T.O. 1H-52A-1

FLIGHT MANUAL

U. S. COAST GUARD

MODEL HH-52A HELICOPTERS

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

Refer to T.O. 0-1-1-5 Index for the current status of Flight Manuals and Safety/Operational Supplements.

This publication is required for official use or for administrative or operational purposes only. Distribution is limited to US Government agencies. Other requests for this document must be referred to Warner Robins ALC/MMEDT, Robins AFB, Georgia 31098.

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

AFLC RAFB, GA

8 JULY 1982

CHANGE 1 25 AUGUST 1983

LIST OF EFFECTIVE PAGES

INSERT LATEST CHANGED PAGES. DESTROY SUPERSEDED PAGES.

NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

Dates of issue for original and changed pages are:

Original . . . 0 . . . . 8 July 82
Change . . . 1 . . 25 August 83

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 356 CONSISTING OF THE FOLLOWING:

Page No.	*Change No.	Page No.	*Change No.	Page No.	*Change No.
Title	1	3-9 — 3-11	0	FO-ii Blank	0
A	1	3-12 — 3-13	1	FO-1 — FO-4	0
Certification-1	0	3-14 — 3-17	0		
Certification-2 Blank	0	3-18	1		
Flyleaf-1 — Flyleaf-2	0	3-18.1 Added	1		
Flyleaf-3	0	3-18.2 Blank Added	1		
Flyleaf-4 Blank	0	3-19 — 3-20	0		
i — iv	0	3-21	1		
1-1 — 1-35	0	3-22 — 3-24	0		
1-36	1	3-24.1 Added	1		
1-37 — 1-38	0	3-24.2 Blank Added	1		
1-39	1	3-25	1		
1-40	0	3-26 — 3-29	0		
1-41	1	3-30 Blank	0		
1-42	0	4-1 — 4-25	0		
1-43	1	4-26	1		
1-44 — 1-55	0	4-27 — 4-52	0		
1-56 Blank	0	4-53	1		
2-1 — 2-2	0	4-54 — 4-91	0		
2-3 — 2-6	1	4-92 Blank	0		
2-6.1 Added	1	5-1 — 5-4	0		
2-6.2 Blank Added	1	5-5	1		
2-7 — 2-9	0	5-6 — 5-10	0		
2-10	1	6-1 — 6-7	0		
2-11	0	6-8 Blank	0		
2-12 — 2-13	1	7-1 — 7-6	0		
2-14 — 2-20	0	8-1 — 8-3	0		
2-21 — 2-22	1	8-4 Blank	0		
2-22.1 Added	1	9-1 — 9-16	0		
2-22.2 Blank Added	1	A-1 — A-60	0		
2-23 — 2-28	0	Index-1	1		
2-29 — 2-30	1	Index-2 — Index-3	0		
2-31 — 2-33	0	Index-4	1		
2-34	1	Index-5	0		
2-35 — 2-40	0	Index-6	1		
3-1 — 3-7	0	Index-7 — Index-8	0		
3-8	1	FO-i	0		

*Zero in this column indicates an original page.

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 date on each new page against the date listed for that page on the A page at the front of the manual or on the title page of the Interim Manual Change, whichever applies. Be sure write-in entries are accurate and placed correctly.

Make the required entry in the spaces below.

Date	Amendement/Change Incorporated	Pages Checked	Signature
26 OCT 87	T.O. 1H-H52A-155-72	comp	[illegible]

RECORD OF APPLICABLE TIME COMPLIANCE TECHNICAL ORDERS

T.O. No.	Issue Date	Recission (Mandatory Compliance) Date	Title	Change/Revision Supplement Date

SAFETY SUPPLEMENT SUMMARY

Safety Supplements are numbered as follows: T.O. 1H-52A-1 SS-1, SS-2, etc. The supplements you receive should follow in sequence and if you are missing one, check the current Numerical Index and Requirement Table (T.O. 0-1-1-5) 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 Publication Distribution Officer and get your copy. It should be noted that a supplement number will never be used more than once.

SAFETY SUPPLEMENTS REPLACED BY THIS CHANGE OR RESCINDED

NUMBER	DATE	SHORT TITLE	DISPOSITION

ACTIVE SAFETY SUPPLEMENTS

This portion is to be filled in by you when you receive your Flight Manual and to be added to as you receive your additional supplements. Refer to the current Numerical Index and Requirement Table (T.O. 0-1-1-5) for latest information if any questions arise. Supplements outstanding at the time of preparation of this page have been listed below for your convenience.

NUMBER	DATE	SHORT TITLE
COMDT G-OSR-2	172023ZMar86	T.O 1H-52A-1SS-10 Low fuel caution light Pg 1-27.
COMDT G-OAV	021805ZSep86	T.O. 1H-52A-1SS-11 Transitory engine power decreases Pg 3-6.
COMDT-G-OAV	232148Z OCT 87	T.O. 1H-HS2A-1SS-12 EMER. WATER EGRESS PROCEDURES Pg-3 thr 28

OPERATIONAL SUPPLEMENT SUMMARY

Operational Supplements are numbered as follows: T.O. 1H-52A-1S-1, 1S-2, etc. The supplements you receive should follow in sequence and if you are missing one, check the current Numerical Index and Requirement Table (T.O. 01-1-15) 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 Publication Distribution Officer and get your copy. It should be noted that a supplement number will never by used more than once.

OPERATIONAL SUPPLEMENTS REPLACED BY THIS CHANGE OR RESCINDED

NUMBER	DATE	SHORT TITLE	DISPOSITION

ACTIVE OPERATIONAL SUPPLEMENTS

This portion is to be filled in by you when you receive your Flight Manual and to be added to as you receive additional supplements. Refer to the current Numerical Index and Requirement Table (T.O. 0-1-1-5) for latest information if any questions arise. Supplements outstanding at the time of preparation of this page have been listed below for your convenience.

NUMBER	DATE	SHORT TITLE
*OS-1		PRIMUS RADAR
**OS-8	29 May 81	FORWARD LOOKING INFRARED RADAR.

*Air Station Kodiak Only
**HH52A 1428 Only

TABLE OF CONTENTS

INTRODUCTION

SCOPE

This manual contains the necessary information for safe and efficient operation of the HH-52A helicopter. These instructions provide you with a general knowledge of the helicopter, its characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized, and therefore, basic flight principles are avoided.

PERMISSIVE OPERATIONS

The Flight Manual takes a "positive approach" and normally states only what you can do. 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.

SAFETY AND OPERATIONAL SUPPLEMENTS

Safety supplements are issued as an expeditious means of reflecting safety information when hazardous or safety conditions exist. These supplements contain operational, precautionary and restrictive instructions that affect safety and safety modifications. Operational supplements are issued as an expeditious means of reflecting information when mission essential operational procedures are involved. Supplements are issued by message (interim) or by printed copy (formal) depending upon the urgency. Formal printed supplements are identified by the letters "SS" for safety supplements and letters "OS" for operational supplements printed around the borders of the title pages. All supplements use the same numbering system, i.e. SS-1, OS-2, SS-3, etc. Current supplements must be complied with. A Safety and Operational Supplement Status page is furnished with each formal supplement to help you to be constantly aware of the status of all supplements. File your supplements in reverse numerical order in front of the manual; i.e. the latest supplement on top, regardless of whether it is a safety or operational supplement.

WARNINGS, CAUTIONS AND NOTES

The following definitions apply to "Warnings," "Cautions," and "Notes" found throughout the manual.

WARNING	Operating procedures, techniques, etc., which will result in personal injury or loss of life if not carefully followed.
CAUTION	Operating procedures, techniques, etc., which will result in damage to equipment if not carefully followed.
NOTE	An operating procedure, technique, etc., which is considered essential to emphasize.

Two or more Warnings, Cautions, or Notes placed in sequence are denoted by the use of a large dot on the left margin. The heading (WARNING, CAUTION or NOTE) is not repeated.

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 (HH52A) Mobile, Alabama 36608.

GLOSSARY OF TERMS AND ABBREVIATIONS

AC — Alternating current or Aircraft commander

ADF — Automatic direction finder

ASE — Automatic stabilization Equipment

ALT — Altitude

APU — Auxiliary power unit

BAR ALT — Barometric altitude control

BDHI — Bearing distance heading indicator

BIM — Blade inspection method

°C — Degrees Celsius

CAS — Calibrated airspeed

CG — Center of Gravity

DC — Direct current

DG — Directional gyro

DRAFT — The depth of water the helicopter draws or requires to float

°F — Degrees Fahrenheit

FM — Flight mechanic

FO — Foldout

FOD — Foreign object damage

FPM — Feet per minute

FT — Feet

GAL — Gallons

GCA — Ground-controlled approach

GW — Gross weight

HR — Hour

Hz — Hertz (cycles per second)

H/V — Height velocity

IAS — Indicated airspeed

IBIS — Inflight blade inspection system

IGE — In ground effect

IGV — Inlet guide vanes

IN — Inches

KCAS — Knots calibrated airspeed

KIAS — Knots indicated airpseed

KT — Knots

KTAS — Knots true airspeed

KVA — Kilovolt-amperes

LAT — Latitude

LB/HR — Pound per hour

LONG — Longitude

MAG — Magnetic

MIN — Minutes

MSL — Mean sea level

Nf — Power turbine speed

Ng — Gas generator speed

Nr — Rotor speed

OAT — Outside air temperature

OGE — Out of ground effect

P_3 — Compressor discharge pressure

PRESS — Pressure

PSI — Pounds per square inch

PUI — Pilot under instruction

Q — Torque

RAD ALT — Radar altimeter

REFERENCE POINT — A known/familiar stationary object within arm's length used for emergency egress

ROC — Rate of climb

ROD — Rate of descent

RPM — Revolutions per minute

SL — Sea level

SP — Safety pilot

STD DAY — Standard day atmospheric conditions

T2 — Compressor inlet air temperature

T5 — Power turbine inlet temperature

TAS — True airspeed

TEMP — Temperature

VA — Volt amperes

VAC — Volts alternating current

Vne — Maximum, never exceed speed

Vmax — Highest airspeed at max continuous power (Vne limited)

WL — Waterline

SECTION I

DESCRIPTION

The function of this section is to describe the helicopter and its systems and controls which contribute to the physical act of flying the helicopter, including all emergency equipment that is not part of auxiliary equipment.

TABLE OF CONTENTS

HELICOPTER

Model HH52A helicopters are manufactured by Sikorsky Aircraft, a Division of United Technologies Corporation, Stratford, Connecticut. The amphibious type helicopter is designed for search, rescue, and observation operations. Configuration is single engine, three-bladed main lifting rotor, two-bladed antitorque tail rotor, and sponson mounting retractable landing gear. The sponsons, one at each main landing gear, together with the watertight lower fuselage will provide stability in the water. Dimensions of the helicopter are shown at the end of this paragraph and on figure 1-1. Refer to the exterior and interior general arrangement illustration in this section and the minimum turning radius and ground clearances diagram in Section I for further familiarization. The helicopter's maximum gross weight is 8300 pounds. For complete weight information see HH52A Weight and Balance Data Book (T.O. 1-1B-40). The boat hull type fuselage is of metal semimonocoque construction and is comprised of five sections: the cockpit section, the cabin section, the transition section, the tail cone section, and the tail pylon section. The entire fuselage, below the cabin floor, is of watertight construction. The cockpit, (figure 1-2), is equipped with dual flight controls and is entered from the cabin. Directly behind the cockpit is the cabin section. The cabin section is approximately 14 feet long, 5 feet 4 inches wide, and 6 feet high. Entrance to the cabin section is through a 4 foot wide, 5 foot high, sliding door. The cabin section may be equipped with 10 troop seats for passenger accommodations or 6 litters and 3 troop seats. The cabin is equipped with tiedown rings for transportation of cargo. A 600-pound capacity hydraulic rescue hoist with approximately 100 feet of usable cable is suspended on a fixed truss over the cargo door. Two single-cell fuel tanks are installed below the cabin floor in the watertight lower fuselage section. Aft of the cabin is the transition section which contains the cabin heater and electrical equipment. The tail cone section extends aft from the transition section. The tail pylon extends from the end of the tail cone and provides mounting facilities for

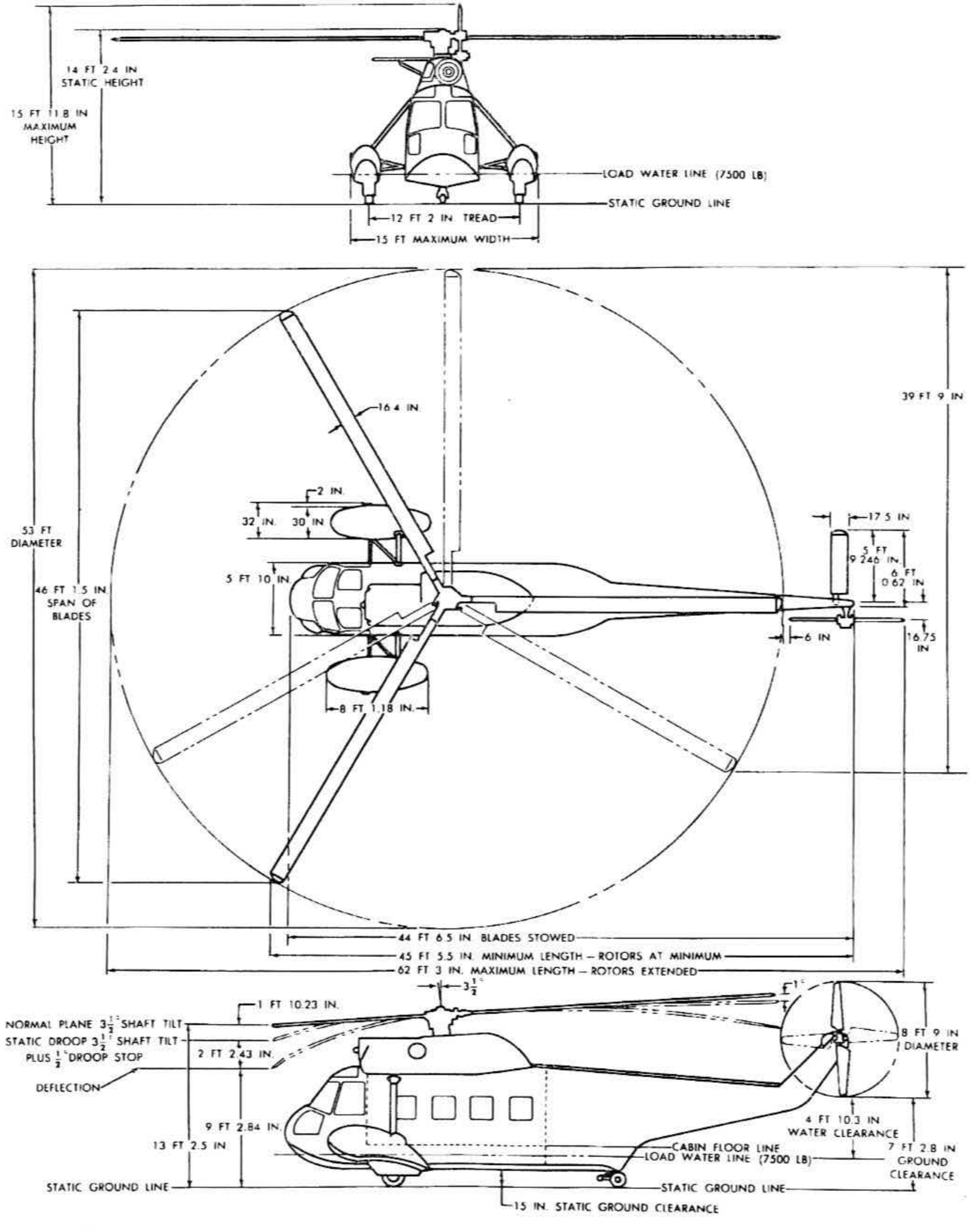
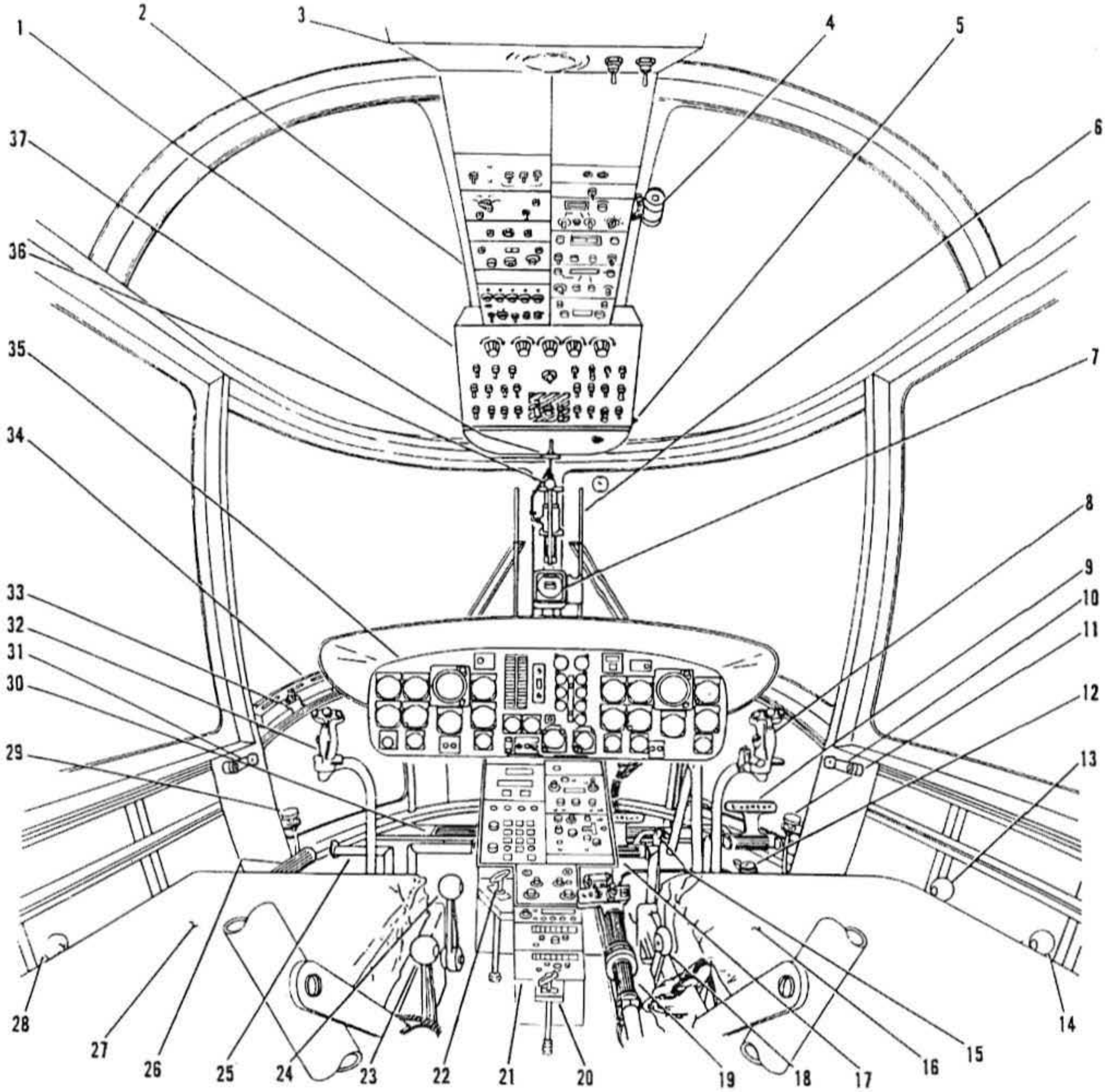


Figure 1-1. Three View Dimensions



1. OVERHEAD SWITCH PANEL
2. OVERHEAD RADIO PANEL
3. OVERHEAD DOMELIGHT PANEL
4. PILOT'S COMPARTMENT SPOTLIGHT
5. P3 VALVE
6. WINDSHIELD WIPER
7. MAGNETIC STANDBY COMPASS
8. PILOT'S CYCLIC STICK
9. PILOT'S BRAKE PEDAL
10. PILOT'S WINDOW EMERGENCY RELEASE HANDLE
11. PILOT'S TAIL ROTOR PEDAL ADJUSTMENT KNOB
12. WINDSHIELD WASHER FOOT PEDAL
13. SEAT FORWARD OR AFT ADJUSTMENT LEVER
14. SEAT HEIGHT ADJUSTMENT LEVER
15. HEATER REGISTER
16. PILOT'S SEAT
17. PILOT'S TAIL ROTOR PEDAL
18. PILOT'S SHOULDER HARNESS INERTIA REEL LOCK LEVER
19. PILOT'S COLLECTIVE PITCH LEVER
20. TAILWHEEL LOCK HANDLE
21. CONSOLE
22. PARKING BRAKE HANDLE
23. COPILOT'S SEAT HEIGHT ADJUSTMENT LEVER
24. COPILOT'S SEAT FORWARD OR AFT ADJUSTMENT LEVER
25. COPILOT'S TAIL ROTOR PEDAL
26. COPILOT'S COLLECTIVE PITCH LEVER
27. COPILOT'S SEAT
28. COPILOT'S SHOULDER HARNESS INERTIA REEL LOCK LEVER
29. COPILOT'S TAIL ROTOR PEDAL ADJUSTMENT KNOB
30. HEATER REGISTER
31. COPILOT'S WINDOW EMERGENCY RELEASE HANDLE
32. COPILOT'S CYCLIC STICK
33. COPILOT'S REMOTE ICS SWITCH AND LANDING LIGHT CONTROL SWITCH
34. WINDSHIELD DEFROSTER VENTS
35. INSTRUMENT PANEL
36. ROTOR BRAKE LEVER
37. FIRE WALL VALVE SHUTOFF HANDLE

Figure 1-2. Cockpit

the tail rotor gear box and associated pitch change control linkages. The engine compartment is above the cabin. The engine is installed with the drive shaft pointed rearward and connected to the main gear box. The transmission compartment housing the main gear box is on the top of the fuselage directly behind the engine compartment. The main rotor drive shaft extends vertically from the top of the main gear box. The main rotor hub assembly, to which the main rotor blades are attached, is splined to the top of the main rotor drive shaft. The tail rotor drive shaft extends rearward from the main gear box tail rotor takeoff shaft, to the intermediate gear box input shaft. The intermediate gear box is installed in the lower portion of the pylon and its output shaft extends upward to the tail rotor gear box input shaft. The tail rotor gear box output shaft is splined to the tail rotor hub. The two-bladed tail rotor is splined to the tail gear box shaft. Two of the main rotor blades may be folded aft parallel to the fuselage to aid storage.

DIMENSIONS

Length	
Maximum main and tail rotor blades extended	62 feet 3 inches
Minimum main and tail rotors at minimum	45 feet 5.5 inches
Minimum main and tail rotor blades removed	44 feet 6.5 inches
Height	
Maximum tail rotor blade vertical	15 feet 11.8 inches
Tail rotor diameter	8 feet 9 inches
Minimum to top of hoisting eye	14 feet 2.4 inches
Width	
Minimum main rotor blades removed	15 feet 7.5 inches
Main rotor diameter	53 feet 00 inches
Minimum Main Rotor Ground Clearance (Tip clearance — forward section) Static	9 feet 2.84 inches
Tail Rotor Ground Clearance	7 feet 2.8 inches
Main Landing Gear Trend	12 feet 2 inches
Draft	
Maximum draft at gross weight of 7500 pounds (From waterline to bottom of retracted wheels)	13.5 inches

ENGINE

The helicopter is equipped with a General Electric T58-GE-8B turbo shaft engine (figure 1-3) which has a designed performance rating under standard sea level static conditions of 1250 shaft horsepower. When installed in the HH-52A helicopter, however, this is reduced to 730-845 shaft horsepower due to helicopter dynamic component limitations. This reduction is accomplished by physically derating the fuel control by limiting maximum fuel flow to 575 pounds per hour with maximum variation of plus 25 and minus zero pounds per hour. The T58 engine is a compact turboshaft engine with high power-to-weight ratio and uses the free turbine principle. The engine is mounted above the cockpit left of the aircraft centerline forward of the main transmission. The engine consists of these major components: an axial-flow compressor, combustion chamber, a two-stage gas generator turbine, accessory section and a single-stage free power turbine. The free power turbine is mechanically independent of the gas generator and, within the power turbine governing range, power turbine speed is independent of output power. High torque is available at low output speeds, providing rapid acceleration characteristics. The gas generator consists of the compressor, annular combustion chamber, two-stage gas generator turbine and the accessory section. The free turbine principle provides a constant free turbine speed output which results in a constant rotor RPM. Variations in power requirements to maintain constant free turbine speed are accomplished by automatic increases or decreases in gas

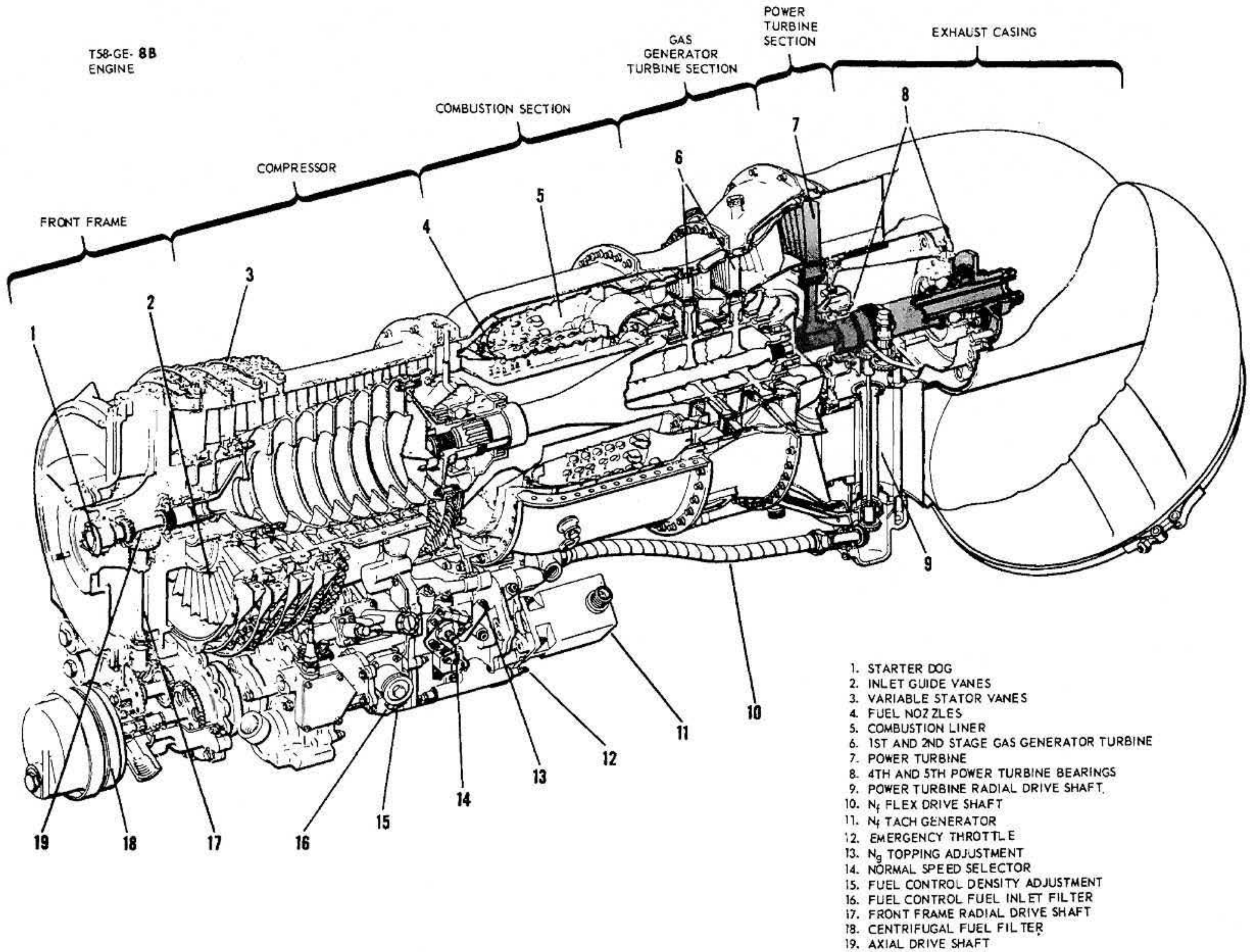


Figure 1-3. Engine Cut-away View

generator speed. A hydromechanical fuel metering (control) unit provides maximum engine performance without exceeding safe engine operating limits. In the normal operating range engine speed is selected by positioning the speed selector. The integrated fuel control system delivers atomized fuel in controlled amounts to the combustion chamber. Flow of fuel and air through the combustion chamber is continuous, and once the mixture is ignited, combustion is self-sustained. Changes in air pressure, air temperature, and rotor operation all affect engine performance. The engine fuel control system automatically maintains selected power turbine speed (Nf) in the Nf governing range by changing fuel flow to increase or decrease gas generator speed as required, thus regulating output power to match the load under changing conditions In the event of automatic fuel control malfunction, the emergency throttle is used to manually control fuel flow through the main metering valve. An electric solenoid-operated bleed valve is installed in the P_3 signal tubing to the automatic fuel control to provide an instant power reduction if the main rotor enters an overspeed condition. A manual bleed valve (figure 1-4) is in the P_3 signal tubing to the automatic fuel control, to permit the pilot to reduce fuel flow during starting. Free power turbine overspeed protection is achieved by automatic fuel cut-off when the power turbine enters an overspeed condition. The accessory drive section, mounted on the front frame and extending beneath the compressor, transmits the necessary power to drive the lube scavenge pump, fuel pump, and dynamic fuel filter. The Ng tachometer generator is driven by the lube pump and the Ng governor, which is in the automatic fuel control, is driven by the fuel pump. Engine exhaust gases are discharged through the exhaust casing extending through an opening on the left side of the fairing that surrounds the engine and main gear box. Small openings in the fairing on both sides of the engine also aide in dissipating engine heat. The openings on the right side have normally open shutters which are a part of the engine fire extinguisher system.

COMPRESSOR

The ten-stage compressor consists of the compressor rotor and stator. The primary purpose of the compressor is to compress air for combustion. Ambient air enters through the front frame and is directed to the compressor inlet, where it passes through ten stages of compression, and is directed to the combustion chambers. The inlet guide vanes (2, figure 1-3) and the first three stages of the stator vanes (3, figure 1-3) are variable and change their angular position, as a function of compressor inlet temperature and gas generator speed to prevent stall of the compressor.

COMBUSTION CHAMBER

In the combustion chamber fuel is added to the compressed air. This mixture is ignited, causing a rapid expansion of gases toward the gas generator turbine section. As the air enters the combustion section, a portion goes into the combustion chamber where it is mixed with the fuel and ignited, while the remaining air forms a blanket between the outer combustion casing and the combustion liner (5, figure 1-3), for cooling purposes. Once combustion is started by the two igniter plugs, it is selfsustaining. After the air has been expanded and increased in velocity by combustion, it is passed through the two-stage gas generator turbine.

GAS GENERATOR TURBINE

The two-stage gas generator turbine (6, figure 1-3) is the rotating component which is coupled directly to the compressor. It extracts the required power from the exhaust gases to drive the compressor. The turbine nozzles that comprise the stator blades direct the exhaust gases to the turbine wheels.

GAS GENERATOR SPEED (Ng)

Gas generator speed (Ng) is primarily dependent upon fuel flow and is monitored by the engine fuel control unit. The principal purpose of monitoring Ng is to control acceleration and deceleration characteristics, prevent overspeed, and establish a minimum idle setting. Gas generator speed controls airflow through the engine and consequently the power available to the power turbine.

POWER TURBINE

The power turbine (7, figure 1-3) is bolted to the rear flange of the second stage turbine casing. The engine utilizes the free turbine principle, which is characterized by a power turbine which is mechanically independent of the gas generator. The power turbine derives its power from the gases which are directed to it by the gas generator turbine nozzles.

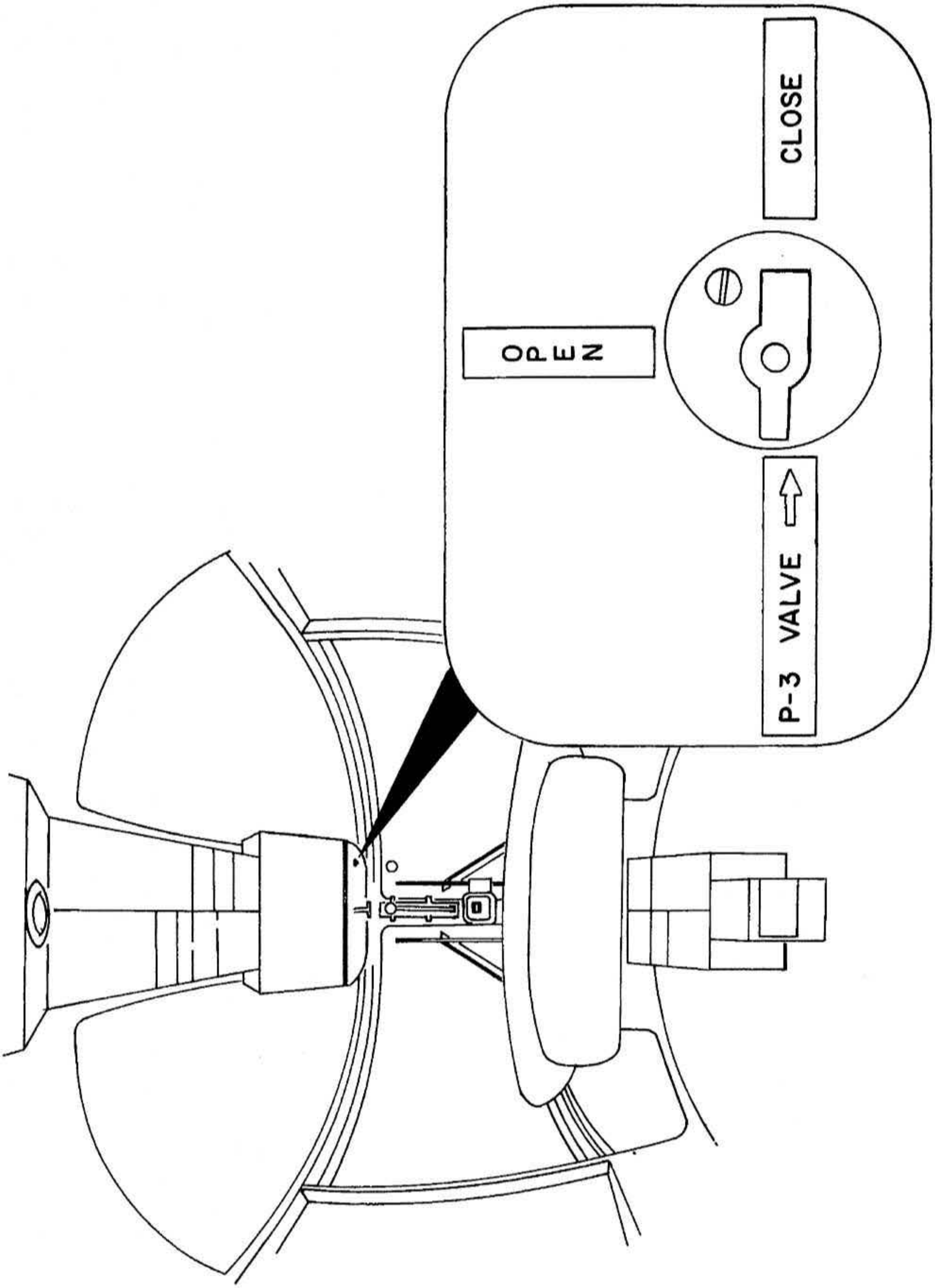


Figure 1-4. Manual P3 Bleed

Power Turbine Speed (Nf)

Power turbine speed is transmitted to the Nf governor in the fuel control by a flexible drive shaft (figure 1-3). The Nf governor regulates fuel flow to maintain an essentially constant power turbine speed for a given speed selector setting within the Nf governing range, 85% to 106% Nf.

POWER TURBINE OVERSPEED SYSTEM

The Nf governor will actuate the overspeed shutoff valve in the fuel control at 122% Nf to prevent destructive overspeed of the power turbine. Actuation of the overspeed shutoff valve causes an immediate flameout. When Nf falls below 122% Nf the overspeed shutoff valve will reopen, admitting fuel to the engine, which may result in uncontrolled ignition followed by overtemperature or oscillations about 122% Nf.

WARNING

This system is inoperative following power turbine flexible drive shaft failure.

