERVO P, SEC SERVO P, SEC HYD LO PRES or SEC HYD HI PRES warning light serves as a secondary indication of an actual system malfunction and the associated procedure should be followed.

Corrective Action:

1. MONITOR FOR SECONDARY INDICATIONS.
2. ABORT MISSION.

# ELECTRICAL SYSTEM

## DUAL AC BUS FAILURE

A Dual AC bus failure results in the loss of all electrically powered flight instruments, cockpit lighting, and all other AC powered equipment.

In cases where the loss of AC power involves a wiring failure (which cannot always be determined), attempting to recover AC power carries a substantial risk of igniting an in-flight fire. If VMC can be maintained, the aircraft should be landed as soon as practicable WITHOUT ATTEMPTING TO RECOVER AC POWER. In some circumstances (dual alternator failure, wiring damage to both systems) recovery of AC power is not possible.

Symptoms:

1. AFCS pitch and roll channels disengaged.
2. Pilot's and copilot's ADI, attitude, and heading gyros failed.
3. Loss of cockpit instrument lighting.
4. Loss of all AC powered equipment.

Corrective Action:

1. COOL SWITCH - OFF.

If VMC can be maintained:

2. LAND AS SOON AS PRACTICABLE.

If VMC cannot be maintained and AC components are required to stabilize the aircraft:

2. AC 26V TRANSFER SWITCH - CENTER.

**NOTE**

If the two AC power systems did not fail concurrently, begin by attempting to recover the LAST system to fail. If unsuccessful, then attempt to recover the first system to fail. If the order of failure is unknown, proceed in the order listed below (#1 system then #2 system).

**WARNING**

Resetting AC system circuit breakers carries a significant risk of igniting an in-flight electrical fire if a wiring failure exists.

3. #1 MAIN AC BUS CIRCUIT BREAKER - RESET ONLY IF POPPED (LOCATED IN THE UPPER LEFT CORNER OF THE CABIN OVERHEAD CB PANEL).

If the #1 alternator fail light is illuminated:

4. #1 ALTERNATOR - RESET.

If power to #1 main AC bus is restored:

5. AFCS GYRO SELECTION SWITCH - MOVE IN THE DIRECTION OF OPERATING GYRO.
6. AFCS - REENGAGE.

**NOTE**

The attitude gyro may not be immediately operable, depending on how long the AC bus was failed.

7. LAND AS SOON AS PRACTICABLE.

If power to #1 main AC bus is not restored:

8. #2 MAIN AC BUS CIRCUIT BREAKER - RESET ONLY IF POPPED (LOCATED IN THE LOWER CENTER OF THE CABIN OVERHEAD CB PANEL).

If #2 alternator fail light is illuminated:

4. #2 ALTERNATOR - RESET.

If power to #2 main AC bus is restored:

5. AFCS GYRO SELECT SWITCH - MOVE IN THE DIRECTION OF OPERATING GYRO.

6. AFCS - REENGAGE.
7. LAND AS SOON AS PRACTICABLE.

If power to #2 main AC bus is not restored, AC power recovery is not possible.

8. PARTIAL PANEL INSTRUMENT FLIGHT - MAINTAIN UNTIL VMC IS ESTABLISHED.
9. LAND AS SOON AS PRACTICABLE.

## AC SYSTEM FAILURE (MAIN AC BUS SHORT, ALTERNATOR, ALTERNATOR CONTROL UNIT OR 115/26 VOLT AC SYSTEM FAILURE)

A main AC bus short, alternator control unit, or alternator failure will result in a loss of power to the affected bus. In some cases a main AC bus short will cause the associated alternator FAIL light and BTC CLOSED light to illuminate and is indistinguishable from an alternator failure from the cockpit. Components powered through the 115/26 VAC XFER relay may be recovered. Other components cannot be recovered including: #1 System--ECS, instrument lights; #2 System -- TACAN, OADS, Radar and instrument lights.

**WARNING**

Resetting AC system circuit breakers carries a significant risk of igniting an in-flight electrical fire and should not be attempted.

**NOTE**

Illumination of the BTC CLOSED light does not indicate a bus transfer, merely the position of the line contactor. The #1 and #2 AC systems are electrically isolated by the open bus tie circuit breakers.

Symptoms:

1. One 26 VAC FAIL light illuminated.
2. AFCS pitch and roll channels disengaged.
3. ADI, attitude gyro, and heading gyro failed on one side of the instrument panel.
4. All equipment on one main AC bus inoperative and/or loss of components powered by single phase 115 VAC and 26 VAC from the respective transformer.
5. Alternator FAIL light illuminated (in some cases).
6. BTC CLOSED light illuminated (in some cases).

Corrective Action:

1. **FLIGHT CONTROLS – STABILIZE AIRCRAFT.**
2. **AC 26V XFER SWITCH – PUSH IN THE DIRECTION OF THE ILLUMINATED FAIL LIGHT.**
3. **AFCS – REENGAGE.**
4. IF ECS FAILED - COOL SWITCH - OFF.
5. LAND AS SOON AS PRACTICABLE.

## MAIN DC BUS SHORT

Possible Symptoms:

1. Loss of all equipment on one main DC bus, to include, but not limited to:

| #1 Copilot | #2 Pilot |
|---|---|
| AFCS Yaw | AFCS Yaw |
| FDS | AFCS Collective |
| SCC #2 | SCC #1 |
| ICS (CP and FM) | ICS (Pilot) |
| Comm 2 | Comm 1 |
| MFD2 (EHSI) | MFD1 (EHSI) |
| CDU2 & GPS2 | CDU1 & GPS1 |
| VSI-TCAS | VSI-TCAS |
| Feel Trim | ECS Fan |
| MDL | Rad Alt |
| Starter Eng 1 | Starter Eng 2 |
| Fuel Pumps 1 and 4 | Fuel Pumps 2 and 3 |
| Eng 1 Overspeed | Eng 2 Overspeed |
| Radar | Heater O/Heat Light |

**CAUTION**

Loss of #1 (copilot) DC bus will cause a loss of MODE IV and it can not be regained.

2. SERVO JAM and SECONDARY HYDRAULIC ISOLATE warning lights (#2, right, main bus only).

Landing gear system will have hydraulic power and will extend normally with landing gear handle actuation.)

3. Loss of radar display on MFD2. (#2 right main bus only)

4. Associated generator FAIL light illuminated.

5. Associated battery relay OPEN light illuminated.

Corrective Action:

1. **AFFECTED AUDIO CONTROL PANEL(S) – ALTN. (Flight Mech audio control panel to ALTN for a #1 DC bus short.)**

**NOTE**

If pilot and copilot Master Volume settings differ significantly, the Master Volume on the unaffected audio control panel may have to be adjusted to ensure effective communication.

2. AFFECTED GENERATOR - OFF.

3. AFFECTED BATT RLY SWITCH - OFF.

4. LAND AS SOON AS PRACTICABLE.

## GENERATOR FAILURE

A single generator or the emergency T/R can provide normal DC electrical requirements.

Symptoms:

1. Generator FAIL light illuminated.

2. BTC CLOSED light illuminated.

Corrective Action:

1. GENERATOR - OFF, RESET.

If problem persists:

2. AFFECTED GENERATOR - OFF.

3. VOLT/LOADMETER - MONITOR.

**NOTE**

The loadmeter should be monitored for BOTH generators. A failed generator presents a potential fire hazard.

4. ABORT MISSION.

## BATTERY OVER TEMPERATURE/ THERMAL RUNAWAY

Possible Symptoms:

1. BATT TEMP warning light illuminated.

2. Smoke and/or fumes from radome or vent.

3. Noises from radome.

Corrective Action:

1. **BATT RELAY SWITCHES – BOTH OFF.** (To prevent the battery from receiving further charge.)

2. LAND AS SOON AS PRACTICABLE.

**WARNING**

Securing the BATT RELAY switches WILL NOT stop or reverse a battery overtemperature/thermal runaway.

**CAUTION**

If BATT TEMP warning light goes out, BATT RELAY switches should be left off unless battery power is absolutely needed. The following procedures shall be followed even if the light goes out.

**NOTE**

In the event of dual DC generator failure, the T/R cannot power either main DC bus with the battery switches secured.

After landing:

3. ALLOW BATTERY TO COOL PRIOR TO REMOVAL.

If BATT TEMP light remains illuminated (thermal runaway suspected):

4. SECURE AND EXIT AIRCRAFT.

5. STAND BY WITH FIRE FIGHTING EQUIPMENT.

**WARNING**

$CO_2$ should never be directed into the battery compartment to effect cooling or displace the explosive gases. The static electricity generated by $CO_2$ could cause the hydrogen/oxygen gases in the compartment to explode.

6. A CREWMAN OR CRASH CREW OUTFITTED IN A "HOT SUIT" MUST PERFORM THE FOLLOWING:

   a. OPEN BATTERY COMPARTMENT.

   b. IF FLAME PRESENT - USE ANY EXTINGUISHER.

   c. IF SMOKE, FUMES, OR ELECTROLYTE PRESENT WITHOUT FLAME - USE WATER FOG TO LOWER TEMPERATURE.

   d. MAKE NO ATTEMPT TO DISCONNECT OR JETTISON THE BATTERY.

### BATTERY BUS SHORT CIRCUIT

Illumination of both battery relay OPEN lights indicates a short circuited battery bus causing both battery relays to open. This condition isolates the battery bus from the main DC buses. Items connected to the battery bus may become unusable if the battery shorts to ground.

Symptom:

1. BOTH BATT RLY OPEN lights illuminated.

Corrective Action:

1. CONFIRM BOTH BATT RELAY SWITCHES - ON.

2. BATT TEMP WARNING LIGHT - MONITOR.

3. LAND AS SOON AS PRACTICABLE.

### BATTERY RELAY FAILURE

A battery start of the corresponding engine will not be possible until the fault is corrected.

Symptom:

1. One BATT RLY OPEN light illuminated.

Corrective Action:

1. CONTINUE FLIGHT AS APPROPRIATE.

### NVG FAILURE

Symptom:

1. Low battery LED indicator flashing.

2. Partial or complete degredation of NVG image, including focus, shading, edge glow, bright or dark spots, excessive honeycomb, distortion, flicker, and veiling glare.

Corrective Action:

**1. ANNOUNCE FAILURE TO THE CREW.**

If failure affects pilot at the controls:

**2. FLIGHT CONTROLS - CONDUCT POSITIVE TRANSFER TO SAFETY PILOT, FLIGHT CONDITIONS PERMITTING.**

3. ATTEMPT TO REGAIN NVG IMAGE AS REQUIRED. (SWITCH TO ALTERNATE BATTERY, INSPECT COMPONENTS, CHECK ALIGNMENT AND DIOPTER SETTINGS, REFOCUS).

4. CONTINUE FLIGHT AS APPROPRIATE.

## FUEL

### ENGINE FUEL PRESSURE LOW

Symptoms:

1. ENG FUEL P warning light illuminated. (Engine fuel pressure less than 6 psi.)

Corrective Action:

**1. COMPLETE THE "BIG 4."**

**2. ENGINE – MONITOR.**

If NORMAL indications:

3. LAND AS SOON AS PRACTICABLE.

If ABNORMAL indications:

3. ENGINE SHUTDOWN PROCEDURE - COMPLETE.

## FUEL FILTER CONTAMINATION

The FUEL FILT caution light indicates a pressure differential across the fuel filter and therefore may extinguish at reduced power levels. This is normal and DOES NOT indicate that the problem has cleared.

**CAUTION**

With possible fuel contamination in one system, DO NOT TRANSFER FUEL UNLESS ABSOLUTELY NECESSARY.

Symptom:

1. FUEL FILT caution light(s) illuminated.

Corrective Action:

If one fuel filter caution light illuminated:

1. LAND AS SOON AS PRACTICABLE.

If both fuel filter caution lights illuminated:

1. LAND AS SOON AS POSSIBLE.

## FUEL TRANSFER PUMP FAILURE

Possible Symptoms:

1. Unable to transfer fuel from one system to the other.
2. XFER circuit breakers (2) popped (pilot's aft and copilot's panels).

**WARNING**

Due to potential for fire, do not reset circuit breakers.

Corrective Action:

1. FUEL TRANSFER - SECURE.
2. CONTINUE FLIGHT AS APPROPRIATE.

## DUAL FUEL BOOST PUMP/EJECTOR FAILURE

Depending on which ejector pump has failed, the problem may manifest itself at any fuel state. In the left system, the unusable fuel may be as much as 280 lbs and in the right system as much as 60 lbs. Above the unusable level, fuel will continue to enter the affected feeder tank via the flapper valve. At or below the unusable fuel level, illumination of the FEED TANK warning light may mean as little as 5 minutes remaining before engine flameout.

**NOTE**

Illumination of a feed tank warning light(s) during a crosswind hover may indicate leaking feed tank covers. If the light(s) can be extinguished by leveling the aircraft, the mission may be completed. Note symptoms and aircraft attitude on CG Form 4377. If the light(s) remains on, complete procedures for dual fuel boost pump/ejector failure.

Symptoms:

1. FEED TANK warning light illuminated with fuel indicated in the system.
2. Loss of fuel pressure on one side.

Corrective Action:

1. BOOST PUMPS - (affected system) - ON.
2. FUEL TRANSFER - AS REQUIRED.
3. PLAN FLIGHT TO LAND WITH FUEL ABOVE THE UNUSABLE QUANTITY.
4. LAND AS SOON AS PRACTICABLE.

## FUEL QUANTITY INDICATING SYSTEM FAILURE

Symptom:

1. System indicator blanks, fails to change during flight, or reads 50% and 50% or 0% and 0%.

Corrective Action:

1. FUEL GAGE CIRCUIT BREAKERS (4) - PULL, RESET (copilot's panel and pilot's aft panel).

If failure persists:

2. MAINTAIN FUEL LOG AND PLAN FLIGHT TO LAND WITH SUFFICIENT RESERVE.

3. CONTINUE FLIGHT AS APPROPRIATE.

### FUEL JETTISON

Fuel may be jettisoned following an in-flight emergency or during an urgent rescue operation. If the situation allows, fuel should be jettisoned from one system at a time. Simultaneous jettison from both systems is at the rate of approximately 270 lbs per minute. When securing fuel jettison, check to ensure that fuel flow stopped. Fuel will continue to flow for several minutes after jettison valves are closed. If not manually secured, fuel will jettison to approximately 150 lbs remaining in the left system and approximately 170 lbs in the right system.

**WARNING**

Center of gravity (CG) limits should be considered before executing an emergency procedure that may result in a significant CG shift, such as jettisoning fuel and/or disembarking personnel during ditching.

Procedure:

1. CREW - BRIEF.

2. COMMUNICATIONS - TRANSMIT INTENTIONS.

3. ANTI-COLLISION LIGHT - OFF.

4. AIRSPEED - 40 TO 120 KIAS (WHEELS DOWN IF BELOW 60 KIAS).

5. FUEL JETTISON VALVE(S) - OPEN.

6. FUEL QUANTITY GAGE - MONITOR.

7. SECURE JETTISON - AS REQUIRED.

8. ANTI-COLLISION LIGHT - ON.

### HIFR EMERGENCY BREAKAWAY

Emergency breakaway can be initiated by either aircrew or ship's personnel.

1. CREW - ALERTED "BREAKAWAY, BREAKAWAY, BREAKAWAY."

2. EMERGENCY QUICK DISCONNECT HANDLE - PULL.

**CAUTION**

To prevent damage to the aircraft and a possible fuel spill, the hoist cable should not be sheared while the HIFR nozzle is connected. Use the emergency quick disconnect only during a HIFR emergency breakaway.

3. ADVISE SHIP.

4. HIFR RIG AND GROUNDING WIRE - DISCONNECT.

5. HIFR REFUEL COVER - REPLACE.

6. HIFR RECEPTACLE COVER - CLOSE.

7. HIFR RIG - RETURN TO SHIP OR STOW IN CLOSED CONTAINER, IF AVAILABLE.

Complete normal Rescue Check Part 3 procedures.

## GYROS, FLIGHT DIRECTOR, AND AFCS

## GYROS

### ATTITUDE GYRO FAILURE

A failure of either attitude gyro automatically disengages AFCS pitch and roll channels and should display an ATT flag in the affected ADI. The pilot must determine which gyro has malfunctioned and select the good gyro on the AFCS control panel. This will permit pitch and roll channel reengagement, but with reduced series actuator authority and loss of hardover protection in case of subsequent attitude gyro failure.

A copilot attitude gyro failure results in FDS failure and loss of radar antenna stab.

AFCS operation with reference to a single attitude gyro is termed "reversionary operation."

Symptoms:

1. AFCS caution light on.

2. Pitch and roll channel lights flashing.

3. Pitch and roll channels disengaged.

4. ATT flag on associated ADI may be visible.

5. FDS Command bars/pointer disappear (CP attitude gyro failure only).

Corrective Action:

1. **AFCS GYRO SELECTOR SWITCH – MOVE IN DIRECTION OF OPERATING GYRO.**

2. **AFCS – REENGAGE.**

3. AFFECTED ATT CIRCUIT BREAKER - PULL, RESET (cockpit avionics panel).

**NOTE**

Allow sufficient time for GYRO to re-energize before attempting to reset AFCS.

4. If failed gyro re-energizes, move AFCS Gyro Selector Switch back to center position to prevent possible hardover. AFCS REENGAGE.

If failure persists:

5. RADAR STAB - OFF (CP attitude gyro failure only).

6. CONTINUE FLIGHT AS APPROPRIATE.

## ATTITUDE GYRO FAILURE DURING REVERSIONARY OPERATION

Hardover protection is not possible during reversionary gyro operation (single gyro referenced by AFCS). Should an attitude gyro malfunction occur, uncommanded movement about the pitch and/or roll axis without corresponding cyclic movement can be expected.

Symptoms:

1. Uncommanded movement about the pitch and/or roll axis.

2. ADI does not indicate true aircraft attitude.

Corrective Action:

1. **AFCS PITCH AND ROLL CHANNELS – DISENGAGE.**

2. ABORT MISSION.

## HEADING GYRO SYSTEM FAILURE

A spinning or frozen heading display that does not affect other related items, such as FMS wind computation, may be a failure of the display only. The heading gyro information is displayed on MFD1, MFD2, and the BDI. The REF CB on the avionics circuit breaker panel provides 26 VAC power to the MFDs; failure or pulling of this CB results in the symptoms of a heading gyro failure

Loss of the CP HDG gyro will result in loss of the AFCS heading retention feature. The FDS will use the HDG gyro on the side with NAV CONTROL.

Loss of the pilot's REF input will result in invalid VOR indications, ILS/LOC and glide slope indications are not affected.

Loss of the copilot's REF input will result in invalid TCN bearing indications.

Possible Symptoms:

1. Red HDG failure flag on effected MFD (all display pages).

2. Yellow CWM (Cross Warning Monitor) failure flag on the good MFD (all display pages).

3. STAT page FAIL line - HDG1 or HDG2.

4. Incorrect or spinning heading display.

5. FMS wind information lost (dual heading failure only).

6. Degraded heading hold capability (CP gyro compass failure only).

7. Flag on BDI (CP gyro compass failure only).

Corrective Action:

1. NAV CONTROL - TRANSFER AS REQUIRED.

2. AFFECTED HDG CIRCUIT BREAKER - PULL, RESET (cockpit avionics panel).

3. AFFECTED REF CIRCUIT BREAKER - RESET IF POPPED (cockpit avionics panel).

4. COMPASS CONTROL PANEL - MANUALLY ALIGN COMPASS.

If valid compass heading not restored:

5. AFFECTED COMPASS - DG.

6. COMPASS CONTROL PANEL - MANUALLY ALIGN COMPASS.

If valid compass heading not restored:

7. AFFECTED HDG CIRCUIT BREAKER - PULL (cockpit avionics panel).

8. CONTINUE FLIGHT AS APPROPRIATE.

### YAW RATE GYRO FAILURE

Failure of either Yaw Rate Gyro will result in AFCS yaw channel disengagement. No reversionary mode is available. Manual control of the pedals is required for balanced flight.

Symptoms:

1. Rate-of-turn pointer out of view on affected ADI.

2. AFCS caution light illuminated.

3. Yaw channel light flashing.

4. AFCS yaw channel - Disengaged.

Corrective Action:

1. AFFECTED R/T CIRCUIT BREAKER - PULL, RESET (cockpit avionics panel).

2. YAW CHANNEL - ATTEMPT TO REENGAGE.

3. CONTINUE FLIGHT AS APPROPRIATE.

## FLIGHT DIRECTOR (FD)

### DETECTED FD FAILURE

Should any of the FD components fail the internal self-test, that particular function or the entire FD will be automatically disengaged. The crew will be alerted by the disappearance of the command bar/pointer from both ADIs and possibly the appearance of the FD flags in the ADIs. Other components may fail in conjunction with an FD failure because they are powered by, and provide valid signals to, the Flight Director Computer (FDC). An Airspeed Sensor failure will be noted by a disparity between the copilot's airspeed indicator and the IAS readout on the MFD and a loss of turn coordination. An Altitude Controller failure will cause FD flags to appear on the ADIs and a BARO annunciation on the CDUs or an FD failure could cause the loss of any or all three accelerometers, depending on the nature of the failure.

Possible Symptoms:

1. Affected FD command bar/pointer out of view.

2. FD flags on both ADIs.

Corrective Action:

1. FLIGHT DIRECTOR - ATTEMPT TO RECOUPLE.

If failure persists:

2. FDS CIRCUIT BREAKER - PULL, RESET (cockpit avionics panel).

3. FLIGHT DIRECTOR - ATTEMPT TO RECOUPLE.

4. FD MODES - ATTEMPT TO REENGAGE.

5. CONTINUE FLIGHT AS APPROPRIATE.

### UNDETECTED FD FAILURE

Failures may occur which are not detected by the self-test circuitry of the Flight Director Computer (FDC). If the FDS command bar/pointer is directing the proper correction, it is likely that the AFCS, for whatever reason, is unable to follow the command. If the command bar/pointer remains centered, an FDS malfunction is suspected.

Symptoms:

1. Deviation of the aircraft from the desired flight path.

2. Command bar/pointer centered.

Corrective Action:

1. FLIGHT DIRECTOR - UNCOUPLE.

2. FD MODES - DESELECT.

3. FDS CIRCUIT BREAKER - PULL, RESET (cockpit avionics panel).

4. FD MODES - ATTEMPT TO REENGAGE.

If failure clears:

5. FLIGHT DIRECTOR - COUPLE.

6. CONTINUE FLIGHT AS APPROPRIATE.

## AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS)

The AFCS pitch and roll channels are redundantly powered from the left (#1/Copilot) and right (#2/Pilot) main DC

buses. The yaw and collective channels are only powered from the right (#2/Pilot) main DC bus.

Failures resulting in displaced flight controls, particularly yaw pedals, may indicate reduced control authority. Avoid maneuvers requiring large control inputs.

## AFCS COMPUTER OR SERIES ACTUATOR FAILURE

The AFCS Computer controls the operation of the four series actuators (1 pitch/2 roll/1 yaw). After channel disengagement, continued illumination of P TRIM; R TRIM; or Y TRIM caution lights indicates the respective series actuator is not centered and the associated flight control (cyclic or pedals) will be displaced. The result may be reduced control authority. Note that the AFCS is unable to execute FDS commands in disabled channels.

Symptoms:

1. AFCS caution light illuminated.
2. One or more AFCS channels disengaged.
3. Associated channel light(s) on Avionics Mode Annunciator Panel flashing.
4. P TRIM, R TRIM, or Y TRIM light may be illuminated.

Corrective Action:

1. DISENGAGED CHANNELS - ATTEMPT TO REENGAGE.

If failure persists:

2. AFCS CIRCUIT BREAKERS (2) - PULL, RESET (cockpit avionics panel), FLIGHT CONDITIONS PERMITTING (night, IMC, etc.).

**NOTE**

Pulling the pilot's AFCS circuit breaker will result in loss of the yaw and collective channels in addition to those already failed.

3. AFCS - ATTEMPT TO REENGAGE.
4. CONTINUE FLIGHT AS APPROPRIATE.

## AFCS SERIES ACTUATOR HARDOVER (UNDETECTED)/PARALLEL SERVO HARDOVER

A Series Actuator failure should be detected by the AFCS computer during normal (two ATT gyro) operation and result in channel disengagement. Should the channel not disengage, the result is an initial uncommanded aircraft displacement, followed by flight control (cyclic or pedals) motion in the direction of the displacement as the parallel servo attempts to recenter the series actuator. The pilot can easily override the control input.

Symptoms:

1. Uncommanded aircraft displacement.
2. P TRIM, R TRIM, or Y TRIM light illuminated.

Corrective Action:

1. **AFFECTED CHANNEL – DISENGAGE.**
2. ABORT MISSION.

## COLLECTIVE PARALLEL SERVO HARDOVER

This failure can only occur during coupled (FDS/AFCS) operation, with an FDS mode using the collective axis. The collective actuator operates without regard to engine or airframe limitations.

Symptoms:

1. Uncommanded movement of the collective.
2. Command pointer directs proper correction.

Corrective Action:

1. COLLECTIVE - C-SYNC DEPRESS AND STABILIZE.
2. AFCS COLLECTIVE CHANNEL - DISENGAGE. (During single pilot operation, it may be necessary to uncouple the FDS from the AFCS prior to releasing C-SYNC.)
3. CONTINUE FLIGHT AS APPROPRIATE.

## AUTOMATIC TRIM FAILURE (AFCS ENGAGED)

Possible Symptoms:

1. AFCS TRM OFF light illuminated.

2. TRIM chevron extinguished on AFCS panel.

3. P TRIM or R TRIM lights illuminated.

Corrective Action:

1. TRIM PUSHBUTTON (AFCS panel) - REENGAGE.

If failure persists:

2. SYNC/TRIM RELEASE BUTTON - TRIM AS REQUIRED.

3. CONTINUE FLIGHT AS APPROPRIATE.

If using the flight director, trim in the direction of attitude command displacement on the ADI.

Yaw trim is also automatic, but as a separate system. If the Y TRIM light remains illuminated, the pedals must be adjusted to extinguish it.

## MANUAL TRIM FAILURE (AFCS DISENGAGED)

Loss of power to the AFCS computer will result in trim failure.

Symptoms:

1. Unable to trim the cyclic using the BEEP TRIM (four-position) switch on the cyclic.

2. TRM OFF light illuminated.

3. TRIM chevron extinguished on AFCS panel.

Corrective Action:

1. AFCS CIRCUIT BREAKERS (2) - PULL, RESET AS APPROPRIATE (cockpit avionics panel).

2. SYNC/TRIM RELEASE BUTTON - TRIM AS REQUIRED.

3. CONTINUE FLIGHT AS APPROPRIATE.

## CYCLIC ARTIFICIAL FEEL (FEEL/TRIM) FAILURE

Failure is manifested in one of two ways: Either cyclic force feel cannot be repositioned using the SYNC/TRIM REL button, or the cyclic has no artificial force feel. Without the electromagnetic clutches of the feel/trim units engaged, the AFCS and FDS are ineffective in pitch and roll.

Symptoms:

1. Unable to reposition cyclic force feel utilizing cyclic SYNC/TRIM REL button or overhead TRIM switch.

or

2. The cyclic has no artificial force feel (clutch disengaged).

Corrective Action:

1. OVERHEAD PANEL TRIM SWITCH - CHECK ON.

2. FEEL TRIM CIRCUIT BREAKER - PULL, RESET (pilot's aft panel).

If failure persists:

3. TRIM AIRCRAFT USING CYCLIC BEEP TRIM SWITCH.

4. CONTINUE FLIGHT AS APPROPRIATE.

## RADAR ALTIMETER CYCLE OR FAILURE

During FDS hover mode operation, this cycle will be sensed as a climb with a corresponding reduction in collective and loss of altitude followed by a downward cycle of the indicator that will result in an increase in collective and possible overtorque.

Possible Symptoms:

1. Undesired movement of the collective.

2. RADALT cycles, freezes, or masks.

3. RADALT audio tones heard.

4. FDS collective command pointer centered.

Corrective Action:

**1. COLLECTIVE – C–SYNC DEPRESS AND STABILIZE.**

If failure persists:

2. FDS or AFCS COLLECTIVE MODE CHANNEL - DISENGAGE.

3. RADALT CIRCUIT BREAKER - PULL, RESET, THEN PULL AS REQUIRED TO ELIMINATE AUDIO TONES (cockpit avionics panel).

**NOTE**

The RADALT audio tones may be silenced temporarily by holding the Horn Aural switch in the Reset position.

4. CONTINUE FLIGHT AS APPROPRIATE.

# FLIGHT MANAGEMENT AND COMMUNICATION SYSTEM

## FLIGHT MANAGEMENT

Failures in the FMS generally fall into two groups: a) Failure of individual components, or b) A major failure, which can result in loss of an entire electrical bus (pilot or copilot) or lockup (freezing) of the entire dual data bus (BUS A/B).

## FAILURE OF AN INDIVIDUAL COMPONENT

The various components of the FMS are equipped with automatic self-test functions which will normally alert the crew should a failure be detected. This is accomplished by a flashing ✓ STATUS or ✓ BUS annunciation on each of the CDUs. The failed component will be listed on the FAIL line of the STAT (status) page of either CDU.

## SINGLE DATA BUS FAILURE

Loss of a single data bus will not impact FMS operation.

Symptoms:

1. Annunciation of ✓ BUS in CDUs.
2. STAT page FAIL line - BUS A; BUS B.

Corrective Action:

1. CONTINUE FLIGHT AS APPROPRIATE.

## SINGLE AVIONICS (ELECTRICAL) BUS FAILURE

Symptom:

1. Loss of all avionics components on either the PILOT or COPILOT side (SCC/DDU/CDU/COMM/GPS/IFF Mode IV) or loss of an entire manual-shed DC bus (refer to FO-4).

Corrective Action:

1. AFFECTED AVIONICS SWITCH - OFF, ON.

**CAUTION**

Turning CPLT Avionics Switch to BUS-OFF will secure power to the KIT-1C Mode IV transponder. If landing gear was cycled or copilots landing gear indicator circuit breaker secured and CODE HOLD was not selected prior to the DUAL SCC failure, Mode IV codes will zeroize.

2. CONTINUE FLIGHT AS APPROPRIATE.

## SIU FAILURE

Symptoms:

1. Annunciation of ✓ STATUS in CDUs.
2. STAT page FAIL line - SIU.
3. Loss of any/all SIU functions: ECMS display of N1, N2, FMP; CHECK CDU caution light signal; RADALT push-to-test and low altitude warning tones; BINGO computation; BDI functions.

Corrective Action:

1. SIU CIRCUIT BREAKERS (2) - PULL, RESET (cockpit avionics panel).
2. CONTINUE FLIGHT AS APPROPRIATE.

## CONTROL DISPLAY UNIT (CDU) FAILURE

With a single CDU failure, the remaining CDU will assume (or maintain) dual data bus (BUS A/B) control. Also, all FMS information will be lost to the MFD on the side of the failed CDU. In the unlikely event of a dual CDU failure, all FMS information will be lost while Navaids and Comm radios will remain tuned to the last frequency. If power is re-

gained after a dual CDU failure, the IFF will be defaulted to STDBY.

**NOTE**

A CDU 1 failure results in loss of radar scan-to-scan integration.

**NOTE**

If the CDU in BC mode fails on the side with NAV Control, FMS guidance and corresponding FD modes may be lost prior to the remaining CDU assuming bus control. If this occurs, the FD modes can be reengaged.

Symptoms:

1. Annunciation of ✓ STATUS in CDUs.
2. STAT page FAIL line - CDU 1, GPS 1 or CDU 2, GPS 2.
3. Check CDU annunciation on WCA panel.
4. Affected CDU display blank (possible NO DATA annunciation on CDU).
5. FMS information lost to MFD on side of failed CDU.

Corrective Action:

1. **FLIGHT CONTROLS – STABILIZE AIRCRAFT.**
2. AFFECTED CDU CIRCUIT BREAKER - PULL, RESET (cockpit avionics panel).
3. CONTINUE FLIGHT AS APPROPRIATE.

## DUAL DATA BUS LOCKUP

COMM 1, COMM 2 and HF radios will remain tuned to last frequency, with blank or scrambled RRUs. The FM radio transmit capability is lost.

A single malfunctioning component on the data bus may cause the lock-up. Alternately placing the avionics switches to BUS OFF secures power to all equipment on the 1553B data bus except for the VFDR. If partial bus function is restored by placing either CPLT or PLT avionics switch to BUS OFF, the defective component is located on that bus. If time permits, isolating the defective component through the use of appropriate circuit breakers can restore the operable components on that bus. If the failure can be isolated to a single component, review the procedure for that specific failure.

Symptoms:

1. CDUs - NO DATA annunciation on both CDUs.
2. Loss of all avionics components except communication radios.

Corrective Action:

1. **FLIGHT CONTROLS – STABILIZE AIRCRAFT.**
2. CPLT AVIONICS SWITCH - BUS OFF (center position).

**CAUTION**

Turning CPLT Avionics Switch to BUS-OFF will secure power to the KIT-1C Mode IV transponder. If landing gear was cycled or copilots landing gear indicator circuit breaker secured and CODE HOLD was not selected prior to the DUAL SCC failure, Mode IV codes will zeroize.

If pilot's avionics components not restored:

3. CPLT AVIONICS SWITCH - ON. Allow adequate time (up to 30 seconds) to permit COPILOT CDU to power up
4. PLT AVIONICS SWITCH BUS OFF (center position).

If copilot's avionics components not restored:

5. PILOT AVIONICS SWITCH - ON. Allow adequate time (up to 30 seconds) to permit PILOT CDU to power up.
6. VFDR CIRCUIT BREAKER - PULL (avionics rack panel).

If pilot and copilot's avionics components not restored:

7. VFDR CIRCUIT BREAKER - RESET.
8. COMMUNICATIONS - LAST TUNED.
9. NAVIGATE - BDI AND MFD IN DF MODE ONLY.
10. LAND AS SOON AS PRACTICABLE.

DEFECTIVE COMPONENT ISOLATION PROCEDURE

1. AFFECTED BUS - IDENTIFY.
2. CDU, COMM, SCC, and MDL CIRCUIT BREAKERS ON AFFECTED BUS - PULL (cockpit avionics panel).

**NOTE**

The MDL is powered through the CP avionics bus. If the data bus lockup is caused by a defective component on the pilot's avionics bus, there is no need to pull the MDL circuit breaker.

3. APPROPRIATE AVIONICS SWITCH - ON.
4. CIRCUIT BREAKERS - RESET, ONE AT A TIME.

When Bus LOCKS UP:

5. LAST CIRCUIT BREAKER RESET - PULL (this is the defective component).
6. REMAINING CIRCUIT BREAKERS - RESET.
7. SPECIFIC COMPONENT FAILURE PROCEDURE - REVIEW (DO NOT RESET CIRCUIT BREAKERS OF DEFECTIVE COMPONENT).

## SCC FAILURE

Failure of an SCC will not effect dual data bus control. Depending on the type of internal SCC failure, components interfaced (IAMs) through the failed SCC may or may not be lost.

Symptoms:

1. Annunciation of ✓ STATUS in CDUs.
2. STAT page FAIL line -.
   a. If SCC 1 fails - SCC1, HF, ADF, VOR, RRU, STR.
   b. If SCC 2 fails - SCC2, FM, IFF, TAC.

Corrective Action:

1. **FLIGHT CONTROLS – STABILIZE AIRCRAFT.**
2. AFFECTED SCC CIRCUIT BREAKER - PULL, RESET (cockpit avionics panel).
3. CONTINUE FLIGHT AS APPROPRIATE.

## STEERING GUIDANCE (STR) FAILURE

STR refers collectively to all non-1553B bus inputs/outputs of the SCC1 Flight Director IAM. This annunciation indicates that a fault has been detected with one or more functions and may be a failure of circuitry within the SCC1 Flight Director IAM. The Flight Director will function normally with VOR and TCN as the navigation source.

Symptoms:

1. Annunciation of ✓ STATUS in CDU.
2. STAT page FAIL line - STR.
3. Loss of FMS FD guidance.

Corrective Action:

1. **FLIGHT CONTROLS – STABILIZE AIRCRAFT.**
2. DO NOT USE THE FLIGHT DIRECTOR SYSTEM WITH FMS AS THE NAV SOURCE.
3. CONTINUE FLIGHT AS APPROPRIATE.

## MISCELLANEOUS COMPONENT FAILURES

Symptoms:

1. Annunciation of ✓ STATUS in CDUs.
2. STAT page FAIL line - any of the following components; TAC, VOR, ADF, IFF, COM1, COM2, HF, FM and RRU.
3. Loss of associated component.

Corrective Action:

1. APPROPRIATE CIRCUIT BREAKER(S) - PULL, RESET.
2. CONTINUE FLIGHT AS APPROPRIATE.

## MISSION DATA LOADER (MDL) FAILURE

Primary site database points and flight plans will not be available. Only SITE (reversionary) database points, if loaded into the CDU, and Mission Identifier Database points will be available. All other MDL functions (GPS Almanac Data and Magnetic Variation Tables) are automatically stored in the CDU and will function normally. CDU soft-

ware updates (referred to as an "OFP") are accomplished through the MDL. If an MDL mission is not reinstalled following an OFP, there will be a loss of all database access (including reversionary SITE database) and navigation in TRUE only. If this condition is found during the Systems/ Equipment Check, a mission shall be installed in the MDL.

Symptoms:

1. Annunciation of ✓ STATUS in CDUs.
2. STAT page FAIL line - MDL.

Corrective Action:

1. MDL CIRCUIT BREAKER - PULL, RESET (cockpit avionics panel).
2. CONTINUE FLIGHT AS APPROPRIATE.

## DISPLAY CONTROL PANEL (DCP) FAILURE

Failure of a DCP will result in the complete loss of MFD display management. The MFD on the affected side will not respond to any DCP functions.

Symptoms:

1. Red DCP annunciation on affected MFD.
2. Heading Bug disappears on the affected MFD.
3. MFD does not respond to DCP inputs.

Corrective Action:

1. **FLIGHT CONTROLS – STABILIZE AIRCRAFT.**
2. AFFECTED DCP CIRCUIT BREAKER - PULL, RESET (cockpit avionics panel).
3. CONTINUE FLIGHT AS APPROPRIATE.

## MFD FAILURE

If an MFD (EHSI) failure occurs on the same side of the cockpit as the CDU with bus control, then FMS, NAV, and attitude input to the VFDR will be lost as well as FMS FD guidance. Transferring bus control to the CDU on the same side of the cockpit as the good MFD will restore input to the VFDR and allow FMS FD modes to be reengaged.

If an MFD failure occurs on the opposite side of the cockpit as NAV control, FD modes will not be affected if the pilot with NAV control is operating with VOR/ILS/LOC or TCN as the navigation source.

Regardless of CDU bus control, FD roll guidance will be lost if the MFD failure occurs on the side with NAV control. Failure of the pilot's MFD will result in the loss of radar display on the copilot's MFD.

Possible Symptoms:

1. Annunciation of ✓ STATUS in CDUs.
2. Yellow CWM (Cross Warning Monitor) failure flag on the good MFD (all display pages).
3. STAT page FAIL line -.
   a. If the failed MFD is on the same side of the cockpit as the CDU with bus control - MFD1, MFD2, HDG1, HDG2.
   b. If the failed MFD is on the opposite side of the cockpit as the CDU with bus control - MFD1, HDG1 or MFD2, HDG2.
4. MFD Status Page (failures annunciated in red) -
   a. Possible PROCESSOR failure - CPU, RAM MEM, EPROM, EEPROM.
   b. Possible DISPLAY failure - GRAPHIC, LCD DRIVER, LAMP, VIDEO.
5. Degraded operation of one MFD, or one MFD becomes inoperative, display blanks, pages fluctuate, and/or edges turn white.
6. Possible loss of FD roll guidance.

Corrective Action:

1. **FLIGHT CONTROLS – STABILIZE AIRCRAFT.**
2. NAV CONTROL - TRANSFER AS REQUIRED.

**NOTE**

HDG SEL will re-engage when NAV CTL is transferred to the same side of the cockpit as the good MFD.

3. Affected EHSI circuit breaker - PULL, RESET (cockpit avionics panel).

If failure persists:

4. CDU CIRCUIT BREAKER ON AFFECTED SIDE (if in BC mode) - PULL, RESET, FLIGHT CONDITIONS PERMITTING (cockpit avionics panel).

**NOTE**

With FMS as the navigation source, the FD modes (NAV and APPR) will re-engage when the CDU with bus control is on the same side of the cockpit as the good MFD.

**NOTE**

When navigating with VOR/ILS/LOC or TCN as the navigation source, the FD modes (NAV and APPR) will disengage when the CDU circuit breaker on the affected side (if in BC mode) is pulled.

5. CONTINUE FLIGHT AS APPROPRIATE.

## DUAL MFD FAILURE

With the dual MFD failure, all FMS input to the FD and FD roll guidance will be lost.

Possible Symptoms:

1. Annunciation of ✓ STATUS on CDUs.
2. STAT page FAIL line - MFD1, MFD2, HDG1, HDG2.
3. MFD Status Page (failures annunciated in red) -
   a. Possible PROCESSOR failure - CPU, RAM MEM, EPROM, EEPROM.
   b. Possible DISPLAY failure - GRAPHIC, LCD DRIVER, LAMP, VIDEO.
4. Degraded operation of both MFDs, or both MFDs become inoperative, displays blank, pages fluctuate, and/or edges turn white.
5. Loss of FMS directed FD guidance and FD roll guidance.
6. FMS information lost to one or both MFDs.
7. TCAS failure.

Corrective Action:

**1. FLIGHT CONTROLS – STABILIZE AIRCRAFT.**

If failure caused by seachlight activation:

2. PLT and CPLT CDU CIRCUIT BREAKERS – PULL, RESET.

**NOTE**

CDU circuit breakers should be pulled and reset one at a time starting with the pilot's CDU circuit breaker.

If failure not caused by seachlight activation:

2. PLT and CPLT EHSI CIRCUIT BREAKERS – PULL, RESET (cockpit avionics panel).

If failure persists:

3. NAVIGATE – BDI in VOR, TACAN, ADF, DF modes.
4. CONTINUE FLIGHT AS APPROPRIATE.

## OMNIDIRECTIONAL AIR DATA SYSTEM (OADS) FAILURE

With inoperative OADS, a CATCH cannot be accomplished. (The FMS uses OADS information at T-HOV capture.)

Symptoms:

1. Annunciation of ✓STATUS in CDUs.
2. STAT page FAIL line - OADS.
3. NO BINGO annunciation on CDU.
4. AIRSPEED FAIL on hover display.

Corrective Action:

1. OADS CIRCUIT BREAKERS (2) - PULL, RESET (avionics rack panel).

If malfunction persists:

2. OADS CIRCUIT BREAKERS (2) - PULL.
3. CONTINUE FLIGHT AS APPROPRIATE.

## ALTITUDE CONTROLLER FAILURE

Barometric altitude information will not be available to the flight director computer. The FDS is affected in ALT/IAS-VS/VS modes. The LOW ALT caution light is inoperative. FMS navigation will be degraded and CATCH maneuver is not available.

Symptoms:

1. Annunciation of ✓STATUS in CDUs.
2. STAT page FAIL line - BARO.

Corrective Action:

1. FDS CIRCUIT BREAKER - PULL, RESET (cockpit avionics panel).
2. CONTINUE FLIGHT AS APPROPRIATE.

## TCAS FAILURE

Symptom:

1. TCAS FAIL annunciation on VSI-TCAS display.

Corrective Action:

1. TCAS ON/OFF BUTTON - OFF.
2. TCAS CIRCUIT BREAKER - PULL, RESET (avionics rack panel).
3. TCAS ON/OFF BUTTON - ON.

If failure persists:

4. TCAS ON/OFF SWITCH - OFF.
5. CONTINUE FLIGHT AS APPROPRIATE.

## "M4/IFF" WCA LIGHT

Symptoms:

Any ONE of the following:

1. Steady M4/IFF WCA light. The transponder computer is installed with power applied, but is not loaded with a valid Mode IV code, or the transponder computer has failed its self-test cycle.
2. Cycling M4/IFF WCA light. A COMPATIBLE Mode IV interrogation was received, but no Mode IV reply was transmitted. Occurs when:
   a. Transponder is in STBY.
   b. A malfunction in the transponder will not allow Mode IV reply to be transmitted, or transmits reply at very low power.
   c. Neither M-4A nor M-4B is selected.

**NOTE**

The IFF MON light on the IFF/COMM panel will also illuminate when the M4/IFF WCA light illuminates.

Corrective Action:

1. **CHECK IFF: NORM.**
2. **CHECK ANT: BOTH.**
3. **CHECK REPLY: TONE.**
4. **SELECT M-4A/M-4B AS APPROPRIATE.**

If Mode IV WCA light extinguishes or no longer cycles:

5. CONTINUE FLIGHT AS APPROPRIATE.

If Mode IV WCA light remains illuminated or cycles and in friendly area:

5. ADVISE CONTROLLING AGENCY.
6. ASSESS RISK/BENEFIT OF CONTINUING MISSION.

If Mode IV WCA light remains illuminated or cycles **and in high threat area:**

5. **IMMEDIATELY EXIT AREA.**
6. ADVISE CONTROLLING AGENCY.
7. ASSESS RISK/BENEFIT OF CONTINUING MISSION.

## MODE IV AUDIO TONE

Symptoms:

Audio tone heard in pilot's and copilot's headset when aircraft is interrogated.

**NOTE**

A VALID but not COMPATIBLE code will cause an audio tone in the pilot's and copilot's headset when aircraft is interrogated, i.e., A code selected during B code crypto period.

Corrective Action:

1. SELECT M-4A/M-4B AS APPROPRIATE.

If tone ceases:

2. CONTINUE FLIGHT AS APPROPRIATE.

If tone remains and in NON-THREAT area:

2. ADVISE CONTROLLING AGENCY.

3. ASSESS RISK/BENEFIT OF CONTINUING MISSION.

If tone remains **and in high threat area:**

2. **IMMEDIATELY EXIT AREA.**

3. ADVISE CONTROLLING AGENCY.

4. ASSESS RISK/BENEFIT OF CONTINUING MISSION.

### MODE IV FAILURE

Symptoms:

Any ONE of the following:

1. Steady M4/IFF WCA light.

   The transponder computer is installed with power applied, but is not loaded with a valid Mode IV code, or the transponder computer has failed its self-test cycle.

2. Cycling M4/IFF WCA light. A COMPATIBLE Mode IV interrogation was received, but no Mode IV reply was transmitted.

3. IFF R/T failed or indicates dashed lines or 7700: SCC #2 has possibly failed, IFF DC circuit breaker popped, Copilot's Avionics Bus short, or #1 DC Bus short exists.

If Mode IV WCA light remains illuminated or cycles, Mode IV fails, or IFF fails and aircraft is in friendly area:

1. ADVISE CONTROLLING AGENCY.

2. ASSESS RISK/BENEFIT OF CONTINUING MISSION.

If Mode IV WCA light remains illuminated or cycles, Mode IV fails, or IFF fails **and aircraft is in high threat area:**

1. **IMMEDIATELY EXIT AREA.**

2. ADVISE CONTROLLING AGENCY.

3. ASSESS RISK/BENEFIT OF CONTINUING MISSION.

**The following emergencies will affect MODE IV operations and require special attention in determining corrective action:**

1. SCC #2 Failure
   If SCC #2 breaker is reset and remains operational, Mode IV will be regained, regardless of gear position.

2. DC-Bus #1 Short
   Mode IV will not operate and cannot be regained.

3. DC IFF Circuit Breaker Popped
   If IFF Breaker is reset and remains operational, Mode IV will be regained ONLY if gear has not been cycled nor Landing Gear Indicator Circuit Breaker pulled/reset during the flight.

4. Copilot's Avionics Bus Short
   If CP Avionics Bus is reset and remains operational, Mode IV will be regained ONLY if gear has not been cycled nor Landing Gear Indicator Circuit Breaker pulled/reset during the flight.

### VOICE FLIGHT DATA RECORDER FAILURE

Failure of the Voice Flight Data Recorder (VFDR) will be accompanied by the illumination of the VFDR FAIL light located on the Avionics Rack circuit breaker panel.

Symptom:

1. VFDR FAIL light illuminated.

Corrective action:

1. VFDR CIRCUIT BREAKER - PULL, RESET (avionics rack panel).

If failure persists:

2. VFDR CIRCUIT BREAKER - PULL.

3. CONTINUE FLIGHT AS APPROPRIATE.

## COMMUNICATION SYSTEM

Communication system failures may be self contained or may be FMS failures which restrict crew access to the transmitters and receivers. If the failure is in the FMS, the radios will normally remain on the frequency selected at the time of failure. An RRU failure will result in a scrambled RRU display. Refer to the COMM page on the CDU to determine selected frequency. The IFF/COMM Emergency panel contains toggle switches which allow tuning COMM-1 or COMM-2 to 243.0 MHz regardless of FMS status. Return-

ing the respective switch to "NORMAL" will return the radio to the previous frequency.

### TRANSMITTER AND RECEIVER FAILURES

Failure of a radio transceiver will be annunciated by the blanking of the respective frequency display on the CDU COMM page and, in the case of COMM1 or COMM2, dashing of the ACTIVE frequency in the RRU. In the event of an RRU failure, refer to the COMM page on the CDU to determine selected frequency.

Corrective Action:

1. APPROPRIATE CIRCUIT BREAKER - PULL, RESET.

2. CONTINUE FLIGHT AS APPROPRIATE.

### AUDIO CONTROL PANEL FAILURE

Selecting ALTN at the Hoist Operator station will provide ICS only (through the No. 2 passenger station), with no ALL CALL and HOT MIC capability.

Symptom:

1. Loss of transmit and/or receive capability from one crew station.

Corrective Action:

1. TRANSMIT SELECTOR KNOB (affected station) - ALTN.

2. ICS CIRCUIT BREAKER - PULL, RESET. (Cockpit avionics panel: Hoist operator station is powered through copilot's circuit breaker.)

**NOTE**

If pilot and copilot Master Volume settings differ significantly, the Master Volume on the unaffected audio control panel may have to be adjusted to ensure effective communication.

3. CONTINUE FLIGHT AS APPROPRIATE.

### AUDIO SYSTEM FAILURE

Operation of both AUDIO BYPASS switches eliminates the audio mixer and provides a power source directly from the respective COMM radio. This eliminates all volume control except for the MSTR VOL (master volume) control on the applicable audio control panel.

For the pilot, copilot, and flight mechanic to communicate, both AUDIO BYPASS switches must be in the bypass position. During BYPASS operation the pilot can only transmit/receive on COMM 1, the copilot on COMM 2. All audio warnings are inoperative.

Possible Symptoms:

1. Complete loss of audio (all stations).

2. All ICS and transmit functions inoperative.

3. Constant squeal or hum heard in headset.

Corrective Action:

1. **PILOT AND COPILOT AUDIO BYPASS SWITCHES – BYPASS.**

2. ICS CIRCUIT BREAKERS (2) - PULL, RESET (cockpit avionics panel).

3. CONTINUE FLIGHT AS APPROPRIATE.

## LANDING GEAR

### WHEELS FAIL TO EXTEND

Symptoms:

1. Amber light or absence of green light(s) with landing gear handle in DOWN position.

2. Gear visually checked not in down position.

3. Blue landing gear indicator light not illuminated.

Corrective Actions:

1. LANDING GEAR INDICATOR - TEST.

**NOTE**

This will reveal a bulb failure or loss of power to the landing gear indicator. Power to the indicator is provided through the GEAR IND circuit breakers (pilot's and copilot's side).

If landing gear lights do not illuminate;

2. GEAR IND CIRCUIT BREAKERS - PULL, RESET (pilot's aft panel and copilot's side panel).

If landing gear lights do illuminate;

2. LANDING GEAR HANDLE - UP, THEN DOWN.

If landing gear failure persists:

3. LANDING GEAR HANDLE - UP.

4. GEAR CONT CIRCUIT BREAKER - PULL, RESET (pilot's aft panel).

5. LANDING GEAR HANDLE - DOWN.

If wheels extend:

6. SAFETY PIN - INSTALL (if available).

7. CONTINUE FLIGHT AS APPROPRIATE.

If failure persists (and a Secondary Hydraulic System low fluid level condition does not exist):

8. ELECTRIC PUMP - ACTIVATE (BKP position).

**NOTE**

Allow approximately 60 seconds for the gear to extend and lock in the down position. If the WCA BKP light illuminates immediately after engaging the BKP pump, secure the BKP pump in alignment with step 9, this is indicative of a malfunctioning Landing Gear Switch. An attempt should be made to forcefully place the landing gear handle to the "DOWN" position.

9. ELECTRIC PUMP - OFF.

If wheels extend:

10. CONTINUE FLIGHT AS APPROPRIATE.

If failure persists:

11. EMERGENCY LANDING GEAR EXTENSION HANDLE - PULL.

**NOTE**

Secondary hydraulic system reservoir fluid level serviced above mid level may vent hydraulic fluid from reservoir when main landing gear blowdown system is activated.

**NOTE**

When wheels are blown down, a burning electrical smell, accompanied by possible residual gas, may be detected in the cockpit and should not be confused with possible electrical malfunction or fire.

**CAUTION**

Leave the Emergency Landing Gear Extension handle in the UP (extended) position.

If wheels fail to extend:

12. CONSIDER EXTERNAL ACTIVATION OF LANDING GEAR BLOW DOWN BOTTLE TO EXTEND LANDING GEAR - ACTIVATE FROM THE GROUND BY REMOVING FLAGGED SAFETY PIN AND ACTUATOR PIN (located in chine panel forward of the left main mount).

If wheels still fail to extend:

13. CONSIDER USE OF EXTERNAL NITROGEN CANISTER VIA THE LANDING GEAR NITROGEN LINE "T" FITTING TO EXTEND LANDING GEAR (located in chine panel forward of the left main mount).

**NOTE**

Emergency extension of the wheels via the Landing Gear nitrogen "T" fitting requires specific tools and equipment which may not be readily available.

14. LAND AS SOON AS PRACTICABLE. (If loss of fluid situation exists or is suspected - PERFORM VERTICAL LANDING.)

## WHEELS FAIL TO RETRACT

If the nose weight-on-wheels microswitch is disconnected, the landing gear actuator locks are installed or the nose wheel is not centered, the wheels will not retract. Additionally, if the nose weight-on-wheels switch remains energized

(with the radar powered, indicated by illumination of the radar caution light), the AFCS will be ineffective in pitch and roll and the collective will not accept FDS inputs.

Possible Symptoms:

1. Three green indicator lights illuminated, when airborne with handle in UP position.

2. RADAR Caution light illuminated when airborne (nose weight-on-wheels switch).

Corrective Action:

1. LANDING GEAR HANDLE - RECYCLE.

If failure persists:

2. LANDING GEAR HANDLE - DOWN.

3. LAND.

4. NOSE WHEEL - STRAIGHTEN.

After takeoff:

5. LANDING GEAR HANDLE - UP.

If failure persists:

6. LANDING GEAR HANDLE - DOWN.

7. CONTINUE FLIGHT AS APPROPRIATE.

### NOSEWHEEL SHIMMY DAMPER FAILURE

Symptom:

1. Lateral vibration when performing run on/off maneuvers and during high speed taxiing. These vibrations may be quite violent.

Corrective Action:

1. **LIFT AIRCRAFT OFF GROUND IMMEDIATELY OR REDUCE TAXI SPEED.**

**CAUTION**

Excessive and/or abrupt aft cyclic application may result in tail skid-to-ground contact.

2. PERFORM VERTICAL LANDINGS OR TAKEOFFS.

3. CONTINUE FLIGHT AS APPROPRIATE.

### UPLOCK FAILURE

Symptom:

1. Amber Gear Unsafe Light remains on or illuminates intermittently with handle in UP position.

Corrective Action:

1. LANDING GEAR HANDLE - RECYCLE.

If failure persists:

2. LANDING GEAR HANDLE - DOWN.

3. CONTINUE FLIGHT AS APPROPRIATE.

## ECS

### HEATER OVERHEAT

Illumination of the HEATER O/HEAT warning light may indicate a fire hazard. A HEATER O/HEAT warning light may be the result of an ECS overheat condition. A bleed air leak could also cause a warning light due to excessive temperature in the aft cabin overhead or near the FADEC computer. Placing the HEAT selector switch to OFF will close the bleed air shutoff valve.

Symptom:

1. HEATER O/HEAT warning light illuminated.

Corrective Action:

1. **HEAT SWITCH – OFF.**

2. HEATER (LOWER) NOZZLES - ALL OPEN.

If O/HEAT light remains illuminated:

3. LAND AS SOON AS PRACTICABLE.

If O/HEAT light extinguishes:

3. CONTINUE FLIGHT AS APPROPRIATE.

**CAUTION**

Do not turn HEAT on again until cause of overheat has been determined. Closed heater nozzles may cause an overheat condition.

## AVIONICS RACK OVERHEAT

Possible Symptoms:

1. AV RACK O/HEAT caution light illuminated.
2. LITTLE OR NO AIR FLOW from cockpit/cabin air nozzles.
3. Discharge air from cockpit/cabin air nozzles AT CABIN AMBIENT TEMPERATURE.
4. FREON HI PRES caution light illuminated.

Corrective Action:

If caution light illuminates on deck after rotor engagement:

1. DUCT INTERCONNECT LEVER - CHECK CLOSED.
2. COOL SWITCH - ON.

If caution light illuminates in-flight or does not extinguish within 15 minutes after COOL SWITCH has been turned on:

1. DUCT INTERCONNECT LEVER - CHECK CLOSED.

If overheat caused by ECS failure (little or no air flow):

2. COOL SWITCH - OFF.

If overheat caused by ECS disengagement (ambient air flow):

3. COOL SWITCH - OFF.

If cause of overheat unknown:

4. COOL SWITCH - CHECK ON.
5. AVIONICS FAN - CHECK AUTO.
6. COCKPIT/CABIN AIR NOZZLES - CLOSED.

**NOTE**

If ambient temperature is cooler than cockpit/cabin temperature, the RAM AIR lever can be opened, otherwise the RAM AIR lever should be closed.

7. AV CLG SW MAINT DISABLE - RESET.
8. CONTINUE FLIGHT AS APPROPRIATE.

If AV RACK O/HEAT light remains on or reilluminates:

9. COPILOT AVIONICS SWITCH - OFF.
10. TACAN CIRCUIT BREAKERS - PULL AS APPROPRIATE.

**NOTE**

The TACAN is the component that generates the most heat within the avionics rack.

11. ABORT MISSION. URGENT SAR/HLS MAY BE COMPLETED.

## ECS FAILURE

The ECS unit malfunctions, i.e., fan failure, or condenser freezes up, thereby providing little or no air flow.

Symptom:

1. LITTLE OR NO AIR FLOW from cockpit/cabin air nozzles.

Corrective Action:

1. COOL SWITCH - FAN.
2. AVIONICS FAN - ON.

If after 5 minutes air flow is restored;

3. COOL SWITCH - ON.
4. AVIONICS FAN - AUTO.

If air flow <u>is not</u> restored:

3. COOL SWITCH - OFF.
4. AVIONICS RACK OVERHEAT - MONITOR.

**NOTE**

Consider turning off selected avionics components to prevent overheat. The FMS and TACAN are the two components that generate the most heat within the avionics rack.

5. CONTINUE FLIGHT AS APPROPRIATE.

## ECS COMPRESSOR DISENGAGEMENT

Coolant (freon) leak, compressor drive belt failure, or other malfunction may result in loss of cool air flow to the avionics rack and the cockpit/cabin. If the condenser inlet pressure is excessive, the compressor will disengage and the FREON HI PRES caution light will illuminate. The COOL system fan will continue to operate, providing recirculated cabin air to the avionics rack.

Symptoms:

1. Discharge air from cockpit/cabin air nozzles AT CABIN AMBIENT TEMPERATURE.
2. FREON HI PRES caution light illuminated.

Corrective Action:

1. DUCT INTERCONNECT LEVER - CHECK CLOSED.
2. COOL SWITCH - CYCLE TO FAN THEN BACK TO ON.

**NOTE**

To recycle system, the COOL switch must be placed in the FAN position and then back to the ON position. This may extinguish the FREON HI PRES amber light and reengage compressor clutch.

If conditions persist:

3. COOL SWITCH - FAN.
4. COCKPIT/CABIN AIR NOZZLES - CLOSED.

**NOTE**

If ambient temperature is cooler than cockpit/cabin temperature, the RAM AIR lever can be opened, otherwise the RAM AIR lever should be closed.

5. AVIONICS RACK OVERHEAT - MONITOR.

**NOTE**

Consider turning off selected avionics components to prevent overheat. The FMS and TACAN are the two components that generate the most heat within the avionics rack.

6. CONTINUE FLIGHT AS APPROPRIATE.

# PITOT/STATIC

The copilot's pitot/static information is used by the AFCS and FDS. Static port blockage could be an indication of airframe icing.

## PILOT'S STATIC SYSTEM FAILURE

Symptom:

1. Pilot's altimeter and VSI indicate erratic or erroneous information.

Corrective Action:

1. PILOT'S STATIC PRESS VALVE - STBY (overhead control panel).
2. APPLY CORRECTIONS TO AIRSPEED AND ALTITUDE (as placarded in cockpit).
3. CONTINUE FLIGHT AS APPROPRIATE.

## PILOT'S PITOT SYSTEM FAILURE

Symptom:

1. Erratic or erroneous pilot's indicated airspeed.

Corrective Action:

1. DO NOT RELY ON PILOT'S AIRSPEED INDICATOR.
2. CONTINUE FLIGHT AS APPROPRIATE.

## COPILOT'S STATIC SYSTEM FAILURE

With a failed copilot's static system, all Flight Director modes will be degraded. ALT, IAS, IAS-ALT, VS, IAS-VS, and GA are unusable. HDG SEL, NAV, and APPR will be affected in turn rate only; T-HOV and HOV AUG will not have a low altitude warning capability.

Symptoms:

1. Copilot's altimeter and VSI indicate erratic or erroneous information.
2. Erratic FDS performance.

Corrective Action:

1. **FLIGHT CONTROLS – STABILIZE AIRCRAFT.**
2. **AFFECTED FLIGHT DIRECTOR MODES – DESELECT.**

3. STATIC PRESS ISOLATING VALVE - OFF (copilot's cockpit instrument panel).

4. DO NOT RELY ON AFFECTED COPILOT INSTRUMENTS.

5. CONTINUE FLIGHT AS APPROPRIATE.

### COPILOT'S PITOT SYSTEM BLOCKED

Automatic turn coordination may be lost with the TOTAL PRESS valve off. The Flight Director is degraded. IAS, IAS-ALT, VERT portion of APPR, and IAS-VS modes are unusable. The GA mode will not have an airspeed input. HDG SEL, NAV, and APPR modes will be affected in turn rate.

Symptoms:

1. Erratic or erroneous copilot's indicated airspeed.

2. MFDs - IAS readout erratic or erroneous.

3. Erratic FDS performance.

4. Possible loss of automatic turn coordination.

Corrective Action:

1. **FLIGHT CONTROLS – STABILIZE AIRCRAFT.**

2. **AFFECTED FLIGHT DIRECTOR MODES – DESELECT.**

3. TOTAL PRESS ISOLATING VALVE - OFF (copilot's cockpit instrument panel).

4. DO NOT RELY ON COPILOT'S AIRSPEED INDICATOR.

5. CONTINUE FLIGHT AS APPROPRIATE.

## HOISTING AND RESCUE SWIMMER

When a hoisting device is on the deck and connected to the hoist hook, or is being delivered/retrieved through any obstacles aboard the vessel that represent possible snag hazards, you are considered to be "committed" to the hoist.

When using a trail line, you are not committed until the device is in a situation as described above due to the weak link which is designed to part if an excessive force is applied.

**WARNING**

If the hoist cable is damaged (i.e., kinked, birdcaged, strands broken or deformed), the cable must not be used for hoisting, nor shall the damaged portion be retrieved into the hoist assembly. Use of the quick-splice should be considered.

### HOIST CABLE FOULED/DAMAGED

Symptoms:

1. Hoist cable becomes fouled or caught on deck or ground items.

2. Hoist cable visibly damaged (e.g., kinked, birdcaged, broken or deformed strands).

Corrective Action:

1. **PAY OUT SLACK IN CABLE.**

2. **ADVISE PILOT.**

3. IF CONDITIONS PERMIT, DIRECT THE VESSEL'S CREW TO FREE THE CABLE.

4. IF UNABLE TO FREE THE CABLE OR THE CABLE IS DAMAGED, AND SITUATION PERMITS, WRAP THE AREA TO BE CUT WITH ANY SUITABLE TAPE (TO PREVENT FRAYING). USE THE CABLE CUTTERS AND SEVER THE CABLE.

5. IF MISSION URGENCY DICTATES A CONTINUED HOIST, ASSEMBLE THE QUICK SPLICE AND COMPLETE THE HOIST WITH REMAINING CABLE LENGTH.

6. UNDER EXTREME CONDITIONS, SHEARING THE CABLE SHOULD BE ACCOMPLISHED BY USING THE SHEAR SWITCH (PILOT'S AND FLIGHT MECHANIC'S) AND SIMULTANEOUSLY SAYING "SHEAR, SHEAR, SHEAR."

**CAUTION**

Use of the QUICK SPLICE will eliminate the automatic speed reduction and up limit switches.

## HOIST FAILURE

Symptom:

1. Hoist fails to respond to flight mechanic's inputs.

Corrective Action:

1. **ADVISE THE PILOT "COMMITTED" OR "NOT COMMITTED."**

If not committed:

2. **ABORT THE HOIST.**

If committed:

2. **CHECK THE CABLE AND DRUM FOR FOULING.**

3. **ACTIVATE EMERGENCY HOIST POWER AND CONTINUE THE HOIST.**

If hoist power is not restored:

4. **ACTIVATE MANUAL OVERRIDE AND CONTINUE THE HOIST.**

**CAUTION**

During manual override operations; hoist limit switches are inoperable, and STEP 1 VALVE must be closed when the rescue device is in the cabin to prevent hoist creep.

If hoist fails to respond to manual override WITH NO personnel in rescue device:

5. RETRIEVE THE RESCUE DEVICE IF PRACTICABLE.

If unable to retrieve rescue device:

6. CUT CABLE WITH CABLE CUTTER OR SHEAR.

**NOTE**

When a survivor or rescue swimmer is attached to the hoist, on scene conditions will dictate possible courses of action. Refer to rescue swimmer emergencies in this Section.

## HOIST BOOM FAILURE

A boom failure may prevent the hatch (and door) from being closed.

**NOTE**

The BOOM STOW and HOIST IN/OUT switches work independently of each other. The BOOM STOW switch will operate regardless of MASTER or EMERGENCY switch positions, as long as the #l MAIN DC BUS is powered.