ENGINE FUEL SYSTEM

The engine fuel system (figure 1-5, consists of a dynamic fuel filter, an engine driven pump, a fuel control unit, an oil cooler, a static fuel filter, a flow divider, and a fuel manifold with nozzles and associated piping. The fuel control unit is supplied fuel from the engine-driven fuel pump. Metered fuel from the engine fuel control unit is piped through an oil-fuel heat exchanger and then enters the flow divider which is connected directly to the fuel manifold on the engine.

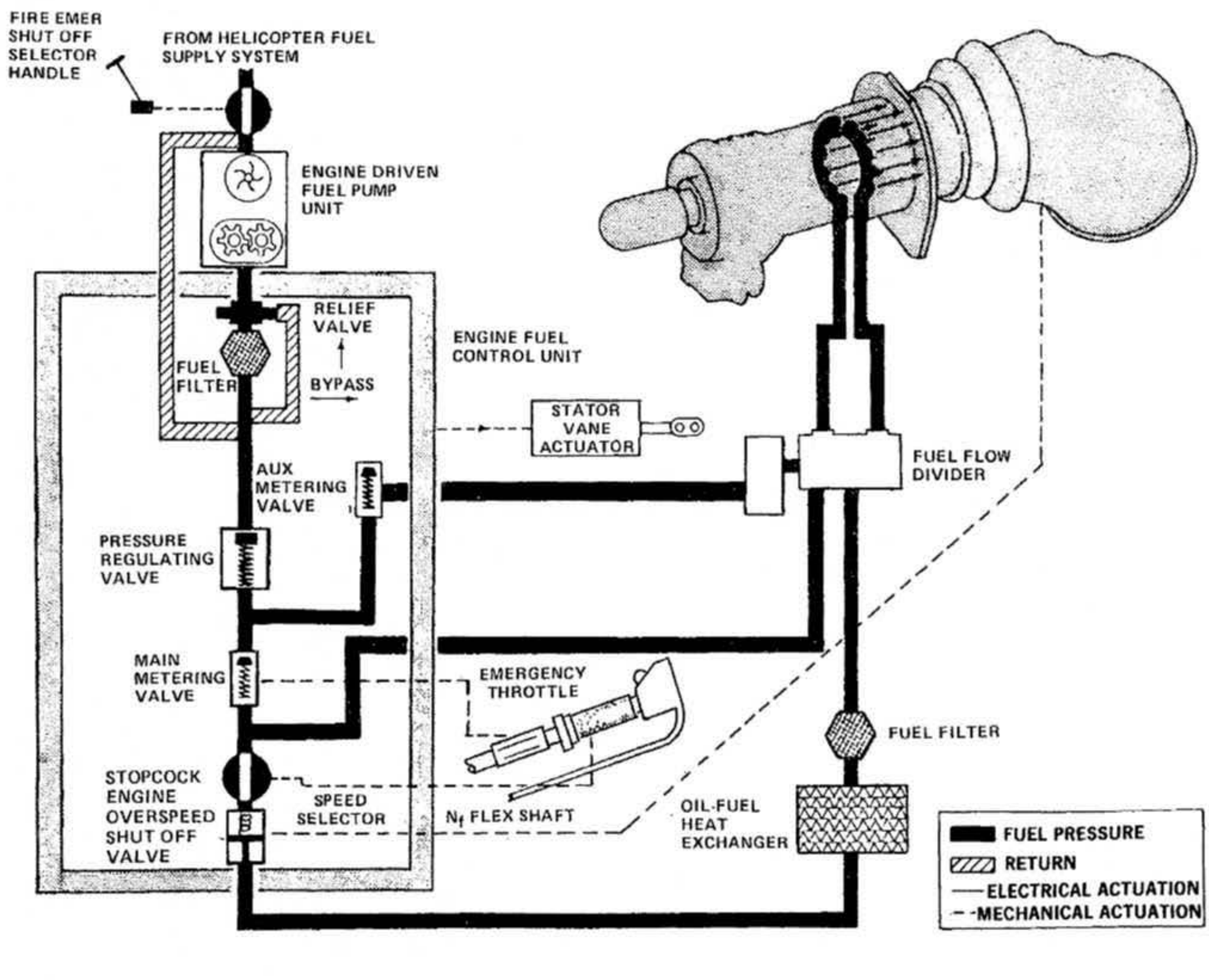


Figure 1-5. Engine Fuel System

Dynamic Fuel Filter

The dynamic fuel filter is mounted on the forward face of and receives power from the engine accessory drive casing. It receives fuel from the airframe fuel system and removes impurities by centrifugal action.

Engine-Driven Fuel Pump

A dual-element engine-driven fuel pump, mounted on the left rear face of the accessory drive casing, consisting of a centrifugal and a positive displacement gear type element, is built into a single housing. Power is furnished by the engine accessory drive case by means of a splined shaft. This shaft drives the fuel pump and simultaneously acts as a link to transmit gas generator speed information to the Ng governor in the fuel control unit.

Engine Fuel Control Unit

The fuel control unit is a hydro-mechanical device. It is mounted on the engine-driven fuel pump which supplies fuel under pressure to the unit. The fuel control consists of a single housing that contains elements necessary to sense five parameters of engine operation; compressor inlet temperature (T_2), gas generator speed (Ng), compressor discharge pressure (P_3), power turbine speed (Nf), and speed selector positions. Based on these five parameters the fuel control performs the following functions: governs gas generator idle and maximum speeds; maintains constant power turbine speed in the Nf governing range, when selected; schedules inlet guide vane and variable stator vanes for optimum compressor performance and prevents compressor stalls, turbine over-temperatures, and rich or lean flameouts. Failure of the power turbine flexible driven shaft causes the Nf governor to sense a false underspeed condition which induces the fuel control to meter maximum fuel flow. Significant power reduction in case of rotor overspeed is accomplished in the fuel control by bleeding part of the compressor discharge pressure signal. The false signal thus sensed by the fuel control results in an immediate reduction of fuel flow.

Engine Speed Selector

Twist grip type speed selectors used for normal engine operation are on the forward end of the pilot's and copilot's collective pitch levers (figure 1-20). Design of the pilot's speed selector provides two ranges of operation, a starting range extending from idle to maximum power turbine speed. The starting range has two positions termed STOPCOCK and GROUND IDLE. STOPCOCK is at full clockwise rotation and GROUND IDLE is at full counterclockwise rotation against a mechanical stop. The operating range is selected by pushing the speed selector forward from the GROUND IDLE position until a mechanical stop is encountered. The operating range has three positions termed FLIGHT IDLE, AUTO DETENT, and MAXIMUM Nf;. FLIGHT IDLE is at full clockwise rotation against a mechanical stop and except for being in the operating range on the speed selector, is identical to ground idle. AUTO DETENT is midway toward the full counterclockwise rotation. MAXIMUM Nf is at full counterclockwise rotation. The pilot's speed selector has full authority from STOPCOCK to MAXIMUM Nf but the copilot's speed selector has authority only in the range of operation selected by the pilot. A friction adjustment is located on the pilot's speed selector. Counterclockwise rotation increases friction while clockwise rotation decreases it. When starting the engine, the speed selector must be in the STOPCOCK position. A pulley limit switch which is closed when the speed selector is in the STOPCOCK position permits the starter to be energized when the starter switch is actuated. The speed selector is mechanically linked to the fuel control stopcock to assure positive cutoff of all fuel flow to the engine in the STOPCOCK position. The stopcock is open when the speed selector is rotated counterclockwise out of the STOPCOCK position. Subsequent to rotor engagement, the speed selector controls Ng until Nf reaches 85% or greater, then it functions as the power turbine speed selector.

Emergency Throttle

Twist-grip type emergency throttles are aft of the speed selectors on the pilot's and copilot's collective pitch levers (figure 1-20). The emergency throttle is always positioned fully clockwise in the CLOSED position except when in use. Counterclockwise rotation of the emergency throttle increases fuel flow. A pulley limit switch which is closed when the emergency throttle is closed, permits the starter to be energized when the starter switch is actuated. The primary function of the emergency throttle is to manually override the automatic features of the fuel control. The initial position of the fuel metering valve is dependent upon the automatic features of the fuel control as established by the setting of the speed selector. The emergency throttle is mechanically connected to a cam within the fuel control. This cam, when actuated by advancing the emergency throttle, contacts the fuel metering valve. Once contact is established, further advance of the emergency throttle will manually control fuel flow, which in turn regulates engine power output. The emergency throttle is unable to reduce the position of the metering valve below that demanded by the speed selector. The speed selector must therefore be placed in FLIGHT IDLE to permit control over the entire engine operating range with the emergency throttle.

CAUTION

The stopcock function is controlled by the pilot's speed selector even though the engine is being governed manually with emergency throttle.

Fuel Density Adjustments

Two adjustments are provided in the engine fuel system to compensate for the various densities of different types of fuel. An adjustment located on the fuel control, marked SPECIFIC GRAVITY, is calibrated in pounds and tenths. The specific gravity of JP-4 and JP-5 are identified for ready reference. The setting of this adjustment should correspond to the specific gravity of the fuel in the fuel lines and fuel control. The second adjustment is a spring loaded, depress-to-turn, knurled knob located on the flow-divider. It has two positions; full clockwise for JP-4 and full counterclockwise for JP-5. These adjustments affect engine starting characteristics and should correspond to the type of fuel in the fuel lines and fuel control. This should be kept in mind when servicing the aircraft with different kinds of fuels. JP-4 should be used at all fuel temperatures below −29°C (−20°F) and JP-5 should be used at temperatures above +38°C (+100°F).

APPROVED FUELS

Fuels conforming to MIL-T-5624 for JP-4 and JP-5 are approved for use in the T58-GE-8B engine. The following is a list of approved fuels:

WARNING

The use of Fuel System Icing Inhibitor in jet fuel is mandatory. Fuels obtained from military facilities contain ice inhibitor. Aviation units and flight crews shall ensure its presence in any commercial fuel procured. Icing inhibitor shall be used in a ratio of 0.08% - 0.20% by volume (approximately 1 pint per 100 gallons of jet fuel). Additive should meet requirements of MIL-I-27686E (commercial name PRIST).

SPECIFICALLY APPROVED COMMERCIAL FUELS

Company	Product Name	Density Setting
American Oil. Co.	American Jet Fuel Type A	JP-5
	American Jet Fuel Type A-1	JP-5
Atlantic-Richfield	Arcojet A	JP-5
	Acrojet A-1	JP-5
	Acrojet B	JP-4
British Petroleum Co., Ltd.	BP A.T.K.	JP-5
	BP A.T.G.	JP-4
	BP AVCAT 48	JP-5
California-Texas	Caltex Jet A-1	JP-5
	Caltex Jet B	JP-4
Cities Service Oil Co,	Turbine Type A	JP-5
Continental Oil Company	Conoco Jet-40	JP-5
	Conoco Jet-50	JP-5
	Conoco Jet-60	JP-5
	Conoco JP-4	JP-4
Empire State	SMC	JP-5
Exxon International	Exxon Turbo Fuel A-1	JP-5
	Exxon Turbo Fuel A	JP-5
	Exxon Turbo Fuel B	JP-4

Company	Product Name	Density Setting
Gulf Oil Corp.	Gulf Jet A	JP-5
	Gulf Jet A-1	JP-5
Humble Oil & Refining Co.	Exxon Turbo Fuel A-1	JP-5
	Enco Turbo Fuel A-1	JP-5
	Exxon Turbo Fuel A	JP-5
	Enco Turbo Fuel A	JP-5
	Exxon Turbo Fuel B	JP-4
	Enco Turbo Fuel B	JP-4
	Exxon Turbo Fuel 5	JP-5
	Enco Turbo Fuel 5	JP-5
Mobil Oil Co.	Mobil Jet A	JP-5
	Mobil Jet A-1	JP-5
	Mobil Jet B	JP-4
	Mobil Jet 4	JP-4
	Mobil Jet 5	JP-5
Phillips Petroleum Co.	Philjet A-50	JP-5
	Philjet JP-4	JP-4
Pure Oil Co.	Purejet Turbine Fuel Type A	JP-5
	Purejet Turbine Fuel Type A-1	JP-5
Shell Oil Co.	Aeroshell Turbine Fuel JP-4	JP-4
	Aeroshell Turbine Fuel 640	JP-5
	Aeroshell Turbine Fuel 650	JP-5
Sinclair Refining Co.	Sinclair Superjet Fuel	JP-5
Chevron Oil Co.	Chevron Jet Fuel A-1	JP-5
	Chevron Jet Fuel B	JP-4
Standard Oil Co. (Kentucky)	Standard JF A	JP-5
	Standard JF A-1	JP-5
Standard Oil Co. (Ohio)	Jet A Kerosene	JP-5
	Jet A-1 Kerosene	JP-5
Standard Oil Co. (Texas)	Standard Turbine Fuel A-1	JP-5
	Standard Turbine Fuel B	JP-4
Texaco, Incorp.	Texaco Avjet A	JP-5
	Texaco Avjet A-1	JP-5
	Texaco Avjet B	JP-4
Union Oil of California	76 Turbine Fuel Union JP-4	JP-4

INDUSTRY/GOVERNMENT SPECIFICATIONS

Air Total Turbine Fuel, 1 and 1A	JP-5
ASTM Jet A Aircraft Turbine Fuel	JP-5
ASTM Jet B Aircraft Turbine Fuel	JP-4
ASTM Jet A-1	JP-5
British Fuel D ENG. R.D. 2482, AVTUR 40	JP-5
British Fuel D ENG. R.D. 2486 AVTAG	JP-4
British Fuel D ENG. R.D. 2494, AVTUR 50	JP-5
British Fuel D ENG. R.D. 2498, AVCAT 48	JP-5
British Fuel D ENG. R.D. 2488, AVCAT	JP-5
Canadian Fuel 3-GP-22	JP-4
Canadian Fuel 3-GP-23	JP-5
MIL-T-5624G JP-4	JP-4
MIL-T-5624G JP-5	JP-5
NATO F-30 (Jet A)	JP-5
NATO F-34 (Jet A-1)	JP-5
NATO F-35 (Jet A-1)	JP-5
NATO F-40 (JP-4)	JP-4
NATO F-42 (JP-5)	JP-5
NATO F-44 (JP-5)	JP-5
NATO F-45 (JP-4)	JP-4

ENGINE OIL SYSTEM

The engine oil system (figure 1-6) is of the positive-displacement recirculating type system. The main points lubricated within the engine are as follows: The compressor rotor front bearing, and the engine accessory drive gear components, the compressor rotor rear bearing, the gas generator turbine bearing, the power turbine rotor bearing and the power turbine accessory drive gear components. The

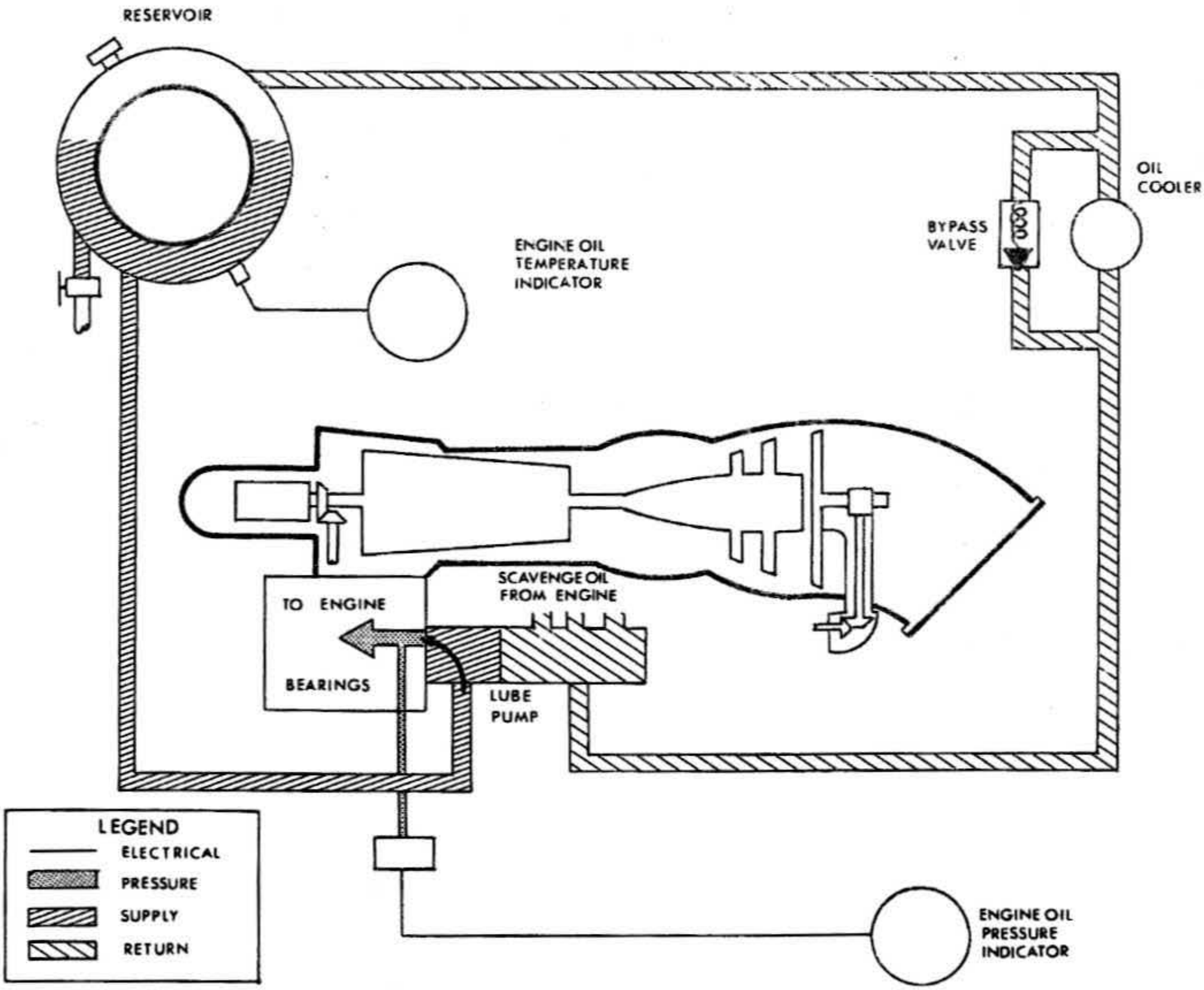


Figure 1-6. Engine Oil System

engine oil system components include an oil tank, a combined oil and scavenge pump, an oil filter, a relief valve, a check valve, and an oil cooler.

Engine Oil Tank

A circular oil tank installed around the engine front frame has a capacity of 3.0 gallons. An oil level dipstick gauge is located at the approximate 1 o'clock position on the tank and indicates 2.5 gallons as FULL. A filler cap is in the approximate 11 o'clock position.

Engine Oil Cooler

Operation of the oil cooler is entirely automatic. The oil cooler is an oil-to-fuel heat exchanger with an associated oil bypass valve. Oil flow through the cooler depends upon oil temperature. At lower temperatures, the pressure differential across the cooler causes most of the oil to bypass the core of the cooler. At higher temperatures, the lower viscosity reduces the pressure differential which closes the bypass valve and causes all of the oil to flow through the cooler.

STATOR VANE ACTUATING SYSTEM

The stator vane actuating system varies the angle of the inlet guide vanes and the first 3 stages of stator vanes to increase the efficiency of the compressor and to prevent compressor stalls. The actuating system is scheduled with respect to T_2 and Ng and is operated automatically by fuel pressure from the fuel control.

ROTOR OVERSPEED SYSTEM

The overspeed system (figure 1-7) provides a means of preventing a destructive overspeed of the main rotor and incorporates provisions for testing the circuit. The system consists of a rotor overspeed switch mounted on the accessory section of the main gear box, a solenoid-operated bleed valve mounted on the engine, and a microswitch mounted on the engine stator vane actuator. Also contained in the system is a circuit breaker, marked ENG OVSPD, on the forward circuit breaker panel, a test switch, marked ENG OVSP TEST, on the overhead switch panel. (figure FO-2) and the necessary wiring to operate the components of the circuit.

Rotor Overspeed Switch

The rotor overspeed switch is mounted on the accessory section of the main transmission. It incorporates one set of electrical contacts which close at 110% Nr.

Stator Vane Actuator Switch

The stator vane actuator switch (figure 1-7) is mounted on the stator vane actuator and is wired in series with the P_3 solenoid valve. Its function is to prevent the engine from decelerating to dangerously low speeds during overspeed conditions. The stator vane actuator switch opens when Ng drops to approximately 75%, interrupting electrical power to the P_3 solenoid valve. This action limits Ng deceleration to approximately 75% during rotor overspeed conditions.

P_3 Solenoid Valve

The P_3 solenoid valve (figure 1-7), mounted on the engine, is installed in the tubing that carries the compressor discharge pressure signal to the fuel control. When electrically energized, the solenoid valve opens, bleeding the P_3 signal to the atmosphere. The false signal thus transmitted to the fuel control causes an immediate reduction in fuel flow.

Overspeed Test Switch

The overspeed test switch permits an operational check of system components at speeds below 110% Nr. The two-position switch lever-lock is on the overhead switch panel (figure FO-2) under the heading ENG OVSPD TEST marked NORMAL and NO. 1. Stator vane actuator switch operation is checked in the NO. 1 position. Operation of the P_3 solenoid valve is checked during the NO. 1 test.

Engine Overspeed Test NO. 2

Two test recepticals are provided in the overhead radio panel (FO-2) under the heading ENG OVERSPEED TEST NO. 2. These recepticals permit the operational check out of the 110% rotor overspeed switch when a speed sensitive switch test harness or multimeter is plugged in.

IGNITION SYSTEM

The ignition system consists of a capacitor discharge unit, two ignitors, and a control circuit (figure 1-8). During engine start, the ignition unit furnishes a spark to ignitor plugs which ignites the fuel-air-mixture in the combustion chamber of the engine. The ignition unit operates on 28 volts dc from the start bus and fires the two ignitor plugs. The system is protected by a circuit breaker, marked START & IGN, under the general heading START BUS, which is on the forward circuit breaker panel.

Ignition Switch

The ignition switch, marked IGN, with positions TEST, OFF, and NORM, is on the overhead switch panel (figure FO-2). The lever lock prevents inadvertent movement to the NORM position and the TEST position is momentary. In the NORM position with the starter switch depressed, current from the start bus will flow to the ignition unit when the speed selector is turned to GROUND IDLE. Current flow to the ignition stops when the starter switch is released. The TEST position is used to operate the ignition unit at times other than during engine starting. When the ignition switch is placed in the momentary TEST position, current from the start bus flows directly to the ignition unit.

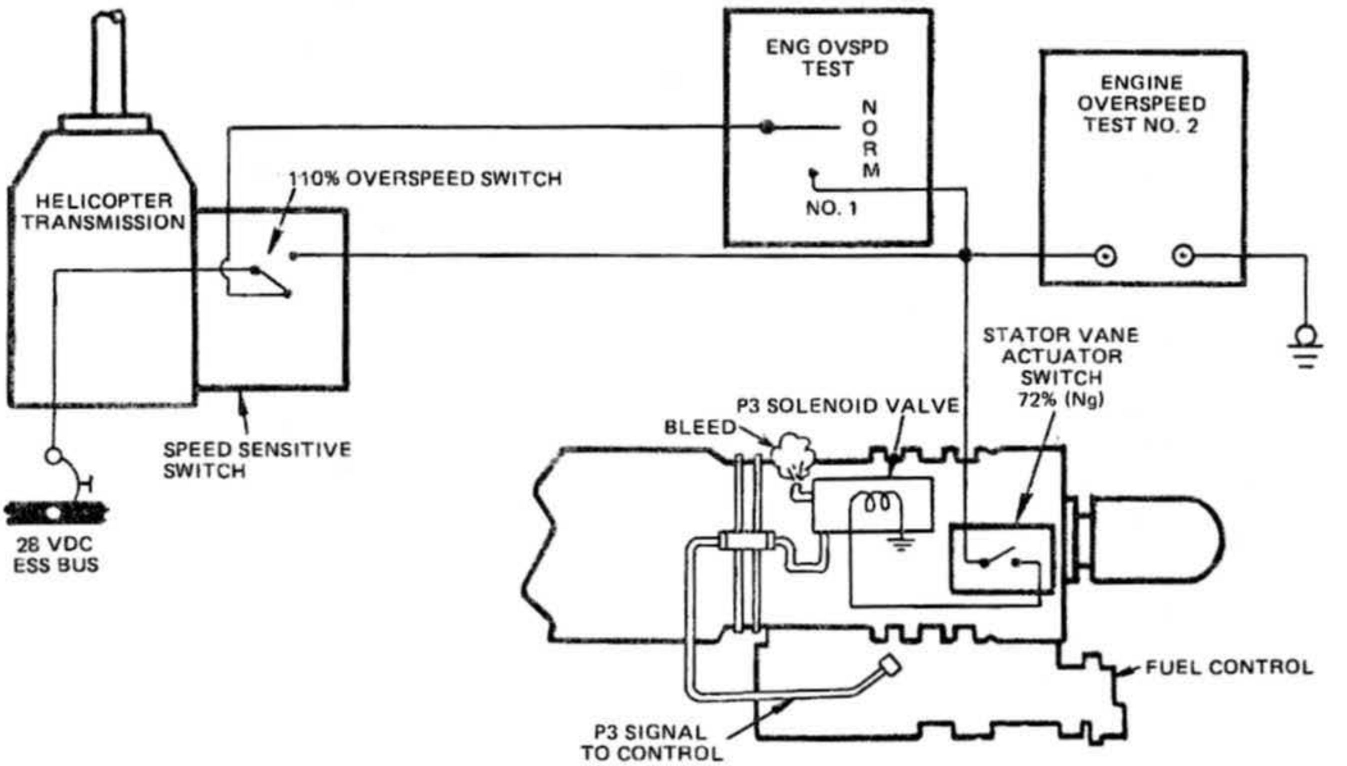


Figure 1-7. Main Rotor Overspeed Switch System

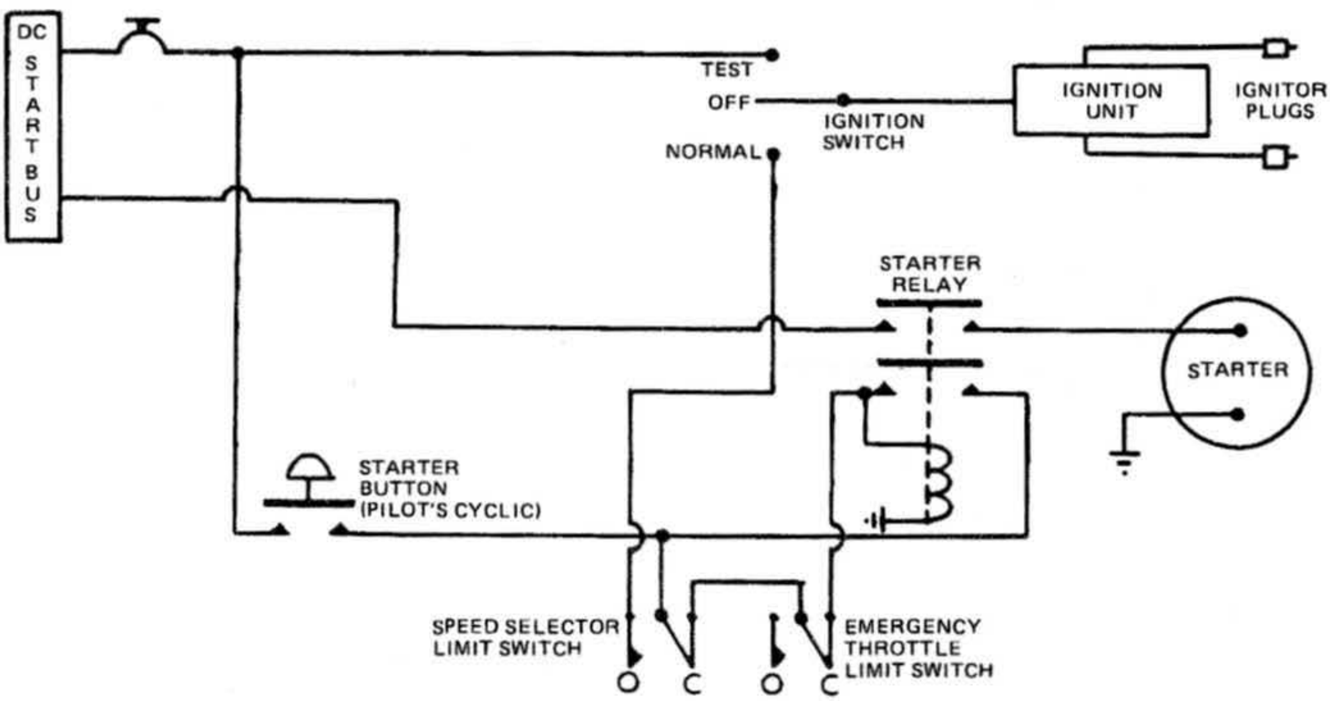


Figure 1-8. Starter and Ignition Systems

STARTER SYSTEM

The starter system (figure 1-8) consists of a starter motor mounted on the front frame of the engine, a starter relay, and a starter switch. The starter motor is protected by a bullet-nose cover. Two pulley limit switches must be closed by placing the engine speed selector in STOPCOCK and emergency throttle in the CLOSED position before the starter motor can be energized. When the starter button is depressed current from the start bus energizes the starter relay, allowing current from the start bus to activate the starter motor. Once the starter relay is energized it remains energized until the starter button is released.

Starter Switch

The starter switch is a push-button type momentary switch on the pilot's cyclic stick below the grip (figure 1-19). When the starter switch is depressed, the starter motor is energized. Releasing the starter switch breaks the circuit to the starter motor. Power is supplied from the START bus through a circuit breaker marked START & IGN, under the general heading START BUS on the forward circuit breaker panel.

ENGINE INSTRUMENTS

Dual Tachometer (Power Turbine and Rotor)

Two electrically-operated dual tachometers which indicate power turbine speed (Nf) and rotor speed (Nr) are on the instrument panel in front of the pilot and copilot (figure FO-1). The power turbine tachometer-generator is on the fuel control and is driven by the power turbine flex shaft. The rotor tachometer-generator is mounted tandem on the rotor speed switch and driven by the main gear box. Both tachometer-generators are synchronized to line up the tachometer needles when the engine is driving the main gear box.

Gas Generator Tachometer

The gas generator tachometer, on the instrument panel (figure FO-1), operates on current developed by a tachometer-generator which senses gas generator speed (Ng). The tachometer will indicate up to 110% gas generator speed.

Power Turbine Inlet Temperature Indicator

A power turbine inlet temperature (T_5) indicator, on the instrument panel (figure FO-1), is wired to eight thermocouples projecting into the hot-gas stream immediately ahead of the power turbine. The thermocouples, connected with a balance-resistance harness, are wired to a thermocouple spool resistor that varies the current flowing to the gage.

Engine Oil Pressure Indicator

An engine oil pressure indicator, on the instrument panel (figure FO-1), is wired to an oil pressure transmitter installed on the discharge side of engine oil pump. The indicator operates on 26 volts from the ϕC autotransformer and is protected by circuit breaker, marked ENG OIL PRESS, on the forward circuit breaker panel.

Engine Oil Temperature Indicator

An engine oil temperature indicator, on the instrument panel (figure FO-1), is wired to a temperature bulb installed on bottom of the oil tank. The indicator operates on 28 volts from the dc essential bus and is protected by a circuit breaker, marked OIL TEMP, under the general heading ENGINE, on the forward circuit breaker panel.

Fuel Pressure Indicator

The fuel pressure indicator installed on the instrument panel (figure FO-1), indicates fuel pressure in pounds per square inch as measured at the fuel inlet on manifold. The system operates on 26 volts from the ϕC autotransformer and is protected by a circuit breaker, marked FUEL PRESS, on the forward circuit breaker panel.

ROTOR SYSTEMS

The rotor system consists of a main rotor and an antitorque tail rotor. Both systems are driven by the engine through the transmission system and are controlled by the flight controls.

MAIN ROTOR SYSTEM

The main rotor system consists of the main rotor head assembly and the rotor blades. The head assembly, mounted directly above the main gear box, consists of a hub assembly and a swash plate assembly. The hub assembly (figure 1-9), consisting of three sleeve-spindle assemblies and three hydraulic dampers clamped between two parallel plates, is splined to the main motor shaft. The root ends of the three rotor blades are attached to the sleeve-spindle assemblies which permit each blade to flap vertically, hunt horizontally, and rotate about their span-wise axis. In a static condition, anti-flap restrainers limit the up movement of the blades and droop restrainers limit the downward movement. In flight, both the anti-flap restrainers and droop restrainer are extended by centrifugal force to allow the free movement of the blades. When the rotor is slowed for shutdown, spring tension draws the droop restrainers in place at approximately 60-56% rotor speed and the anti-flap restrainers in at approximately 20%. The hydraulic dampers minimize hunting movement of the blades about the vertical hinges as they rotate, prevent shock to the blades when the rotor is started or stopped, and aid in the prevention of ground resonance. The blades can be folded back from the attachment points at the sleeves of the main rotor hub. The three all-metal main rotor blades are of the pressurized spar type, identified as BIM® blades (figure 1-10). The blades are constructed of aluminum with the exception of forged steel cuffs which attach the root ends of the blades to the sleeve-spindle assemblies on the main rotor hub. Each blade consists of a hollow extruded aluminum spar pressurized with nitrogen, 22 sheet aluminum blade pockets, a tip cap, a root cap, a steel cuff, a pressure (IBIS) indicator, and an air valve. The blade pockets are constructed of an aluminum foil honeycomb with an aluminum skin covering. Each blade is balanced statically and dynamically within tolerances that permit individual replacement of the blades. A pretrack number is stenciled on each blade to eliminate the necessity for blade tracking. Balancing and the assignment of a pretrack number is done during manufacture or overhaul. The swashplate assembly consists of an upper (rotating) swashplate, which is driven by the rotor hub, and a lower (stationary) swashplate, which is secured by a scissors assembly to the main gear box to prevent rotation. Both swashplates are mounted on a ball-ring and socket assembly, which allows them to be tilted, raised, or lowered simultaneously by components of the main rotor flight control system, which connect to arms on the lower (stationary) swashplate. Cyclic or collective pitch changes, introduced at the stationary swashplate, are transmitted to the blades by linkage (pitch change rods) on the rotating swashplate.

BIM (Blade Inspection Method) Indicators

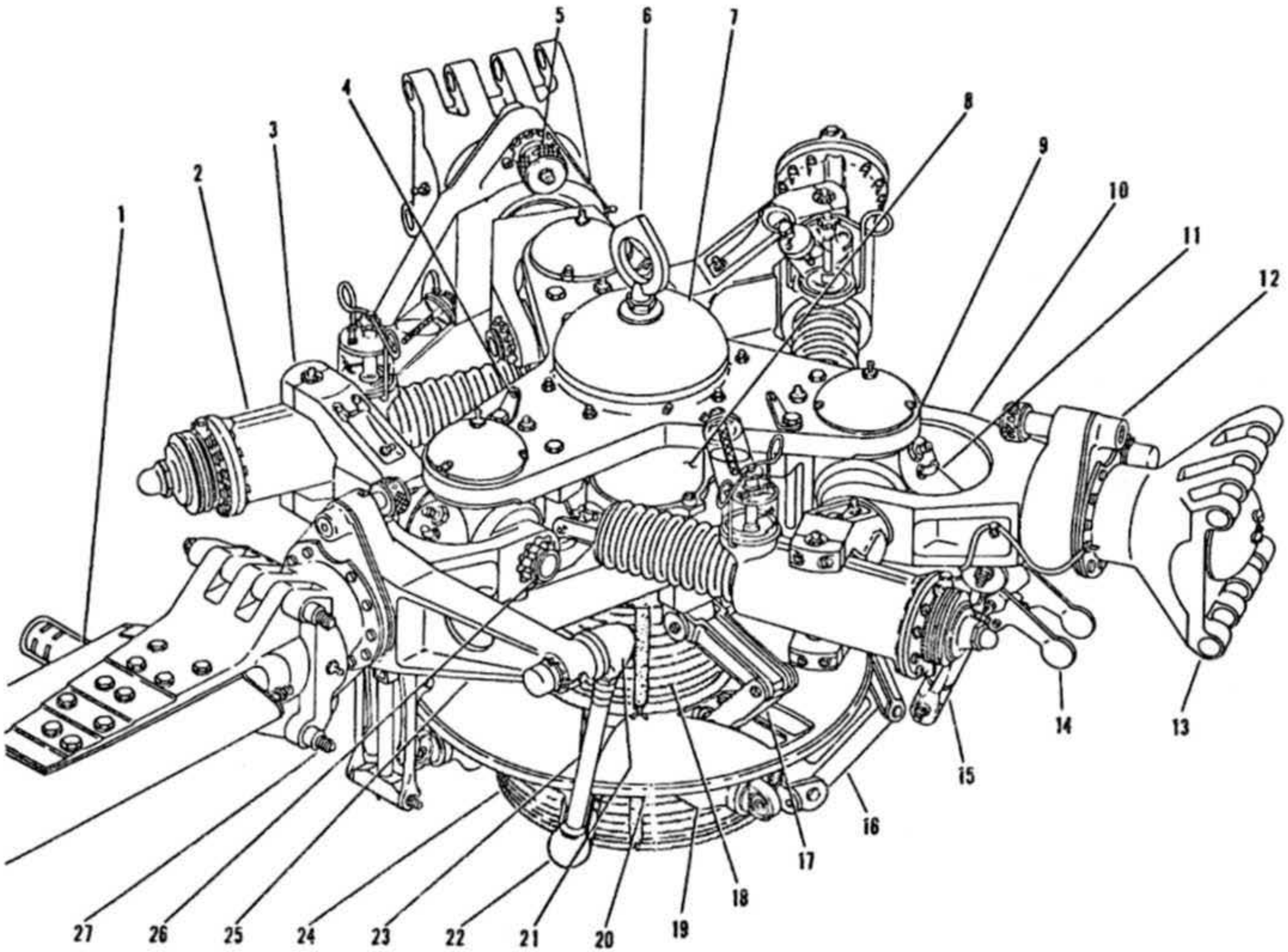
A cylindrical BIM indicator is in the back wall of the spar at the root of each main blade and an air valve is in the root end plate of the blade. The pressure indicator has a transparent cover through which a color indication can be observed to determine blade serviceability. The indicator, compensated for temperature changes, compares a reference pressure, built into the indicator, with the pressure in the blade spar. When the pressure in the spar is within the required service limits, three yellow stripes show in the indicator, indicating the blade is serviceable. If an unforeseen combination of events should occur impairing the structural integrity of the spar, or if a seal should leak, nitrogen pressure will decrease. If the pressure in the blade spar drops below the minimum permissible service pressure, the indicator will be actuated and will show three red stripes.