Symptom:

1. Hoist boom does not respond to electrical control inputs.

Corrective Action:

1. **HOIST MASTER SWITCH – CHECK "CREW" POSITION.**

2. **BOOM MOTOR CIRCUIT BREAKERS (2) – PULL, RESET (cabin overhead panel).**

If boom still does not respond to electrical control inputs:

3. BOOM MOTOR CIRCUIT BREAKERS (2) - PULL.

4. HOIST OPERATOR'S PENDANT - DISCONNECT.

5. MANUAL CRANK - INSTALL.

6. MANUALLY CRANK BOOM TO STOWED POSITION.

7. MANUAL CRANK - REMOVE.

If unable to move boom:

8. CONTINUE FLIGHT AS APPROPRIATE. (Observe hatch/door speed limits, if applicable.)

## HOIST ELECTRICAL RUNAWAY

Symptom:

1. Hoist cable extends/retracts without crew input.

Corrective Action:

1. **SECURE HOIST POWER AT THE HOIST CONTROL PANEL ONLY.**

2. **ADVISE THE PILOT "COMMITTED" OR "NOT COMMITTED."**

If committed to the hoist or mission urgency dictates:

3. ACTIVATE MANUAL OVERRIDE AND CONTINUE THE HOIST.

If not committed to the hoist:

3. ABORT THE HOIST.

**WARNING**

DO NOT SECURE the cockpit hoist master switch as all shear capabilities will be lost.

**CAUTION**

During manual override operations; hoist limit switches are inoperable, and STEP 1 VALVE must be closed when the rescue device is in the cabin to prevent hoist creep.

## LOST COMMUNICATIONS DURING HOISTING OPERATIONS

Extreme conditions, such as confined areas or no reference hoist, may require going directly to VOCAL COMMANDS at the first sign of an ICS failure. During VOCAL COMMANDS, pilot reception may be improved if the pilot keys ICS or selects HOT MIC.

Symptom:

1. Pilot and/or flight mechanic unable to listen and/or talk during a hoist.

Corrective Action:

1. **FLIGHT MECH – TAP THE PILOT AND GIVE HOLD SIGNAL (closed fist).**

2. **ADVISE THE PILOT "COMMITTED" OR "NOT COMMITTED."**

If not committed:

3. **ABORT HOIST.**

If committed:

3. **FLIGHT MECH - ENSURE HOT MIC IS SELECTED, HELMETS PROPERLY CONNECTED; ATTEMPT HOT MIC ICS COMMS.**

If communications are not restored:

4. **PRESS PUSH–TO–TALK SWITCH; ATTEMPT NORMAL COMMS.**

If communications are still not restored,

5. **AUDIO CONTROL PANEL – SELECT ALTN AND ATTEMPT COMMS (ALL CALL and HOT MIC are inoperative in ALTN).**

If communications are still not restored and you are committed to hoist, or mission urgency dictates:

6. **COMMUNICATE BY VOCAL COMMANDS AND CONTINUE HOIST.**

# RESCUE SWIMMER

If ditching the aircraft or immediate continued flight is necessary while the swimmer is attached to the hoist, consideration must be given to the actual location of the rescue swimmer. This scenario must be fully briefed prior to the evolution. The swimmer should be brought into the cabin or firmly held by the crewman if located between the cabin door and the hoist drum. The hoist cable should be sheared if the rescue swimmer is below the cabin door and over the water or on the ice. If the rescue swimmer is over land or hard ice and is off the surface, consideration should be made to lowering the swimmer and/or the aircraft prior to the cable shearing to prevent injury to the rescue swimmer. If hoisting to a vertical surface, the option of shearing or hoisting the swimmer aboard will depend on the existing conditions. This SHALL NOT hinder, delay, or stop required action in the event that an aircraft malfunction requires an immediate ditching or transition to forward flight to save the aircraft and crew in the aircraft.

## LOST SWIMMER

Corrective Action - DAY:

1. **"MARK" POSITION.**
2. **TRANSITION AND ESTABLISH RIGHT ORBIT.**
3. **LOOK AND LISTEN FOR RS SIGNAL.**
4. **WHEN VISUAL – RESUME HOVER POSITION.**

If these procedures fail to relocate RS:

5. **COMPLETE LEAVING RESCUE SWIMMER ON SCENE PROCEDURE.**

Daytime Rescue Swimmer signals may include one or more of the following:

a. Radio, pre-briefed frequency.

b. Smoke.

c. Dye marker.

d. Mirror.

Corrective Action - NIGHT:

1. **"MARK" POSITION.**
2. **FLASH LANDING/HOVER LIGHT.**
3. **LOOK AND LISTEN FOR RS SIGNAL.**
4. **WHEN VISUAL – CEASE FLASHING LIGHT.**

If these procedures fail to relocate RS:

5. **COMPLETE LEAVING RESCUE SWIMMER ON SCENE PROCEDURE.**

Nighttime Rescue Swimmer signals may include one or more of the following:

a) Radio, pre-briefed frequency.

b) Strobe light.

c) Flare.

## EMERGENCY RECOVERY OF RESCUE SWIMMER

The preferred method of recovery is by rescue basket.

If the aircrew observes a hazard to the RS in the water, hoisting of the RS should be initiated by placing the rescue device or bare hook between the RS and the hazard.

If the "IN TROUBLE, NEED ASSISTANCE" signal is observed, recovery should be accomplished as soon as practicable by one of the following methods:

1. **RESCUE BASKET – IF RIGGED AND EMPTY.**
2. **BARE HOIST HOOK – IF BASKET NOT READILY AVAILABLE.**

## RESCUE SWIMMER FALLS THROUGH ICE

Corrective Action - Hoist Cable attached:

1. **RESCUE SWIMMER–EXTRACT OUT OF THE ICE HOLE BY ROLLING OUT, OR PULLING OUT WITH THE ICE AWLS OR HOIST CABLE.**
2. **ESTABLISH A HOVER. FM CONNS HELO INTO POSITION SO THAT THE RS MAY BE HOISTED OUT OF THE HOLE.**

Corrective Action - Safety line attached:

1. **HOLD SAFETY LINE.**

**WARNING**

Pulling on the back-attached safety line may jam the rescue swimmer against or under the ice, preventing the maneuvering required to return to the surface.

2. **RESCUE SWIMMER – EXTRACT OUT OF THE ICE HOLE BY ROLLING OUT, OR PULLING OUT WITH ICE AWLS OR THE SAFETY LINE.**

If the swimmer is unable to extract:

3. **COMPLETE EMERGENCY RECOVERY OF THE RESCUE SWIMMER.**

Corrective Action - Safety line NOT attached:

1. **RESCUE SWIMMER – EXTRACT OUT OF THE ICE HOLE BY ROLLING OUT, OR PULLING OUT WITH ICE AWLS.**

If the swimmer is unable to extract:

**2. COMPLETE EMERGENCY RECOVERY OF THE RESCUE SWIMMER.**

## EMERGENCY BREAKAWAY OF DISEMBARKED RESCUE SWIMMER ON ICE

If an aircraft emergency situation develops requiring an immediate transition to forward flight (loss of engine oil lubrication, engine fire, etc.), expedient action with the safety line is necessary to ensure the fly out capability of the aircraft and the safety of the rescue swimmer.

**1. ON PRE-BRIEFED FREQUENCY PILOT ANNOUNCE, "BREAKAWAY, BREAKAWAY, BREAKAWAY."**

**2. RS RELEASE SAFETY LINE BELT/HOIST CABLE.**

**3. FM DISCARD SAFETY LINE AND TUCK SACK OR SHEAR/CUT HOIST CABLE.**

**WARNING**

If safety line becomes snagged during the discard, cut the safety line free with web cutter.

**4. COMPLETE LEAVING RESCUE SWIMMER ON SCENE PROCEDURES.**

## LEAVING RESCUE SWIMMER ON SCENE

The abandoned rescue swimmer's, and survivor's, survivability is enhanced by providing any extra equipment possible, i.e., LR-1 raft, Hypothermia bags, EMT kit, etc., that can be left on scene as the aircraft departs.

In the event the aircraft must depart scene due to serious malfunction or other reason:

**1. "MARK" AND RECORD POSITION.**

**2. DEPLOY LIGHTED RAFT.**

**3. DEPLOY DMB.**

4. NOTIFY OPCEN OR OTHER RESCUE RESOURCE.

# DITCHING/EGRESS

## DITCHING (POWER ON)

In a dual engine ditching situation, the PIC should consider dropping off passengers, crew, raft, and survival gear prior to ditching. If the aircraft is then ditched downwind of their position, the crew may be able to assist. Slight collective loading may decrease rotor deceleration time. The helicopter floats with the tailrotor partially submerged.

**WARNING**

When the emergency flotation gear is activated a burning electrical smell, accompanied by possible residual gas, may be detected in the cockpit and should not be confused with a possible electrical malfunction/fire.

Failure to jettison the cockpit doors prior to water entry will preclude opening them by normal means (using door handle) due to blockage by the flotation bags. However, the doors can still be jettisoned by following proper jettison procedures. The doors should not, however, be opened by normal means prior to water entry as they may puncture the flotation bags.

1. CREW AND PASSENGERS - ALERTED.
2. DISTRESS MESSAGE - TRANSMIT.
3. PERSONAL EQUIPMENT - CHECKED.
4. BEFORE LANDING/HOVER CHECK - COMPLETE.

<u>If DUAL ENGINE:</u>

5. DOORS - JETTISON IN A HOVER.
6. FLOATS - INFLATE IN A HOVER.

<u>If SINGLE ENGINE:</u>

5. DOORS - JETTISON IN A CLIMB @ 70 KIAS IF ABLE; OTHERWISE @ 200 FEET @70 KIAS, STRAIGHT AND LEVEL.
6. PRIOR TO WATER ENTRY - FLOATS INFLATE.
7. ENTER WATER IN A LEVEL ATTITUDE.
8. FCSLs - SHUT OFF.

9. ROTOR - ALLOW TO COAST DOWN.

10. EGRESS HELICOPTER WHEN ROTOR STOPS.

## EMERGENCY EGRESS PROCEDURES

Because of the high probability of spatial disorientation due to aircraft attitude, damage, and/or environmental factors (noise, night, water), it is imperative that all crew members become familiar with normal/emergency aircraft escape routes and the egress procedures. All helicopter doors (except the baggage compartment door) are equipped with interior/exterior quick release mechanisms (Figures 3-2 and 3-4). Emergency equipment is depicted in Figure 3-3. The importance of reference points and mental rehearsal cannot be overstressed. Prior preparation for egress, such as having all pockets closed, will reduce snagging hazards. Kicking should normally be avoided prior to exiting the aircraft to preclude snagging or possibly injuring/hampering another crew member.

**WARNING**

- Failure to maintain a handhold on a Reference Point until clear of the aircraft could result in disorientation. In the event of an inverted egress, release of the 5 point harness may prove difficult due to load imparted in the 5 point harness.

- If fuel or oil cover the water surface, do not ignite signal devices.

- If the forward ball end of the gas strut on the cockpit door does not release from its mount when the jettison handle is activated, the door will not jettison properly. If necessary, physically remove it prior to pushing out on the door.

- To ensure proper jettisoning of the cockpit door, pressure should be applied above the upper hinge attachment point on the forward door frame.

Land/Water (Upright) - Wait until all buffeting stops (recommended 8-10 seconds).

Water (Inverted) - Take normal breath and wait until completely immersed (recommended 8-10 seconds).

Sudden immersion in cold water may make it difficult to hold breath for even a short period.

1. **EMERGENCY EXIT – LOCATE EMERGENCY RELEASE HANDLE; ACTIVATE AND JETTISON.**

2. **REFERENCE POINT – LOCATE AND HOLD.**

3. **MIKE CORD – DISCONNECT.**

4. **SEATBELT/HARNESS – RELEASE/MAINTAIN REFERENCE.**

5. **EGRESS – HOLDING REFERENCE POINT, EXIT AT RIGHT ANGLES TO THE AIRCRAFT.**

6. **LIFE VEST – WATER – INFLATE WHEN CLEAR OF THE AIRCRAFT.**

**NOTE**

A wet suit will exhibit some positive buoyancy when immersed.

## EMERGENCY ENTRANCE

Emergency entrance may be gained by opening any of the doors in the normal manner, or by using the emergency door release handles to jettison the pilot's, copilot's, and passenger doors. The plastic window located aft of the sliding door may be jettisoned by pulling outward on the red tabbed lanyard and pushing inward on the window. Access to the passenger compartment can also be accomplished through the baggage compartment door. (Refer to Figure 3-4.)

## JAMMED SLIDING CABIN DOOR

Symptom:

1. Cabin sliding door does not fully open or will not secure in the closed position.

Corrective Action:

1. **FLIGHT MECHANIC – REMAIN SECURED TO AIRCRAFT.**

2. DO NOT USE EXCESSIVE FORCE.

3. DOOR ASSEMBLY - INSPECT:

   a. RESCUE HATCH - SECURED.

   b. FORWARD UPPER ROLLER ASSEMBLY - IN TRACKS.

   c. FORWARD LOWER ROLLER ASSEMBLY - ATTACHED TO THE DOOR.

4. AERODYNAMIC LOAD ON DOOR - REDUCE (when ops permit); USING THE FOLLOWING:

   a. DECREASE AIRSPEED.

   b. INDUCE LEFT SIDESLIP (right pedal).

   c. OPEN PILOT'S WINDOW.

If door assembly operable:

5. COMPLETE DOOR MOVEMENT.

6. CONTINUE FLIGHT AS APPROPRIATE.

If door assembly non-operable (left cabin door becomes primary exit):

5. DOOR - SECURE INTERIOR HANDHOLD ON DOOR TO DECK TIEDOWN USING TRAIL LINE OR STRAP.

6. SPEED - 80 KIAS MAXIMUM.

7. LAND AS SOON AS PRACTICABLE.

**WARNING**

A jammed sliding door may present an egress hazard. Over-water operations below 200 feet should not be conducted with a jammed door.

If mission urgency or ship landing dictates removal of the door and distance offshore precludes landing for door removal:

8. JETTISON DOOR:

   a. FLIGHT PROFILE - 30 KIAS MAXIMUM; LEVEL OR CLIMB.

   b. DOOR - JETTISON.

   c. CONTINUE MISSION; OBSERVING DOOR REMOVED SPEED LIMIT - 120 KIAS MAXIMUM.

# UNUSUAL ATTITUDES

An unusual attitude is an aircraft attitude occurring inadvertently. Unusual attitudes may result from one factor or a combination of several factors internal or external to the aircraft. Common factors leading to aircraft unusual attitudes include but are not limited to: failure of a VGI, spatial disorientation, distraction of cockpit duties, break down in instrument scan, instrument failure, and turbulence.

Unusual attitudes are normally recognized in one of two ways, either by an unusual attitude display on the attitude indicator or unusual performance on the performance instruments (airspeed indicator, vertical speed indicator, turn and slip indicator, heading indicator, and altimeter). Regardless of how an unusual attitude is recognized, the condition must be verified by comparing all control and performance instruments prior to initiating a recovery. This comparison precludes entering an unusual attitude as a result of making control inputs to correct for erroneous instrument indications. In most instances, unusual attitudes are mild enough for the pilot to recover by re-establishing the proper attitude for the desired flight condition and resuming a basic instrument scan.

# UNUSUAL ATTITUDE RECOVERY

Symptoms:

1. Any unintentional, undesirable, or unsafe aircraft attitude.

Corrective Action:

**1. LEVEL THE WINGS.**

**2. NOSE ON HORIZON.**

**3. CENTER THE BALL.**

**4. POWER – ADJUST TO MAINTAIN LEVEL FLIGHT.**

**NOTE**
**The baggage compartment door has an exterior mounted door handle only. However, the door opening mechanism is accessible from the inside and allows the door to be opened from the inside and used as an alternate emergency exit.**

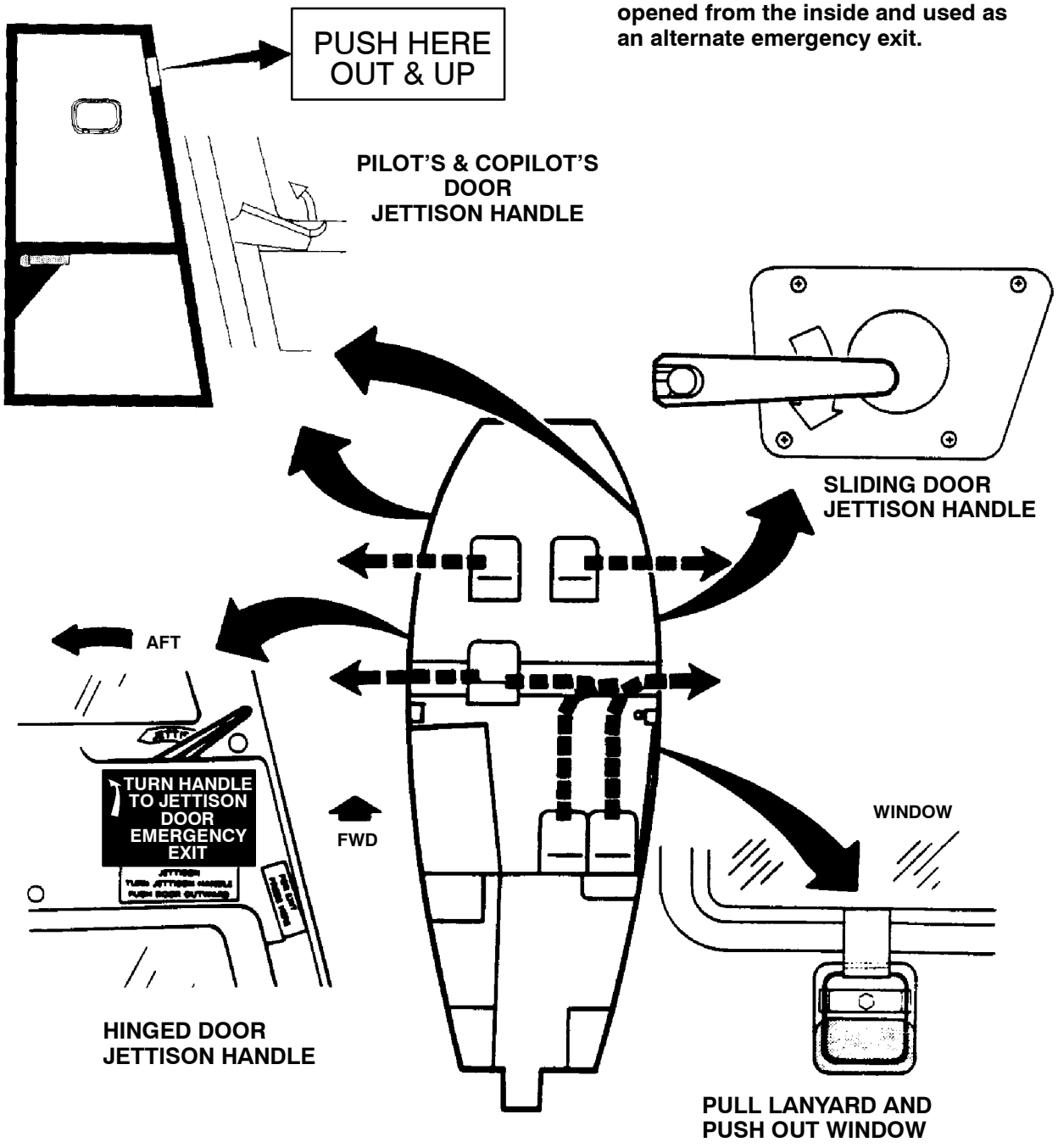



*Figure 3-2. Emergency Exits*

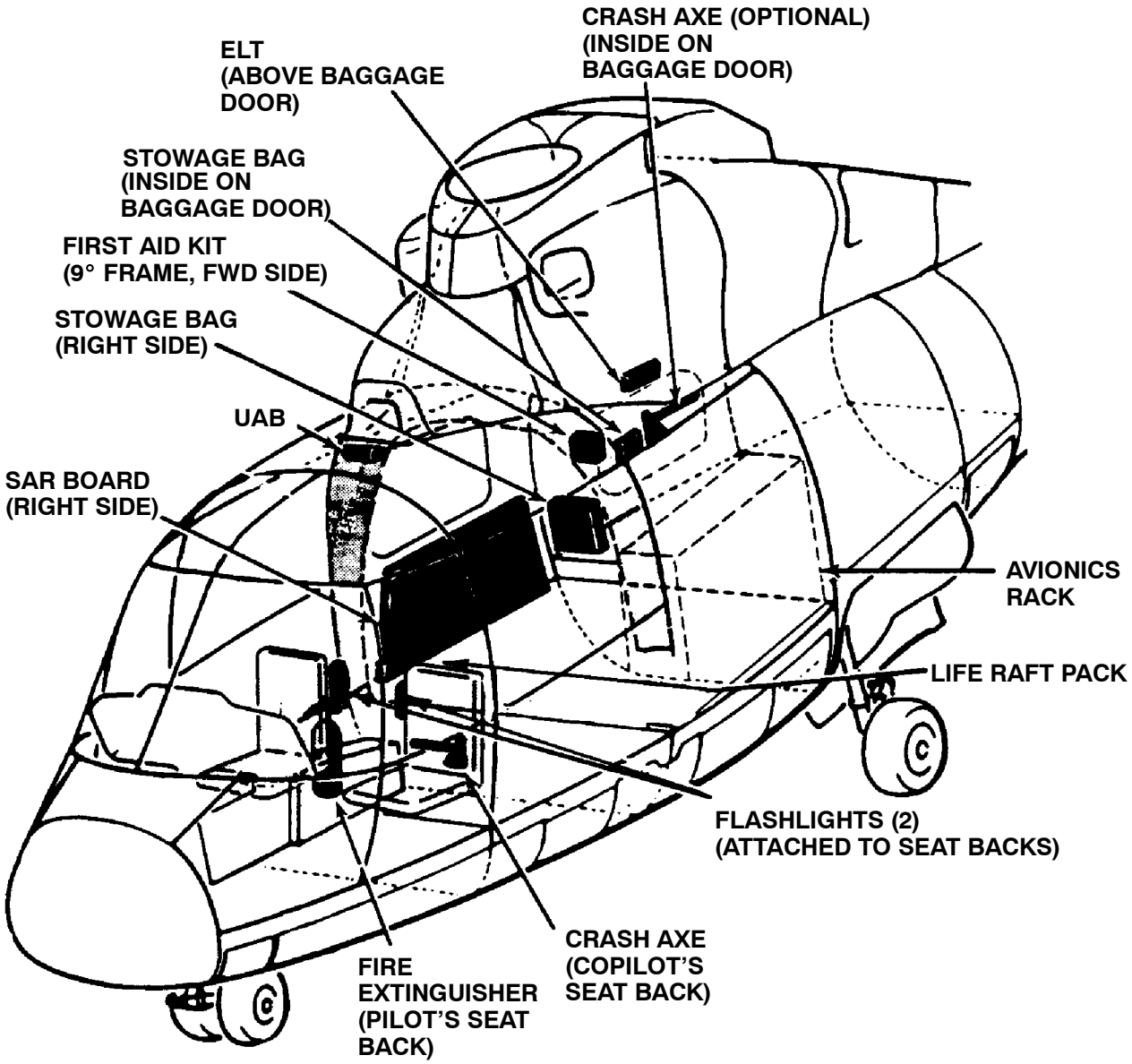



*Figure 3-3. Emergency Equipment*

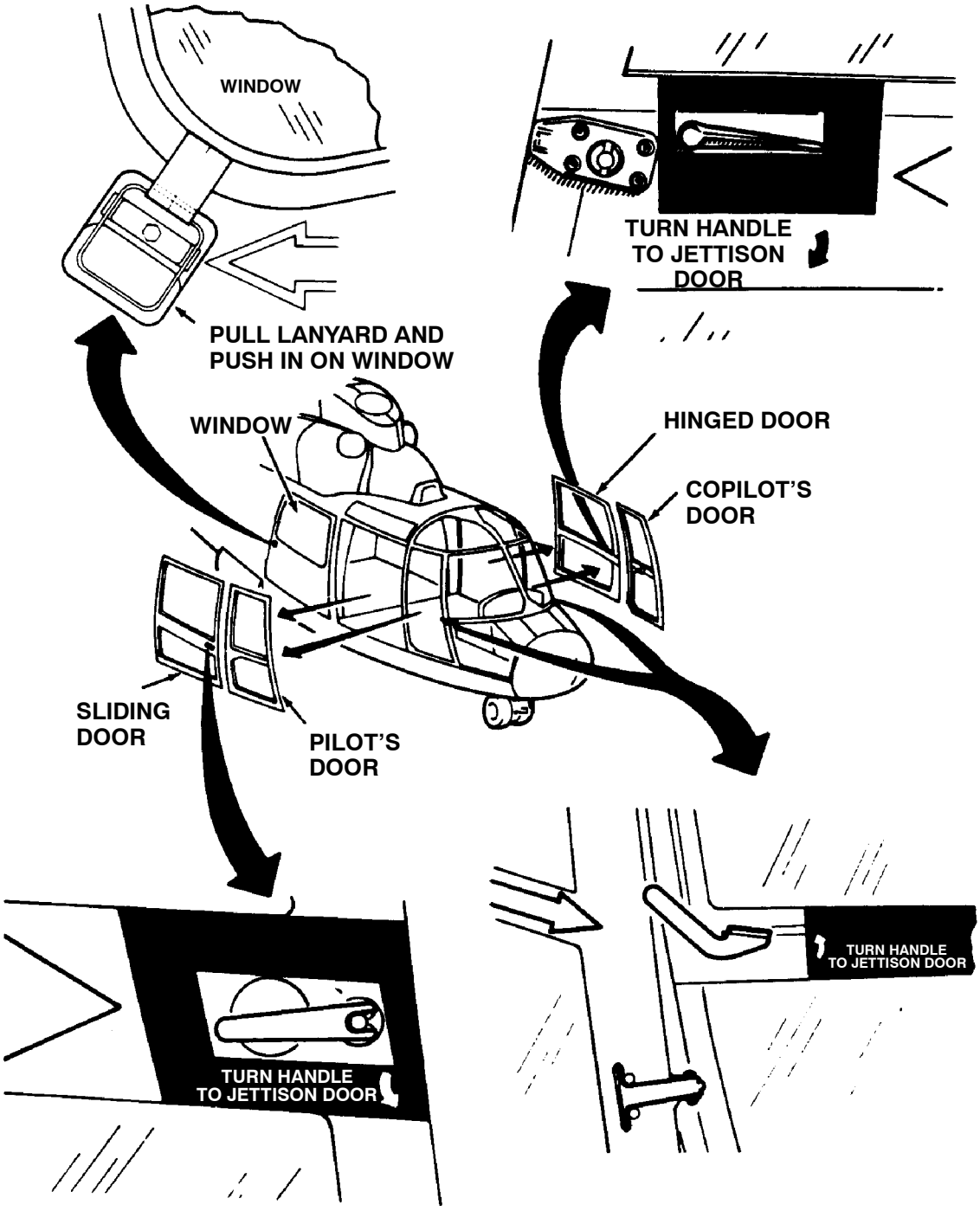



*Figure 3-4. Emergency Entrance*

| LIGHT | CAUSE |
|---|---|
| MASTER WARNING<br>Two flashing lights on either side of instrument panel. | One or more warning lights on warning–caution–advisory panel illuminates. |
| FIRE<br>Two engine lights above warning–caution–advisory panel.<br>Engine fire lights on each EFSL.<br>One MGB light below COM 1 RRU. | Engine or MGB fire/overheat condition. |
| MASTER WARNING plus<br>ELEC PUMP | Emergency hydraulic system pressure above 1377 psi. |
| MASTER WARNING plus<br>PRI SERVO P plus<br>SERVO JAM plus<br>LIMIT | Primary hydraulic system pressure below 145 psi resulting in loss of pressure to the upper bodies of the main servo controls.<br>NOTE: The LIMIT light will always come on during normal flight, but may remain off in autorotation or during reduced power conditions. |
| MASTER WARNING plus<br>SEC SERVO P plus<br>SEC HYD LO PRES plus<br>SERVO JAM | Secondary hydraulic system pressure below 145 psi resulting in loss of pressure to the lower bodies of the main servos and the left body of the tail servo. |
| MASTER WARNING plus<br>SEC HYD LO PRES plus<br>SEC HYD ISOLATE plus<br>SEC SERVO P plus<br>SERVO JAM | Sec hydraulic system press below 145 psi resulting in loss of pressure to the lower bodies of the main servos and the left body of the tail servo.<br>Sec hydraulic system reservoir below 1 gal resulting in loss of primary landing gear actuating system, wheel braking system and normal electrical power to the hoist. |
| MASTER WARNING plus<br>FEED TANK 1 or<br>FEED TANK 2 | Case 1: If one fuel system gage reading is zero, then the fuel quantity in the corresponding feed tank is below 37 pounds of JP–5.<br>Case 2: If the fuel in the corresponding tank system is greater than zero and fuel pressure is normal, the fuel ejector system has failed.<br>Case 3: If the fuel in the corresponding tank system is greater than zero and fuel pressure is zero with BOTH boost pumps ON, a dual boost pump failure has occurred. |
| MASTER WARNING plus<br>BATT TEMP | Battery has exceeded internal temperature limit of 135 °F (57 °C). |
| MASTER WARNING plus<br>ENG 1 CHIP or ENG 2 CHIP ON WCA w/corresponding ENG # CHIP on the VEMD | Ferrous particles detected in engine oil system. |
| MASTER WARNING plus<br>GB CHIP (w/VEMD TGB CHIP annunciation) | Ferrous particles detected in tail gearbox. |
| MASTER WARNING plus<br>SEC HYD HI PRES | Secondary hydraulic system pressure above 3480 psi caused by governing failure of the self–governed hydraulic pump. |
| MASTER WARNING plus<br>ENG 1 OIL P or ENG 2 OIL P | Engine oil pressure below 20 psi. |
| MASTER WARNING plus<br>SERVO JAM | Jammed servocontrol distribution valve.<br>NOTE: Cyclic control load increases slightly (approximately 1 lb). |
| MASTER WARNING plus<br>SEC HYD LO PRES | Secondary hydraulic system pressure below 2450 psi. |

*Figure 3-5. Warning and Caution Lights (Sheet 1 of 2)*

| LIGHT | CAUSE |
|---|---|
| MASTER WARNING plus<br>OIL TEMP | Main gearbox temperature has exceeded 120 °C or engine oil temperature has exceeded 115 °C. (Check VEMD) |
| MASTER WARNING plus<br>SEC HYD ISOLATE plus<br>SERVO JAM | Secondary hydraulic system reservoir below one gallon.<br>NOTE: Primary landing gear actuating system, wheel braking system and left body of the tail rotor control servo automatically shut off. Normal electrical power to hoist control is shut off. |
| MASTER WARNING plus<br>ENG 1 FUEL P or ENG 2 FUEL P | Engine fuel pressure below 6 psi. |
| MASTER WARNING plus<br>MGB PRES plus<br>MGB PMP MAIN plus<br>MGB PMP AUX | Main gearbox lubrication system failure (oil pressure below 8.7 psi). |
| MASTER WARNING plus<br>GB CHIP (w/VEMD MGB CHIP annunciation) | Ferrous particles detected in main gearbox. |
| L EXT or R EXT | Engine fire extinguisher system low or exhausted. |
| AV RACK O/HEAT | Overheat condition in avionics rack. |
| FUEL FILT 1 or FUEL FILT 2 | Clogged engine fuel filter. |
| L PITOT or R PITOT | Applicable PITOT HEAT switch OFF or pitot heater has failed. |
| MGB PUMP MAIN | MGB main oil pump failure. Pump pressure below 12 (±1) psi.<br>NOTE: Auxiliary pump automatically provides lubrication at reduced pressure and without cooling. |
| MGB PUMP AUX | Main gearbox auxiliary oil pump failure. Pump press below 12 (± 1) psi. Loss of redundancy. |
| ROTOR BRAKE | Rotor brake microswitch not fully seated. |
| L WSCRN ANT ICE or R WSCRN ANT ICE | Failure of the regulator box of the corresponding anti−ice system. |
| AFCS | One or more of the AFCS axis are disengaged and not acknowledged. |
| FREON HI PRES | Condenser inlet pressure exceeds approx 392 psi for more than 20 seconds. |
| HEATER O/HEAT | High temperature sensed at one or more of six thermoswitches. (Two in lower duct system at approximately 275 °F, two near bleed air mixing valve at approximately 275 °F and two above FADEC computers at approximately 158 °F. |

*Figure 3−5. Warning and Caution Lights (Sheet 2 of 2)*

# SECTION IV

# CREW DUTIES

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PILOT IN COMMAND (PIC) . . . . . 4-1
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SELF-LOCATING DATUM MARKER BUOY (SLDMB) . . . . . 4-6

## INTRODUCTION

Each flight crewmember has duties other than those covered in NORMAL PROCEDURES, Section II, and EMERGENCY PROCEDURES, Section III. These additional duties are contained in this Section.

## PILOT AT THE CONTROLS (PAC)

The pilot operating the flight controls (cyclic, collective, and pedals). The heading control knob may be considered an extension of the flight controls when operating the Heading Select flight director mode. The PAC is responsible for movement and maneuvering of the aircraft via control inputs with reference to either visual or instrument information.

## SAFETY PILOT (SP)

During dual pilot operation of the aircraft, the SP is the pilot not operating the flight controls. The safety pilot provides back–up to the PAC by performing cockpit duties such as checklists, briefings, communications, CDU operation, and flight director operation (at the PAC's direction). In general, the SP should handle any cockpit duty that may potentially distract the PAC from concentration on flight control operation with reference to visual or instrument information.

## PILOT IN COMMAND (PIC)

The pilot in command is responsible for the safe and orderly conduct of the flight. Responsibility and authority for the flight commences with the preparations for the flight and terminates with the completion of post–flight requirements. The PIC shall be responsible for ensuring that crew and passengers are properly briefed. Responsibility for all phases of the flight rests with the pilot in command.

## COPILOT (CP)

The copilot's duty is to assist the pilot. General duties are:

1. Ensure an adequate crew briefing from the pilot in command is received.
2. Assist the pilot in performing exterior and interior inspections of the helicopter.
3. Assist the pilot in mission planning.
4. Assist the flight mechanic in determining the cargo and passenger distribution for computing the Center of Gravity (CG) of the helicopter.

## FLIGHT MECHANIC (FM)

The duties of the flight mechanic normally include but are not limited to the following:

1. Brief passengers on aircraft emergency procedures, emergency exits, egress procedures, and survival equipment as directed by the pilot.
2. Perform routine mechanic duties, such as servicing and maintenance, when away from home base.
3. Perform fireguard duties.

4. Assist the pilot(s) with the evaluation of landing/confined areas as directed by the pilot in command.

5. Act as "Ground Taxi Signalman" or "Wing Walker" as directed by the pilot in command.

6. Assist the Safety Pilot as directed by the pilot in command.

7. Supervise all activities in the cabin.

8. Operate the rescue hoist; perform hoist check.

9. Deploy rescue swimmers.

10. Supervise external load operations.

11. Deploy a datum marker buoy or MK 25.

12. Supervise cargo loading and offloading.

13. Search.

14. Routinely conduct a safety check. This check includes, but is not limited to, the following items:

    a. Instrument panel – Check for normal indications.

    b. Avionics rack and overhead circuit breaker panels – Check for popped circuit breakers.

    c. General cabin area – Check for leaks and security of equipment, cabin doors, and hatch.

    d. Landing gear – Check DOWN prior to each landing.

15. Conduct radio communication as directed by the pilot.

## AIRCREWMEMBER

The duties of the aircrewmember normally include, but are not limited to, the following:

1. Brief passengers on aircraft emergency procedures, emergency exits, egress procedures, and survival equipment as directed by the pilot.

2. Perform routine mechanic duties such as servicing and maintenance, when away from home base.

3. Perform fireguard duties.

4. Supervise all activities in the cabin.

5. Deploy a datum marker buoy or MK 25.

6. Supervise cargo loading and offloading.

7. Search.

8. Routinely conduct a safety check. This check includes, but is not limited to, the following items:

    a. Instrument panel – Check for normal indications.

    b. Avionics rack and overhead circuit breaker panels – Check for popped circuit breakers.

    c. General cabin area – Check for leaks and security of equipment, cabin doors, and hatch.

    d. Landing gear – Check DOWN prior to each landing.

## CREW BRIEFING GUIDE

The following briefing guide is provided to assist the pilot in conducting briefings, as applicable to the mission assigned.

1. Mission.

2. Risk assessment.

3. Flight plan and radio guard.

4. Fuel load.

5. Equipment.

    a. SAR.

    b. Survival.

    c. Maintenance checks.

    d. Special equipment (NVGs, FLIR, etc.).

6. Weather.

7. Crew duties and responsibilities.

8. CRM (wave–off authority, sterile cockpit, two–challenge rule, etc.).

9. Emergencies and emergency egress.

**WARNING**

Careful consideration should be given to the position of the Flight Mechanic's seat when personnel are carried aft of the 9° frame. With the sliding cabin door open, the passenger window exit will be blocked; and if the Flight Mechanic's seat is positioned on the starboard side, it may present a hindrance to successful egress and/or raft deployment. Additionally, if the VIP seat is installed at station 110, egress through the port cabin door will be hindered.

## PASSENGER BRIEFING GUIDE

The pilot in command shall ensure that all passengers embarked receive an adequate briefing. The briefing shall encompass at least the following:

1. No smoking and seat belt rules and signals.

2. Emergency exits.

3. Action required in case of ditching or crash landing (signals and exits).

4. Use of life jackets.

5. Use of other emergency equipment.

6. Movement within helicopter.

7. Additional considerations (i.e., weapons).

## HOIST CHECK

The Flight Mechanic will conduct the following check prior to all flights requiring the use of the Hoist System. This check is designed to ensure proper operation of the Hatch, Hoist, Boom, and ICS Systems. It is accomplished during the Systems/Equipment check as described in Section II, Normal Procedures.

1. Hatch – OPEN.
   a. Support Locks – CHECK PROPER ENGAGEMENT.
   b. Support Rod Attachment and Hinge Points – CHECK.
2. Control Box Power – ON (check for green light).
   a. Boom In/Out Switch – CONTROL BOX.
   b. Hoist Speed Control through intermediate Speed Switch – CONTROL BOX.
   c. Boom In/Out Switch – PENDANT.
   d. Hoist Speed Control – PENDANT.
3. Emergency Power – CHECK.
   a. Emergency Power Switch – ON.
   b. Control Box Power – ON (check for green light).
   c. Boom In/Out Switch – BOX OR PENDANT.
   d. Hoist Speed Control – BOX OR PENDANT.
   e. Emergency Power Switch – OFF.
4. Manual Hydraulic Override – CHECK.

**CAUTION**

The hoist up–limit switch will be inoperative during this check. Do not run the hook all the way to the hoist.

   a. Step I and Step II doors – OPEN.
   b. Manual Shutoff Valve – OPEN.
   c. Manual Up/Down Valve – CHECK: Clockwise–UP, Counterclockwise – DOWN.
   d. Manual Shutoff Valve – CLOSE.
5. Cable – Check.
   a. Hook – EXTEND (approximately 3 feet).
   b. Cable – Inspect for damage, (i.e., broken wires, birdcaging, kinks, etc.). The hoist will

not be used if the cable is damaged, nor shall the damaged portion of the cable be retrieved into the hoist assembly.

6. Hoist Hook – CHECK.
   a. Hook and Mouse: Gate – CONDITION / FREE TO MOVE.
   b. Swivel – CONDITION / FREE TO ROTATE.
   c. Swage–Ball End – SECURE.
   d. Spring/Plate – CONDITION.
   e. Set screw – PRESENCE and SECURITY.
7. Up–Limit Switch – CHECK.
   a. Up–Limit Switch – PUSH AND HOLD.
   b. Select hoist "UP" (cable should not move up).
   c. Up–Limit Switch – RELEASE (cable should move up).
   d. Hook – RUN UP TO STOP.
8. Boom Stow – CHECK.
   a. Boom Stow Switch – PRESS (momentarily): Monitor boom to stow position.
9. Hatch / Cabin Door – CLOSE.

**CAUTION**

Improper or incomplete closing of the Hatch can cause loss of the Cabin Door.

   a. Support Release Handle – PULL TO RELEASE LOCKS.
   b. Hatch – CLOSE (Pull down at center while holding the Lock–Pin Release Handle "OPEN").
   c. Hatch – LOCK (By pushing the Lock–Pin Release Handle to the "LOCKED" position).
   d. Lock–Pin – CHECK ENGAGEMENT AT FORWARD AND AFT END.
   e. Cabin Door – CLOSE AND LOCK.
10. Hot–Mic/Alt ICS – CHECK.
   a. Audio Monitor/Volume Buttons – AS DIRECTED BY PIC.

**NOTE**

Monitor COMM–1 and COMM–2 to reduce interruption of pilot communications.

   b. Hot–Mic Switch – HOT MIC (confirm communications).
   c. Hot–Mic Switch – OFF.

**NOTE**

If you are unable to hear yourself on ALT, ensure that the right Passenger Aux Audio Volume Control is turned up.

   d. Audio Select Switch – ALT (confirm communications).
   e. Audio Select Switch – ICS.
11. Hoist Power – SECURE.
   a. Hoist Control Power/Ind Switch (control box) – OFF.
   b. Hoist Master Switch (overhead) – SECURE HOIST POWER.

## QUICK SPLICE

The hoist quick splice may be used any time the hoist cable has been manually cut.

**WARNING**

After the cable is cut, the strands may separate. Use care when handling the cable to prevent injury from the sharp ends.

**WARNING**

Failure to insert the cable past the keeper clip in notch #5 may result in the cable unwinding off the quick splice.

To install the quick splice:

1. Hold the quick splice plate so that "START" is in the upper right corner.
2. Hold the cut end of the severed hoist cable over "START." The end should be aligned flush with the top of the quick splice plate.
3. Begin wrapping the cable downward into notch "1" (lower–left). Proceed around the back of the plate into notch "2." Tightly wrap the cable around the plate, fitting the cable into the notches "3" through "5." See Figure 4–1.
4. When hoisting is complete, bring quick splice into the cabin, stow in the area between the raft and window. Place hoist cable in the aft lower hatch opening and close the hatch. The cable will be held in place by the rubber seal in the hatch.

**CAUTION**

- With the quick splice installed, the hoist up – limit switch may not stop hook movement.
- Ensure hoist power is secured at the Pilot's overhead control panel at completion of the hoist.

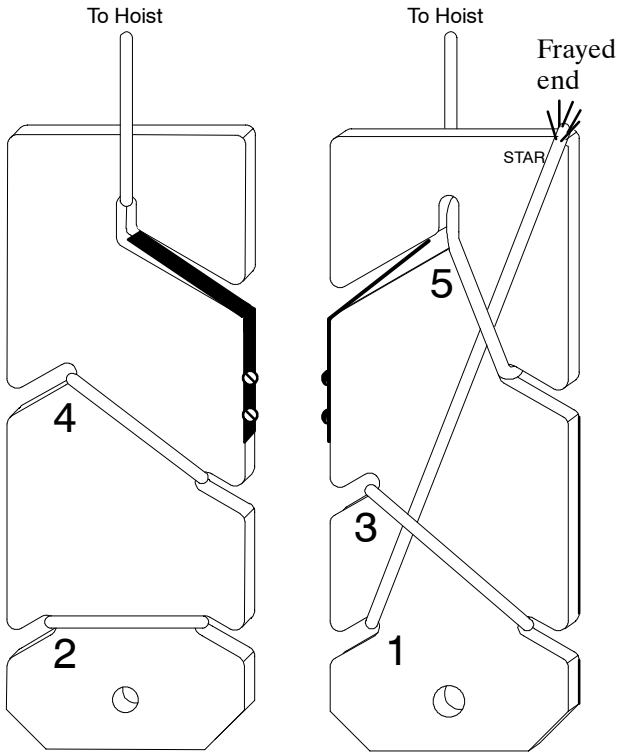



*Figure 4-1. Quick Splice*

- The 50 FPM speed reduction switch may be inoperative.

## MK 25 DEPLOYMENT

**WARNING**

Do not deploy an MK 25 from a steady hover due to the possibility of valve plug FOD after ignition.

1. Sliding door – OPEN.
2. Unscrew plastic protective cap.
3. Fully depress and rotate arming cap to the arm position and remove cap and spring.

**NOTE**

The MK 25 should not be armed until the helicopter is 30–60 seconds from the drop point, or it is certain that the flare will be needed.

4. The addition of salt is required when working over fresh or brackish water.

CAUTION

Once salt has been added to the MK 25 it must be deployed.

5. Holding the flare clear of the helicopter with nipple end down, deploy straight down over drop point.

6. To disarm the MK 25, reinstall arming cap and spring, depress and rotate to the safe position.

7. Reinstall plastic protective cap.

## DMB–4 DEPLOYMENT

1. Sliding door – OPEN.

2. Ensure a COMM radio is tuned to frequency as found on DMB placard.

3. Altitude and airspeed for DMB insertion shall be according to the DMB placard for the specific DMB being used.

4. DMB must be dropped (not thrown) in the insertion position impact cone first.

## SAFETY BELTS

During routine landings, takeoffs, and when directed, the flight mechanic will be seated with seat belt and harness fastened and seat facing forward. During flight, crewmembers and passengers shall remain seated with belt fastened, except when necessary activities require temporary removal. This removal shall not be made below 1,000 feet absolute altitude without authorization by the pilot in command.

## ICS COORDINATION

Crewmembers shall inform the pilot prior to disconnecting from the ICS.

## SELF–LOCATING DATUM MARKER BUOY (SLDMB)

### SYSTEM DESCRIPTION

Each SLDMB consists of a center cylinder that houses a Global Positioning System (GPS) receiver, transmitting equipment, ARGOS electronics plus batteries, four 50 x 70 cm (19.5 x 25.5 in.) cloth vanes with flotation blocks and antennae (Figure 4-2). The SLDMB is securely held in a biodegradable launch container by water-soluble tape. The packaged cylinder is 10 inches in diameter, 43 inches tall, weighs 25 lbs, and has a nylon cap and static line attached to one end. The buoy is designed to land within 100 meters (110 yards) of the aircraft track. After deployment and contact with the water, the SLDMB slowly deploys (unfolds) as the water-soluble tape dissolves. Once deployed, the SLDMB will communicate with the National Oceanic and Atmospheric Administration (NOAA) n-series polar orbiting satellites via Service Argos and provide GPS positions at 30 minute intervals continuously for up to 30 days. The internal GPS receiver and other internal electronics allow critical data relay to a Coast Guard database where the information can be processed and made available over the intranet to SAR controllers. The Coast Guard's SLDMB website is:

http://sldmb.osc.uscg.mil//.

Under ideal conditions the SLDMB is operational within 4 minutes after water contact and 11 minutes in less than favorable conditions.

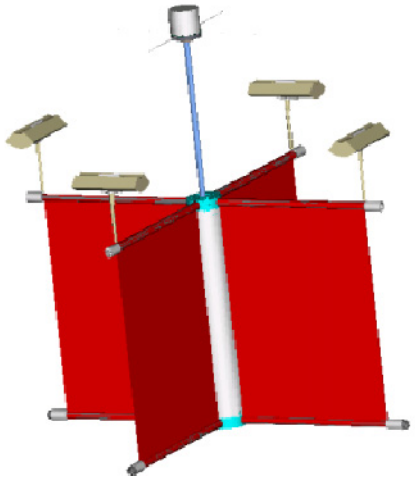


*Figure 4-2. SLDMB Deployed view*

## DEPLOYMENT PROCEDURES

1. ARGOS Number, time, and position - RECORD.

**NOTE**

The SLDMB should not be removed from the moisture-proof foil wrapper unless it is certain that the SLDMB will be needed.

**WARNING**

Once the SLDMB has been removed from its protective moisture-proof casing it must be deployed. Do not remove the tape from the cardboard casing. This tape is made of water-soluble material and care must be taken to ensure that water does not come into contact with the tape prior to deployment causing inadvertent activation of the folded arms. Activation of the folded arms could result in personal injury and present a possible egress hazard.

2. Moisture-proof foil wrapper - REMOVE.

3. Cabin sliding door - OPEN.

4. Cap, static line, and plastic bag - REMOVE FROM DROUGE CHUTE.

5. SLDMB - POSITION AT SLIDING DOOR WITH DROUGE CHUTE ATTACHMENT UP.

6. Drouge chute - HOLD TIGHTLY AGAINST END PLATE.

7. SLDMB - DEPLOY WHEN DIRECTED.

**CAUTION**

Deployment from altitudes/airspeeds of greater than 300' AWL/70 KIAS or to areas of water depth less than 12' can result in SLDMB failure or aircraft damage.

# SECTION V

# OPERATING LIMITATIONS

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## INTRODUCTION

The operating limitations contained in this section are derived from experience gained during the design, production, and flight test of the helicopter. These limitations, which must be observed if safe and efficient operations are to be attained, should be studied carefully to become familiar with proper operations of the helicopter and associated equipment. The instruments in the helicopter are marked to indicate that flight operations are being accomplished in a safe and desirable, or unsafe region. Appropriate explanations are provided where the markings are not self–explanatory. In addition, other limitations on operational procedures, maneuvers, and loading are covered.

**NOTE**

- If any of the limits included in this section of the flight manual are exceeded, remarks concerning the degree to which the limits are exceeded and the time duration of the exceedance shall be entered on form CG–4377.
- The Engine Condition Monitoring System (ECMS) automatically records certain engine and transmission exceedances any time the Control Display Unit (CDU) is operating. This data is stored and can be transferred to a magnetic tape cartridge during post–flight operations for maintenance analysis. Refer to Engine Condition Monitoring System in Section I.

## MINIMUM CREW

The minimum crew required for the proper operation of this helicopter is one pilot in the right seat.

## INSTRUMENTATION

Instrumentation in the HH–65C consists of various digital, analog and pitot–static displays. It includes the use of a First Limit Indicator (FLI) as part of a two–screen Vehicle Engine Management Display (VEMD). The VEMD combines engine, hydraulic, fuel and maintenance functions into an easy to read LCD display.

The VEMD uses color–coded markings and gauge animation logic to enhance aircrew situational awareness and reduce pilot workload. Descriptions of the color–coding and animation logic are provided in figure 5–1 of this section. Color–coding and gauge animation should be the primary means of identifying an over limit situation, and all pilots should be thoroughly familiar with their operation. For more information on the operation of the VEMD and other instruments refer to Section I of this manual.

### FLI COMPUTATIONS

FLI computations are made with the three power parameters (Torque, N1 and TOT) and NR. The display will remain similar regardless of dual (AEO) or single engine operation (OEI). The digital values of TRQ, TOT and N1 for each engine are displayed on the respective side of the FLI. Any power parameter over limit will be indicated by the value being underscored in red or yellow. The FLI detects engine status (AEO, OEI, Training, etc.) and converts the highest single parameter (TRQ, TOT and N1) to determine the FLI %. The maximum FLI % value drives the FLI single–needle. This allows the pilot to monitor a single gauge for engine power.

**NOTE**

Actual N1 values change based on pressure altitude and OAT; therefore, it is critical that FLI gauge markings and aural warnings be the primary indicator of over limit conditions.

### VEMD MANAGEMENT

The FLI will provide information in the message zone to alert the crew to a fuel, hydraulics, or engine limit exceedance if the page is not currently displayed. The message displayed will be one of the following:

VEH PARAM OVER LIMIT

FUEL PARAM OVER LIMIT

Should one of the messages be displayed, the crew should scroll to the appropriate page. To identify the parameter or parameters over limit, reference the numerical value underscored in red or yellow directly below the gauge. The pilot can then take appropriate action.

### AURAL WARNINGS

An audio tone will sound via the ICS system anytime NR > 380 RPM or NR < 345 RPM (see figure 5–3). In addition a “gong” tone will sound and the illumination of the limit light will occur in the following situations:

- Takeoff - Accelerate to IAS ≥ 75k in TOP range.
- Cruise Flight - IAS ≥ 75k for 5 seconds in TOP range.
- Torque 1 + 2 > 102.5%.
- Excessive load factor.
- Excessive fore or aft cyclic (on the ground).
- N1 exceeds the MTOP N1 +0.4%, i.e., 101.9%

**NOTE**

MTOP limitations change according to PA and OAT.

Aural warnings are an intricate part of the instrumentation of this aircraft, and the pilot should be familiar with their operation.

# GENERAL MARKINGS

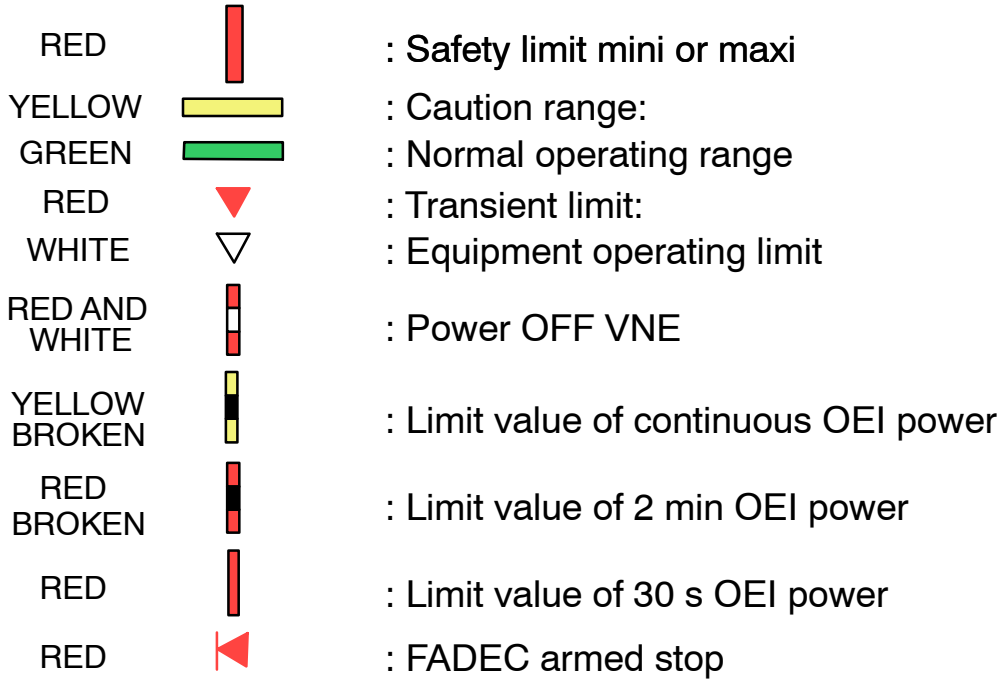



*Figure 5-1. General Markings*

# SCALE LOGIC

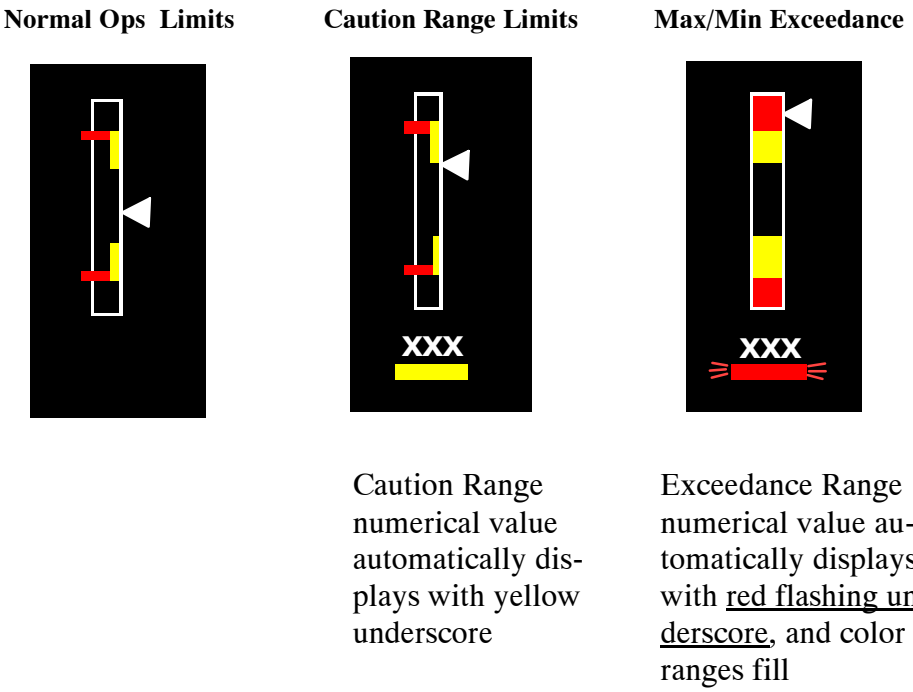



*Figure 5-2. Scale Logic*

## MAIN ROTOR LIMITATIONS

NR is indicated on the copilot's NR gage and the outer scale of the pilot's NR/N2 gauge by a single–needle pointer. NR is a function of pressure altitude (PA) and is rated at 355 RPM from 0 to 1,650 ft PA. An increase of 1 RPM per 840 ft PA will occur from 1,650 ft PA to 5,740 ft PA to increase rotor efficiency and reduce noise signature. This will result in a maximum NR of 360 RPM. A "HI NR" switch is located on the overhead panel. It will allow for selection of NR at 365 RPM above the continuous operating range, for increased performance during demanding phases of flight. An aural warning will alert the crew to NR at or below 345 RPM and at or above 380 RPM. Refer to figure 5–3 for specific NR limits.

**WARNING**

Due to the operation of the FADEC, a decrease in NR will result in a decrease in overall power. It is critical to attempt to maintain rotor RPM in all flight regimes.

**CAUTION**

With HI NR switch on, airspeed is restricted to 135 KIAS and AOB is restricted to 40 degrees.

MAIN ROTOR LIMITATIONS

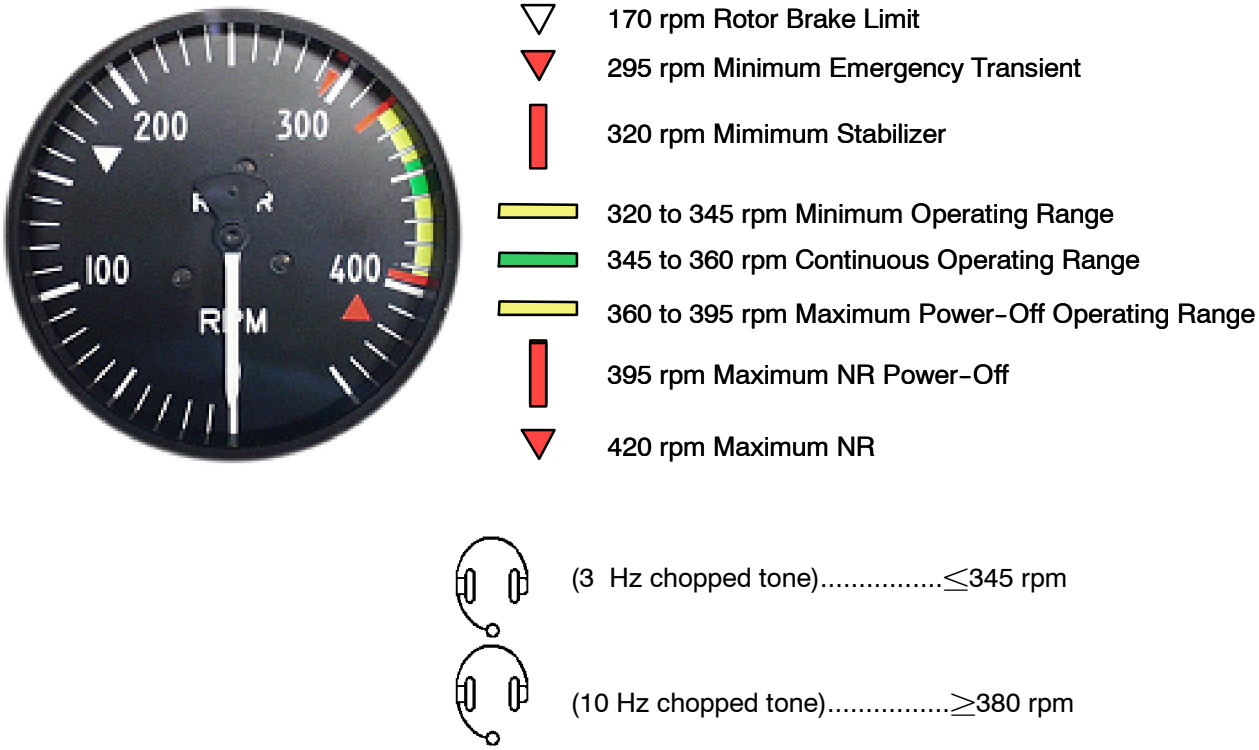



*Figure 5-3. Main Rotor Limitations*

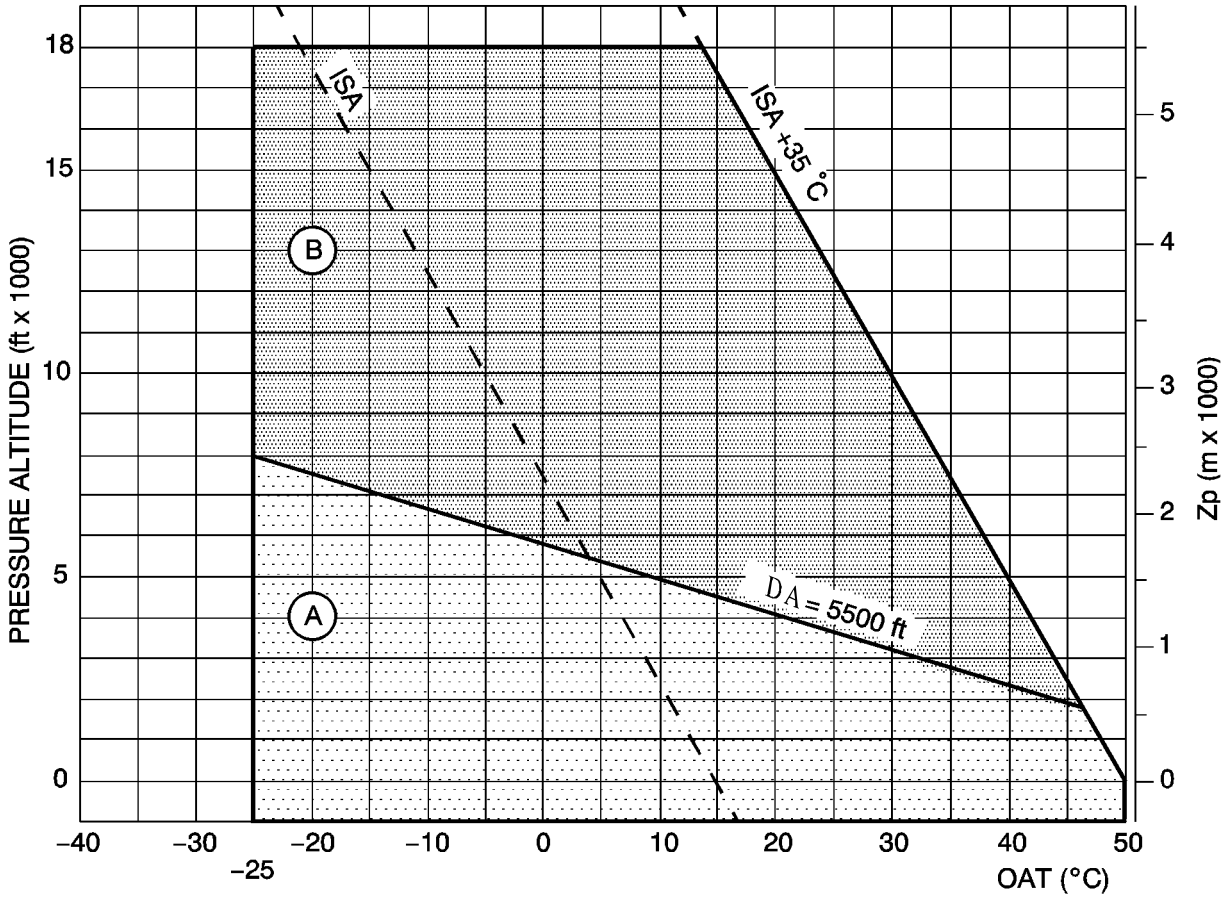



*Figure 5-4. Approved Flight Envelope*

In addition, based on main rotor aerodynamics, PA, and DA, the figure 5−4 takeoff and flight envelope limits apply.