WARNING

When red is visible in the indicator, the cause of the red indication shall be determined before accepting the helicopter for flight.

In-Flight Blade Inspection System (IBIS)

Helicopters modified by TCTO 1H-52-509 are equipped with an In-flight Blade Inspection System (IBIS) that visibly indicates in the cockpit as well as on an indicator that the pressure in one or more main rotor blade spars has dropped below allowable limits. The IBIS indicator (figure 1-10), which replaces the BIM indicator, contains a small radioactive source which is completely shielded and emits no radiation when the rotor blade spar is at normal pressure. When the pressure drops below prescribed limits, the indicator will activate causing the radioactive source to move to an unshielded position, thereby emitting beta radiation. The detector assembly, on the transmission oil cooler fairing assembly, detects the beta radiation and sends a signal to the signal processor. The signal processor causes the BLADE PRESS caution light to go on. Loss of pressure in the blade spar is also indicated



1. Main Rotor Blade
2. Damper
3. Damper Arm
4. Hoisting Lug
5. Blade Lock
6. Hoisting Eye
7. Cover
8. Hub
9. Upper Plate
10. Sleeve-Spindle Assembly
11. Vertical Hinge Assembly
12. Blade Lock Bracket
13. Sleeve
14. Droop Restrainer (Flight Position)
15. Anti-Flapping Restrainer
16. Stationary Scissors
17. Rotating Scissors
18. Boot
19. Stationary Star
20. Rotating Star
21. Boot
22. Boot
23. Pitch Control Rod (Adjustable)
24. Boot
25. Horn
26. Horizontal Hinge Pin
27. Taper Pin

Figure 1-9. Main Rotor Head

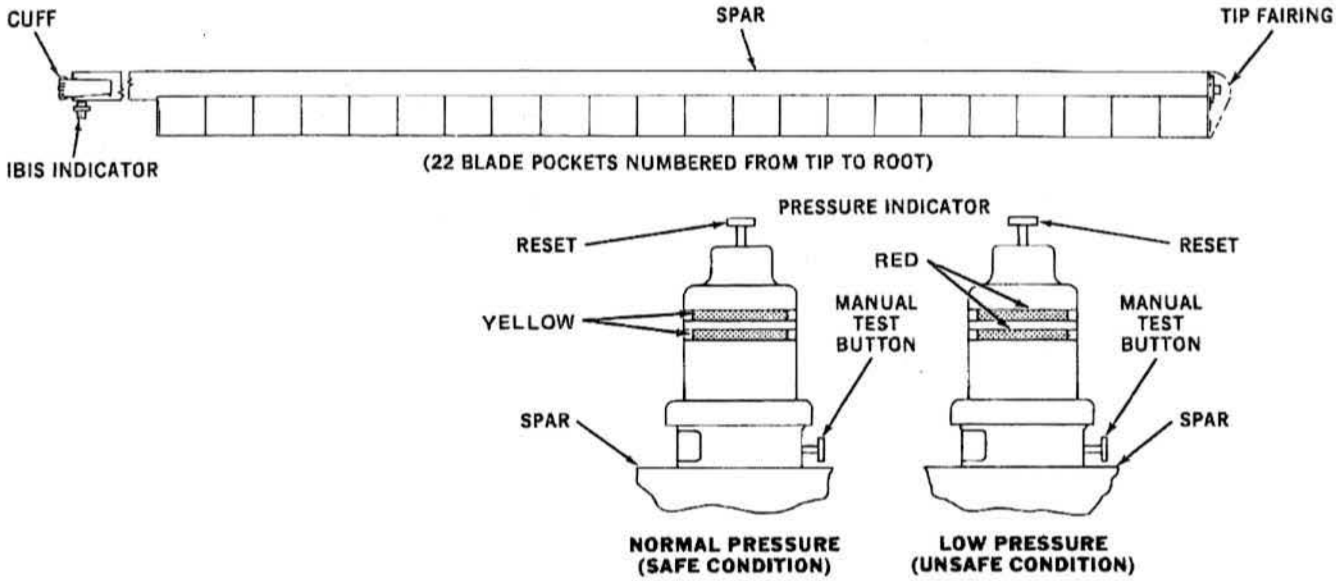


Figure 1-10. Main Rotor Blade

by the IBIS indicator on the blade. The indicator, compensated for temperature changes, compares a reference pressure built into the indicator with the pressure in the blade spar. When the pressure in the blade spar is within the required service limits, two yellow stripes show in the indicator. If the pressure in the blade spar drops below the minimum permissible service pressure, the indicator will activate and show two red stripes. Loss of ac power, failure of the detector, and/or failure of the signal processor will cause the BLADE PRESS caution light to go on. The system receives power from the ac essential bus and is protected by a circuit breaker marked IBIS AC ESS on the aft circuit breaker panel. The caution light is powered by the dc essential bus and is protected by a circuit breaker marked IBIS DC ESS on the aft circuit breaker panel.

WARNING

When red is visible in the indicator, the cause of the red indication shall be determined before accepting the helicopter for flight.

NOTE

A protective cover, on the Standard SAR Board, is for use in case of a red indication on the IBIS Indicator. The cover is designed to eliminate radiation leakage.

TAIL ROTOR

The tail rotor system consists of two variable pitch, all metal blades, counterweight assembly, and tail rotor hub. The tail rotor hub is splined to the tail rotor gear box output shaft which transmits engine torque to the tail rotor hub and blades. The blade pitch change mechanism is contained inside the tail rotor gear box output shaft and is connected to the tail rotor flight control system. Control rods from the counterweight beam assemblies to the sleeves on the blades can be adjusted to fixed values. Centrifugal force acting on the counterweights set the pitch of the blades if the tail rotor controls fail. The tail rotor counterweights are rigged to provide an approximate stable heading in a hover should loss of tail rotor control occur.

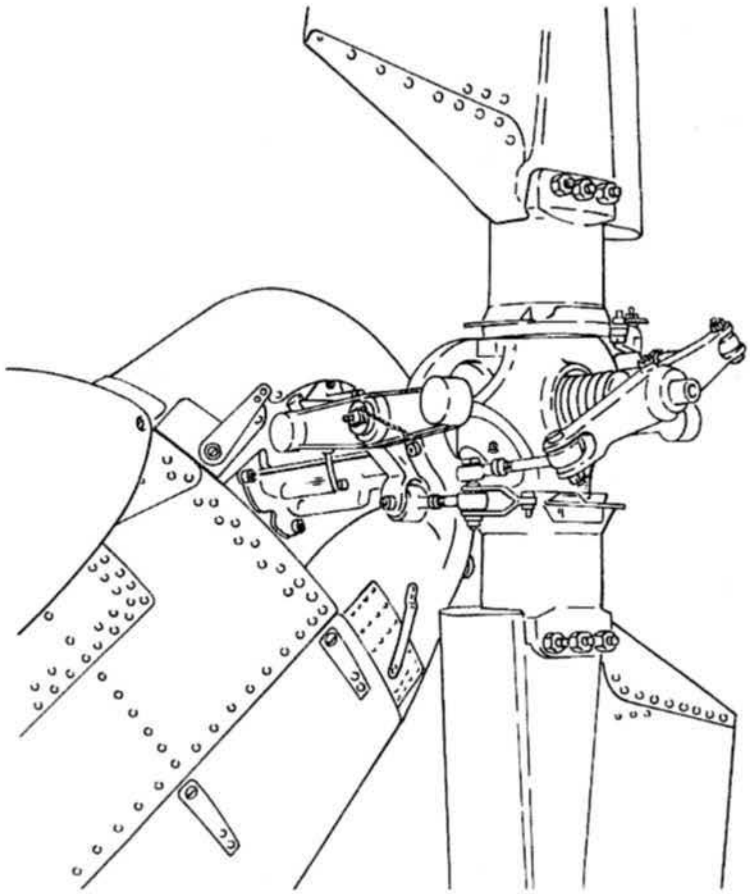


Figure 1-11. Tail Rotor Hub

ROTOR BRAKE SYSTEM

The rotor brake system (2, figure 1-12) is a manually operated hydraulic system for stopping the rotor at shutdown or holding the rotors and power turbine during starting or with gas generator at ground idle. The rotor brake system consists primarily of a hydraulic panel incorporating a relief valve, accumulator, pressure switch; a caution light, a master cylinder, rotor brake, and connecting hydraulic lines.

HYDRAULIC PANEL

The pressure switch, accumulator, and relief valve are connected in the hydraulic line between the master cylinder and the rotor brake. These three components comprise the hydraulic panel. The pressure switch, when actuated, powers the warning light on the instrument panel. The accumulator is installed in the hydraulic system to compensate for expansion or contraction of the hydraulic fluid due to temperature changes. If the line pressure reaches 650 psi, the relief valve opens to bypass the excessive pressure to the auxiliary reservoir. The master cylinder reservoir is filled when the handle is in the off (detent) position.

ROTOR BRAKE CAUTION LIGHT

The rotor brake caution light, marked ROTOR BRAKE, is on the caution-advisory panel, (figure 1-27) on the instrument panel. It goes on when the pressure in the brake line exceeds 10 ± 1 pounds PSI. 28 volts dc power for the system is taken from the essential bus through a circuit breaker, marked ROTOR BRAKE, on the forward circuit breaker panel.

MASTER CYLINDER

Hydraulic fluid from the auxiliary reservoir furnishes fluid to the master cylinder mounted on the

1. Main Drive Shaft
2. Rotor Brake
3. Freewheeling Unit
4. Auxiliary Hydraulic Reservoir
5. Auxiliary Hydraulic Pump
6. Transmission Oil Cooler
7. Tail Rotor Gear Box
8. Tail Drive Shaft Section (Section V)
9. Intermediate Gear Box
10. Splined Coupling
11. Tail Drive Shaft (Sections III and IV)
12. Oil Cooler Thermostat
13. Tail Drive Shaft (Section II)
14. Generator
15. Generator
16. Oil Pumps
17. Primary Servo Reservoir
18. Sight Plug

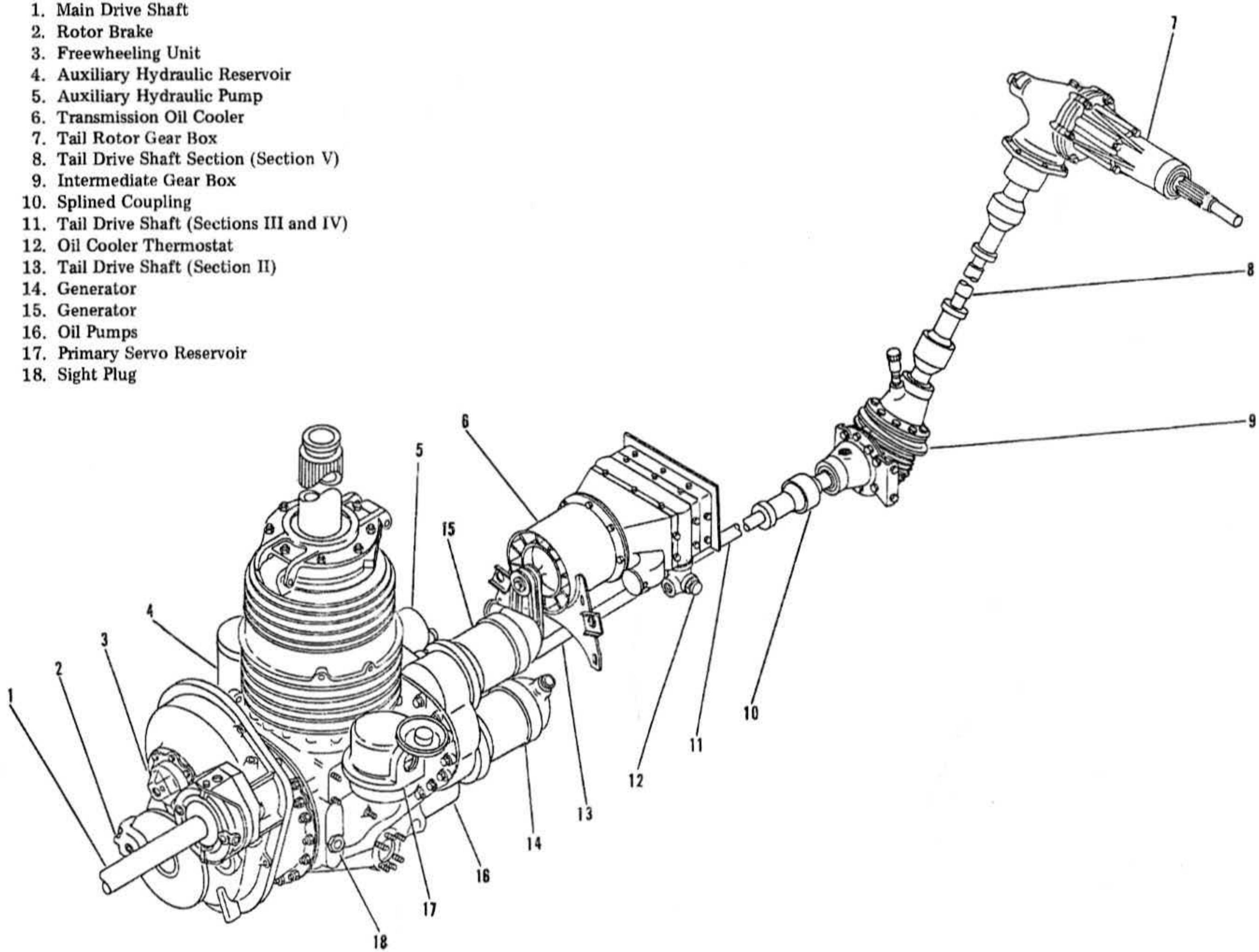


Figure 1-12. Transmission System

center frame of the windshield. The master cylinder is handoperated and furnishes hydraulic pressure to actuate the rotor brake, on the main gear box. The rotor brake is applied by pulling down and pushing forward on the handle (36, figure 1-2). A spring-loaded lock, at the right side of the cylinder, automatically locks the brake lever in the applied (down) position if the pilot places the small handle in the vertical or downward position. The lockpin must be pulled out in order to allow rotor brake release. The lockpin may be made inoperative by turning it until it remains in the OUT position.

ROTOR BRAKE

The rotor brake consists of a cylinder assembly positioned at the side of the brake disc. This cylinder assembly consists of two cylinder housings, two pistons, and two brake pucks. The brake disc is mounted on the rotor brake takeoff flange on the input housing of the main gear box. The rotor brake cylinder assembly is mounted on a bracket attached to the lower input housing of the main gear box. Hydraulic pressure forces the pucks against opposite sides of the brake disc causing drag to stop the rotor. The rotor brake cylinder is self-adjusting for wear of the brake pucks.

TRANSMISSION SYSTEM

The transmission system (figure 1-12) consists of three gear boxes (main, intermediate, and tail) and interconnecting shafting for the transmission of engine power to the rotor systems. The main gear box reduces engine speed, supports and drives the main rotor and furnishes a means of driving the tail rotor. An intermediate gear box changes the direction of the drive and shafting from the main gear box to the tail gear box. The tail gear box, in turn, drives the tail rotor.

MAIN GEAR BOX

The main gear box, mounted above the cabin aft of the engine, reduces engine speed to the main rotor through a five-stage reduction gear system at a ratio of 85.839 to 1. The main gear box also reduces engine speed at a ratio of 12.274 to 1 for driving the tail rotor. A freewheeling unit in the input housing to the gear box permits main rotor speed to exceed engine speed without engine drag. When the engine is driving the main rotor shaft, the rollers in the freewheeling unit are forced by cam action to lock the freewheeling cam and the output gear. Power is then transmitted from the freewheeling output gear into the main gear box. When the engine is not driving the main rotor shaft, the rollers in the freewheeling unit remain in the roller retainer, disengaged from the freewheeling cam. This allows the main rotor shaft to rotate indepentently from the main drive shaft. An accessory section (figure 1-13), at the rear of the main gear box, drives the two alternating current generators, the primary and auxiliary hydraulic pumps, the rotor speed switch and the tandem mounted rotor tachometer generator and the main gear box oil pump with the tandem-mounted torquemeter oil pump.

Chip Detector Caution Light

A main gear box chip detector caution light (figure 1-27), marked CHIP DETECTED, is on the caution-advisory panel. The light is connected to a magnetic chip detector in the main gear box. The caution light will visually indicate that the chip detector has picked up and retained metallic particles or chips present in the oil. The light operates on 28 volts dc from the essential bus and is protected by a circuit breaker, marked CHIP DET, on the forward circuit breaker panel.

INTERMEDIATE GEAR BOX

The intermediate gear box, at the junction of the tail cone and pylon, contains a bevel gear, direct drive system. Its only functions are to change the angle of the tail rotor drive shaft and transmit engine torque to the tail rotor gear box (figure 1-12).

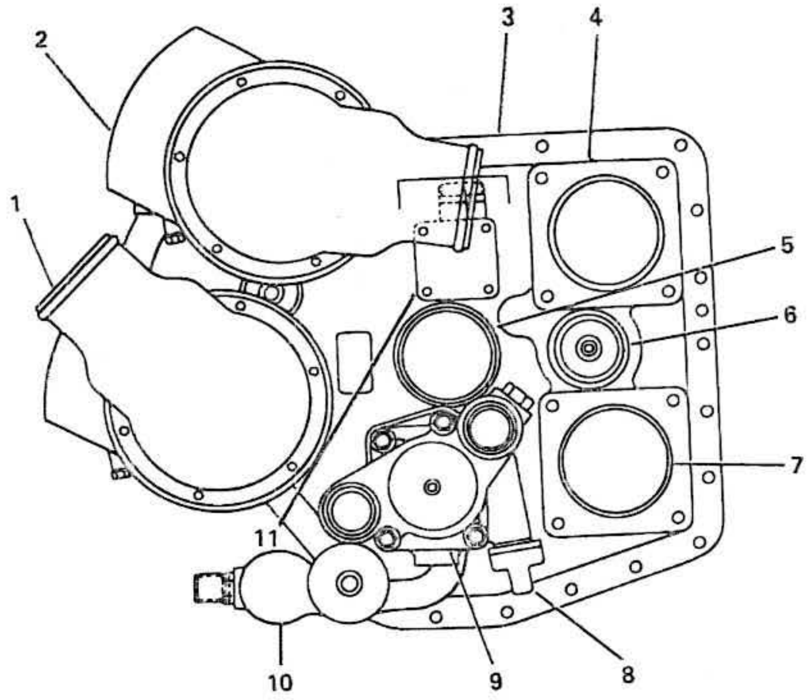
TAIL ROTOR GEAR BOX

The tail rotor gear box at the upper end of the tail rotor pylon, contains a bevel gear reduction-drive system to transmit engine torque to the tail rotor. The tail gear box also contains part of the tail rotor pitch change linkage which extends through the hollow horizontal output shaft to the pitch change beam (figure 1-12).

TRANSMISSION OIL SYSTEMS

Main Gear Box Oil System

The main gear box lubrication system (figure 1-14) consists of drilled internal oil passages connected



1. No. 2 Generator
2. No. 1 Generator
3. Accessory Cover
4. Auxiliary Hydraulic Pump
5. Tail Rotor Take Off
6. Idler Gear
7. Primary Hydraulic Pump
8. Torquemeter Pressure Regulating Valve Adjustment
9. Oil Pump
10. Oil Return From Pressure Regulating Valve, Temperature Bulb, Chip Detector and Oil Strainer
11. Speed Sensitive Switch and Nr Tachometer

Figure 1-13. Main Gear Box Accessory Section

by external oil lines to a self-priming oil pump. The oil pump is on the lower accessory housing and receives oil from the oil sump at the bottom of the lower housing. Oil flows from the sump through an oil strainer/magnetic chip detector past a thermometer bulb to the pump. From the pump, the oil passes through a filter and pressure regulating relief valve to the oil cooler, aft of the main gear box. Cooling air enters the fairing through a screened intake and is forced through the oil cooler by a blower driven by belts and pulleys from the tail rotor drive shaft. The oil is then distributed through internal oil passages and seven pressure jets to the bearings and gears and is returned to the sump by gravity flow. The torquemeter oil pump mounted tandem on the main gear box oil pump provides lubricating oil flow into the front cover of the gear box after passing through the torque sensing mechanism. The oil from the torquemeter pump returns to the same strainer as the main gear box oil pump. The torquemeter oil pump pressure is regulated by a pressure relief valve in the torquemeter oil pump housing. The main gear box oil level is indicated in a circular sight gage on the left side of the lower housing. An oil filler is on the left side of the main gear box.

MAIN GEAR BOX OIL PRESSURE INDICATOR

The main gear box oil pressure indicator (28, figure FO-1), marked XMSN OIL PRESS, is in the center of the instrument panel. The function of the indicator is to display the main gear box inlet oil pressure in pounds per square inch. The indicator is electrically connected to a pressure transmitter which sends electrical signals to the indicator. The indicator operates on 26 volts ac from the ϕC autotransformer and is protected by a circuit breaker, marked XMSN OIL PRESS, on the forward circuit breaker panel.

MAIN GEAR BOX OIL PRESSURE CAUTION LIGHT

The main gear box oil pressure caution light (figure 1-27), marked TRANS OIL PRESS is on the caution/advisory panel and is completely independent of the oil pressure indicating system. The light is connected to a pressure switch which senses pressure at the point of lowest oil pressure in the main gear box lube system. When the oil pressure at the switch drops to approximately seven psi, the caution light goes on. The oil pressure indicator should read approximately 15 psi. The light operates on 28 volts dc from the essential bus and is protected by a circuit breaker, marked XMSN LOW OIL PRESS, on the forward circuit breaker panel.

MAIN GEAR BOX OIL TEMPERATURE INDICATOR

The main gear box oil temperature indicator (24, figure FO-1), marked XMSN OIL TEMP, is in the center of the instrument panel. The indicator operates on 28 volts dc from the essential bus and is protected by a circuit breaker marked XMSN OIL TEMP on the forward circuit breaker panel.

Intermediate and Tail Gear Box Oil Systems

Both the intermediate and tail gear boxes are splash-lubricated from individual sump systems. Internal spiral channels insure oil lubrication to all gearing. An oil filler plug, drain plug, and oil level sight gage are in each gear box casing. When the oil in the intermediate gear box is at FULL on the oil level sight gage, it contains 1.25 pints. When the oil in the tail gear box is at FULL on the oil level gage it contains 0.72 pints.

Transmission Torque Indicating System

The torque indicating system provides a constant visual indication of engine torque input to the transmission. Components of the system include the torquemeter oil pump, torque sensing mechanism, torque sensor transmitter, two torquemeter indicators, two pressure switches, a time delay relay and an overtorque flag indicator. The torquemeter oil pump provides main gear box lubricating oil under pressure to the torque sensing mechanism (figure 1-14). This measures variations in torque system oil pressure caused by changes in the displacement of the main gear box second stage helical gear resulting from variations in engine input torque. The sensed pressure is received by the torque sensor transmitter and displayed in the cockpit on the torquemeters. If oil pressure within the sensing mechanism chamber increases above a value representing 100% torque, the elapsed time indicator is energized by the associated pressure switch. If oil pressure further increases to a value representing 116% torque, a second pressure switch trips the time delay relay energizing the overtorque flag indicator. The time delay allows momentary surges of overtorque above 116% before activating the flag indicator.

TORQUEMETER INDICATOR

Two torquemeter indicators (2 and 34, figure FO-1), one for the pilot and one for the copilot, are on the instrument panel. Each indicator, marked PERCENT TORQUE, contains a single needle which indicates torque input to the main gear box in percent. The indicators operate on 26 volts ac from the ϕC autotransformer and are protected by a circuit breaker marked TORQUE SENSOR, on the forward circuit breaker panel.

ELAPSED-TIME INDICATOR

An elapsed-time indicator is on the forward circuit breaker panel (figure FO-3). The indicator, marked HOURS AND HUNDREDTHS, provides a digital indication of the amount of time the main gear box has been operated above 100% torque. The indicator operates on 28 volts from the dc essential bus and is protected by a circuit breaker marked TORQUE SENSOR on the forward circuit breaker panel.

FLAG INDICATOR

A flag indicator is on the forward circuit breaker panel next to the elapsed time indicator (figure FO-3). The indicator can be identified by its circular, normally dull black face. When a 116% overtorque condition has existed for 4.5-5.5 seconds, a rectangular fluorscent red flag appears. The indicator operates on 28 volts from the dc essential bus and is protected by a circuit breaker, marked TORQUE SENSOR, on the forward circuit breaker panel.

FUEL SUPPLY SYSTEM

The fuel system (figure 1-15) for the helicopter supplies fuel for the engine and heater. System components consist of two fuel cells, vent lines, two fuel boost pumps, airframe fuel filter, fuel filter bypass warning system, fuel transfer system, fuel pressure indicating system, a manual fuel shutoff valve and drain lines.

FUEL TANKS

The forward and aft non-sealing bladder type fuel tanks are installed below the cabin floor in the watertight lower fuselage section. Each tank has a filler unit on the left side of fuselage. The forward

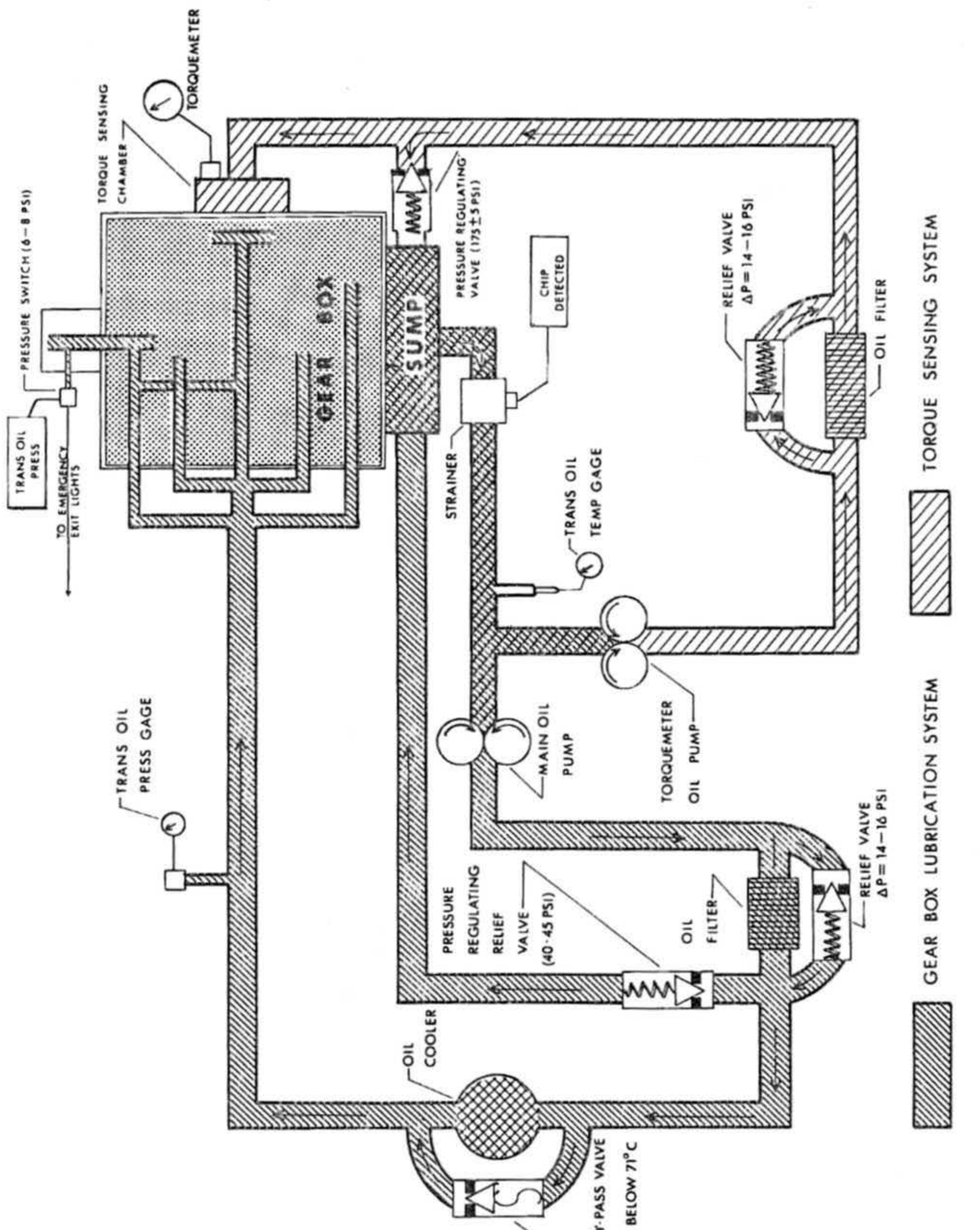


Figure 1-14. Main Gear Box Oil System

fuel tank has an additional filler unit, on the cabin floor, to enable the helicopter to be refueled while at rest on the water or from suitable containers during flight. A defueling valve is in the sump of each tank and is used to drain fuel from the tanks. Each tank sump also is equipped with a poppet-drain cock to be used to drain any water that may have accumulated in fuel tank sump. Both tanks are vented by lines that extend through the side of the fuselage. The forward fuel tank components consist of two ejectors and a three gallon collector unit containing the NO. 1 and NO. 2 fuel boost pumps. A float-type fuel level control is also installed in the forward tank to prevent overfilling in flight from the aft tank. The aft tank has one ejector unit.

FUEL QUANTITY DATA—U.S. GALLONS

Tank	Total Capacity	Unusable Fuel
Forward Tank and Collector Unit	187.0 GAL. (1216 LB.) (1272 LB.)	0.4 GAL. (2.6 LB.) (2.7 LB.)
Aft Fuel Tank	138.0 GAL. (897 LB.) 938 LB.	0.67 GAL. (4.4 LB) (4.6 LB.)
TOTAL	325.0 GAL. (2113 LB.) (2210 LB.)	1.07 GAL. (7.0 LB) (7.3 LB.)

THE PARAMETERS FOR DETERMINING UNUSABLE FUEL ARE: 5° NOSE-DOWN ATTITUDE. FUEL JP-4, 6.5 LB/GAL UNDER STANDARD CONDITIONS. SECOND WEIGHTS ARE JP-5, 6.8 LB/GAL UNDER STANDARD CONDITIONS.

FUEL BOOST PUMPS

Two electrically-operated fuel boost pumps submerged in the collector unit in the forward tank supply fuel under pressure to the engine and the ejectors. These pumps are controlled by two switches marked NO. 1 and NO. 2 with positions ON and OFF, under the general heading FUEL PUMP, on the overhead switch panel (figure FO-2). Normally both pumps are used for engine ground operation and flight. If either pump should fail, the remaining pump will continue to provide enough fuel pressure to operate the engine and fuel ejectors. The NO. 1 fuel boost pump operates on direct current power from the start bus. The NO. 1 fuel boost pump electrical circuit is protected by a circuit breaker, marked PWR, under the general heading NO. 1 FUEL PUMP, on the forward circuit breaker panel. The NO. 2 fuel boost pump operates on direct current from the dc non-essential bus and is protected by a circuit breaker, marked PWR, under the general heading NO. 2 FUEL PUMP, on the forward circuit breaker panel.

Fuel Boost Pump Caution Lights

Each fuel boost pump has a low pressure warning light, on the caution-advisory panel (figure 1-27) marked NO. 1 FUEL PUMP and NO. 2 FUEL PUMP. Lighting of a warning light indicates the output pressure from the associated pump is insufficient for the engine-driven fuel pump and to maintain fuel flow to the collector unit thru the ejectors. The NO. 1 fuel boost pump caution light operates on direct current from the start bus and is protected by a circuit breaker, marked WARN LT, under the general heading NO. 1 FUEL PUMP, on the forward circuit breaker panel. The NO. 2 fuel boost pump caution light operates from the dc essential bus and is protected by a circuit breaker, marked WARN LT, under the general heading NO. 2 FUEL PUMP, on the forward circuit breaker panel.

AIRFRAME FUEL FILTER

An airframe fuel filter, on the left side of the transmission deck, decontaminates fuel. If contaminates clog the filter, a pressure differential develops between the inlet and the outlet ports. As the filter progressively clogs, the increasing pressure differential will actuate a pressure switch, lighting the fuel bypass warning light. Additional clogging will cause the internal bypass valve to actuate, allowing unfiltered fuel to flow to the engine.

Fuel Filter Bypass Caution Light

A fuel filter bypass caution light, marked FUEL BYPASS on the caution advisory panel (figure 1-27), goes on when the airframe fuel filter pressure switch closes. Lighting of the FUEL BYPASS caution light indicates that the airframe fuel filter is partially clogged and the bypass of unfiltered fuel to the engine is imminent or already in progress. The fuel filter bypass circuit operates on direct current from the dc essential bus and is protected by

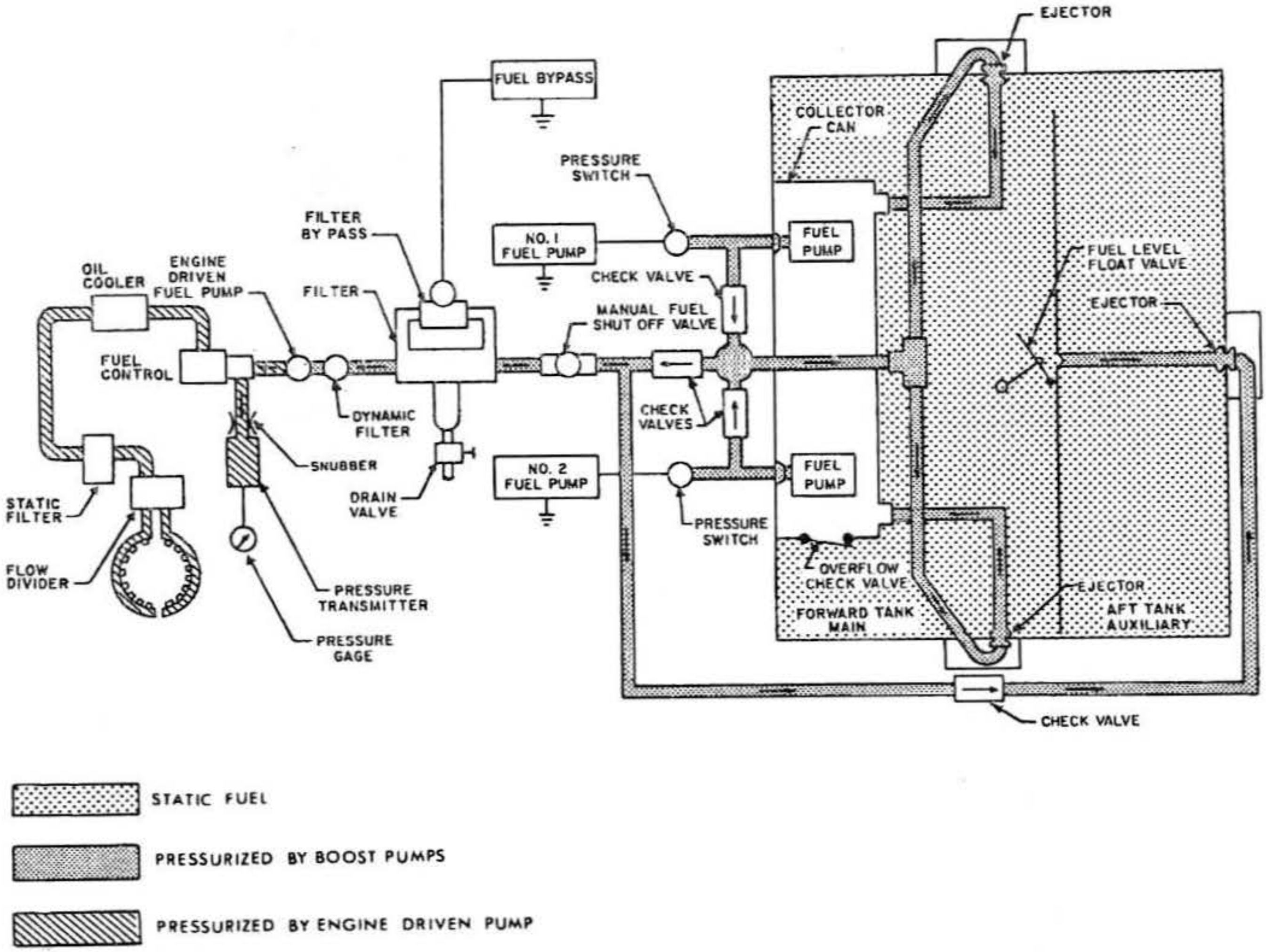


Figure 1-15. Fuel-Supply System

a circuit breaker, marked FILTER BYPASS, under the general heading FUEL, on the forward circuit breaker panel.

FUEL SHUTOFF VALVE T-HANDLE

See Section I, FIRE EXTINGUISHER ARM T-HANDLE

A manually operated fuel shutoff valve on the port side transmission deck controls the flow of fuel through the main fuel line from the fuel boost pumps to the engine. The valve is used in the event the speed selector will not stop fuel flow to the engine. The valve is actuated by a T-shaped handle (figure 1-16) with marked positions, FUEL ON (forward), FUEL OFF (midposition), and FIRE EXT ARMED (aft), forward of the overhead switch panel (figure 1-2). When the T-handle is in the FUEL ON position, fuel is permitted to flow from the fuel booster pumps to the engine. When the T-handle is in the FUEL OFF position, the fuel shutoff valve is closed. After placing the T-handle in the FUEL OFF position the engine will continue to operate on fuel in the line and fuel control for approximately 1 minute.

WARNING

If the engine is shutdown with a T-handle it should be allowed to coast down to a complete stop before repositioning the T-handle to the FUEL ON position to avoid a post-shutdown internal engine fire.

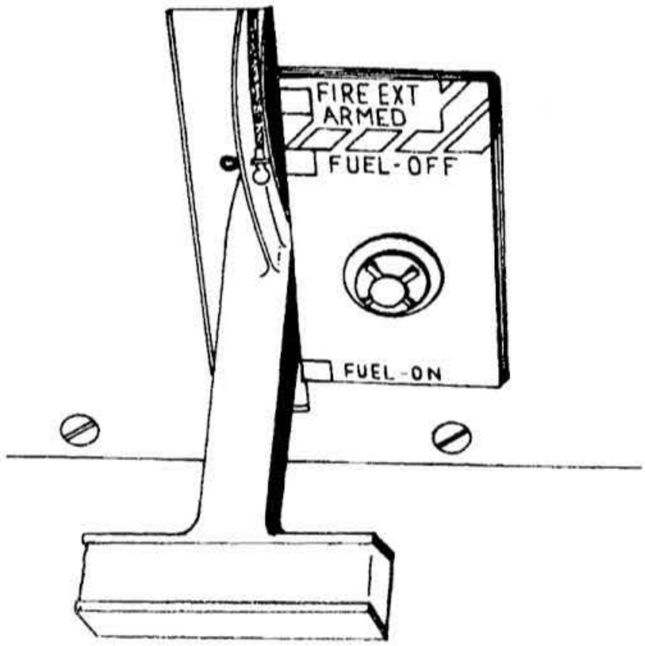


Figure 1-16. Fuel Shutoff T-Handle

FUEL TRANSFER SYSTEM

See Section VII

FUEL QUANTITY INDICATING SYSTEM

The fuel quantity indicating system is of the capacitance type and consists of the following components: four fuel sensing units, a fuel quantity indicator, fuel quantity selector switch, a fuel indicator test switch, a low fuel level sensor and a caution panel light. The system accurately measures the fuel quantity in both tanks regardless of temperature changes, provides low fuel level warning, has testing capability and indicates total, forward, or aft fuel quantity as selected by the pilot.

Fuel Quantity Indicator

A fuel quantity indicator, on the instrument panel (16, figure FO-1), indicates the total fuel quantity or the quantity in each tank in pounds. Due to the principle of operation, there is virtually no error in fuel quantity indication arising from volumetric changes of the fuel at different temperatures. The indicator receives power from the ac essential bus or ground inverter through a circuit breaker marked QTY under the heading FUEL on the forward circuit breaker panel.

Fuel Quantity Selector Switch

A fuel quantity selector switch is on instrument panel (figure FO-1). The switch is marked FUEL QTY SEL, and has positions, TOT, FWD, and AFT. When the selector switch is placed on TOT, the fuel quantity indicator will indicate total amount of fuel in both forward and aft fuel tanks. When the switch is placed in either FWD or AFT, the indicator will indicate only the amount of fuel in that specific tank, the selector switch is always left on the FWD position following checks of TOT or AFT fuel quantity because the engine draws fuel from the forward tank.

Fuel Quantity Indicator Test Switch

A momentary switch (18, figure FO-1), marked FUEL GAGE TEST is on the instrument panel below the fuel quantity indicator. The switch, when depressed, should cause the fuel quantity needle to reflect down scale without hesitation. When the switch is released the needle should return to its original reading.

FUEL LOW LEVEL CAUTION LIGHT

A fuel low level caution light, marked FUEL LOW, is on the caution-advisory panel (figure 1-27). The light is connected through a control unit to a sensing element located in the forward fuel tank. The light goes on when approximately 237 to 269 pounds of JP-4 or 255 to 289 pounds of JP-5 (37 to 42 gallons) remain in the forward tank with a 5° nose down attitude. This remaining fuel is enough for approximately 30 minutes of flight at cruising power. The system operates on current from the dc essential bus and is protected by a circuit breaker, marked LOW LEVEL, under the general heading FUEL, on the forward circuit breaker panel. The caution light operates on current from the dc essential bus and is protected by a circuit breaker marked FUEL LOW under the general heading WARNING LIGHTS.

ELECTRICAL SYSTEMS

Two electrical systems (figures FO-3 and FO-4), an ac system and a dc system, are installed in the helicopter. The ac system supplies and distributes 115/200 volts and 26 volts ac power. The dc system supplies and distributes 28 volts or 24 volts dc power. The primary power sources are two generators. The generators provide 115/200 volts ac

When the aircraft is in a nose level attitude, the light will illuminate when approximately 157 to 181 pounds of JP-4 or 179 to 207 pounds of JP-5 (26-30 gallons) remain in the forward tank (approximately 20 minutes of flight at cruise power).

thru voltage regulator/supervisory panels to the ac essential and nonessential buses. Two autotransformers step down 115 volts ac, from the ac essential bus to provide 26 volts ac. 115 volts ac power is also provided by a ground inverter that functions automatically when the dc essential bus is energized and the ac essential bus is de-energized. Two transformer rectifiers (T/R's) rectify 115/200 volts ac from the A/C busses to provide 28 volts dc from the dc system. The T/R's power the start, essential, and non-essential busses thru reverse current cutout relays. When the ac system is not energized, a 24 volt dc nickel-cadmium battery is provided to operate dc powered equipment for a limited time. The electrical systems may be operated from a ground power source thru the ac or dc external power receptacles. With ac external power, all ac and dc equipment may be utilized. With dc external power, only the dc buses are powered. Both systems are controlled by various switches in the cockpit. Each item of electrical equipment is protected from overload by a circuit breaker on one of three circuit breaker panels. A failure of the ac or dc power source is indicated by an appropriate caution light on the caution advisory panel.

GENERATORS

The two brushless 10KVA, 115/200 volts, 400 cycle three-phase generators are mounted on, and driven by, the accessory drive section (figure 1-13) of the main gear box. Each generator has its own voltage regulator supervisory panel and each generator maintains separate loads. The generators operate whenever the main gear box is operating, supplying ac electrical power to the ac distribution system when the generator switches are in the ON position and all supervisory panel functions are satisfied.

Voltage Regulator—Supervisory Panels

The voltage regulator-supervisory panels (figure FO-3) in the transition section, provide voltage regulator, overvoltage, undervoltage, ground or line-to-line faults and under frequency protection. Output voltage of each generator is controlled at 115 volts by a voltage regulator. The supervisory panels sense proper voltage, overvoltages, undervoltages line faults, under frequencies and when all conditions are proper, allow power to flow through the NO. 1 and NO. 2 line contactors to the ac essential and non-essential busses. If any improper conditions are sensed, the supervisory panel drops the generator from its load by de-energizing the respective line contactor. Underfrequency occurs at 90% Nr or less. The generator is automatically returned to the line when rotor speed is increased above 90% Nr. A generator disabled due to overvoltage, undervoltage or line faults may be regained by correcting the discrepancy and moving the appropriate generator switch to the OFF RESET position, then to the ON position.

Generator Switches

The generator switches, on overhead switch panel (figure FO-2) under general heading GENERATOR, have marked positions ON, OFF RESET, and TEST. When the switches are placed in ON, generator power is connected through the respective line contactor to the appropriate bus. When NO. 1 generator switch is placed in OFF RESET, the NO. 1 main line contactor relay and the bus-tie relay are de-energized. When the NO. 2 generator switch is placed in OFF RESET, only the NO. 2 line contactor is de-energized. The momentary TEST position provides a means to test the operation of the generator and supervisory panel. By placing the generator switch in the TEST position, power that would normally be used to energize the line contactor is diverted to a test relay. If the generator and supervisory panel are operating correctly, the respective generator caution light on the caution advisory panel will go off.

Generator Caution Lights

Two generator caution lights, marked NO. 1 GENERATOR and NO. 2 GENERATOR respectively, are on the caution-advisory panel (figure 1-27). These lights will go on whenever the associated generator is taken off the line by the opening of its line contactor. The generator caution lights are powered by the dc essential bus and are protected by circuit breakers 1-GEN-2 under the general heading WARNING LIGHTS on the forward circuit breaker panel.

GROUND INVERTER

The ground inverter is in the transition section and is used when the generators are off to provide ac power for engine instruments prior to and during engine start. The ground inverter is rated at 115 volts ac, 100 VA, single phase and 400 cycles. The ground inverter is automatically energized whenever the dc essential bus is energized and the ac essential bus is not energized. When the ac essential bus is energized, a relay is actuated that disconnects the ground inverter from the dc essential bus and shifts the ground inverter's load to the ac essential bus. The ground inverter is protected by a circuit breaker marked INV INPUT, on the aft circuit breaker panel.

AUTOTRANSFORMERS

Two autotransformers step down B and C phase 115 volts ac essential bus power to 26 volts for navigation radio and pressure indicators. The ϕB (radio) autotransformer powers navigation indicators. (See Section IV, ELECTRICAL POWER DISTRIBUTION). The ϕC (pressure indicator) autotransformer powers engine, transmission, and hydraulic pressure indicators and the torque indicators. The ϕB autotransformer is protected by a circuit breaker marked AUTO XMFR ϕB, on the forward circuit breaker panel (figure FO-3). The ϕC autotransformer is protected by a circuit breaker marked AUTO XMFR ϕC, on the aft circuit breaker panel (figure FO-3). The ϕC autotransformer also operates off of the ground inverter when it is powered.

AC ESSENTIAL BUS

The ac essential bus, which distributes power to all ac essential equipment, may be powered by the NO. 1 generator, the NO. 2 generator, or external power. The NO. 1 generator, when operating, will always power the ac essential bus through the NO. 1 line contactor. Failure of the NO. 1 generator deenergizes the NO. 1 line contactor and bus tie relay. The NO. 2 generator will then power the ac essential bus through the NO. 2 and NO. 1 line contactors. External power is supplied to the ac essential bus through the external power relay and th NO. 2 and NO. 1 line contactors.

AC NON-ESSENTIAL BUS

The ac non-essential bus, which powers the NO. 2 TR, is energized by the NO. 2 generator or by external power. Power is supplied from the generator to the bus through the NO. 2 line contact and bus-tie relay. Failure of either generator will result in loss of the ac non-essential bus. The NO. 2 TR will be the only ac powered equipment lost.

PILOT'S VGI

The pilot's VGI is normally powered by the NO. 2 generator. If the NO. 2 generator fails, the NO. 2 generator caution light goes on and the pilot's VGI is automatically switched to the ac essential bus. (See Section I ASE Vertical Gyro.)

ALTERNATING CURRENT CIRCUIT BREAKERS

Alternating current circuit breakers, protecting various ac circuits, are on the forward and aft circuit breaker panels (figure FO-3). The forward circuit breaker panel is to the left of the cockpit access door. The aft circuit breaker panel is on the cabin compartment aft bulkhead by the entrance door to the transition section. All circuit breakers are marked to indicate the circuit they protect and are of push-pull type that may be reset. Any malfunctioning circuit may be isolated from the ac power supply system by pulling out its circuit breaker. Circuit breaker guards are installed on the forward circuit breaker panel. The guards provide protection against accidental tripping or breakage of the circuit breakers.

TRANSFORMER RECIFIERS

Two transformer-rectifiers rated at 200 amperes, 28 volts dc, are used to convert 115/200 volts ac to 28 volts dc. The TR's are on the right side of the transition section (figure FO-3). Two loadmeters, one for each T/R indicate the output of the respective T/R. The NO. 1 transformer-rectifier is powered by the NO. 1 generator through the ac essential bus, and the NO. 2 transformer-rectifier is powered by the NO. 2 generator through the ac non-essential bus. The NO. 1 transformer-rectifier is protected by a ganged circuit breaker, marked NO. 1 TR, on the aft circuit breaker panel, and the NO. 2 transformer-rectifier is protected by a ganged circuit breaker, marked NO. 2, also on the aft circuit breaker panel. The loss of either generator will result in the loss of the NO. 2 transformer-rectifier. The loss of either TR will result in the loss of the dc non-essential bus. The non-essential bus may be regained by placing the dc non-essential override switch to the ON position.

Transformer-Rectifier Caution Lights

Two transformer-rectifier caution lights marked NO. 1 RECTIFIER and NO. 2 RECTIFIER, are on the caution advisory panel (figure 1-27). Failure of a transformer-rectifier, or reverse current cutout relay will light the associated caution light. The lights are powered by the start bus and do not have circuit breakers.

Reverse Current Cutout Relays

Two reverse current cutout relays, one for each TR, monitor the output of the TR's. These relays automatically connect their respective TR to the dc start bus when TR output voltage is greater than that of the bus. Conversely, they automatically disconnect their respective TR from the dc start bus when TR voltage drops to a value lower than that of the bus supply. A caution light on the caution-advisory panel, marked NO. 1 RECTIFIER or NO. 2 RECTIFIER goes on indicating which TR has been dropped from the line.

BATTERY

The 24-volt, 22-ampere hour nickel cadmium battery, on the right side of the transition section, is accessible from inside the helicopter. Battery power is used for limited ground operations, including starting of the engine, when no external source of power is available. The battery is used as an emergency source of power in event of failure of both generators and/or transformer-rectifiers, or failure of the NO. 1 TR and either generator. The battery is charged whenever the start bus is powered by a T/R or external power and the battery switch is in the START or ON position. The battery is protected by an overtemperature circuit which limits the charge to the battery when the battery temperature reaches approximately 135°F. Then, an advisory light on the caution-advisory panel, marked BAT OVTEMP, goes on. This advisory light will remain on until the battery cools to approximately 115°F, even though the aircraft may be shut down with all power secured.

CAUTION

If the BAT OVTEMP advisory light goes on, monitor the battery for possible thermal runaway. Refer to Section III for procedures.

The overtemperature circuit is protected by a circuit breaker marked BAT OVTEMP, on the aft circuit breaker panel.

Battery Switch

The three position battery switch is on the overhead panel (figure FO-2) with marked positions START, OFF, and ON. In either the START or ON positions, the battery is connected to the start bus. The START position also provides a convenient way to limit dc loads by disconnecting the dc essential bus from the start bus. This position is used during battery starts.

START BUS

The start bus functions to distribute power to the essential and non-essential buses and to certain equipment required for engine starting. It may be powered by the battery, transformer-rectifiers or external power. During battery starts with the battery switch in the START position, the start bus supplies power to the NO. 1 fuel pump caution light, nonflight instrument lights NO. 1 fuel boost pump, rectifier caution lights, and the starter and ignition systems.

DC ESSENTIAL BUS

The dc essential bus supplies power to operate all dc equipment necessary for safety of flight and limited mission accomplishment. The dc essential bus receives power from the start bus and may be energized by either T/R, external power or the battery.

DC NON-ESSENTIAL BUS

The dc non-essential bus supplies power for dc equipment that is not essential to safety of flight or limited mission accomplishment, and receives power from the start bus. The dc non-essential bus is automatically energized any time both T/Rs are operating or when dc external power is applied. Loss of either T/R automatically reduces the dc electrical load by de-energizing the dc non-essential bus. The non-essential bus may be regained through the use of the dc non-essential bus override switch.

DC NON-ESSENTIAL BUS OVERRIDE SWITCH

The non-essential bus override switch on the overhead switch panel, (figure FO-2) under the general heading DC NON ESS BUS OVD, provides a means for the pilot to manually connect the dc non-essential bus to the start bus. The switch has two positions, one of which is marked ON. In the ON position, the non-essential bus will remain energized as long as the dc essential bus is energized.

Monitor Ammeter Advisory Light

A green MONITOR AMMETER advisory light is on the caution advisory panel (figure 1-27). This light will go on whenever the dc non-essential bus override switch is placed in the ON position and a generator or transformer-rectifier is off the line. This light is connected to the start bus and does not have a circuit breaker.

LOADMETER

Two loadmeters on the forward circuit breaker panel (figure FO-3), visually indicate the power output of its respective transformer-rectifier. The face of both loadmeters from 0 to 1.0. The 1.0 indication is equivalent to 100% of the rated output of the T/R or 200 amps. During engine start, the loadmeters are dropped from the circuit to protect them from the high dc loads encountered during start.

DC UTILITY RECEPTACLE

A utility receptacle labeled UT RECPT 28 VDC, is in the cabin, aft of the cargo door on the right side. Power to the receptacle is supplied by the dc non-essential bus through the UTILITY RECP circuit breaker, on the aft circuit breaker panel. The receptacle is protected from damage and entrance of foreign matter by a cap.

DIRECT CURRENT CIRCUIT BREAKERS

Direct current circuit breakers, protecting the various dc circuits are on the forward and aft circuit breaker panels (figure FO-3). All circuit breakers are marked as to the circuit they protect and are of the push-pull type that may be reset. Any malfunctioning circuit may be isolated from the dc power supply system by pulling out the circuit breaker. Circuit breaker guards are installed on the forward circuit breaker panel. The guards provide protection against tripping or breakage of the circuit breakers.

EXTERNAL POWER

External Power Switch

The external power switch in on the overhead switch panel (figure FO-2) under the heading EXT PWR with positions marked ON and OFF. In the OFF position, neither external power relay can be energized. With the switch in the ON position and either ac or dc external power applied, the appropriate external power relay will be closed, provided that with ac external power, the BATT switch has been placed in the ON position. The external power switch is protected by a circuit breaker marked EXT PWR on the forward circuit breaker panel.

External Power Advisory Light

The external power advisory light, on the caution advisory panel (figure 1-27) and marked EXT PWR, will go on when the external power switch is ON and external power is being supplied to the aircraft. This light goes on whenever the external power relay is energized.

AC External Power Receptacles

The ac external power receptacles permits connection of an external source of 115/200 volt, 400 cycle ac power to the ac distribution system. The ac receptacle (figure FO-3) is on the right side of the fuselage, aft of the cabin door. With external power connected, the battery and external power switches ON, dc power from the battery passes through the external power plug and receptacle to the phase sensing relay. If proper phasing and voltage of applied external power are sensed by the phase sensing relay, the external power relay will be energized, allowing the ac power through the NO. 2 and NO. 1 line contactors to the ac essential bus. The ac non-essential bus is energized, through the external power relay and bus-tie relay. The EXT PWR advisory light goes on when the external power relay is energized. When AC external power is applied, all busses of both the ac and dc are energized.

DC External Power Receptacle

The dc external power receptacle (figure FO-3) permits connection of an external source of 28 volts dc power to the dc system. The dc receptacle is on the right side of the fuselage aft of the cabin door. The external power switch must be in ON to utilize external power. External dc power is supplied through the start bus to the dc essential and non-essential busses.

FLIGHT CONTROL SYSTEMS

The flight controls are divided into three major systems: The cyclic control system, the collective pitch control system, and the directional control system (figure 1-18). Components of the systems include two cyclic control sticks, two collective pitch levers and two sets of directional control (tail rotor) pedals, all in the cockpit, the auxiliary servo cylinder assembly, the mixer unit, three primary servo units, and various control rods, cranks, and cables. The cyclic control system controls the pitch of the main rotor blades by changing the angle of incidence of each blade individually and unequally. Moving either cyclic control stick in the desired direction of flight (fore, aft, left, or right) tilts the tip path plane in that direction causing the helicopter to move in the same direction. A cyclic control stick trim system maintains a selected cyclic position, a requirement of proper operation of the Automatic Stabilization Equipment (ASE). The collective pitch control system controls the angle of the main rotor blades by changing the angle of incidence of each blade simultaneously and equally. Moving either collective pitch lever up or down causes the helicopter to climb or descend by increasing or decreasing blade pitch angle. Cyclic control stick and collective pitch lever movements in the cockpit are transmitted by a series of control rods and bell cranks to the auxiliary servo cylinder assembly, the mixing unit and the primary servo units. The directional control system controls the pitch angle of the tail rotor blades. Pushing either left pedal increases blade pitch so the tail rotor over compensates for main rotor torque, causing the helicopter to turn left. Pushing either right pedal decreases blade pitch, allowing torque to turn the helicopter to the right. Tail rotor pedal movements are transferred thru control rods to the auxiliary servo cylinder assembly and cables to the tail rotor pitch change mechanism.

CYCLIC CONTROL STICKS

Two cyclic control sticks in the cockpit provide lateral and longitudinal control of the helicopter. Each cyclic control stick has a stick grip (figure 1-19) containing several switches for controlling various systems and equipment installed in the helicopter. The copilots cyclic may be removed for maintenance by pulling a small ring near the base of the cyclic.

COLLECTIVE PITCH LEVERS

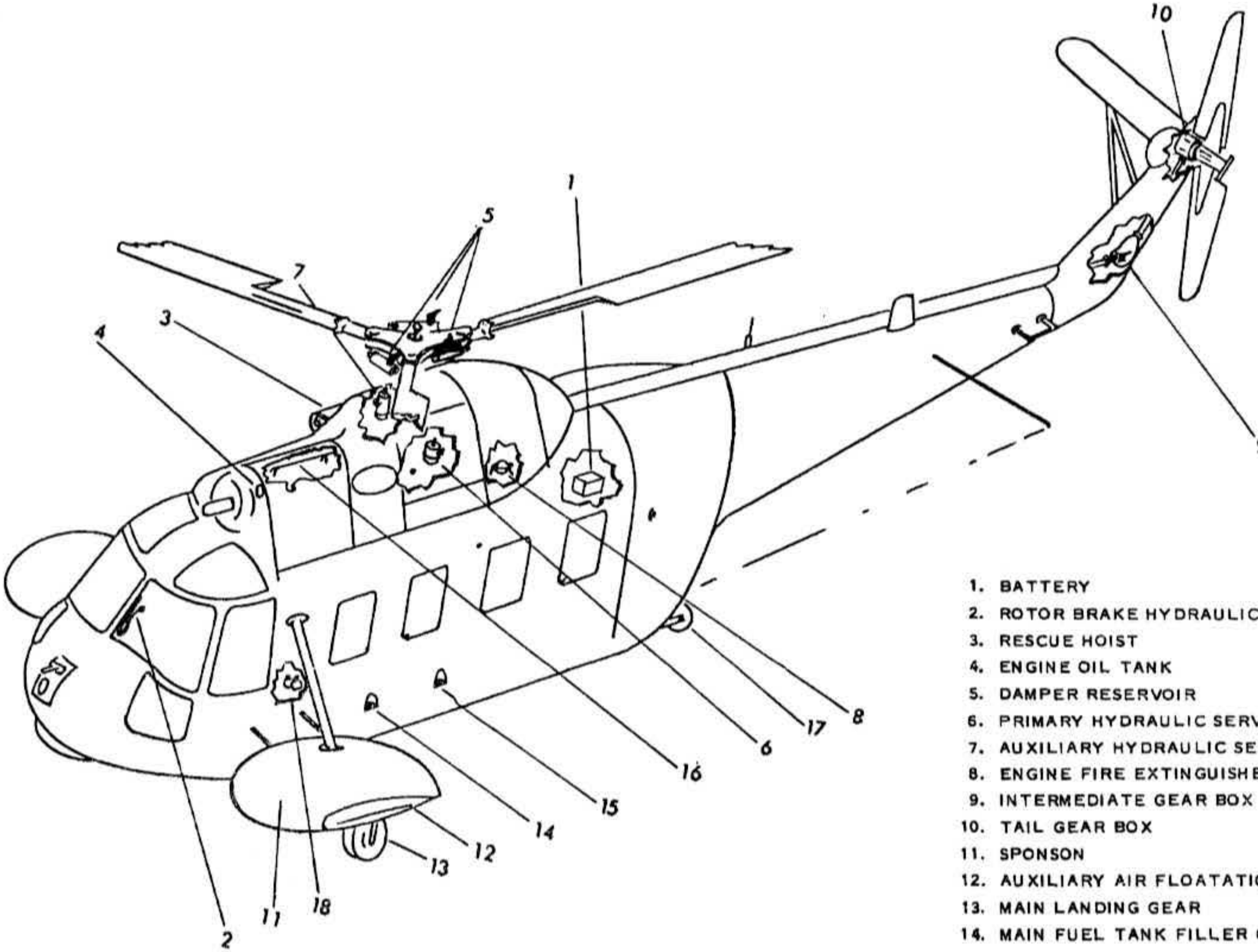
Two collective pitch levers, in the cockpit (figure 1-20), provide vertical control of the helicopter. A control box, mounted on the forward end of the pilot's collective pitch lever, contains several switches controlling various systems and equipment installed in the helicopter. Speed selector and emergency throttle controls are mounted on both collective pitch levers. The pilot's collective pitch lever also has a friction lock that may be adjusted to prevent the collective from creeping in flight.

TAIL ROTOR PEDALS

Two sets of tail rotor pedals (17 and 25, figure 1-2), in the cockpit, provide heading (yaw) control of the helicopter. Each set of tail rotor pedals may be independently adjusted, fore or aft, by a separate tail rotor pedal adjustment knob marked FWD and AFT with appropriate arrows. Toe brakes are mounted on the pilot's tail rotor pedals.

AUXILIARY SERVOCYLINDER ASSEMBLY

The auxiliary servocylinder assembly, in a compartment behind the pilot, provides a separate hydraulic assist to each flight control system. Hydraulic power is supplied by the auxiliary servo hydraulic system pump. The auxiliary servocylinder assembly will continue to function in case hydraulic pressure is lost. Mounted on the fore-and-aft and laterial banks of the servocylinder assembly are a pair of solenoid-operated cylic control stick trim system valves. Mounted on the fore-and-aft, lateral, and directional (yaw) banks are flapper valves for the introduction of automatic stabilization equipment (ASE) control signals. There is no flapper valve for ASE control of the collective bank. The directional bank also incorporates a pedal dampening piston



1. BATTERY
2. ROTOR BRAKE HYDRAULIC CYLINDER
3. RESCUE HOIST
4. ENGINE OIL TANK
5. DAMPER RESERVOIR
6. PRIMARY HYDRAULIC SERVO SYSTEM RESERVOIR
7. AUXILIARY HYDRAULIC SERVO SYSTEM RESERVOIR
8. ENGINE FIRE EXTINGUISHER BOTTLE
9. INTERMEDIATE GEAR BOX
10. TAIL GEAR BOX
11. SPONSON
12. AUXILIARY AIR FLOATATION SYSTEM
13. MAIN LANDING GEAR
14. MAIN FUEL TANK FILLER CAP
15. AFT FUEL TANK FILLER CAP
16. ENGINE FIRE EXTINGUISHER
17. TAIL LANDING GEAR
18. AIR BOTTLES (SEE 12)

Figure 1-17. Servicing Diagram

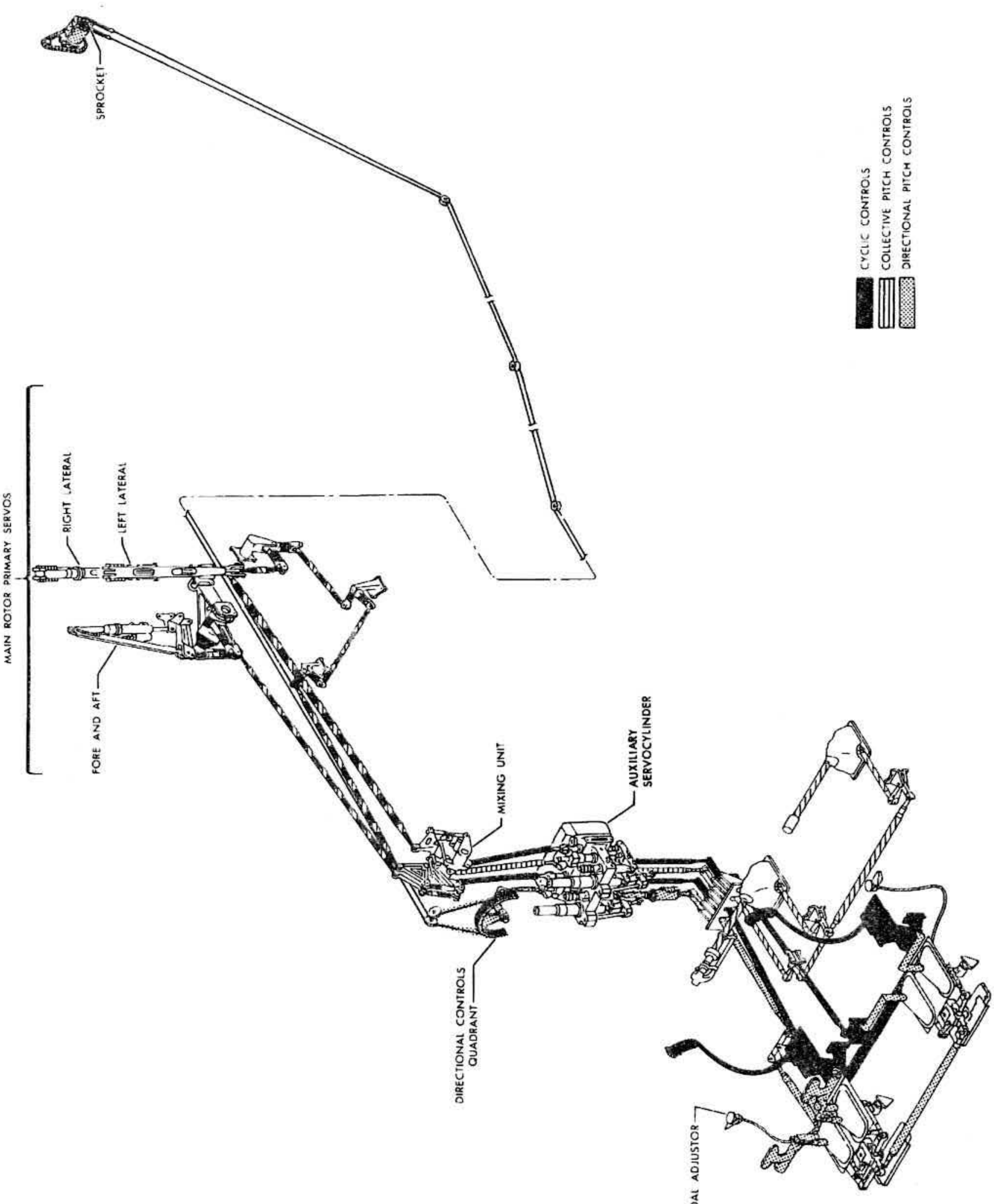


Figure 1-18. Flight Controls

which restricts sudden turns of the helicopter preventing overtorque of the tail rotor drive system. Hydraulic pressure to the auxiliary servocylinder assembly may be shut off by actuating the servo hydraulic electrical shutoff system switch.

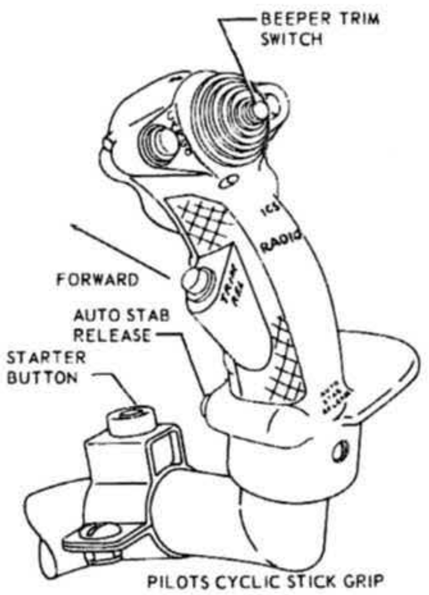


Figure 1-19. Pilot's Cyclic Stick Grip

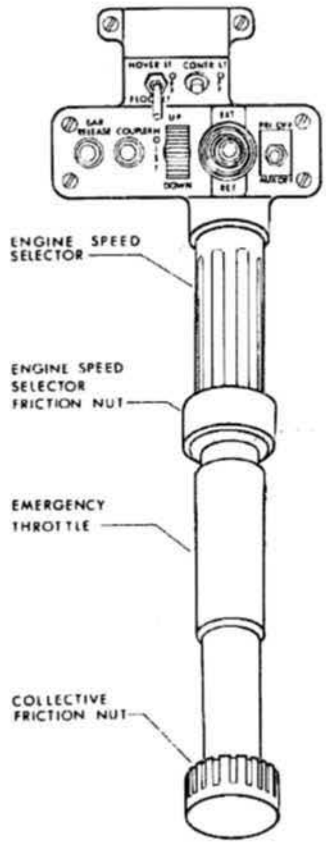


Figure 1-20. Pilot's Collective Pitch Lever

AUXILIARY SERVO HYDRAULIC SYSTEM PUMP

The auxiliary servo hydraulic system pump, (figure 1-21), on the main gear box accessory section, (figure 1-13) is a variable delivery, piston type, constant pressure pump. The pump provides pressurized hydraulic fluid to operate the auxiliary servocylinder assembly, the main landing gear and rescue hoist. The pump is driven by the main gear box.

MIXER UNIT

The mixer unit, above the auxiliary servocylinder assembly, is the junction point where cyclic control stick movements and/or collective pitch lever control movements merge to transmit individual or combined control movements to the primary servo units.

PRIMARY SERVO UNITS

Three primary servo units, mounted on the main gear box, transmit fore-and-aft, lateral and vertical control inputs to the stationary star assembly. The primary servo units are hydraulically assisted by power supplied from the primary servo hydraulic system pump. The primary servo will continue to function if hydraulic pressure is lost. Hydraulic pressure to the primary servo units may be shut off by actuating the servo hydraulic electrical shutoff system switch.

PRIMARY SERVO HYDRAULIC SYSTEM PUMP

The primary hydraulic system pump (figure 1-21), mounted on the accessories section of the main gear box, (figure 1-13) is a variable delivery, piston type, constant pressure pump that provides pressurized hydraulic fluid to operate the primary servo units. The pump is driven by the main gear box.