## POWER LIMITATIONS

Power is limited by the engines or the main gearbox (MGB). The TRQ, TOT, or N1 parameter first reached during normal operations is the limit that must be observed. During most conditions, power will be limited by MGB TRQ. The use of an FLI gauge needle will indicate the instantaneous highest parameter of TRQ, TOT, or N1, and will assist the pilot in observing power limits. Two built in FADEC safety features will add power to the engine or engines in case of NR mismanagement. The first feature will cause the FADEC to begin increasing TRQ once NR < 335 RPM. A maximum of an 8% scaled increase will occur by 300 RPM. The second FADEC safety feature will allow N1 to increase to the 2-minute OEI rating when N1 is the FLI limiting factor under the following situations 1) if NR < 308 RPM and is decaying at 17.5 RPM/second or greater. 2) Anytime NR< 301 RPM. For a more detailed discussion of these FADEC features, refer to Section 1 of this manual. Refer to figure 5-5 and 5-6 for FLI AEO and FLI OEI power limitations. The following table indicates actual service ratings for the engines converted to shaft horsepower (SHP) for a standard day at sea level pressure.

| Rating | Time | Power | SHP |
|---|---|---|---|
| 30s OEI | 30 Sec | 789 KW | 1058 SHP |
| 2min OEI | 2 Min | 714 KW | 958 SHP |
| Cont OEI | Continuous | 688 KW | 923 SHP |
| Max TO | 5 Min | 697 KW | 935 SHP |
| Max Cont | Continuous | 636 KW | 853 SHP |

### TORQUE (TRQ)

Torque values are indicated on the corresponding sides of the FLI for each engine. If TRQ limits are exceeded, the TRQ values at the side of the FLI are underscored in yellow or red, based on the current range, and TRQ will also be indicated on the FLI needle. In addition, an aural

"gong" will sound, and the limit light will illuminate at 102.5%, warning the pilot to lower the collective. There is a transient TRQ limit not indicated on the FLI at 103.4% for momentary excursions above the continuous limit. During normal AEO operations, the FADEC stop is set at 11.0 and only applies to TRQ. This is not a limit but an actual power stop. Any increase in collective beyond the stop will result in a decrease in NR and a decrease in overall power. The following table provides TRQ limits in cruise flight.

| Power Limit | FLI | TRQ |
|---|---|---|
| Max Continuous | 8.8 | 88 |
| Max Takeoff 5 min | 10 | 100 |
| Transient 5 sec | 10.3 | 103.4 |

## TRQ DURING HOVER OPERATIONS

When IAS $\leq$ 75 KIAS, FLI pointer is limited to 10.0, with no time restriction. TRQ must be the limiting parameter in order for the 10.0 FLI no time limit to apply. If TRQ is the limiting parameter, it will be indicated by a yellow underscore on each engine value on the FLI once power is applied above 8.8 and is equal to TRQ 1 + TRQ 2 / 10. If N1 or TOT is the limiting parameter, MTOP 5−minute limits apply. If N1 or TOT is the limiting parameter and mission urgency dictates, HIP/SARM limits can be applied as described below under HIP/SARM Operations. During a hover, a pedal−induced transient limit of up to 10.7 applies to TRQ. It is displayed on the FLI with the red triangle. Refer to figure 5−5 and 5−6 for FLI AEO and FLI OEI limitations.

| Power Limit | FLI | TRQ |
|---|---|---|
| Max Continuous | 10 | 100% |
| Transient yaw induced 5 sec | 10.7 | 107% |

## TURBINE OUTLET TEMPERATURE - T4.5 (TOT)

TOT values are indicated on the corresponding sides of the FLI for each engine. If TOT limits are exceeded, the TOT values at the side of the FLI are underscored in yellow or red, based on the current range and TOT will also be indicated on the FLI needle. In addition, there is a transient TOT limit of 944 degrees for 5 seconds for momentary excursions above the continuous limit. For engine starting, TOT is limited to 750 °C and will be underscored with a red blinking line when this limit is reached. Once above 750 °C, TOT is limited for 10 seconds up to 840 °C. If TOT exceeds 840 °C during the start cycle, it will be indicated with a solid red line and the FADEC will automatically shut down the engine. Refer to figure 5−5 and 5−6 for FLI AEO and FLI OEI limitations.

| Power Limit | FLI | TOT |
|---|---|---|
| Max Continuous | 8.8 | 891 °C |
| Max Takeoff 5 min | 10 | 929 °C |
| HIP/SARM 30 min | 10 | 929 °C |
| Transient 5 sec | 10.7 | 944 °C |

## GAS GENERATOR (N1)

N1 values are indicated on the corresponding sides of the FLI for each engine. If N1 limits are exceeded, the N1 values at the side of the FLI are underscored in yellow or red, based on the current range and N1 will be the limiting factor on the FLI needle. During normal AEO operations when N1 is a limiting factor, the FADEC stop is set at maximum takeoff power N1+0.7%. This is not a seperate limit but an actual stop. Any increase in collective beyond this stop will result in an NR decrease.

**NOTE**

N1 values change based on pressure altitude and OAT, therefore, it is critical that FLI gauge markings and aural warnings be the primary indicator of over limit conditions.

Refer to figure 5−5 and 5−6 for FLI AEO and FLI OEI, N1 limitations. The following table provides N1 limits on a standard day at sea level pressure.

| Power Limit | FLI | N1 |
|---|---|---|
| Max Continuous | 8.8 | 99.7% |
| Max Takeoff 5 min | 10 | 101.9% |
| HIP/SARM 30 min | 10 | 101.9% |
| Transient 5 sec | 10.7 | 103.4% |

## OEI OPERATIONS

Should a difference ≥ 6% N1 develop between the two engines, the FADEC assumes an engine failure and arms OEI 30-second rating for the good engine. Two collective guarded pushbuttons allow for selection of a 2-minute or continuous OEI rating when flight conditions permit. The selected OEI rating is considered a FADEC stop. Increasing power beyond the OEI stop will decrease NR and reduce overall power. Refer to Figure 5-6 for OEI, TRQ, N1, TOT and FLI limits.

## HIP/SARM OPERATIONS

If N1 and/or TOT is the power limiting factor below 75 KIAS and operational necessity dictates, HIP/SARM limits may be applied. The HIP/SARM limits permit AEO operations above MAX Continuous Power (MCP) beyond 5 minutes up to, but not more than, Max Takeoff Power (MTOP) for up to 30 continuous minutes. Continuous use beyond 30 minutes or usage equaling 100% on the VEMD status page will require engine maintenance. Accumulated time and number of events in zone will result in increased maintenance cycles and reduce TBO on the engines.

## TRAINING MODE SWITCH OPERATIONS

To return the training mode switch to the normal (center) position, NR should be stable at 355 RPM (365 RPM with the NR HI switch on), and the FLI should indicate at or below 8.0 with power reduction.

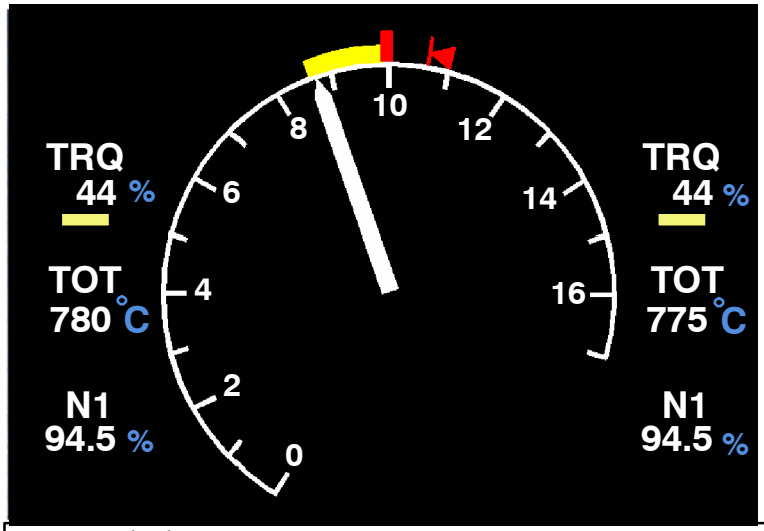
**CAUTION**

Movement of the training switch back to flight with the FLI above 8.0 should only be done in extreme circumstances when aircraft damage is likely to result if the training switch is left in Idle 1/2. If the training switch is placed to flight at power settings above 8.0, actual OEI time may be accrued which shall be annotated on the CG–4377.

## POWER TURBINE N2 LIMITATIONS

N2 is indicated by the two small needles on the pilot's NR/N2 gauge. The gauge consists of a single needle indicating NR and two smaller needles labeled with their corresponding engine and indicating their respective N2. N2 is expressed in terms of RPM, with a N2 of 350 RPM equal to 39,129 turbine RPM. N2 is regulated via a proportional-in-

**POWER LIMITATIONS (TRQ, TOT, N1)**
**FLI DUAL ENGINE (AEO)**




8.8 MAX CONTINUOUS POWER

8.8 to 10TAKEOFF POWER (5 min max)

10.0 MAX TAKEOFF POWER (5 min max) (See NOTE 2)

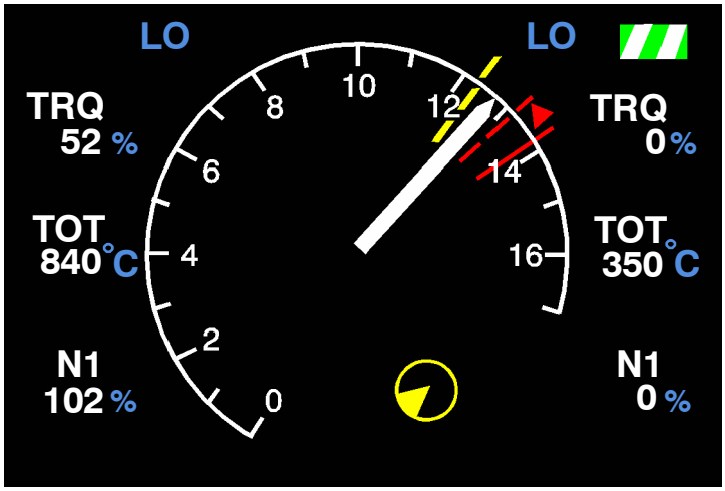
10.7 MAX TRANSIENT POWER

| **Power Limit** | Max Cont | MTOP 5 min | HIP/SARM 30 min | Transient 5 sec |
|---|---|---|---|---|
| **FLI Marking** | 8.8 | 10 | 10 | 10.7 |

Note 1 – Actual N1 values change with PA and OAT.
Note 2 – 10.3 is the max TRQ transient, 10.7 is the max TRQ transient for yaw induced exceedances with IAS < 75 KIAS.
Note 3 – For starting, TOT is limited to 750 °C and will automatically shut off above 840 °C.

*Figure 5-5. Dual Engine FLI*

**POWER LIMITATIONS (TRQ, TOT, N1)**
**FLI SINGLE ENGINE (OEI)**




| Power Limit | FLI Marking | N1 % | TOT C | TRQ % |
|---|---|---|---|---|
| OEI continuous | 12.4 | 101.3 | 926 | 66.3 |
| OEI 2 min | 13.2 | 102.2 | 944 | 75.5 |
| OEI 30 sec | 13.8 | 106.0 | 996 | 77.7 |

*Figure 5-6. Dual Engine FLI*

tegral digital controller. Nominal NR and the measured N2 are compared so that N2 and, thus, NR are maintained constant without static droop. N2 requirements drive N1 demand, which sets target fuel flow. Like NR, N2 is a function of PA and uses the same formula as described in Main Rotor Limitations for N2 variations. A FADEC overspeed safety feature will shut down an engine at 429 RPM +/- 4 RPM. This feature also includes an added safety measure that will not allow the shutdown of a second engine if it subsequently reaches this limit. Section 1 of this manual has additional information on these FADEC features. Refer to figure 5-7 for specific N2 limitations.

## STARTER LIMITATIONS

### STARTING

To prevent possible overheat damage to the starter and ignition system, limit use of the starter to 40 seconds maximum duration. Limit the total number of starter engagements to five consecutive attempts. For cooling purposes, allow a minimum of 60 seconds between start attempts, and 30 minutes after the fifth attempt.

### CRANKING

Limit use of the starter cranking to 20 seconds, maximum duration. A maximum of five consecutive cranking periods are allowed. Allow a minimum of a 60 second cooling cycle between cranking periods and 30 minutes after the fifth cranking period.

**CAUTION**

Use of the crank button with the EFSL pulled will result in severe damage to the engine fuel pump.

## ENGINE OIL (ENG OIL) PRESSURE AND TEMPERATURE

Engine oil pressure and temperature are indicated on the vehicle page of the VEMD. A bar graph using the scale logic described in figure 5-2 provides the values for the corresponding engines. Oil temperature must be above 0 °C prior to advancing FADEC switch past the idle position. Oil pres-




238 rpm Minimum Transient

316 rpm Mimimum Stabilized

316 to 345 rpm Min Operating Range

345 to 360 rpm Cont Operating Range

360 to 379 rpm Max Power-off Operating Range

379 rpm Maximum Power-Off

423 rpm Maximum Transient

**Pilots NR Gauge**

**N2 Limits on Inner Scale – Use N2 needles (the two separate smaller needles) – one for each engine labeled appropriately. (Pilots and copilots NR Gage outer markings are the same.)**

*Figure 5-7. N2 Limits*

sure on start can reach 128 PSI without damaging the engine. Any exceedance above 128 PSI during the start shall be referred to maintenance. For oil pressure and temperature limits refer to figure 5-8.

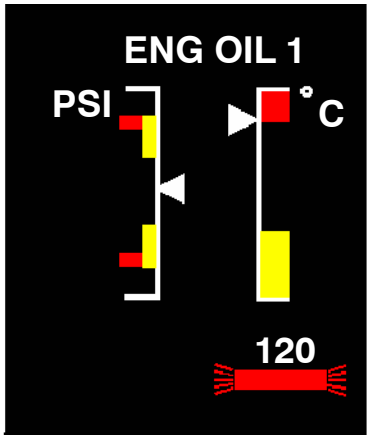
PRESSURE

above 128 PSI

87 to 128 PSI

22 to 29 PSI

0 to 22 PSI




TEMPERATURE

above 115°C

40-0°C

*Figure 5-8. Engine Oil Limits*

## TRANSMISSION OIL (XMSN OIL) PRESSURE AND TEMPERATURE

Transmission oil pressure and temperature are indicated on the vehicle page of the VEMD. A bar graph using the scale logic described in figure 5-2 provides the values for the MGB. For transmission pressure and temperature limits refer to figure 5-9.

## HYDRAULIC (HYD1, HYD2) SYSTEM

Primary (HYD2) and secondary (HYD1) hydraulic pressures are indicated on the vehicle page of the VEMD. A bar graph using the scale logic described in figure 5-2 provides the values for the HYD pressures. For HYD pressure limits, refer to figure 5-10. The nominal pressure for both the primary and secondary hydraulic circuits is 870 PSI, with a maximum of 1060 PSI to operate the flight control servo controls. The secondary system also supplies the landing

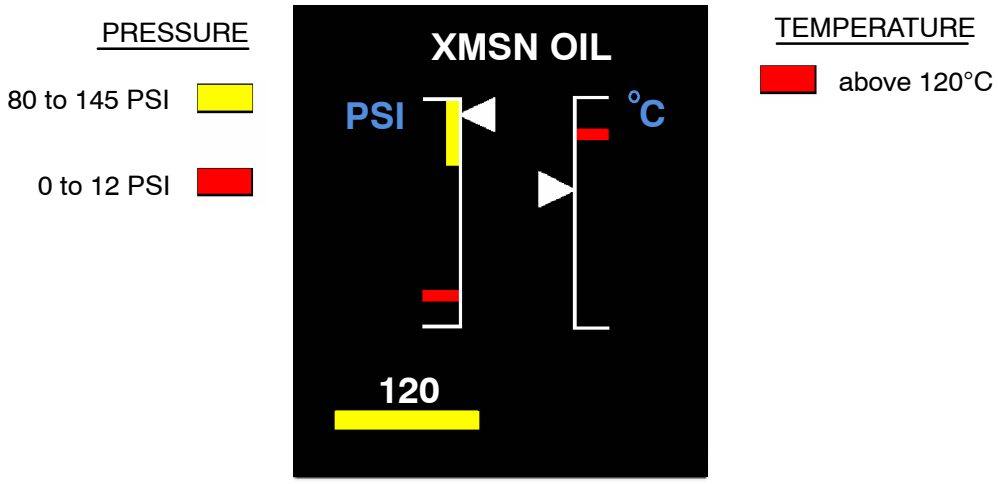



*Figure 5-9. Transmission Oil Pressure and Temperature*

gear actuating system and the hoist system. The hydraulics are monitored by warning lights located on the warning-caution-advisory panel and illuminate when pressure is above or below maximum or minimum limits. Refer to Hydraulic System Controls and Indicators in Section I for discussion of warning light and secondary hydraulic system pressure limits.

## FUEL PRESSURE (FP1, FP2)

Engine fuels used must comply with the specifications found in Fuel and Lubricants Limitations. FP 1 and FP 2 pressures are indicated on the fuel page of the VEMD. A bar graph using the scale logic described in figure 5-2 provides the values for boost pump generated fuel pressures. A minimum of 5.8 PSI is required prior to the engine start. A minimum of 3.6 PSI is required during the starting phase. For fuel pressure limits, refer to figure 5-11.

**NOTE**

Once engine is started, engine driven, low pressure fuel pump will provide enough suction to operate the engine at all power ranges. If no fuel pressure is displayed, fuel transfer ejectors will not function.

## ELECTRICAL SYSTEM LIMITS

### DC

The DC electrical system maximum voltage is 30 volts (as indicated on the cockpit voltmeter) with a maximum continuous current of 160 amps per generator displayed as 100% on the cockpit loadmeter. Loads should be within 10% of each other for both DC generators.

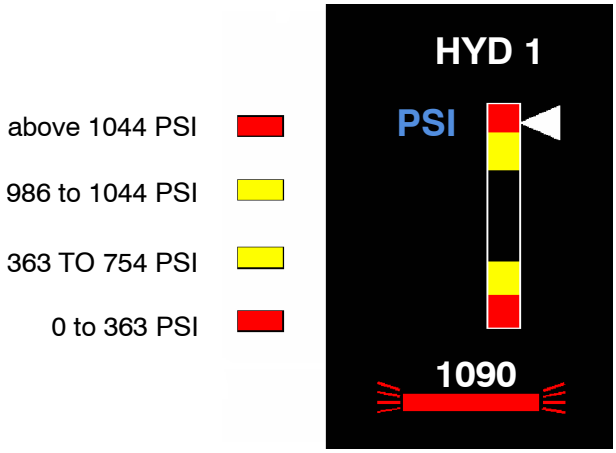
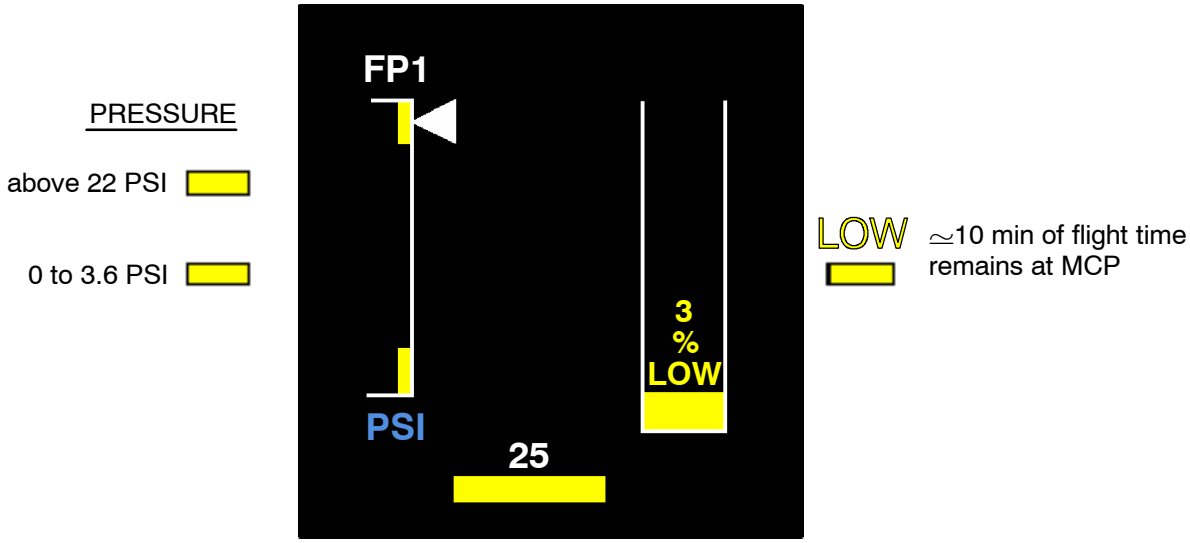



*Figure 5-10. Hydraulic System*




- Minimum engine starting pressure:

| | |
|---|---|
| Purge phase preceeding starting phase | 5.8 psi |
| Starting phase | 3.6 psi |

*Figure 5-11. Fuel System*

**NOTE**

The 100% current limitation does not apply during engine start or the first minute of battery charging after engine start.

### AC

The AC electrical system maximum voltage is 120 volts (as indicated by the cockpit voltmeter) with a maximum continuous current of 29 amps per alternator phase displayed as 100% on the cockpit loadmeter.

### BATTERY

A minimum of 17 VDC is required for battery start. Both engines must be started using the same power source.

## WEIGHT LIMITATIONS

The maximum gross weight is 9,480 pounds. The performance charts give detailed information on maximum weights for specific missions and ambient conditions.

**NOTE**

As weight increases, acceleration limits will decrease. Proper planning must be completed to ensure load limits are maintained. Refer to acceleration limits for more information.

### Cabin Area Load Limits

The cabin has a usable volume of 176 cubic feet of loading space. High-density cargo should be distributed over the deck area not to exceed 125 pounds per square foot. The floor tie-down ring strength is 1,800 pounds acting upward or through a 30-degree arc from vertical.

### Baggage Compartment Load Limits

The compartment has a usable volume of 88 cubic feet and a maximum allowable load of 440 pounds. The center composite panel limit is 125 pounds per square foot and the two outboard metal panels are limited to 61.5 pounds per square foot. Tie down rings are provided on the composite panel.

## AIRSPEED LIMITATIONS

### Forward Air Speeds

The maximum permissible forward airspeed is 175 KIAS at sea level, at a gross weight not exceeding 6,614 pounds. Fig-

ure 5-13 and the VNE Performance Chart show airspeed limits based on gross weight and altitude.

**WARNING**

VNE is established for 1G, straight and level flight only. VNE is reduced by maneuvers that increase G loading.

## Hover Air Speeds

Hover flight wind limitations are based on airspeed and must take into account wind direction and velocity combined with aircraft lateral movement. Refer to Figure 5–14 for hovering flight wind limitations. For actual sideward movement, the aircraft is limited based on PA and OAT as described in the below caution. In addition, the use of NR high is mandatory.

**CAUTION**

- Actual sideward flight at high PA or extreme temperatures is limited to below 2,000 PA and temperatures between –25 °C and 40 °C. The use of NR high is mandatory for all lateral flight.
- Hovering at high PA or extreme temperatures requires increased monitoring of MGB temperature. If hovering above 4,000 PA or at temperatures colder than –25 °C or warmer than 40 °C, monitoring of MGB temp is mandatory.

## Miscellaneous Air Speeds

Maximum speed for opening or closing the sliding door is 80 KIAS. Maximum power–off/autorotation airspeed is 135 KIAS. The airspeed for opening and closing the overhead hatch is 60 KIAS forward airspeed and 30 knots sideward flight. The hatch may remain latched full open to 80 KIAS forward flight and 35 knots sideward. Above those speeds it must be closed. Maximum wheelbrake application speed is 38 KGS at gross weights below 8,900 lbs, and 30 KGS at gross weights above 8,900 lbs. With NR HI switch on, airspeed is limited to 135 KIAS and angle of bank is limited to 40 degrees. Refer to table 5–1 for a summary of Air Speed limits.

## Rotor Start Wind Limits

Rotor engagement is limited to winds of 55 knots within 20 degrees of the aircraft heading, or 35 knots from all other directions. Refer to figure 5–12 for rotor start and stop wind limits.

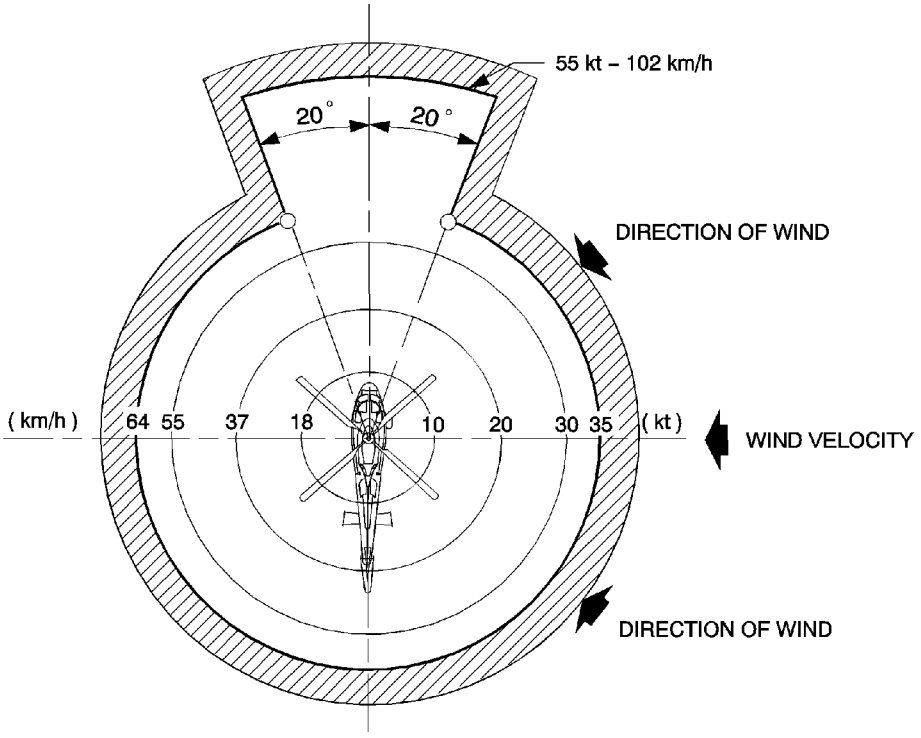



*Figure 5-12. Rotor Start/Lateral CG Limits* 0002a

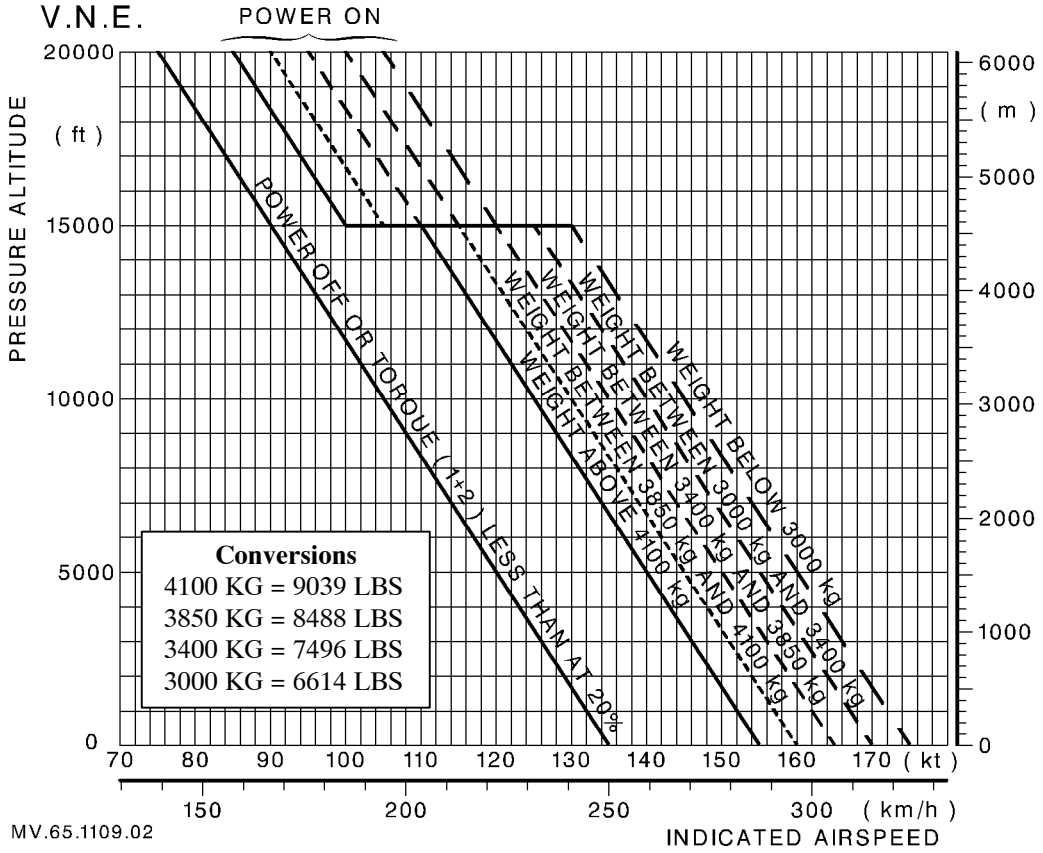
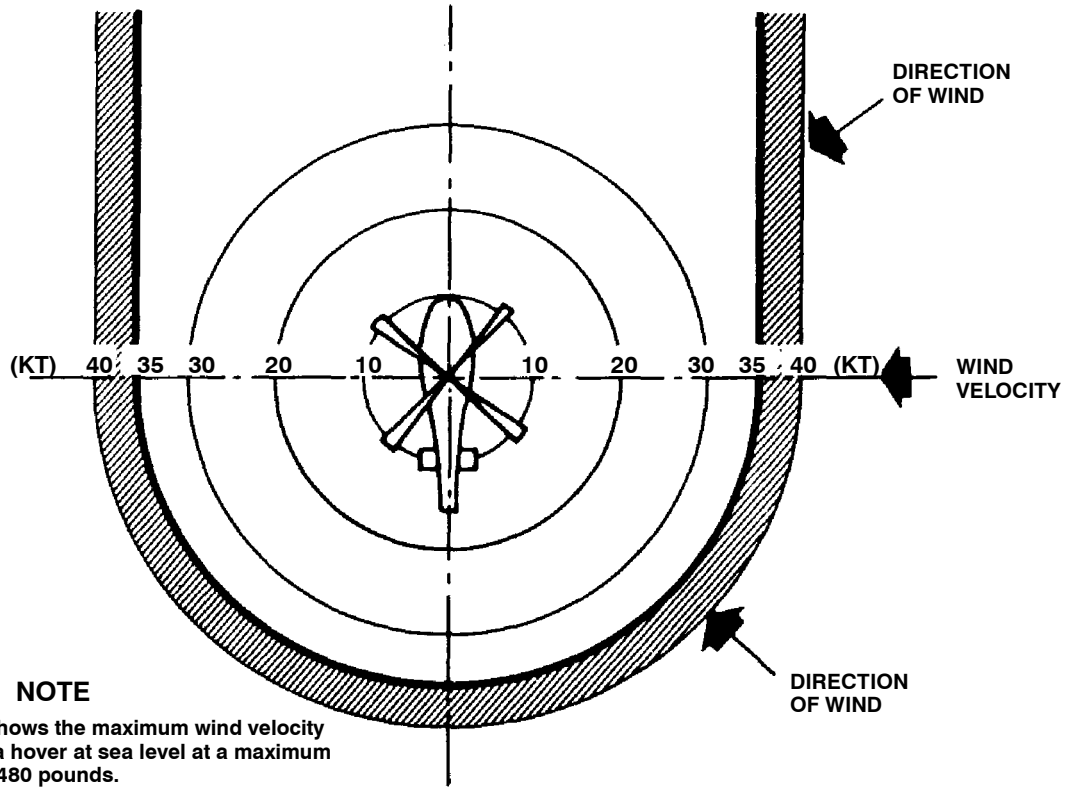



*Figure 5-13. Max Power On VNE*




**NOTE**

**This illustration shows the maximum wind velocity demonstrated in a hover at sea level at a maximum gross weight of 9480 pounds.**

*Figure 5-14. Hovering Flight Wind Envelope*

| Speed Limitations | |
|---|---|
| Absolute VNE Power-On | 175 Kts |
| Absolute VNE Power-Off | 135 Kts |
| Maximum Cabin Sliding Door Speeds | |
| Door removed | 120 KIAS |
| Door locked in open position | 100 KIAS |
| Door movement | 80 KIAS |
| Maximum Rescue Hatch Speeds | |
| Hatch locked in open position | 80 KIAS, 35 Kts sideward |
| Hatch movement | 60 KIAS, 30 Kts sideward |
| Maximum Cargo Hook Load Speed | 90 KIAS |
| Maximum Airspeed with Float Bags Armed or Inflated | 90 KIAS |
| Maximum Airspeed with Skis Installed | 120 KIAS |
| Maximum Touchdown Speed | 60 KGS |
| Maximum Touchdown Speed with Skis on Snow | 35 KGS |
| Maximum Brake Speed | |
| Gross weight at or less than 8900 lbs | 38 KGS |
| Gross weight above 8900 lbs | 30 KGS |
| Maximum Airspeed with NR HI | 135 KIAS |
| Maximum Sideward Flight | 35 Kts |

Table 5–1. Air Speed Limitations

## ACCELERATION LIMITS

The maximum permissible acceleration is 3.5 to 0.5 positive g at 6,718 pounds. Maximum acceleration under various flight conditions will be detected by illumination of the LIMIT load lights on the instrument panel. If the LIMIT lights illuminate, reduce severity of the maneuver. Refer to FLIGHT CONTROL SYSTEM, Section I for explanation of load sensing. As the helicopter weight increases, its ability to withstand additional loads resulting from maneuvers or gust conditions decreases. The margin of safety is the amount of additional load that the structure will sustain before damage or failure occurs. Flight load factors are used as an indication of the margin of safety available for the helicopter. Therefore, it is of prime importance that the maximum flight load factors expected during the mission be anticipated and the helicopter loaded accordingly. The load limit factor must not be exceeded during any phase of flight. The lower load limit of 0.5 positive g is a flight control limit. Flight loads of less than 0.5 positive g may result in cavitation of the hydraulic pumps and flight control lock–up.

## CENTER OF GRAVITY (CG) LIMITATIONS

**WARNING**

It is possible to exceed the CG limits of the helicopter if it is improperly loaded.

### Longitudinal CG Limits

The aircraft weight and balance data, CGTO 1H–65C–5, is part of the aircraft equipment, and is delivered with the aircraft. The takeoff and anticipated changes to gross weight, such as hoisting and fuel burn, should, if possible, be calculated prior to each mission and determined to be within limits. If a local standard weight and balance computation is not on file, a specific computation should, if possible, be made for the mission. The forward CG limit is 149.6 inches for loading conditions up to 7,826 pounds. From 7,826 to 9,480 pounds, the limit moves aft linearly to 151.6 inches. The aft CG limit

is 159.4 inches up to 7,165 pounds GW. From 7,165 to 9,480 pounds, the aft limit moves forward to 157.0 inches. The maximum allowable gross weight limit is 9,480 pounds. The limits at 9,480 pounds extend from 151.7 to 157.0 inches. Figure 5–15 shows longitudinal CG limits based on gross wt. Fuel burn initially results in a forward CG shift, but as the total fuel supply (evenly distributed) reduces below approximately 1,000 pounds, the CG shifts aft. This shift can be as much as 1.5 inches, from fuel burn alone. Thus, if the CG is forward of 157.5 inches, fuel burn alone should not put the helicopter out of limits. The addition of passengers and/or survivors also shifts CG, and must be computed. CG may be computed by computer program, Form 365F, or using the Center of Gravity Chart provided at the end of this section (figure 5–16 with instructions in figure 5–17). If the CG chart is used and indicates that CG is within 1 inch of the limit, a Form 365F should be used.

### Lateral CG Limits

In order to maintain lateral CG limits, operational hovering (i.e., hoisting, fast roping) is limited to winds of 55 knots within 20 degrees of the aircraft heading or 35 knots from all other directions. Refer to Figure 5–12 for lateral CG limits.

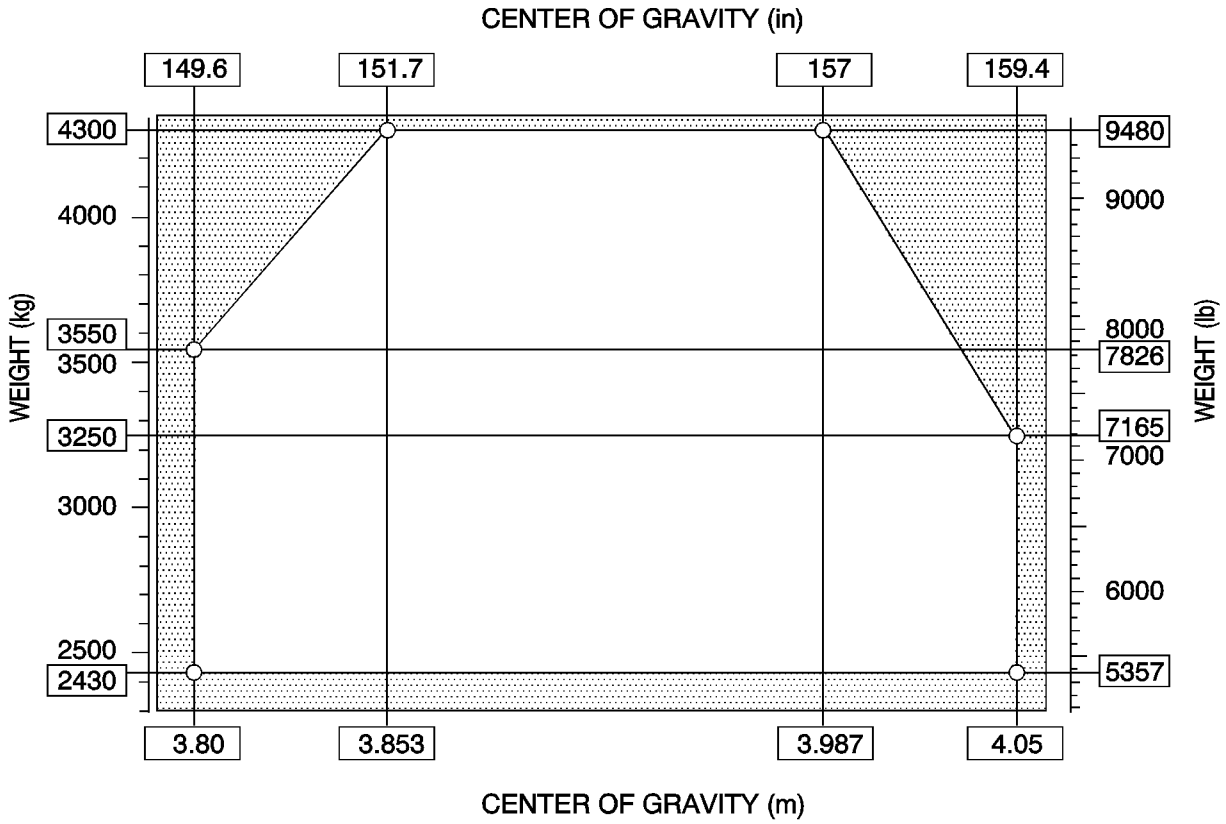



*Figure 5-15. Center of Gravity Chart*

## LANDING GEAR LIMITATIONS

The maximum touchdown sink rate at maximum gross weight of 8,900 lbs. is 600 feet per minute. The maximum speed for touchdown is 60 knots. Ship landings with aircraft gross weight above 8,900 pounds are prohibited.

## SLOPE LIMITATIONS

The slope limitation for landing and stopping the rotor is 10 degrees.

## EQUIPMENT LIMITATIONS

### Environmental Control System (ECS)

FADEC will automatically activate an ECS bleed air system shut off valve and electrically disengage the Freon compressor clutch during high N1 demands or upon engine failure detection. If additional hovering power is anticipated, heat should be manually shut off prior to attaining hover flight.

### Rotor Brake Limitations

Maximum rotor speed for use of the rotor brake is 170 RPM, with a minimum cooling period of 5 minutes between braking applications. After three consecutive applications, allow 10 minutes cooling time. Operating either engine with the brake on is prohibited. Never apply the brake with an engine operating. Rotor brake may be on with one engine operating and with the low idle rotor brake switch activated. This switch limits N1 to 52% at idle. It is intended for maintenance functions and should not be used during normal operations. Maximum braking time is 15 seconds. If time exceeds 15 seconds, release brake and record on form CG–4377.

### Emergency Flotation Gear Limitations

Maximum airspeed with the emergency flotation bags inflated or with the EMERG FLOAT switch in the ARM position is 90 KIAS. The limiting altitude for inflation is 9,800 feet pressure altitude, and 4,900 feet pressure altitude for water landings. Arming the flotation system during over–water flight below 200 feet radar altitude is recommended.

### Rescue Hoist Limitations

A hoist operator is required for all flights involving hoisting operations. The maximum permissible load for the hoist is 600 pounds. Operational cycle limits are defined as follows:

Heavy Load Hoist – 300 to 600 pounds, any length, 30–second rest period between delivery and recovery.

Normal Load Hoist – 300 pounds or less, any length, 10–second rest period between delivery and recovery.

No Load (only the rescue device attached), no rest requirement.

### CARGO HOOK LIMITATIONS

The maximum permissible hook load weight is 2,000 pounds. Minimum crew requirements are: one pilot in the right seat, one crewmember qualified for external cargo operations, and a qualified ground member to signal the pilot when load is released. Simultaneous use of the hoist and cargo hook is prohibited. The landing gear shall be kept extended whenever the cargo hook is installed. The maximum airspeed limit of 90 KIAS applies only with an external load attached.

### Fuel Jettison Limitations

Fuel may be jettisoned at airspeeds between 40 and 120 KIAS at any rate of climb and descents up to 1,500 fpm. In addition, the landing gear must be extended if jettisoning below 60 KIAS to help keep the fuel clear of the fuselage. If the situation allows, fuel should be jettisoned from one system at a time, to minimize the risk of excessive jettison due to jettison valve malfunction. Do not operate the fuel transfer pump during jettisoning. Allow at least 1 minute after jettison is terminated before hovering or landing. If applicable, inform appropriate authority that fuel has been jettisoned.

**WARNING**

Fuel jettisoning during hover or other in–ground effect maneuvers is prohibited.

### Flight Director System Limitations

The following limitations apply:

| | |
|---|---|
| IAS | Above 40 KIAS |
| VS | 70 KIAS min, 0-3000 FPM |
| ALT | 70 KIAS min |
| IAS-VS | 40 KIAS min, 0-3000 FPM |
| IAS-ALT | 40 KIAS min, +/- 150 ft |
| HDG SEL | 40 KIAS min |
| NAV | Above 40 KIAS |
| APPR | Above 40 KIAS, 12 deg GP |
| T-HOV | Below 2500 radalt |
| HOV AUG | Visual hover maneuver |
| GA | Above 25 ft AGL |

The IAS–VS and IAS–ALT mode should not be used above 80% Maximum Continuous Power (MCP). The limit above 75 KIAS in cruise flight would be 80% of 8.8 FLI or approximately 7.0 indicated on the FLI.

## PROHIBITED MANEUVERS

1. Aerobatic flight.
2. Angles of bank
   a. Greater than 60 degrees less than 110 KIAS.
   b. Greater than 45 degrees at or above 110 KIAS.
3. Abrupt cyclic movement above 110 KIAS.
4. Takeoff and landing on slopes steeper than 10 degrees.
5. Shipboard landings at gross weights at or above 8,900 lbs.
6. Practice single engine maneuvers to a landing above gross weights of 8900 lbs.

# FUEL AND LUBRICATION LIMITATIONS

## Authorized Fuel Additives

### Anti−Icing Additives:

S748 NATO symbol: MIL−1−27686, D.ENG.RD 2451 (AL−31), AIR 3652B, or T1301 (standard SH 0369)

or S1745 NATO symbol: MIL−1−85 470A, D.ENG.RD 2451 (AL−41), AIR 3652B.

Maximum concentration by volume: 0.30%.
Minimum concentration by volume: 0.10%.

**Anti−icing additive must be used for OAT lower than −20 °C.**

Antistatic Additive:

. SHELL ASA−3 (maximum concentration 0.0001% by volume).
. DUPONT STADIS 450 (maximum concentration 0.0003% by volume).
. SIGBOL (TU38−101741) (maximum concentration 0.0005% by volume).

Antioxidant, Metal Deactivator, Corrosion Inhibitor:
. According to the approved specifications in force.

### Fungicide Additive:

. BIODOR J.F type, KATHON FP 1.5.
− Limited to a treatment every 500 operating hours or 3 months (curative treatment).
− Unlimited (preventive treatment).

Authorized lubricants and fuels are listed in tables 5−2 through 5−4.

# AUTHORIZED FUELS

## 1 NORMAL FUELS

| | FUEL | NATO | SPECIFICATIONS | | | | Limit Temp Without Additive Adjunction in A/C Tanks | |
|---|---|---|---|---|---|---|---|---|
| | Type | Symbol | USA | UK | FRANCE | Including Anti-freeze | Min °C | Max °C |
| 1 | Kerosene 50 (AVTUR-FS11) JP8 | F34 | MIL-T-83 133 JP8 | D. ENG. RD 2453 | AIR 3405 F34 | Yes | -50 | 55 |
| 2 | Kerosene 50 (AVTUR) JET A1 | F35 | ASTM-D-1655 Jet A1 | D. ENG. RD 2494 | AIR 3405 F35 | No | -20 | 55 |
| 3 | Kerosene | | ASTM-D-1655 Jet A1 | | | No | -30 | 55 |
| 4 | High flash point Kerosene (AVCAT) JP5 | F43 | | D. ENG. RD 2498 | AIR 3404 F43 | No | -30 | 55 |
| 5 | High flash point Kerosene JP5 (AVCAT FSII) | F44 | MIL-J-5624 JP5 | D. ENG. RD 2452 | AIR 3404 F44 | Yes | -40 | 55 |
| 6 | Kerosene TS-1, RT | | GOST 10227 | | | No | -30 | * * |

* * : +43 °C below 15,000 ft and +10 °C above 15,000 ft with oil temperature < 90 °C

## 2 ALTERNATIVE FUELS

These fuels shall be subjected to operating limitations..

| | FUEL | NATO | SPECIFICATIONS | | | | Limit Temp Without Additive Adjunction in A/C tanks | |
|---|---|---|---|---|---|---|---|---|
| | Type | Symbol | USA | UK | FRANCE | Including Anti-freeze | Min °C | Max °C |
| 7 | Large Cut (AVTAG FSII) JP4 | F40 | MIL-T-5624 JP4 | D. ENG. RD 2454 | AIR 3407 | Yes | -50 | ** |
| 8 | Large Cut (AVTAG) JP4 | (F45)* | | D. ENG. RD 2486 | | No | -20 | ** |

* : Abandoned NATO symbol
* * : +43 °C below 15,000 ft and +10 °C above 15,000 ft with oil temperature < 90 °C

Table 5−2. Authorized Fuels

# HYDRAULIC FLUID SPECIFICATIONS

- Hydraulic fluids: Must comply with specifications:
  – MIL–H–83282 for all temperature ranges.

## AUTHORIZED ENGINE LUBRICANTS

| Oil type | NATO Code | SPECIFICATIONS | | | Class | Approved oil trademarks |
|---|---|---|---|---|---|---|
| | | FRANCE | USA | UK | | |
| Recommended use<br>Average synthetic<br>5 cST at 98.9 °C | 0.156 | - | MIL-PRF 23699 | DEF STAN 91-101 | HTS (High thermal stability) | EXXON Turbo Oil 2197<br>Mobil Jet Oil 254<br>Mobil Jet Oil 291 |
| Normal use<br>Average synthetic<br>5 cSt at 98.9 °C | 0.156 | - | MIL-PRF 23699 | DEF STAN 91-101 | (Corrosion inhibiting) | CASTROL Aerojet 5 |
| | | | | | Standard | CASTROL 5000<br>AeroSHELL Turbine oil 500<br>EXXON Turbo Oil 2380<br>MOBIL Jet OIl 2<br>TURBO NYCOIL 600<br>TOTAL Aero turbine 535<br>ELF Turbo Jet 2<br>AeroSHELL Turbine oil 560 |
| OTHER OILS: USE AUTHORIZED BUT NOT RECOMMENDED. SHALL NOT BE USED FOR HIGH TEMPERATURE ≥ 30 °C. | | | | | | |
| **Oil type** | **NATO Code** | **SPECIFICATIONS** | | | **Class** | **Approved oil trademarks** |
| | | **FRANCE** | **USA** | **UK** | | |
| Synthetic fluid<br>3 to 3.5 cSt at 98.9 °C | 0.148 | - | MIL-PRF 7808 | - | - | EXXON Turbo Oil 2389<br>MOBIL AVREX 256<br>CASTROL 325<br>CASTROL 3C<br>TURBO NYCOIL 160 |
| | 0.150 | AIR 3514 | - | - | - | ELF Jet Synthetic Oil 15<br>TURBO NYCOIL 13B |
| Synthetic fluid<br>3.9 cSt at 98.9 °C | - | - | - | DEF STAN 91-94 | - | AeroSHELL Turbine oil 390 |

**NOTE**

- The oils mentioned under OTHER OILS may be the subject of particular recommendations from the engine manufacturer.
- For changing from one oil trade mark or specification to another, the oil system must be flushed as prescribed in TURBOMECA Maintenance Manuals.

Table 5–3. Authorized Engine Lubricants

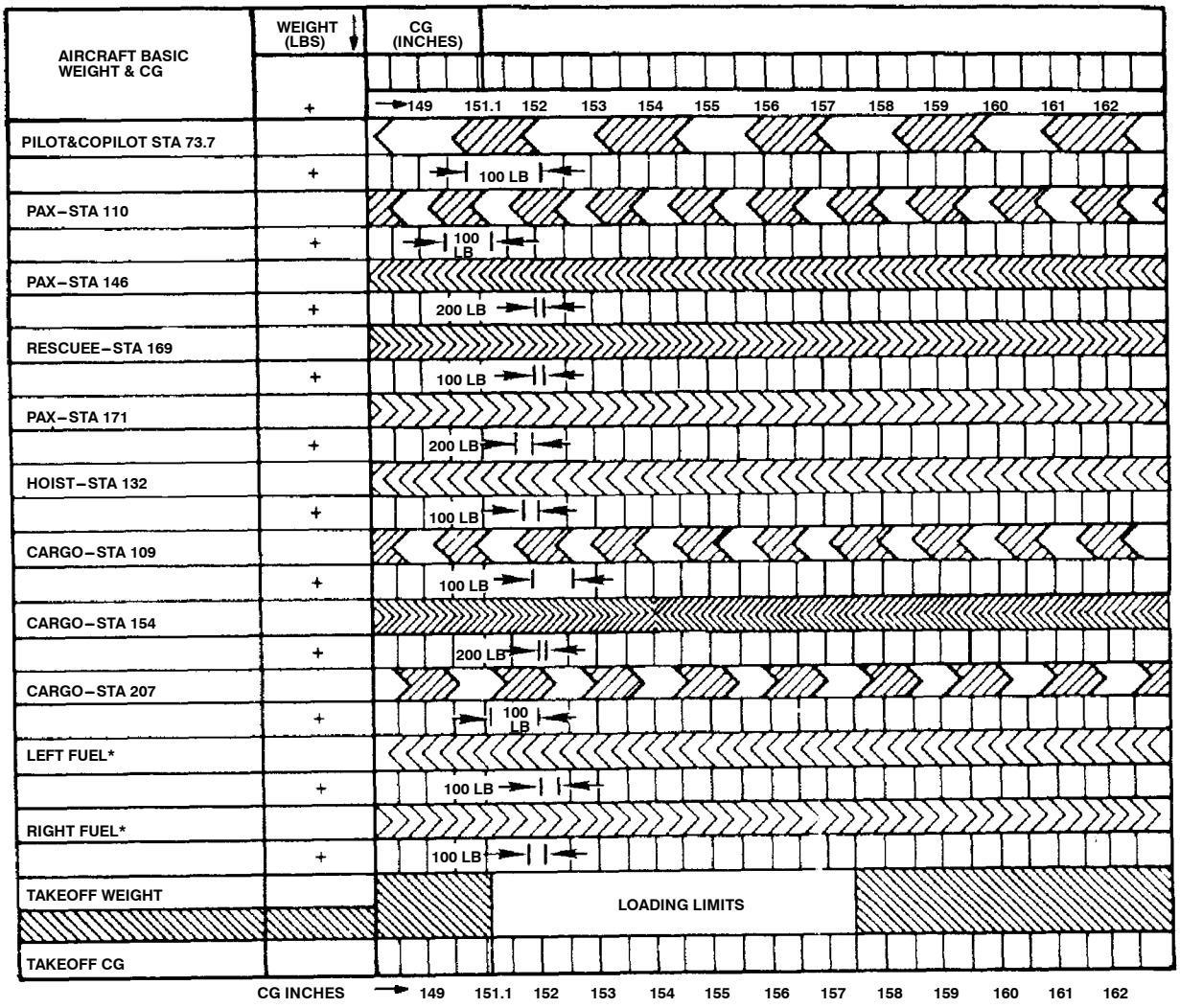
## AUTHORIZED GEARBOX LUBRICANTS

Oils with different specifications must not be mixed.

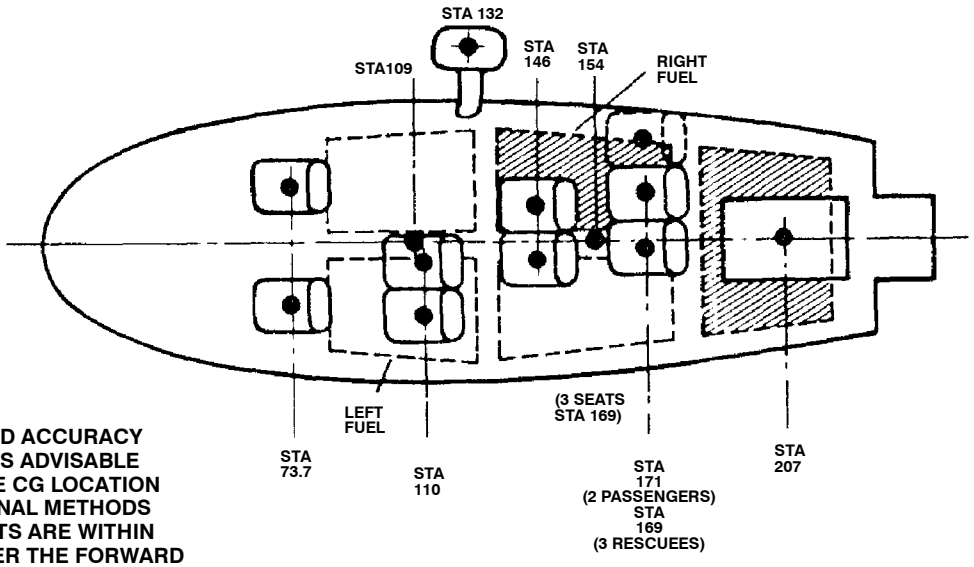
SHELL brand is not authorized.

| DESIGNATION | NATO Code | SPECIFICATIONS (At the latest issue or admendment) | | | REMARKS |
|---|---|---|---|---|---|
| | | FRANCE | USA | UK | |
| MINERAL OIL | 0.155 | AIR 3525B | MIL L 6086 C Grade M | DTD 581 C | TEMPERATURE ENVELOPE LIMITED BETWEEN -25 °C AND +50 °C |

Table 5–4. Authorized Gearbox Lubricants




*DO NOT USE IF FUEL QUANTITY FOR EITHER LEFT OR RIGHT SIDE IS LESS THAN 325 LBS.




**NOTE:**

**DUE TO THE LIMITED ACCURACY OF THIS CHART, IT IS ADVISABLE TO CALCULATE THE CG LOCATION USING CONVENTIONAL METHODS (365F), WHEN POINTS ARE WITHIN ONE INCH OF EITHER THE FORWARD OR AFT LIMITS.**

*Figure 5-16. Center of Gravity Chart*

1. Obtain the basic aircraft weight and CG from Chart C and enter in the blocks labeled WEIGHT (LBS) and CG (INCHES) at the top of the chase–around chart.

2. Enter PILOT/PAX/RESCUE/HOIST/CARGO & FUEL weights in WEIGHT blocks as mission configuration dictates.

3. At the top of the chart, move right to the CG for the acft basic weight and then vertically downward to the center of the "PILOT & COPILOT STA 73.7" line. Each chevron on this line equates to 100 lbs at this station (see note). Move in the direction indicated (left) the number of chevrons corresponding to the weight entered in the weight block (e.g., 360 pounds=3.6 chevrons).

4. Subsequent stations/lines are completed in the same manner. If no weight is listed at a station, continue moving vertically downward unitl reaching the next station with a weight listed. continue this process until reaching the "TAKEOFF CG" line at the bottom of the chart.

5. READ TAKEOFF CG from bottom of chart.

**NOTE**

The values for the chevons on each line of chase–around chart vary and are depicted directly below each oine. To obtain maximum accuracy from this chart, ensure propervalues are used.

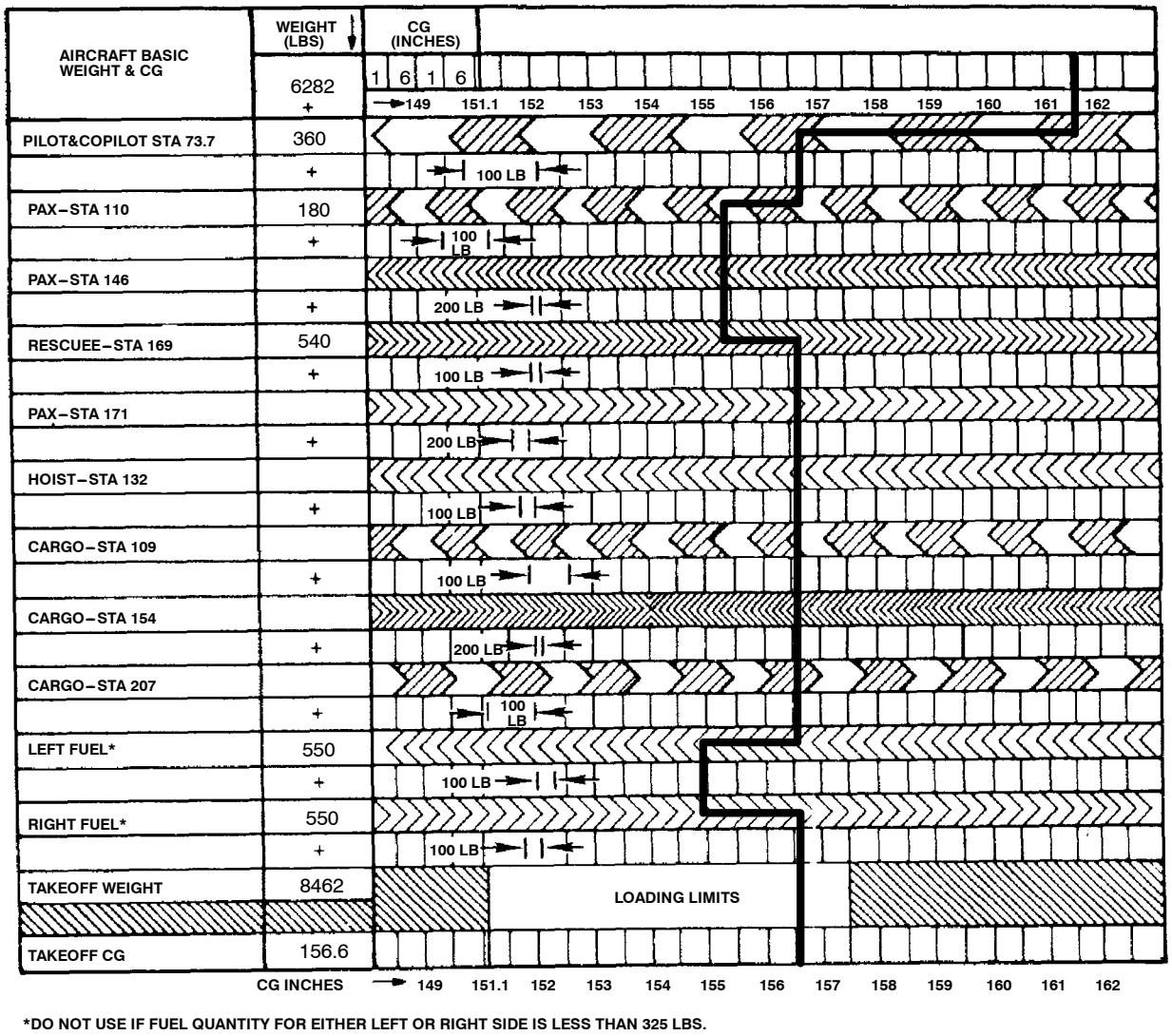



*Figure 5-17. Center of Gravity Chart Instructions*

# SECTION VI

# FLIGHT CHARACTERISTICS

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## INTRODUCTION

The HH–65 is capable of flight over a speed range of 175 KIAS forward, 35 knots rearward, and 35 knots sideward. There is adequate tail rotor control available to accomplish any desired directional maneuvering within the above limits. The wind envelope for starting and stopping the main rotor is shown in Figure 5–12. The tricycle landing gear makes the helicopter highly maneuverable on the ground due to its short turning radius. The Automatic Flight Control System (AFCS) provides all the necessary features for fully automatic flight or stability/command augmentation over the typical helicopter envelope for all mission phases. It is specifically oriented toward safety and ease of pilot involvement in low speed and hovering tasks, enhancing the performance of those tasks through improved stability and reduced pilot workload. Controllability is further enhanced through automatic main rotor rpm control by the engine governing systems. Once the FADEC Control Switches are placed in the FLT position, no further engine adjustments are necessary during flight.

## FLIGHT CONTROLS

### FLIGHT CONTROL SERVOS

The MGB–mounted and TGB–mounted flight control servos are continuously supplied by two fully independent hydraulic systems. Because of the damping and boost effects of the servo units, control forces are light and constant throughout each control's full range. Due to this damping, there is little feel in operating the cyclic. Therefore, a stick trim system using parallel trim/feel units is employed to artificially induce feel into the cyclic controls. If either hydraulic system fails, the remaining system is capable of ensuring helicopter control throughout the flight envelope. Two features, which operate whenever hydraulic pressure is applied to either system, provide increased operating safety. One is the servo jam feature which warns the pilot, through illumination of a caution light on the warning–caution–advisory panel, of a jammed distributor valve in the tail rotor or one or more of the main rotor flight control servos. The second feature is a load sensing system which illuminates the LIMIT lights on the instrument panel to alert the pilot that the main rotor head has reached a permissible load limit. Refer to Sections I, II, and III for further discussion of the flight control systems.

### COORDINATION OF FLIGHT CONTROLS

Control of the HH–65 without the use of the AFCS is accomplished in the conventional manner with the exception of antitorque control. Because of the clockwise rotation of the main rotor (as viewed from above), antitorque control requires the use of the tail rotor control pedals in a manner opposite to that used on previous U.S. Coast Guard single rotor helicopters. Climb and descent are controlled by raising or lowering the collective in the conventional manner. Heading control is maintained entirely by the pilot through coordinated movements of the tail rotor control pedals and cyclic. Sideward flight from a hover is accomplished by lateral cyclic displacement and tail rotor control pedal displacement to maintain a constant heading. Turns in a hover are made by corresponding pedal movements. Turns to the right will normally require greater pedal displacement to counteract the effects of torque. When hovering, or at slow airspeeds, the tail rotor pedals must be used for turning. At higher speeds (above 60 KIAS) the vertical fin becomes an antitorque device and reduces the need for tail rotor control.

## LEVEL FLIGHT CHARACTERISTICS

Control displacement while transitioning from hover to forward flight is positive in all directions. Without the

AFCS engaged, the aircraft exhibits strong aerodynamic coupling about all axes of motion. For example, a yaw input produces a positive roll effect in addition to yawing, and large rolling and pitching moments are induced by speed changes. Yaw oscillations, which occur during high power and high rates of climb, may become divergent. The AFCS damps all these characteristics within one cycle and slightly increases the response rate of the aircraft to pilot inputs. Pilot workload without the AFCS varies directly with the level of turbulence. In autorotations above 100 knots, increased pilot workload is required to maintain a constant airspeed. Lateral directional stability is very positive and requires no special technique or precautions. Rotor speed varies rapidly with collective changes during autorotation, but is more than adequate to accomplish touchdown autorotations using conventional flare and landing procedures.

## BLADE STALL

Blade stall is caused by a high angle of attack on the retreating blade and starts at the outboard section and progresses inboard with increased airspeed. Blade stall is the result of factors such as: gross weight, rotor rpm, airspeed, acceleration, attitude, and altitude. The condition is most likely to occur at higher airspeeds and low operating rpm; it also follows that the condition will occur sooner at higher density altitudes and gross weight. If a blade stall is allowed to fully develop, a significant nose–up movement will be experienced. However, in the HH–65, the pilot is always alerted by the instrument panel LIMIT lights and the VEMD SERVO LIMIT caution that the main rotor is at the limit load factor. As soon as the LIMIT lights illuminate, the pilot can eliminate the stall condition by initiating any of the following corrective actions:

- Decrease the severity of the maneuver.
- Reduce airspeed.
- Reduce power with collective.
- If possible, descend to a lower altitude.

## POWER SETTLING

At high altitudes, and high gross weights, or when operating with reduced power, it may not be possible to maintain level flight, and settling will occur. The settling is normally of minor consequence, except at high rates of descent and low forward speed, where it is extremely critical. When a critical power settling condition occurs, extreme vibration and a partial loss of control may occur. The vertical velocity of the downward airflow through the main rotor is extremely high while at or near a hovering attitude. Under certain power and rate–of–descent combinations, the rotor downwash recirculates up, around, and back down through the effective outer rim of the rotor disc. The helicopter sinks into the air mass it has just displaced in trying to obtain lift and the main rotor blades rotate continually in their own turbulent airstream. The velocity of the recirculating air mass may become so high that full high collective pitch will not produce sufficient lift to control rate–of–descent, which can initiate at 1000 to 2300 feet-per-minute and rapidly build up to 5000 feet-per-minute in fully developed power settling. Further increase of collective pitch and/or power will further aggravate the turbulent airflow. The turbulent airflow leads to a large reduction in cyclic authority, which combined with uncommanded pitch and roll due to main rotor asymmetric vortex shedding, greatly reduces aircraft controllability. To recover from this condition, FULL forward cyclic is required with a reduction in collective setting. The aircraft will begin to regain controllability 1–2 seconds after forward cyclic displacement and should fully recover in 6-8 seconds as airspeed increases. An alternative recovery method is to enter an autorotation. Flight conditions causing power settling should be avoided at low altitudes because considerable altitude will be lost before the condition is recognized and recovery completed.

## VIBRATIONS

The inherent vibrations in any helicopter are those created by the mechanical functions of the engines and transmission systems, dynamic action of the main and tail rotors, and aerodynamic effects on the fuselage. The overall vibration level is influenced by the many individual frequencies of vibration and combination thereof. Many multiples of a basic frequency are felt, and often two or more different superimposed frequencies create beats. The overall magnitude is resultant of the amplitudes of all the frequencies, and it would be difficult for the pilot to completely separate all types of vibrations encountered. Generally, these are divided into three categories: low, medium, and high frequencies. Varying magnitudes of all three types of vibrations are often present in an individual helicopter. Only through experience will the pilot be able to judge what is normal and what is abnormal and correctable.

### LOW FREQUENCY VIBRATIONS

One Times Main Rotor Speed (One–Per–Revolution). This type of vibration emanates from the main rotor system. It produces a rotary excitation of the fuselage which feels like a lateral oscillatory roll or wallow to the pilot. If this vibration is present in all regimes of flight, it should be noted on form CG–4377. The most probable causes are:

- An unbalanced main rotor head.
- A tracking error on one of the main rotor blades.

An out–of–track condition can be caused by:

- An incorrect tab setting.
- A damaged blade leading edge.
- A damaged blade tip fairing.

### MEDIUM FREQUENCY VIBRATIONS

The most common inherent vibration is caused by the dynamic response of the main rotor blades to unsymmetrical aerodynamic blade loading. The amplitude of these vibrations increases with airspeed, the aircraft weight, and the load factor. Excessive vibrations could be caused by a MGB suspension malfunction or, if the vibrations are felt by the pilot at foot level, a problem with the battery attachments. Any vibration considered excessive shall be noted on form CG–4377.

### HIGH FREQUENCY VIBRATIONS

These vibrations may be felt as a tingling sensation in the soles of the feet or a tickling in the nose. In extreme cases, the instrument pointers will appear to be fuzzy. High frequency vibrations will normally emanate from the engine, main gear box input section, or tail rotor drive system, and are often equally apparent on the ground as in flight. The most important cue, by far, to high frequency vibration will be the associated sounds. Note any such vibrations on form CG–4377.