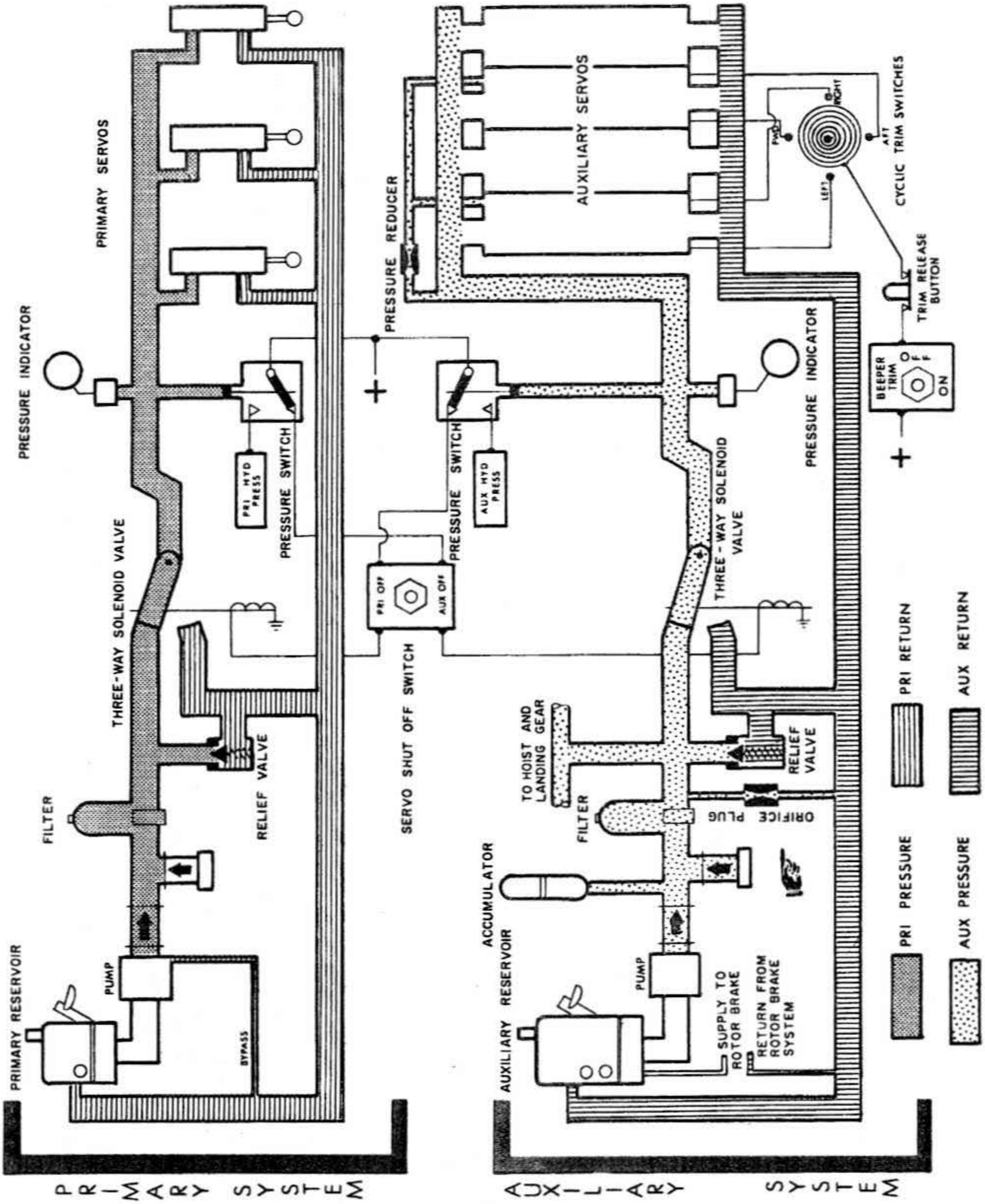


Figure 1-21. Primary and Auxiliary Hydraulic Systems

SERVO HYDRAULIC ELECTRICAL SHUTOFF SYSTEM

The servo hydraulic electrical shutoff system (figure 1-21), interconnects the two servo systems electrically to provide a means of shutting off hydraulic pressure to only the selected servo system. System components include a servo shutoff switch, two servo hydraulic pressure indicators, two pressure switches and two caution advisory panel capsule lights. Electrical power for the system, except the pressure indicators, is supplied from the 28 volt dc essential bus protected by two circuit breakers marked PRI and AUX under the general heading SERVO, on the forward circuit breaker panel.

Servo Hydraulic Electrical Shutoff System Switch

The servo shutoff switch on the pilot's collective control box, is a three-position toggle switch. The marked switch positions are PRI OFF and AUX OFF. Both servo systems are normally in operation with the switch in the unmarked center (ON) position. To turn off the primary servos, the switch is placed in the forward PRI OFF position. To turn off the auxiliary servo, switch is placed in the aft AUX OFF position. Neither servo may be shut off unless normal hydraulic pressure is in the remaining system.

SERVO HYDRAULIC PRESSURE INDICATORS

The servo hydraulic system pressure indicators (25 and 29, Figure FO-1), marked AUX HYD PRESS and PRI HYD PRESS, are on the instrument panel. The indicators visually indicate pressure within the auxiliary and primary servo systems and operate on 26 volts ac from the ϕC autotransformer. The indicators are individually protected by circuit breakers marked HYD PRESS AUX and HYD PRESS PRI on the forward circuit breaker panel.

SERVO LOW PRESSURE CAUTION LIGHTS

Two hydraulic servo low pressure caution lights marked AUX HYD PRESS and PRI HYD PRESS are on the caution advisory panel (figure 1-27). If the pressure in the auxiliary servo drops below 1000 PSI or the pressure in the primary servo drops below 750 PSI, the respective caution light will go on.

CYCLIC CONTROL STICK TRIM SYSTEM

The cyclic control stick trim system is an electrically-controlled, hydraulically-actuated system for moving the cyclic control sticks either fore, aft, left or right or maintaining the cyclic sticks in a selected position. Components of the system include a BEEPER TRIM master switch, two TRIM RELY switches, two STICK TRIM switches, four solenoid-operated valves, two hydraulically-operated actuators, each containing a force gradient spring, and a pressure reducer to reduce auxiliary servo pressure to 60 PSI. The system is powered by 28 volts from the dc essential bus and is protected by a circuit breaker, marked BEEPER TRIM, on the forward circuit breaker panel.

Beeper Trim Master Switch

A BEEPER TRIM switch, on the overhead console (figure FO-2) with positions marked ON and OFF, provides master control of the stick trim system. With the BEEPER TRIM switch in the OFF position power is supplied to all four solenoids, opening the valves to allow free movement of the cyclic. When the BEEPER TRIM switch is placed in the ON position, electrical power is removed from the four solenoids, closing the valves to hydraulically lock both actuators. The force gradient springs within the actuators allow the cyclic sticks to be manually moved without disturbing the trim setting. When the cyclic stick is released, the force gradient springs will return the cyclic to the trimmed position.

Cyclic Stick Trim Release Switches

A cyclic stick trim release momentary switch, marked TRIM REL, is on each pilot's cyclic control stick grip (figure 1-19). By depressing the TRIM REL switch on either cyclic stick momentary disengagement of the system occurs by electrically opening all four solenoid valves. This allows free movement of the cyclic sticks to a new position. Releasing the switch will allow the cyclic sticks to be retained in the newly selected position. The cyclic sticks may also be moved against the tension of the force gradient springs and, when the stick is in the desired position, the TRIM REL switch may be momentarily depressed to allow followup of the actuators to hold the stick in the new position.

Cyclic Stick Trim Switches

Two thumb-operated cyclic stick trim four-way momentary switches, one on each cyclic control stick grip (figure 1-19) marked FWD, AFT, L, and R, allows the stick trim system to be operated with a fine degree of control. Both cyclic sticks may be repositioned at a controlled rate of displacement by momentarily actuating either switch in the desired direction. This enables the pilot to make gradual changes in cyclic stick position without a tendency to over control. It also prevents inadvertent coupling of lateral and longitudinal cyclic movements.

AUTOMATIC STABILIZATION EQUIPMENT (ASE)

The ASE used in this helicopter differs from the autopilot used in fixed wing aircraft in that it may be engaged at all times, has less control authority than the primary flight control system, and may be easily overridden through normal use of the flight controls. The pilot has direct control of the system at all times and can engage or disengage the entire ASE or any channel, as desired, by means of switches on the ASE control panel, channel monitor panel, and cyclic sticks. The flight directors in the ASE mode provides the pilot and copilot with visual indications of all ASE signals. Attitude and directional stabilization are controlled through pitch, roll and yaw channels. A fourth channel for barometric altitude stabilization is incorporated in the ASE but BAR ALT HOLD components are not installed in this helicopter. In the pitch and roll channels, fuselage attitude is held constant by comparing the actual attitude signal received from the selected vertical gyro with the desired attitude signal received from the cyclic stick position sensor. Automatic pitch and roll attitude stability correction occurs any time the helicopter is displaced from the desired attitude. In the yaw channel, the helicopter heading is maintained by comparing actual heading signals received from the MA-1 compass system with desired heading signals. The helicopter can be flown to the desired heading by use of the yaw trim knob on the ASE control panel or by use of the tail rotor pedals. When the pilot flies the helicopter to the desired heading by use of the tail rotor pedals, the yaw channel is placed in a synchronizing mode and no heading correction signal is developed until his feet are removed from the pedals. During the synchronizing mode, the yaw rate gyro developes a signal proportional to the rate of turn of the helicopter. This signal initiates an open-loop spring condition that produces a feedback force at the pedals. As the pilot presses either pedal to turn the helicopter, he feels an opposing force proportional to the rate of turn. The feedback force remains until the pilot rolls out on the need reference heading. Heading stability correction occurs any time the helicopter is displaced from the desired reference heading. The ASE system utilizes power from the ac essential bus, the NO. 2 generator if the STBD gyro is selected, and the dc essential bus. Switches in the control circuit enable the pilot to enage and disengage the ASE. A thermal time delay relay is incorporated in the ASE engage circuit to allow approximately 120 seconds for ac power to bring the vertical gyro to a stabilized state before the ASE can be engaged. DC power is applied to the system when the ASE is engaged. The ASE is comprised of the following components: stick position sensors, vertical gyros, vertical gyro indicators, force link assembly micro switches, ASE amplifier, dual channel lag amplifier, ASE control panel, ASE disengagement switches, auxiliary servo, channel monitor panel, flight director and caution advisory panel lights.

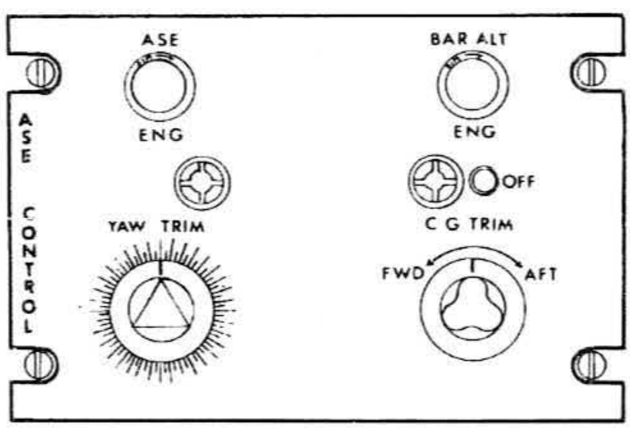


Figure 1-22. ASE Control Panel

STICK POSITION SENSOR

Cyclic stick position sensors, in the auxiliary servo enclosure, provide desired attitude signals in pitch and roll channels.

VERTICAL GYRO

Two vertical gyros, copilot's (port) and pilot's (starboard), provide actual attitude signals in pitch and roll. Either gyro may be selected for ASE operation by a switch on the channel monitor panel. Three-phase 115V ac electrical power is supplied to the pilot's (starboard) vertical gyro by the NO. 2 generator through a ganged circuit breaker marked NO. 2 GEN under the heading PILOT'S VGI. In the event of NO. 2 generator failure, the pilot's vertical gyro is automatically switched to the ac essential bus and is then protected by a ganged circuit breaker marked NO. 1 GEN under the heading PILOT'S VGI, on the forward circuit breaker panel. The copilot's (port) vertical gyro is powered by the ac essential bus through a ganged circuit breaker marked COPILOT'S VGI, on the forward circuit breaker panel.

Vertical Gyro Indicator

The actual attitude of the helicopter, sensed by the vertical gyros, is displayed on two vertical gyro indicators (7 and 40, figure FO-1). The output from the copilot's (port) vertical gyro is fed to the copilot's vertical gyro indicator and the output from the pilot's (starboard) vertical gyro is fed to the pilot's vertical gyro indicator.

Off Flag and Caution Panel Lights

Power failure detectors mounted on the tilt table monitor the three-phase ac power provided to each of the vertical gyro assemblies. It detects either a power failure or a voltage unbalance and causes the OFF flag to appear on the vertical gyro indicator of the affected assembly. In addition, a loss or unbalance of power to the pilot's (starboard) vertical gyro assembly will put on the GYRO ERECT light on the caution advisory panel (figure 1-27). The vertical gyro indicator OFF flags are displayed and the GYRO ERECT light remains ON for 60 seconds after power is applied to their respective vertical gyros. This indicates that they are unreliable until the gyros have had enough time to come up to speed. The GYRO ERECT caution light is protected by a circuit breaker marked GYRO ERECT, under the heading WARNING LIGHTS, on the forward circuit breaker panel. Additionally, a caution light (figure 1-27) marked ASE OFF comes on when the ASE is disengaged while the dc essential bus is energized. The ASE OFF caution light is protected by a circuit breaker marked ASE OFF WARN, on the forward circuit breaker panel.

YAW CHANNEL

The force link assembly microswitches actuate when 6-8 pounds of force is applied to either right or left tail rotor pedal. This nulls actual heading signals to the yaw channel while the pilot selects a new heading using the tail rotor pedals. Artificial feel in the tail rotor pedals is provided by feeding signals from the yaw rate gyro to the auxiliary servo which tends to move the pedals in a direction opposite to the direction of turn. Heading selection can also be made using the YAW TRIM knob on the ASE control panel.

ASE AMPLIFIER

The ASE amplifier compares desired attitude signals to actual attitude signals and derives an error signal which is fed to the auxiliary servo flapper valves. The ASE amplifier consists of a chassis assembly, four plug-in transistorized modules, and a yaw rate gyro. Three of the plug-in modules are the pitch, roll, and yaw channel amplifier modules which serve to amplify, modify, and compare the attitude signals received from the various attitude sensors. The fourth, the yaw synchronizer module, serves to keep the yaw channel nulled when the pilot is making a manual turn. The ASE amplifier utilizes both dc and ac electrical power. The dc essential bus provides dc power through a circuit breaker marked AUTO STAB, on the forward circuit breaker panel. The ac essential bus provides single-phase power through two circuit breakers marked AUTO STAB ϕA and ϕB, on the forward circuit breaker panel.

DUAL CHANNEL LAG AMPLIFIER

The dual channel lag amplifier is on the ASE component rack. Helicopter response to control movement is more rapid in roll than in pitch. To prevent overcontrolling in roll, the desired attitude signal to the ASE amplifier is lagged by 0.5-0.8 seconds in the dual channel lag amplifier. In this way a new desired attitude signal does not combine with lateral cyclic movement to produce an excessive roll rate and subsequent overcontrolling by the pilot.

AUXILIARY SERVO

The auxiliary servo is a component of the flight control system. Its construction features permit either ASE or manual flight control inputs to be made at the auxiliary servo. Electrical input signals from the ASE amplifier actuate auxiliary (flapper) valves, on three of four auxiliary servo power pistons. The collective auxiliary servo valve is not used since altitude stabilization components are not installed in this aircraft.

ASE CONTROL PANEL

The ASE control panel, on the lower console (figure FO-2), contains the ASE system engage switch and trim controls for the pitch and yaw channels.

ASE Engage Switch

The ASE ENG switch is a normally open, momentary contact, push-button switch with a green self-contained indicating light, provided with a bezel-operated dimming iris. Pressing the ASE ENG switch engages the pitch, roll and yaw channels, lights the green indicating light, and turns off the ASE OFF caution light. The ASE is held engaged by power from the dc essential bus.

CG Trim Control

The CG TRIM control knob is cloverleaf-shaped. It allows the pilot to adjust the center point of pitch channel authority. This compensates for changes in the center of gravity of the helicopter which would shift cyclic stick position away from the center point of ASE authority.

YAW Trim Control

The YAW TRIM control knob is triangular-shaped. It permits the pilot to select a new desired heading without using the tail rotor pedals. The control dial is engraved with 72 units of 1° each so that one full rotation of the knob initiates a turn of 72°. Turning the clock clockwise initiates a right turn; turning the knob counterclockwise initiates a left turn. The actual position of the dial pointer is not important since the yaw channel is self-nulling.

BAR ALT Engage Switch

The BAR ALT ENG switch is of the same type as the ASE ENG SWITCH. When depressed, the BAR ALT ENG indicator light will go on, but does not affect ASE operation since barometric altitude stabilization is not incorporated in this installation.

CHANNEL MONITOR PANEL

The channel monitor panel (figure 1-23) contains controls which permit disengaging individual channels and introducing test signals. It also provides a means of selecting either vertical gyro as a source of actual pitch and roll attitude signals for the ASE amplifier. The channel monitor panel will be fitted with a removable plastic cover which protects the panel from water. All switches, except the hardover switches may be actuated with the plastic cover in place.

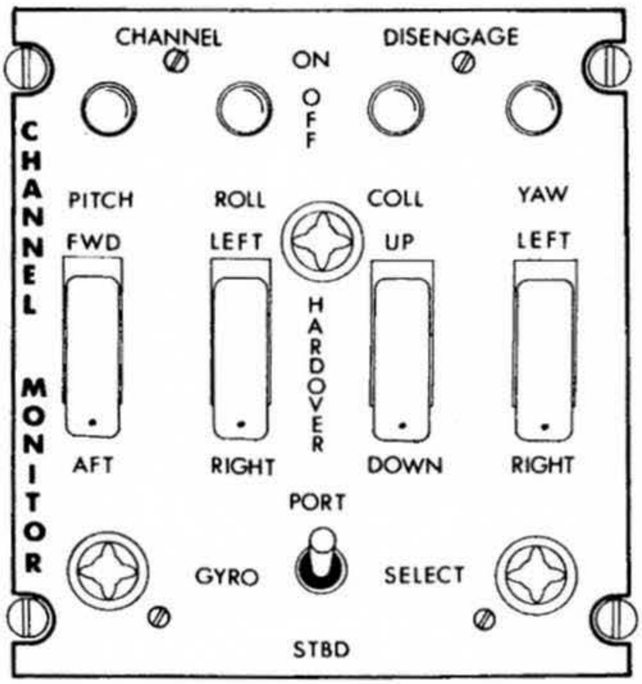


Figure 1-23. Channel Monitor Panel

Channel Disengage Switches

The channel disengage switches are in the electrical circuit between the hardover switches and the auxiliary servo flapper valves. Four CHANNEL DISENGAGE switches marked PITCH, ROLL, COLL, and YAW permit disengagement of individual channels. Actuation of the COLL CHANNEL DISENGAGE switch does not affect operation of the ASE.

Hardover Switches

The hardover switches are in the electrical circuit between the ASE amplifier and the channel disengage switches. Four HARDOVER switches marked PITCH, ROLL, COLL, and YAW, when actuated, apply hardover signals to the individual channels for testing. Actuation of the COLL HARDOVER switch does not affect operation of the ASE.

WARNING

Do not operate the HARDOVER switches in flight. Operation of one or more hardover switches in flight will cause sudden and violent displacement of the helicopter.

Gyro Select Switch

The GYRO SELECT switch with marked positions PORT and STBD is used to select the reference vertical gyro for the ASE. In PORT position the copilot's vertical gyro provides actual attitude signals for the ASE; in STBD position the pilot's vertical gyro provides the signals.

FLIGHT DIRECTOR ASE MODE

Two OFF flags come into view when the ASE is disengaged or when dc electrical power to the ASE amplifier fails. When the ASE is engaged, the horizontal and vertical indicator bars indicate the amount and direction of the ASE correction signals fed to the pitch and roll auxiliary servo (flapper) valves. The lower pointer indicates the ASE signal input to the yaw servo valve. The horizontal bar monitors pitch channel correction signals; upward deflection of the bar indicates a nose-down signal and downward deflection of the bar indicates a nose-up signal. The vertical bar monitors roll channel correction signals: left deflection of the bar indicates a left roll signal and right deflection of the bar indicates a right roll signal. The power pointer monitors yaw channel correction signals; left deflection of the pointer indicates a left tail rotor pedal signal and right deflection of the pointer indicates a right tail rotor pedal signal. This indicator is used in flight to monitor ASE functioning and the helicopter's center of gravity. It may also be used during testing to determine whether the various channels are functioning properly. During the ASE ground check the fuselage cannot change attitude to follow cyclic control inputs. Consequently the actual attitude signals to the ASE amplifier remain the same. However the desired attitude signals change as the pilot moves the cyclic and yaw trim knob. Forward cyclic causes the horizontal bar to rise; aft cyclic causes the horizontal bar to fall. Left cyclic causes the vertical bar to move left, right cyclic causes the vertical bar to move right. Counterclockwise rotation of the yaw knob causes the lower pointer to move left. Clockwise rotation of the yaw trim knob causes the lower pointer to move right. Flight director response in flight is opposite to the above, due to negative stability of the helicopter; for example, shortly after selecting a lower nose attitude with cyclic the horizontal bar will fall because ASE is feeding a nose-up correction signal to the pitch channel auxiliary servo valve.

ASE DISENGAGE SWITCHES

The ASE disengage switches are pushbutton, momentary-type, mounted on each cyclic control (figure 1-19) and are marked AUTO STB RELEASE. Depressing either switch disengages the ASE which can be observed by the green ASE ENG light going off, lighting of the ASE OFF caution light and the display of OFF flags in the flight directors when ASE mode is selected.

TURN SWITCH

The TURN engage switch is a momentary-type on the pilot's and copilot's cyclic grips. The coordinated turn function is not incorporated in this aircraft.

BAR ALT OFF SWITCH

Depressing the momentary OFF switch, on the collective, will put off the BAR ALT ENG indicator light if it is on. This does not effect the operation of the ASE.

INSTRUMENTS

STANDBY COMPASS

A magnetic standby compass is mounted on the windshield center support (7, figure 1-2). The compass indicates helicopter heading in relation to magnetic north pole. Its dial is graduated with

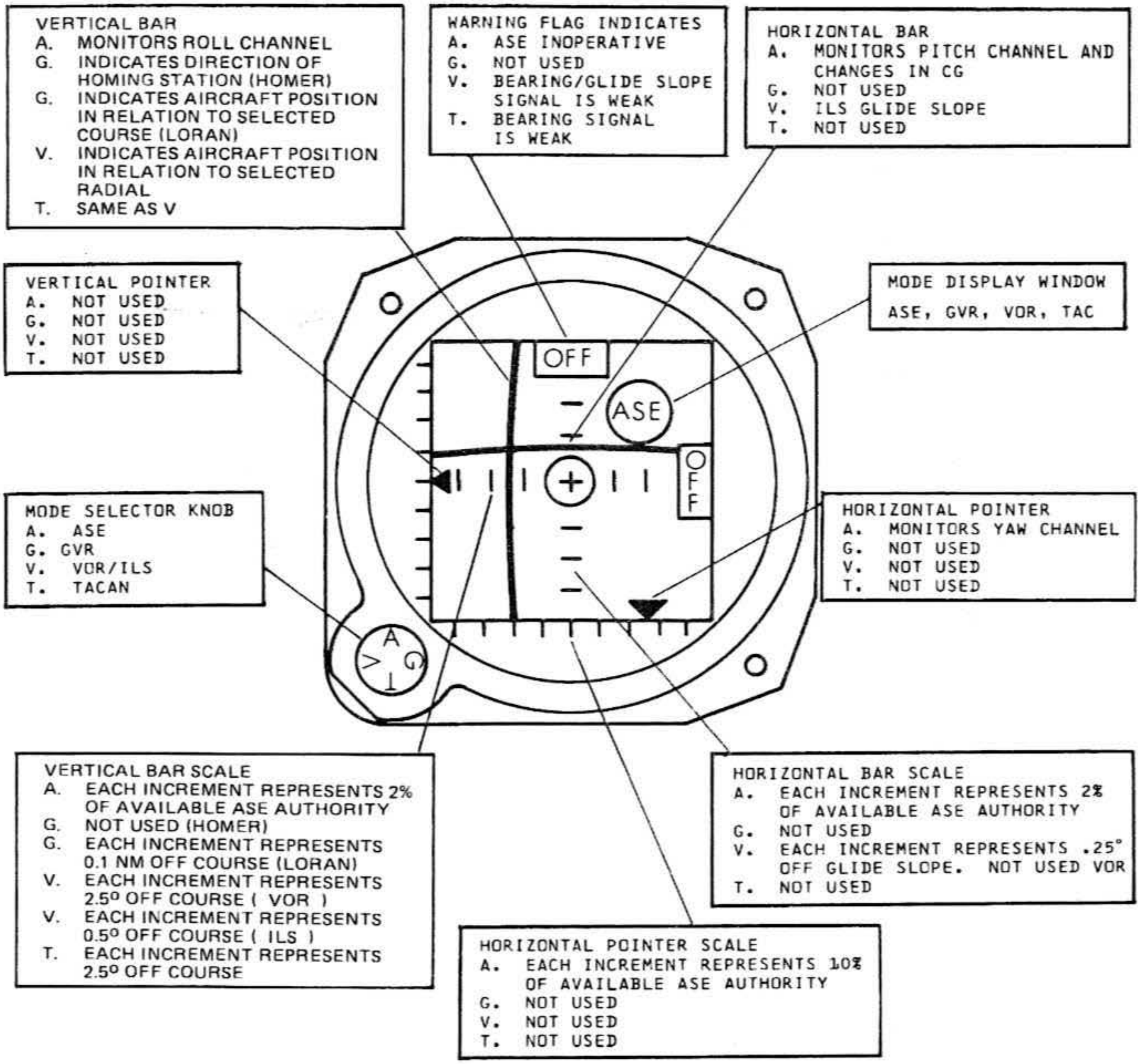


Figure 1-24. Flight Director

cardinal heading indicated by enlarged letters with subordinate heading numerically indicated in 30° units each, with finer linear graduations of 5° each. A compass correction card is provided so that compass readings may be compensated for deviation.

FREE-AIR TEMPERATURE GAGE

A bimetallic free-air temperature gage is in the center of the windshield. It indicates temperatures from −70°C to +50°C in units of 2° each.

CLOCKS

An 8-day, elapsed-time, 12-hour clock is on both the pilot's and copilot's instrument panel (3 and 34, figure FO-1). The control knob for the elapsed-time mechanism is in the upper right corner. Three successive depressions of this knob start, stop and return to the starting position, the sweep-second and totalizer hands.

PITOT-STATIC SYSTEM

An electrically-heated pitot tube is on the right side of the fuselage above the pilot's compartment. The static ports, on the left and right-hand sides of the fuselage transition section, are connected through tubing to the pilot's and copilot's vertical speed indicators and the altimeters. The pitot and static ports are connected through tubing to airspeed indicators.

PRESSURE ALTIMETERS

Altimeter-Encoder AAU-21/A or AAU-32/A

One altimeter-encoder (figure 1-25) is installed in the pilot's instrument panel. The altimeter-encoder combines a conventional barometric type altimeter, possessing a counter-drum-pointer display, with an altitude reporting encoder in one self-contained unit. The 10,000- and 1,000-foot counters and the 100-foot drum provide a readout of altitude in units of 100 feet, from −1,000 to 38,000 feet. The pointer repeats the indications of the 100-foot drum, and serves both as a vernier for the drum and as a quick indication of the rate and sense of altitude changes. Two methods may be used to read indicated altitude on the counter-drum-pointer altimeter: (1) read the counter-drum window, without reference to the pointer as a readout in thousands and hundreds of feet; or (2), thousands of feet on the two counter indicators, without referring to the drum, and then add the 100-foot pointer indication. The self-contained servo driven encoder provides altitude encoded in 100-foot units for automatic transmission when the AN/APX-99 transponder is interrogated in the altitude mode. The digital output to ground radar is referenced to 29.92 in Hg and not the pilot-selected altimeter setting. In case of power loss to the encoder servo system, a CODE OFF flag appears automatically in a window in the upper left portion of the display, indicating that altitude information is no longer being transmitted to the ground. In this condition, the instrument continues to function as a normal barometric altimeter. The barometric pressure is entered by use of a barometric set knob in the lower left front of the instrument case. The altimeter setting appears on counters in the window at the lower right of the display and has a range of settings from 28.10 to 31.00 in Hg. On those helicopters with an altimeter-encoder AAU-21/A installed, an internal vibrator operates continuously whenever power is supplied to the DC Essential Bus. The vibrator minimizes internal mechanical friction, allowing the instrument to provide a smoother display during changing altitude conditions. Should vibrator failure occur, the altimeter will continue to function pneumatically, but a less-smooth movement of the instrument display will be evident with changes in altitude. The altitude-encoder AAU-32/A does not require an internal vibrator due to its solid-state construction.

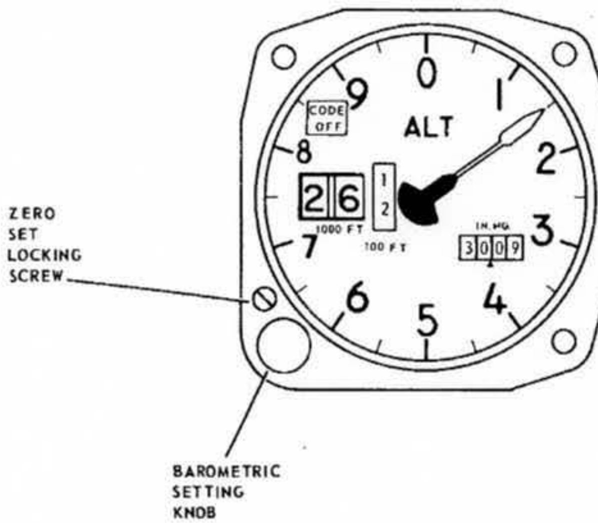


Figure 1-25. Altimeter-Encoder AAU-21/A or AAU-32A

Altimeter AAU-24/A

One altimeter (figure 1-26) is installed in the copilot's flight instrument panel. The instrument is similar to the altitude-encoder, except that it does not have an altitude-encoder nor the CODE OFF display mechanism. The indicated altitude on the altimeter is from −1000 to 38,000 feet. The altitude display, altimeter setting, and vibrator considerations described for the altimeter-encoder also apply to the copilot's altimeter.

WARNING

If the internal vibrators of the altimeter encoder (AAU-21/A) or altimeter (AAU-24/A) are inoperative due to either internal failure or dc power failure, the 100-foot pointers may momentarily hang up when passing through 0 (12 o'clock position). If the vibrators have failed, hangup of the 100-foot pointers can be lessened by tapping the case of the altimeters. Pilots should be especially watchful when the minimum approach altitude lies within the 800-1000-foot part of the scale (1800-2000 feet, etc.)

NOTE

When each 1,000-foot unit is nearly completed, the counter(s) abruptly index to the next digit. The counter-drum-pointer altimeter mechanism may also cause a noticeable pause or hesitation of the pointer due to the additional intermittent friction and intertia loads applied to the mechanism to turn over the 1,000-foot counter. This effect may be more pronounced at 10,000-foot intervals, where both counters are turned over simultaneously. This momentary pause is followed by a noticeable acceleration as the altimeter mechanism overcomes the counter wheel load and rolls the dial over to the next digit. The pause occurs during the "9" to "1" portion of the scale. The pause-and-accelerate behavior is normally more pronounced at high altitudes and high rates of ascent or descent and at low altitudes, the effect will be minimal.

Vertical Speed Indicators (VSI)

Two vertical speed indicators are on the instrument panel (13 and 45, figure FO-1). The indicators give climb or descent speed information on two logarithmic scales. This allows widely spaced markings near zero and a condensed scale at higher vertical speeds. A zero setting screw permits the pointer to be reset to the zero graduation. The indicators are connected to the static pressure line through tubing.

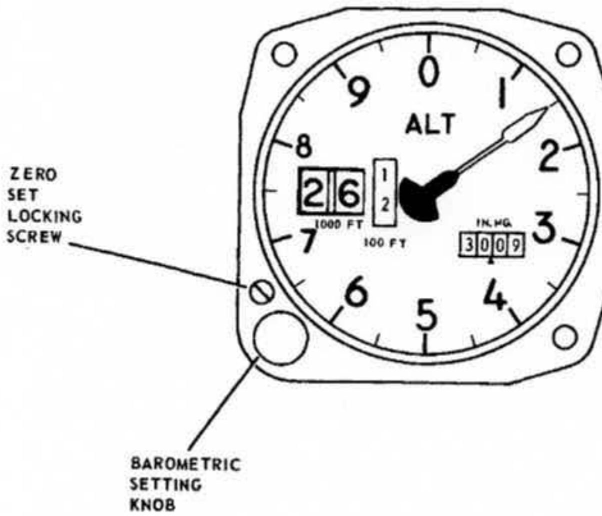


Figure 1-26. Altimeter AAU-24/A

Airspeed Indicators

Two airspeed indicators are on the instrument panel (4 and 37, figure FO-1). The indicators give forward speed information. The indicators are connected to both the pitot pressure system and the static pressure system.

Pitot Heat Switch and Advisory Panel Light

A switch marked PITOT HEAT, with positions ON and OFF, is on the overhead switch panel (figure FO-2). When the switch is placed ON, the pitot head is electrically-heated to prevent formation of ice on or within the tube. The ON position provides power from the dc essential bus to two circuits. One circuit includes a circuit breaker marked PITOT HEAT and the pitot tube heater. The other circuit includes a circuit breaker marked PITOT HEATER under the general heading WARNING LIGHTS and the light capsule marked PITOT HEAT, in the caution advisory panel (figure 1-27). Both circuits pass through a relay which allows the PITOT HEAT advisory light to go on only if the heater is operating. Lighting of the light indicates that the switch is ON and the pitot tube heater is working. Both circuit breakers are on the forward circuit breaker panel.

TURN AND SLIP INDICATORS

Two turn and slip indicators (6 and 39, figure FO-1) are installed on the instrument panel; one in front of the pilot and one in front of the copilot. The indicators visually indicate helicopter rate-of-turn and balanced flight. Single needle width deflection indicates a 4 minute turn. A standard rate turn will require a two needle width deflection. The gyros of the indicators operate on dc power from the essential bus and are protected by circuit breakers, marked TURN & SLIP, PILOT-COPILOT, on forward circuit breaker panel.

CAUTION ADVISORY PANEL

The HH-52A caution advisory panel, (figure 1-27) to the left center of the instrument panel, is composed of 28 different capsules, 22 amber and 6 green. The amber caution capsules offer information of an emergency nature such as generator failures, low fuel, hydraulic and oil pressure failures, etc. The green advisory capsules provide information of an advisory nature such as external power on, parking brake on, etc. When an irregularity is detected in any system serviced by the caution portion of the caution advisory panel, a brilliant master CAUTION light in the center of the master switch panel will go on. Also, an amber capsule on the caution advisory panel will light, giving a printed statement of the irregularity detected. The capsule and the master CAUTION light will remain on until the difficulty is corrected. Conditions of the aircraft systems which light any of the advisory lights on the caution advisory panel will cause a green printed statement to appear in the capsule but will not light the master warning light. The caution advisory panel capsules are individual, swivel-mounted units containing two bulbs each. Depressing either side of the capsules will turn the capsule 180° so that its aft side is visible, and the face of the capsule is facing into the unit itself. This exposes the bases of the two bulbs within the capsule, which may be removed and replaced as needed. Each caution advisory capsule has its own operating electrical circuit and receives power through the .ystem is serves.

MASTER SWITCH PANEL

The master switch panel, (figure 1-27) to the right of the caution-advisory panel, contains a test-reset switch, a bright-dim switch, and a master caution light that goes on when an irregularity is indicated by any caution capsule on the caution-advisory panel. The test-reset switch is spring-loaded to the center position with two momentary positions marked TEST and RESET. The pilot may put off the master caution light by depressing the TEST-RESET switch to the RESET position. This may be done even though the caution condition which caused the amber light go to on has not been corrected. This feature is provided so that the pilot's attention may be attracted to any new caution condition which may arise and cause the re-lighting of the master CAUTION light. All lamps, the caution advisory panel and the master CAUTION light, may be tested by placing the spring-loaded TEST-RESET switch to the test position. The bright-dim switch, spring-loaded to the center position, has two momentary positions marked BRIGHT and DIM. Dimming of all lamps on the caution advisory/panel and the master CAUTION light may be done by placing the bright-dim switch in the DIM position. Also dimmed is the indicator light in the controllable landing light master switch. The master switch panel receives power from the dc essential bus and is protected by a circuit breaker on the forward circuit breaker panel under the heading CAUTION PANEL.

Conditions causing the lighting of a caution or advisory light are discussed in Sections I or IV, under the subject heading of the affected aircraft system. Correct pilot response to a caution light is covered in Section III.

LANDING GEAR SYSTEM

The landing gear system consists of two partially retractable main landing gear assemblies, a non-retractable full swiveling tailwheel and an actuating system. The main landing gear retracting system operates on hydraulic pressure from the auxiliary hydraulic system. The necessary electrical power is provided from the dc essential bus through a circuit breaker marked LDG GEAR, on the forward circuit breaker panel.

MAIN LANDING GEAR

The two main landing gear assemblies are attached to the sponsons by oleo struts and support struts, and may be partially retracted into the sponsons

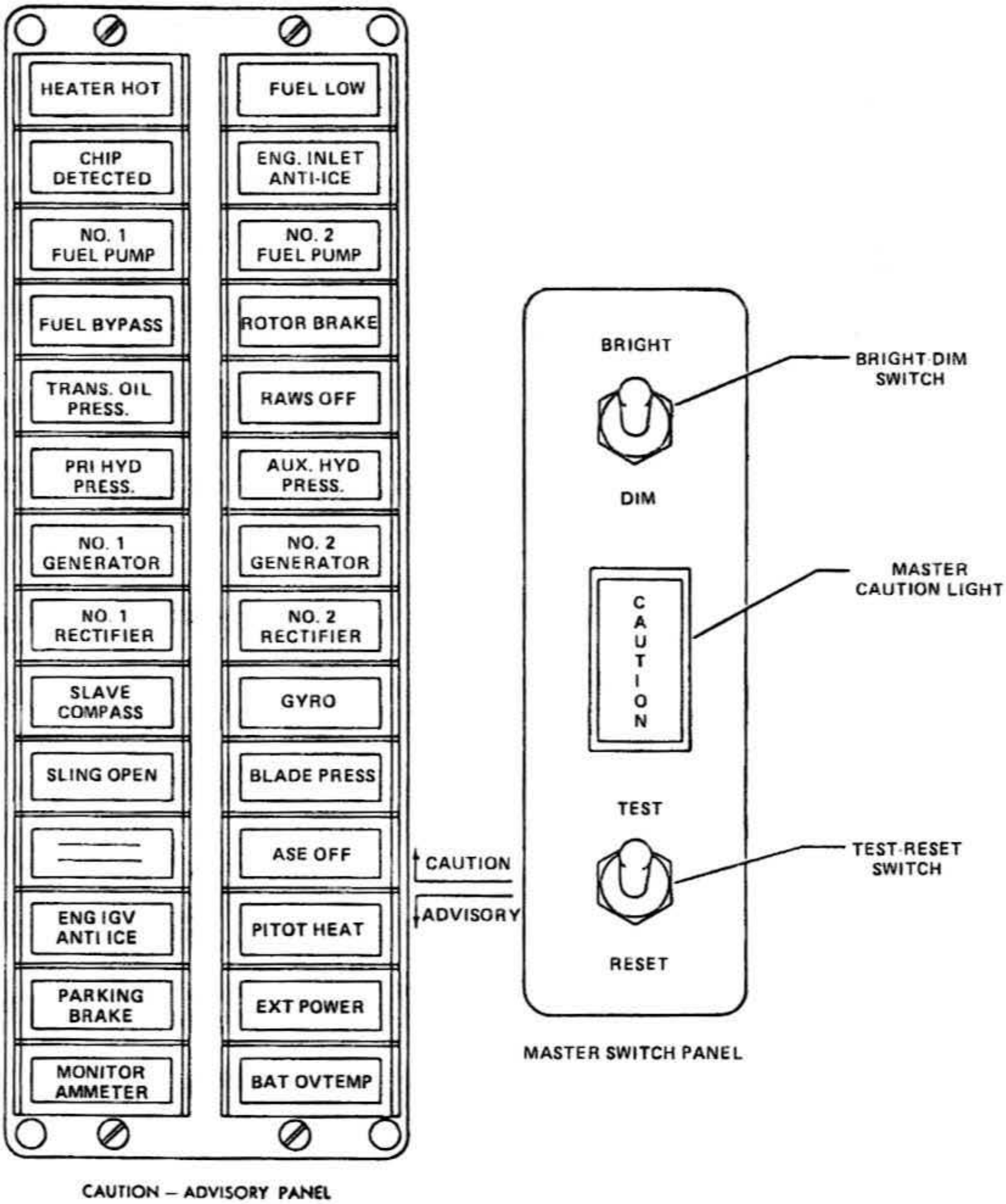


Figure 1-27. Caution-Advisory Panel

for water landing. Each main landing gear is equipped with hydraulic brakes. Round inspection windows made of transparent acrylic are on the outboard surface of each sponson strut fairing panel. The inspection windows aid inspection of the shear bolts' indicator tape.

Main Landing Gear Switch

The main landing gear switch, marked LANDING GEAR, with marked positions UP and DOWN, is on the instrument panel (19, figure FO-1). When the main landing gear switch is placed in UP, a control valve is energized and allows the auxiliary hydraulic system pressure to retract the main landing gear. When the main landing gear switch is placed in DOWN, the control valve is de-energized and hydraulic pressure is released. The normal air charge in the oleo strut of each main landing gear, plus weight of the wheels, forces the struts to move to the extended position.

Main Landing Gear Position Indicator

The main landing gear position indicator is on the instrument panel by the main landing gear switch. When the main landing gear is in the retracted position, the indicator shows an UP indication. When the main landing gear is in the extended position during flight, the indicator shows a symbol representing the wheels. While on the ground, a barber pole type indication will be visible. A barber pole indication also shows when the gear are in transit.

TAILWHEEL

The non-retractable tailwheel is underneath the aft section of the hull. The tailwheel is the full-swiveling and self-centering type, and may be mechanically locked in the center (fore-and-aft) position.

Tailwheel Lock Handle

The tailwheel lock handle, marked PULL UP TO LOCK, is at the aft end of the lower ratio console. When the handle is pulled up to the LOCKED position, the control cable slackens, allowing the spring-loaded lockpin to engage after the tailwheel centers. When the handle is pushed down to the UNLOCKED position, the control cable pulls the lockpin from the swivel joint, permitting the tailwheel to swivel through 360°. A button in the center of the handle must be pressed to release a rachet-type lock, before the tailwheel lock handle can be pushed down to the unlocked position.

WHEEL BRAKE SYSTEM

The main landing gear wheels are equipped with hydraulic brakes. The self-contained brake system is operated by toe pedals (9, figure 1-2). A parking brake valve and handle permits locking the brakes when the helicopter is parked.

BRAKE PEDALS

Each main landing gear wheel is individually braked by depressing the corresponding brake pedal, mounted on the pilot's tail rotor pedals. The copilot's tail rotor pedals do not have brake pedals.

PARKING BRAKE

The parking brake handle marked PARKING BRAKE is on the left side of the lower ratio console (22, figure 1-2). The brakes are locked by depressing the brake pedals pulling the parking handle up, and releasing the brake pedals before releasing the parking brake handle. Pressing the right brake pedal releases the parking brakes, causing the parking brake handle to return to the unlocked position. The parking brake handle should be held and lowered gently when the brakes are released.

Parking Brake Advisory Light

A light marked PARKING BRAKE, on the caution advisory panel (figure 1-27), goes on any time the parking brake handle is in the UP position, regardless of whether the brakes are set. The light receives electrical power from the dc essential bus through a circuit breaker marked PARK BRAKE, on the forward circuit breaker panel.

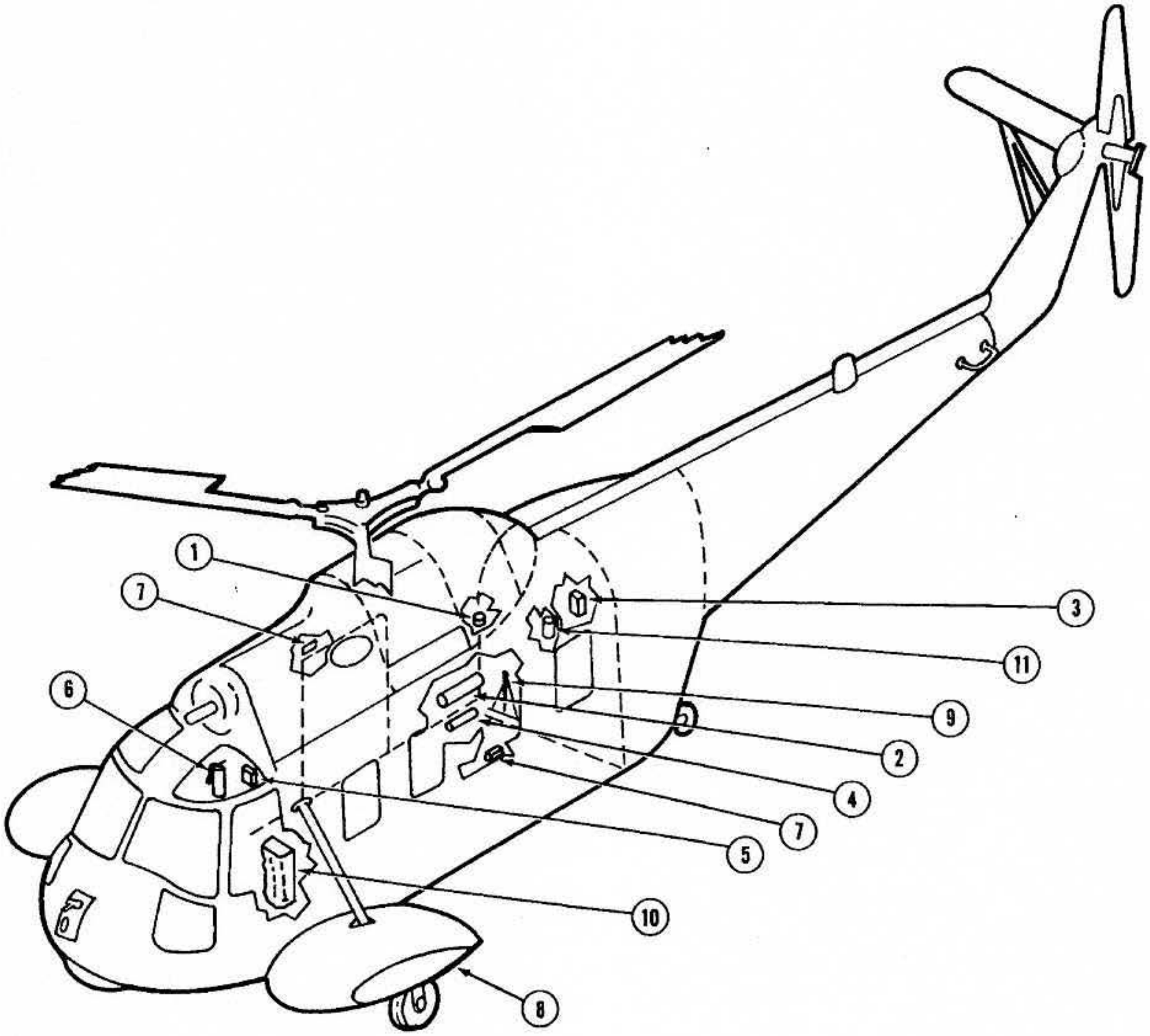
EMERGENCY EQUIPMENT

LIFE RAFTS

Four one-man life rafts (figure 1-28) designated LR-1 are on the Standard SAR Board. The rafts have a single compartment flotation tube that is inflated by CO_2. The floor is non-inflatable. The rafts are equipped with a sea anchor and weather-shield, and have a sea anchor and retaining line pocket. The rafts are inflated by pulling the inflation assembly actuating lanyard. After boarding, additional inflation of the LR-1 is possible by use of an oral inflation valve. There are no survival items in the raft. The rafts may be air-dropped to a survivor in the water.

FIRST AID KITS

There are two first aid kits (figure 1-28) carried aboard the helicopter. One is installed on the aft



1. ENGINE COMPARTMENT FIRE EXTINGUISHER
2. LIFE RAFT LR-1
3. FIRST AID KIT (CABIN)
4. FIRE EXTINGUISHER (CABIN)
5. FIRST AID KIT (COCKPIT)
6. FIRE EXTINGUISHER (COCKPIT)
7. EMERGENCY EXIT LIGHTS
8. AUXILIARY FLOATATION
9. ANCHOR
10. DROGUE
11. UNDERWATER ACOUSTIC LOCATOR BEACON

Figure 1-28. Emergency Equipment

cabin bulkhead, and one on the bulkhead behind the copilot's seat. The kits are mounted to the bulkheads by web straps and snaps. They may be removed from the bulkhead for use. The kits contain adhesive bandages, iodine swabs, ammonia inhalants, compresses, tourniquets, forceps, petrolatum, and scissors.

SURVIVAL RADIOS (AN/PRC-63/90) AND PERSONAL LOCATOR BEACON (URT-33A)

One of either of the above is in a stowage pocket on each SRU-21/P Survival Vest.

CRASH AXE (figure 4-49)

Located on the Standard SAR Board.

CABLE CUTTER (figure 4-49)

Located on the Standard SAR Board.

HOIST CABLE QUICK SPLICE

A hoist cable quick splice (figure 4-49) is on the Standard SAR Board.

PORTABLE FIRE EXTINGUISHERS

One hand-held portable CO2 fire extinguisher (figure 1-28) is in the cockpit on the bulkhead behind the pilot's seat. A second CO2 fire extinguisher is on the aft bulkhead in the cabin.

LIFEJACKET STOWAGE

SRU-21/P Survival Vests with LPU-10/P Life Preservers are stowed in the cabin. The location is determined by the operating unit.

COCKPIT EMERGENCY INSTRUMENT LIGHT RHEOSTAT

A rheostat (figure 4-45) marked INST EMER LTS, is on the overhead switch panel. The instrument emergency light rheostat controls the red lamp of the pilot's compartment dome light if an emergency source of instrument lighting is desired.

UNDERWATER ACOUSTIC LOCATOR BEACON (PINGER)

The underwater acoustic beacon (figure 1-28) is a highly reliable, impact-resistant, water-activated, lightweight unit that will enhance locating crashed aircraft in a water environment of any depth to 20,000 feet. This unit has an operating life of 30 days after immersion in fresh or salt water and has a detection range of 2,000 to 4,000 yards, depending upon exposure and sea state.

EMERGENCY EXIT LIGHT SYSTEM

The emergency exit light system (figures 1-28 and 4-45) consists of two light assemblies, a control panel with a three-position switch marked ARM-OFF-DISARM, a relay, and associated wiring and circuit breakers. The control panel is mounted on the instrument panel (figure FO-1). One emergency exit light is below the port cabin emergency exit hatch and the other is at the upper forward corner of the cabin entrance. They light up the emergency exit release handles. With the switch in the ARM position, the batteries will receive a trickle charge from the dc essential bus. The charging circuit is protected by a circuit breaker marked EMERG EXIT LIGHT under the general headings LIGHTS on the forward circuit breaker panel. Two small lights glow within the lens of the light assemblies when the batteries are being charged. Automatic activation of the emergency exit lights depends on interruption of the charging current. This may occur in two ways: when transmission oil pressure drops to 6-8 psi or less and following the loss of dc essential power. The system is deactivated by moving the switch to the momentary DISARM position then to OFF. The DISARM position does not require a power source. The lights may be removed from their retainers for use as an emergency flashlight by pulling the red PULL EMERGENCY LIGHT handle. This handle then functions as an ON-OFF switch for the light. A full-charged battery will provide sufficient power to operate the light for about 30 minutes.

AUXILIARY FLOTATION SYSTEM

An auxiliary flotation system (figure 1-29) is installed to improve lateral stability in adverse sea conditions when the helicopter is resting on the water with the rotor shut down. The manually-operated system consists of two dual compartment inflatable floats, two air bottles, two gages, two manually-operated valves and an actuating handle with control cables. The floats are made from neoprene-impregnated nylon and are stowed in rubberized nylon enclosures attached to the out-board side of each sponson. Each float is divided into two airtight compartments. Two compressed air bottles, stowed beneath the vertical gyro tilt table in the cabin aft of the copilot, supply air for inflation of the floats; the left bottle inflates the forward compartment of each float while the right bottle inflates the aft compartment of each float. Pressure gages are provided for both air pressure spheres and can be viewed through the protective screen surrounding the bottle. The bottles are fully serviced if the gages indicate between 2400 and 2800 psi. The system is activated by pulling the manual release handle, on the left side of the cockpit entrance, aft of the copilot. Pulling the handle actuates both floats simultaneously. Normally the floats will take 6 to 7 seconds to inflate.

BOW LINE ASSEMBLY (ANCHOR ROPE)

Two bow line assemblies form a bridle around the nose of the helicopter. For stowage, each assembly is secured to the shackle at the bow. The opposite ends are stowed under each cockpit sliding window to a stud mounted on the helicopter. The bow line assembly, (line, thimble, ring, and retrieving line) is secured to the stud with a short length of shock cord to hold the rope assemblies secure and taut. The upper end of the retrieving line is secured to a spring clip. The retrieving line is coiled and lashed to the anchor rope assembly. When deployed, the snap hook on the end of the drogue or anchor line is attached to the thimble only.

PARACHUTE SEA DROGUE

The sea drogue (figure 1-28) consists of a parachute. The risers for the chute are joined at the base to a large drogue line. Attached to the end of the drogue line is a large snap hook which is hooked to the thimble of the bow line during drogue deployment. For stowage, the drogue chute is packed in a protective nylon cover with the drogue line wrapped around it. Also attached to the nylon cover is a rip cord line, with a small red snap hook, that allows the chute to be deployed after the pack is in the water. The entire assembly is mounted on the bulkhead in the cockpit behind the copilot seat.

DANFORTH ANCHOR

The helicopter is equipped with a shallow water anchor, of Danforth design (figure 1-28), with 150 feet of anchor line and a snap hook. The anchor is stowed on the aft cabin bulkhead in a protective canvas bag. Use of the Danforth anchor in water depth exceeding the length of the anchor line makes the anchor ineffective. Should the anchor drag, its effect will be similar to that of the sea drogue and should tend to hold helicopter into the wind and waves. To be most effective in stopping all drift, the anchor line should be at least 6 times the depth of the water.

ENGINE COMPARTMENT FIRE DETECTOR SYSTEM

The engine compartment fire detector system visually indicates a fire or an overheat condition within the engine compartment. The system consists of four sensing elements, a control unit, three warning lights, a test switch, and three circuit breakers. The engine compartment fire detector system operates on 115 volts from the ac essential bus or the ground inverter when energized. A circuit breaker marked FIRE DET located on the forward circuit breaker panel protects the system. The fire detector system's four sensing elements, within the engine compartment, actuate the control unit in the event of an overheat condition or fire. When actuated, the control unit lights the engine fire warning light on the instrument panel and two engine fire warning lights in the emergency fuel shut-off fire extinguisher arm T-handle.

Engine Compartment Fire Detector Sensing Elements

Four sensing elements in the engine compartment are connected in series to the control unit. The elements consist of Inconel tubing with a nickel wire center conductor. The hermetically sealed tubing contains an insulation and a special impregnation of a selected inorganic salt compound. When an overheat condition or fire occures, the resistance of the inorganic salt drops sharply, changing the impedance. The change is sensed by the control unit which transmits the signal to the engine fire detector warning lights. The elements in this system have a critical temperature of 575°F (301.6°C). The sensing element could be broken into two pieces and both pieces would still be able to sense an overheat, providing that there is no

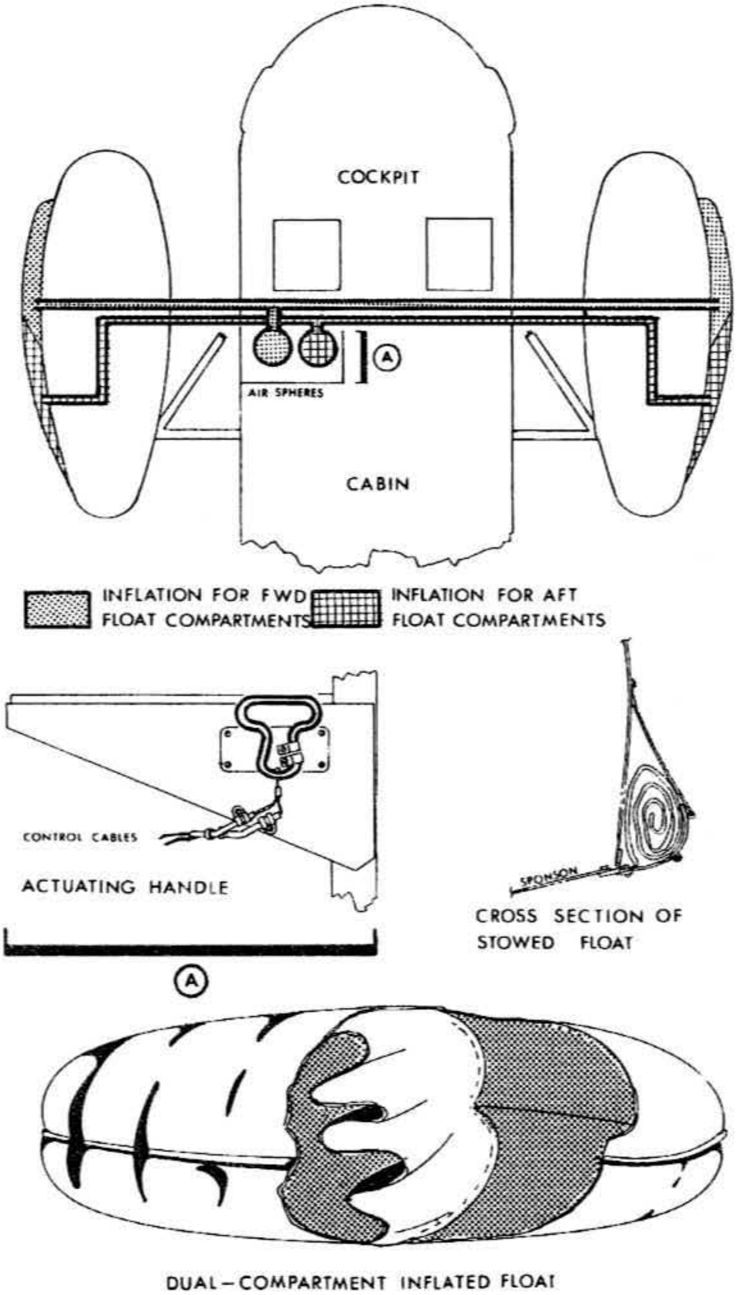


Figure 1-29. Auxiliary Flotation System

shorting out of the broken ends of either piece. If a broken end is shorted out, the fire warning lights will go on. If neither end is shorted out, the sensors will detect an overheat, but the fire warning lights will not go on when the engine fire detector warning test switch is depressed.

Engine Compartment Fire Detector Warning Lights

A red, press-to-test type warning light, (36, figure FO-1) marked "FIRE WARN" is installed on the pilot's side of the instrument panel and two additional engine fire warning lights are installed in either end of the T-handle (figure 1-16). The lights are put on by the control unit in case of overheat or fire within the engine compartment. When testing the panel light, current is drawn from the dc essential bus. The press-to-test circuit is protected by a circuit breaker marked FIRE DET TEST under the general heading ENGINE on the forward circuit breaker panel.

Engine Compartment Fire Detector Warning Light Test Switch

A momentary push button switch (36, figure FO-1) marked FIRE TEST, on the instrument panel next to the engine fire warning light, provides a means for testing the engine compartment fire detector system. When the switch is closed, a relay in the control unit is actuated which causes a condition similar to fire or overheat. The warning lights will go on with this test. The test switch circuit is powered by the dc essential bus and is protected by a circuit breaker marked FIRE DET TEST under the general heading ENGINE.

ENGINE FIRE EXTINGUISHING SYSTEM

The engine fire extinguisher system provides a means of extinguishing fires in the engine compartment. The system consists of a fire extinguisher container, a T-handle marked FUEL ON-FUEL OFF-FIRE EXT ARMED, two microswitches, a fire extinguisher switch, a circuit breaker, a forked engine compartment discharge tube, an overboard discharge tube, and a thermal discharge indicator. With dc essential power available, when the T-handle (figure 1-16) is pulled to the FIRE EXT ARMED position and the fire extinguishing switch is depressed, a liquid extinguishing agent is discharged from the container through the engine compartment discharge tubes and vaporizes.

Fire Extinguisher Container

The fire extinguisher container is charged with 2.5 pounds of bromotrifluoromethane (CR_3BR), and is pressurized with nitrogen (N_2) to 350 psi at 21.1°C. The container is on the left side of the transmission deck, just aft of the transmission. A pressure gage is secured to the lower surface of the container. A safety outlet on the lower surface of the container contains a fusible plug which provides for release of the contents when the internal pressure becomes excessive due to high temperature. The contents are released through the overboard discharge tube and thermal discharge indicator, when the ambient temperature reaches 208° to 220°F (97.8° to 104.4°C). The extinguishing agent is retained by a frangible disc within the neck of the container.

WARNING

> Bromotrifluoromethane (CF_3BR) is very volatile but is not easily detected by odor. It is non-toxic and can be considered to be about the same as other freons and carbon dioxide, causing danger to personnel primarily by reduction of oxygen. The liquid should not be allowed to contact the skin as it may cause frostbite or low temperature burns because of its very low boiling point.

Thermal Discharge Indicator

The thermal discharge indicator consists of a red disc and retaining ring and is outside, just forward of the escape hatch, on the left side of the helicopter. The thermal discharge indicator provides an immediate visual check on whether or not the container has discharged due to abnormally high container pressure.

Fire Extinguisher Arm T-handle

(See Section I, **FUEL SHUTOFF VALVE – T-HANDLE**)

The T-handle, when moved to the FIRE EXT ARMED position actuates two microswitches simultaneously. One microswitch arms the fire extinguisher system. The other microswitch closes the engine cowling shutters.

Engine Compartment Fire Extinguisher Switch

This switch is on the overhead switch panel (figure FO-2) and is labeled FIRE EXT. When the fire extinguisher system is armed, by placing the T-handle in the FIRE EXT ARMED position, and the switch is depressed, the contents of the fire extinguisher container are discharged through the forked engine compartment discharge tube. Power from the dc essential bus fires an explosive cartridge which ruptures a disc in the fire extinguisher container discharge valve, releasing the fire extinguishing agent. The firing circuit is protected by a circuit breaker marked FIRE DET EXT under the general heading ENGINE.

Engine Cowling Fire Shutter System

The engine cowling fire shutter system provides a means of closing the engine cowling shutters instantly, thereby confining a fire to the area within the engine compartment. The system consists of four shutter assemblies on the right engine cowling (figure 1-30), a shutter control solenoid, and a T-handle microswitch. Placing the T-handle in the FIRE EXT ARMED position closes the microswitch and allows power from the dc essential bus to actuate the shutter control solenoid. Solenoid actuation allows the shutter assemblies to close. The shutter control solenoid circuit is protected by a circuit breaker marked SHUTTER CONT on the forward circuit breaker panel.

EMERGENCY EXITS

For emergency routes of escapes and exits, see figure 1-31.

PILOTS' COCKPIT SLIDING WINDOWS

The pilots' cockpit sliding windows are normally opened or closed by actuating the handle on the bottom of each window. The windows will lock in any detent position when the handle is released. The manual emergency release handles, marked EMER EXIT PULL, are on the lower edge of each window inside the cockpit. The windows can be jettisoned outward and downward by pulling the release handle aft and pushing out the window. The windows can also be released from the outside by turning the handle marked EMERGENCY RESCUE-BUTTON TURN HANDLE PULL WINDOW OUT.

CABIN DOOR EMERGENCY EXIT

The cabin door can be jettisoned for emergency exit by pulling down on the handle marked EXIT RELEASE-TURN, which is on forward upper corner of cabin door. When proper conditions exist this handle is lit by an emergency exit light. A similar handle is provided to open cabin door from outside of helicopter. An orange-yellow stripe is painted on the guard assembly of the inside door handle to indicate when the emergency handle is

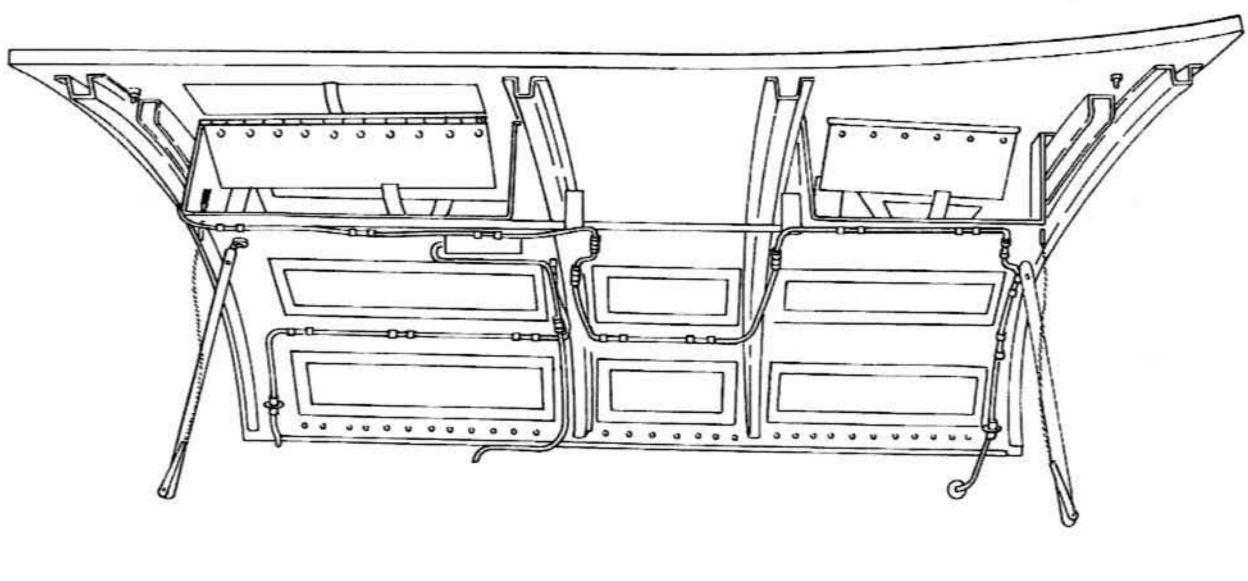


Figure 1-30. Engine-Cowling Fire Shutters

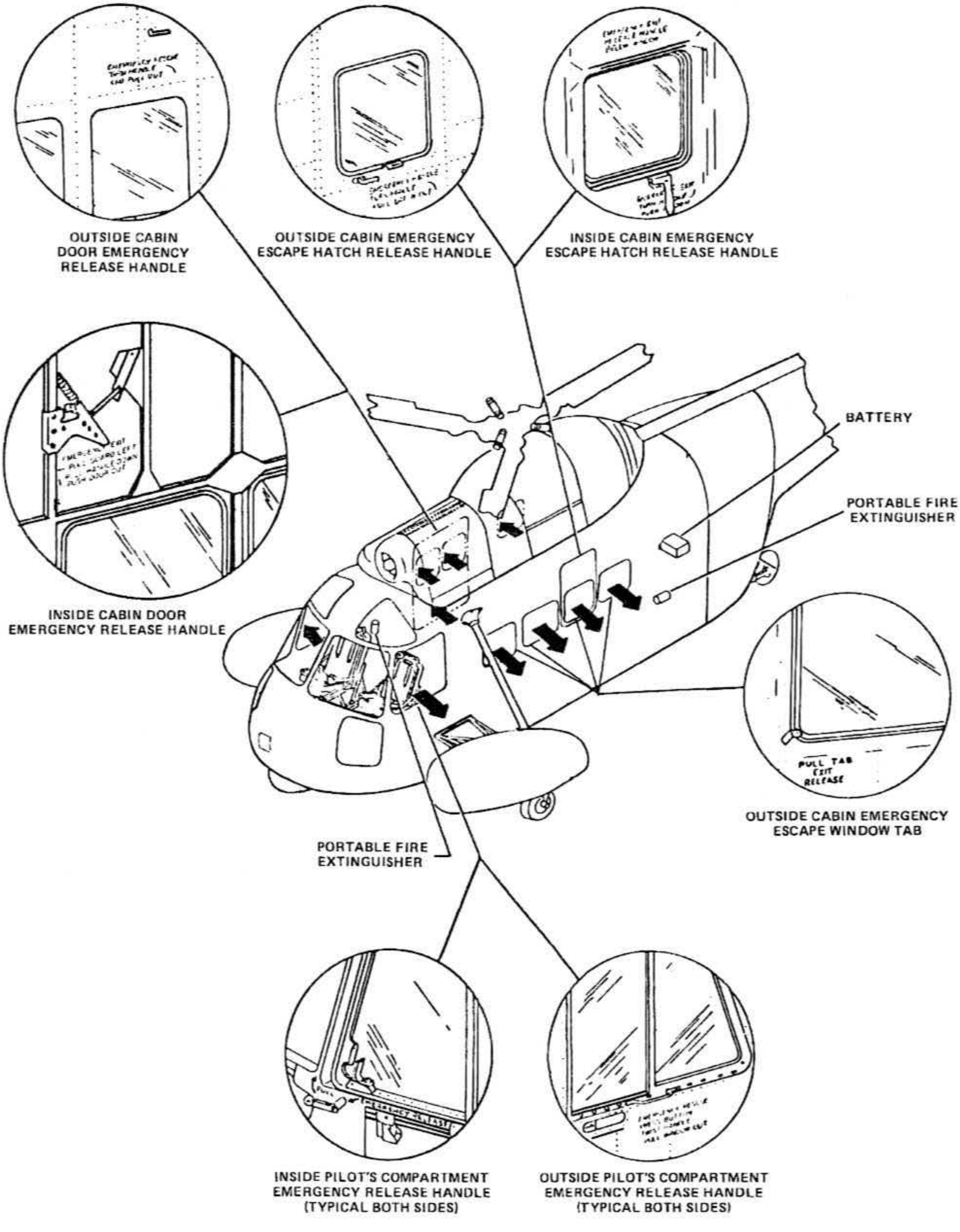


Figure 1-31. Emergency Entrances and Exits

aligned and locked. The guard lever is wired with breakaway copper wire to prevent accidental release of the cabin door.

CABIN EMERGENCY HATCH

The panel surrounding the next to last window on left side of cabin can be jettisoned to provide a cabin emergency exit or entrance. An emergency release handle, marked EMERGENCY EXIT-TURN, is on forward lower corner of the panel. To jettison the cabin emergency hatch, the release handle is turned in direction of the arrow and the hatch is pushed out. A similar release handle is provided to open the hatch from outside the helicopter.

CABIN COMPARTMENT WINDOWS

The four remaining cabin windows may be pushed out to provide emergency exits. EMERGENCY EXIT, PUSH OUT WINDOW is stenciled above each window. Each window has an externally located pull tab, marked PULL TAB EXIT RELEASE. Pulling the tab pulls the locking strip out of the rubber seal surrounding the window to aid window removal.

PILOT'S AND COPILOT'S SEATS

The pilot's and copilot's seats are track-mounted in the cockpit. The pilot's seat is on the right. The track-mounted seats are designed to accommodate a back pack parachute, pararaft and seat pan if so desired. Standard configuration prescribes outfitting with custom made seat cushions. Both seats are interchangable and have an approximate 4-inch range for fore-and-aft and height adjustment.

SEAT HEIGHT ADJUSTMENT LEVER

The seat height adjustment levers (14 and 23, figure 1-2) are the rear levers at the right of the pilot's and copilot's seat. The spring loaded levers are pulled up to release the height adjustment lockpins.

SEAT FORE-AND-AFT ADJUSTMENT LEVERS

The fore-and-aft adjustment levers (13 and 24, figure 1-2) are the front levers on the right side of the pilot's and copilot's seats. The spring loaded levers are pulled up to release the fore-and-aft seat adjustment lockpins.