## FLIGHT WITH EXTERNAL LOADS

The aircraft has no unusual characteristics when carrying an external load except in tight turns and strong or gusty winds when cargo may tend to oscillate. External loads create fewer oscillating forces when using shorter hook-up cables. Oscillations can usually be controlled by slowing the forward speed of the aircraft. The helicopter center of gravity will not be affected adversely since the cargo hook is attached directly beneath the rotor centroid.

## DYNAMIC ROLLOVER

When excessive angular momentum about a wheel in contact with the deck is developed, a phenomenon referred to as dynamic rollover occurs, resulting in the tipping over of the helicopter. Dynamic rollover may occur on a level surface, but is most likely to occur during slope or ship operations. Usually, one or more of the following conditions are necessary:

1. Rotor disc tilt due to cyclic displacement.
2. Fuselage tilt due to ship list or slope angle and/or unequal strut extension.

Rotor disc tilt creates a tilting force to the "down–hill" side. Fuselage tilt reduces static stability. Collective application will initiate a tilting movement.

Recovery procedures for dynamic rollover vary. An immediate reduction of collective will reduce the main rotor tilting force which may allow the remaining static stability to stop the rolling movement. If the angular momentum is large and/or static stability small (i.e., center of gravity over the trapped wheel), this procedure will not stop the rollover. If the trapped wheel can be freed before rotor blade contact with the ground/ship, dynamic rollover will cease. This may be accomplished by applying full opposite cyclic and rapidly pulling collective.

Neither procedure will be effective if the situation is not recognized in time. The key is to avoid those conditions that lead to dynamic rollover.

## UNCOMMANDED LEFT YAW

Uncommanded Left Yaw (ULY) is a critical, low–speed aerodynamic flight characteristic which can result in a rapid, uncommanded yaw rate, that does not subside of its own accord, and if not immediately corrected, can result in loss of aircraft control. In other helicopters, this characteristic has been described as "loss of tail rotor effectiveness" or "LTE." Previously in the HH–65, it was identified as "loss of Fenestron effectiveness" or "LFE." Tests on the HH–65 and various helicopters have identified five major relative wind azimuth regions and/or aerodynamic factors that are conducive to ULY. ULY is generally the result of a combination of these factors. The following factors are illustrated in Figure 6–1.

1. Weathercock Stability (120° – 240° relative wind): All relative winds tend to cause the nose of

the aircraft to weathervane into the windline. This characteristic is the result of the aerodynamic design of the fuselage and the vertical/lateral fins. The most significant aspect of tailwinds is that they can accelerate an established yaw rate. In the HH–65, this can be critical due to the large surface area (approximately 35 square feet) of the vertical fin.

2. Main Rotor/Tail Rotor Interaction (040° – 095° relative wind): Relative winds from these areas can cause the main rotor vortices to shed directly onto the vertical fin/fenestron. These winds can potentially disturb the airflow through the fenestron causing variations in fenestron thrust for a given pedal position. Relative wind velocity is as important as the azimuth in directing the main rotor vortices into the fenestron. Regardless of helicopter type, the retreating blade side is most susceptible to this interaction. This area coincides with portions of the HH–65 low airspeed pedal workload critical azimuth (Figure 6–2).

3. Loss of Translational Lift (winds from all directions): As the aircraft decelerates through translational lift, the increased power required to establish a hover requires a corresponding increase in right pedal. If pedal input is not coincident with collective application, a left yaw will occur. Translational lift, while generally thought of as lift gained or lost during transitions from a hover to a forward flight regime or vice versa, can also impact power/anti–torque requirements during strictly hover flight. For example, if an aircraft is in a stable (into the wind or crosswind) hover, it may have some degree of translational lift. If that same aircraft is allowed to drift with the wind, vice maintaining position, and the pilot makes no further control inputs, as translational lift is lost, the aircraft may both lose altitude and/or yaw in the torque direction. Such an abrupt and unexpected loss of translational lift could contribute to initiate ULY.

4. Left Cross Winds (255° – 310° relative wind): Since the intake of the fenestron is on the left side, relative winds from this region increase induced airflow through the fenestron, reducing tail rotor blade angle of attack and ultimately resulting in reduced tail rotor thrust for a given pedal position. This area coincides with the HH–65 low airspeed pedal margin critical azimuth (Figure 6–3).

5. Collective Induced Yaw: The relationship between collective application and aircraft yaw is a fundamental of rotary wing aerodynamics. Rapid, positive collective application during an established left yaw, or while operating in any of the above regions may increase the possibility of encountering ULY.

Testing on the HH–65 has identified the following low airspeed critical azimuth regions for pedal workload and pedal margin.

1. Low Airspeed Pedal Workload Critical Azimuth (Figure 6–2): Relative winds from these regions require frequent pedal movement due to yaw instabilities. Inattention to aircraft heading in these areas may allow yaw rates to build rapidly.

2. Low Airspeed Pedal Margin Critical Azimuth (Figure 6–3): With relative wind from 255° – 305° at velocities in excess of 30 knots, the pedal control margin is less than 1 in. Due to the reduced pedal control margin in this region, it may be difficult to establish a right yaw or arrest a left yaw.

HH–65 Flight Regimes Susceptible to ULY: Some maneuvers may involve a higher risk of encountering ULY. It is important to remember that most ULY incidents can be attributed to a combination of the previously discussed factors.

1. Low Speed Left Downwind turns: A low speed left downwind turn, particularly in high winds, may allow a number of ULY factors to influence the helicopter. Loss of translational lift, weathercock stability and main rotor/tail rotor interaction can combine to accelerate the yaw rate in these turns.

2. Hovering Pedal Turns, Tail Through Windline in High Winds: The large surface area of the HH–65's vertical fin can be a tremendous yaw accelerant when passing through the wind line. Combined with the possibility of main rotor disc vortex interference, this could produce a substantial yaw rate.

3. Pilot Induced High Yaw Rates: Inattention or failure to make immediate pedal inputs to arrest

an uncommanded left yaw rate can result in the establishment of high yaw rates. During AFCS off operations, the usual pedal feel is altered and may give pilots the perception that the pedals are not responding "normally." Allowing high yaw rates to develop during AFCS off operation can make recovery more demanding. In addition, yaw rates will develop or accelerate more rapidly when operating at lighter gross weights.

4. Low Pedal Margin Maneuvers: When attempting any low speed maneuver with pedal control margin less than 1 in., there may not be sufficient right pedal remaining to arrest a left yaw once it is established.

5. Left Sideward Flight: In left sideward flight above 30 knots, high pedal workloads combined with possible low pedal control margin can result in ULY.

Specific recovery procedures for ULY are published in Section III of this flight manual. The best course of action to prevent ULY is to avoid the flight regimes and conditions conducive to ULY. However; if the ULY condition develops, the following actions should be taken:

1. Immediate full right pedal to maximum deflection. Gradual input will not arrest increasing yaw rates and up to 300° of lag may be experienced between full pedal application and yaw stabilization.

2. Altitude/obstacles permitting, smoothly apply forward cyclic. This will achieve translational lift, which will reduce main rotor torque, thus reducing the left yaw rate. In addition, this will take advantage of the strong directional stability of the aircraft due to the large vertical fin and permanently offset lateral fins.

3. Altitude permitting, reduce collective. This will reduce main rotor torque and the resultant left yaw created by the torque effect. Lowering the collective will initiate or increase a descent rate. Pilots should recognize that if a large descent rate develops close to the ground/water, the subsequent collective increase required to arrest the descent prior to ground/water contact may aggravate or re–initiate ULY.

4. NR HI switch–HI. Increasing main rotor RPM to 365 will significantly increase tail rotor effectiveness. HI NR should be selected prior to entering any flight regime where a ULY could become a factor. If dual pilot, copilot should select HI NR without request if ULY is encountered.

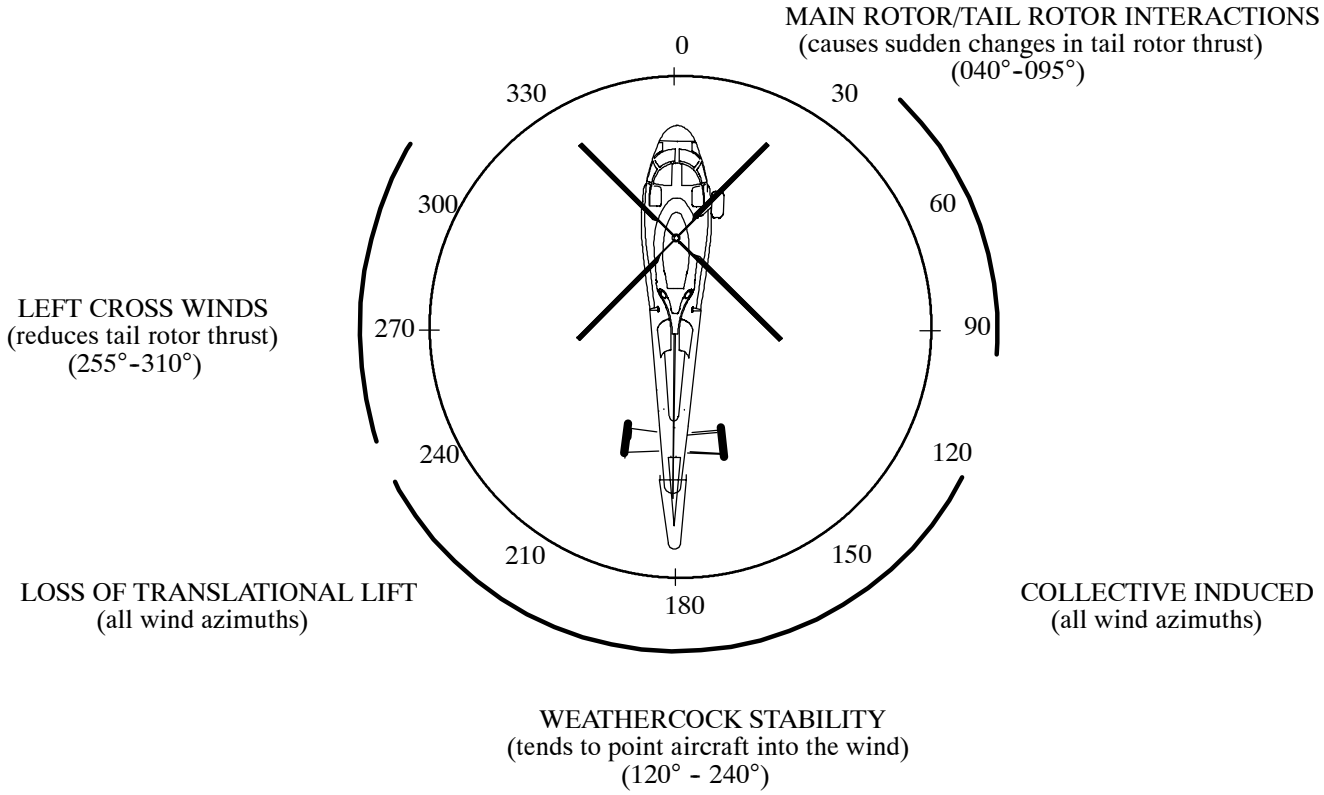



*Figure 6-1. Aerodynamic Factors Affecting Aircraft Yaw Control in the HH-65*

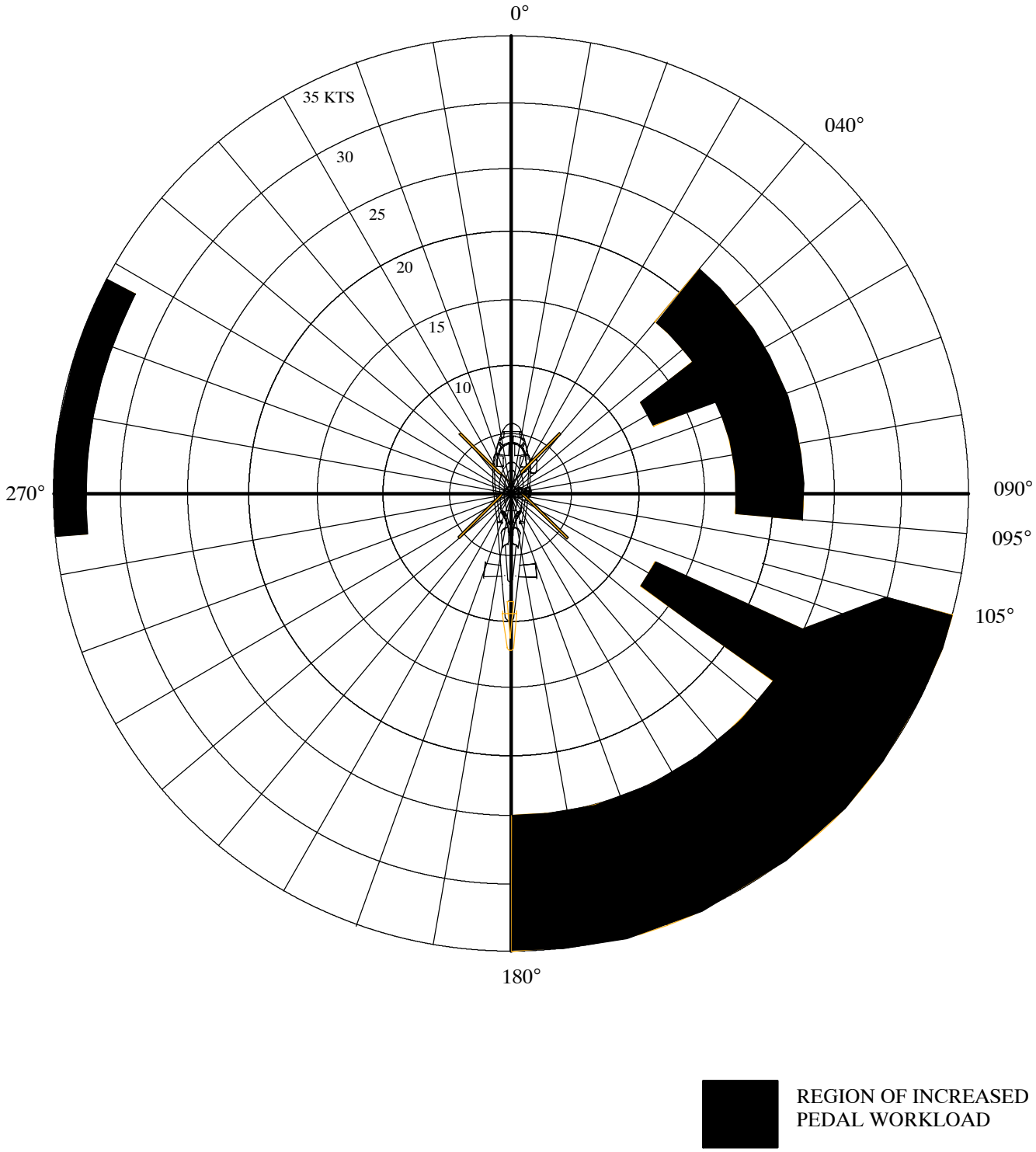



*Figure 6-2. HH-65 Low Airspeed Pedal Workload Critical Azimuth*

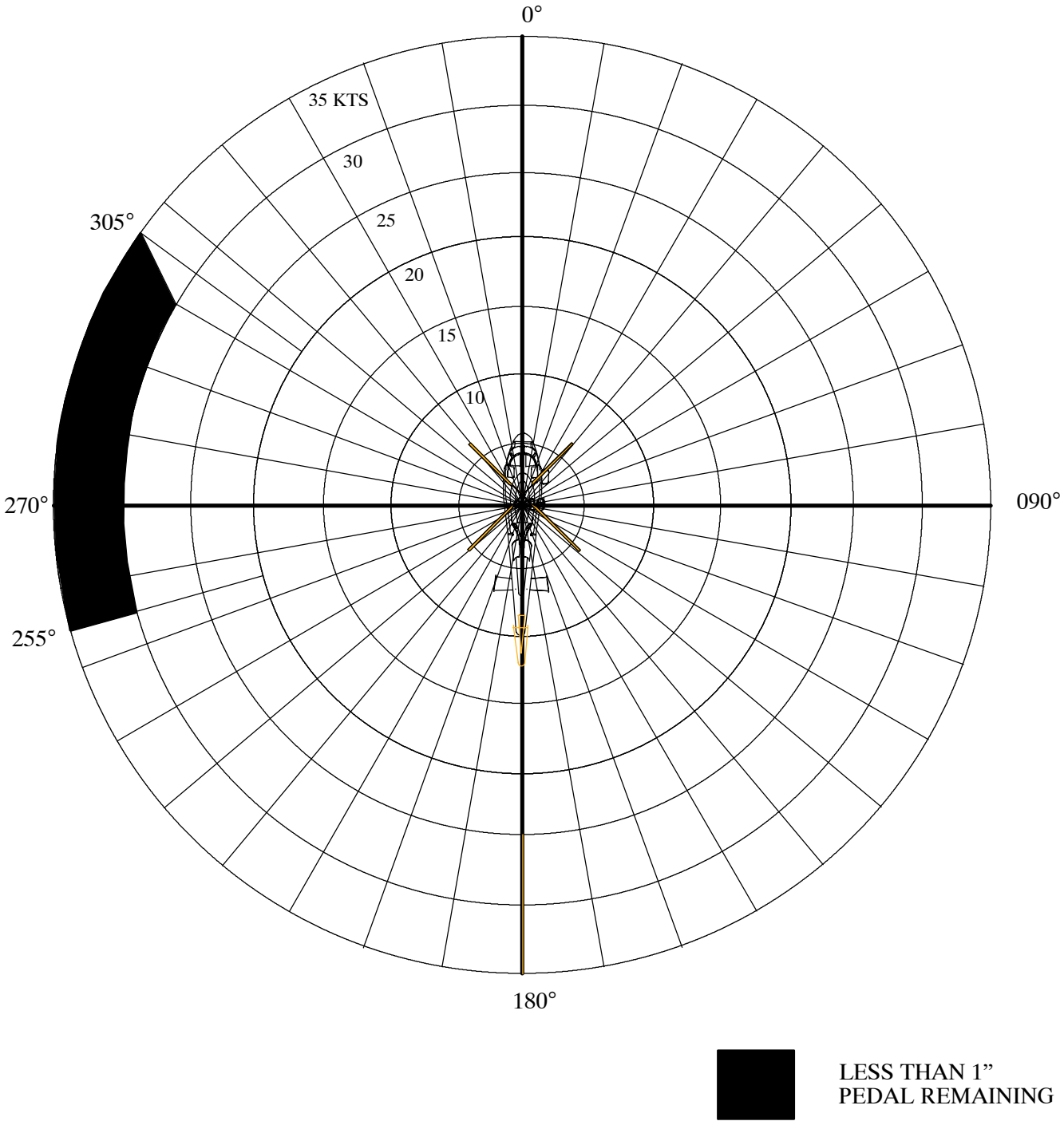



*Figure 6-3. HH-65 Low Airspeed Pedal Margin Critical Azimuth*

# SECTION VII

# ADVERSE WEATHER OPERATION

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## INTRODUCTION

This section contains information and procedures that affect operation of the helicopter in adverse weather and climatic conditions which differ from the normal procedures in Section II. The procedures for normal instrument flight are found in Section II.

## TURBULENCE AND THUNDERSTORMS

### TURBULENT AIR OPERATION

Flight through areas of moderate or greater turbulence shall be avoided. If moderate or greater turbulence is inadvertently encountered, trim the helicopter for level flight and establish the turbulence penetration airspeed of 80 KIAS. Avoid the use of ALT, IAS–VS, IAS–ALT, and APPR flight director modes. With the use of all channels of the AFCS, the helicopter handles very well in light turbulence. As turbulence levels increase, a reduction in cruise airspeed is recommended for crew comfort and ease of control. Flying under conditions of high gross weight, high airspeed, and heavy turbulence shall be avoided. The pilot will be alerted by illumination of the LIMIT lights on the instrument panel and SERVO LIMIT on the VEMD of a pending load limit, or possible blade stall condition of the main rotor.

### THUNDERSTORMS

Flight through or near thunderstorms shall be avoided. If thunderstorms are inadvertently encountered, trim the helicopter for level flight and establish the turbulence penetration airspeed of 80 KIAS. Utilize aircraft or ground radar information for selecting the best flight path. If practical, land and wait for the storms to pass. If lightning is encountered at night, turn the cockpit lighting to full intensity to preclude temporary blindness.

## IN–FLIGHT ICING

Flight through known icing conditions shall be avoided. The areas of greatest concern in icing conditions are the engine and rotor systems. Engine inlet icing can occur anytime water is present, in any form (liquid, snow, ice crystals, fog), and can occur when the ambient temperature is below 10 °C. To prevent any possible ice buildup inside the internal engine screen, the engine anti–icing system should be operated continuously during all conditions when ice may be encountered. Ice can also accrete on the external engine inlet screen without any accretion on the main rotor blades. This condition is most prevalent in icing conditions above –5 °C, where the dynamic heating of the rotor blades prevents ice from accreting on their leading edges.

In normal forward flight operations, ice will build a protective cap on the front of the inlet screen. After this cap is formed, the water droplets suspended in the air will be deflected around the engine inlet and be prevented from accreting on the sides of the screen or in the screen bypass. In slow speed or extended hover operations, these accretions can completely ice over the screen, accumulate in the engine inlet bypass and possibly reduce engine power by obstructing the engine air inlet area. The best

indicators of inlet screen ice accumulation are the OAT probe and pilot's door handles. These protrusions accumulate ice at nearly the same rate as the engine inlet screens. An increase in gas generator speed and a rise in MGT are indicative of near total engine inlet screen icing and bypass area blockage.

**WARNING**

To preclude the possibility of ice ingestion engine failure, the helicopter shall not be flown in visible moisture when temperatures are at or below 5 °C (41 °F) without the engine anti–ice system in operation.

**WARNING**

When engine inlet icing is detected, change altitude as soon as possible to leave the icing layer. Reduce power as necessary to maintain normal MGT.

In ambient temperatures between –10 °C and –5 °C, the ice accretions are prevented from bonding firmly to the blades by the dynamic heating effect. Minor accumulations will build and periodically be shed at these temperatures. During the shedding process, light to moderate vibrations will be experienced depending on how symmetrically the ice is shed. Normally, the vibrations will subside within several seconds of their onset. At temperatures below –10 °C, however, the dynamic heating of the blades is not sufficient to prevent significant ice accumulation. Accumulations at these temperatures can build very rapidly and become very hazardous to further flight operations. The greatest danger caused by the ice accumulations is lowered rotor blade efficiency. Ice accumulation accelerates blade stall, reduces rate–of–climb capability, and increases power requirements, thus increasing fuel consumption and decreasing range and endurance.

**NOTE**

If power requirements become critical during approach to landing, a running landing should be made if terrain permits.

Another area of concern during flight in icing conditions is the possibility of projectile damage. As ice is shed from the rotor blades or antennae, it may impact the airframe or tail rotor with sufficient velocity to cause damage. This situation is most prevalent when exiting icing conditions into warmer ambient temperatures.

## COLD WEATHER OPERATION

The major problems in cold weather operations are the preparation for flight, restricted visibility from blowing snow, and the adverse effects on helicopter materials. Moisture, usually from condensation or melted ice, may freeze in critical areas. Tire, fire extinguisher bottle, flotation bottle, and accumulator air pressure will decrease as the temperatures decrease. Extreme diligence on the part of both ground and flight crews is required to ensure successful cold weather operation. The problems encountered when operating from snow covered surfaces are compounded when operating from other than an operational air base. Colored glasses should be worn in snow areas to prevent snow blindness. Poor visibility can create difficulty in assessing groundspeeds and distances during approaches. When hovering in loose or powdery conditions, all ground references may be lost due to blowing snow. Smoke markers will assist in providing reference and determining wind.

**WARNING**

Static electricity generated by the helicopter should be dissipated prior to attempting a cargo hook or hoist pickup, particularly in colder dry climatic conditions when static electricity buildups are large. To dissipate this static charge, allow the hoist to touch the ground, or use a conductor to make contact between the helicopter and the ground. Use care not to break contact as the static charge will rebuild immediately.

**NOTE**

Rotor wash or wind will have a super–cooling effect, which may reduce the efficiency of exposed personnel. Consequently, the time that survivors and/or ground personnel are exposed to rotor wash should be held to a minimum.

## PREPARATION FOR FLIGHT

In addition to accomplishing a normal exterior inspection, engine inlets, rotor head, main rotor blades, tail rotor, and flight controls should be thoroughly inspected and be free of all ice and snow. Failure to remove snow and ice accumulations while on the ground can result in serious aerodynamic and structural effects when flight is attempted. It is recommended that ice chocks be used.

Check that fuel tank vents, battery compartment vent tube, and pitot tubes (including static ports and the omnidirectional airspeed sensor) are free of snow and ice; that tires are properly inflated; and that a warm, well–charged battery has been installed, if practicable. Check the engines for ice and snow. If ice or snow is found, the engine must be thawed out with hot air prior to attempting to start.

**CAUTION**

Do not attempt to chip or scrape snow and ice from any surfaces or controls. Portable ground heaters or U.S. Coast Guard approved de–icing fluid may be used to remove any accumulations that cannot be swept off.

## ENGINE STARTING

Engine start is permissible between –25 °C and 40 °C. The FADEC control switch can not be advanced past idle until oil temperature is above 0 °C.

## TAXIING

The helicopter can be taxied in snow, but the pilot must be aware that snow–covered surfaces may contain hidden obstructions, and braking action will be limited. Increased collective may improve steering. If outside visual references are lost due to re–circulating snow, slowly lower the collective and bring the helicopter to a complete stop. Allow time for the snow to clear before resuming taxi. If possible, proceed at a lower or minimum collective setting and higher ground speed to get ahead of the blowing snow. If hover taxiing is required, be prepared to make an instrument takeoff if blowing snow obscures the landing surfaces.

## TAKEOFF

Cold weather presents no particular takeoff problem unless the cold weather is accompanied by snow. The problem of restricted visibility due to blowing or swirling snow (from rotorwash) can be acute and may require a maximum performance takeoff, or perhaps even an instrument takeoff without hover to get the helicopter safely airborne. If the takeoff area is surrounded by a large expanse of smooth, unbroken snow, there is danger that the pilot may become disoriented because of the absence of visible ground reference objects. In this case, use any available objects for reference, such as smoke grenades, oil drums, rocks, etc.

**WARNING**

Before takeoff under icing conditions, check that landing gear is not frozen to the ground or deck.

## DURING FLIGHT

During flight, the horizon may be lost when flying over large unbroken expanses of snow. If such a situation exists, the helicopter should be flown entirely by instruments at a safe instrument altitude. Engine anti–icing, windshield anti–icing, and pitot heat shall be used as required.

## LANDING

In normal operations, helicopters are often required to land or maneuver in areas other than prepared airfields. In cold weather this frequently involves landing and taking off from snow covered terrain. The snow depth is usually less in open areas where there is little or no drift effect. The snow depth is usually greater on the downwind side of ridges and wooded areas. Whenever possible, the pilot should familiarize himself with the type of terrain under the snow (tundra, brush, marshland, etc.).

**CAUTION**

When the helicopter is equipped with skis, all landings to snow–covered terrain shall be made with the nose L/G unlocked.

On all snow landings anticipate the worst conditions; that is, restricted visibility due to loose whirling snow and an unfirm ice crust under the snow. When loose or powdery snow is expected, make an approach and landing with little or no hover to minimize the effect of rotorwash on

the snow. If possible, have some prominent ground reference objects in view during the approach and landing. If no such objects are available, a smoke grenade, etc., dropped from the helicopter may suffice.

**WARNING**

If visual reference is lost, accomplish an instrument takeoff immediately.

After contacting the surface with all wheels, slowly decrease collective while moving the cyclic slowly in a small circular pattern until the helicopter is firmly on the ground. Be ready to take off immediately if, while decreasing collective, one landing gear should hang up or break through the crust. If feasible, have a crew member get out and check the surface before reducing rpm.

### ENGINE SHUTDOWN

Make a normal engine shutdown as outlined in Section II. As soon as the helicopter is secured, chock the wheels and release the brakes to prevent the brake pucks from freezing to the discs.

### BEFORE LEAVING THE HELICOPTER

When possible, leave the helicopter parked with full fuel tanks. Every effort should be made during servicing to prevent moisture from entering the fuel system. Close all doors and maintenance platforms. Clean landing gear oleo struts of dirt, snow, and ice with clean cloth soaked in hydraulic fluid. If the helicopter is to remain parked outside for an extended period of time at below freezing temperatures, remove the battery for storage in a heated room.

## HOT WEATHER OPERATION

Hot weather operation, as distinguished from desert operation, generally means operation in a hot, humid atmosphere. High humidity usually results in the condensation of moisture throughout the helicopter. Possible results include malfunctioning of electrical equipment, fogging of instruments, corrosion of metal parts, and the growth of fungi in vital areas of the helicopter. Further results may be pollution of lubricants and fluids, and deterioration of non–metallic materials. Normal procedures, outlined in Section II, will be followed for all phases of operation with emphasis placed on the data contained herein. More power will be required to hover during hot weather than on a standard day. Hover ceilings will be lower for the same gross weight and power settings on a hot day. The flight should be thoroughly planned to compensate for existing conditions by using the charts in Appendix I. Check for the presence of corrosion or fungus at joints, hinge points, and similar locations. Any fungus or corrosion found must be removed. If instruments, equipment, and controls are moisture coated, wipe them dry with a clean, soft cloth.

**NOTE**

As fuel density decreases with a rise in ambient temperature, total usable fuel quantities will be reduced, thus resulting in a decrease in normal operating range.

## DESERT OPERATION

Desert operation generally means operation in a very hot, dry, dusty, often windy atmosphere. Under such conditions sand and dust will often be found in vital areas of the helicopter. Sand ingestion by the engines can cause compressor damage and recirculation of sand during hovering will sand–blast rotor blade leading edges.

### PREPARATION FOR FLIGHT

Plan the flight thoroughly to compensate for existing conditions by using the charts in Appendix I. Check for the presence of sand and dust in controls and actuating linkages, and inspect the tires for proper inflation. High temperatures may cause over inflation. The oleo struts should be checked for sand and dust, and any accumulation removed with a clean dry cloth. Inspect for, and have removed, any sand or dust deposits on instrument panel and switches, and on and around flight and engine controls.

### ENGINE STARTING, WARMUP, AND GROUND TESTS

If possible, engine starting and ground operation should be accomplished from a hard, clean surface. Accomplish the normal engine start, warmup, and ground test as outlined in Section II, but limit ground operation to a minimum, as the downwash from the main rotor may stir up clouds of sand. Every effort should be made to minimize the sand from being blown up around the main rotor and engines.

## TAXIING INSTRUCTIONS

When it is absolutely necessary to ground taxi in sand or dust, use minimum collective and a high taxi speed to stay ahead of blowing sand or dust.

## TAKEOFF

Execute a no–hover takeoff and climb as outlined in Section II. If possible, make the takeoff from a hard packed, clear surface, free from sand and dust.

## DURING FLIGHT AND DESCENT

Avoid flying through sand or dust storms whenever possible. Excessive dust and grit in the air will cause considerable damage to internal engine parts.

## LANDING

The best procedure to minimize blowing sand and dust is a running landing. If the terrain does not permit a running landing, an approach should be made to a no–hover landing.

**WARNING**

If visual reference is lost, accomplish an instrument takeoff immediately.

**CAUTION**

If operation in sand cannot be avoided, landings shall be made using an approach angle compatible with available power, keeping in mind that an ITO may be necessary if visual reference is lost. Ground speed and vertical descent rate shall be kept to the minimum necessary to preclude the possibility of overloading the landing gear and depending on surface conditions, to minimize dust or sand cloud generation. Maximum performance takeoffs shall be used. All doors and windows shall be kept closed during landings and takeoffs to prevent sand from entering the cockpit and cabin.

## ENGINE SHUTDOWN

The engine shall be shut down as soon as possible after landing to minimize the ingestion of sand and dust.

## BEFORE LEAVING THE HELICOPTER

Accomplish the normal procedures as outlined in Section II. Install all protective covers and shields. Leave windows and doors open to ventilate the helicopter except when sand and dust are blowing.

# APPENDIX A

# PERFORMANCE DATA

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# INTRODUCTION

This section contains performance data pertinent to HH–65C helicopters with Turbomeca Arriel 2C2CG engines.

## PURPOSE OF PERFORMANCE CHARTS

The charts presented on the following pages are provided to aid in preflight and in–flight planning. These charts enable the pilot to select the best power setting, altitude, and airspeed to be used to obtain optimum performance for the mission to be flown. They also provide critical information in regards to single engine performance to be used by pilots to minimize operations when single engine flight is not possible.

**CAUTION**

Under certain conditions the engine power output capability can exceed the authorized mechanical limits for the power transmission system. Therefore, the power limitations given in Section V shall be observed.

If an example of how to read the chart is not given on the chart, a description of how to read the chart is covered in this section.

## COMPRESSIBILITY EFFECTS

Rotor compressibility effects have been encountered on this helicopter. This phenomenon is a result of the rotor-tip approaching the speed of sound. Compressibility causes an abrupt and large increase in drag and a slight decrease in lift when the velocity of some portion of an airfoil approaches the speed of sound. A convenient parameter to measure the degree of compressibility is Mach number, which is the ratio of the airfoil velocity to the local speed of sound. It is important to remember that the speed of sound is dependent on the ambient temperature. Thus if the resultant rotor tip velocity remains constant (such as constant rotor rpm in hover), changes in the ambient temperature will change the speed of sound and will thus change the tip Mach number. A cold day will produce higher tip Mach numbers than a warm day, all other things being equal. Consequently, the ambient temperature affects the degree of compressibility present and, therefore, also affects the power required. Placing the Nr switch to Hi will increase rotor RPM, which will result in a slightly higher power requirement. The charts in the Appendix have been corrected for the effects of rotor blade compressibility.

## ALTITUDE DATA

### Pressure Altitude

Pressure altitude is the altitude indicated on the altimeter when the barometric scale is set on 29.92 inches. It is the height above the theoretical plane at which the air pressure is equal to 29.92 inches of mercury. The Pressure Altitude Chart (Figure A–1) provides a means of determining the Pressure Altitude from a known altimeter setting.

### Density Altitude

Density altitude is an expression of the density of the air in terms of height above sea level; hence the less dense the air, the higher the density altitude. For standard conditions of temperature and pressure, density altitude is the same as pressure altitude. As temperature increases above standard conditions for any altitude, the density altitude will also increase to values higher than pressure altitude. The density altitude chart (Figure A–2) provides a means of determining density altitude from known pressure altitude and Outside Air Temperature (OAT) values. Figure A–2 also provides a means of converting

Fahrenheit temperatures to Centigrade temperatures or vice versa.

## TEMPERATURE CONVERSION CHART

The temperature conversion chart (Figure A–3) can be used to convert temperature values between Fahrenheit and Celsius.

## MAXIMUM HOVERING WEIGHT CHARTS

Charts A–4 and A–5 indicate the maximum weight that the helicopter can hover in or out of ground effect with a zero power margin. As pressure altitude and temperature increases, the engines become less effective and the helicopter must be lighter to hover without exceeding aircraft limits. At sea level up to 45 °C, the engines produce sufficient power to hover out of ground effect at the maximum gross weight of 9,480 pounds.

## MAXIMUM HOVERING WEIGHT OGE WITH POWER RESERVE

Chart A–6 provides weights for which the helicopter can hover out of ground effect and have a power margin from 0% to 15%, taking pressure altitude, temperature, and wind into account. To use the chart enter the top left side with pressure altitude and read across to temperature. Follow straight down to the torque margin chart. Trace parallel to the closest line of influence down and left to the desired torque margin. When the line of influence intersects the desired torque margin, go straight down to the wind chart. Follow the closest line of influence down and right to reach the desired wind value. The weight to hover out of ground effect with the selected torque margin is computed by reading straight down to the bottom scale.

## TRANSFER SCALE AND WEIGHT INDEX CHARTS

To determine rate of climb for dual or single engine configurations a reduced weight must be used. The reduced weight is expressed as the weight index. To determine the weight index the transfer scale must first be computed. The transfer scale and weight index charts (Figure A–7 and A–8) provide a means of computing the transfer scale.

**NOTE**

The transfer scale and weight index both are dependent on temperature and pressure altitude. If rate of climb is being computed for differing conditions (i.e., sea level for initial take off and 5,000 feet cruising altitude) the transfer scale and weight index must be figured for each set of conditions.

## OEI RATE OF CLIMB

This chart (Figure A–9) provides a means of computing the maximum rate of climb using continuous OEI based on a given weight, temperature, and pressure altitude.

## LEVEL FLIGHT PERFORMANCE CHART

Figure A–10 is used to determine the minimum and maximum airspeed achievable at continous OEI and optimum climb airspeed (Vy). Vy is valid for single or dual engine configurations. To compute the minimum and maximum airspeeds, find the page that best fits the pressure altitude and temperature for the operating conditions. Next locate the curved line that represents aircraft weight. Follow the curved weight line to intersect the OEI MAX CONT line on the left and right sides of the chart. From the points where the lines intersect read straight down to get airspeeds. Vy is read directly below the point where line E intersects the weight line.

## NEVER EXCEED SPEED (VNE) CHART

This chart (Figure A–11) illustrates indicated VNE with respect to pressure altitude and gross weight. Enter the chart on the left side pressure altitude. Move horizontally to the right to intersect the gross weight line that fits aircraft configuration. From this intersection move down to the airspeed scale and read VNE. Figure A–11 is also available as a placard in the cockpit.

## HEIGHT LOSS AFTER ENGINE FAILURE IN HOGE CHART

Figure A–12 illustrates the altitude loss resulting from an engine failure in a hover and use of 30 second OEI. It has two scales, the top scale represents the altitude loss after an actual engine failure and the bottom scale represents altitude loss when using the training mode. Altitude loss with the training mode is greater than with an actual engine failure due to FADEC derated limits which are used to prevent use of actual OEI power. The training mode is discussed in detail in Section I.

## HEIGHT/VELOCITY (H/V) DIAGRAMS

Figure A–13, sheet 1 and 2, determines if the H/V diagram on Figure A–13, sheet 3, is applicable. The applica-

bility of the H/V diagram is dependent on weight, temperature, and pressure altitude. At weights below 8,475 pounds and density altitudes of 3,000 feet and lower, the H/V diagram (Figure A–13 sheet 3) does not apply. For weights above 8,475 pounds and density altitudes up to 3,000 feet, use sheet 1 to determine at what weight the H/V diagram applies. Enter the chart on the left side at pressure altitude. Read across to temperature, then down to determine weight. The H/V diagram is applicable above the computed weight. For density altitudes above 3,000 feet, read sheet 2 in the same manner as sheet 1. The H/V diagram is applicable at all pressure altitudes when aircraft weight is 9,260 pounds or more. The shaded area of sheet 3 is the area to avoid when the H/V diagram applies.

## HOVER OGE PERFORMANCE AT 30s OEI CHART

The performance in hover OGE chart (Figure A–14), depicts the weight at which the helicopter can hover OGE with one engine at the 30s OEI rating at a given pressure altitude, temperature, and wind. Enter the left side of the chart at pressure altitude. Read across to the temperature line, then go straight down to the head wind line. Follow parallel to the head wind line of influence until reaching the desired head wind component. Go down and read the weight to hover OGE using the 30s OEI rating.

## AIRSPEED CORRESPONDENCE CHART

The true airspeed (TAS) to calibrated airspeed (CAS) chart (Figure A–15) provides the correction required to determine the TAS from indicated airspeed (IAS). The differences between IAS and CAS are negligible and the terms CAS and IAS are used interchangeably. Because of the speed range through which the helicopter operates, compressibility corrections to airspeed are negligible and are intentionally omitted.

## SIDE AND TAIL WIND CHART

The side and tail wind chart (Figure A–16) provides a means of computing the maximum side and tail wind envelope for hovering. As temperature and pressure altitude increase above normal operating conditions, the side and tail wind velocities at which an adequate pedal margin can be maintained decreases. For operations with high temperatures and/or high pressure altitudes this chart may be consulted to ensure side and tail wind velocities are not exceeded.

## DISTANCE TO CLEAR 50 FT OBSTACLE

This chart (Figure A–17) provides the distance required to clear a 50 foot obstacle during takeoff. It assumes a no wind condition and airspeed below 40 kts until clear of the obstacle.

## DISTANCE REQUIRED FOR LANDING AFTER CLEARING A 50 FT OBSTACLE CHART

This chart (Figure A–18) provides a means of determining the distance required after clearing a 50 foot obstacle to land and bring the helicopter to a complete stop with one engine inoperative.

## SERVICE CEILING CHARTS

The service ceiling charts (Figures A–19 and A–20) show the highest altitude at which a rate–of–climb of 100 feet–per–minute can be attained at a specific gross weight and OAT. Figure A–19 reflects the service ceiling for two engine operation at maximum continuous power, and Figure A–20 reflects the service ceiling for one engine operation at 2 minute and continuous OEI setting.

## MAX WEIGHT TO MAINTAIN LEVEL FLIGHT CHART

This chart (Figure A-21) depicts the maximum weight at which level flight can be maintained using the continuous OEI setting while maintaining TAS of 75 kts.

## MINIMUM AIRSPEED PERMITTING CLIMB AT 100 FPM

The minimum airspeed permitting climb at 100 fpm chart (Figure A-22) consists of six sheets. Three sheets are based on 30s OEI and three are based on 2 minute OEI, with pressure altitudes from 0 to 2,000 feet. After selecting the desired sheet, enter the chart on the left or right side with weight and read across to temperature. Then read straight down to find the minimum airspeed at which a climb of 100 fpm can be maintained.

## TWIN ENGINE RATE OF CLIMB

This chart (Figure A-23) shows the rate of climb with a TAS of 75 kts and both engines operating at maximum continuous power.

## MAXIMUM TAKEOFF WEIGHT PERMITTING OEI CLIMB AT 150 FPM

This chart (Figure A-24) shows the maximum takeoff weight that will allow for a climb of 150 fpm at 1,000 ft AGL with one engine at the continuous OEI setting.

## PERFORMANCE IN HOVER OGE AT 2 MINUTE OEI

The performance in hover OGE at 2 minute OEI chart (Figure A-25), depicts the weight at which the helicopter can hover OGE with one engine at the 2 minute OEI rating at a given pressure altitude, temperature, and wind. Enter the left side of the chart at pressure altitude. Read across to the temperature line, then go straight down to the head wind line. Follow parallel to the head wind line of influence until reaching the desired head wind component. Go down and read the weight to hover OGE using the 2 minute OEI setting.

## PERFORMANCE IN HOVER IGE OEI

This chart (Figure A-26) consists of two sheets. Sheet 1 is for the 30s OEI setting and sheet 2 is for the 2 minute OEI setting and depicts the weight at which the helicopter can hover IGE with one engine at the chosen OEI rating at a given pressure altitude, temperature, and wind. Enter the left side of the chart at pressure altitude. Read across to the temperature line, then go straight down to the head wind line. Follow parallel to the head wind line of influence until reaching the desired head wind component. Go down and read the weight to hover IGE using the appropriate OEI setting.

## TAKEOFF AND DESTINATION DATA CARD

A Takeoff and Destination Data (TODD) card (Figure A-28) is provided as a tool to assist the pilot in flight planning and is designed to be reproduced, folded, and attached to a pilot's kneeboard. It is intended that pilots will complete sections of the TODD card that are applicable to the mission being flown. In most situations all fields will not be filled in. The performance charts are incorporated in the Blue Book and may be consulted in flight if the mission changes or additional performance information is needed. Figures A-1 through A-14 are to be used to complete the TODD card. The H/V diagram is provided on the TODD in chart format for reference when it is applicable. To complete the MGW to HOGE at 30s OEI portion of the TODD card, use on scene conditions. Enter the chart on the left side with pressure altitude and read across to temperature. Go straight down to head wind. Follow parallel to the lines of influence down and right. Note the point where the 10, 20, and 30 kt wind lines are crossed. From where the wind lines are crossed read straight down and obtain the weight at which HOGE is possible using 30s OEI. Record the weights on the TODD card in the block below the appropriate wind velocity.

PRESSURE ALTITUDE CONVERSION

| ALITITUDE SETTING IN HG. | ALTITUDE ADDITION FOR OBTAINING PRESSURE ALTITUDE |
|---|---|
| 28.3 | 1,533 |
| 28.4 | 1,436 |
| 28.5 | 1,340 |
| 28.6 | 1,244 |
| 28.7 | 1,148 |
| 28.8 | 1,053 |
| 28.9 | 957 |
| 29 | 863 |
| 29.1 | 768 |
| 29.2 | 673 |
| 29.3 | 579 |
| 29.4 | 485 |
| 29.5 | 392 |
| 29.6 | 298 |
| 29.7 | 205 |
| 29.8 | 112 |
| 29.9 | 20 |
| 29.92 | 0 |
| 30 | -73 |
| 30.1 | -165 |
| 30.2 | -257 |
| 30.3 | -348 |
| 30.4 | -440 |
| 30.5 | -531 |
| 30.6 | -622 |
| 30.7 | -712 |
| 30.8 | -803 |

*Figure A-1. Pressure Altitude Conversion*

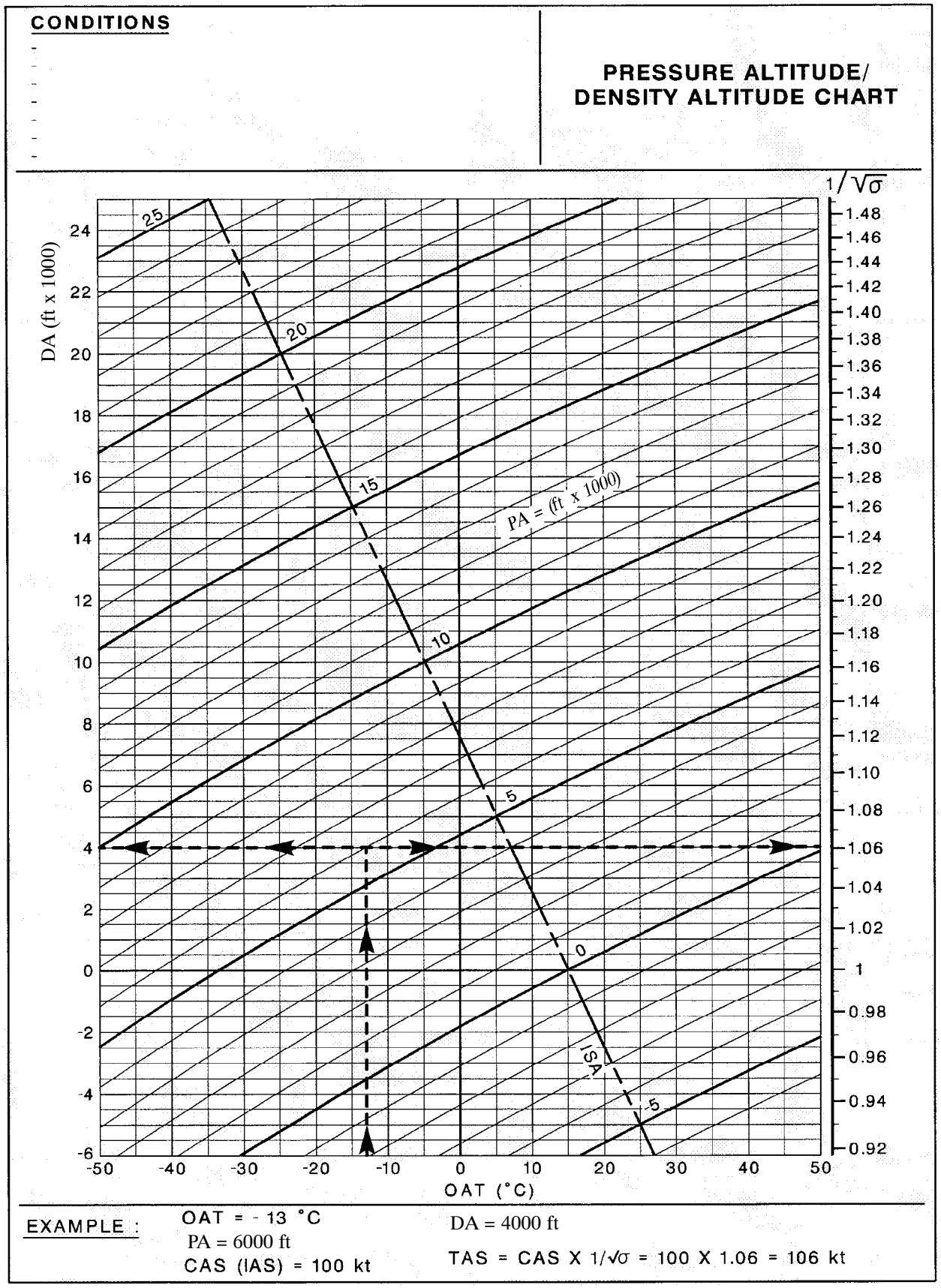



*Figure A-2. Density Altitude*

Temperature Conversion Chart

| Celsius | Fahrenheit |
|---|---|
| -30 C | -22.0 F |
| -29 C | -20.2 F |
| -28 C | -18.4 F |
| -27 C | -16.6 F |
| -26 C | -14.8 F |
| -25 C | -13.0 F |
| -24 C | -11.2 F |
| -23 C | -9.4F |
| -22 C | -7.6 F |
| -21 C | -5.8 F |
| -20 C | -4.0 F |
| -19 C | -2.2F |
| -18 F | -0.4 F |
| -17 C | 1.4F |
| -16 C | 3.2 F |
| -15 C | 5.0 F |
| -14 C | 6.8 F |
| -13 C | 8.6 F |
| -12 C | 10.4 F |
| -11 C | 12.2 F |
| -10 C | 14.0 F |
| -9 C | 15.8 F |
| -8 C | 17.6 F |
| -7 C | 19.4 F |
| -6 C | 21.2 F |
| -5 C | 23.0 F |
| -4 C | 24.8 F |
| -3 C | 26.6 F |
| -2 C | 28.4 F |
| -1 C | 30.2 F |
| 0 C | 32.0 F |
| 1 C | 33.8 F |
| 2 C | 35.6 F |
| 3 C | 37.4 F |
| 4 C | 39.2 F |
| 5 C | 41.0 F |
| 6 C | 42.8 F |
| 7 C | 44.6 F |
| 8 C | 46.4 F |
| 9 C | 48.2 F |
| 10 C | 50.0 F |
| 11 C | 51.8 F |
| 12 C | 53.6 F |
| 13 C | 55.4 F |
| 14 C | 57.2 F |
| 15 C | 59.0 F |
| 16 C | 60.8 F |
| 17 C | 62.6 F |
| 18 C | 64.4 F |
| 19 C | 66.2 F |
| 20 C | 68.0 F |
| 21 C | 69.8 F |
| 22 C | 71.6 F |
| 23 C | 73.4 F |
| 24 C | 75.2 F |
| 25 C | 77.0 F |
| 26 C | 78.8 F |
| 27 C | 80.6 F |
| 28 C | 82.4 F |
| 29 C | 84.2 F |
| 30 C | 86.0 F |
| 31 C | 87.8 F |
| 32 C | 89.6 F |
| 33 C | 91.4 F |
| 34 C | 93.2 F |
| 35 C | 95.0 F |
| 36 C | 96.8 F |
| 37 C | 98.6 F |
| 38 C | 100.4 F |
| 39 C | 102.2 F |
| 40 C | 104.0 F |

*Figure A-3. Temperature Conversion*

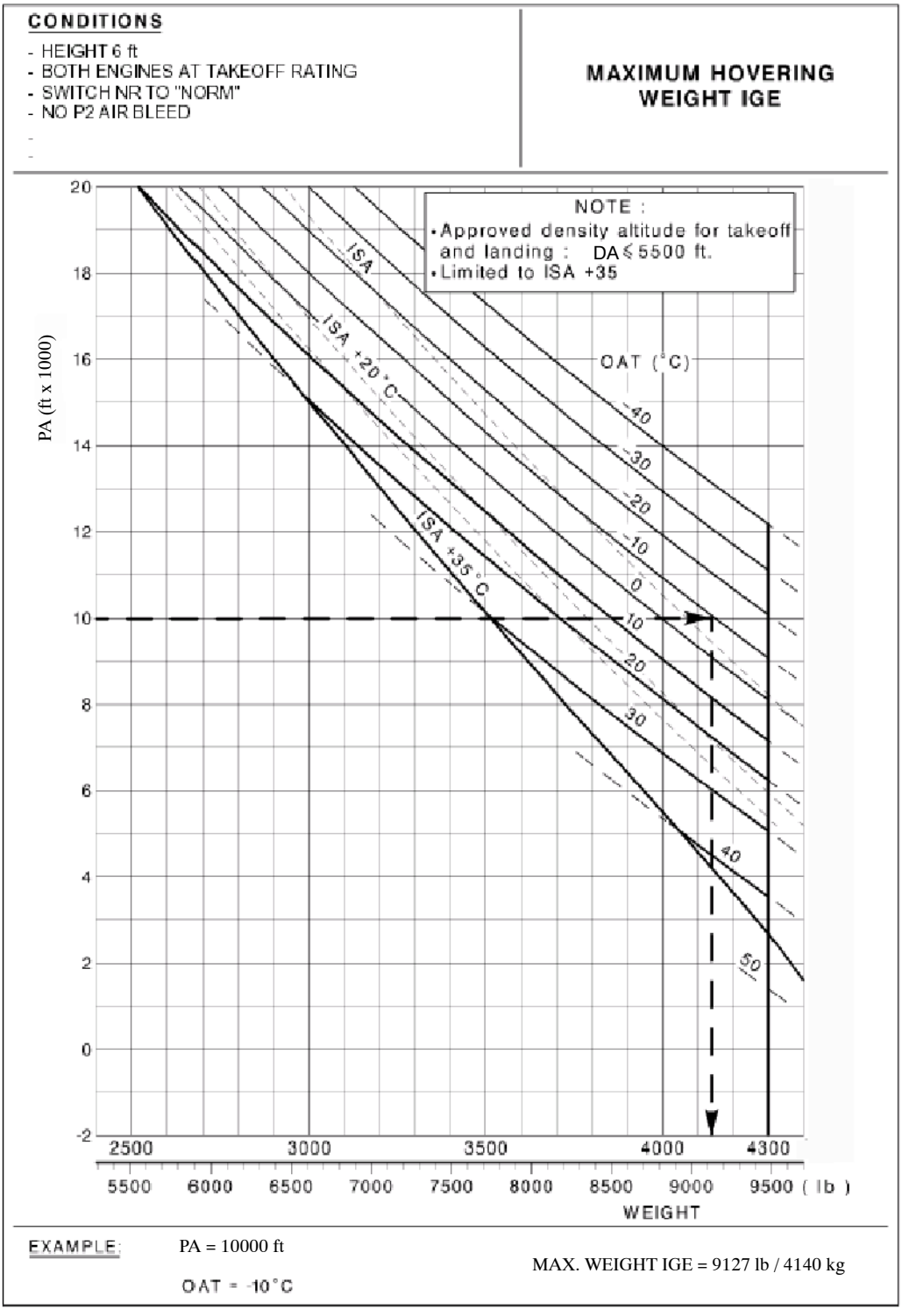



*Figure A-4. Maximum Hovering Weight IGE*

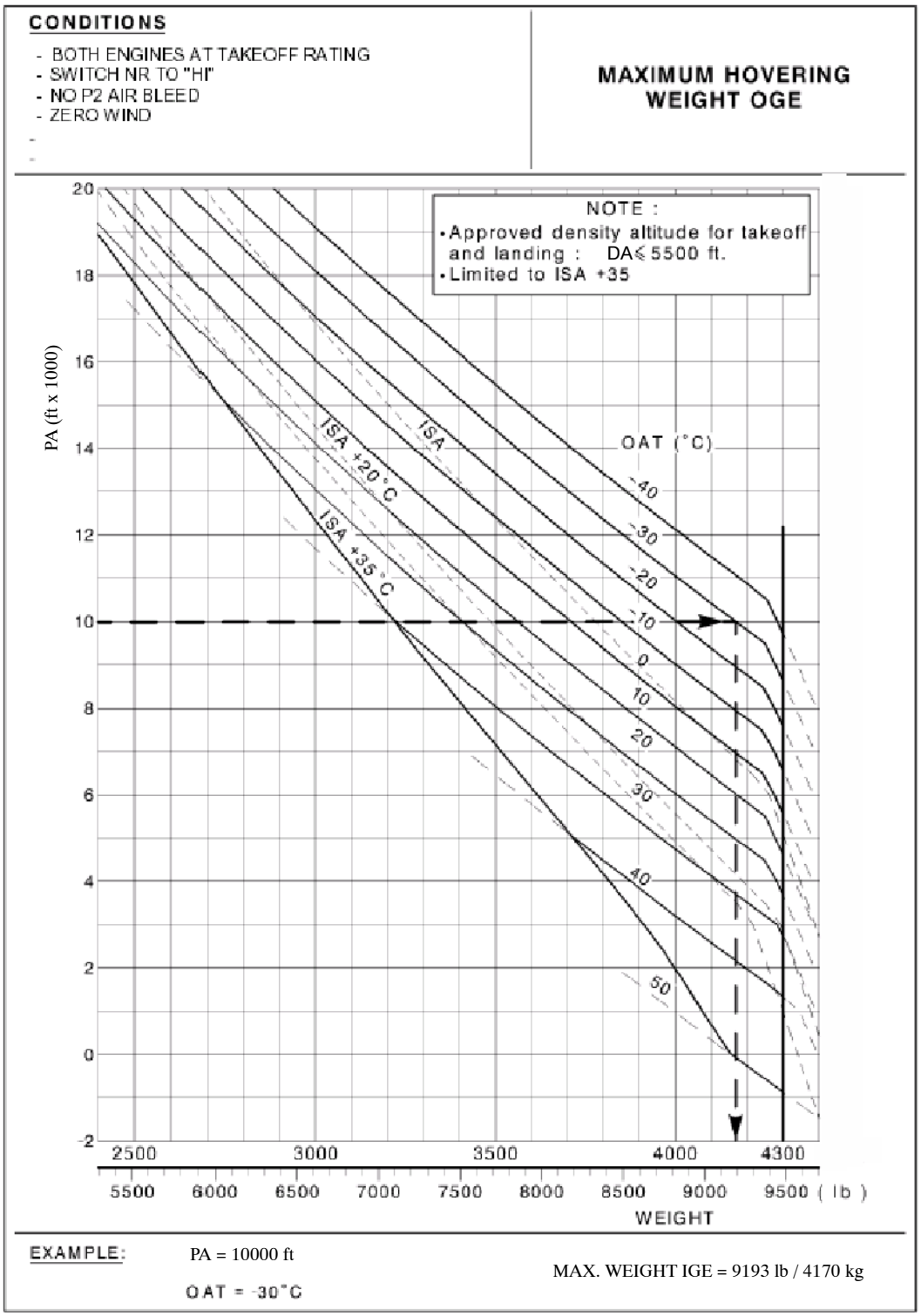



*Figure A-5. Maximum Hovering Weight OGE*

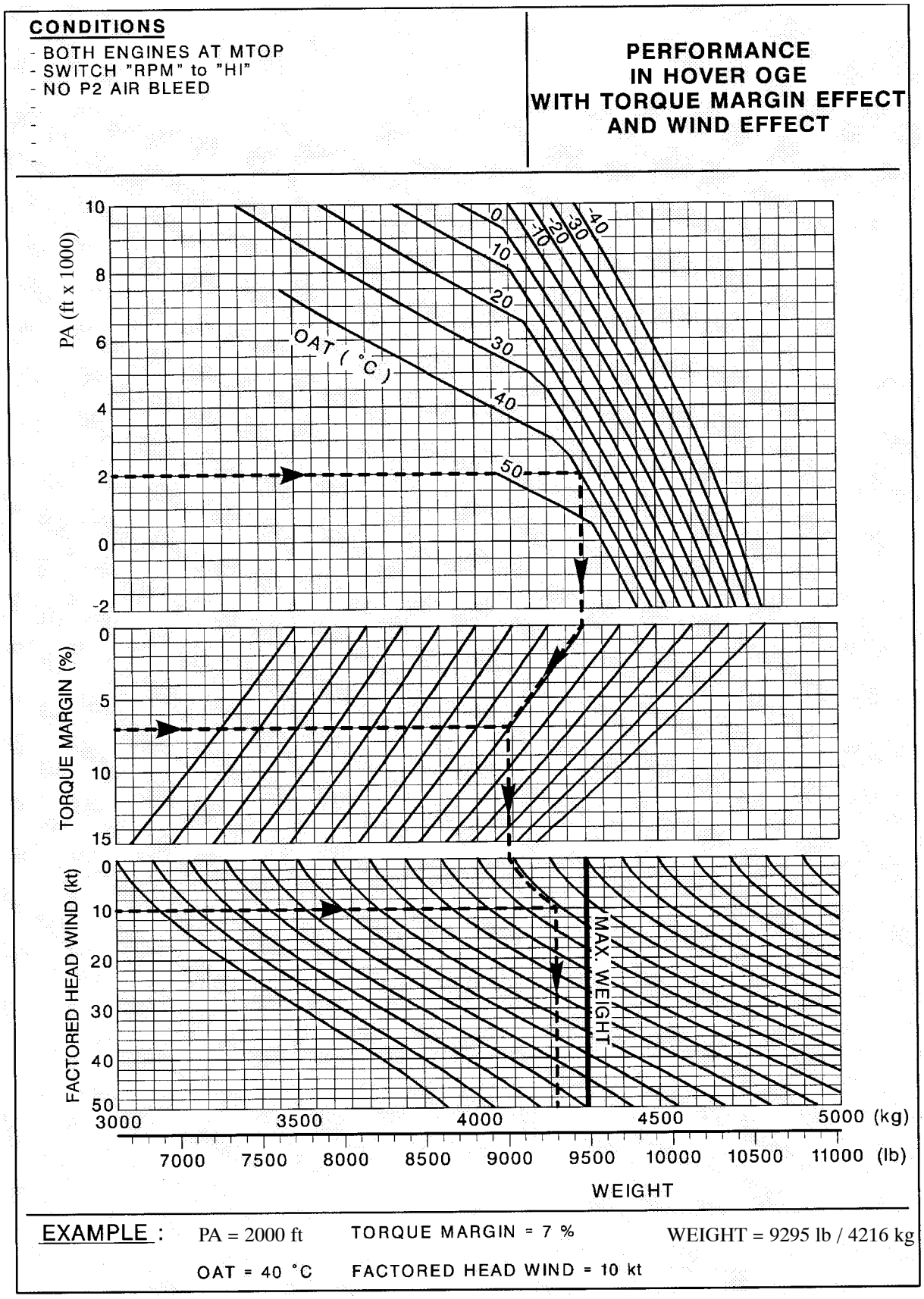
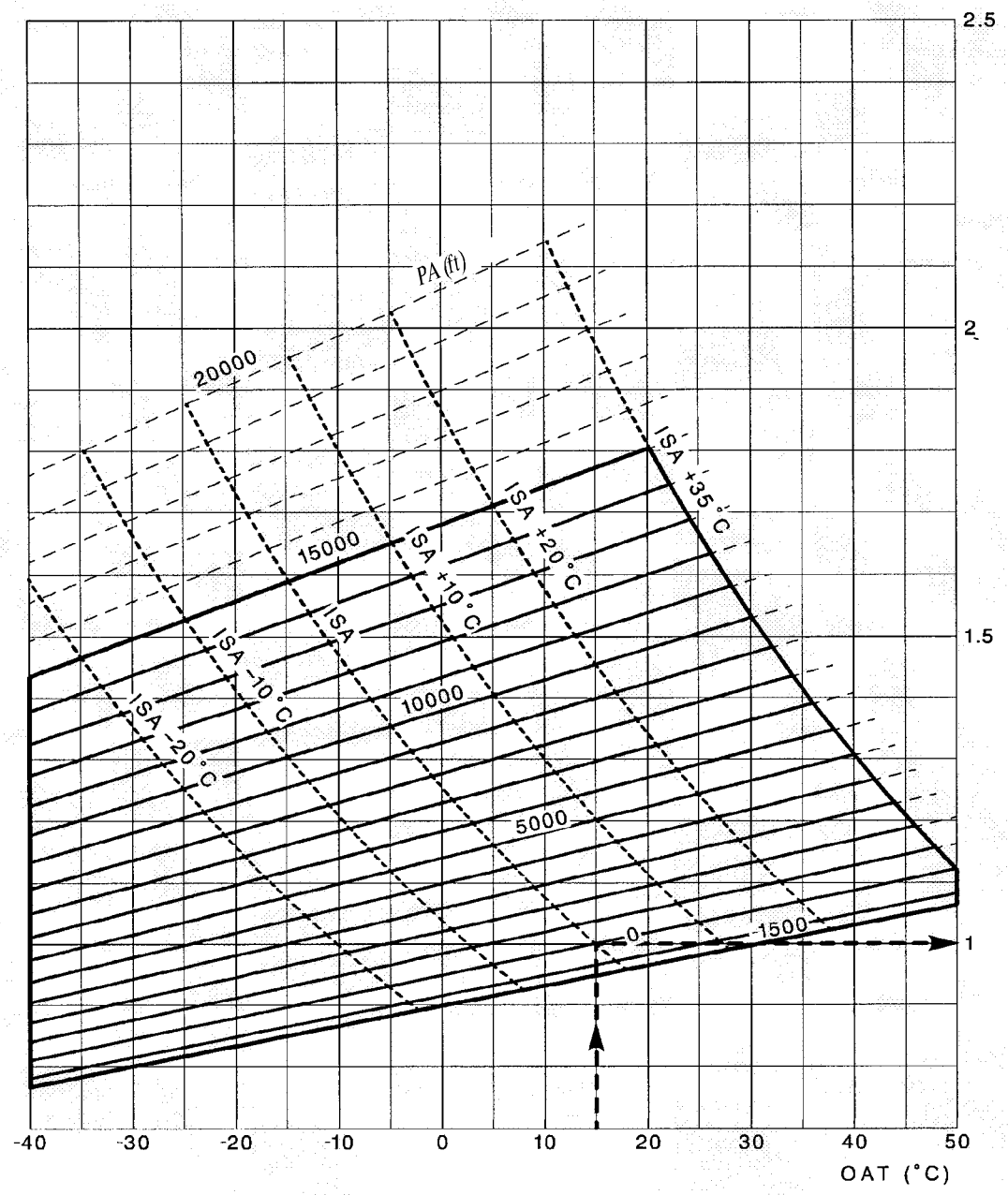