SHOULDER HARNESS LOCK LEVER

A two-position shoulder harness inertia reel lock lever (18 and 28, figure 1-2) is at the left side of each seat. When the lever is in the unlocked (aft) position, the shoulder harness cable will extend to allow the occupant to lean forward; however, the inertia reel will automatically lock if an impact force between two and three Gs is encountered. When this occurs, the inertia reel will remain locked until the lever is cycled. When the lever is placed in the locked, forward position, the shoulder harness cable is locked so that the occupant is prevented from leaning forward. The lock position is used to provide an added safety precaution over that of automatic lock on the inertia reel.

SECTION II
NORMAL PROCEDURES

TABLE OF CONTENTS

PREPARATION FOR FLIGHT

Fuel requirements, weight and center of gravity location will be determined for each flight. Standard weight and balance computations are acceptable when filed and representative of aircraft loading.

BRIEFINGS

Refer to Section VIII for passenger and crew briefings.

PILOT'S PREFLIGHT INSPECTION

A pilot's preflight inspection will be accomplished prior to each flight or ground runup and it will be the final inspection prior to flight. This is performed by the pilot or a qualified copilot assigned to the flight. The purpose of this inspection is to insure removal of any protective covers/devices, and to detect damage or discrepancies which have developed since completion of the maintenance preflight inspection. The inspection will include, but is not limited to, the following items:

Exterior Inspection

1. GENERAL

a. Be alert for damage to any part of the aircraft that may have resulted from ground handling, careless operation of flight line vehicles, other aircraft, etc. — CHECKED.

b. Be alert for any sign of fluid leakage — CHECKED.

2. BIM or IBIS indicators for normal indication — CHECKED.

3. Bottom side and tip of main rotor blades for dents or scratches — CHECKED.

4. Tail rotor blades for dents or scratches — CHECKED.

5. Tailwheel assembly for proper oleo extension, tire inflation, and lockpin seated — CHECKED.

6. Fuel filler caps for security — CHECKED.

7. Engine exhaust cover removed — CHECKED.

8. Fire extinguisher thermal discharge indicator — CHECKED.

9. Overboard drains for excessive discharge — CHECKED.

10. Left main landing gear for proper oleo extension and tire inflation — CHECKED.

11. Left-hand engine cowling fasteners, work platforms, and transmission cowling for security — CHECKED.

12. Engine intake covers removed — CHECKED.

13. Pitot cover removed — CHECKED.

14. Right-hand engine cowling fasteners, work platforms, and transmission cowling for security — CHECKED.

15. Right main landing gear for proper oleo extension and tire inflation — CHECKED.

Interior Inspection

1. Circuit breakers (aft panel) — CHECKED.

2. Cargo and equipment for proper loading and security — CHECKED.

3. Circuit breakers (forward panel) — CHECKED.

4. Transmission overtorque clock and flag — CHECKED.

5. Circuit breakers (radio panel) — CHECKED.

Air Crew Inspection

1. Minimum equipment and condition.

a. Flight mechanic's safety harness — ADJUSTED.

b. Cargo door safety strap - CHECKED.

c. Cargo door jettison handle — PROPER POSITION AND BREAKAWAY WIRE INTACT.

d. Cabin emergency escape hatch jettison handle — PROPER POSITION AND BREAKAWAY WIRE INTACT.

e. Cabin — SECURED.

f. Standard SAR Board items — CHECKED.

g. Rescue platform — CHECKED.

h. Rescue basket — CHECKED.

i. Rescue sling — CHECKED.

BEFORE STARTING

1. Seats, lap belt, shoulder harness, inertial reel lock, pedals fastened/adjusted — CHECKED.

2. Gyro select switch — PORT.

3. ASE hardover switches — CENTERED.

4. ASE channel disengage switches — ON.

5. Cockpit emergency window release handles — PROPER POSITION AND BREAKAWAY WIRE INTACT.

6. Flight controls — CHECK FOR COMPLETE FREEDOM OF MOVEMENT AND CORRESPONDING MOVEMENT OF ROTOR BLADES.

7. Collective friction — ADJUST FOR SLIGHT AMOUNT.

8. Emergency throttle — OPERATE THROUGH FULL TRAVEL TO INSURE SMOOTH AND COMPLETE MOVEMENT, THEN CLOSED.

9. Speed selector — OPERATE THROUGH FULL TRAVEL TO INSURE SMOOTH AND COMPLETE MOVEMENT, THEN STOPCOCKED.

10. Flight control servo shutoff switch — CENTERED.

11. Flood and hover light switch — OFF.

12. Tailwheel — LOCKED.

13. ICS control panels — AS REQUIRED.

14. Transponder

a. STBY.

b. Code — AS REQUIRED.

15. Parking brake — RESET ON.

16. ASE CG trim index — SET TO ONE O'CLOCK.

17. Loran C navigator — OFF.

CAUTION

Aboard ship, the ARN-133 loran C circuit breaker shall be pulled prior to connecting the aircraft to ship's power. Shipboard power contains voltage spikes of sufficient intensity and duration to destroy the ARN-133 power supply module even in the off position.

18. ADF/UHF radios — ON.

19. Landing gear switch — DOWN.

20. Fuel quantity selector — TOT.

21. Rotor brake lever — RESET ON.

22. Outside air temperature — NOTED.

23. T-handle — FUEL ON.

24. P3 valve — AS REQUIRED.

a. Batt start — OPEN.

b. External power start — CLOSED.

25. Pitot heater switch — OFF.

26. Windshield defroster switch — OFF.

27. Engine anti-ice switch — OFF.

28. Hoist master switch — OFF.

29. Hoist shear switch — GUARD COVER CLOSED AND BREAKAWAY WIRE INTACT.

30. NON ESS BUS OVRD switch — CENTERED.

31. Heater master switch — OFF.

32. Heater start switch — OFF.

33. Heater HI-LO cycling switch — HI.

34. Vent blower switch — NORMAL.

35. Navigation lights master switch — ON.

36. Position lights master switch — AS REQUIRED.

37. Rotating anti-collision light switch — AS REQUIRED.

a. Normal operations — ON.

b. Night ship operations — OFF.

38. Windshield wiper switch — OFF.

39. All lighting rheostats — AS DESIRED.

40. Overhead console COMM/NAV equipment — ON.

NOTE

Homing selector and Loud Hailer should remain OFF until system is to be used.

41. Pilot's compartment and cabin dome light switches — AS DESIRED.

42. Cockpit spotlight — AS DESIRED.

43. Cargo sling master switch — SAFE.

44. Release mode switch — TUGBIRD.

45. Radio master switch — ON.

46. Beeper trim switch — ON.

47. Fuel boost pump switches — ON.

48. Overspeed test switch — TEST NO. 1.

49. Ignition switch — NORMAL.

50. Generator switches — ON.

51. Battery switch — OFF.

52. External power switch — OFF.

STARTING ENGINE

BATTERY START

Refer to ENGINE FUEL CONTROL SYSTEM OPERATION in Section VII for description of abnormal starts and to ENGINE STARTING AND GROUND FIRE emergency procedures in Section III.

1. Before starting check — COMPLETED.

2. Fire guard — POSTED.

3. Speed selector stopcocked — RECHECKED.

4. Battery switch — ON.

5. Fire warning lights check:

   a. Test switch — DEPRESSED.

   b. T-handle and instrument panel warning lights go on — CHECKED.

6. Battery switch — BATT START.

7. Starter button and clock — DEPRESSED.

8. T_5 Less than 100°C — CHECKED.

9. Ng Accelerating through 14% — CHECKED.

10. Speed selector — ADVANCE TO GROUND IDLE.

11. Elapsed time — NOTED.

12. Engine light-off should occur within 15 seconds after opening speed selector — CHECKED. (Refer to Section III, engine fails to light off.)

13. When light-off occurs — MONITOR T_5 AND Ng ACCELERATION. (Refer to Section III for hot start abort procedures.)

14. When T_5 peaks and is less than 650°C — CLOSE P_3 VALVE. (Refer to Section III for cold hangup procedures.)

15. Observe 45% Ng — RELEASE STARTER BUTTON.

16. Starter Disengaged — CHECKED.

NOTE

Verify the starter disengaged by observing the swing of the standby compass back to the heading of the helicopter. If the starter does not disengage, stopcock the speed selector and secure the helicopter.

17. Ng 56% ±3% — CHECKED.

18. Battery switch — ON.

19. Engine instruments — CHECKED.

STARTING WITH DC EXTERNAL POWER

NOTE

Availability of dc external power is determined by momentarily placing the external power switch on prior to initiating the start. It must be turned off prior to starter engagement.

1. Before starting check — COMPLETED.

2. Fire guard — POSTED.

3. Speed selector stopcocked — RECHECKED.

4. External power switch — ON. External power advisory light — CHECKED ON. External power switch — OFF.

5. Battery switch — ON.

6. Fire warning lights check:

a. Test switch — DEPRESSED.

b. T-handle and instrument panel warning lights go on — CHECKED.

7. Starter button and clock — DEPRESSED.

8. External power switch — ON. External power advisory light — CHECKED ON.

NOTE

Allow sufficient time for starter engagement with battery power only (approximately 1-2 seconds).

9. T_5 less than 100°C — CHECKED.

10. Ng accelerating through 14% — CHECKED.

11. Speed selector — ADVANCE TO GROUND IDLE.

12. Elapsed time — NOTED.

13. Engine light-off should occur within 15 seconds after opening speed selector — CHECKED. (Refer to Section III for engine failure to light-off malfunction.)

14. When light-off occurs — MONITOR T_5 AND Ng ACCELERATION. (Refer to Section III for hot start abort procedures.)

15. Observe 45% Ng — RELEASE STARTER BUTTON.

16. Starter Disengaged — CHECKED.

NOTE

Verify the starter disengaged by observing the swing of the standby compass back to the heading of the helicopter. If the starter does not disengage, stopcock the speed selector and secure the helicopter.

17. Ground idle Ng 56% ± 3% — CHECKED.

18. Engine instruments — CHECKED.

19. External power switch — OFF.

20. External power source — DISCONNECTED.

STARTING WITH AC EXTERNAL POWER.

1. Before starting check — COMPLETED.

2. Fire guard — POSTED.

3. Speed selector stopcocked — RECHECKED.

4. External power switch — ON. (External power advisory light should not go on.)

5. Battery switch — ON.

6. External power advisory light — ON.

7. Fire warning lights check:

a. Test switch — DEPRESSED.

b. T-handle and instrument panel warning lights go on — CHECKED.

8. Starter button and clock — DEPRESSED.

9. T5 less than 100°C — CHECKED.

10. Ng accelerating through 14% — CHECKED.

11. Speed selector — ADVANCE TO GROUND IDLE.

12. Elapsed time — NOTED.

13. Engine light-off should occur within 15 seconds after opening speed selector — CHECKED. (Refer to Section III for engine failure to light-off malfunction.)

14. When light-off occurs — MONITOR T5 AND Ng ACCELERATION. (Refer to Section III for hot start abort procedures.)

15. Observe 45% Ng — RELEASE STARTER BUTTON.

16. Starter Disengaged — CHECKED.

NOTE

Verify the starter disengaged by observing the swing of the standby compass back to the heading of the helicopter. If the starter does not disengage, stopcock the speed selector and secure the helicopter.

17. Ground idle Ng 56% ± 3% — CHECKED.

18. Engine instruments — CHECKED.

19. External power switch — OFF.

20. External power source — DISCONNECTED.

CAUTION

- During all engine starts, regardless of the procedure used, Ng acceleration from starter engagement until reaching ground idle should be monitored closely. Any Ng hangup or lag during start could indicate engine bearing or accessory drive problems and should be investigated.
- During all engine starts, regardless of the procedure used, if Nf indications are observed the start should be aborted and the cause investigated. Nf indications during the start cycle may signal failure of the freewheeling unit.
- During all engine starts, regardless of the procedure used, if the rotor brake fails to hold, the start should be aborted and the cause investigated. Continued rotor movement with the rotor brake ON will result in rotor brake damage or fire.

ROTOR ENGAGEMENT

1. Aircraft clear of personnel and equipment — CHECKED.

2. Collective pitch — MINIMUM.

3. Rotor brake — OFF.

a. Rotor brake caution light out — CHECKED.

4. Auxiliary servo pressure — CHECKED.

5. Primary servo pressure — CHECKED.

6. Transmission oil pressure rise — CHECKED.

a. TRANS OIL PRESS caution light on below approximately 15 psi — CHECKED.

7. Nr 33% or higher — CHECKED.

8. Flight controls — CHECKED.

CAUTION

If any binding of the flight controls is felt or if rotor response is abnormal — SECURE THE AIRCRAFT.

a. Note that no unusual cyclic stick position is required to maintain a level tip path plane.

b. Trim release — DEPRESSED FOR CYCLIC ACTUATION.

c. Actuate flight controls a slight amount in all directions, one at a time.

d. Freedom of movement — CHECKED.

e. Normal rotor response — OBSERVED.

9. Servo systems — CHECKED.

CAUTION

When performing servo system check, keep thumb on flight control servo shutoff switch and be prepared to return switch to ON (centered) position in event of erratic behavior or malfunction of flight control system when switch is placed in either PRI OFF or AUX OFF. Inability to secure either servo is a grounding discrepancy.

a. Primary and auxiliary servo hydraulic pressure gages — CHECKED.

b. Servo shut-off switch — PRI OFF.

(1) Observe reaction of tip path plane. Normal indication is a slight movement of tip path plane as stationary star is allowed to move within sloppy links — CHECKED.

(2) Primary servo pressure indicates zero — CHECKED.

(3) PRI HYD caution light — ON.

c. Trim release — DEPRESS FOR CYCLIC MOVEMENT.

d. Actuate cyclic and collective, one at a time.

(1) Freedom of movement — CHECKED.

(2) Observe tip path plane. Abnormal response of tip plane might indicate an auxiliary servo malfunction — CHECKED.

WARNING

If an excessive movement of the tip path plane is noted, do not continue servo check. Place flight control servo shutoff switch in the ON position and SECURE THE AIRCRAFT.

e. Servo shutoff switch — CENTERED.

(1) Primary servo pressure indication normal — CHECKED.

(2) PRI HYD caution light off — CHECKED.

f. Raise collective slightly.

g. Servo shutoff switch — AUX OFF.

(1) Observe reaction of tip path plane for no movement.

(2) Stick jump — CHECKED.

(a) Maximum allowable jump in the flight controls when the AUX SERVO is turned off is: Tail rotor pedals and collective 1/16 inch, Cyclic 1/8 inch.

WARNING

If limits are exceeded, do not fly the aircraft until the cause of excess jump is corrected.

(3) Auxiliary servo pressure indicates zero — CHECKED.

(4) AUX HYD PRESS caution light on — CHECKED.

h. Trim release — DEPRESS FOR CYCLIC MOVEMENT.

i. Actuate flight controls, one at a time.

(1) Freedom of movement — CHECKED.

NOTE

With auxiliary servo off, increased friction will be felt in the cyclic and collective. Pedal forces are less than normal due to pedal damper being off.

(2) Normal rotor response — CHECKED.

CAUTION

There should be no tendency of the cyclic to move when checking collective response. If a collective to cyclic coupling is noticed, return the servo shutoff switch to ON and secure the helicopter. A slight cyclic to collective coupling may be felt due to installation of solid primary servo input rods. The pilot should be able to override the coupling and it should not be felt with the engine above ground idle.

j. Servo shutoff switch — CENTERED.

(1) Auxiliary servo pressure indication normal — CHECKED.

(2) AUX HYD PRESS caution light off — CHECKED.

10. Speed selector — FLIGHT IDLE.

11. Rotor overspeed system — CHECKED.

a. Speed selector — ADVANCE TO AUTO DETENT OR UNTIL Ng STARTS TO OSCILLATE.

b. Ng trips within limits and oscillates — CHECKED.

NOTE

Ng should decelerate upon reaching approximately 75% Ng. The exact limits are specified in Figure 5-3. The first trip may occur at a higher than normal reading and should be disregarded.

c. Overspeed test switch — NORMAL.

12. Speed selector — MAXIMUM.

a. Maximum Nf 103%-106% — CHECKED.

13. Free wheeling unit — CHECKED.

a. With positive motion turn speed selector to FLIGHT IDLE.

b. Nf/Nr tach needles split — CHECKED.

c. Rotate speed selector to auto detent and allow power surge to peak — CHECKED.

NOTE

Nf in the auto detent should be between 86%-91%. If below 86%, rotate speed selector to just above auto detent and back into the auto detent rechecking for 86% Nf minimum.

14. 100% Nf/Nr — SET.

15. Hoist Master Switch — CREW (if Hoist check is required)

HOIST CHECK

The hoist shall be checked if it is to be used during the flight. The flight mechanic will perform the following:

1. Hoist glove — ON.

2. Extend the hoist approximately three feet. Inspect for damage to the hook and cable. The hoist may not be used if any of the cable strands are broken.

3. Actuate the hoist and check the up limit switch for proper operation.

4. Actuate the hoist using manual override for proper operation.

CAUTION

Do not raise the hoist hook to the full up position when operating on manual override. The up limit protection is bypassed and the hook and cable may be damaged or disconnected.

5. Return the hoist to the full up position.

6. Report the status of the hoist upon request of the pilot.

INSTRUMENT EQUIPMENT CHECK

If single-piloted, the pilot's instruments will be checked for normal readings during the check. If dual-piloted, the instruments which are duplicated on the copilot's instrument panel will be cross-checked as an additional check for proper instrument operation.

1. Loran C Navigator — PREFLIGHT.

CAUTION

Aboard ship, insure that ship's power is disconnected before resetting Loran C circuit breaker.

a. Mode switch — INITIALIZE

b. Position, GRI and secondary pair, variation — ENTERED/CHECKED.

c. Mode switch — OPERATE.

d. Waypoints/search data, etc. — ENTERED/ CHECKED AS DESIRED.

2. Fuel quantity indicator — CHECKED.

a. Selector to TOT position — CHECK QUANTITY.

b. Rotate selector to AFT — CHECK QUANTITY.

c. Depress test switch, needle deflects to below zero — CHECKED.

d. Release test switch, needle returns to same reading — CHECKED.

e. Rotate selector to FWD — CHECK QUANTITY.

f. Quantity in TOT equals FWD plus AFT — CHECKED.

3. Caution/Advisory panel — CHECKED.

a. Master switch to TEST. All modules and master caution light go on with equal intensity — CHECKED.

b. Master switch — RESET.

4. Emergency exit lights — CHECKED.

a. Emergency exit lights switch — ARMED, THEN OFF.

b. Both emergency exit lights — AIR CREWMAN OR FM CHECK ON.

c. Emergency exit lights switch — ARMED.

d. Both emergency exit lights — AIR CREWMAN OR FM CHECK OFF (trickle charge).

5. Engine and transmission instruments for normal indications — CHECKED.

6. GVR/LORAN selector switch — AS DESIRED.

7. Dual tachometer — CHECKED.

8. Airspeed indicator — CHECKED.

9. Vertical gyro indicator — CHECKED.

a. "OFF" flag - HIDDEN.

b. Adjust indicies as necessary to set actual attitude.

10. Radar altimeter control knob — SET TO 140 FEET.

11. Torquemeter — CHECKED.

12. Flight director ASE mode — SET.

a. Both "OFF" flags — VISIBLE.

b. Bars and pointers — CENTERED.

13. MA-1 compass — SET.

a. MA-1 compass and STBY compass — COMPARED.

b. Slave indicator centered — CHECKED. SLAVE MANUALLY IF NECESSARY.

c. Compass acknowledge button — DEPRESS.

NOTE

During shipboard operations, the MA-1 compass may not be accurate due to magnetic disturbances created by the ship. Use the ship's magnetic heading in this instance and compare with the STBY compass once clear of the ship.

14. Barometric altimeter — SET.

CAUTION

During normal use of the setting knob the counter drums may momentarily lock. If this occurs, do not force the setting knob. Use of force may cause internal gear disengagement and result in excessive altitude error. If locking occurs, the required setting may sometimes be obtained by turning the knob a full turn in the opposite direction and approaching the setting again with caution.

15. Clock — CHECKED.

16. Turn and slip indicator — CHECKED.

17. VOR/TACAN #2 needle selector switch — AS DESIRED.

18. Vertical speed indicator — CHECKED.

19. Pitot heater switch — AS REQUIRED. (on below 10° C OAT).

20. Windshield defroster switch — AS REQUIRED.

21. Engine inlet duct anti-ice system — CHECKED. (if it's use is contemplated).

a. Engine anti-ice switch — HOLD IN TEST POSITION.

b. ENG INLET ANTI-ICE caution light cycles on and off — CHECKED.

c. Engine anti-ice switch — ON.

d. Slight T_5 rise — CHECKED.

e. Engine anti-ice switch — AS REQUIRED. (Normally on below 10°C OAT). Refer to COLD WEATHER OPS, During Flight, section IX.

22. Hoist check — AS REQUIRED.

a. FM report on hot mike — "HOIST CHECK COMPLETE, ON HOT MIKE, HOW DO YOU READ?"

b. Pilot — ACKNOWLEDGE.

c. Hoist master switch — OFF.

23. NON ESS BUS OVRD switch — ON.

24. Heater system — AS REQUIRED.

RADALT CHECK

The RADALT check may be performed as soon as it is warmed up. The check must be complete prior to the before takeoff check.

1. Low level warning light on — CHECKED.

2. RAWS switch — ON.

3. Press to test for accuracy 100 ± 15 feet — CHECKED.

4. RAWS audio — CHECKED.

5. Needle indicates zero — CHECKED.

ASE CHECK

The ASE check may be performed any time prior to the before takeoff check.

1. Tailwheel — LOCKED.

2. Parking brake — ON.

3. ASE ENG button — DEPRESS.

a. Green light — ON.

b. ASE OFF caution light — OFF.

c. Flight Director OFF flags hidden — CHECKED.

4. Move cyclic in pitch and roll to check proper movement of mode bars.

5. Pilot adjust CG control to place the pitch mode bar two units below center index while maintaining a center cyclic position.

6. Adjust yaw mode pointer one unit to right, then center by depressing left rudder pedal. Reverse this procedure to the left. Disengage, ASE ENG light off — CHECKED.

BEFORE TAXI/TAXI

1. Crew and passengers — READY.

2. Chocks — REMOVED.

3. Parking Brake — OFF.

4. Tailwheel — UNLOCKED.

NOTE

The tailwheel may be unlocked with or without forward movement of the helicopter at the pilot's discretion. In either case, side loads on the locking pin must be neutralized by use of tail rotor pedals before the locking pin will unlock.

5. During taxi check brakes for proper operation.

6. During taxi, MA-1 compass and turn needles tracking properly — CHECKED.

7. The LORAN, Communications and navigation systems which will be used during the flight should be checked prior to takeoff.

BEFORE TAKEOFF CHECK

1. Crew and passengers — ALERTED.

2. Tailwheel — LOCKED.

3. Parking brake — AS REQUIRED.

a. Water, ship deck with grid — OFF.

b. Ship deck without grid — ON.

4. Transponder — SET TO ALT.

5. ASE — ENGAGED.

CAUTION

Aboard ship, ASE shall be disengaged anytime the ship is turning to avoid full throw tail rotor pedal deflection induced by the ASE heading retention feature.

6. COMM-NAV equipment — AS REQUIRED.

7. Caution panel — CHECKED.

8. Engine instruments — CHECKED.

9. Nf/Nr. 103% — SET.

10. Flight instruments — CHECKED.

11. Ship operations, cockpit sliding windows and cabin door — OPEN.

CRUISE CHECK

1. NF/Nr - 96-100% — SET.

2. Wheels — DOWN

BEFORE LANDING CHECK

1. Heater switch — AS REQUIRED. (Secured 5 minutes prior to shutdown).

2. Tailwheel — LOCKED.

3. Parking Brake — AS REQUIRED.

a. Water, ship deck with grid — OFF.

b. Ship deck without grid — ON.

4. Wheels — AS REQUIRED.

5. Caution panel — CHECKED.

6. Speed Selector — SET TO ARRIVE IN A HOVER WITH 100% Nf/Nr.

7. Crew and passengers — ALERTED

8. Water and ship operations, conditions permitting, cabin door and cockpit sliding windows — OPEN.

AFTER LANDING AND TAXIING

1. Collective pitch — MINIMUM.

2. Nf/Nr 100% — SET.

3. ASE — DISENGAGED.

4. Tailwheel — UNLOCKED.

5. Transponder — AS REQUIRED.

PARKING

1. Head helicopter into the wind if possible.

2. Tailwheel — LOCKED.

3. Parking Brake — SET.

4. LORAN C Navigator — INITIALIZE, then OFF.

5. RAWS — OFF.

6. Emergency exit lights — DISARM.

ROTOR SHUTDOWN-ENGINE RUNNING

1. Speed selector to FLIGHT IDLE — SET.

2. Droop stops in — CHECKED.

3. Nf/Nr at or below 48%, rotor brake — ON.

NOTE

Apply rotor brake full ON using one steady motion. Make no attempt to ease rotor to a stop.

CAUTION

If the rotor brake fails to bring the rotor to a complete stop, immediately release the rotor brake and abort the shutdown or STOPCOCK the speed selector and proceed with Rotor and Engine Shutdown. Continued rotor movement with the rotor brake ON will result in rotor brake damage or fire.

4. Electrical load — REDUCE AS NECESSARY.

NOTE

Battery drain can be reduced by turning off equipment individually or by using the BATT START position of the battery switch.

CAUTION

At least one fuel boost pump must be ON to supply fuel to the engine to preclude flameout. If the engine flames out due to fuel starvation, STOPCOCK the speed selector immediately and monitor T_5 for internal engine fire.

ROTOR AND ENGINE SHUTDOWN

1. For engine cooling operate at least 1 minute at minimum pitch.

2. Speed selector — FLIGHT IDLE.

3. Droop stops in — CHECKED.

4. Speed selector — STOPCOCK.

5. Nr 48% or less, rotor brake — APPLY. EXACT TIME AND AMOUNT OF APPLICATION DEPENDS ON THE WIND CONDITIONS OR OPERATIONAL NECESSITY. EASE ROTOR TO A STOP BY REDUCING ROTOR BRAKE PRESSURE DURING THE LAST FEW REVOLUTIONS OF THE ROTOR, STOPPING THE BLADES AT THE DESIRED LOCATION.

NOTE

In winds greater than 25 knots, apply rotor brake full ON at 48% Nr using one steady motion. Make no attempt to ease rotor to a stop.

6. T_5 less than 300°C — MONITOR.

(Refer to Section III INTERNAL ENGINE FIRE PROCEDURES.)

BEFORE LEAVING THE HELICOPTER

1. Overhead switch panel — SWITCHES OFF.

NOTE

Use the same sequence as before starting check, omitting overhead NAV/COMM control heads.

2. T_5 less than 300°C — RECHECKED.

POSTFLIGHT

1. Overtorque clock and flag — CHECKED.

2. Chocks in — CHECKED.

3. Perform brief EXTERIOR INSPECTION.

BASIC MANEUVERS

GROUND TAXIING

Ground taxiing should be performed with tailwheel unlocked, the ASE disengaged, and 100% Nr/Nf. A small amount of collective may be used. Check brakes for proper operation. Maintain level attitude with cyclic.

CAUTION

The helicopter may pitch over on the nose if taxied downwind with high or gusty winds. If taxiing under these conditions can not be avoided, taxi very slowly utilizing collective and cyclic to control ground speed assisting with light braking as necessary.

NOTE

Utilize a taxi director when taxiing in close proximity to obstructions.

CAUTION

The rotor disk as well as the tail cone is displaced in the opposite direction of a turn.

AIR TAXI

Align the helicopter with the desired track. Crosswind and downwind taxi should not be accomplished in winds greater than 25 knots or 20 knots respectively. Air taxi altitude should be no higher than 5 to 10 feet unless obstacles, FOD, or spray requires higher altitude. Air taxi speed is dictated by the surface to which a forced landing would be made.

HOVERING

Hover is conducted at 100% Nf/Nr at a suitable altitude selected by the pilot. Hover altitude is based on existing conditions and should be sufficient to avoid inadvertant ground contact. Factors which should be considered are the consequences of engine failure, gross weight, obstructions to visibility (blowing snow, dust, sand, water spray) wind velocity, and wind direction with respect to the helicopter. High gross weights dictate a lower hover altitude.

VERTICAL TAKEOFF

ASE is normally engaged prior to takeoff. Set 103% Nf/Nr at minimum collective pitch. Establish a hover at an altitude appropriate for existing conditions.

RUNNING TAKEOFF

A running takeoff reduces the power required to become airborne. Increase the collective and coordinate the cyclic as necessary to begin rolling across the surface. Continue accelerating until translational lift is attained, then smoothly increase collective until takeoff occurs. Lift-off should be made in a level attitude. Adjust nose attitude to insure continued acceleration after lift-off and continue transition to forward flight.

NO HOVER TAKEOFF

This maneuver is useful for departing congested or rough areas and to minimize the exposure of the helicopter to blowing material. (FOD).

Procedure

1. Increase collective and coordinate cyclic and tail rotor pedals to begin a vertical takeoff.

2. As the helicopter leaves the surface, apply forward cyclic to transition to forward flight.

TRANSITION TO FORWARD FLIGHT AND CLIMB

Procedure

1. From a takeoff or a hover, apply forward cyclic to accelerate, adding collective as necessary to prevent settling.

2. When translational lift has been attained, below 20 feet AGL, with a ground speed of approximately 10 knots, increase collective (100% Q max) and continue acceleration and climb at a level attitude until reaching 55 knots. Adjust nose attitude to climb at 55 knots until 1000 feet AGL. Climb at 70 knots thereafter. 95 percent torque should be utilized for climb where practicable. Limit torque settings above 96% to 5 minutes duration.

NOTE

A nose attitude of up to 3 degrees nose down may be required in strong winds to maintain the departure profile.

TRAFFIC PATTERN

Normal traffic patterns will be flown at 55 knots, 1000 feet (AGL). Pattern altitude may be varied to meet local requirements. The autorotative characteristics should be considered when determining the down wind distance from the landing area.

NORMAL APPROACH (figures 2-1, 2-2)

This maneuver is used to transition to a hover or to a landing, at a specific spot, over land, water, mountainous terrain, elevated structures or confined areas. With the wide variety of approach angles available, the pilot is able to adapt to various operational situations. An approach requiring a low rate of descent such as cargo sling operations, would utilize a shallow angle. A steep angle might be used when approaching a spot bounded by obstacles. High rates of descent and/or fast closure rates should be avoided. Maintaining a constant apparent ground speed during the last 200-400 feet of descent is one method of determining closure rate. Although the normal approach is best initiated from a downwind position, it may successfully be accomplished from any position. Ability to establish a visual picture of the desired approach angle, from any altitude and position, through the use of a windshield sight picture, is a requirement for properly completing an approach. This is essentially a HEAD OUT OF THE COCKPIT type of approach. Occasionally, the pilot may desire to change the spot to which he is making an approach. To approach this new spot, power should be applied to establish level flight (or decrease rate of descent) until the new angle is then made. If the

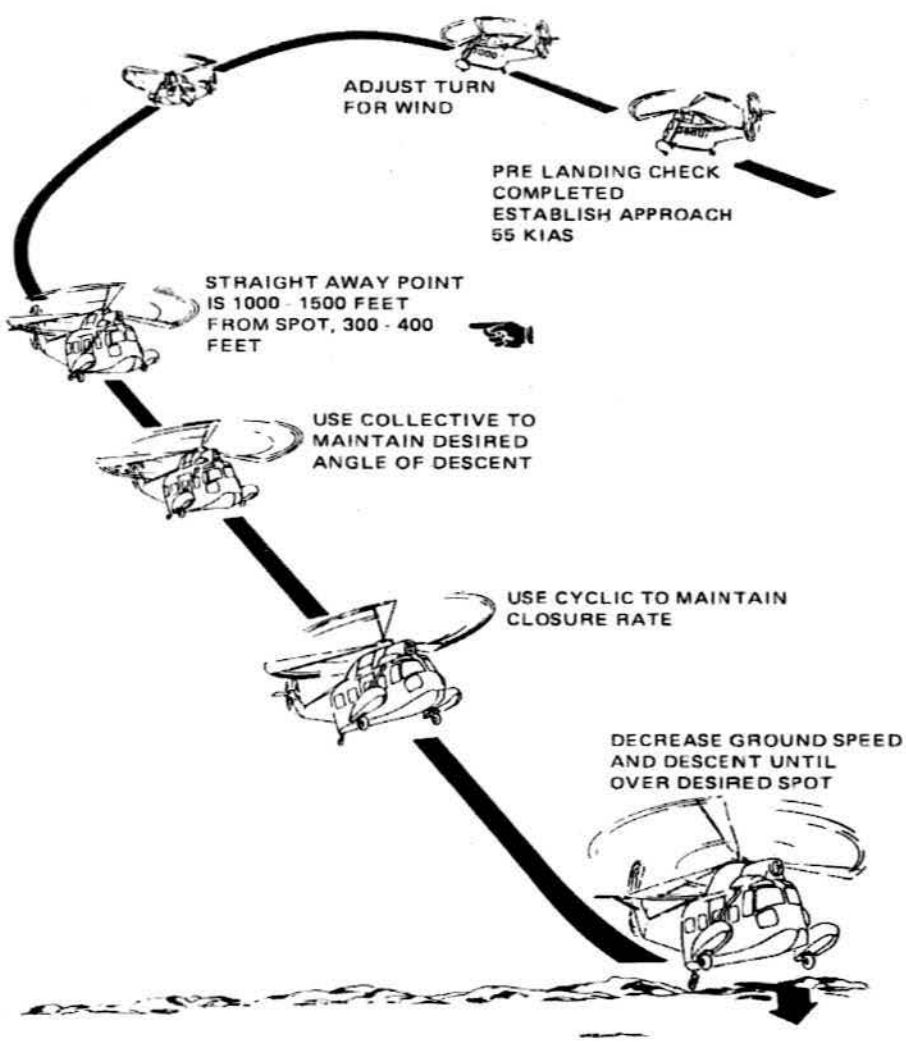


Figure 2-1. Normal Approach

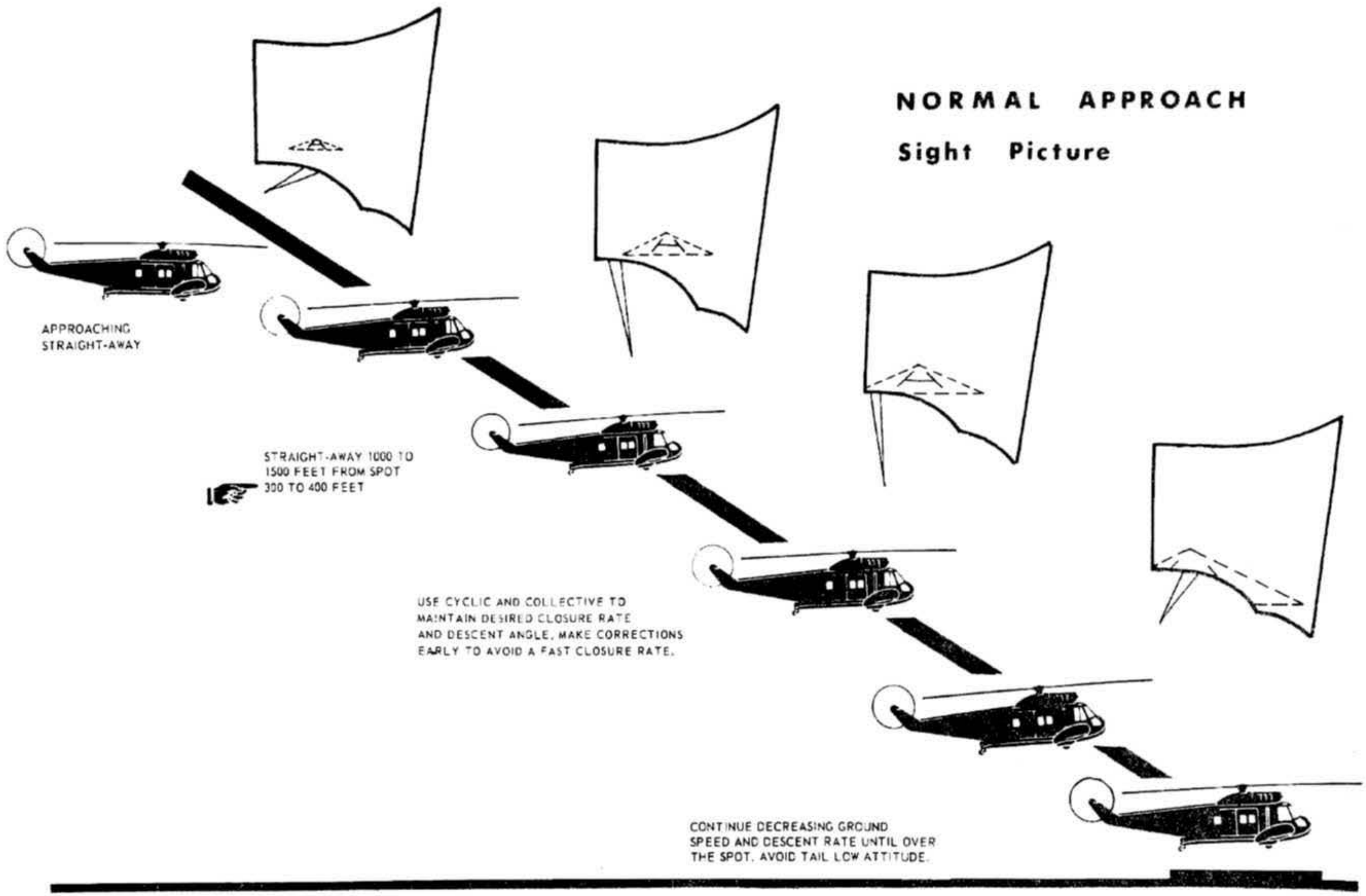


Figure 2-2. Normal Approach Sight

newly selected spot is closer than the original, power should be further reduced to increase the rate of descent until the new angle is intercepted. Power is then applied to descend along the new angle to the desired spot.