*Figure A-6. Performance in Hover OGE*

**CONDITIONS**

-
-
-
-
-
-
-

**WEIGHT INDEX FOR DETERMINING LOSS OF HEIGHT AFTER ENGINE FAILURE**




EXAMPLE 2 : OAT = +15°C

PA = 0 ft

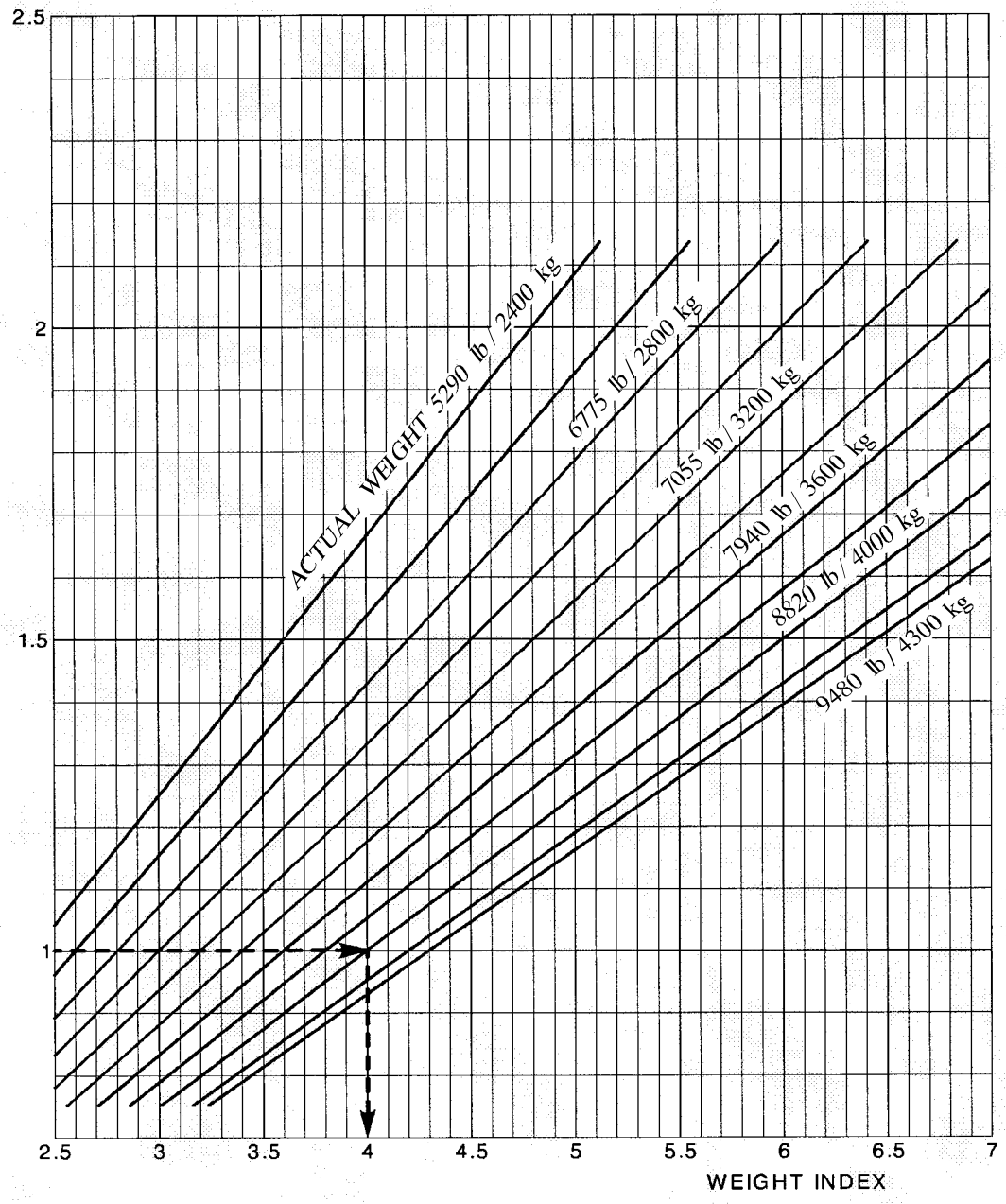
TRANSFER SCALE = 1

*Figure A-7. Weight Index for Determining Rate of Climb*

**CONDITIONS**

-
-
-
-
-
-
-

**WEIGHT INDEX FOR DETERMINING LOSS OF HEIGHT AFTER ENGINE FAILURE**




EXAMPLE : Transfer scale = 1

Actual weight = 8820 lb / 4000 kg

WEIGHT INDEX = 4

*Figure A-8. Weight Index for Determining Rate of Climb*

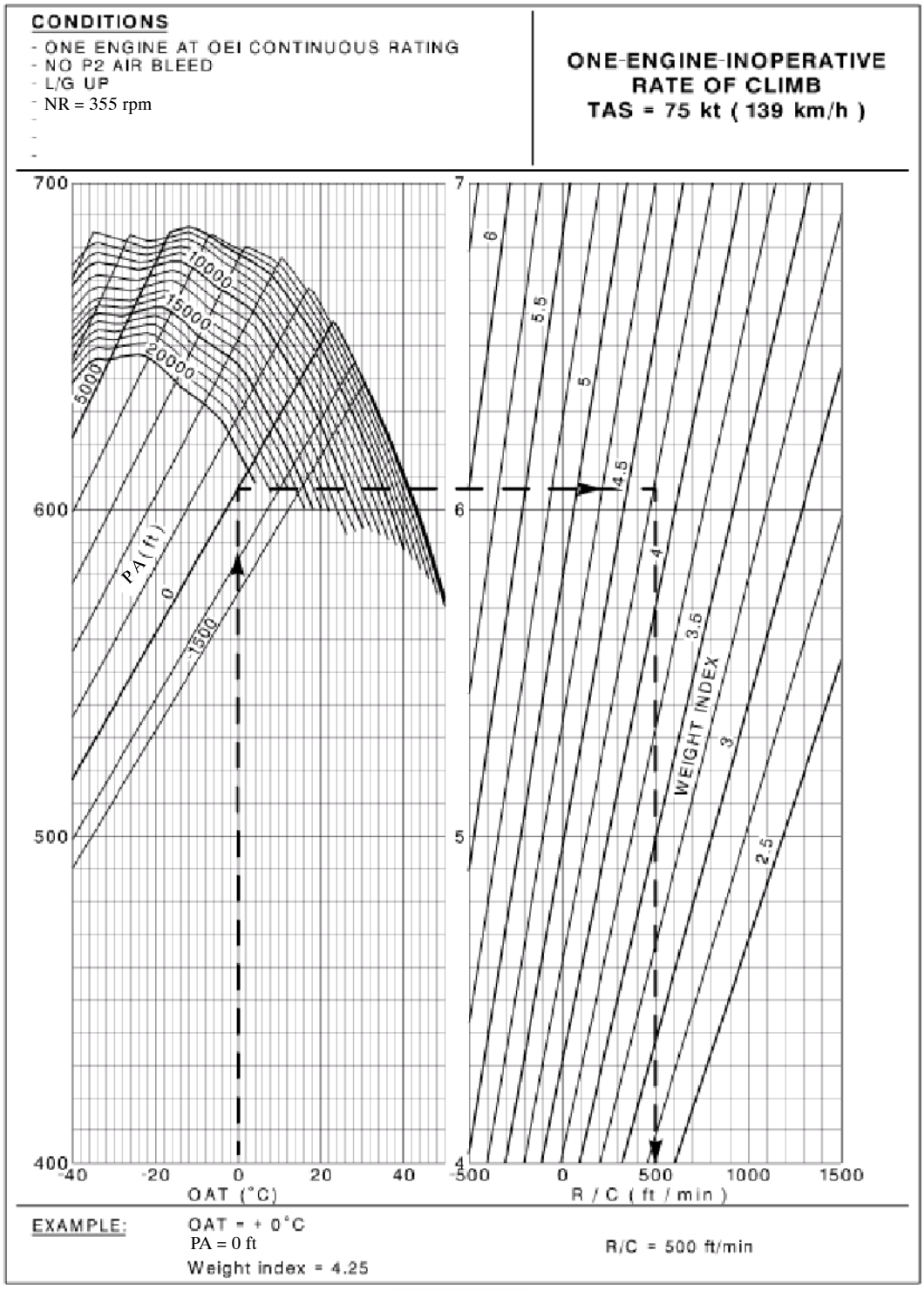



*Figure A-9. One Engine Inoperative Rate of Climb*

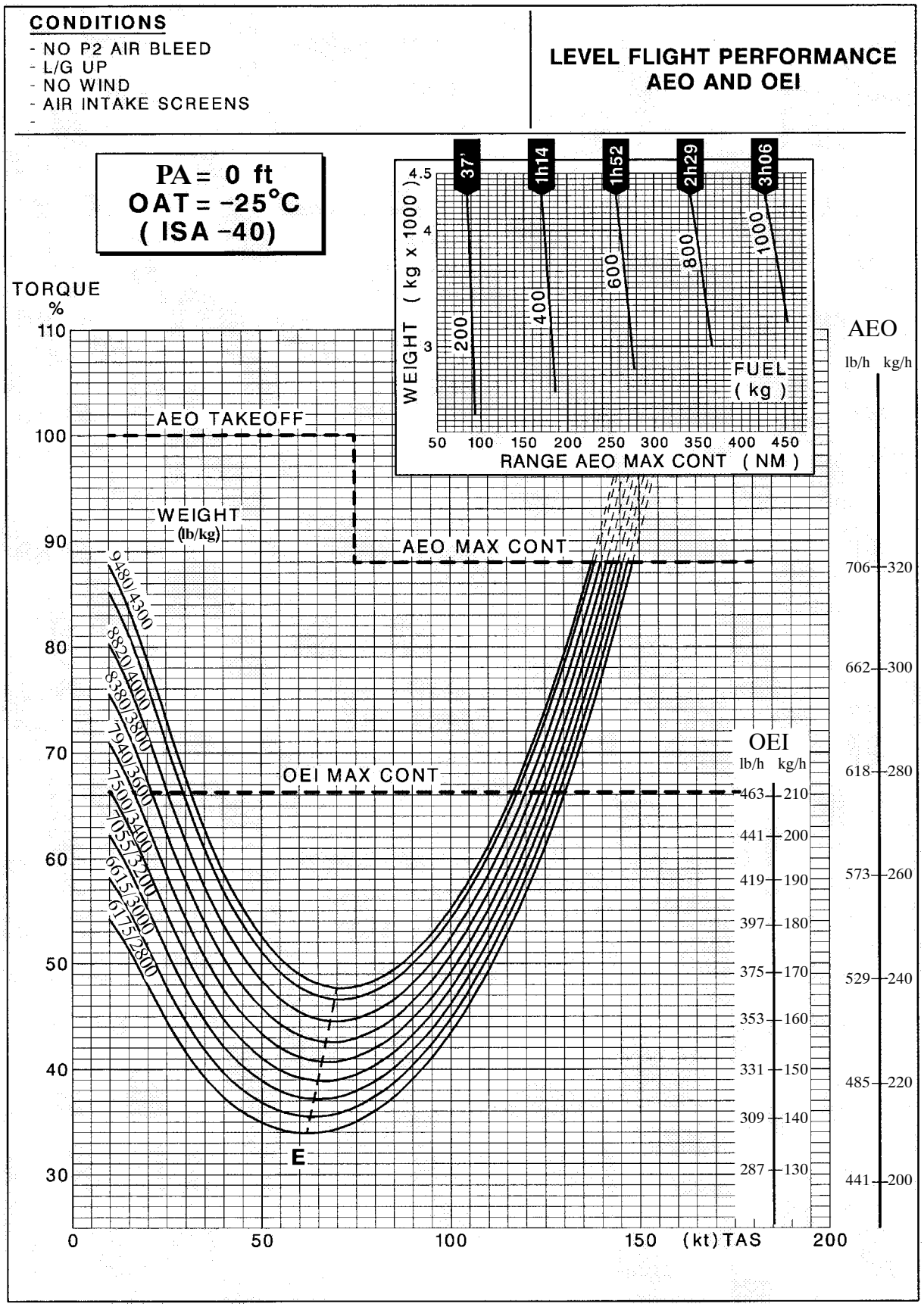



*Figure A-10. Level Flight Performance AEO and OEI (sheet 1 of 17)*

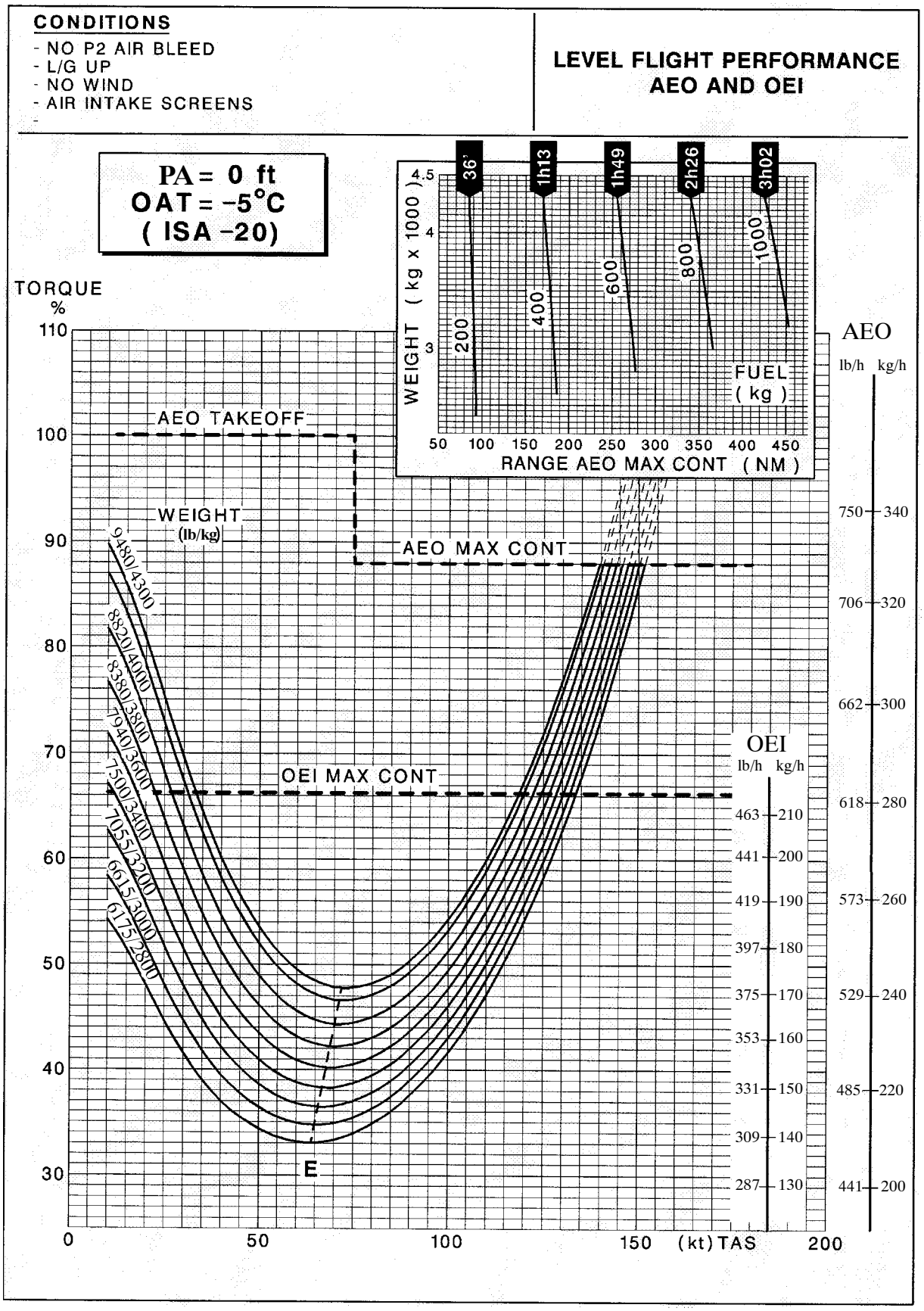



*Figure A-10. Level Flight Performance AEO and OEI (sheet 2 of 17)*

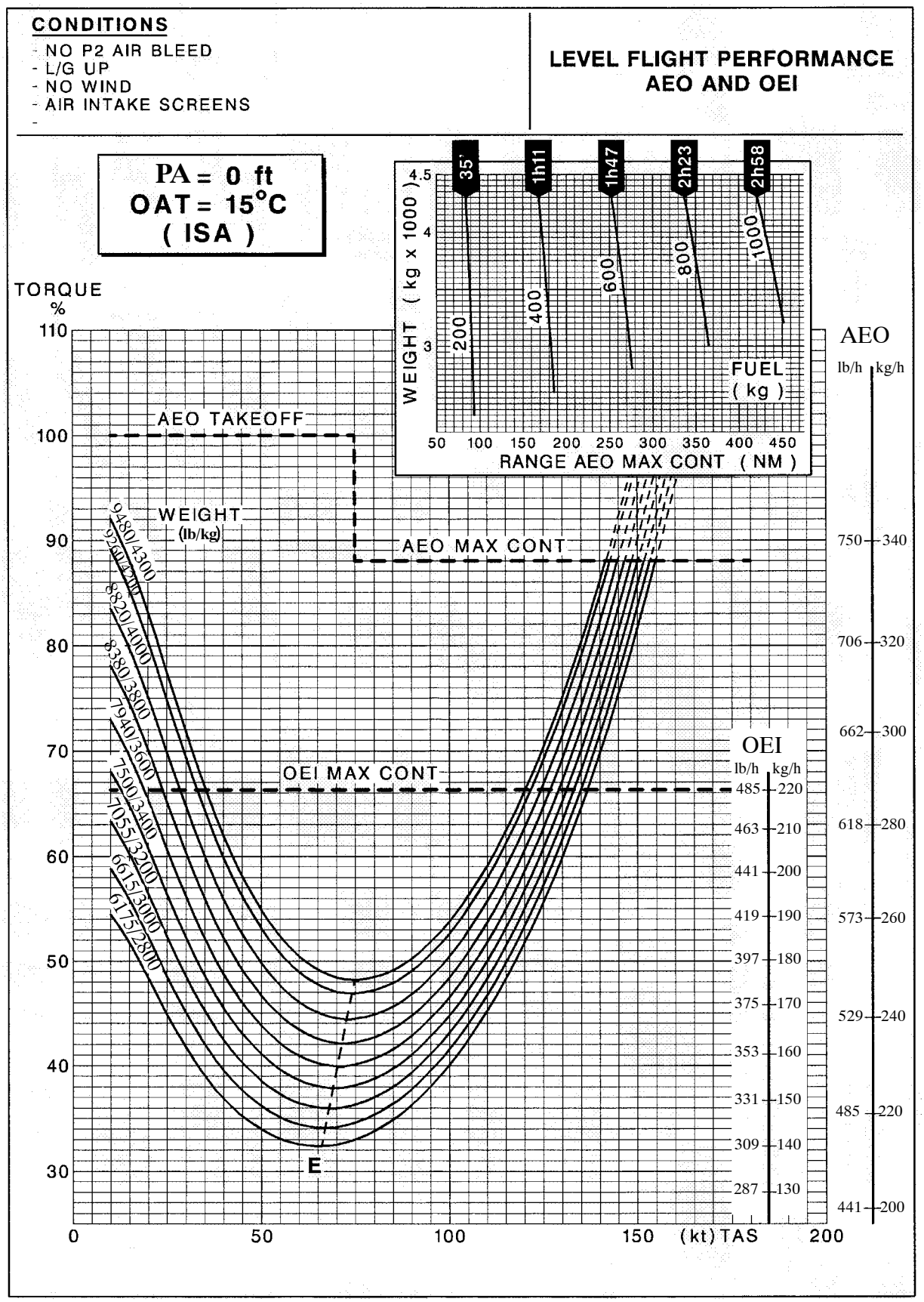



*Figure A-10. Level Flight Performance AEO and OEI (sheet 3 of 17)*

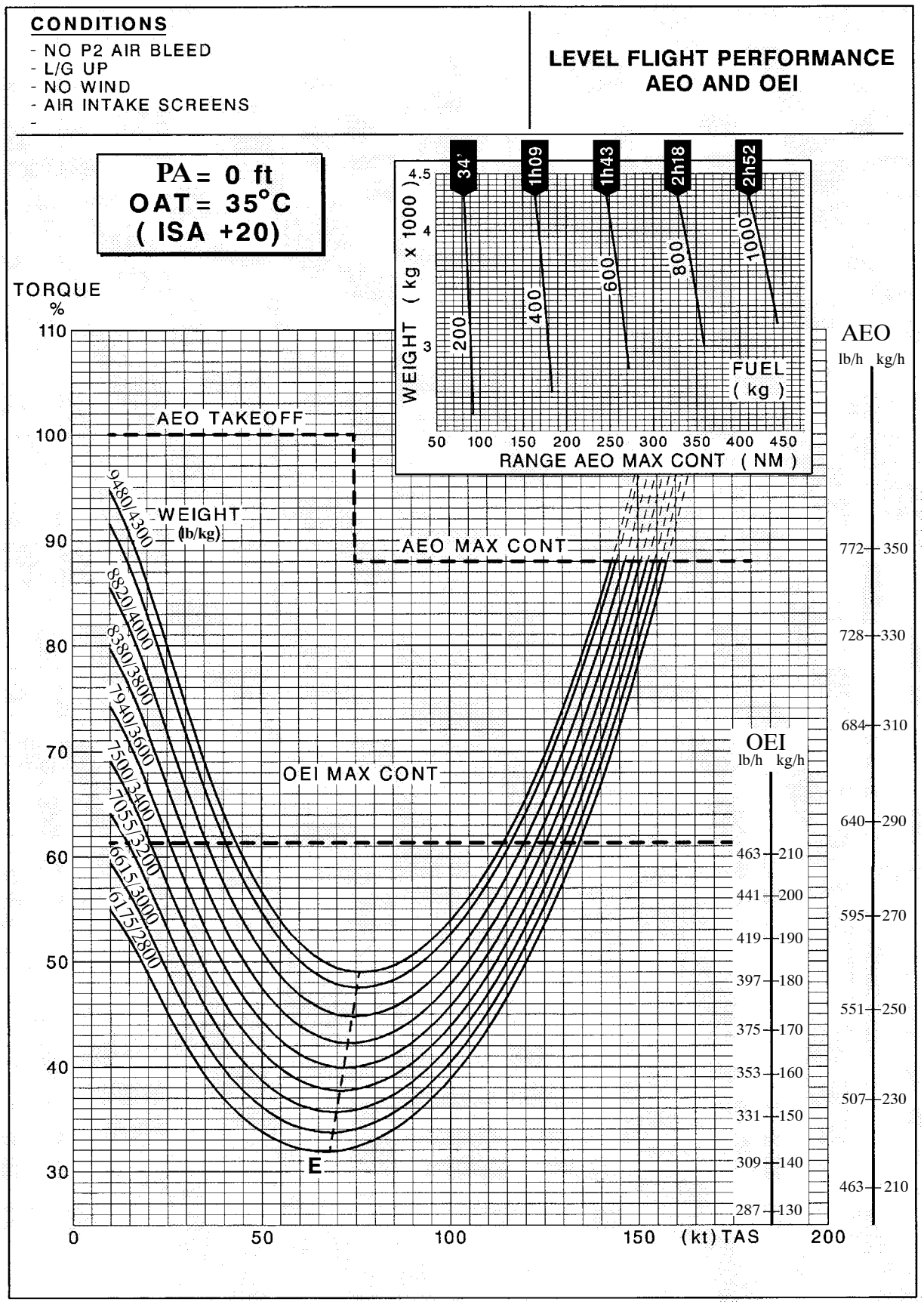



*Figure A-10. Level Flight Performance AEO and OEI (sheet 4 of 17)*

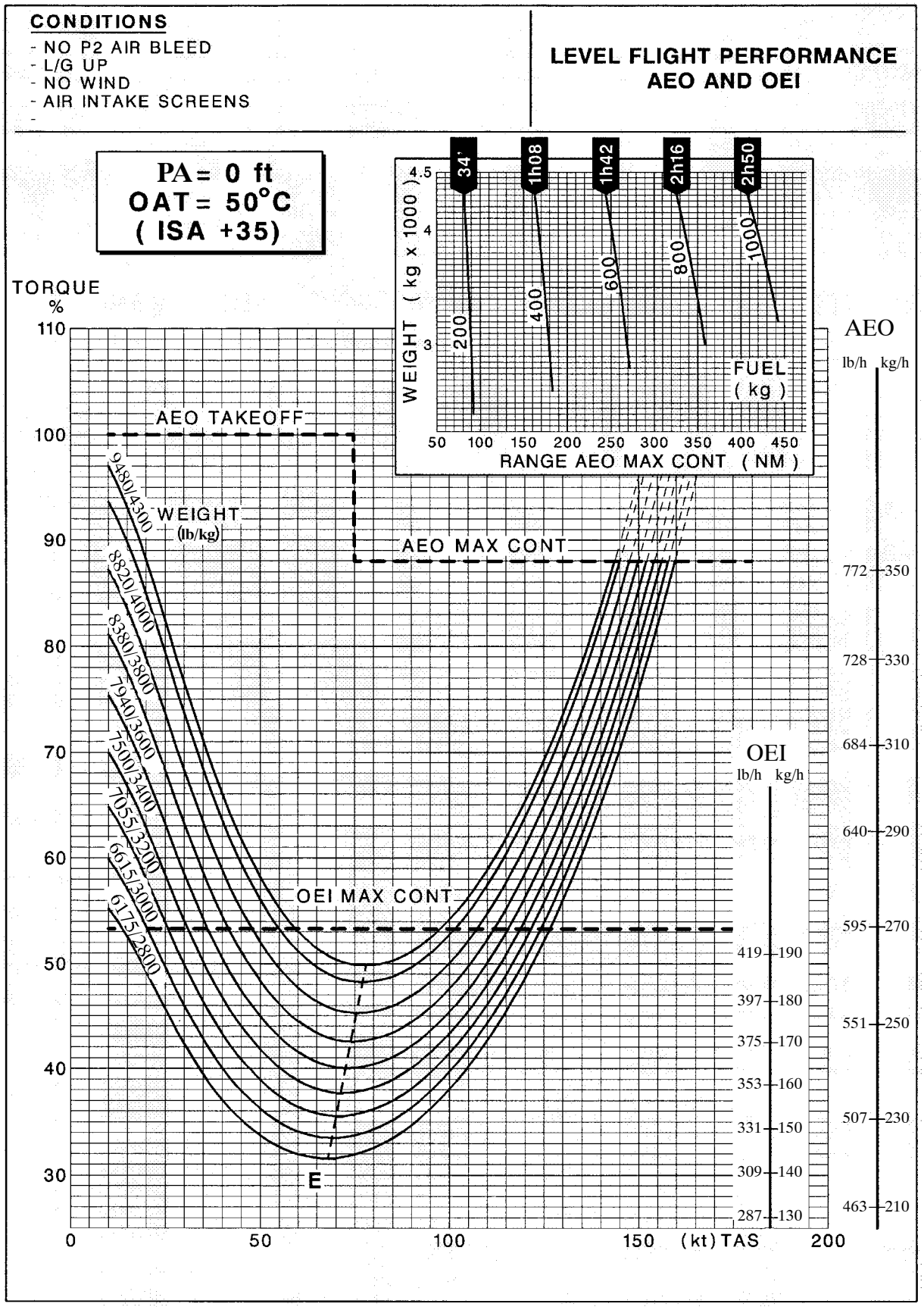



*Figure A-10. Level Flight Performance AEO and OEI (sheet 5 of 17)*

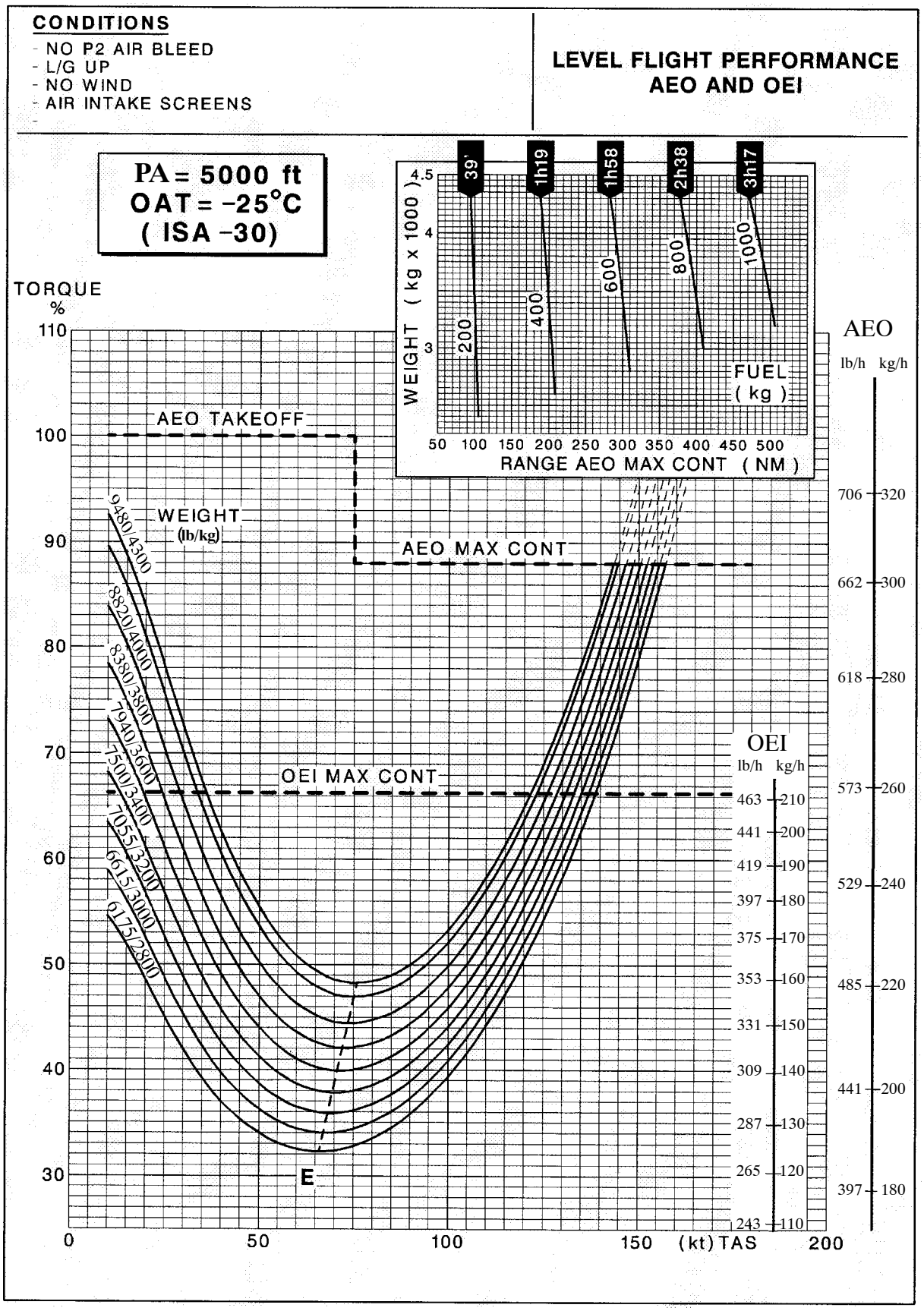



*Figure A-10. Level Flight Performance AEO and OEI (sheet 6 of 17)*

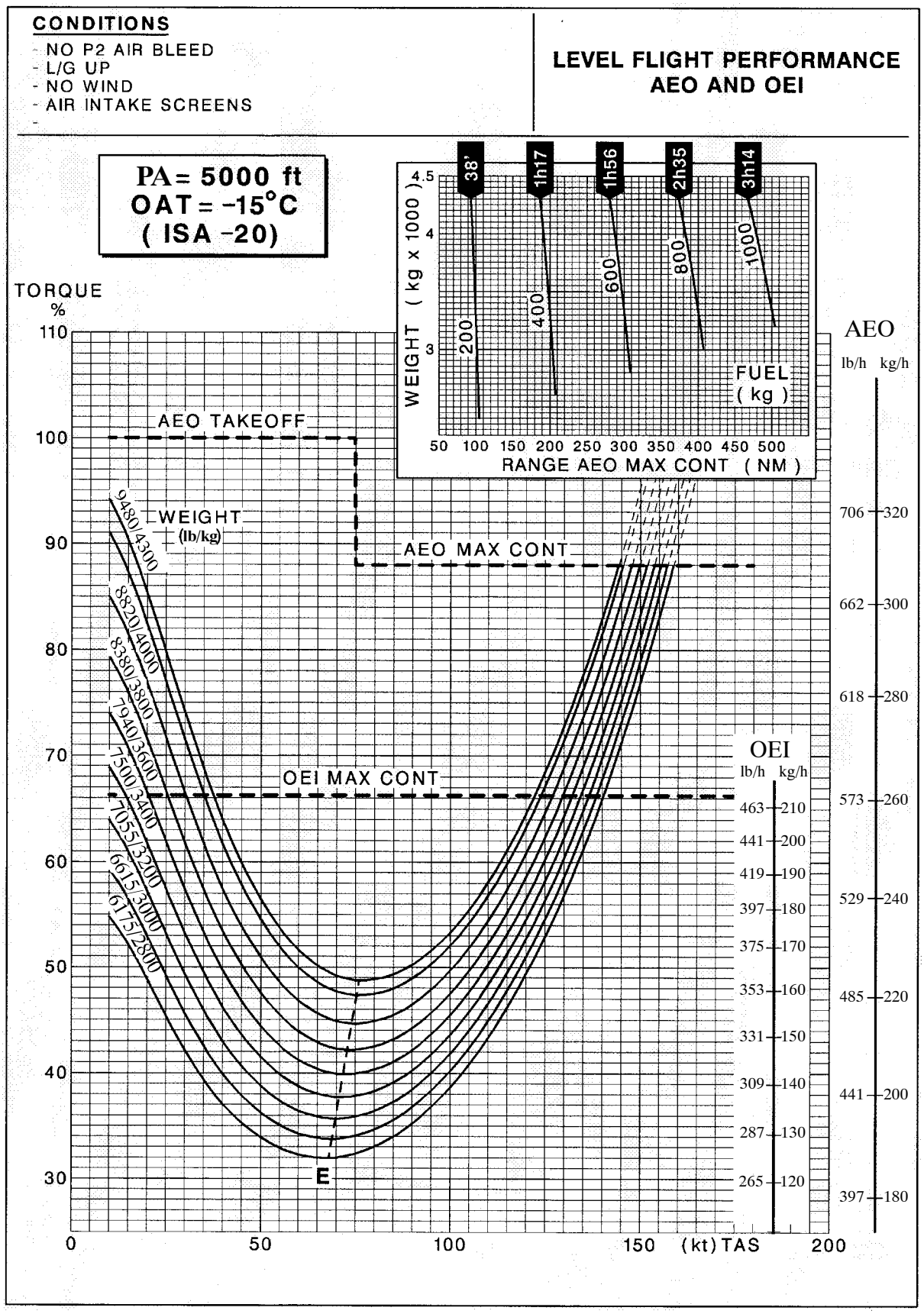



*Figure A-10. Level Flight Performance AEO and OEI (sheet 7 of 17)*

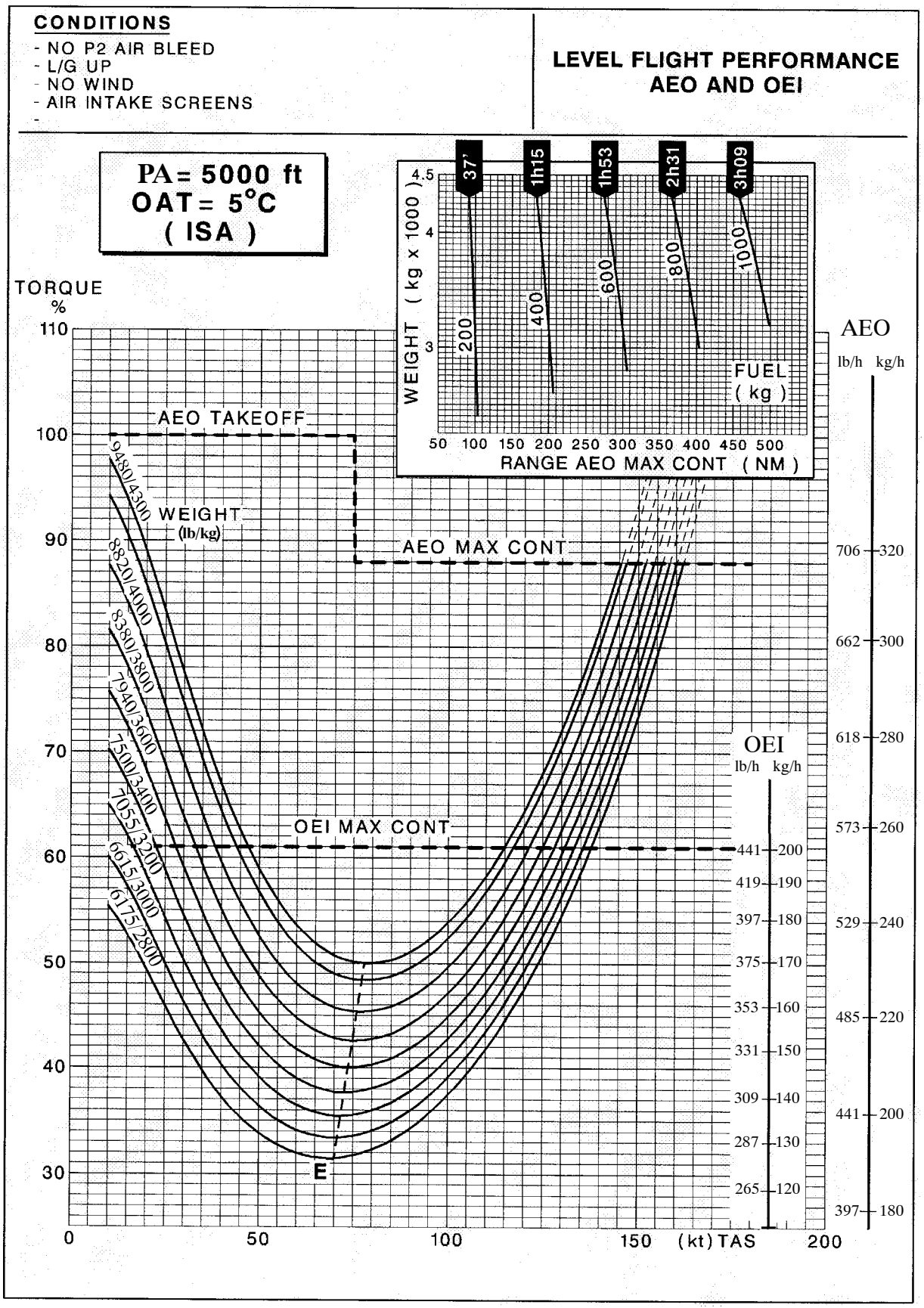



*Figure A-10. Level Flight Performance AEO and OEI (sheet 8 of 17)*

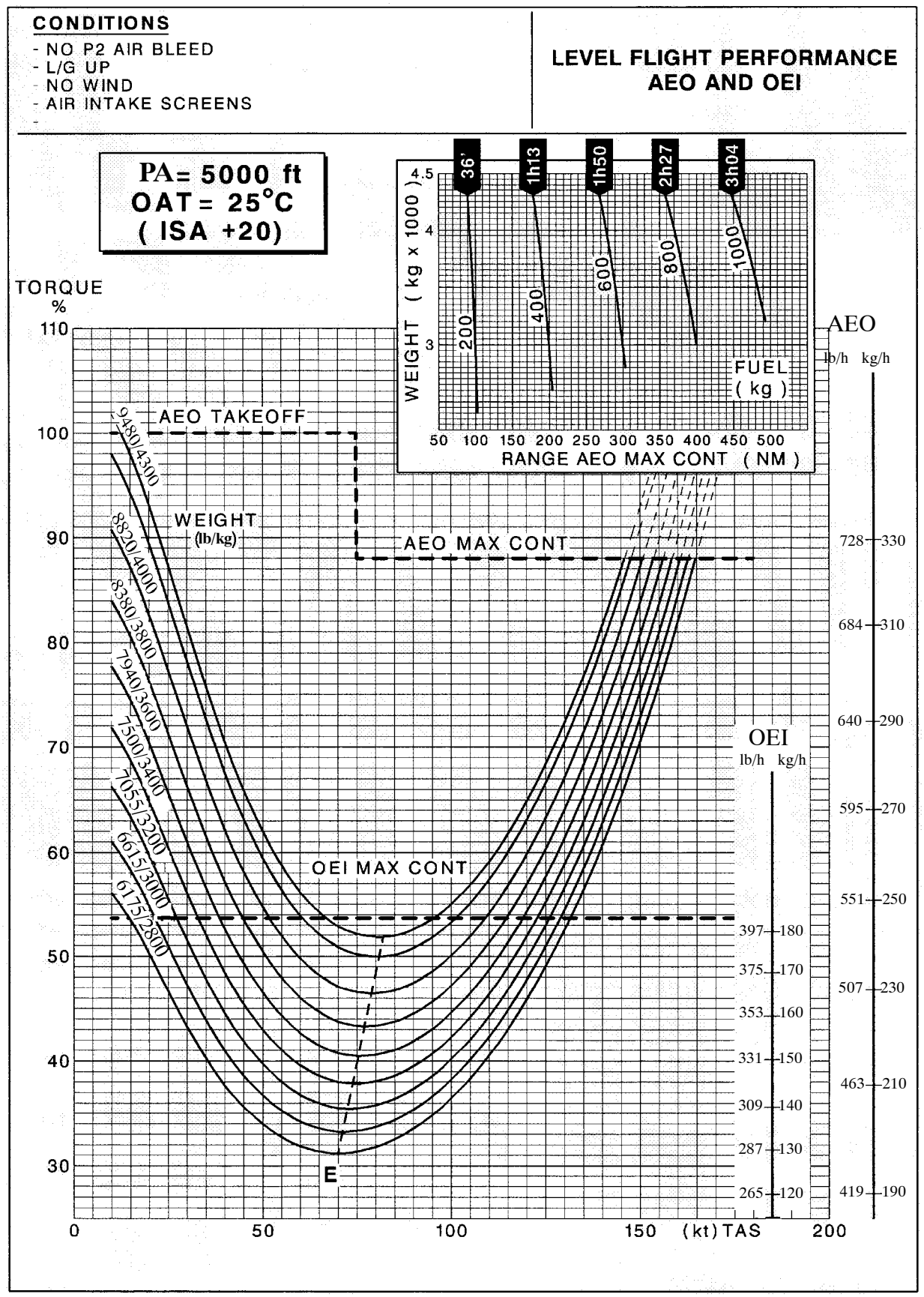



*Figure A-10. Level Flight Performance AEO and OEI (sheet 9 of 17)*

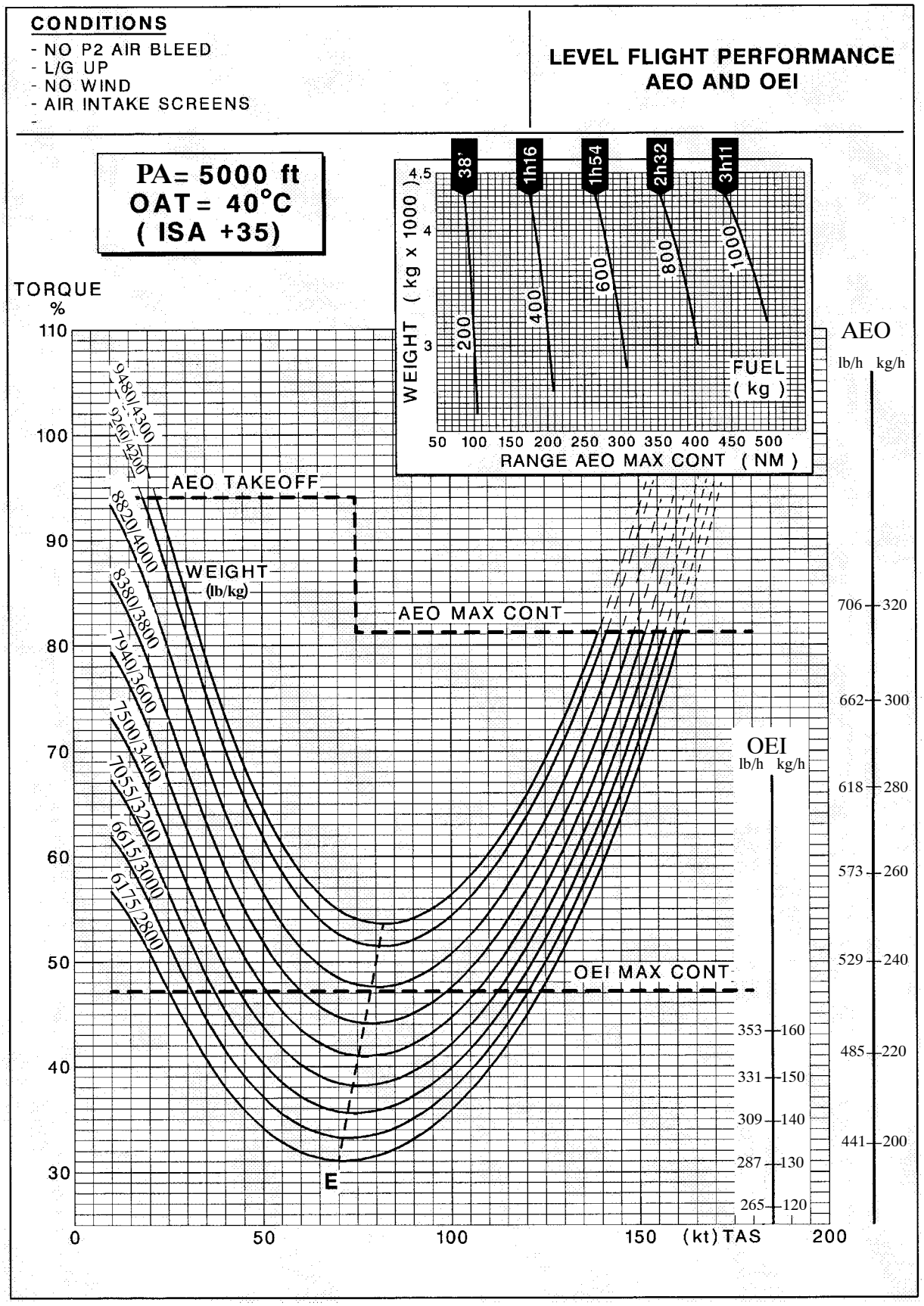



*Figure A-10. Level Flight Performance AEO and OEI (sheet 10 of 17)*

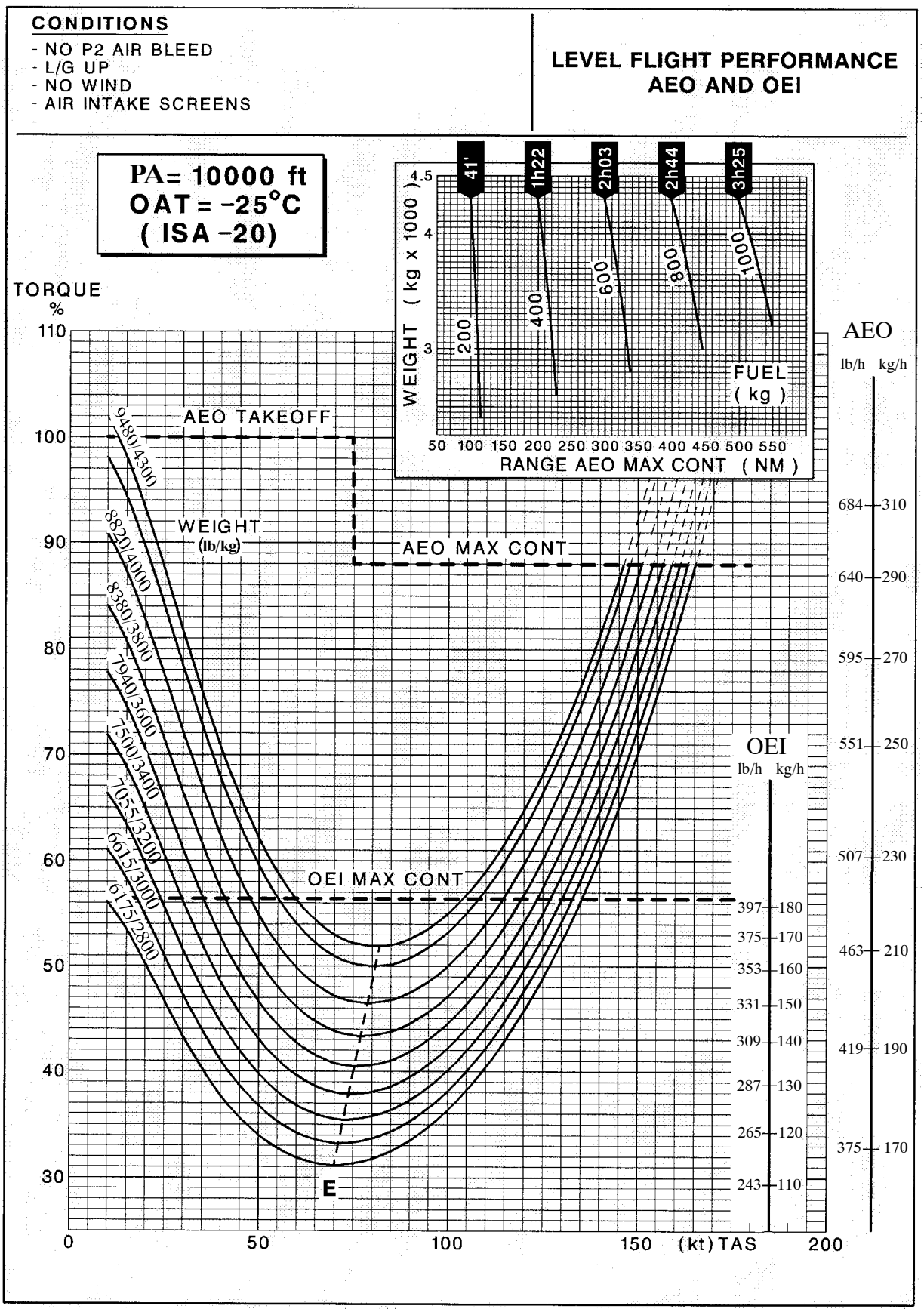



*Figure A-10. Level Flight Performance AEO and OEI (sheet 11 of 17)*

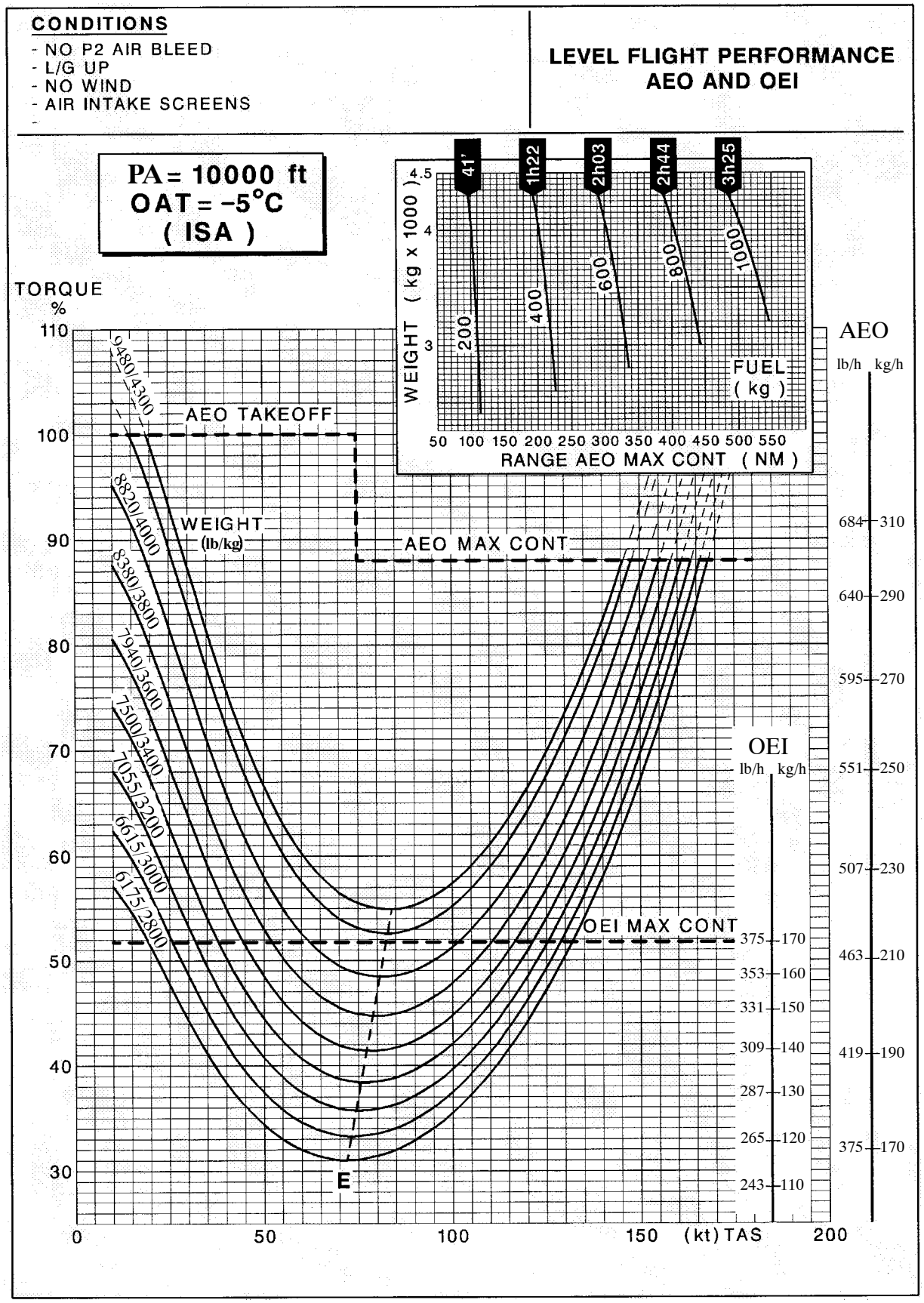



*Figure A-10. Level Flight Performance AEO and OEI (sheet 12 of 17)*

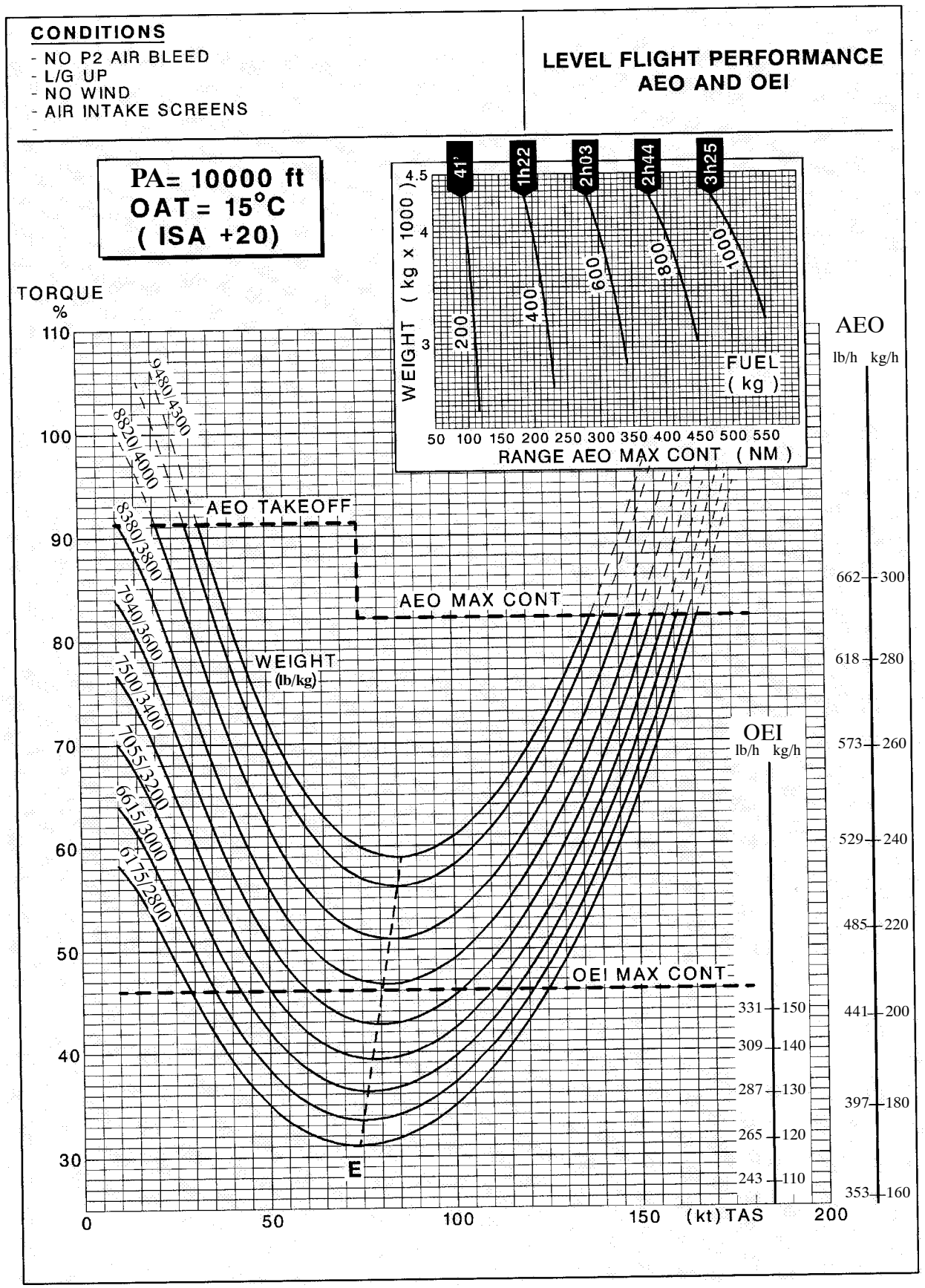



*Figure A-10. Level Flight Performance AEO and OEI (sheet 13 of 17)*

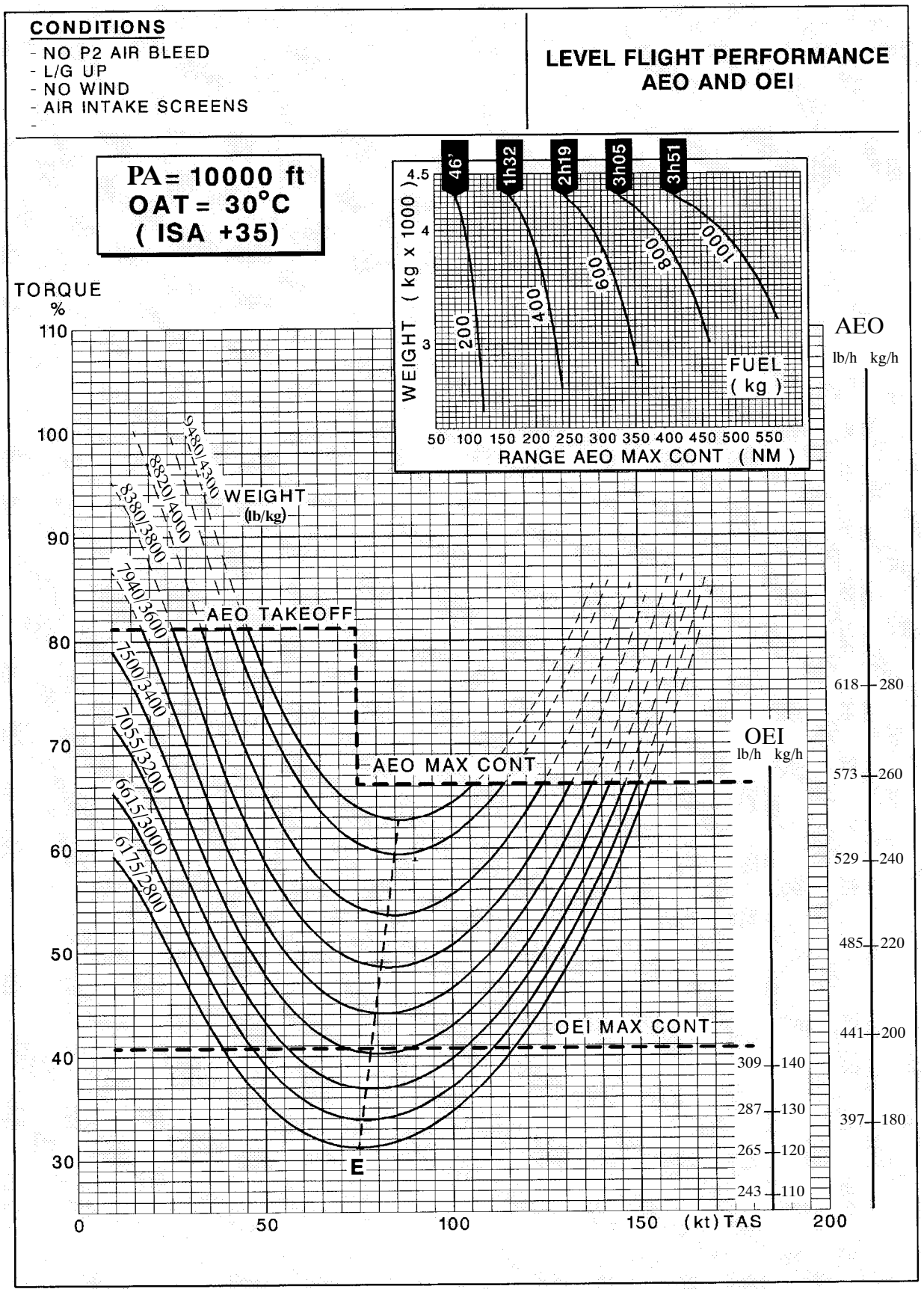



*Figure A-10. Level Flight Performance AEO and OEI (sheet 14 of 17)*

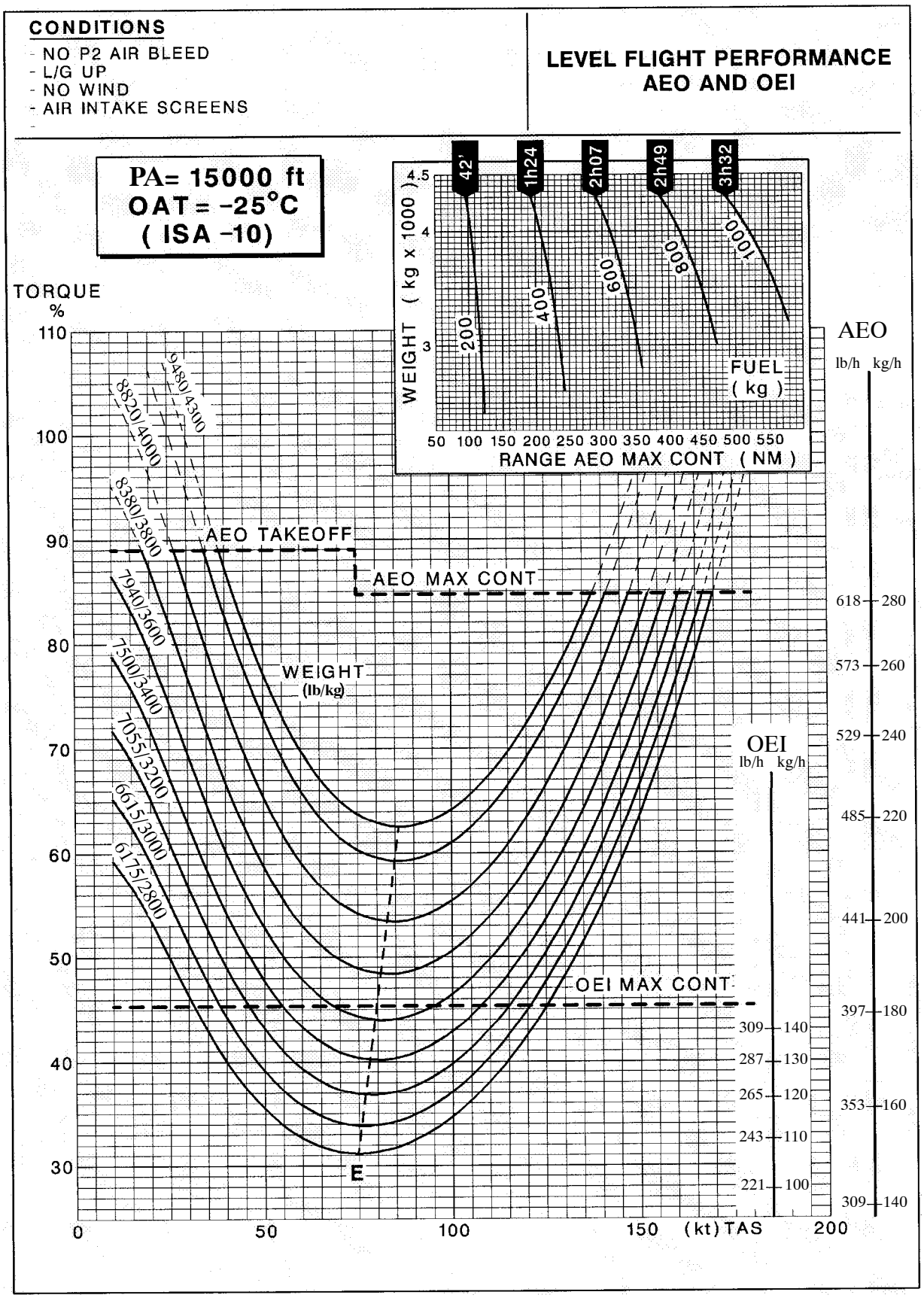



*Figure A-10. Level Flight Performance AEO and OEI (sheet 15 of 17)*

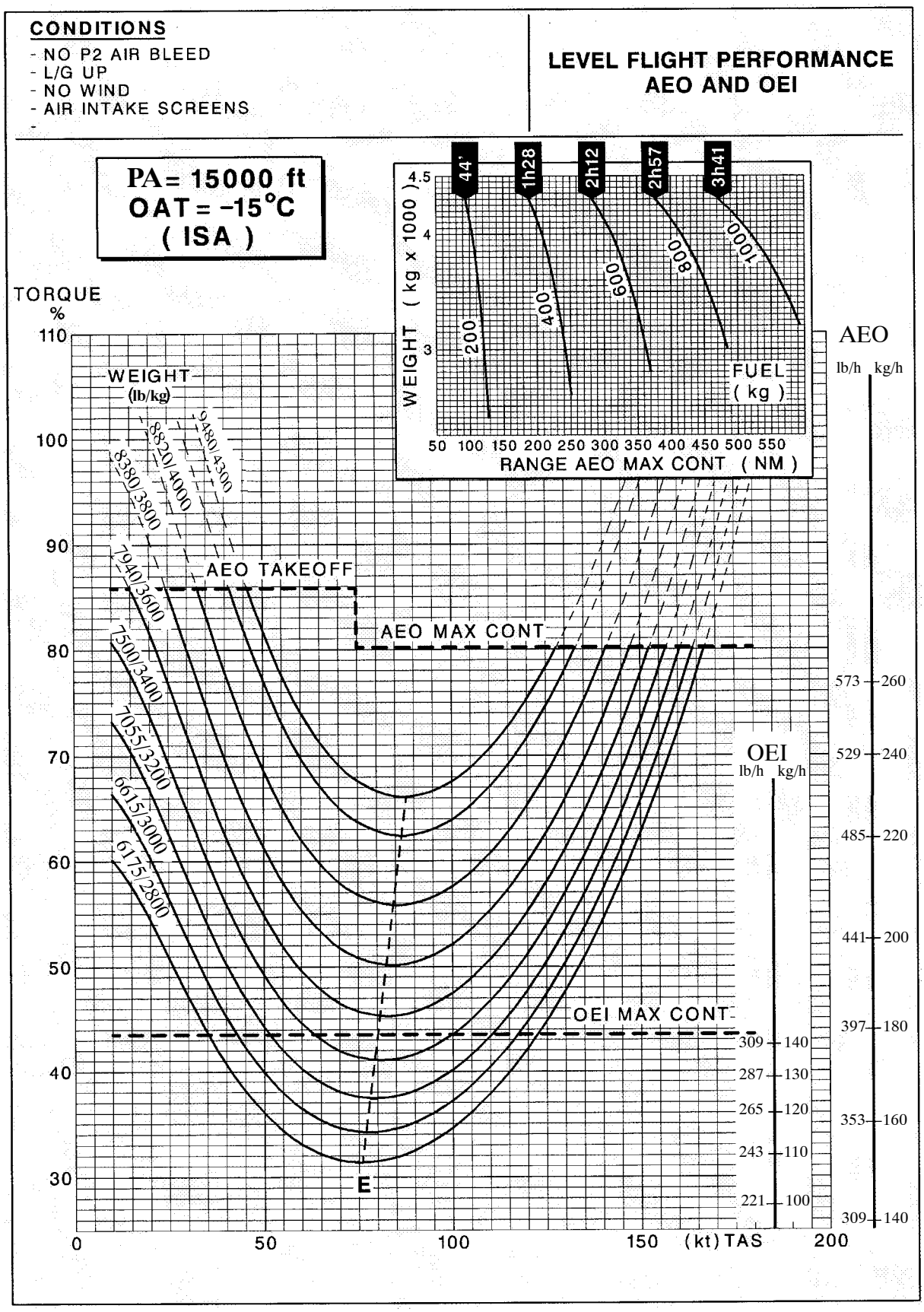



*Figure A-10. Level Flight Performance AEO and OEI (sheet 16 of 17)*

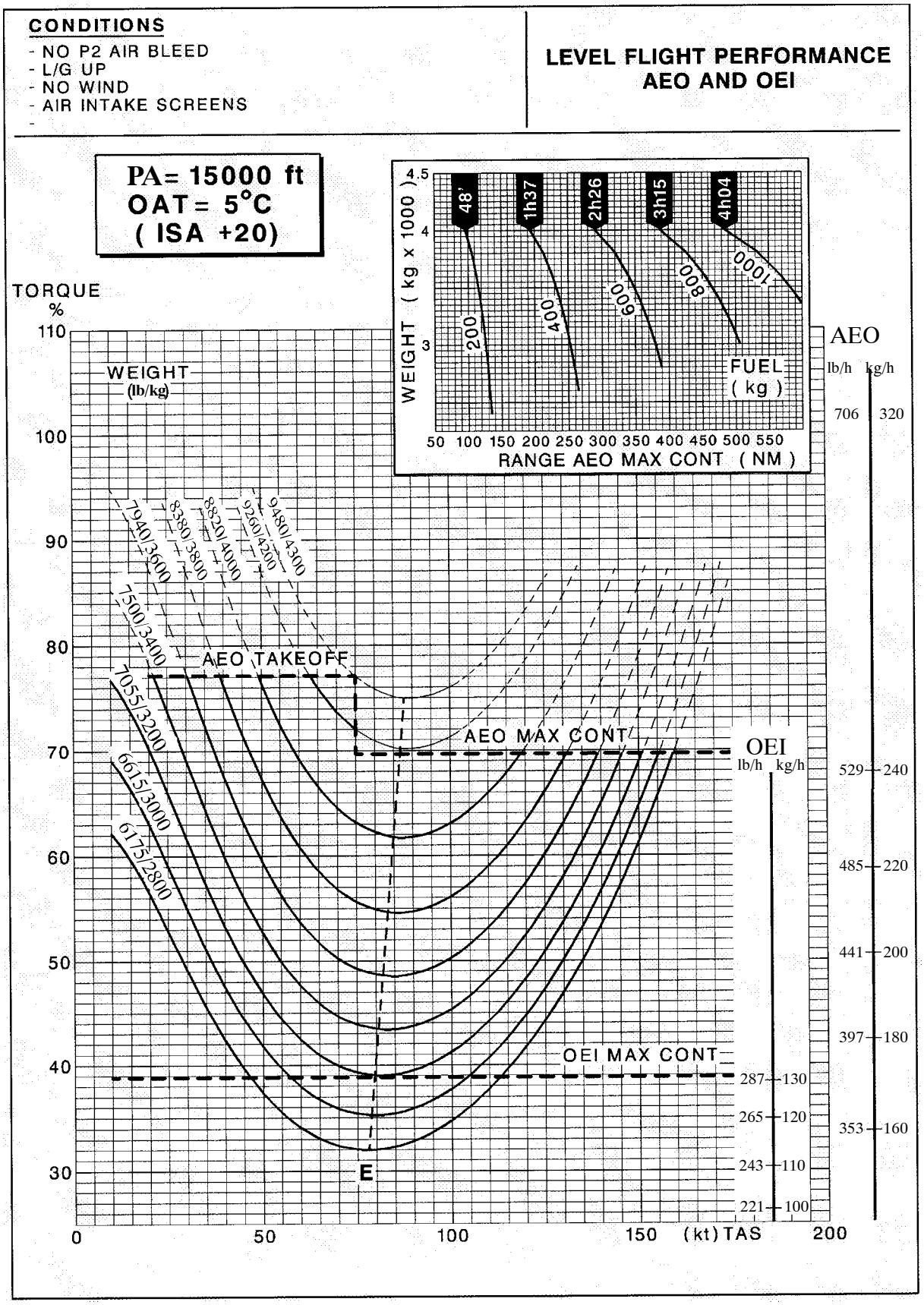



*Figure A-10. Level Flight Performance AEO and OEI (sheet 17 of 17)*

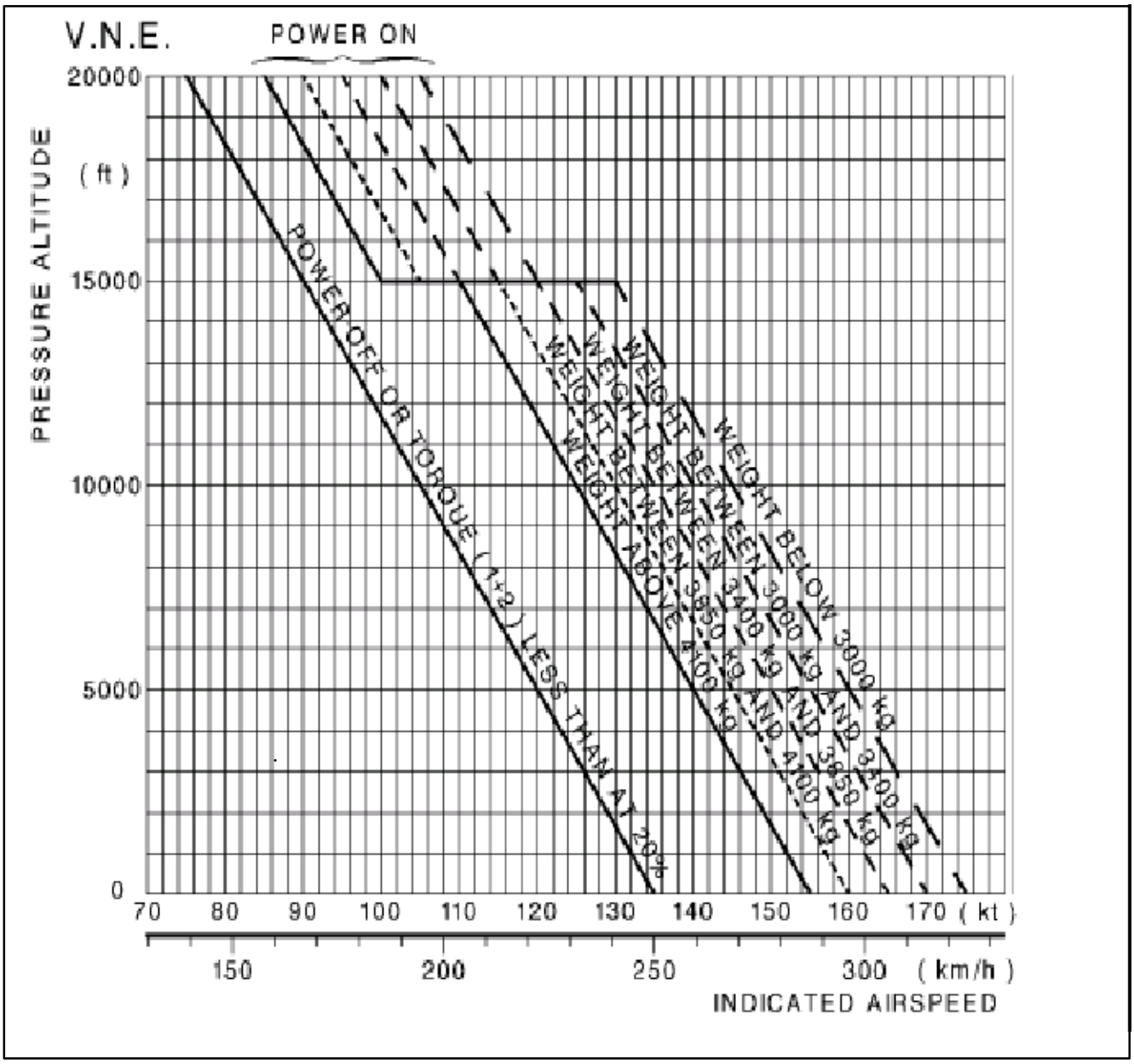



*Figure A-11. VNE*

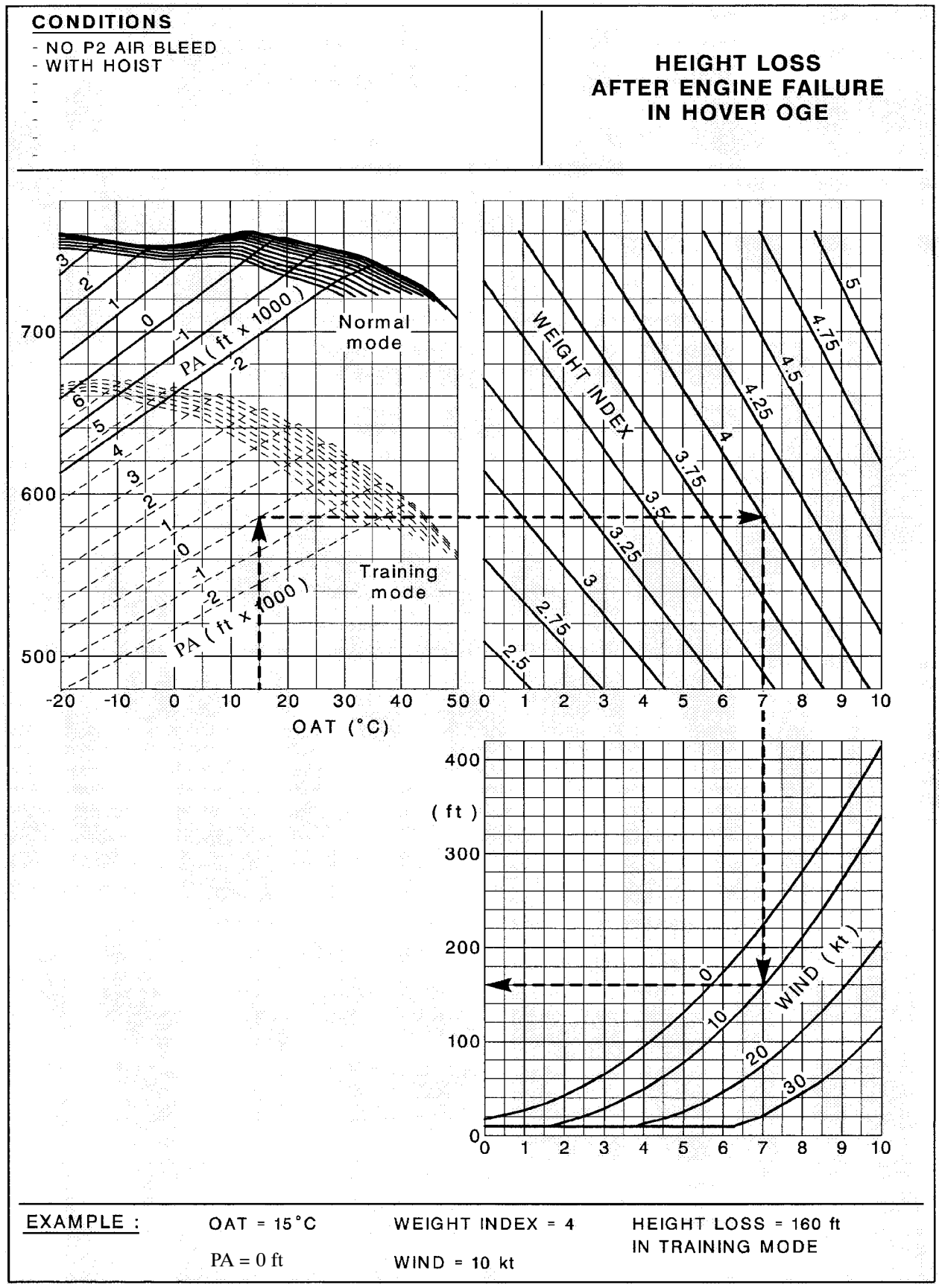



*Figure A-12. Height Loss After Engine Failures In Hover OGE*

## HEIGHT/VELOCITY DIAGRAM

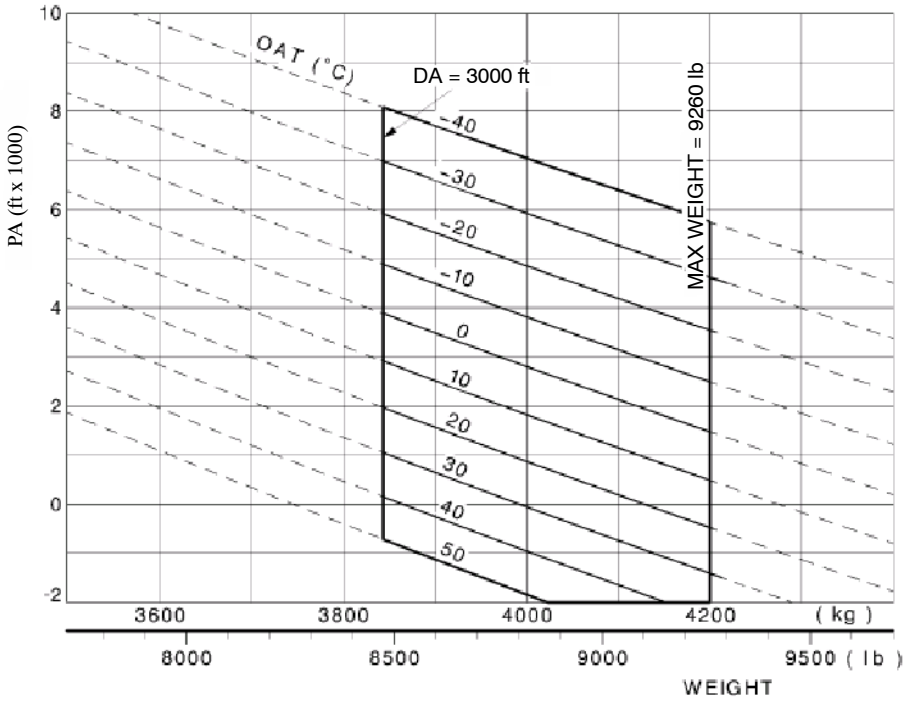
**CAUTION**

**USE OF NR HI IS MANDATORY (NR SWITCH TO "HI")**
**IN HOVERING FLIGHT AT A HEIGHT ≥ 10 FEET**

- For DA ≤ to 3000 ft

  If aircraft weight < the weight computed below (limited to 4200 kg (9260 lbs), there is no Height/Velocity Diagram.

  If aircraft weight > the weight given below, refer to the Height/Velocity Diagram.




Maximum weight without H/V diagram for DA ≤ to 3000 ft and limited to 9260 lbs (4200 kg)

*Figure A-13. Height/Velocity Diagram (sheet 1 of 3)*

- For DA > to 3000 ft

  If aircraft weight ≤ weight given below there is no Height/Velocity Diagram.

  If aircraft weight > weight given below, refer to the Height/Velocity Diagram.

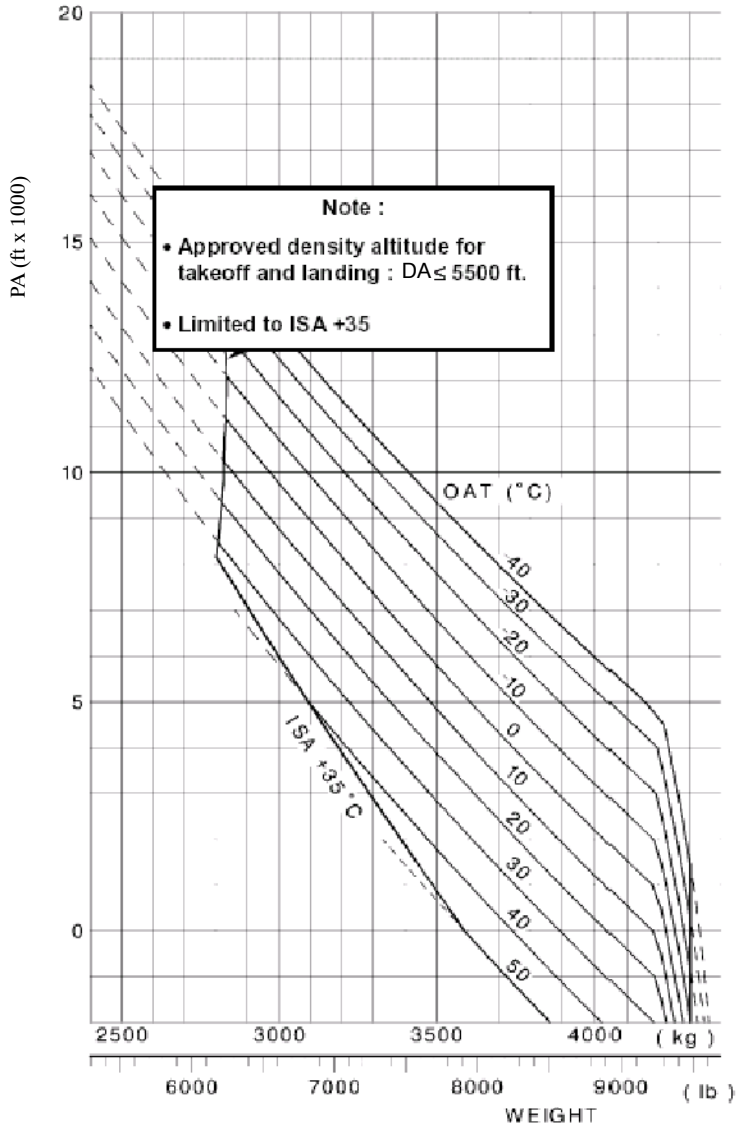
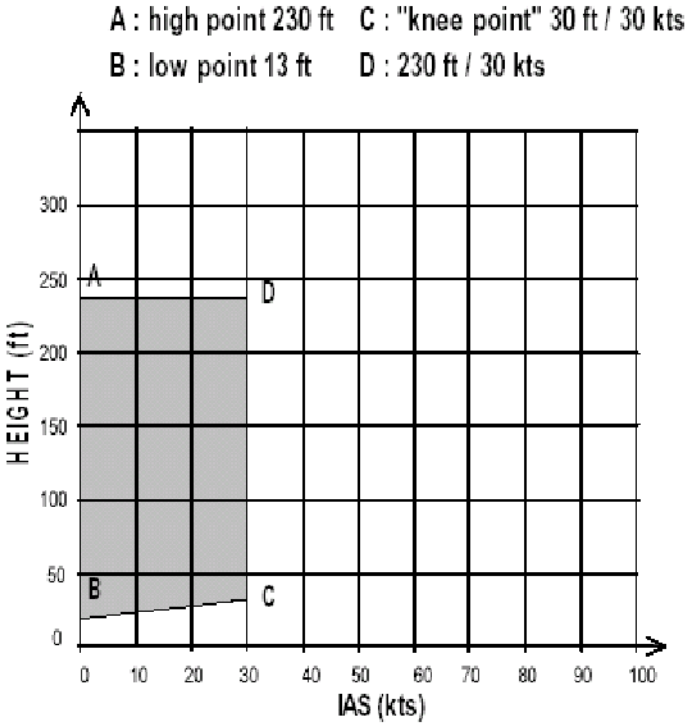



*Figure A-13. Height/Velocity Diagram (sheet 2 of 3)*




Height/Velocity Diagram

*Figure A-13. Height/Velocity Diagram (sheet 3 of 3)*

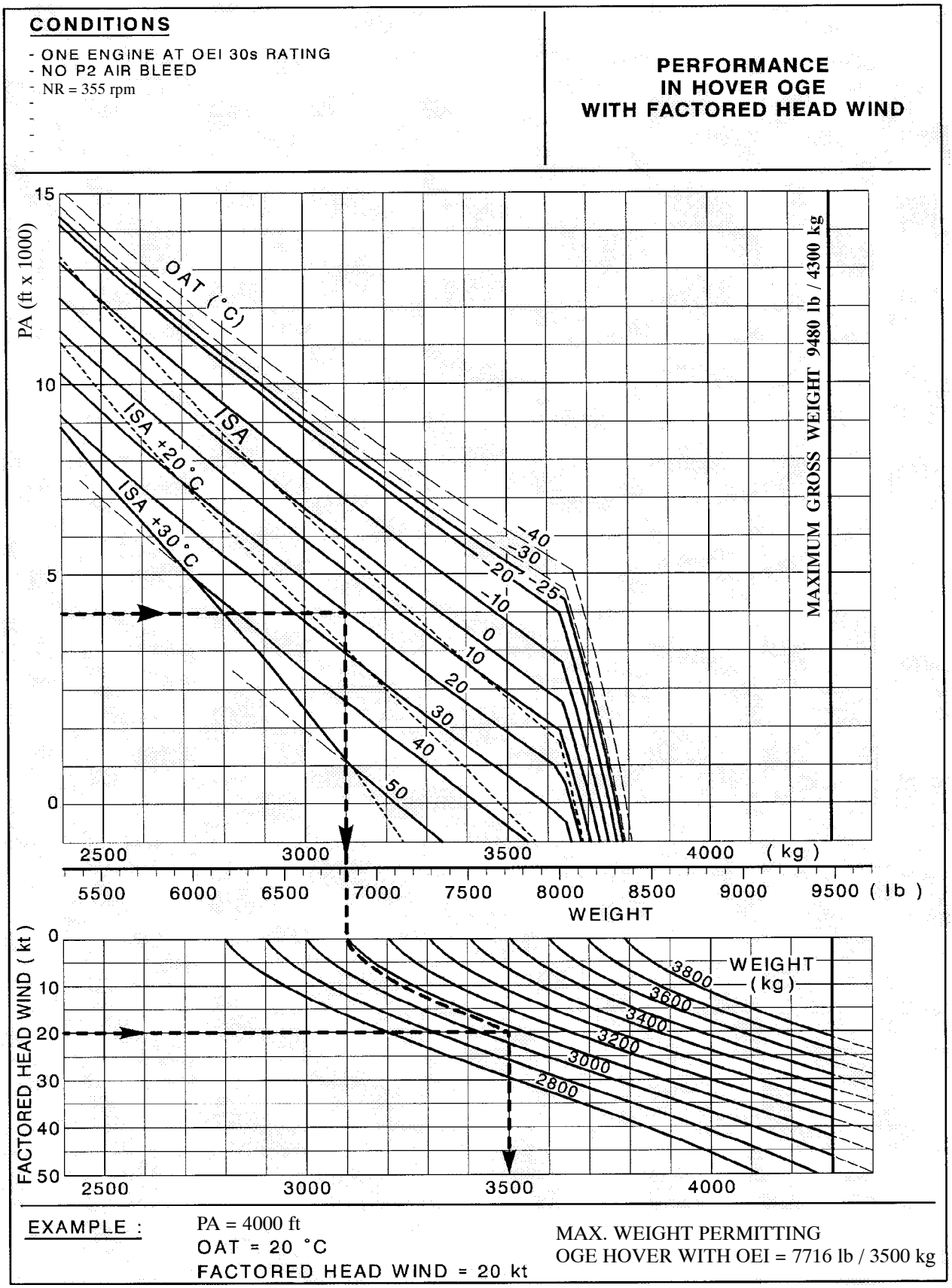



*Figure A-14. Peformance in Hover OGE with One Engine at 30s OEI Rating with Wind Effect*

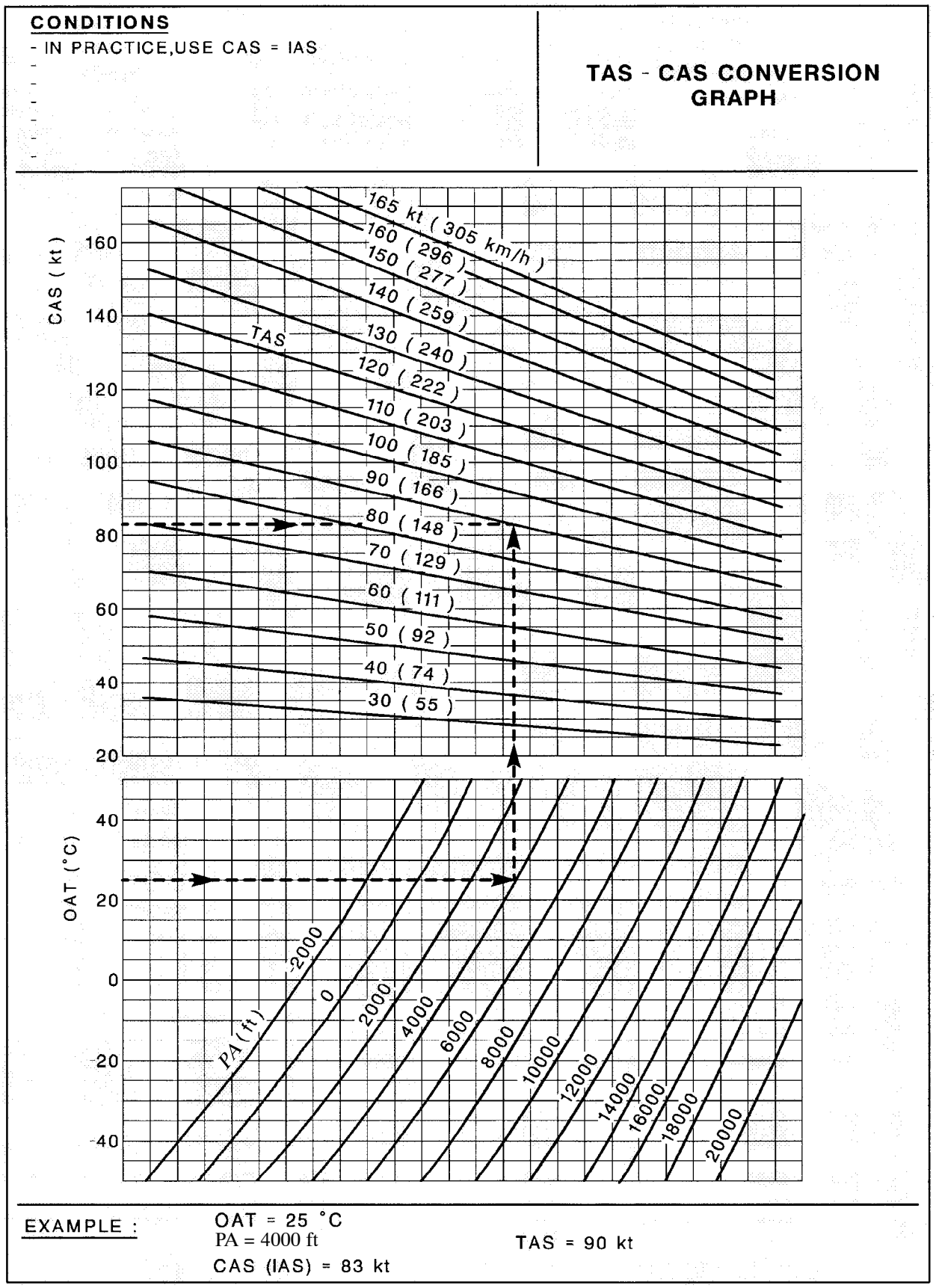



*Figure A-15. TAS-CAS Correspondence Chart*

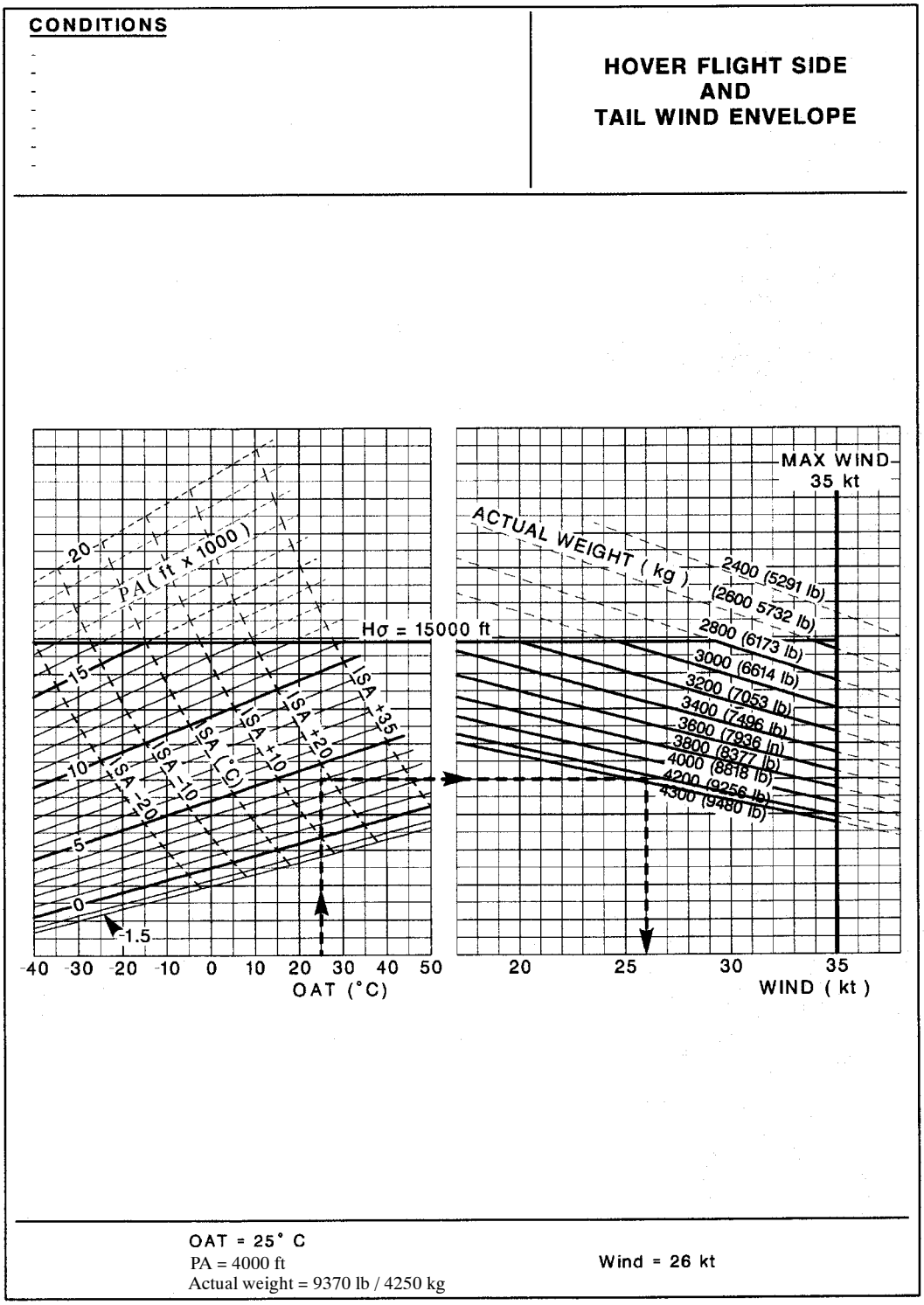



*Figure A-16. Hover Flight Side and Tail Wind Envelope*

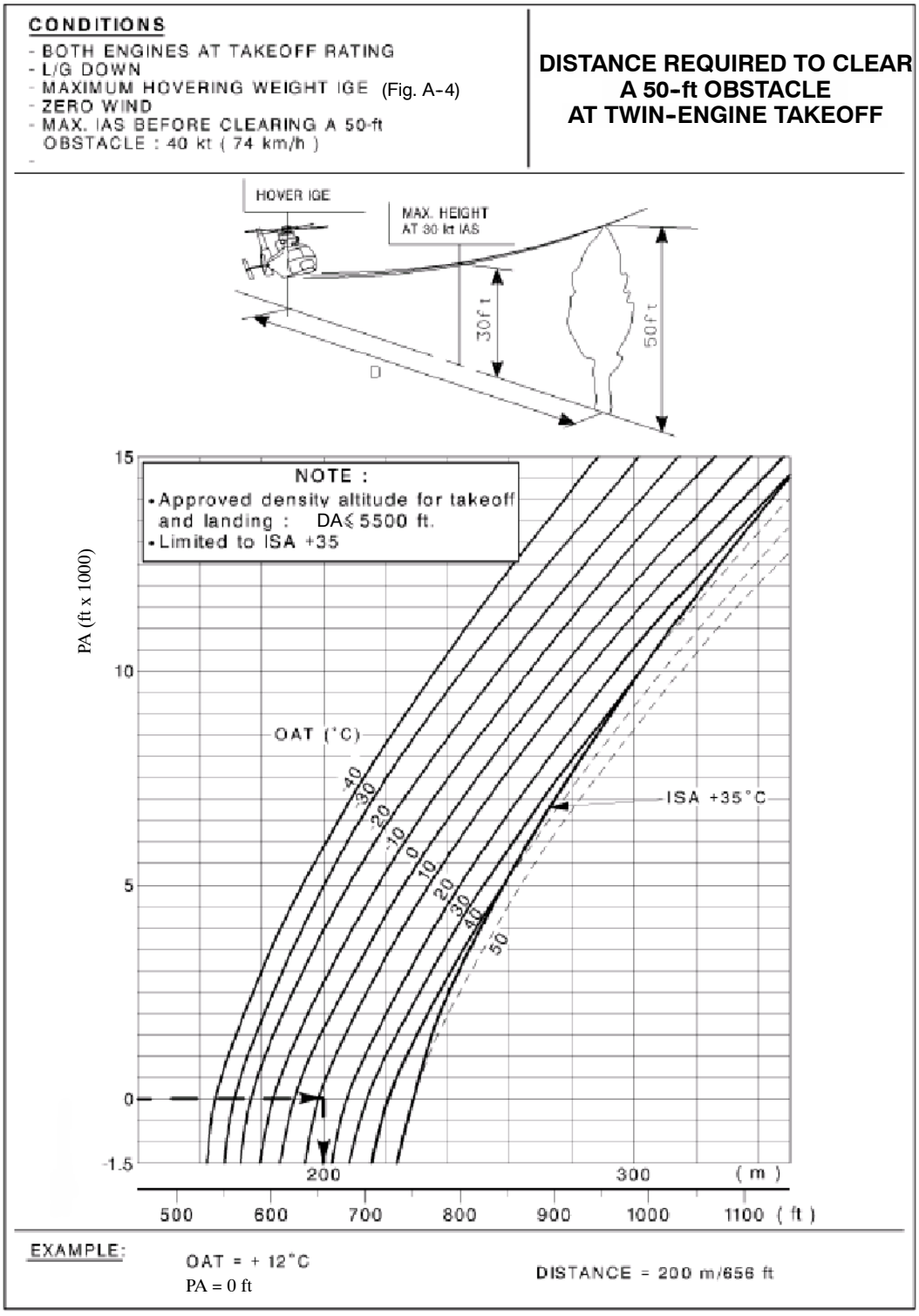



*Figure A-17. Distance Required to Clear a 50-ft Obstacle at Twin-Engine Takeoff*

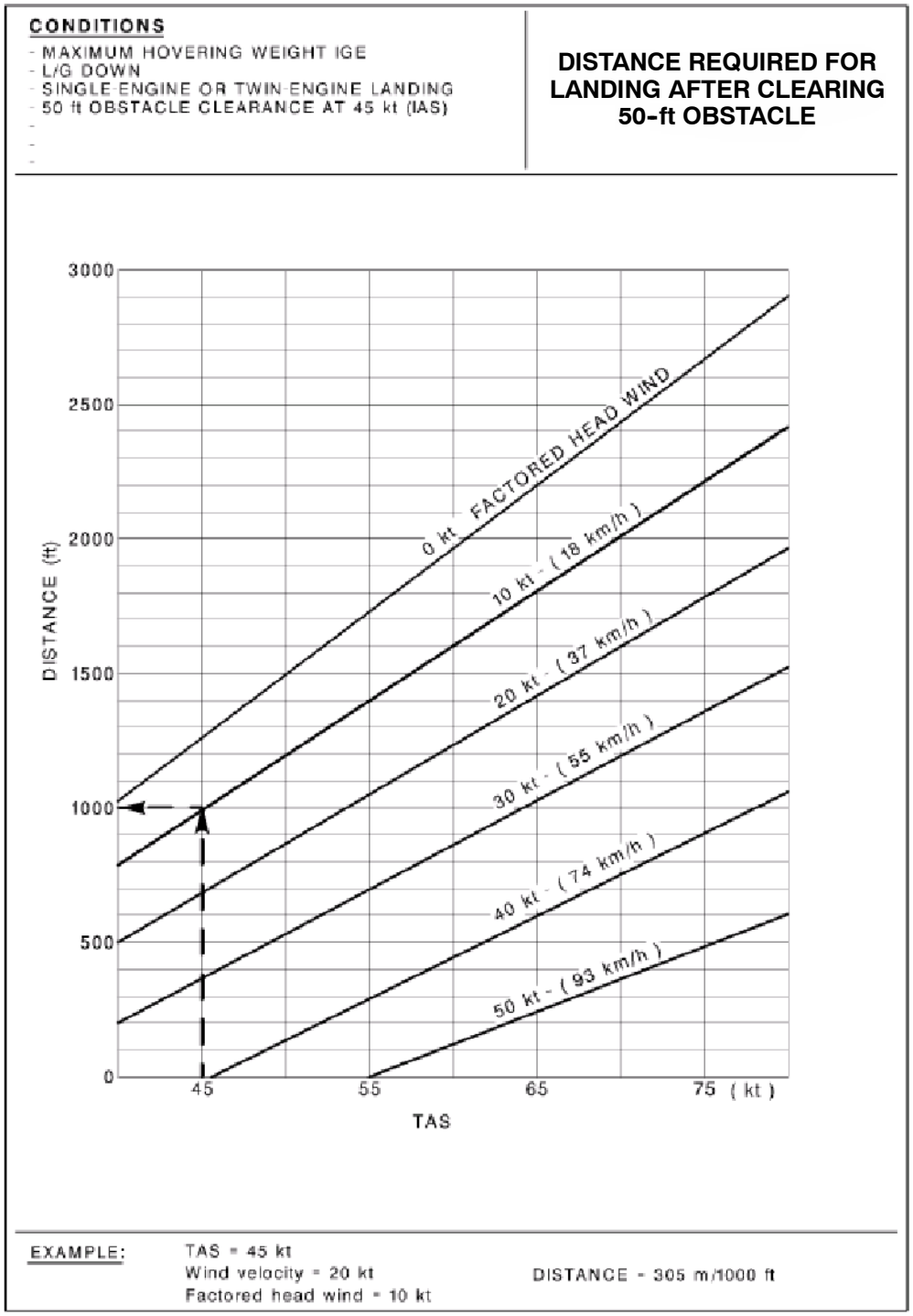



*Figure A-18. Distance Required for Landing After Clearing a 50-ft Obstacle*

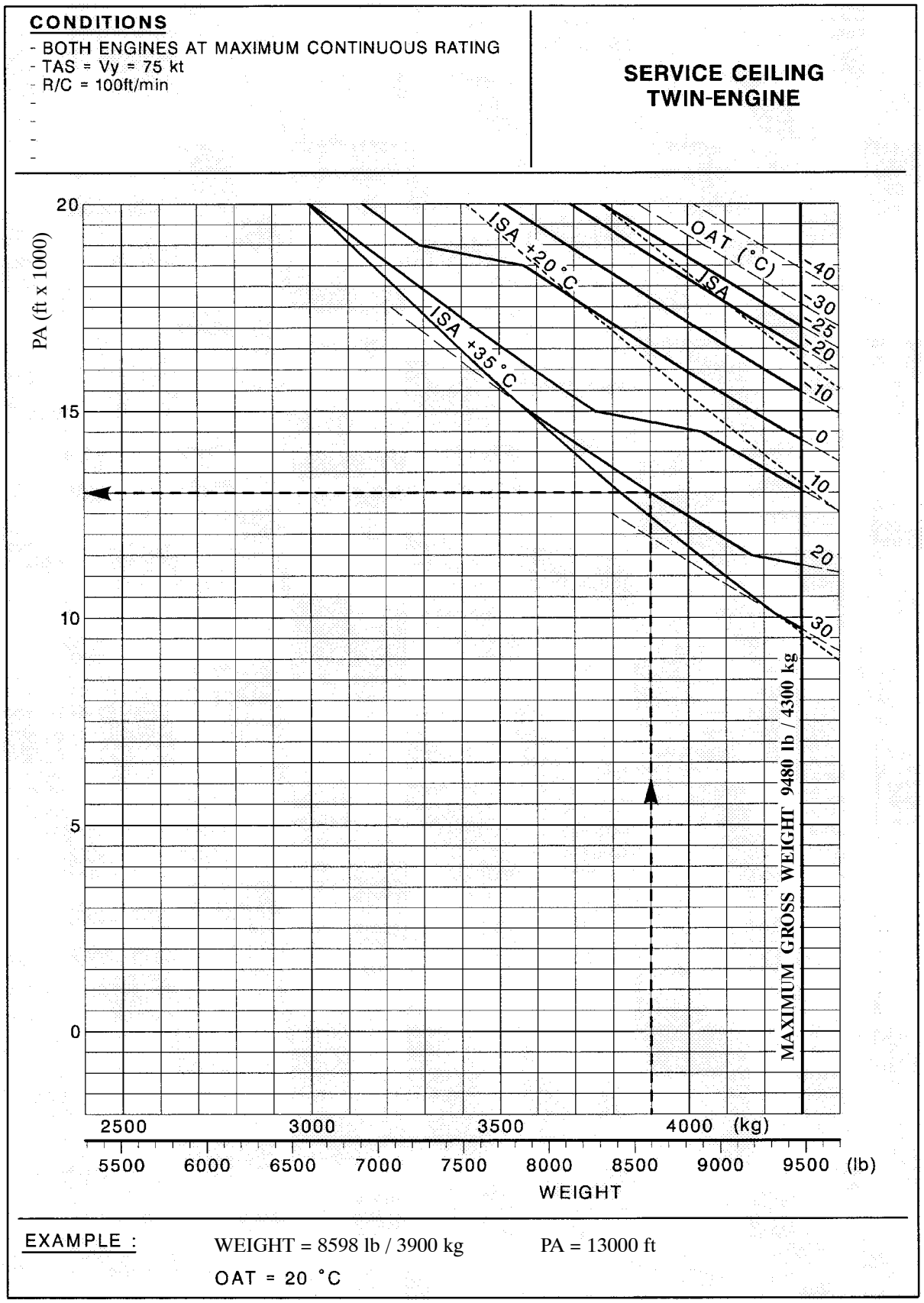
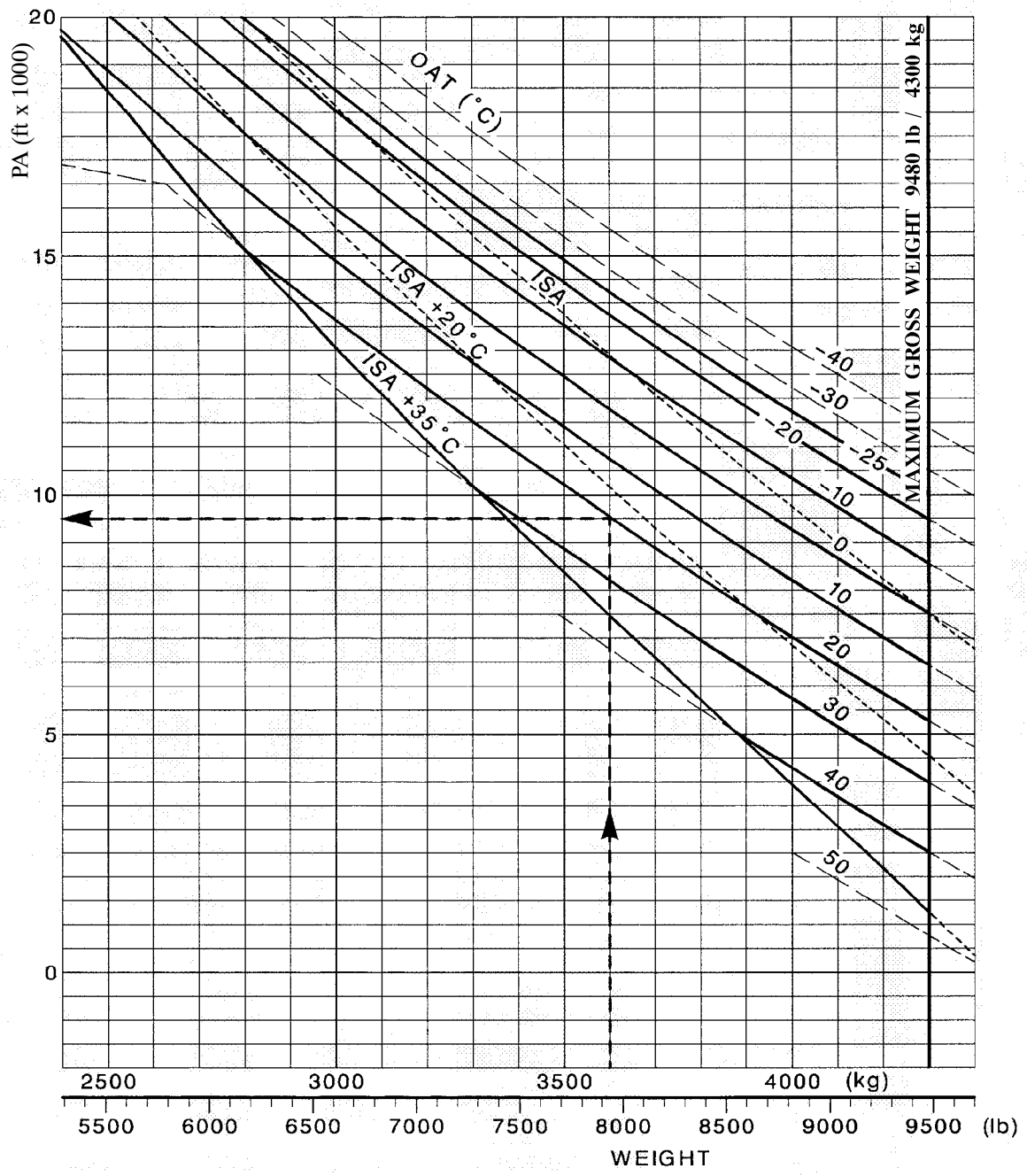



*Figure A-19. Service Ceiling in Forward Flight with Both Engines at MCP Rating*

**CONDITIONS**

- ONE ENGINE AT OEI 2 min RATING
- TAS = Vy = 75 kt
- R/C = 100ft/min
- NR = 355 rpm
-
-
-

**SERVICE CEILING**
**OEI**




**EXAMPLE :** WEIGHT 7936 lb / 3600 kg

OAT = 20 °C

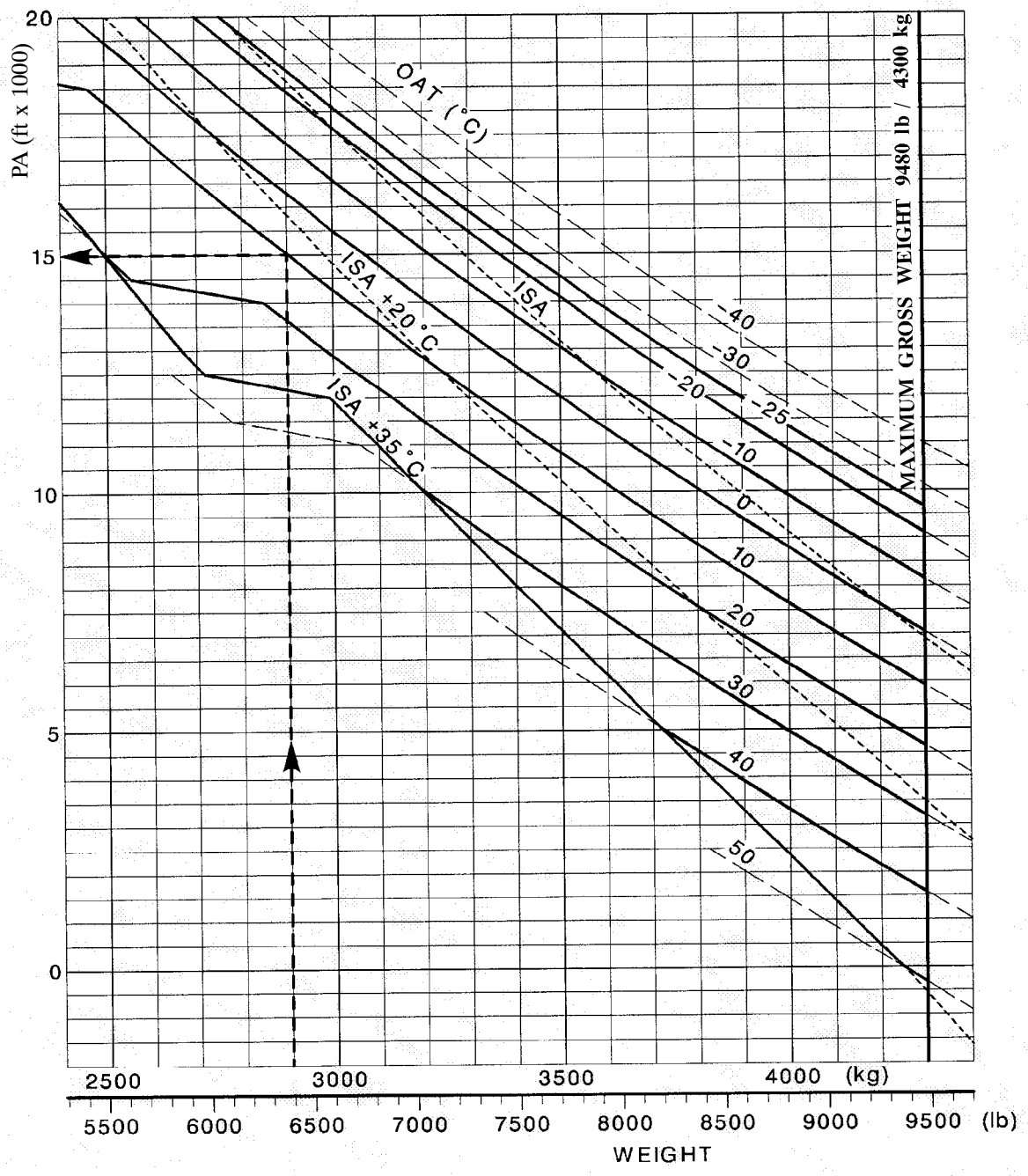
PA = 9500 ft

*Figure A-20. Service Ceiling in Forward Flight with One Engine at 2MN OEI Rating (sheet 1 of 2)*

**CONDITIONS**

- ONE ENGINE AT OEI CONTINUOUS RATING
- TAS = Vy = 75 kt
- R/C = 100ft/min
-
-
-

**SERVICE CEILING**
**OEI**




EXAMPLE : WEIGHT = 6393 lb / 2900 kg

OAT = 10 °C

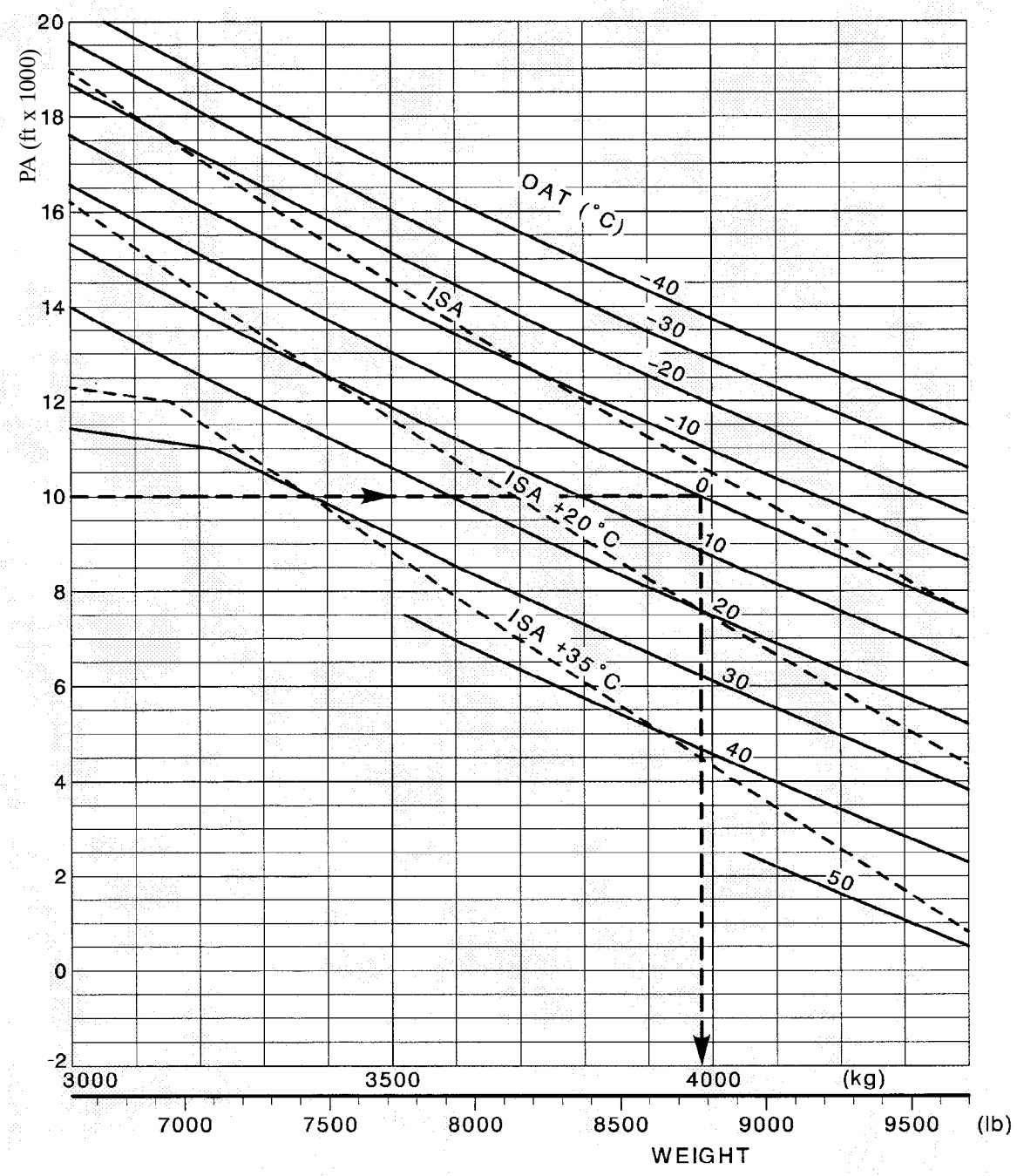
PA = 15000 ft

*Figure A-20. Service Ceiling in Forward Flight with One Engine at OEI Continuous Rating (sheet 2 of 2)*

**CONDITIONS**

- ONE ENGINE AT OEI CONTINUOUS RATING
- TAS = Vy = 75 kt
-
-
-
-
-

**MAXIMUM WEIGHT PERMITTING TO MAINTAIN LEVEL FLIGHT AFTER FLY AWAY**




**EXAMPLE :** PA = 10000 ft

OAT = 0 °C

WEIGHT = 8775 lb / 3980 kg

*Figure A-21. Maximum Weight to Maintain Level Flight After Fly Away*

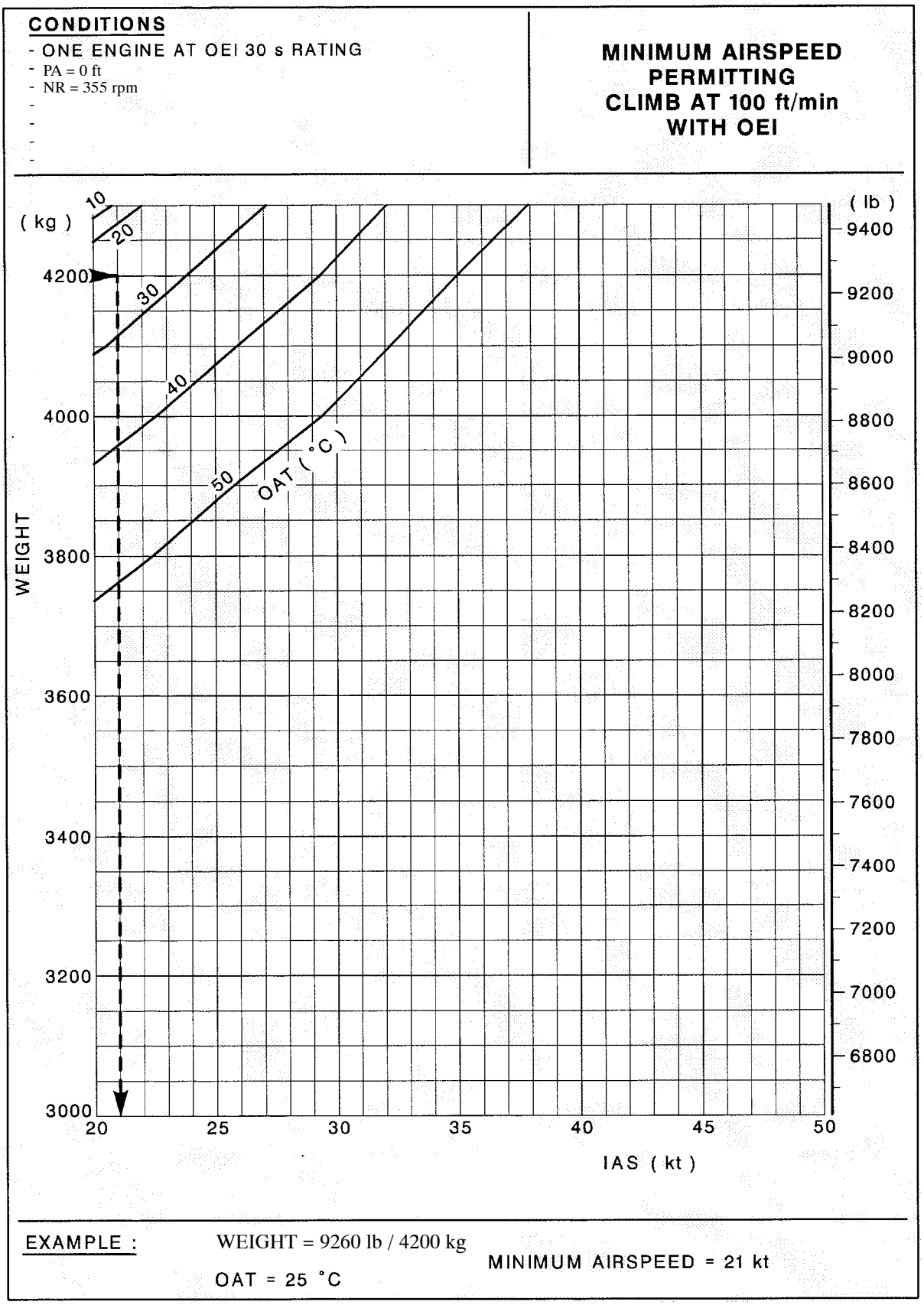



*Figure A-22. Minimum Airspeed Permitting Climb at 100 FT/MN at OEI 30s Rating (sheet 1 of 6)*

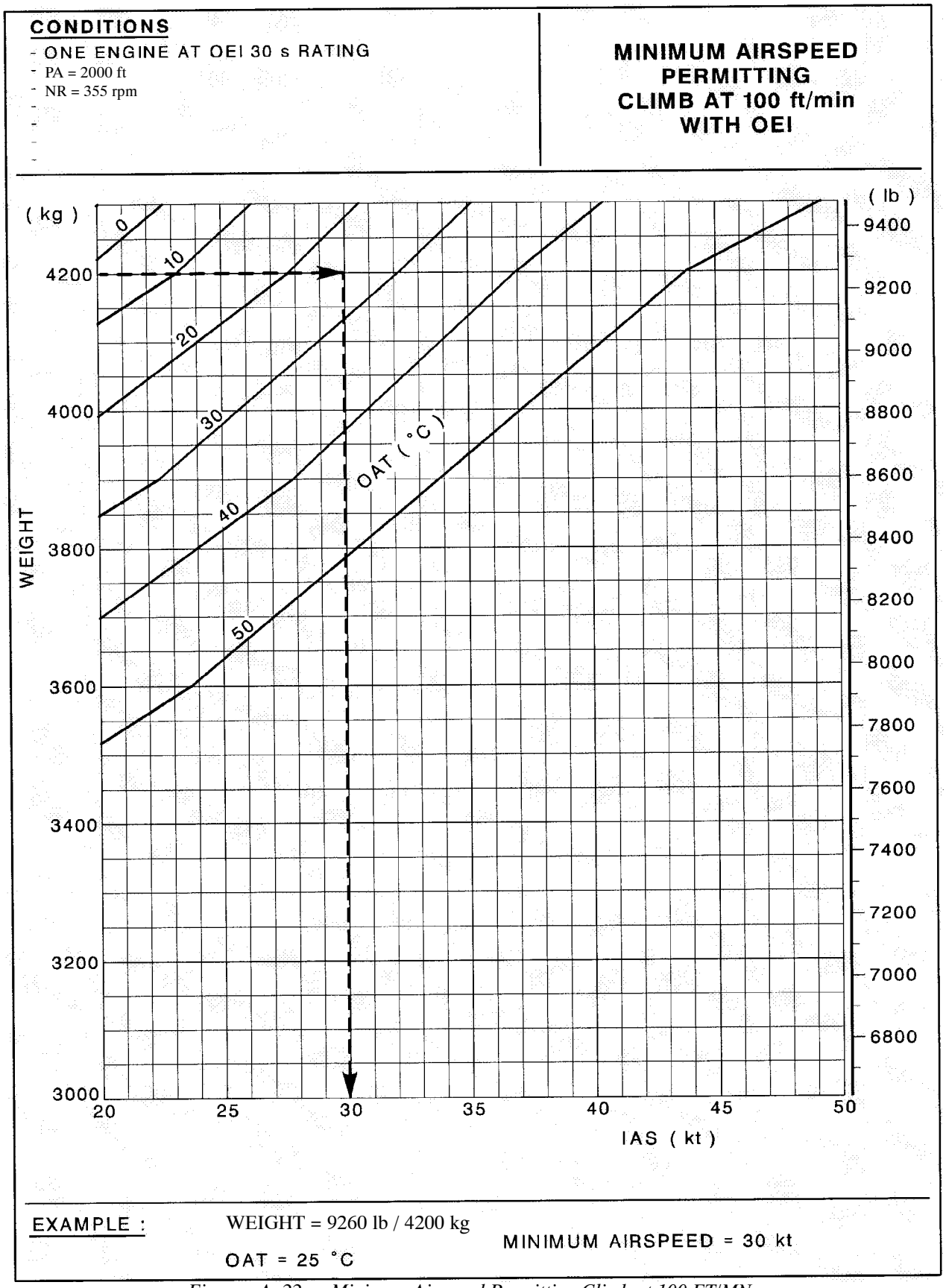



*Figure A-22. Minimum Airspeed Permitting Climb at 100 FT/MN at OEI 30s Rating (sheet 2 of 6)*

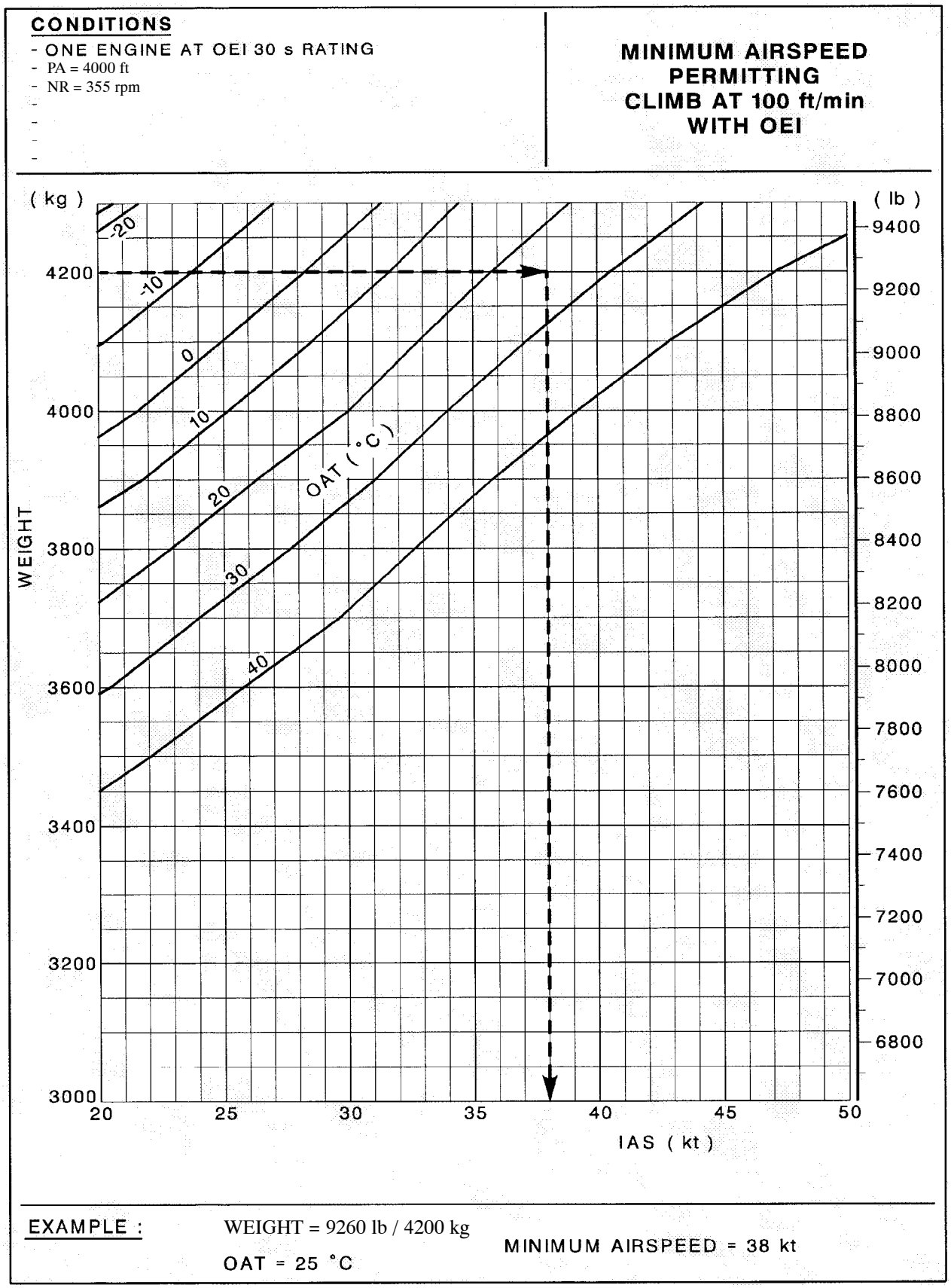



*Figure A-22. Minimum Airspeed Permitting Climb at 100 FT/MN at OEI 30s Rating (sheet 3 of 6)*

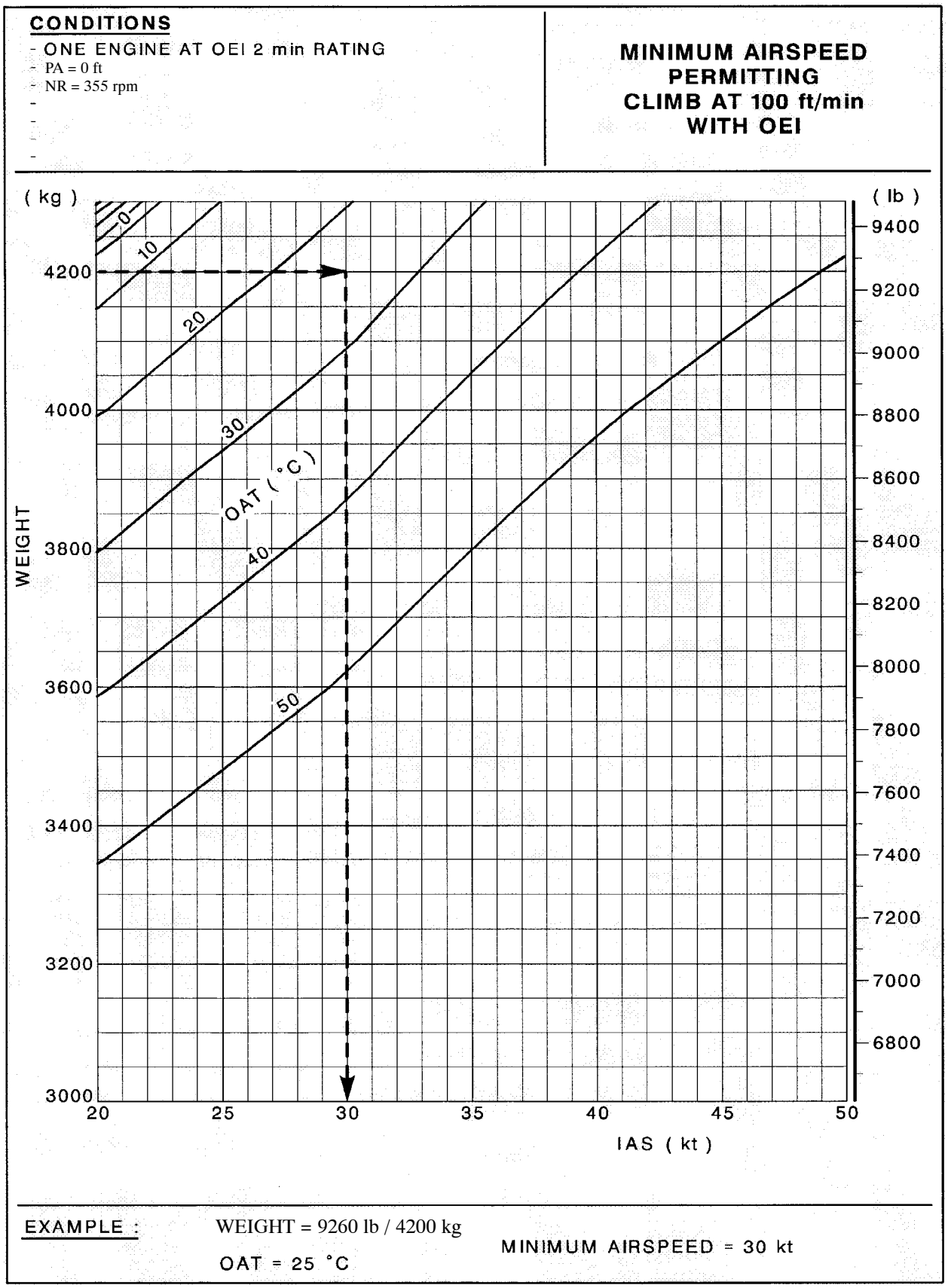



*Figure A-22. Minimum Airspeed Permitting Climb at 100 FT/MN at OEI 2MN Rating (sheet 4 of 6)*

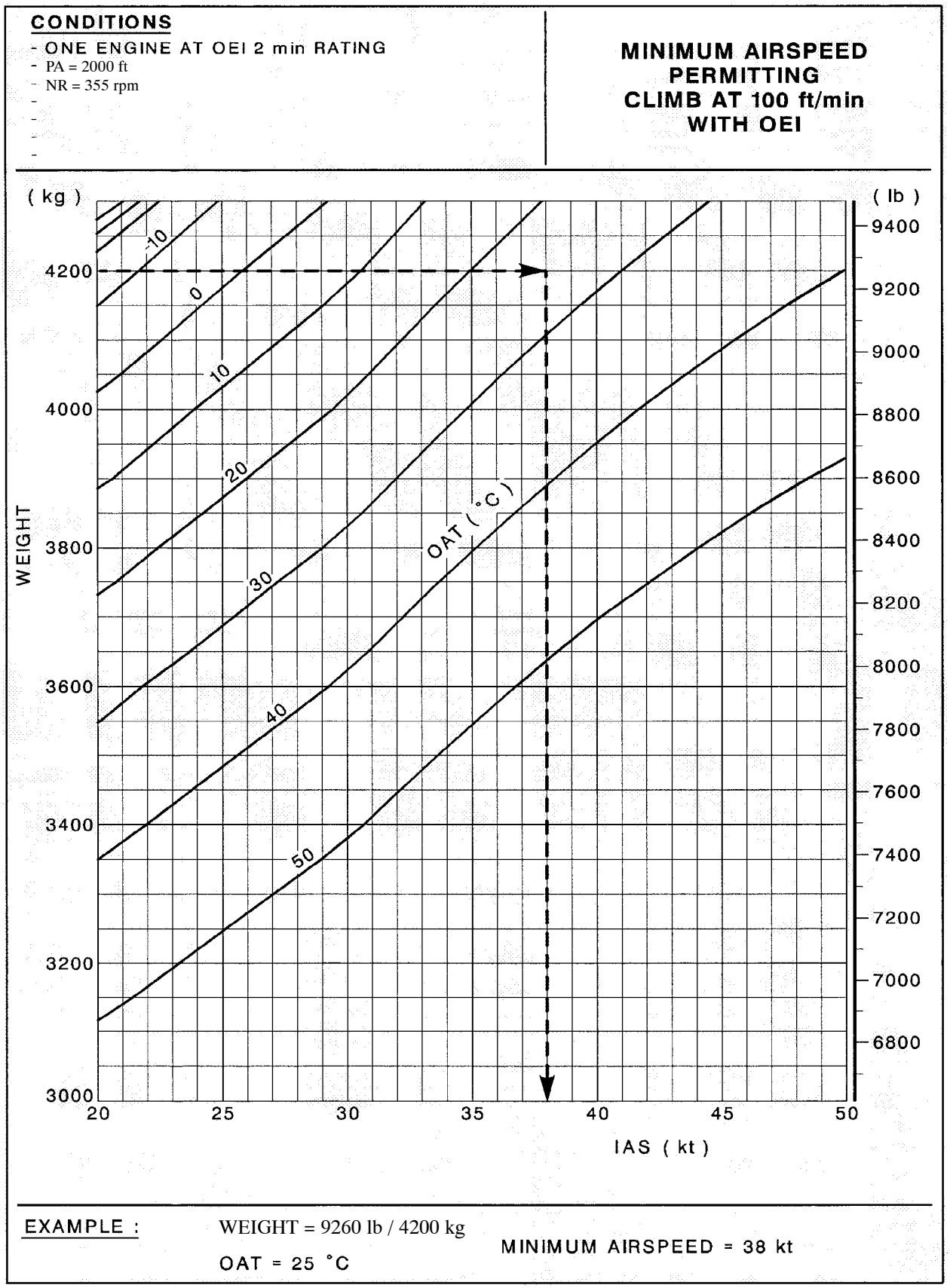



*Figure A-22. Minimum Airspeed Permitting Climb at 100 FT/MN at OEI 2MN Rating (sheet 5 of 6)*

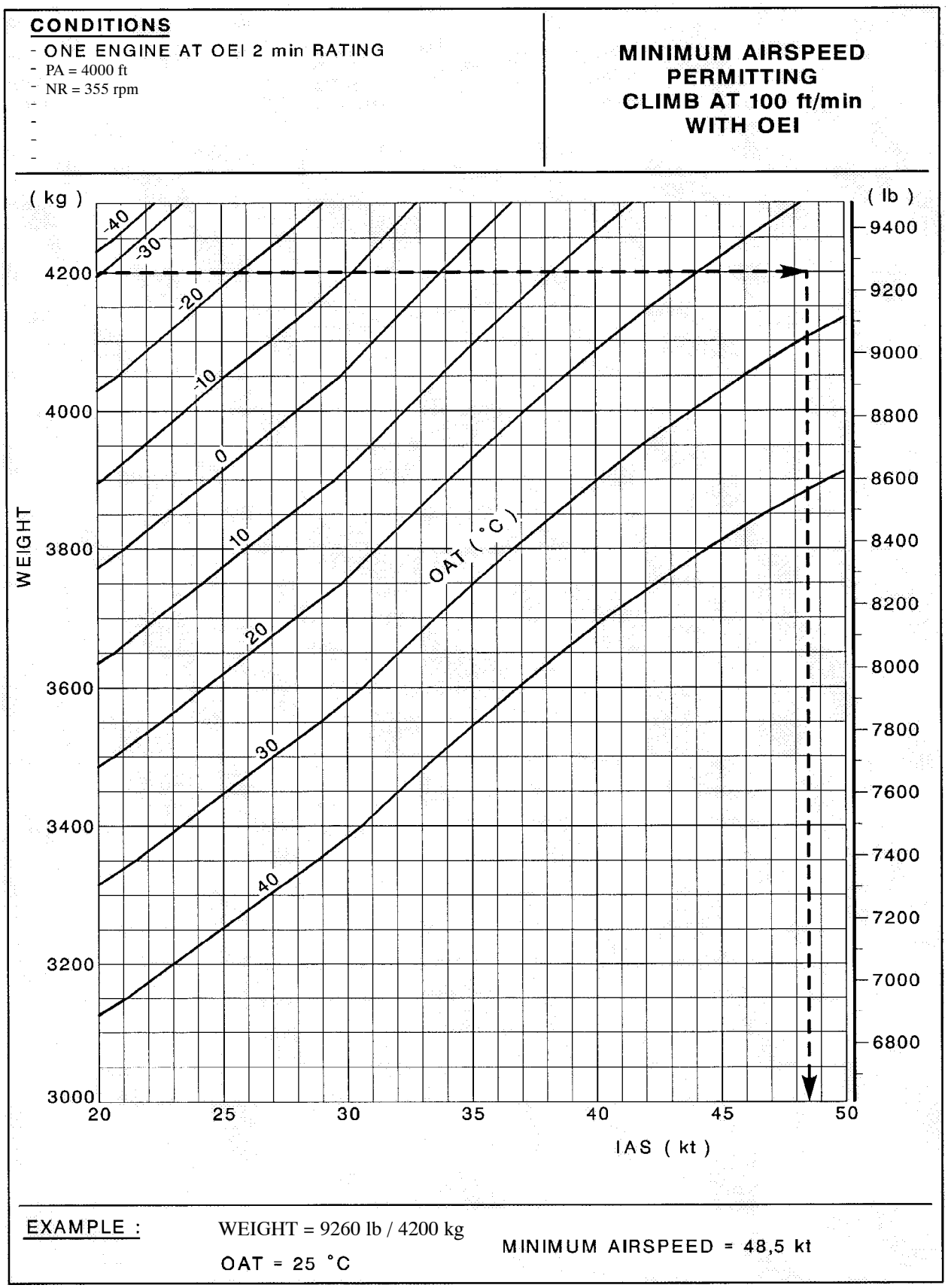



*Figure A-22. Minimum Airspeed Permitting Climb at 100 FT/MN at OEI 2MN Rating (sheet 6 of 6)*

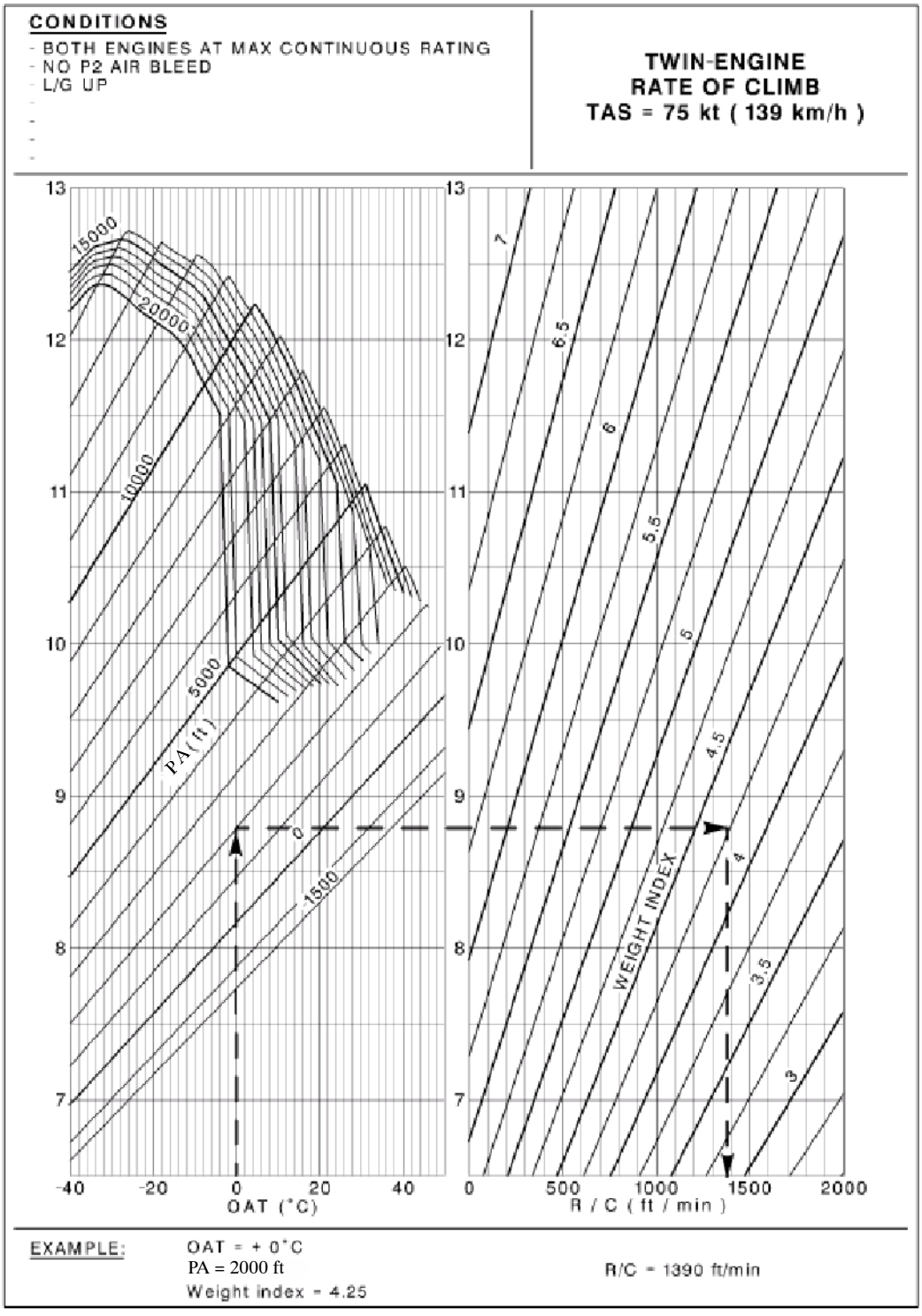



*Figure A-23. Twin-Engine Rate of Climb*

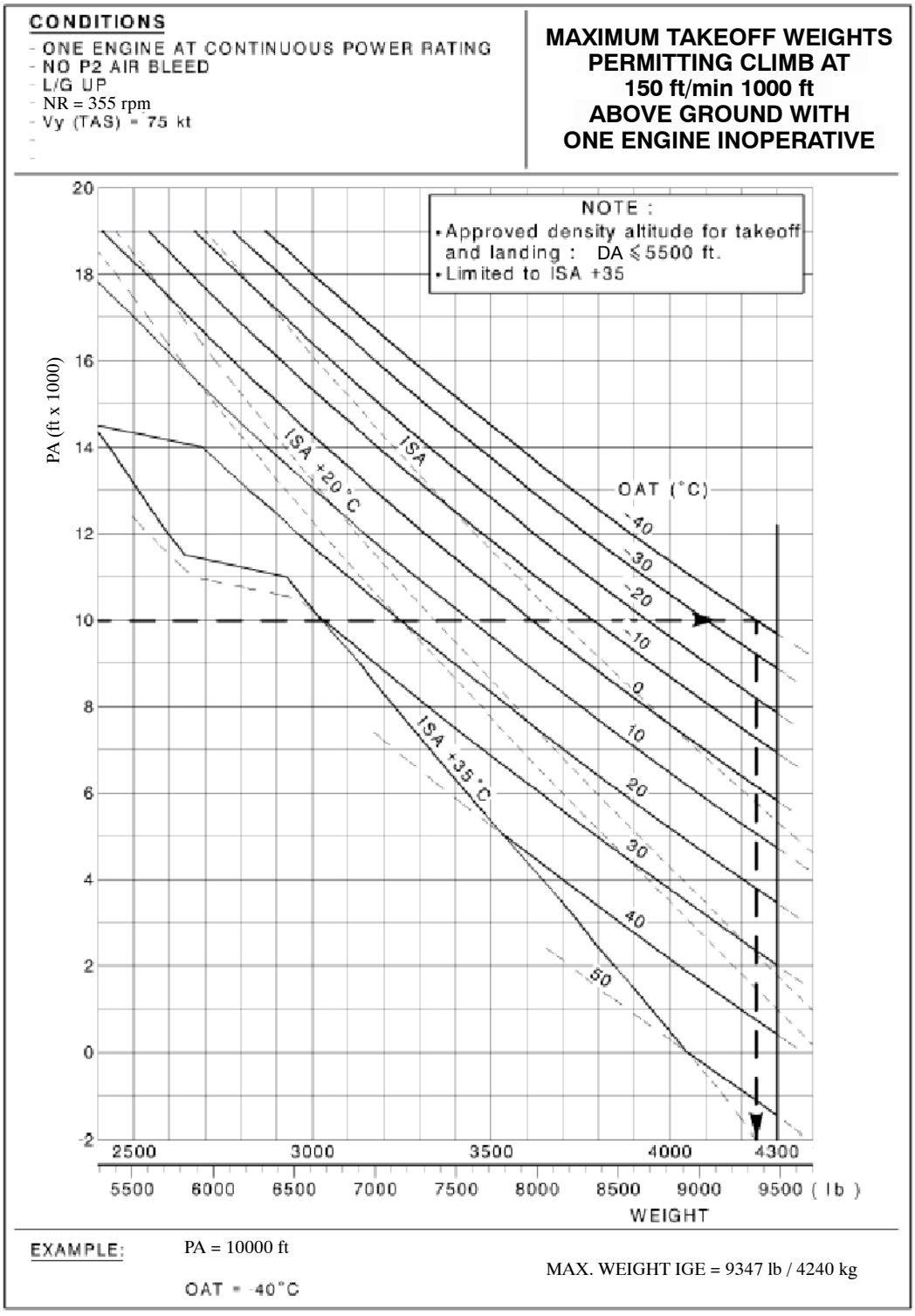



*Figure A-24. Maximum Takeoff Weights Permitting Climb at 150 ft/min 1000 ft Above Ground with One Engine Inoperative*

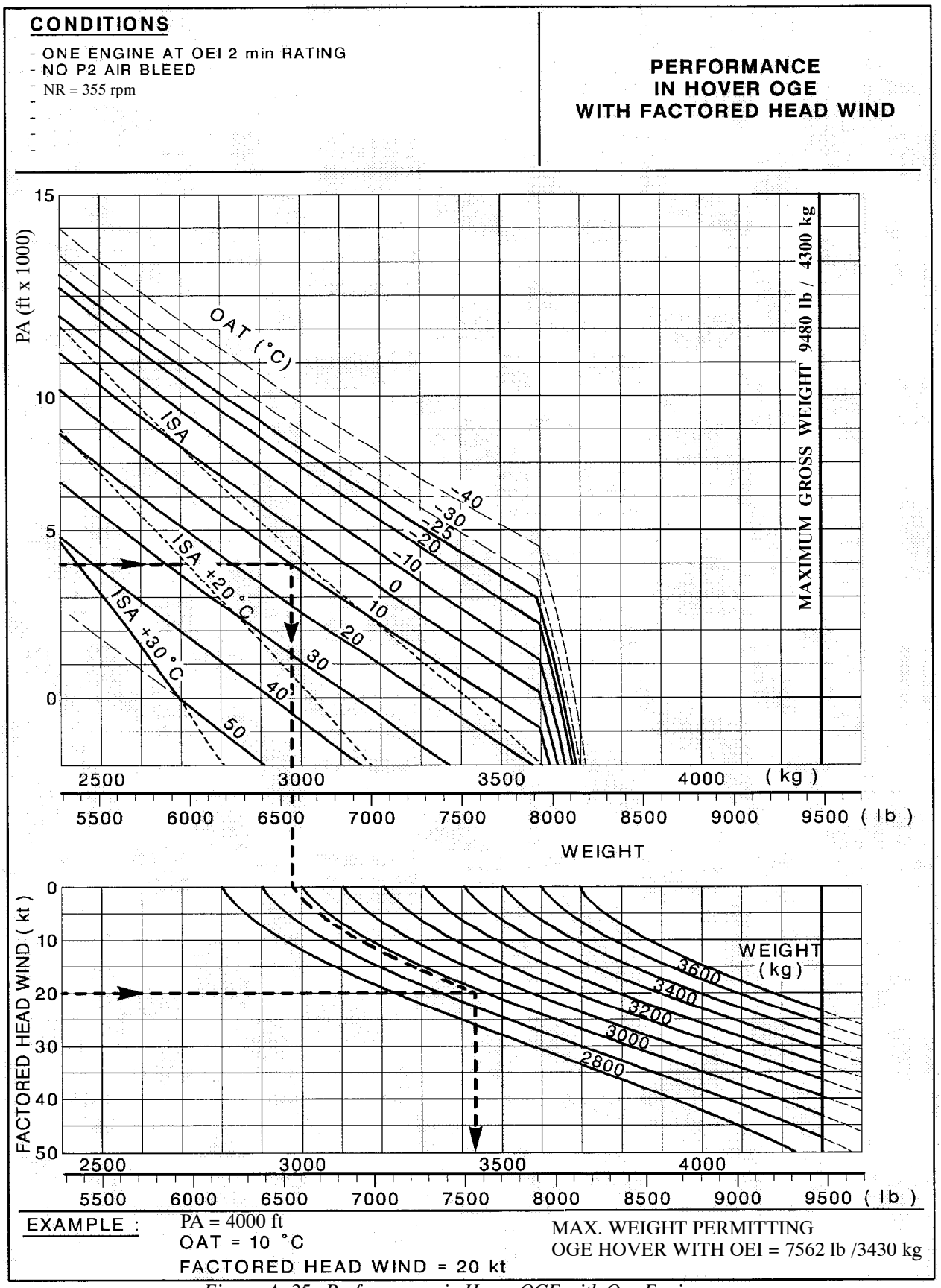



*Figure A-25. Performances in Hover OGE with One Engine at 2MN OEI Rating with (Head) Wind Effect*

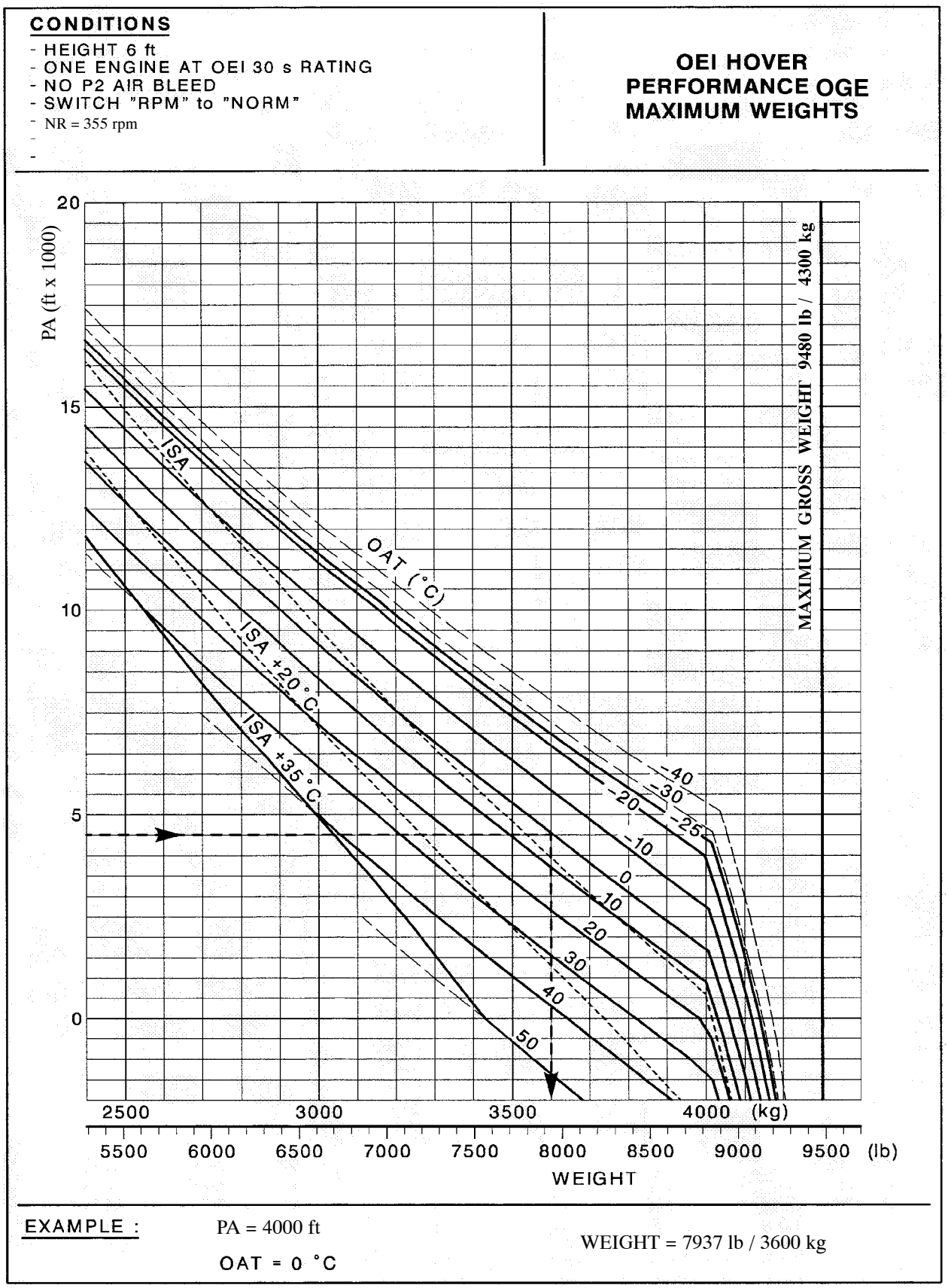



*Figure A-26. Performance in Hover IGE with One Engine at OEI Rating (sheet 1 of 2)*

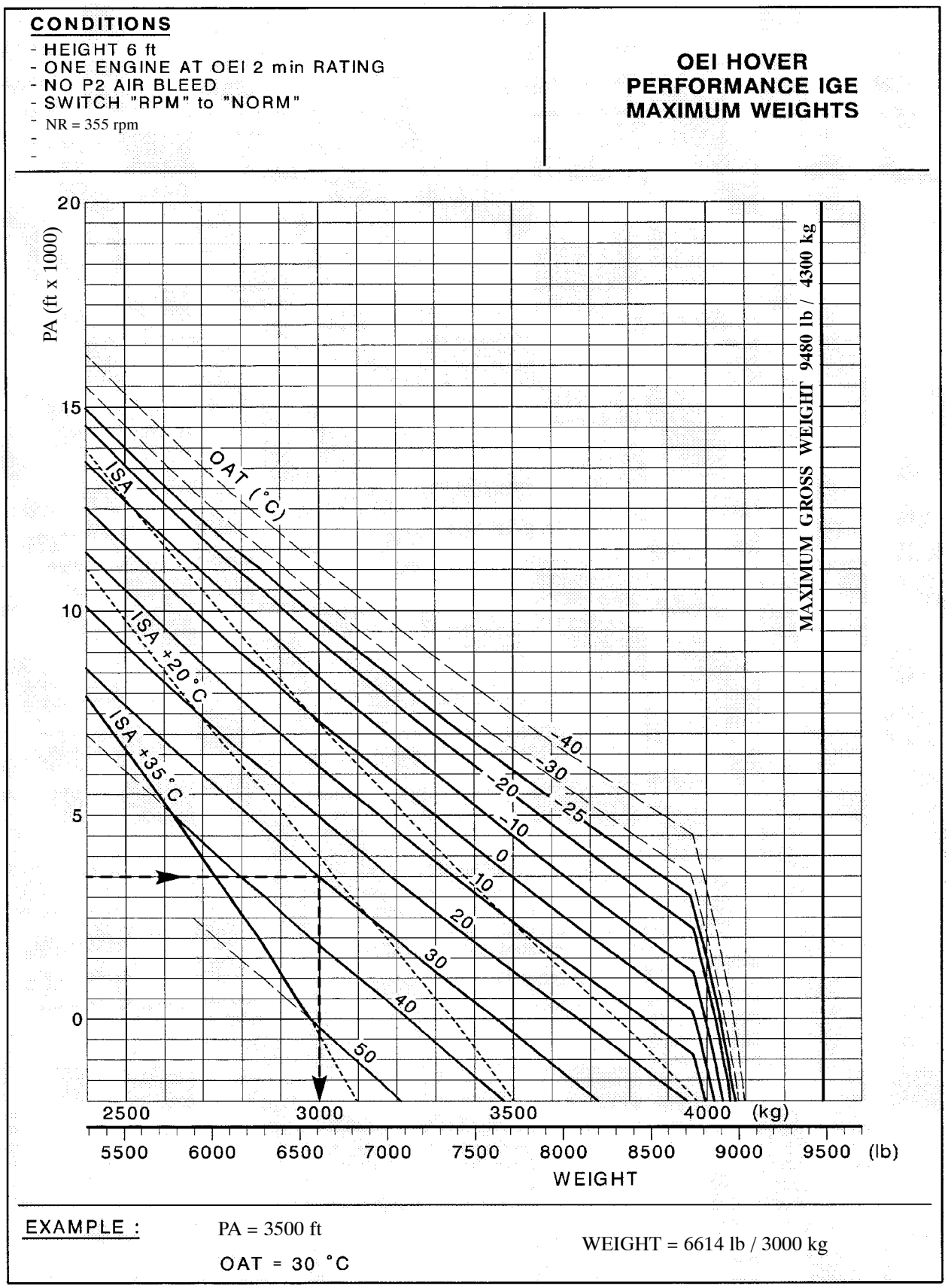



*Figure A-26. Performance in Hover IGE with One Engine at OEI Rating (sheet 2 of 2)*

## KILOGRAMS/POUNDS CONVERSION

1 kg = 2.2045855 lbs

1 lb = .4536 kg

| Kilograms | **Pounds** | Kilograms | **Pounds** | Kilograms | **Pounds** |
|---|---|---|---|---|---|
| 2722 | **6000** | 3334 | **7350** | 3946 | **8700** |
| 2744 | **6050** | 3357 | **7400** | 3969 | **8750** |
| 2767 | **6100** | 3379 | **7450** | 3992 | **8800** |
| 2790 | **6150** | 3402 | **7500** | 4014 | **8850** |
| 2812 | **6200** | 3425 | **7550** | 4037 | **8900** |
| 2835 | **6250** | 3447 | **7600** | 4060 | **8950** |
| 2858 | **6300** | 3470 | **7650** | 4082 | **9000** |
| 2880 | **6350** | 3493 | **7700** | 4105 | **9050** |
| 2903 | **6400** | 3515 | **7750** | 4128 | **9100** |
| 2926 | **6450** | 3538 | **7800** | 4150 | **9150** |
| 2948 | **6500** | 3561 | **7850** | 4173 | **9200** |
| 2994 | **6600** | 3606 | **7950** | 4218 | **9300** |
| 3016 | **6650** | 3629 | **8000** | 4241 | **9350** |
| 3039 | **6700** | 3651 | **8050** | 4264 | **9400** |
| 3062 | **6750** | 3674 | **8100** | 4287 | **9450** |
| 3084 | **6800** | 3697 | **8150** | 4309 | **9500** |
| 3107 | **6850** | 3720 | **8200** | 4332 | **9550** |
| 3130 | **6900** | 3742 | **8250** | 4355 | **9600** |
| 3153 | **6950** | 3765 | **8300** | 4377 | **9650** |
| 3175 | **7000** | 3788 | **8350** | 4400 | **9700** |
| 3198 | **7050** | 3810 | **8400** | 4423 | **9750** |
| 3221 | **7100** | 3833 | **8450** | 4445 | **9800** |
| 3243 | **7150** | 3856 | **8500** | 4468 | **9850** |
| 3266 | **7200** | 3878 | **8550** | 4491 | **9900** |
| 3289 | **7250** | 3901 | **8600** | 4513 | **9950** |
| 3311 | **7300** | 3924 | **8650** | 4536 | **10000** |

*Figure A-27. Kilograms/Pounds Conversion Chart*

**TODD CARD** **HELO**_____ **DATE**_____

| DATA | Takeoff | O/S Enr | Dest |
|---|---|---|---|
| Field Elevation | _____ft | _____ft | _____ft |
| OAT | _____°C | _____°C | _____°C |
| Pressure Alt | _____ft | _____ft | _____ft |
| Wind | _____kts | _____kts | _____kts |
| Op Weight | _____lbs | _____lbs | _____lbs |
| Extra Crew/Equip | _____lbs | _____lbs | _____lbs |
| Fuel | _____lbs | _____lbs | _____lbs |
| Mission Gross Weight | _____lbs | _____lbs | _____lbs |
| MGW HIGE-no reserve (A-4) | _____lbs | _____lbs | _____lbs |
| (9480 if PA<3000ft & OAT <40C) | | | |
| MGW HOGE-no reserve (A-5) | _____lbs | _____lbs | _____lbs |
| (9480 if PA<1500ft & OAT <40C) | | | |
| MGW HOGE-10% reserve | _____lbs | _____lbs | _____lbs |
| w/ wind (A-6) | | | |
| Transfer scale/Weight index | ___/___ | ___/___ | ___/___ |
| (A-7/8) | | | |
| Cont OEI ROC (A-9) | _____fpm | _____fpm | _____fpm |
| Cont OEI min/max speed | ___/___kts | ___/___kts | ___/___kts |
| (A-10) | | | |
| Vy (A-10) | _____kts | _____kts | _____kts |
| VNE (A-11) | _____kts | _____kts | _____kts |
| Ht loss trng/normal mode | ___/___ft | ___/___ft | ___/___ft |
| (A-12) | | | |
| HV valid above (A-13) | _____lbs | _____lbs | _____lbs |

| Kts | 0 | 10 | 20 | 30 |
|---|---|---|---|---|
| Hi | 230 | 230 | 230 | 230 |
| Lo | 13 | 19 | 25 | 30 |

MGW HOGE 30S OEI (A-14)
On scene conditions

| Wind | 0 | 10 | 20 | 30 |
|---|---|---|---|---|
| | | | | |

*Figure A-28. Takeoff and Destination Data Card*

Flight Number: _____

_____ Cycle N1 _____
_____ Total _____
_____ Cycle N2 _____
_____ Total _____

Failure: _____

_____ OEI Lo _____
_____ OEI Hi _____
_____ Usage _____

Flight Number: _____

_____ Cycle N1 _____
_____ Total _____
_____ Cycle N2 _____
_____ Total _____

Failure: _____

_____ OEI Lo _____
_____ OEI Hi _____
_____ Usage _____

EPC

_____ TOT Reserve _____
_____ Torque Reserve _____

## GLOSSARY OF TERMS AND ABBREVIATIONS

### A

| | |
|---|---|
| AAR | Air-to-Air Receive (TACAN) |
| AATR | Air-to-Air Transmit/Receive |
| AC | Alternating Current |
| A/C | Aircraft |
| ACK | Acknowledge |
| ACU | Alternator Control Unit |
| ADC | Air Data Converter |
| ADF | Automatic Direction Finding |
| ADI | Attitude Director Indicator |
| ADU | Air Data Unit |
| AEO | All Engines Operating |
| AFC | Automatic Frequency Control (Radar) |
| AFCS | Automatic Flight Control System |
| AGC | Automatic Gain Control (Radar) |
| AGL | Above Ground Level |
| ALT | Altitude |
| ALTN/ALT | Alternate |
| ALTNR | Alternator |
| AM | Amplitude Modulation |
| APPR | Approach (FDS Mode) |
| ASC | Aircraft System Coupler |
| ASR | Airport Surveillance Radar |
| ATT | Attitude |
| ATCRBS | Air Traffic Control Radio Beacon System |
| AUX | Auxiliary |
| AV | Avionics |
| AV CLG SW MAINT | Avionics Cooling Maintenance Disable Switch |

### B

| | |
|---|---|
| BARALT | Barometric Altitude |
| BAT | Battery |
| BATT RLY | Battery Relay |
| BB | Baseband |
| BC | Back Course |
| BDI | Bearing Distance Indicator |
| BIM | Engine Interface Unit |
| BIT | Built-In-Test |
| BKP | Brake Pressure |
| BRT | Brightness |
| BTC | Bus Tie Contactor/Circuit |

### C

| | |
|---|---|
| C | Commence Search Point |
| C | Degrees Celsius |
| CAS | Calibrated Air Speed |
| CATCH | Computer Approach to a Coupled Hover |
| CB | Circuit Breaker |
| CBIT | Continuous Built-In Test |
| CDI | Course Deviation Indicator |
| CDU | Control Display Unit |
| CF3BR | Bromtrifloromethane |
| CG | Center of Gravity |
| CHR | Chronograph Time |
| CLR | Clear |
| CMD | Command (Airspeed) |
| CMS | Cockpit Management System |
| CMS | Computerized Maintenance System |
| COMM | Communications (1&2) |
| COMPR | Compare |
| CONT | Contrast |
| CPLT | Copilot (CP) |
| CPS | Cycles per Second |
| CRM | Crew Resource Management |
| CRP | Creep |
| CRS | Course |
| CRT | Cathode Ray Tube |
| CSI | Compass Synchronization Indicator |
| CSL | Console |
| CSP | Commence Search Point |
| C-SYNC | Collective Synchronize |
| CTRL | Control |
| CW | Continuous Wave |

### D

| | |
|---|---|
| D | Datum |
| DA | Density Altitude |
| DC | Direct Current |
| DECU | Digital Engine Computer Unit |
| DES | Digital Encryption System |
| DEST | Destination |
| DF | Direction Finding |
| DG | Directional Gyro |
| DH | Decision Height |
| DIR | Direct To |
| DIW | Dead in the Water |
| DL | Data Link |
| DL DISAB | Data Link Disabled |
| DL MSG | Data Link Message |
| DMB | Datum Marker Buoy |
| DME | Distance Measuring Equipment |

| | |
|---|---|
| DP | Diphase |
| DR | Dead Reckoning |
| DTK | Desired Ground Track |

**E**

| | |
|---|---|
| EBCAU | Engine Back-Up Control Auxiliary Unit |
| ECMS | Engine Condition Monitoring System |
| ECS | Environmental Control System |
| EFSL | Engine Fuel Shutoff Levers |
| EGB 1 | Engine/MGB Module |
| EHE | Estimated Horizon Error |
| ELT | Emergency Locator Transmitter |
| EMER | Emergency |
| ENG PRMTRS | Engine Parameters |
| EOP | Engine Oil Pressure |
| EOT | Engine Oil Temperature |
| EP | Emergency Procedure |
| EPC | Engine Power Check |
| ET | Elapsed Time |
| ETE | Estimated Time Enroute |
| EXP SQ | Expanding Square |
| EXPND LMT | Expanded Limit |
| EXT | External or Extinguisher |

**F**

| | |
|---|---|
| FAA | Federal Aviation Administration |
| FADEC | Full Authority Digital Engine Control |
| FAF | Final Approach Fix |
| FCS | FADEC Control Switch |
| FD | Flight Director |
| FD UNCPL | Flight Director Uncoupled |
| FDB | Flight Data Base |
| FDC | Flight Director Computer |
| FDS | Flight Director System |
| FDSU | Flight Data Storage Unit |
| FFCL | Fuel Flow Control Lever |
| FFR | Fuel Flow Rate |
| FILT | Filter |
| FLI | First Limit Indicator |
| FLPN | Flight Plan |
| FM | Flight Mechanic |
| FM | Frequency Modulation |
| FMP | Fuel Manifold Pressure |
| FMS | Flight Management Systems |
| FO | Fold Out |
| FOD | Foreign Object Debris/Damage |
| FP | Fuel Pressure |
| FPLN | Flight Plan Page |
| FPM | Feet-Per-Minute |
| FS | Fast Set (clock) |
| FT | Feet |

**G**

| | |
|---|---|
| GA | Go Around |
| GAL | Gallons |
| GBP | Gear Box Pressure (Main) |
| GBT | Gear Box Temperature (Main) |
| GCA | Ground Controlled Approach |
| GCU | Generator Control Unit |
| GEN | Generator |
| GMT | Greenwich Mean Time (Universal) |
| GP | Grand Pitch (Collective) |
| GP | Gas Producer |
| GRD XMT | Guard Transmit |
| GS | Ground Speed |
| GS | Glide Slope |
| GSI | Gyro Stabilized Glide Slope |
| GW | Gross Weight |
| GYRO REV | Gyro Reversionary Operation |

**H**

| | |
|---|---|
| HAT | Height Above Touchdown |
| HCO | Helicopter Control Officer |
| HDG | Heading |
| HDG SEL | Heading Select |
| HF | High Frequency |
| HIFR | Helicopter-In-Flight Refueling |
| HIGE | Hover In Ground Effect |
| HIPSARM | Hover Increased Power Search and Rescue Mission |
| HLD | Hold |
| HO | Hoist Operator |
| HOGE | Hover Out of Ground Effect (>100 ft) |
| HOISTCAM | Rescue Hoist Camera |
| HOSP/Fuel | Hospital Refuel |
| HOV | Hover |
| HOV AUG | Hover Augmentation |
| HR | Hour |
| HSI | Horizontal Situation Indicator |
| H/V | Height/Velocity |
| HYD | Hydraulic |
| Hz | Hertz |

**I**

| | |
|---|---|
| IAF/FAF | Initial Approach Fix/Final Approach Fix |
| IAM | Interface Adapter Module |
| IAS | Indicated Airspeed |
| IBIT | Initiated Built-In Test |

| | |
|---|---|
| ICAO | International Civil Aeronautical Organization |
| ICS | Intercom System |
| ID | Identifier |
| IDX | Index |
| IDX RTN | Index Return |
| IFF | Identification Friend or Foe (Transponder) |
| IGE | In Ground Effect |
| ILS | Instrument Landing System |
| IM | Inner Marker (CAT II ILS) |
| IMC | Instrument Meteorological Conditions |
| IND | Indicator |
| IN HG | Inches Mercury |
| INTGR | Integration (Radar/Scan) |
| IP | Instructor Pilot |
| IPL | Initial Program Loading |
| ITO | Instrument Takeoff |

**J**

| | |
|---|---|
| JETT | Jettison |

**K**

| | |
|---|---|
| KCAS | Knots Calibrated Airspeed |
| KGS | Knots Ground Speed |
| kHz | Kilohertz |
| KIAS | Knots Indicated Airspeed |
| KTAS | Knots True Airspeed |
| KTS | Knots |
| kV | Kilovolt (1,000) |

**L**

| | |
|---|---|
| L | Left |
| LAT | Latitude |
| LB/HR | Pound per Hour |
| LCTR LT | Locator Light |
| LF | Low Frequency |
| L/G | Landing Gear |
| L GEAR DN | Landing Gear Down |
| LKP | Last Known Position |
| LNAV | Lateral Navigation |
| LOC | Localizer |
| LOM | Compass Locator (Outer Marker) |
| LONG | Longitude |
| LOP | Line of Position |
| LOW ALT | Low Altitude Warning Lights |
| LRU | Line Replaceable Unit |
| LSO | Landing Signal Officer |
| LTR | Letter |

**M**

| | |
|---|---|
| MAAF | Mishap Analysis Animation Facility |
| MADPU | Military Aviator Double Pick-Up |
| MAG | Magnetic |
| MAN | Manual |
| MAN XMIT | Manual Transmit (DL) |
| MAP | Missed Approach Point |
| MATCH | Manual Approach to a Controlled Hover |
| MCP | Maximum Continuous Power |
| MDA | Minimum Descent Altitude |
| MDL | Mission Data Loader |
| MFD | Multi Functional Display |
| MGB | Main Gearbox |
| MGB AUX PMP | Main Gearbox Pump (Auxiliary System) |
| MGRS | Military Grid Reference System |
| MIN | Minutes |
| MKB | Marker Beacon |
| MM | Middle Marker |
| MO/DY | Month/Day |
| MRNG | Maximum Range |
| MSG | Message (DL) |
| MSL | Mean Sea Level |
| MSTR | Master |
| MSTR IND | Master Independent |
| MSTR VOL | Master Volume |
| MTOP | Maximum Takeoff Power |

**N**

| | |
|---|---|
| N1 | Gas Generator Speed |
| N2 | Power Turbine Speed |
| NATCH | NVG Aided Approach to a Controlled Hover |
| NAV | Navigation |
| NAV CTL | Navigation Control |
| NAV XFR | Navigation Transfer |
| NDB | Non Directional Beacon |
| NM | Nautical Miles |
| NO ACK | No Acknowledgement |
| Nr | Rotor Speed |
| NVG | Night Vision Goggle |

**O**

| | |
|---|---|
| OADS | Omnidirectional Air Data System |
| OAS | Omnidirectional Airspeed Sensor |
| OAT | Outside Air Temperature |
| OEI | One Engine Inoperative |
| OFST | Offset |
| O/HEAT | Over Heat |
| OM | Outer Marker |

| | |
|---|---|
| O/R | Override (OR) |
| OVHD CSL | Overhead Console |

**P**

| | |
|---|---|
| P | Pitch |
| P3 | Compressor Discharge Pressure |
| PA | Pressure Altitude |
| PA | Proximity Alert (TCAS) |
| PAC | Pilot-at-the-Controls |
| PAR | Precision Approach Radar |
| PCA | Point of Closest Approach |
| PCMCIA | Personal Computer Memory Card International Association |
| PFD | Personal Flotation Device |
| PIC | Pilot In Command |
| PLT | Pilot (P) |
| PMP | Pump |
| POS | Position |
| PPH | Pounds per Hour |
| PPM | Parts per Million |
| PRES | Pressure |
| PREV ENG 1 | Previously Installed Engine |
| PRI | Primary |
| PROG | Progress |
| PRU | Portable Recording Unit |
| PSI | Pounds per Square Inch |
| PSN IDX | Position Index |
| P TRIM | Pitch Trim |
| PT | Power Turbine |
| PTA | Planned Time of Arrival |
| PTMU | Pressure and Temperature Measurement Unit |
| PTT | Press to Test |
| PUI | Pilot Under Instruction |

**Q**

| | |
|---|---|
| Q | Torque |
| QT | Total Torque |
| QTY | Quantity |

**R**

| | |
|---|---|
| R | Receive (TACAN) |
| R | Right |
| R | Roll |
| RADALT | Radar Altimeter |
| RADAR | Radio Detection and Ranging |
| RAIM | Receiver Autonomous Integrity Monitoring |
| R/ALT | Radar Altitude |
| RAWS | Radar Altimeter Warning System |
| R/C | Rate of Climb |
| REFERENCE POINT | A known/familiar stationary object within arm's length, used for emergency egress. |
| RENDZ | Rendezvous |
| RESV | Reserve |
| RETR | Retract |
| RLY | Relay |
| RMAP | Radar Map Display |
| RNAV | Area Navigation |
| RNG | Range |
| ROD | Rate of Descent |
| RPM | Revolutions per Minute |
| RRU | Remote Readout Unit |
| RS | Rescue Swimmer |
| RST | Reset |
| R/T | Receiver - Transmitter |
| R TRIM | Roll Trim |

**S**

| | |
|---|---|
| SADPU | Sling Augmented Double Pick-Up |
| SAR | Search and Rescue |
| SA/AS | Selective Availability/Anti-Spoofing(GPS) |
| SCC | System Coupler Compiler |
| SCC | System Coupler Computer |
| SDB | Site Data Base |
| SDC | Signal Data Converter |
| SEC | Secondary |
| SGSI | Stabilized Glide Slope Indicator |
| SHP | Shaft Horsepower |
| SIU | Signal Interface Unit |
| SLDMB | Self-Locating Datum Marker Buoy |
| SP | Safety Pilot |
| SQL | Squelch |
| SRCH | Search |
| SRR | Short Range Recovery |
| SS | Slow Set (clock) |
| STAB | Stability |
| STAT | Status |
| STBY | Standby |
| STD DAY | Standard Day Atmospheric Conditions |
| SW | Switch |

**T**

| | |
|---|---|
| T 4.5 | Free Power Turbine Inlet Temperature |
| TA | Traffic Avoidance (TCAS) |
| TAS | True Airspeed |
| TCAS | Traffic Alert and Collision Avoidance System |
| TCN | Tactical Air Navigation (TACAN) |
| TD | Time Delay (Microseconds) |

| | |
|---|---|
| TEMP | Temperature |
| TGB | Tail Rotor Gearbox |
| TGT | Target |
| T-HOV | T-Hover |
| TKE | Track Angle Error |
| TODD | Takeoff and Destination Data |
| TOT | Turbine Outlet Temperature |
| TNAV | Time Navigation |
| TR | Transformer Rectifier |
| TR | Transmit/Receive |
| TRK | Track |
| TRQ | Torque |
| TTA | Time to Alert (Fuel) |
| TTG | Time to Go |
| TTR | Time to Rendezvous |
| TTW | Time to Waypoint |

**U**

| | |
|---|---|
| UAB | Underwater Acoustic Beacon |
| UCPL | Uncouple |
| UHF | Ultra High Frequency |
| ULY | Uncommanded Left Yaw |
| UPS | Universal Polar Stereographic |
| UTC | Universal Coordinated Time |
| UTM | Universal Transverse Mercator |

**V**

| | |
|---|---|
| V | Volts |
| VAC | Volts Alternating Current |
| VEMD | Vehicle Engine Management Display |
| VERT | Vertical |
| VERTREP | Vertical Replenishment |
| VFDR | Voice Flight Data Recorder |
| VHF | Very High Frequency |
| VIS | Visibility |
| VLEA | Variable Load Energy Absorber |
| V/L | VOR/LOC NAV Source |
| VMC | Visual Meteorological Conditions |
| VMU | Vibration Monitoring Unit |
| VNAV | Vertical Navigation |
| VNE | Maximum Never Exceed Speed |
| VOL | Volume |
| VOR | Very High Frequency Omni-directional Radio Range |
| VP | Voice Privacy |
| VS | Vertical Speed |

**W**

| | |
|---|---|
| WARN | Warning |
| W-C-A | Warning-Caution-Advisory |
| WF | Fuel Flow Rate |
| WPTS | Waypoints |
| WSCRN | Windscreen |
| WX | Weather |
| WxA | Weather Alert |

**X**

| | |
|---|---|
| XFER | Transfer |
| XMIT | Transmit |
| XMSM | Transmission (MGB) |
| XMT DL | Transmit Data Link |
| XMT/RCV | Transmit/Receive |
| XTK | Cross Track Deviation |

**Y**

| | |
|---|---|
| Y | TACAN Channel (A/A) |
| Y | Yaw |
| Y TRIM | Yaw Trim |

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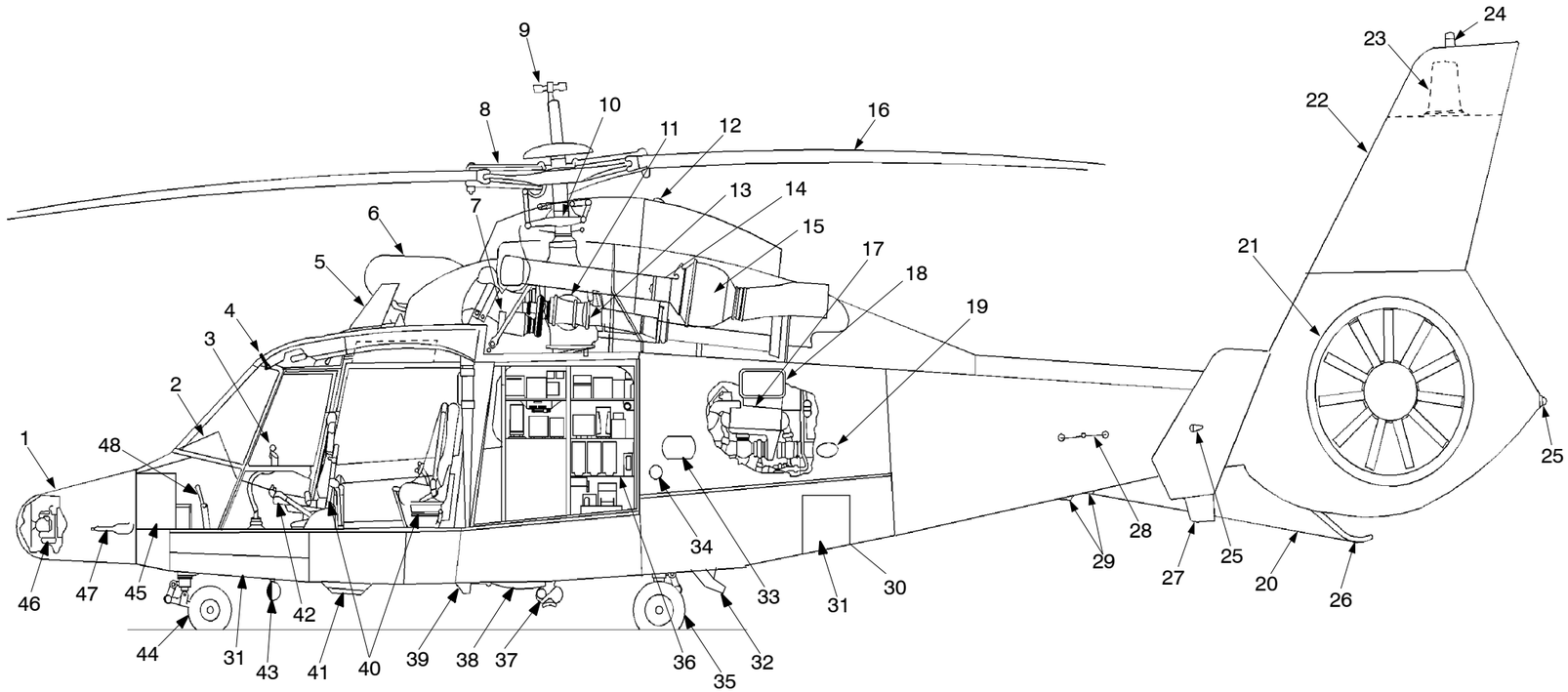
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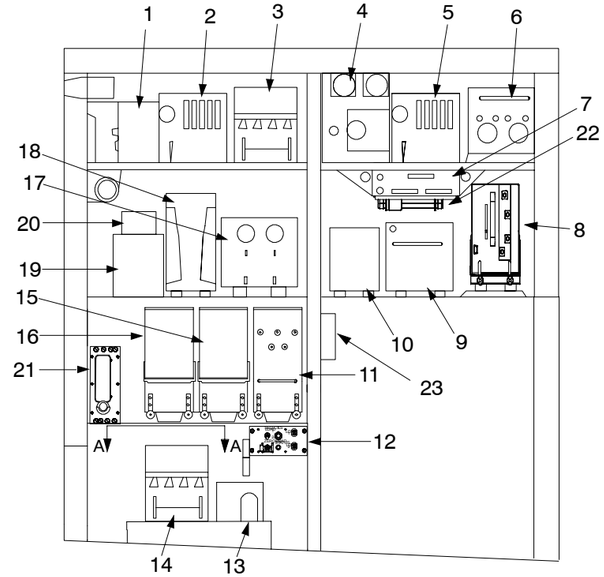
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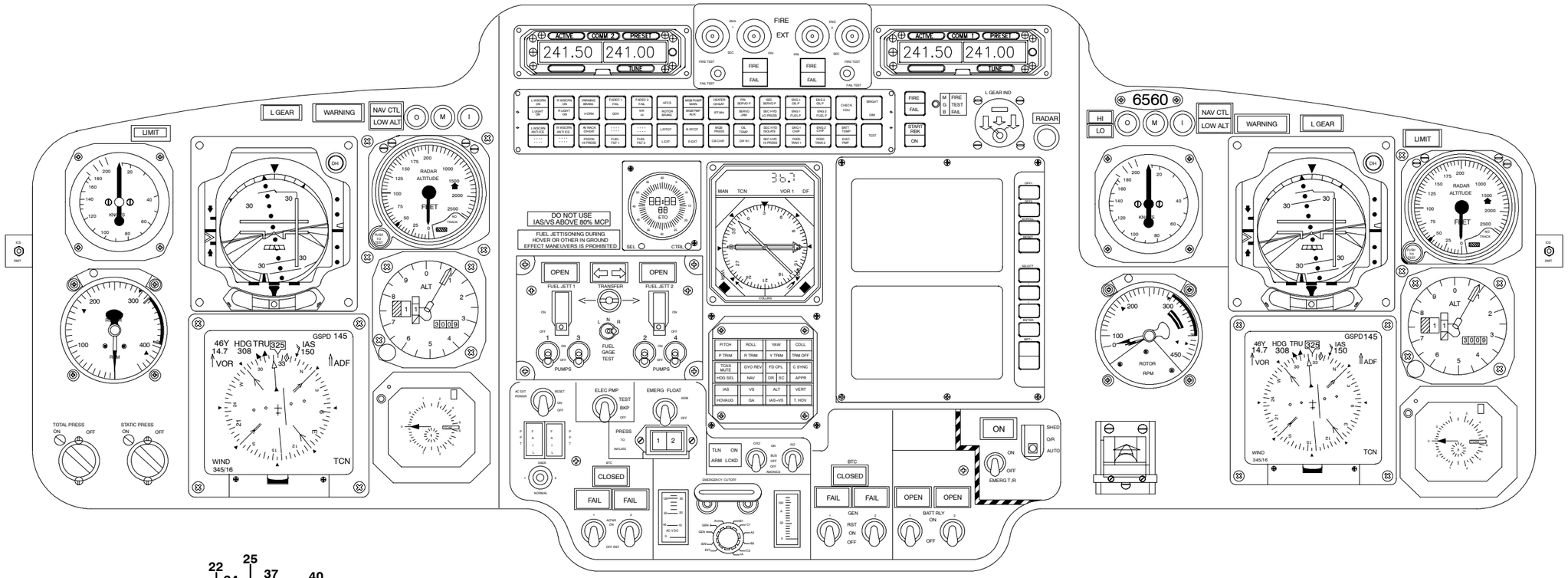

VIEW A
AVIONICS RACK LOOKING OUTBOARD

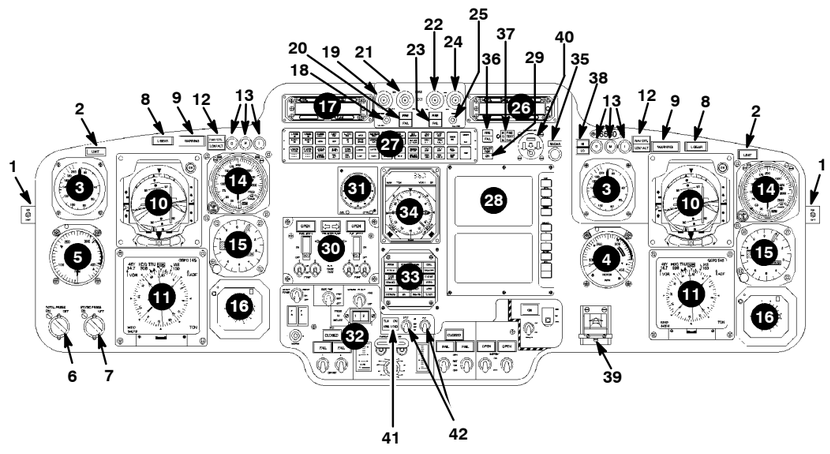



1. Radome
2. Instrument Panel
3. Cyclic (2)
4. Free Air Temperature Probe
5. VHF/FM Radio Antenna
6. Rescue Hoist
7. Alternator (2)
8. Rotor Head
9. Omnidirectional Air Data Probe
10. Rotating Swashplate
11. Main Gearbox
12. GPS Antenna (2)
13. Drive Coupling Shaft
14. Starter/Generator (2) (Out of View)
15. Engine (2)
16. Rotor Blade (4)
17. Air Conditioner Heat Exchanger
18. ECS Air Intake
19. ECS Air Exhaust
20. HF Radio Antenna
21. Tail Rotor
22. Vertical Stabilizer
23. UHF/VHF COMM 1 & TCAS Antenna
24. Anticollision Light
25. Position Light
26. Tail Skid
27. UHF/VHF COMM 2 Radio Antenna
28. VOR/ILS Antenna
29. Radar Altimeter Antennas
30. UHF/DF Antenna (Out of View)
31. Flotation Equipment Bay (2 Shown)
32. Fuel Dump Fairing
33. Gravity Refueling Receptacles (2)
34. External Air Conditioning Receptacle
35. Main Landing Gear
36. Avionics Equipment Rack (See View A for Detailed Plan)
37. Cargo Hook
38. Marker Beacon Antenna
39. TACAN Antenna
40. Crew Seats (3)
41. ADF Loop Antenna (Right) TCAS Antenna (Left)
42. Collective (2)
43. Landing Light (2)
44. Nose Landing Gear
45. Battery
46. Search/Weather Radar
47. Pitot Probes (2)
48. Directional Control Pedals

1. Altitude Controller
2. System Coupler Computer #1
3. VHF/UHF Receiver/Transmitter #1
4. OADS Converter
5. System Coupler Computer #2
6. IFF Receiver/Transmitter
7. Audio Mixer
8. TCAS or Kit 1C
9. VHF/FM Receiver/Transmitter
10. Voice Flight Data Recorder
11. Signal Interface Unit
12. GPS Fill Panel
13. Yaw Rate Gyros and Accelerometers
14. VHF/UHF Receiver/Transmitter #2
15. FD Computer
16. AFCS Computer
17. TACAN
18. VHF NAV Receiver
19. LF–ADF Receiver
20. IAS Transducer
21. Mission Data Loader (MDL)
22. Diplexer
23. ADU 3000

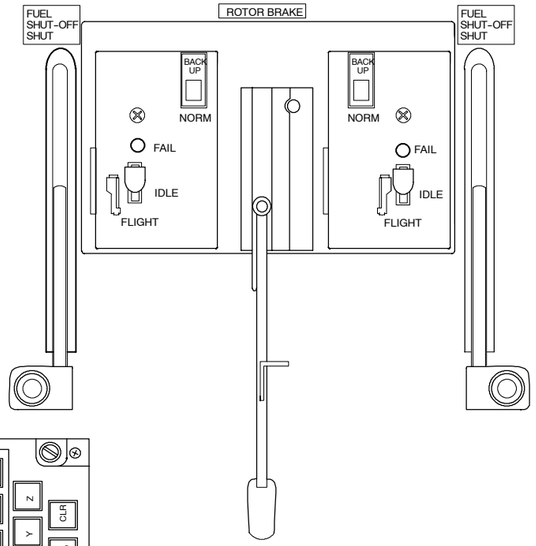
*Figure FO-1. General Arrangement Diagram*



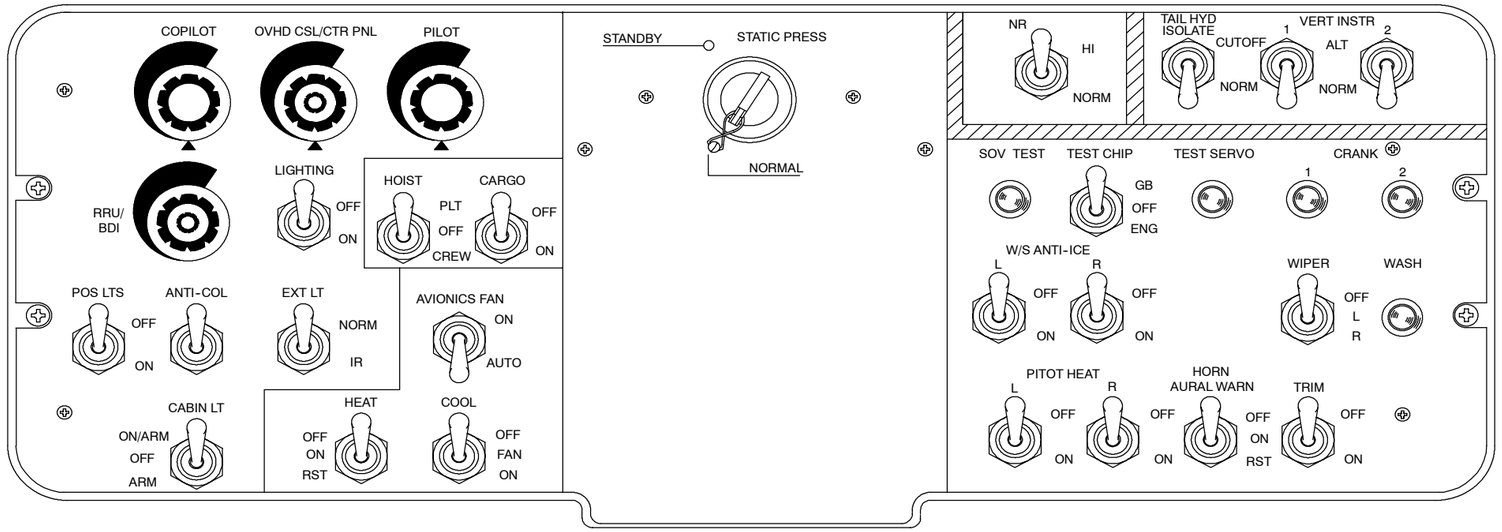




1. Remote Microphone Switch
2. Limit Light
3. Airspeed Indicator
4. Pilots NR/N2 Tachometer
5. Copilot NR Tachometer
6. Total Pressure System Shutoff Valve
7. Static Pressure System Shutoff Valve
8. Landing Gear Warning Light
9. Master Warning Light
10. Attitude Director Indicator
11. Multifunction Display
12. NAV CTL/LOW ALT Light
13. O/M/I Marker Beacon Lights
14. Radar Altimeter
15. Barometric Altimeter
16. VSI–TCAS Indicator
17. COMM–2 Remote Readout Unit (RRU)
18. Engine 1 Fire Detection System Test Switch
19. Engine 1 Secondary Extin–guisher Actuator Pushbutton
20. Engine 1 Fire and Detector Fail Warning Lights
21. Engine 1 Primary Extinguisher Actuator Pushbutton
22. Engine 2 Primary Extinguisher Actuator Pushbutton
23. Engine 2 Fire and Detector Fail Warning Lights
24. Engine 2 Secondary Extinguisher Actuator Pushbutton
25. Engine 2 Fire Detection System Test Switch
26. COMM–1 Remote Readout Unit (RRU)
27. Warning Caution Advisory Panel
28. VEMD
29. Start Rotor Brake Switch
30. Fuel Management Panel
31. Clock
32. Electrical Control Panel
33. Avionics Mode Annunciator Panel
34. Bearing Distance Indicator (BDI)
35. Radar Operating Caution Light
36. MGB Fire and Detector Fail Warning Lights
37. MGB Fire Detection System Test Switch
38. Marker Beacon Sensitivity Switch
39. Landing Gear Control Handle
40. Landing Gear Position Indicator
41. TALON Master Switch
42. Pilot and Copilot Avionic Switches

*Figure FO-2. Cockpit Instruments and Controls (sheet 1 of 2)*

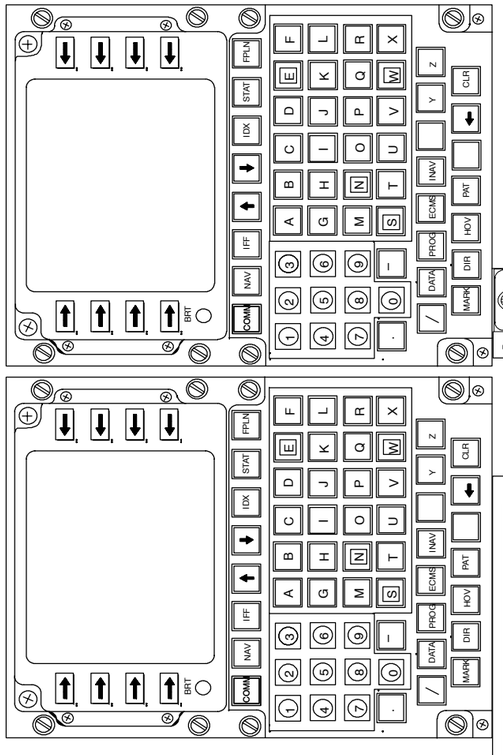



**OVERHEAD QUADRANT**




**OVERHEAD CONTROL PANEL**

**PILOT'S CONTROL DISPLAY UNIT**



**COPILOT'S CONTROL DISPLAY UNIT**




*Figure FO-2.. Cockpit Instruments and Controls (sheet 2 of 2)*

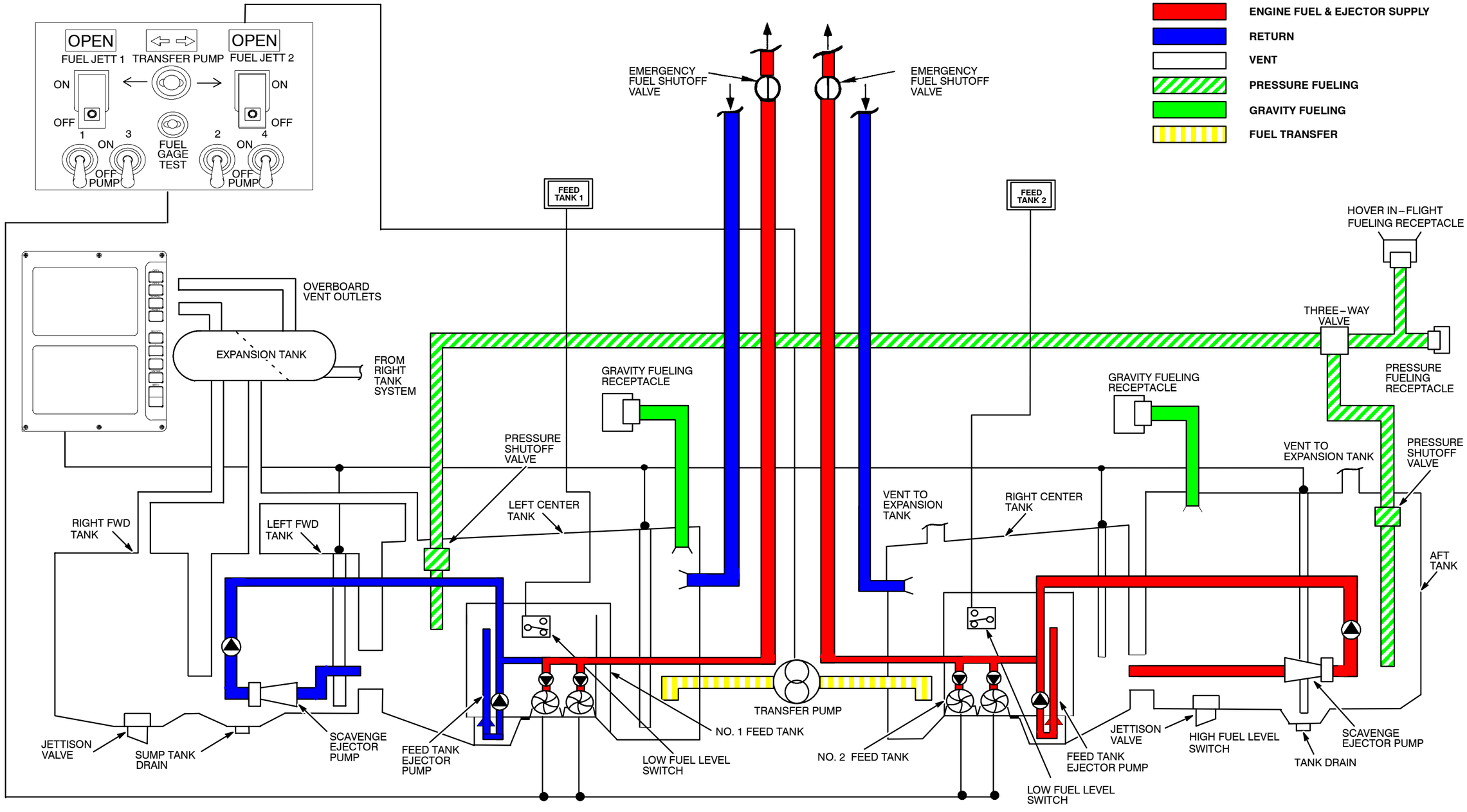



*Figure FO-3. Fuel Supply System*

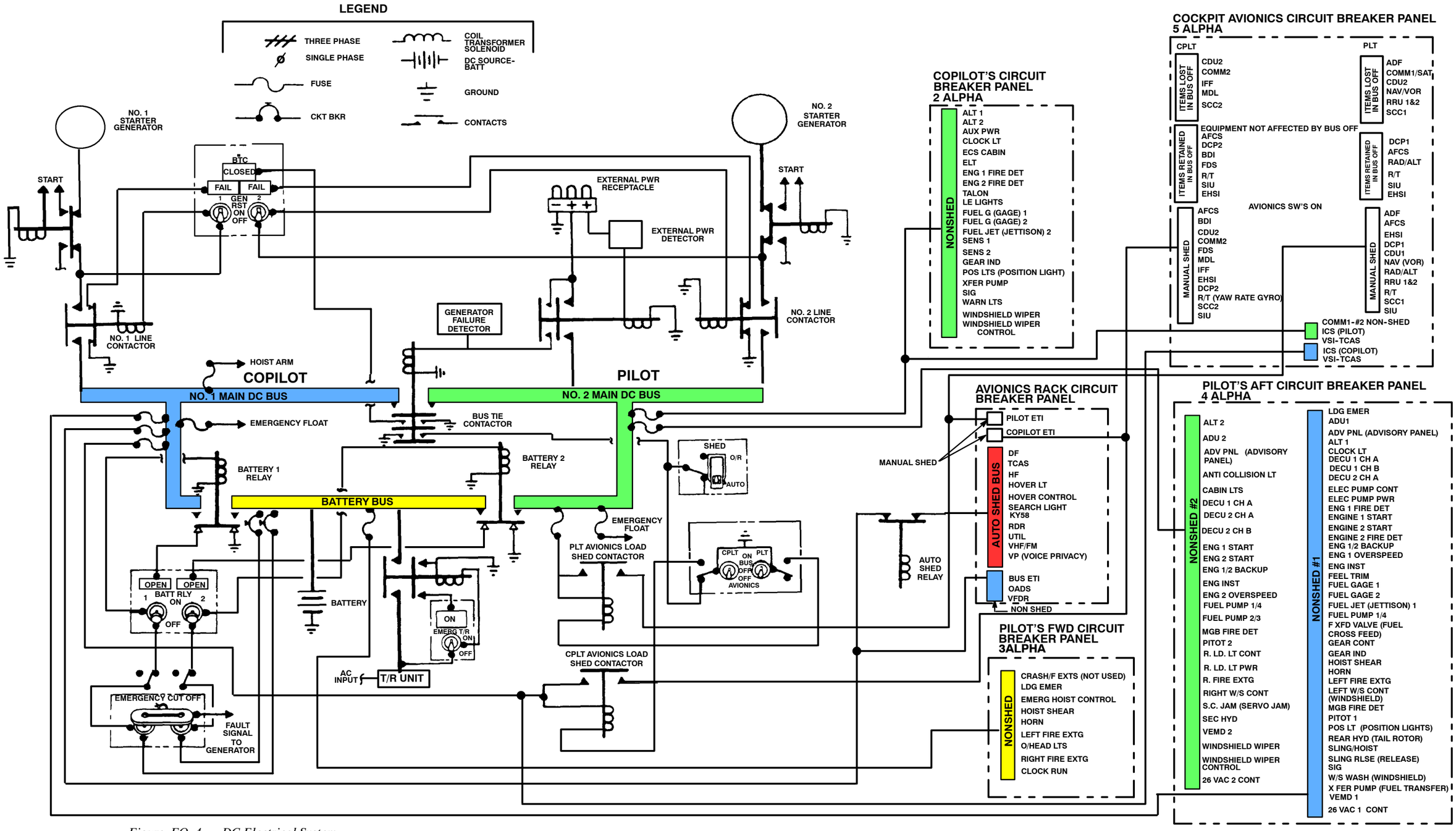



*Figure FO-4. DC Electrical System*

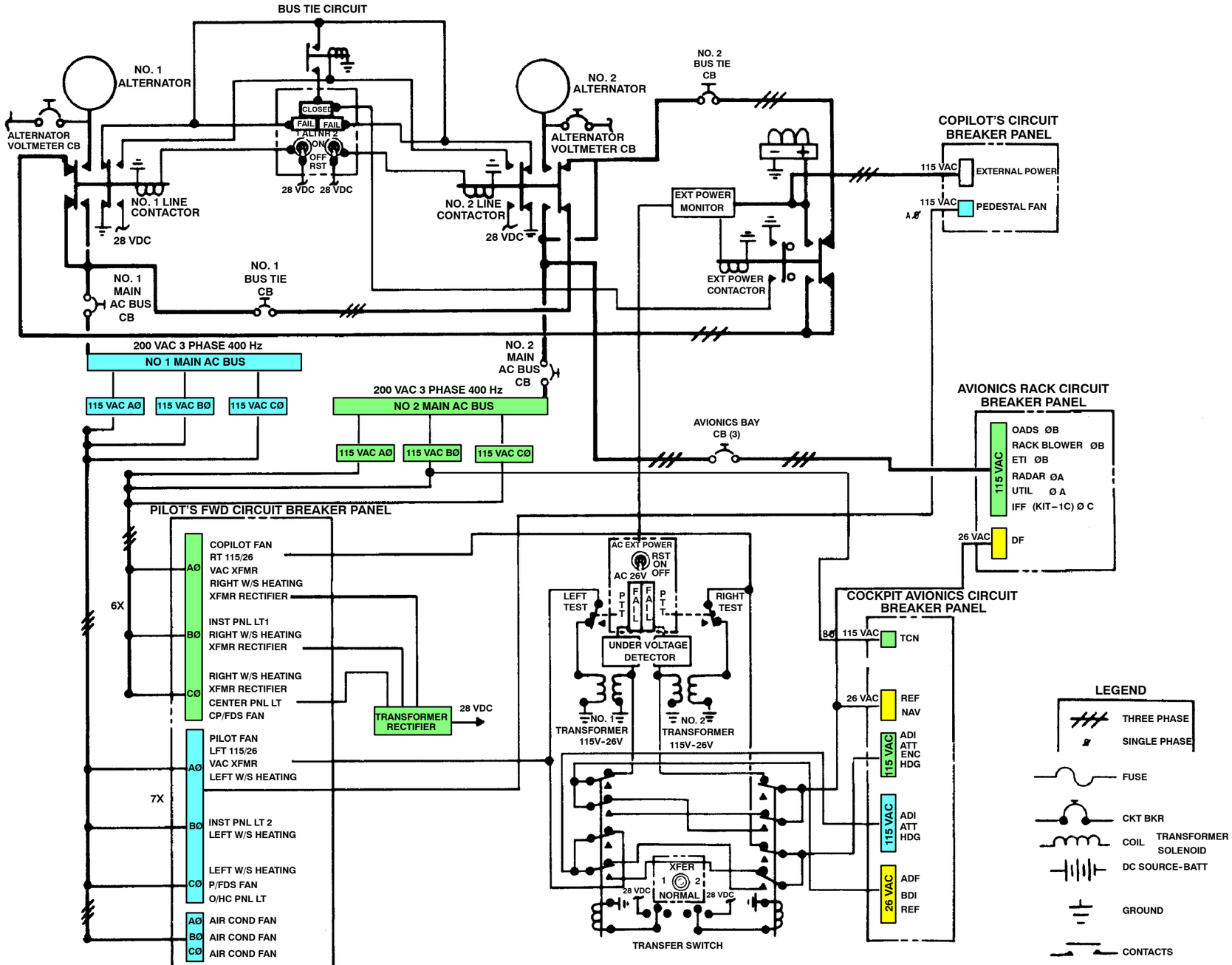



*Figure FO-5. AC Electrical System*

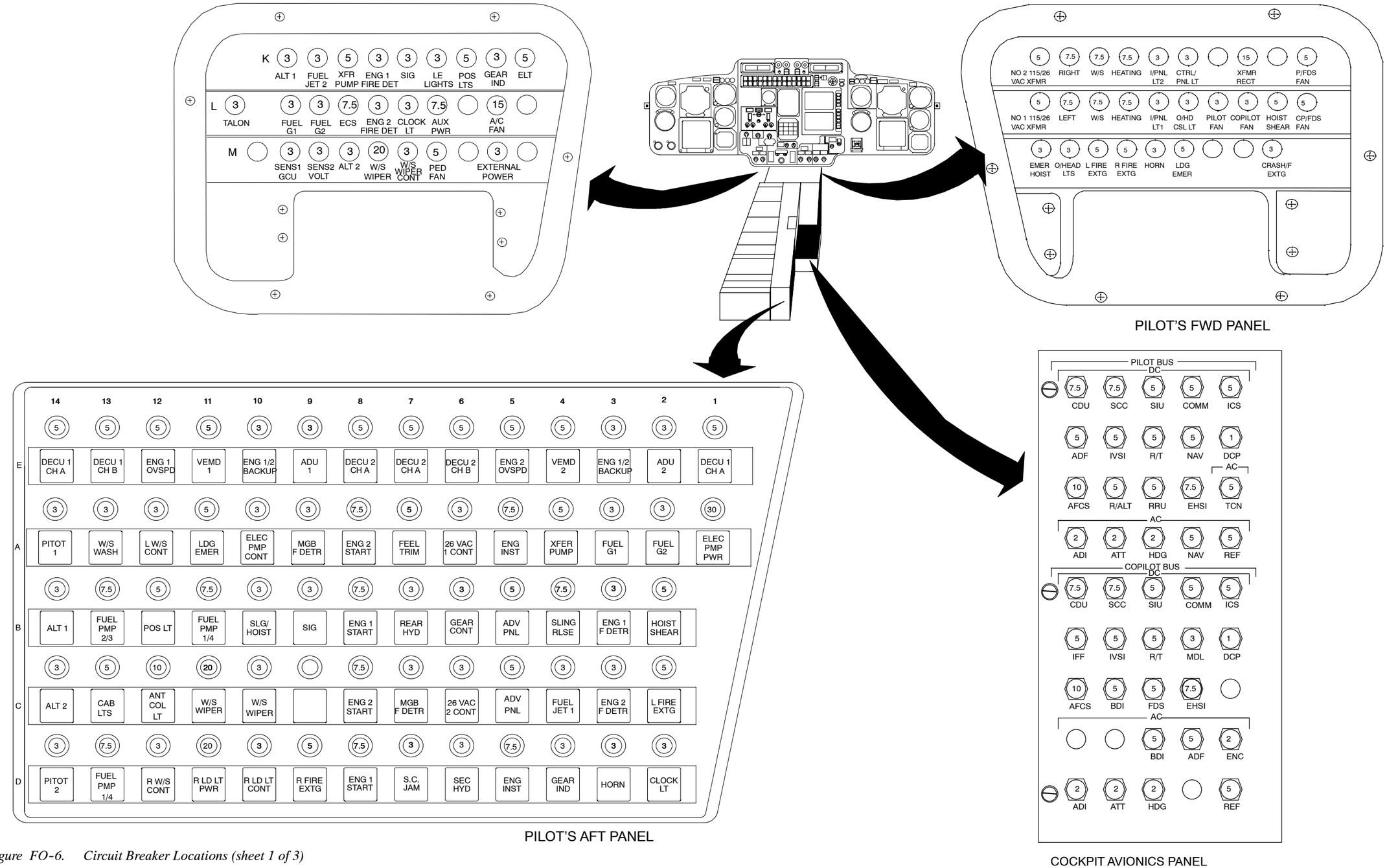



*Figure FO-6. Circuit Breaker Locations (sheet 1 of 3)*

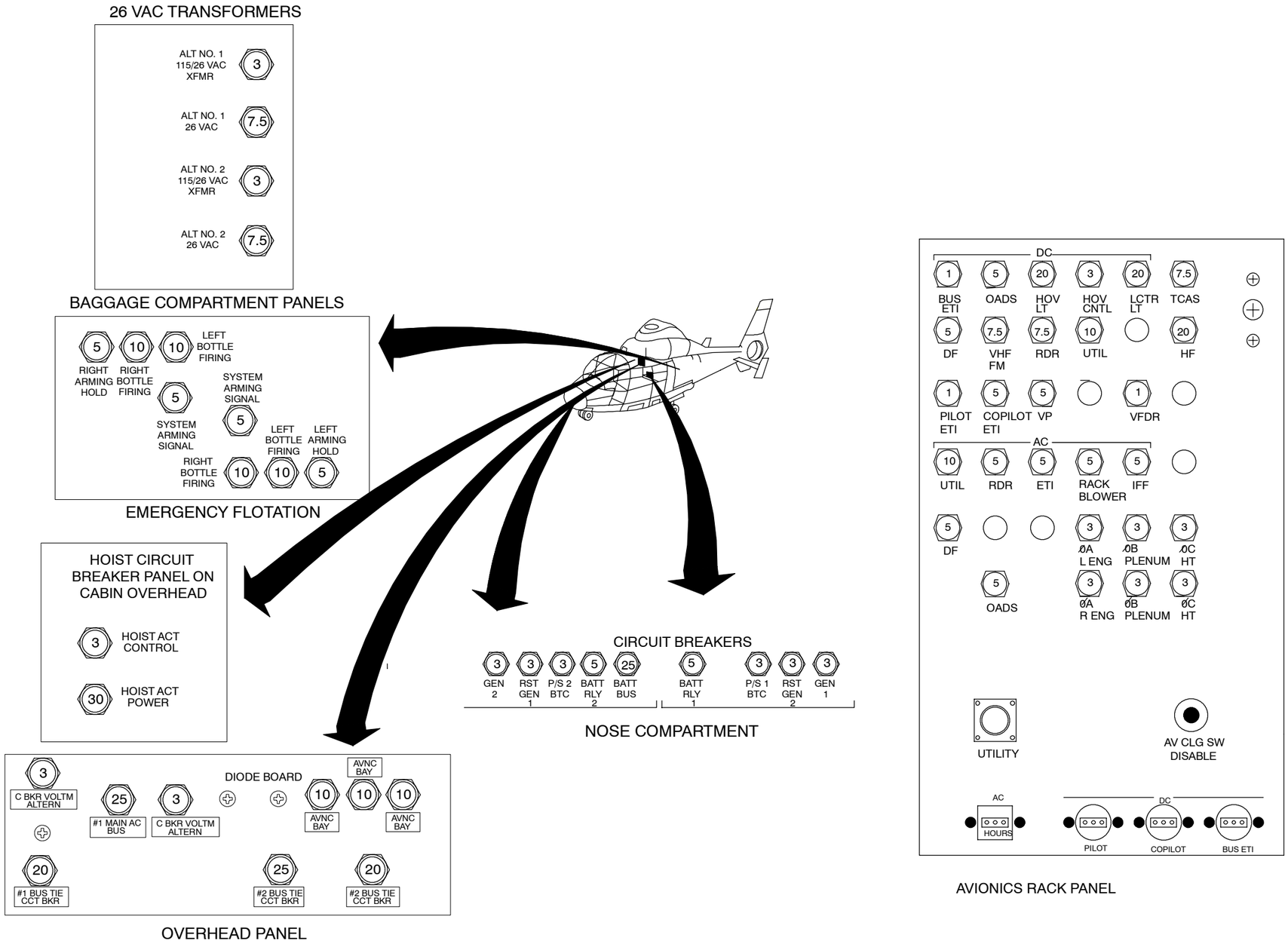



*Figure FO-6. Circuit Breaker Locations (sheet 2 of 3)*

## OVERHEAD PANEL

| LEGEND | CIRCUIT FUNCTION |
|---|---|
| MAIN AC BUS (left)<br>C BKR VOLTM<br>ALTERN (left) | 3 phase power from No. 1 alternator.<br>Voltmeter indication from No. 1 alternator. |
| BUS TIE CCT BKR (left)<br>AVNC BAY (3) | No. 1 bus tie circuit.<br>Phase A, B, and C to AC circuits on avionics rack. |
| C BKR VOLTM<br>ALTERN (right) | Voltmeter indication from No. 2 alternator. |
| MAIN AC BUS (right)<br>BUS TIE CCT BKR (right) | 3 phase power from No. 2 alternator.<br>No. 2 bus tie circuit. |

## HOIST PANEL

| LEGEND | CIRCUIT FUNCTION |
|---|---|
| HOIST ACT CONTL<br>HOIST ACT POWER | Control circuit for boom.<br>Power to boom stow switch and boom motor. |

## 26 VAC TRANSFORMER PANEL

| LEGEND | CIRCUIT FUNCTION |
|---|---|
| ALT No. 1<br>115/26 VAC XFMR | 115 VAC to left 115/26 VAC circuit. |
| ALT No. 1<br>26 VAC | 26 VAC from left 115/26 VAC circuit. |
| ALT No. 2<br>115/26 VAC XFMR | 115 VAC to right 115/26 VAC circuit. |
| ALT No. 2<br>26 VAC | 26 VAC from right 115/26 VAC circuit. |

## AVIONICS RACK PANEL

| LEGEND | CIRCUIT FUNCTION |
|---|---|
| BUS ETI | DC BUS elapsed time indicator. |
| OADS (DC) | OADS converter. |
| HOV LT | Hover light power. |
| HOV CONT | Hover light control. |
| LCTR | Nite Sun power and control. |
| DF | DF 301. |
| VHF FM | VHF/FM receiver/ transmitter. |
| RDR (DC) | Radar On light and radar receiver/ transmitter. |
| UTIL | 28 VDC utility receptacle power. |
| LOUD HAIL | Loudhailer amplifier power. |
| HF | HF power amplifier, coupler and receiver/exciter. |
| PILOT ETI | Pilot's elapsed time indicator. |
| COPILOT ETI | Copilot's elapsed time indicator. |
| VP | KY 58 power. |
| UTIL | 115 VAC utility receptacle power. |
| RDR (AC) | Radar antenna drive. |
| ETI | AC elapsed time indicator. |
| RACK BLOWER | Avionics fan power. |
| IFF | APX–100 receiver/transmitter. |
| DF | 26 VAC to DF–301. |
| OADS (AC) | OADS converter and sensors drive motor. |
| GPS CTL | GPS control. |
| DDU1 | Provides 26 VAC ref voltage to the No.1 DDU for pitch and roll input. |
| DDU2 | Provides 26 VAC ref voltage to the No.2 DDU. |
| VFDR | Voice Flight Data Recorder Power |
| TCAS | TCAS TRC791A power. |

## COPILOT'S PANEL

| LEGEND | CIRCUIT FUNCTION |
|---|---|
| *ALT 1 | Copilot's barometric altimeter vibrator power. |
| FUEL JET 2 | Right fuel system jettison valve. |
| *XFER PUMP | Fuel transfer pump. |
| *ENG 1 F DETR | Left engine fire detector system. |
| *SIG | Secondary hydraulic low pressure annunciation on W–C–A panel. |
| ENG 2 OEI | Right engine OEI 1 minute power system. |
| *POS LTS | Position lights. |
| *GEAR IND | Landing gear panel lights and 200 ft gear warning lights. |
| ELT | ELT transmitter. |
| *FUEL G1 | Fuel quantity indicator for left fuel system. |
| *FUEL G2 | Fuel quantity indicator for right fuel system. |
| ECS CABIN | Cabin temperature regulator switch. |
| *ENG 2 F DETR | Right engine fire detector system. |
| *CLOCK LT | Analog readout on electric clock. |
| AUX PWR | Overhead utility receptacle (DC). |
| AIR COND FAN | Air conditioning fan power. |
| ENG 1 OEI | Left engine OEI 1 minute power system. |
| SENS 1 (GCU–VOLT) | Left DC voltage regulator. |
| SENS 2 (GCU–VOLT) | Right DC voltage regulator. |
| *ALT 2 | Pilot's barometric altimeter vibrator power. |
| W/S WIPER | Windshield wiper power. |
| *W/S WIPER CONT | Windshield wiper motor control circuit. |
| PED FAN | Pedestal fan motor circuit. |
| EXTERNAL PWR | External power monitor circuit. |
| TALON | TALON control circuit. |

## PILOT'S FORWARD PANEL

| LEGEND | CIRCUIT FUNCTION |
|---|---|
| LFT 115/26 V.XFMR<br>RIGHT W/S HEATING | Left 115/26 volt AC transformer.<br>Three phase power to right windshield temperature regulator and heating elements. |
| I/PNL LT 2 | Pilot's instrument panel lights. |
| O/HD PNL LT | Overhead control panel lights. |
| XFMR RECT | Transformer rectifier input power. |
| RT 115/26 V.XFMR<br>LEFT W/S HEATING | Right 115/26 volt AC transformer.<br>Three phase power to left windshield temperature regulator and heating elements. |
| I/PNL LT 1 | Copilot's instrument panel lights. |
| CONS PNL LT | Center console lights. |
| PILOT FAN | Pilot's instrument panel blower. |
| COPILOT FAN | Copilot's instrument panel blower. |
| HOIST SHEAR | Hoist shear circuit. |
| EMER HOIST CONTROL | Hoist emergency control circuit. |
| O/HEAD LIGHTS | Pilot's and copilot's overhead spotlights. |
| *L FIRE EXTG | Left fire extinguisher bottle. |
| *R FIRE EXTG | Right fire extinguisher bottle. |
| *HORN | Rotor speed detector and horn warning circuit. |
| *LDG EMER | Landing gear emergency extension. |
| *F. XFD VALVE | Fuel crossfeed valve. |
| CLOCK RUN | Electric clock power. |

* Indicates redundantly powered functions.

## PILOT'S AFT PANEL

| LEGEND | CIRCUIT FUNCTION |
|---|---|
| PITOT 1 | Left pitot tube heater and caution annunciator. |
| W/S WASH | Windshield washer motor and timing circuit. |
| L W/S CONT | Left windshield heating control circuit. |
| *LDG EMER | Landing gear emergency extension circuit. |
| ELEC PMP CONT | Electric hydraulic pump control circuit. |
| *MGB F DETR | MGB fire detector and control circuit. |
| ENG 1 A. ICE | Left engine anti–ice valve. |
| FEEL TRIM | Beep trim for pitch and roll. |
| 26 VAC 1 CONT | Left 26 VAC transfer circuit. |
| ENG INST | Vertical scale instruments (No. 1 system). |
| *XFER PUMP | Fuel transfer pump. |
| *FUEL G2 | Fuel quantity indicator for right fuel system. |
| *FUEL G1 | Fuel quantity indicator for left fuel system. |
| ELEC PMP PWR | Electric hydraulic pump motor power. |
| *ALT 1 | Copilot's barometric altimeter vibrator power. |
| ANTIC 1 | Left engine anticipator system. |
| *POS LTS | Position lights. |
| *F XFD VALVE | Fuel crossfeed valve. |
| SLG/HOIST | Cargo hook and hoist control. |
| *SIG | Secondary hydraulic low pressure annunciation on W–C–A panel. |
| ENG 1 START | Left engine starter circuit. |
| REAR HYD | Tail rotor servo control solenoid valve. |
| GEAR CONT | Landing Gear Control Circuit. |
| *ADV PNL | Warning–Caution–Advisory (W–C–A) panel power. |
| SLING RLSE | Cargo hook release circuit. |
| *ENG 1 F.DETR | Left engine fire detector system. |
| HOIST SHEAR | Hoist shear circuit. |
| *ALT 2 | Pilot's barometric altimeter vibrator power. |
| CAB LTS | Overhead cabin lights and power to emergency lighting. |
| ANT COL LT | Anticollision light circuit. |
| *W/S WIPER | Windshield wiper power. |
| *W/S WIPER C | Windshield wiper motor control circuit. |
| ECS A/BAY | Avionics rack temperature sensor. |
| ENG 2 A–ICE | Right engine anti–ice valve. |
| *MGB F DETR | MGB fire detector control unit and detectors. |
| 26 VAC 2 CONT | Right 26 Vac transfer circuit. |
| *ADV PNL | Warning–Caution–Advisory (W–C–A) panel power. |
| FUEL JET 1 | Left fuel system jettison valve. |
| *ENG 2 F DETR | Right engine fire detector system. |
| *L FIRE EXTG | Left fire extinguisher bottle. |
| PITOT 2 | Right pitot tube heater and caution annunciator. |
| ANTIC 2 | Right engine anticipator system. |
| R W/S CONT | Right windshield heating control circuit. |
| R LD LT PWR | Pilot's landing light power. |
| R LD LT CONT | Pilot's landing light control. |
| *R FIRE EXTG | Right fire extinguisher bottle. |
| ENG 2 START | Right engine starter circuit. |
| S.C. JAM | Servocontrol jam circuit. |
| SEC HYD | Secondary hydraulic system reservoir low level probe and tail rotor isolate valve. |
| ENG INST | Vertical scale instruments (No. 2 system). |
| *GEAR IND | Landing gear panel lights and 200 ft. gear warning lights. |
| *HORN | Rotor speed detector and horn warning circuit. |
| *CLOCK LT | Analog readout on electric clock. |

## COCKPIT AVIONICS PANEL (PILOT BUS)

| LEGEND | CIRCUIT FUNCTION |
|---|---|
| CCD | Pilot's CCD power. |
| SCC | SCC 1 power. |
| *SIU | SIU power. |
| COMM | COMM1 and pilot audio control panel. |
| ICS | Pilot's audio control panel, aux control panels and audio mixer. |
| ADF | ADF–60A. |
| R/T | Pilot's yaw rate gyro. |
| NAV (DC) | NAV receiver, and outer, middle, and inner marker beacon lights. |
| HSVD (DC) | Pilot's HSVD control panel and DDU 1. |
| AFCS | AFCS engage panel, AFCS comp, YAW servo, Collective servo and Trim feel unit. |
| R/ALT | Pilot's and copilot's R/ALT indicator, and pilot's and copilot's ADI Decision Height light. |
| RRU | Left and right RRUs. |
| TCN | TACAN receiver/transmitter. |
| MCU | Mission computer. |
| ADI | Pilot's ADI power. |
| ATT | Pilot's vertical gyro. |
| HDG | Pilot's directional gyro. |
| NAV (AC) | 26 VAC to VOR, NAV receiver and VOR #1 and #2 pointers on BDI. |
| HSVD (AC) | Pilot's HSVD control panel and DDU 1. |
| VSI PLT | Pilot's VSI–TCAS indicator power. |

## COCKPIT AVIONICS PANEL (COPILOT BUS)

| LEGEND | CIRCUIT FUNCTION |
|---|---|
| CCD | Copilot's CCD power. |
| SCC | SCC 2 power. |
| *SIU | SIU power. |
| COMM | COMM 2 and copilot audio control panel. |
| ICS | Copilot's audio control panel, hoist operator control panel, and audio mixer. |
| IFF | Power to IFF receiver/transmitter. |
| R/T | Copilot's yaw rate gyro. |
| HSVD (DC) | Copilot's HSVD control panel and DDU 2. |
| AFCS | AFCS engage panel and AFCS computer. |
| BDI (DC) | BDI–36 power. |
| FDS | FD panel and computer. |
| BDI (AC) | BDI–36 power. |
| ADF | 26 VAC to ADF–60A and pilot's and copilot's HSVDs. |
| ENC | Power to encoder on pilot's barometric altimeter. |
| ADI | Copilot's ADI power. |
| ATT | Copilot's vertical gyro. |
| HDG | Copilot's directional gyro. |
| VSI CPLT | Copilot's VSI–TCAS indicator power. |
| HSVD (AC) | Copilot's HSVD control panel and DDU 2. |
| GPS | GPS power. |



*Figure FO-6. Circuit Breaker Locations (sheet 3 of 3)*

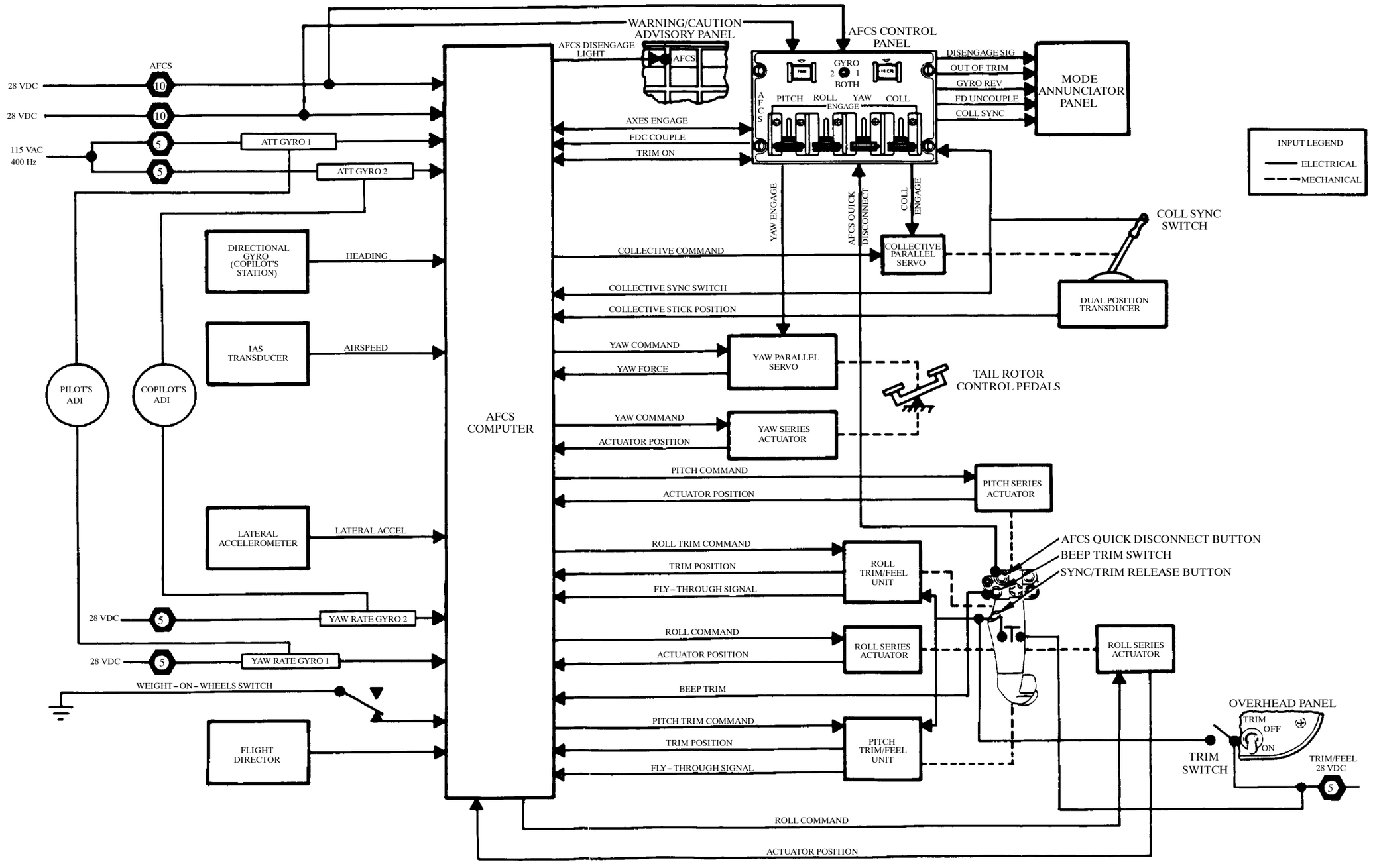



*Figure FO-7. Automatic Flight Control System Block Diagram*

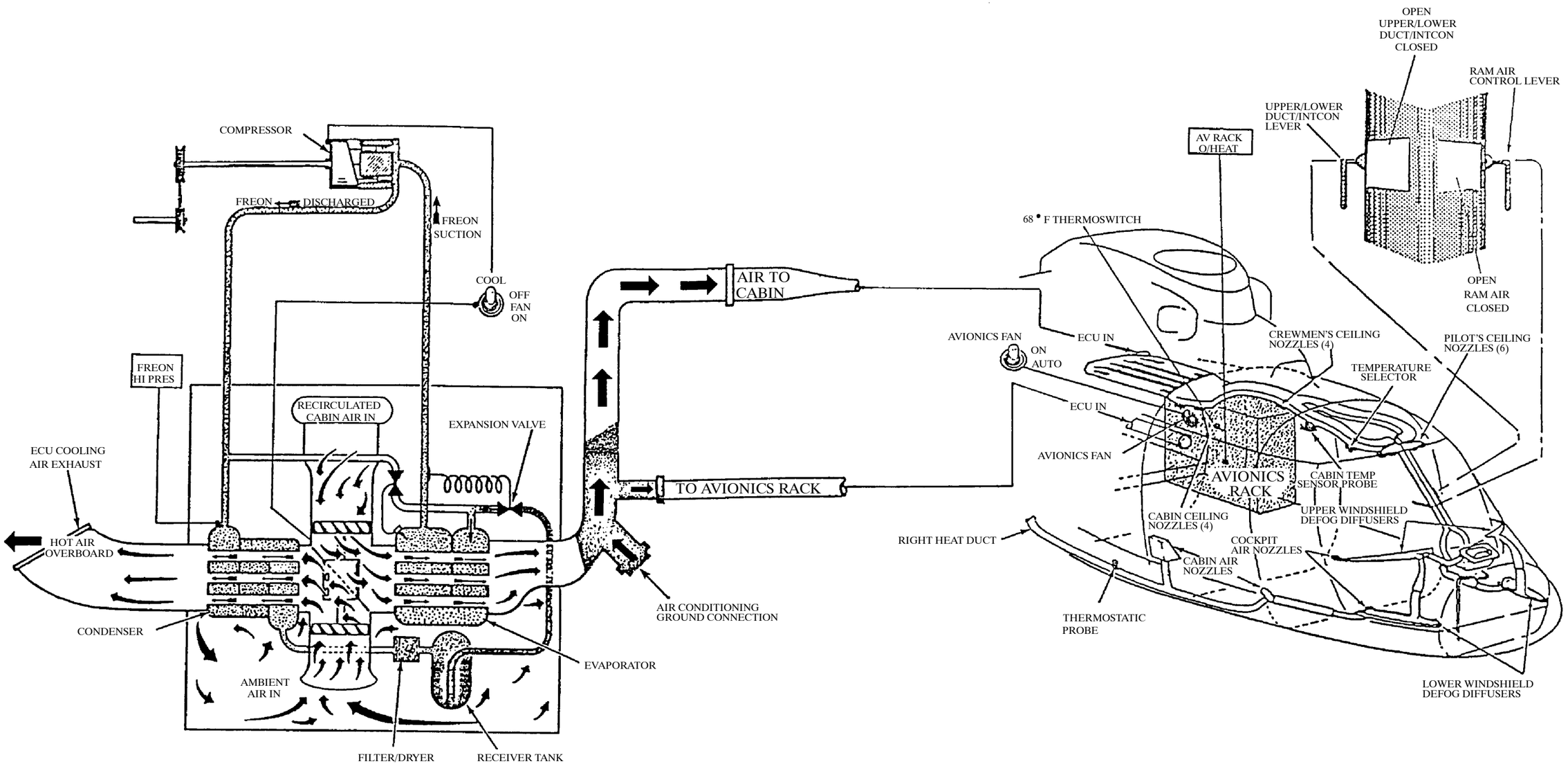



*Figure FO-8. Environmental Control System Diagram*

# US COAST GUARD
# RESCUE SWIMMER HAND SIGNALS

## DAY SIGNALS



FIGURE 1

SIGNAL – "RAISED ARM"
MEANING – I AM ALL RIGHT



FIGURE 2

SIGNAL – "VIGOROUS WAVING OF ONE ARM"
MEANING – IN TROUBLE NEED ASSISTANCE

## DAY OR NIGHT SIGNALS



FIGURE 3

SIGNAL – "RAISED ARM THUMB UP"
MEANING – MOVE IN FOR PICKUP



FIGURE 4

SIGNAL – "CLENCHED FIST, ARMS CROSSED OVERHEAD"
MEANING – DEPLOY RAFT



FIGURE 5

SIGNAL – "HAND HELD TO EAR"
MEANING – MONITOR RADIO



FIGURE 6

SIGNAL – "ONE ARM RAISED AND EXTENDED VERTICALLY WITH THE PALM OPEN FACING FORWARD. THE OTHER ARM SHALL BE RAISED SO THAT IT CROSSES OVER THE SWIMMER'S HEAD AND TOUCHES THE FIRST ARM AT THE ELBOW"
MEANING – DEPLOY RESCUE LITTER



FIGURE 7

SIGNAL – "BOTH ARM'S EXTENDED OVER THE SWIMMER'S HEAD, PALM OPEN FACING FORWARD AT A 45° ANGLE TO THE SIDE OF THE SWIMMER'S HEAD"
MEANING – DEPLOY RESCUE BASKET



FIGURE 8

SIGNAL – "BOTH ARM'S EXTENDED OVER THE SWIMMER'S HEAD, WITH FINGERS INTERLOCKED"
MEANING – DEPLOY RESCUE STROP

## AFTER HOOK UP TO RESCUE HOOK



FIGURE 9

SIGNAL – "ARM RAISED, THUMB UP"
MEANING – READY TO BE HOISTED



FIGURE 10

SIGNAL – "ARM RAISED, CLENCHED FIST"
MEANING – STOP HOISTING



FIGURE 11

SIGNAL – "ARM RAISED, THUMB DOWN"
MEANING – LOWER CABLE

## NIGHT/LOW VISIBILITY



FIGURE 12

SIGNAL – "WAVE SIGNAL DEVICE"
MEANING – MOVE IN FOR PICK UP
(NIGHT OR LOW VISIBILITY)



FIGURE 13

SIGNAL – "WAVE SIGNAL DEVICE"
MEANING – ALTERNATE MOVE IN FOR PICK UP
(NIGHT OR LOW VISIBILITY)



FIGURE 14

SIGNAL – "STROBE ON"
MEANING – IN TROUBLE, NEED ASSISTANCE

*Figure FO-9. U.S. Coast Guard Rescue Hand Signals*

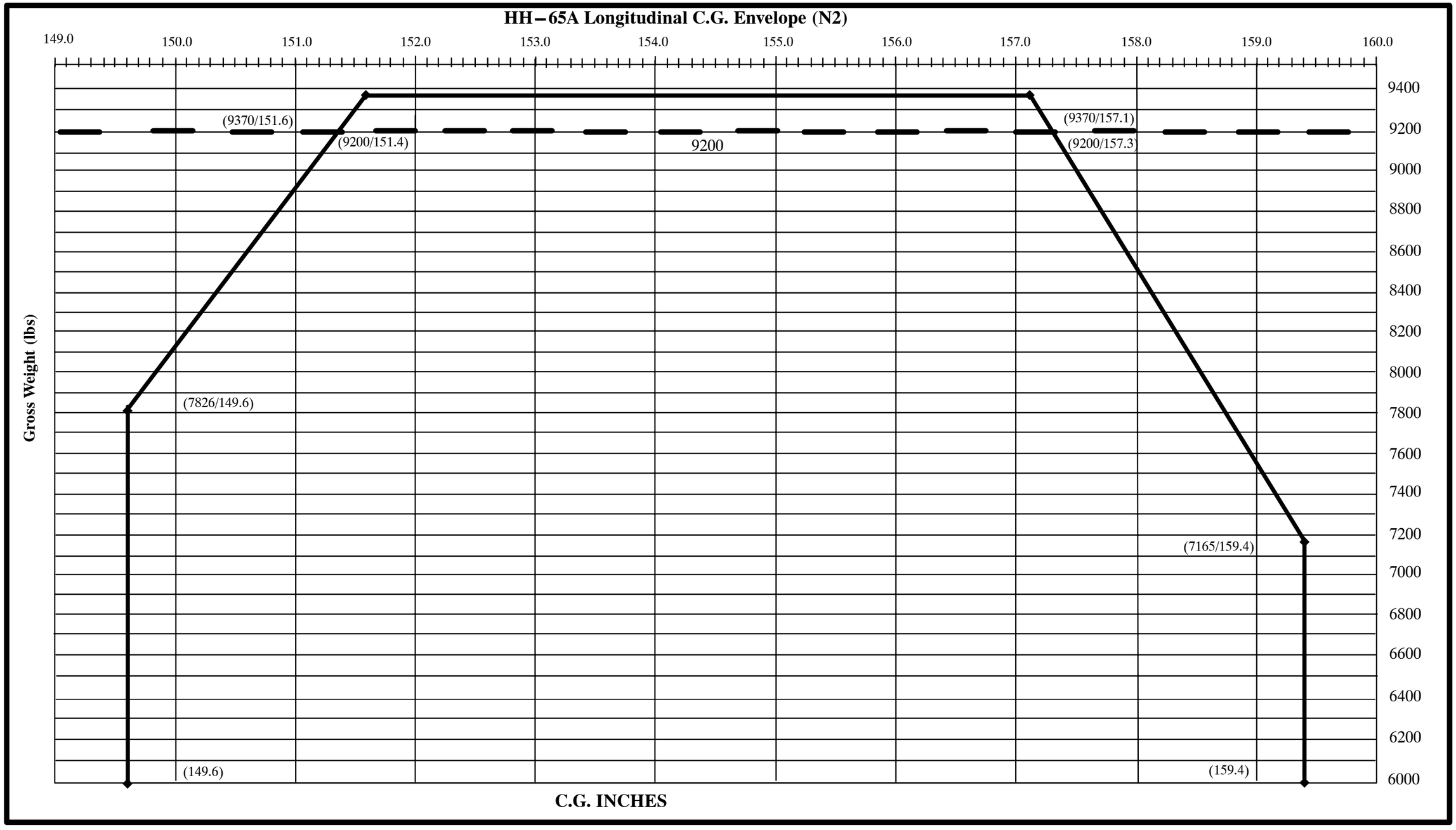



*Figure FO-10. Center of Gravity Envelope*

# US COAST GUARD
# RESCUE SWIMMER HAND SIGNALS

## DEPLOYMENT HAND SIGNALS



FIGURE 1

SIGNAL – "EXTEND ARM THEN BEND ELBOW TO TOUCH HEAD WITH OPEN PALM"
MEANING – UP

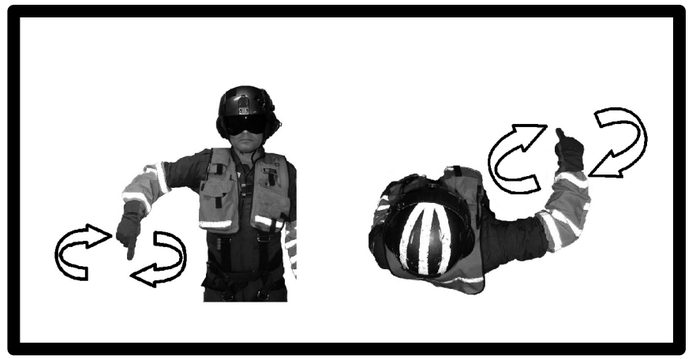


FIGURE 2

SIGNAL – "WITH FINGER POINTED DOWN, ROTATE FOREARM IN HORIZONTAL CIRCLE"
MEANING – DOWN

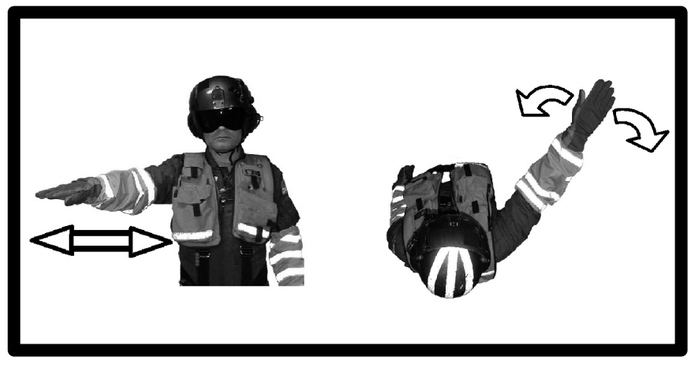


FIGURE 3

SIGNAL – "SWEEP HORIZONTAL USING ENTIRE ARM"
MEANING – LEVEL OFF

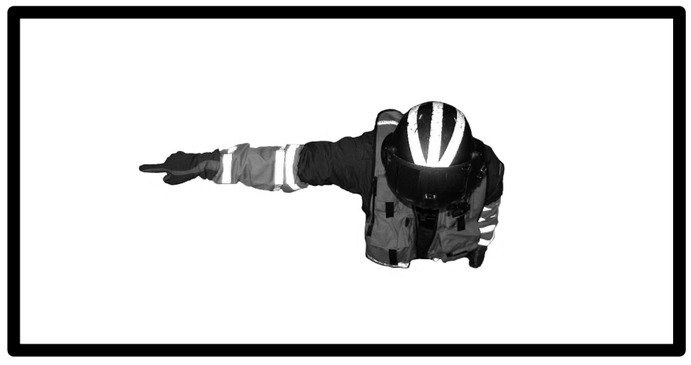


FIGURE 4

SIGNAL – "POINT IN DIRECTION OF DESIRED MOVEMENT"
MEANING – MOVE IN DIRECTION INDICATED

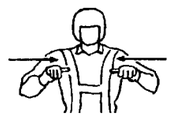
*Figure FO-11. Rescue Swimmer Direct Deployment Hand Signals*

| SIGNAL | DAY | NIGHT | REMARKS |
|---|---|---|---|
|  LANDING DIRECTION | LSO stands with arms raised vertically above head and facing toward the point where the aircraft is to land. The arms are lowered repeatedly from a vertical to a horizontal position, stopping finally in the horizontal position. | Same as day signal with addition of wands. | |
|  MOVE UPWARD | Arms extended horizontally sideways beckoning upwards, with palms turned up. Speed of movement indicates rate of ascent. | Same as day signal with addition of wands. | Conforms to ICAO signal. |
|  HOVER | Arms extended horizontally sideways, palms downward. | Same as day signal with addition of wands. | Conforms to ICAO signal. |
|  MOVE DOWNWARD | Arms extended horizontally sideways beckoning downwards, with palms turned down. Speed of movement indicates rate of descent. | Same as day signal with addition of wands. | Conforms to ICAO signal. |
|  MOVE BACK | Arms by sides, palms facing forward, swept forward and upward repeatedly to shoulder height. | Same as day signal with addition of wands. | Conforms to ICAO signal. |
|  TURN TO LEFT | Point right arm downward, left arm is repeatedly moved upward – backward. Speed of arm movement indicates rate of turn. | Same as day signal with addition of wands. | Also used for spot turns for airborne aircraft. Conforms to ICAO signal. |
|  TURN TO RIGHT | Point left arm downward, right arm is repeatedly moved upward – backward. Speed of arm movement indicates rate of turn. | Same as day signal with addition of wands. | Also used for spot turns for airborne aircraft. Conforms to ICAO signal. |
|  MOVE AHEAD | Arms extended from body and held horizontal to shoulders with hands upraised and above eye level, palms facing backwards. Execute beckoning arm motion angled backward. Rapidly indicates speed desired of aircraft. | Same as day signal with addition of wands. | |

*Figure FO-12. Ship/Helicopter Landing Signals (sheet 1 of 2)*

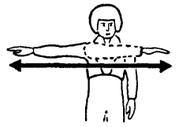
| SIGNAL | DAY | NIGHT | REMARKS |
|---|---|---|---|
|  MOVE TO LEFT | Right arm extended horizontally sideways in direction of movement and other arm swung over the head in same direction, in a repeating movement. | Same as day signal with addition of wands. | |
|  MOVE TO RIGHT | Left arm extended horizontally sideways in direction of movement and other arm swung over the head in same direction, in a repeating movement. | Same as day signal with addition of wands. | |
|  LOWER WHEELS | When aircraft approaches LSO with landing gear retracted, LSO gives signal by side view of a cranking circular motion of the hands. | Same as day signal with addition of wands. | |
|  WAVEOFF | Waving of arms over the head. | Same as day signal with addition of wands. | Signal is mandatory. |
|  LAND | Arms crossed and extended downwards in front of the body. | Same as day signal with addition of wands. | Conforms to ICAO signal. |
|  DROOP STOPS OUT | When rotor starts to “run down” LSO stands with both hands raised above head, fists closed, thumbs pointing out. | Same as day signal with addition of wands. | |
|  DROOP STOPS IN | When droop stops go in, LSO turns thumbs inward. | Same as day signal with addition of wands. | |
|  START ENGINES | Left hand overhead with appropriate number of fingers extended, to indicate the number of the engine to be started, and circular motion of right hand at head level. | Similar to day signal except the wand in the left hand will be flashed to indicate the engine to be started. | Conforms to ICAO signal. |

| SIGNAL | DAY | NIGHT | REMARKS |
|---|---|---|---|
|  READY TO START ENGINE (pilot) | Moves hand in a circle perpendicular to the deck; follows with a “thumbs up” signal. Signify by number of fingers engine to be started. | Turns on flashlight or movable light and moves it in a circle perpendicular to the deck. | |
|  READY TO ENGAGE ROTORS (pilot) | Moves hand in horizontal circle at eye level, index finger extended. Aircraft lights flashing bright. | Same as day signal except holds red light in hand. Aircraft lights flashing dim. | At night, aircraft lights should be on “flashing dim” until aircraft is declared up and ready for takeoff by the pilot. |
|  TAKEOFF | LSO conceals left hand and makes circular motion of right hand over head in horizontal plane ending in a throwing motion of arm towards direction of takeoff. | Same as day signal with addition of wands. | |
|  READY FOR TAKEOFF (pilot) | Gives “thumbs up” signal at eye level. Aircraft lights steady bright. | Places running and formation lights on “steady dim”. May give “thumbs up” signal by turning on flashlight or other movable lights and moving it up and down. | |
|  ENGAGE ROTOR(S) | Circular motion in horizontal plane with right hand above head. | Same as day signal with addition of wands. | |
|  CUT ENGINE(S) | Either arm and hand level with shoulder, hand moving across throat, palm downward. The hand is moved sideways with the arm remaining bent. | Same as day signal with addition of wands. | Conforms to ICAO signal. |
|  CONNECT GROUND ELECTRICAL POWER SUPPLY | Hands above head, left fist partially clenched, right hand moved in direction of left hand with first two fingers extended and inserted into circle made by fingers of the left hand. | Same as day signal with addition of wands. | |
|  DISCONNECT GROUND ELECTRICAL POWER SUPPLY | Hands above head, left fist partially clenched, right hand moved away from left hand, withdrawing first two fingers from circle made by fingers of the left hand. | Same as day signal with addition of wands. | |

| SIGNAL | DAY | NIGHT | REMARKS |
|---|---|---|---|
|  REMOVE CHOCKS | Arms down, fists closed, thumbs extended outwards, swing arms outwards. | Same as day signal with addition of wands. | Conforms to ICAO signal. |
|  INSERT CHOCKS | Arms down, fists closed, thumbs extended inwards, swing arms from extended position inwards. | Same as day signal with addition of wands. | Conforms to ICAO signal. |
|  PERSONNEL APPROACHING THE AIRCRAFT | Left hand raised vertically overhead, palm towards aircraft. The other hand indicates to personnel concerned and gestures towards aircraft. | Same as day signal with addition of wands. | |
|  CLEARANCE FOR PERSONNEL TO APPROACH AIRCRAFT | A beckoning motion with right hand at eye level. | | |
|  INSERT CHOCKS AND/OR INSTALL TIEDOWNS (pilot) | Swings arms together, thumbs extended inwards, at eye level. In single piloted aircraft, pilot may swing one arm alternately from each side, thumb extended inwards. | Moves hand held light or flashlight at eye level in a horizontal plane alternately inwards from each side. | |
|  INSTALL TIEDOWNS (LSO) | To tiedown crew: rotates hands in a circle perpendicular to and in front of body. | Same as day signal with addition of wands. | |
|  REMOVE CHOCKS AND/OR REMOVE TIEDOWNS (pilot) | Swings arms apart, thumbs extended outwards, at eye level. In single piloted aircraft, pilot may swing one arm alternately from each side, thumb extended outwards. | Using hand held light or flashlight, at eye level, flash light on/off at one second intervals. | |
|  REMOVE TIEDOWNS (LSO) | To tiedown crew: makes wiping motion down left arm with right hand. | Same as day signal with addition of wands. | |

| SIGNAL | DAY | NIGHT | REMARKS |
|---|---|---|---|
|  ENGINE FIRE | Describes a large figure eight with one hand and points to the fire area with the other hand. | Same as day signal with addition of wands. | Signal is meant for information only. Specific action to be taken shall be determined by pilot. |
|  LANDING WITH PRIMARY TIEDOWNS (LSO) | To tiedown crew: tap fists together in a horizontal plane in front of body. | Same as day signal with addition of wands. | Signal given prior to helo commencing approach. |
|  TOUCH AND GO LANDING (LSO) | To tiedown crew: taps fist together in a vertical plane in front of body. | Same as day signal with addition of wands. | Signal given prior to helo commencing approach. |
|  TIEDOWNS REMOVED READY FOR TAKEOFF (LSO) | Holds right thumb at eye level; holds left fist at eye level. | Same as day signal with addition of wands. | |
|  DISENGAGE ROTORS (LSO) | Holds left fist above head; makes throat cutting motion with right hand. | Same as day signal with addition of wands. | |
|  CARGO HOOK NOT DOWN/UP | Arms extended, makes short up and down cutting action alternating hands. | Same as day signal with addition of wands. | |
|  BRAKES | "ON" Arms above head, open palms and fingers raised with palms toward aircraft, then fist closed.<br>"OFF" Arms above head, palms towards aircraft, fists closed, then open with fingers raised. | "ON" Arms above head, with signal wands uncrossed, then crossed.<br>"OFF" Arms above head, with signal wands crossed, then uncrossed. | |
|  HOLD POSITION | Makes clenched fists at eye level. | Holds crossed signal wands overhead. | Signal is mandatory. |

| | | | |
|---|---|---|---|
|  LOCK TAIL WHEEL | Hands together overhead, opened from the wrists in a "V", then closed suddenly. | Same as day signal with addition of wands. | |
|  HOOK UP LOAD | Rope climbing motion with hands. | Same as day signal with addition of wands. | |
|  RELEASE LOAD | Left arm extended forward horizontally, fist clenched, right hand making horizontal slicing motion below the left fist, palm downward. | Same as day signal with addition of wands. | |
|  LOAD HAS NOT BEEN RELEASED | Bend left arm horizontally across chest with fist clenched, palm downward; open right hand pointed up vertically to center of left fist. | Same as day signal with addition of wands. | |
|  WINCH (HOIST) UP | Left arm horizontal in front of body, fist clenched, right hand with palm turned upwards making upward motion. | Same as day signal with addition of wands. | |
|  WINCH (HOIST) DOWN | Left arm horizontal in front of body, fist clenched, right hand with palm turned downwards making downward motion. | Same as day signal with addition of wands. | |
|  CUT (SHEAR) CABLE | A signal similar to "RELEASE LOAD", except that the right hand has the palm downward and not clenched. Rapid repetition of right hand movement indicates urgency. | Same as day signal with addition of wands. | |
|  SPREAD PYLON (UNFOLD ROTOR BLADES) | Bend elbow across chest, palm downward. Extend arm outward to horizontal position, keeping palm open and facing down. | Same as day signal with addition of wands. | |

| | | | |
|---|---|---|---|
|  FOLD PYLON (FOLD ROTOR BLADES) | Extend right arm horizontally, palm downward. Bend arm keeping palm down. | Same as day signal with addition of wands. | |
|  I DESIRE HIFR/FUEL | Helo crewmember brings thumb to mouth as if drinking from glass. | Same as day signal except helo crewmember holds red lens flashlight in hand. | |
|  COMMENCE FUELING | Helo crewmember makes circular motion with right hand. | Helo crewmember makes circular motion with red lens flashlight. | |
|   AM PUMPING FUEL | LSO holds green device vertically over red device. | LSO holds green wand vertically over red wand. | |
|  CEASE FUELING | Helo crewmember makes horizontal throat cutting motion with right hand. | Helo crewmember makes horizontal motion with red lens flashlight. | |
|   HAVE CEASED PUMPING FUEL | LSO holds red device vertically over green device. | Same as day signal with addition of wands. | |
|  DESIRE TO MOVE OVER DECK AND RETURN HOSE | Helo crewmember makes vertical motion with hand. | Helo crewmember makes vertical motion with red lens flashlight. | |
|  EXECUTE EMERGENCY BREAKAWAY | LSO makes waveoff signal. | Same as day signal with addition of wands. | Signal is mandatory. |

| SIGNAL | DAY | NIGHT | REMARKS |
|---|---|---|---|
|  AFFIRMATIVE (ALL CLEAR) | Hand raised, thumb up. | Same as day signal with addition of wands. | Conforms to ICAO signal. |
|  NEGATIVE (NOT CLEAR) | Arm held out, hand below waist level, thumb turned downwards. | Same as day signal with addition of wands. | |
|  TURN OFF/ON LIGHTS | Points to eyes with two fingers to signal "turn lights off". | Flashes wands on and off. | Same signal for "turn lights on". |
|  COME FORWARD (LSO) | Makes sweeping motion with right arm from straight out to across chest. | Same as day signal with addition of wands. | |
|  TALON ENGAGED (pilot) | Left arm held vertically, with fist clenched. | Red flashlight moved in a circular pattern. | |
|  TALON DISENGAGED (pilot) | Swings arms apart, thumbs extended outwards, at eye level. In single piloted aircraft, pilot may swing one arm alternately from each side, thumb extended outwards. | Using hand held light or flashlight, at eye level, flash light on/off at one second intervals. | |
|  TALON ENGAGED (LSO) | Left arm held vertically, with fist clenched. | Repeat pilot signal using amber wand held in a vertical position. | |
|  TALON DISENGAGED (LSO) | Hold right thumb at eye level: hold left fist at eye level. | Same as day signal, but using amber wands. | |

*Figure FO-12. Ship/Helicopter Landing Signals (sheet 2 of 2)*