Procedure

1. The helicopter is normally established on downwind at 1000 feet, 55 knots. However, this approach can be commenced from any point from 180° position to a straight position.

2. After aligning the helicopter on straight away, regardless of initial altitude, fly a constant angle (STRAIGHT-LINE) descent, to the desired spot by maintaining a proper windshield sight picture.

3. On straight away, the constant angle (STRAIGHT-LINE) descent will place the helicopter 300-400 feet above the ground 1000-1500 feet downwind from the desired spot.

4. Use the crab method for drift correction through 200 feet, then shift to the wing down method.

5. Maintain the desired approach angle using collective while coordinating cyclic to give a comfortable closure rate to terminate in a hover or landing at the selected spot.

VERTICAL LANDING

Upon firm contact with the surface decrease collective while adjusting cyclic to neutral. Stop any forward movement with brakes.

RUNNING LANDING

A running landing is one method of terminating a normal approach utilizing less power than is required for a hover or a no hover landing, or when a touchdown with only small changes in power is desirable. It utilizes the effect of forward airspeed (translational lift) to reduce the power required for landing.

Procedure

1. When airspeed decreases in the normal approach to the desired touchdown speed, adjust the nose attitude to maintain that speed.

2. Control descent with collective to touch down on the spot with translational lift. Nose attitude at touchdown should be 0° - 5° nose up.

3. When on the ground coordinate the cyclic, collective, and brakes as required to control ground speed.

NO-HOVER LANDING

The no-hover landing is a method of terminating a normal approach. It utilizes less power than is required for a hover and can be used to minimize FOD ingestion when landing.

Procedure

1. During the last portion of the normal approach, coordinate cyclic and collective to give a well controlled landing with 0-5 knots of ground speed (depending on the surface conditions).

2. After landing, coordinate the cyclic, collective, and brakes to control ground roll.

WAVEOFF

A waveoff provides the pilot a means of aborting an unfavorable approach. This maneuver may be executed during any portion of an approach by increasing collective to 95% torque and establishing a 55 knot climb.

CONFINED AREA PROCEDURES

These procedures provide the pilot with guidelines for landing in and taking off from an area that is restricted by terrain features or other obstacles. Additionally, portions of these procedures apply when operating below safe obstacle clearance altitudes when no landing is intended. Adequate crew briefing and coordination cannot be overemphasized. Each member of the crew must understand what is intended and be alert for any hazard which may be encountered during the course of the operation, which may require an immediate WAVEOFF. Normally a confined area operation consists of several parts: high recon, low recon, approach and termination, maneuvering, and takeoff.

HIGH RECON

The high recon affords the pilot the opportunity to evaluate and plan the operation from a safe altitude. The high recon is usually flown at about 1000 feet AGL and in a circular orbit to the side of the area. This gives the pilot the best possible view. The approach, termination, and takeoff should be tentatively planned based on the observation and estimate of:

1. Size of the area and long axis of the area.

2. The presence and height of obstacles.

3. The condition and slope of the terrain.

4. Wind direction and velocity.

5. Forced landing areas.

6. Anticipated helicopter performance (APPENdix I).

7. Waveoff route.

LOW RECON

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. If conducted separately, the low recon is usually commenced by using the approach planned during the high recon. As the descent is made to the area, the approach is broken off so as to fly to the side of the area. The low recon is flown at 55 knots and at an altitude sufficient to provide adequate observation of the area. As the low recon is completed, a climb to pattern altitude is made to set up for the actual approach.

APPROACH AND TERMINATION

Prior to initiating the approach the pilot will brief the copilot and crewman. The crewman is utilized to advise the pilot of obstacle clearnace on the approach. The approach should be a normal approach if possible. The angle selected should be one which will clear the obstacle and continue to the planned termination point, which is normally as far forward in the landing area as conditions permit. If a steeper than normal approach is required, only that portion from just above the obstacle to the spot should be steeper. As the approach progresses, the pilot should continue to evaluate the factors considered on the high and low recons. The approach is terminated in either a hover or no hover landing depending on the power available and the terrain. Determine the stability of the helicopter after touchdown prior to reducing power. Use of the foot-actuated wheel brakes should be considered to prevent forward motion on touchdown in confined areas.

MANEUVERING

Air or ground taxi may be utilized depending on existing conditions. All crewmembers should keep a constant lookout for obstacles during maneuvering.

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 should be applied to establish a straight line climb angle that will clear the obstacle. Attain 55 knots as soon as practicable. In some areas, the wind cannot be depended on for added lift until the helicopter is above the obstacles.

LOW ALTITUDE OPERATIONS

Prior to descending below a 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 available 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 during maneuvering at low altitudes. If weather conditions require continuous operation below safe obstacle clearance altitude, ground speed must be reduced so that obstacles may be seen and avoided.

SLOPE OPERATIONS

Slope operations are conducted either upslope or sideslope. Never land downslope nor turn the tail into a slope during hovering, as the tail rotor may contact the ground.

UPSLOPE

Landing with the nose of the helicopter pointed upslope is the most desirable procedure. The wheels are normally down but may be raised at pilot's discretion for landing on steeper slopes. The parking brakes are set on the PRELANDING check. When over the desired landing spot, commence a slow, vertical descent, until the main wheels touch down. Continue lowering collective, while coordinating upslope cyclic, until the tailwheel, and the weight of the helicopter is resting firmly on the ground. If the rotor blades contact the droop stops before reaching minimum collective pitch, raise the collective until the blades are just off the droop stops. Maintain this position to complete the mission.

WARNING

The helicopter may not be shut down after a wheels-up landing on an upslope. The wheels will extend when electrical power is secured which may preclude a subsequent rotor engagement due to the increased nose-up attitude.

SIDESLOPE

Execute the landing by heading the aircraft parallel to the slope with the parking brake and wheels as desired. Descend slowly, placing the upslope wheel on the ground. Coordinate reduction of collective pitch with lateral cyclic (into the slope). Reduce collective pitch until the tailwheel and the downslope main wheel touch the ground. Continue coordinating reduction of collective pitch and application of cyclic into the slope until all the weight of the aircraft is resting firmly on the ground. If the rotor blades contact the droop stops, cease lowering the collective and hold this position to complete the mission. To take off, coordinate cyclic control and collective pitch 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 pitch to bring the aircraft to a hover.

WARNING

The helicopter may not be shutdown after a wheels-up landing on a sideslope. The wheels will extend unevenly when electrical power is secured, and may roll the helicopter over.

ELEVATED HELIPAD APPROACH PROCEDURES

Elevated helipads are found on roof tops, on oil rigs, on aids to navigation platforms, etc. Approaches to elevated helipads are executed in the same manner as the confined area approach.

HIGH RECON AND LOW RECON

Perform reconnaissance in the same manner as in confined area operations.

APPROACH AND TERMINATION

A normal approach should be made to the helipad with termination at the forward edge of the pad to take best advantage of the wind and to insure that the tailwheel will be placed on the landing surface. The approach may be terminated in a hover or with a no hover landing as necessary. Use of the foot-actuated wheel brakes will prevent the helicopter from rolling after touchdown. The pilot will brief the flight mechanic to open up and provide clearance information, especially tailwheel clearance.

TAKEOFF

The takeoff may utilize the no hover technique or be made from a hover. Following takeoff from an elevated structure, a rapid gain in air speed is more important than a gain in altitude. This provides the pilot better autorotative characteristics should an engine failure occur.

CARGO SLING PROCEDURES

The mechanical and electrical operation of the cargo sling is explained in detail in Section IV. The cargo sling provides the pilot with a method of transporting external loads weighing up to 3000 pounds. Before commencing cargo sling operations, the pilot should obtain information on load weights, operating areas and weather as necessary to compute the aircraft performance from Appendix I. For aircraft weight and balance, the pilot need only insure that the center of gravity is within limits prior to lifting the external load and that the load will not exceed gross weight limitations. External loads shift the center of gravity toward the main rotor centroid. The minimum crew for cargo sling operations is one pilot and one flight mechanic in the cabin. The flight mechanic is mandatory since the pilot does not have manual release capability in the cockpit. Cargo sling operations may be subdivided into hookup, transition to forward flight, cruise, and approach phases.

PREFLIGHT

Prior to flight the pilot shall ensure that the following items are inspected:

1. The cargo sling for proper installation and security.

2. Manual release for proper rigging.

3. Cargo hook for security and condition. Insure that at least 3/8-inch clearance is visible between the swaged ball and the latch inside the hook.

4. Prior to the first hookup of the day, check both manual and electrical operation of the hook. A manual release capability is mandatory.

HOOKUP

1. Insure the sling is fully extended so that all cables and lines are clear.

2. Cargo sling master switch — ON.

3. Release mode switch — SLING.

4. Hot mike — CHECK.

5. Flight mechanic direct pilot into position over cargo using hoist voice procedures.

6. Ground personnel discharge static electricity.

7. Crewman monitor hookup and check ground personnel clear of cargo.

NOTE

Ground personnel should enter and depart the hookup area from the starboard side of the helicopter.

8. Crewman report hookup and ready for lift-off.

9. Pilot increase power until the cable is under tension and lift the load vertically.

10. Crewman report cargo clear of deck.

NOTE

Training loads will not exceed 1000 pounds.

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 dependant 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^{o} - 10^{o} bank). Do not exceed a 30^{o} bank.

NOTE

The crewman should monitor the load for oscillation and other unsatisfactory indications. Be ready to manually release the load as directed.

CRUISE

Cargo sling master switch — SAFE (after 1000 feet terrain clearance).

NOTE

Control of oscillating loads is a major factor in external load operations. Light, bulky, and odd shaped objects swing and spin easier than heavy, compact loads. Oscillations are usually initiated by too much airspeed and abrupt control movements. Control swing by reducing airspeed and applying slight lateral cyclic as necessary.

CAUTION

Release uncontrollable loads.

WARNING

Do not fly over populated areas, buildings, or other surface conditions that would be endangered or damaged by inadvertent cargo release. Gusty wind conditions, action of the load, or aircraft equipment malfunction can cause or require unplanned load release.

APPROACH

1. Use a NORMAL APPROACH not exceeding a rate of descent of 300 feet-per-minute on final.

2. Hot mike — ON.

3. Cargo sling master switch — AS REQUIRED.

4. Crewman direct helicopter into position.

5. Crewman report — "CARGO ON DECK."

6. Crewman report — "CARGO RELEASED."

7. Crewman report prior to landing — "SLING STOWED."

CAUTION

AUTO position is not to be used with loads less than 500 pounds. Do not switch to AUTO position until over a safe drop area.

The Radar Altimeter may be unreliable with a load attached.

WATER OPERATIONS

TAXI

Taxiing is accomplished by adding forward cyclic and raising collective. Taxi speed is regulated by cyclic control. High speed taxiing will result in a nose low attitude and build-up of bow wave which will tend to cause the nose of the helicopter to tuck. Sideward taxiing speed will be limited to 2 to 3 knots water speed as the helicopter will assume a high degree of roll. Rearward taxiing should only be performed when absolutely necessary as rearward vision is limited and the possibility of taxiing into a floating or sunken object is greater. Rough water taxiing should be accomplished by utilizing enough collective to keep the aircraft in light contact with the water and using cyclic to resist pitching and rolling tendencies. Rough water taxiing should be kept to a minimum.

CAUTION

- Extreme care should be used when taxiing crosswind or downwind in high winds. Downwind taxiing in high winds can result in an excessively high taxi speed.

- Do not allow the sea to break on helicopter and/or come up the windshield and go into the engine. Very little water with the collective full down will cause the the engine to flame out.

- When taxiing in unfamiliar areas or shallow water, be alert to preclude striking floating surface or subsurface objects that could damage the hull or sponsons. If hull or sponson damage is suspected, an immediate takeoff should be made. Wheels should be lowered prior to landing in water of questionable depth. Actuation of the system while on the water may contaminate the struts and cause system malfunction.

NOTE

Conditions permitting, the cabin door should be open for all approaches to the water and for all water taxiing, take offs, and landings. Interaction between the cabin door assembly and the airframe could cause difficulty in opening, and virtually prevent jettisoning the cabin door if the helicopter should become inverted in the water.

HOVERING

Refer to Basic Maneuvers in this section. Maintaining position over water is difficult and aids must be used, such as debris, seaweed, foam, rotor downwash, and smoke float signals.

VERTICAL TAKEOFF

Refer to Basic Maneuvers in this section.

NO HOVER TAKEOFF

Refer to Basic Maneuvers in this section.

TRANSITION TO FORWARD FLIGHT AND CLIMB

Refer to Basic Maneuvers in this section.

TRAFFIC PATTERN

Refer to Basic Maneuvers in this section.

NORMAL APPROACH

Refer to Basic Maneuvers in this section.

VERTICAL LANDING

Refer to Basic Maneuvers in this section.

NOTE

Altitude and movement, particularly at night, are difficult to see and judge properly, and it is very easy to contact the water prematurely. The radar altimeter should be used to cross check the altitude.

NO HOVER LANDING

Refer to Basic Maneuvers in this section.

WARNING

To avoid tail rotor contact, do not exceed 12 degrees nose up attitude on touchdown.

WAVEOFF

Refer to Basic Maneuvers in this section.

CONFINED AREA PROCEDURES

Refer to Basic Maneuvers in this section.

ROTOR SHUTDOWN AND ENGAGEMENT

While heading into the wind, disengage the ASE and decrease the speed selector to FLIGHT IDLE. Once the droop stops are in, turn the helicopter 180° from the windline. Commence a smooth application of rotor brake, simultaneously applying a right rudder until directional control is lost (15% to 35% Nr). When directional control is lost, apply rotor brake full on. The helicopter will then swing left to the approximate desired shutdown heading. The amount and rate of turn will be influenced by the strength of the wind.

CAUTION

If the rotor brake fails to bring the rotor to a complete stop, immediately release the rotor brake and abort the shutdown or STOPCOCK the speed selector and proceed with Rotor and Engine Shutdown. Wind, sea and aircraft stability conditions will dictate which course of action to follow. Continued rotor movement with the rotor brake ON will result in rotor brake damage or fire.

When engaging the rotor (engine in FLIGHT IDLE), the helicopter will turn to the right as torque is applied to the rotor system. To minimize turning of the helicopter and to gain control as soon as possible, apply full tail rotor pedal prior to releasing the rotor brake. Tail rotor control will start to become effective at approximately 20% Nr. A slight amount of right tail rotor pedal is necessary to keep the tail rotor blades from striking the flapping stops, which is indicated by a medium frequency vibration. Tail rotor control will be effective for slow turns while at FLIGHT IDLE (45% to 50% Nf/Nr). Slowly increase Nf/Nr to 103% and conduct BEFORE TAKEOFF CHECK to resume water operation.

CAUTION

Rotor shutdown and engagement shall not be practiced unless the following conditions are present: Sheltered water, day VFR, winds 10 knots or less, Seas 1 foot or less.

HOIST PROCEDURES

Most SAR hoists will be made from a vessel. Although the procedures below cover vessel hoists, they are adaptable to land and water hoists. The following items shall be briefed prior to commencing a hoist:

1. Point at which hoist will be made.

2. Ship's heading and speed.

3. Helicopter heading for hoist.

4. Type of rescue device to be used (Basket, Sling, Litter) including use or non-use of trail line.

5. Horizontal and/or vertical clearance to be used.

6. Altitude during the hoist.

7. Anticipated unusual circumstances.

8. Expected helo exit direction.

The quality of the crew briefing will determine how efficient and safe the hoist will be. After the crew briefing, the pilot will direct the flight mechanic to accomplish the Rescue Checklist.

RESCUE CHECKLIST

1. Flight mechanic's safety harness — ON AND ADJUSTED.

2. Visor — DOWN.

3. Hoist glove — ON.

4. Hot mike — CHECKED.

5. Request hoist power and permission to open up.

6. Rig rescue device.

7. Report — RESCUE CHECKLIST COMPLETE, READY AFT.

HOIST FROM A VESSEL

Communications should be established with the vessel as early as possible to expedite the rendezvous and hoist. The ship's personnel should be briefed as follows:

1. If possible, have the vessel assume a heading 35° to 45° right of the wind line, underway or maintain steerageway.

2. Have the vessel lower or stow all antennas, booms, rigging, flag staffs, from the hoist area.

3. The rescue device to be utilized will be provided by the helicopter.

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.

4. Discharge static electricity before handling the hoist rig.

5. Have the vessel's personnel disconnect the hoist cable if the rig is to be moved away from the hoist location. Empahsize that the hook is not to be attached to any part of the vessel.

6. Pass additional information as required.

The pilot must evaluate the characteristics and rigging of the vessel, select the safest hoisting location, and establish horizontal and/or vertical clearance criteria. The Rescue Checklist will be completed in level flight or a hover as appropriate. When hoist preparations are completed, move into position while climbing to the desired hoist altitude. The hoist rig should be dipped or grounded before delivering it directly to a survivor.

CAUTION

If any possibility exists of fuel spillage, caution must be used when discharging static electricity.

When ready to commence the hoist, the pilot directs the flight mechanic to "GO ON HOT MIKE." At this time the flight mechanic should go on hot mike, start the hoisting rig down, and commence giving ADVISORY REPORTS. When the pilot directs the flight mechanic to "CONN ME IN" the flight mechanic commences giving COMMANDS to position the helicopter over the hoisting area as previously briefed. The running flow of ADVISORY REPORTS keep the pilot informed as to the progress of the hoist.

WARNING

If at any time during the hoist the flight mechanic loses sight of the vessel, he will immediately inform the pilot. If possible, hoisting should be discontinued and the helicopter maneuvered for another approach.

CAUTION

- Simultaneous operation of the hoist and main landing gear may overload the auxiliary hydraulic system.
- If ICS communications are lost, hoisting should be discontinued if possible until conditions permit a safe continuation of the hoist operation.
- If the hoist does not respond properly to the electrical inputs, the flight mechanic shall immediately notify the pilot. Refer to Rescue Hoist Malfunctions, Section III.

If the sea conditions are rough, it may be desirable to have the pilot lift the helicopter while the flight mechanic simultaneously raises the rig with the hoist. This expedites clearing the rig from the vessel's deck. Once the rig is clear of the deck and obstructions, the pilot must be advised so he can move the helicopter clear of the vessel. When clear of the vessel, the pilot may lower the helicopter to a safe hovering altitude as the hoisting rig is raised. The helicopter should not be transitioned to forward flight until the hoisting rig is inside the cabin, all personnel are seated and strapped in, and all equipment is properly secured.

TRAIL LINE HOIST

The safest hoist is one using a trail (heaving) line. This may be used on any hoist but is most advantageous when the pilot cannot obtain a visual reference or the deck cannot be "plumbed" with the cable. One end of the line should be attached to the hoist hook with a 300-pound weak link. By moving as close as practical to the vessel, the end of the trail line may be passed to personnel on deck so they may guide the rig to their position. The bitter end of the line should be weighted sufficiently and lowered hand-over-hand to the vessel. Additional weights should be used in high winds or where the trail line sails excessively. When on-scene conditions require, the trail line may be tossed to or across the vessel. If possible, the weighted trail line should be tossed across the vessel to avoid personnel injury or damage to the vessel.

WARNING

The flight mechanic must use extreme care when lowering or tossing the weighted trail line to prevent fouling of the helicopter rotor system.

The trail lines are bundled in 100 ± 5-foot links. The trail line will feed out smoothly when lowered and should not be uncoiled before use. Once the weighted end is on deck, the flight mechanic should continue to pay out line while the pilot moves laterally to obtain visual contact with the vessel.

WARNING

Do not attach the trail line to the hoist hook/rig until the rig is ready to go out the door. Attaching the trail line prior to this could allow the hoist rig to be jerked out of the cabin door from behind the flight mechanic if the line should foul in the vessel's standing rigging.

SALVAGE PUMP DELIVERY

Salvage pumps may also be delivered to a vessel by one of two trail line methods. The DIRECT METHOD for pump delivery is done exactly like the trail line hoist described above. The 300 pound weak link should be used. If environmental conditions or mast and rigging obstructions do not permit direct delivery of the salvage pump, the INDIRECT METHOD should be utilized. With this method of delivery the weighted end of the trail line is lowered to the vessel. The helicopter is moved left and a low hover is established clear of the vessel. After the end of the trail line (without a weak link) is attached to the salvage pump, the pump is pushed into the water. The vessel's crew must pull the pump alongside and lift it aboard.

NOTE

A salvage pump weighs approximately 110 pounds. The indirect method of delivery should only be used when sufficient personnel are available on the vessel to pull the pump alongside and lift it aboard.

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. 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 that will be utilized during a rescue hoist:

COMMAND	MEANING
GO ON HOT MIKE (given by pilot)	FM begins ADVISORY REPORTS
CONN ME IN (given by pilot)	FM begins giving COMMANDS to position helo over the hoist site.
FORWARD____	Move helo forward-____feet.
BACK____	Move helo back ____feet.
LEFT____	Move helo left____feet.
RIGHT____	Move helo right____feet.
UP	Increase helo altitude.
DOWN	Decrease helo altitude.
HOLD	Hold the helo is a position relative to the target.
EASY____. (LEFT, RIGHT, ETC.)	Move helo very slowly in direction indicated.
FORWARD AND RIGHT____	Combination COMMAND.
CEASE COMMANDS (given by pilot)	Cease giving COMMANDS but continue ADVISORY REPORTS.
SHEAR! SHEAR! SHEAR!	FM and CP (if aboard) activate their respective shear switch.

ADVISORY REPORT	MEANING
(Basket hoist example)	
ON HOT MIKE, HAVE TARGET IN SIGHT, BASKET GOING OUT THE DOOR	FM is beginning the hoist.
BASKET BELOW AIRCRAFT	Basket is below the hull.

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 any 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 LEFT	Basket is well clear of the deck and not in danger of fouling in the rigging. Move left so the pilot can regain visual contact (if lost) and clear the helo away from the vessel. Continue COMMANDS.
BASKET OUTSIDE DOOR	Self-explanatory.
BASKET IN CABIN, GOING OFF HOT MIKE	Basket is in the cabin and being disconnected from the hoist. FM is going off hot mike.
CABIN SECURED, READY FOR FORWARD FLIGHT	All rescue gear has been stowed; all passengers and crewmen are strapped in and ready for forward flight.
BASKET (CABLE) FOULED	Basket (cable) has become fouled on the vessel.
BASKET (CABLE) FREE	Basket (cable) no longer fouled on the vessel.
LOST TARGET (given by pilot)	Pilot has lost sight of the hoisting reference.
TARGET (given by pilot)	Pilot has regained sight of the hoisting reference.

If a trail line hoist is performed, the following additional ADVISORY REPORTS shall be utilized.

ADVISORY REPORT	MEANING
TRAIL LINE GOING OUT THE DOOR	FM is beginning to deliver a 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, and 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 line still in the cabin.
WEAK LINK CONNECTED TO HOIST HOOK	Basket is ready to go out, and FM is making last-minute connection of the weak link to hoist hook.
BASKET CLEAR OF VESSEL, TRAIL LINE STILL ON DECK, CLEAR TO MOVE LEFT	Self-explanatory
BASKET IN CABIN, RETRIEVING TRAIL LINE	Self-explanatory
TRAIL LINE IN CABIN, GOING OFF HOT MIKE	Basket and trail line are in the cabin. FM is going off hot mike to secure passenger and equipment.

RESCUE PLATFORM RECOVERY PROCEDURES

The Rescue Platform provides the pilot with a particularly effective device to recover personnel or objects from the water or small boats when a water landing can be made. The platform is designed to permit the flight mechanic to work at the outboard side of the right sponson to assist mobile survivors or to rescue immobile survivors with a minimum of time and maneuvering of the helicopter. A platform recovery is usually a safer method of rescue than a hoist when conditions are favorable. Platform recoveries are divided into calm water and rough water recoveries depending upon the sea conditions. Each platform recovery is commenced by making a sea evaluation to determine the direction of the primary and secondary swell systems, the wind-driven sea, and the wind. With this information and thorough observation of the recovery target, the pilot briefs the crew for the recovery. An approach is made into the wind terminating in a hover with the recovery target in the approximate 1 to 2 o'clock position outside the rotor wash pattern. This position affords the pilot and flight mechanic the best view of the target. Once in a stable hover, the pilot will direct the flight mechanic to complete the Rescue Checklist.

CALM WATER RECOVERY

The rescue platform will normally be used to effect the rescue of survivors from sheltered water or smooth, calm, open sea conditions. The flight mechanic will lower the platform and go on HOT MIKE at the direction of the pilot. Immediately after touchdown, the flight mechanic should position himself on the platform with the safety harness adjusted to permit complete freedom of movement on the platform. Normally the flight mechanic will use the boat hook to help retrieve the survivors.

WARNING

To prevent rotor blade contact, the boat hook must not be raised above the shoulders.

Water touchdown should be accomplished with the survivor in the approximate 2 o'clock position just outboard of the rotor wash. When the pilot desires to receive COMMANDS from the flight mechanic, he will direct him to "CONN ME IN." The helicopter should be maneuvered to bring the survivor alongside the rescue platform. The closure rate should be slow enough to ensure that the survivor is not endangered. The helicopter should be brought to a stop in the water when the survivor is alongside the platform. Forward flight should not be commenced until the cabin is secured.

CAUTION

- Extreme care must be used in approaching parachutes in the water. When recovering an immoblie survivor attached to a parachute, land with the parachute well outside of the rotor wash and have the flight mechanic use a raft or swim to the survivor and free him of the parachute.

- Do not air taxi close to a small raft as the downwash could cause the raft to become airborne and contact the rotor blades. Land with the raft well outside the rotor wash and use minimum collective during recovery.

- When approaching a small boat, the pilot must be ready to take corrective action if persons in the boat stand up, raise oars, or in any way jeopardize themselves or the helicopter. A rotor shutdown may be warranted.

ROUGH WATER RECOVERY

If the sea conditions are such that it is inadvisable to land the helicopter into the wind due to possible tail rotor damage, or it is necessary to keep the time on the water to a minimum, a rough water recovery should be accomplished. The flight mechanic will lower the platform and go on HOT MIKE at the direction of the pilot. Turn the helicopter to place the major swell on the port bow to the port beam, holding the survivor in the approximate 1 o'clock position well outside the rotor wash. When the pilot desires to receive COMMANDS from the flight mechanic, he will direct him to "CONN ME IN." While maintaining the desired position, evaluate the sea and wind conditions, close on the survivor, and when sea conditions permit, land with the survivor inside of the rotor disc. During this phase, the copilot must alertly scan the sea to port.

CAUTION

Do not allow the swells to break over the bow of the helicopter, as an engine flameout could occur.

NOTE

Certain wind/sea conditions may dictate that the major swell system be placed off the starboard bow to starboard beam in order to avoid hovering downwind. Example: A north wind combined with a major swell system from the east.

When the survivor is on the platform, establish a safe hover and, as the helicopter clears the water, turn into the wind. Forward flight should not be commenced until the cabin is secured.

RESCUE PLATFORM RECOVERY PHRASEOLOGY

The pilot and flight mechanic must perform as a team to make a safe platform 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 with COMMANDS are in feet. ADVISORY REPORTS keep the pilot informed of everything else that is occuring during the recovery. An ADVISORY REPORT is information, not a command.

The following is a list of COMMANDS and ADVISORY REPORTS that will be utilized during a rescue platform recovery:

COMMAND	MEANING
FORWARD____	Move helo forward - ____ feet.
BACK____	Move helo back____feet.
RIGHT____	Move helo right____feet.
LEFT____	Move helo left____feet.
EASY____ (RIGHT, LEFT, ETC)	Move helo very slowly in direction indicated.
FORWARD and RIGHT	Combination COMMAND.
HOLD	Hold the helo in this exact position.
UP	Immediately establish a hover. Danger to the survivor or helo exists. May be given by the copilot.
CONN ME IN	FM begins giving COMMANDS to position survivor alongside the platform.

ADVISORY REPORTS	MEANING
RESCUE CHECKLIST COMPLETE, READY AFT.	Self-explanatory.
MAN APPROACHING PLATFORM	The survivor is close to the platform and closing.
MAN AT PLATFORM	Self-explanatory.
MAN ON PLATFORM, CLEAR TO HOVER.	Self-explanatory.
MAN IN CABIN, GOING OFF HOT MIKE	FM is going off hot mike to assist survivor and secure the cabin.
CABIN SECURED, READY FOR FORWARD FLIGHT	All rescue gear has been stowed; all passengers and crewmen are strapped in and ready for forward flight.

PICK-UP INTO HOVER, MAN DRIFTING	This is very important. If the survivor drifts into an area that would endanger him, such as too far aft, immediately lift into a hover. This ADVISORY REPORT informs the pilot of a potentially serious situation. "UP" is a COMMAND and differs in that it represents an immediate emergency.

TOWING

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 the 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

The Air Operations Manual (COMDT-INST M3710.1) outlines the circumstances under which formation flying may be conducted. When flying formation it is imperative that the flight leader fly as smoothly as possible with a minimum of attitude and power changes. The flight leader must allow his wingman a minimum of 10% torque for maneuvering. Communication between units of the formation is recommended. The normal distance between helicopters is one rotor disc diameter with a 10 foot set-up.

BASIC FORMATIONS

Column

The wingman flies directly astern of the flight leader.

Parade

The wingman flies on a bearing of 45° left or right of the astern position of the flight leader. This is a show or flyover formation. The flight leader will be advised when maneuvering from this position.

Tactical

The wingman flies on a bearing of 35° left or right of the astern position of the flight leader, and is free to maneuver from side to side as he desires.

Cross Country Cruise

The wingman flies on a bearing of 35° left or right of the astern position of the flight leader at a distance of three to four rotor disc diameters.

MANEUVERING

When the formation is maneuvering, the flight leader should advise the wingman of the expected evolution.

Break-up

Formations may need to break up for landing separation or other purposes. When breaking left the formation should be formed in parade right or tactical right. The flight leader will bank his helicopter smartly to commence the break-up, 3 seconds later the next helicopter will break, etc.

Join-Up

Join-up may be accomplished from any angle within 45° left or right of the astern position and terminates when the desired formation position is attained. As the helicopters close in range, the wingman must avoid a fast closure rate.

SHIPBOARD-HELICOPTER OPERATIONS

Shipboard-helicopter operations require a great deal of coordination between the crew of the helicopter and the ship's personnel. Pilot's contemplating ship-helicopter operations should refer to the Shipboard-Helicopter Operational Procedures Manual (COMDT-INST M3710.2). The paragraphs below cover flight procedures peculiar to the shipboard operations.

RECOVERY PROCEDURES

Prior to commencing recovery, the pilot should satisfy himself that flight deck motion is acceptable for landing.

TRAFFIC PATTERN

The normal traffic pattern will be flown at 500 feet. Prior to reaching the abeam position, complete the PRELANDING CHECK.

APPROACH

When landing clearance has been granted, a normal approach to a hover (approximately two rotor diameters and altitude of 50 feet astern of the vessel) may be commenced. The pilot will vary the approach to align the helicopter with the extended center line of the vessel, establish a closure rate and descent path that will allow positive control of the relative motion prior to reaching the Hover position. During the straight in portion of the approach, signals will be available from the LSO to assist the pilot in the approach. LSO signals are advisory except the WAVE OFF, which is mandatory. Maintain sight of the LSO at all times. If sight of the LSO is lost, a WAVE OFF IS MANDATORY. Arrive at or near the stern of the vessel with sufficient altitude to preclude unintentional deck contact. Continue the approach to a hover within the maneuvering zone. Make a final evaluation of deck motion and other existing conditions to determine if a landing should be attempted.

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, HCO, or LSO. There is no set pattern for a waveoff: rather the pilot is expected to maneuver the aircraft to a safe flight condition and position to resolve the difficulty before commencing another approach.

HOVER

Position the helicopter over the optimum touchdown point with the assistance provided by signals from the LSO. The pilot and LSO must be aware of the importance of optimum deck placement on landing to permit a rapid, coordinated tiedown.

LANDING

From a hover over the touchdown point, the pilot should note the vessel's movement cycle and attempt to land at the most favorable moment. Lower the collective to establish a positive rate of descent. A positive touchdown should be made to prevent multiple contacts which can result in excessive stresses on the landing gear. As deck contact is made, continue lowering the collective to the full down position. After reaching minimum collective pitch, center the cyclic. No further control inputs should be made. Cyclic movement on deck has no effect on aircraft stability. In the event of a landing distant from the optimum touchdown point, a secure tiedown may not be possible. The helicopter should be moved to a more suitable position.

NOTE

On vessels with a grid installed, landing with one or more main wheels outside the grid will normally require repositioning the aircraft in order to effect a tiedown.

LANDING WITHOUT THE GRID INSTALLED

The procedures for approach and landing without the grid installed remain the same as for operations with the grid except that the landing will be accomplished with the parking brake SET.

NIGHT RECOVERY.

Depth perception is seriously impaired and closure rate is more difficult to determine at night. Night pattern and approach procedures are the same as for daylight, however, if positive visual contact is not made with the surface by 140 feet, a BEEP should be used. Once established in a stable hover, air taxi to the ship.

NOTE

Prior to approaching the ship, secure the nose light and the anti-collision lights. Hover lights should be used if they are tilted downward sufficiently to preclude blinding the LSO.

Due to the difficulty in discerning deck motion at night, the helicopter should cross the stern of the vessel at a slightly higher altitude than during daylight to insure adequate tail wheel clearance. Once over the deck, the pilot should closely monitor the signals from the LSO as these will usually be his only source of information on position, attitude, and altitude.

NOTE

The pilot should consciously avoid trying to fly formation on the superstructure.

PRIMARY TIEDOWNS

When the aircraft is firmly on deck, give the "attach tiedowns" signal, if they are to be used. After the pilot signals to accept primary tiedowns the aircraft is considered to be attached to the deck unless the LSO gives a waveoff or hover signal in reply. FURTHER ATTEMPTS AT FLIGHT ARE PROHIBITED. Subsequent to signaling for the tiedowns, should the helicopter become unstable to the point where a mishap is imminent, the appropriate action for the pilot is to stopcock the engine, apply the rotor brake, and turn the battery switch off.

REMAINING ON DECK WITHOUT SHUTDOWN

Should the vessel change course while the helicopter is on deck, the pilot must disengage the ASE to avoid full throw rudder pedal deflection induced by the ASE heading retention feature.

WARNING

The use of secondary tiedowns with the rotor engaged is prohibited due to the danger of inducting ground resonance.

SHUTDOWN

The LSO will provide droop stop signals. Under conditions of extreme wind, excessive flight deck motion, or with faulty droop stops, the flight deck will be cleared of all personnel. Normal Rotor and Engine Shutdown procedures apply.

ENGINE START AND ROTOR ENGAGEMENT NORMAL PROCEDURES APPLY

SHIPBOARD TAKEOFF

When ready for takeoff, signal the LSO to remove the primary tiedown straps. Observe all straps removed. Execute a vertical takeoff, ensuring that the nose of the aircraft does not cross the forward peripheral line, and when sufficient altitude is attained, move laterally clear of the ship, left or right, into a position where a normal or instrument takeoff, as appropriate, can be made.

NIGHT TAKEOFF

The night takeoff will be the same as the day takeoff until the aircraft is laterally clear of the ship. From that point, an instrument takeoff is required.

EMERGENCY PROCEDURES TRAINING

The procedures set forth in Section III of the Flight Manual should be studied and used for all actual emergencies. The procedures described in this section are for training only. They ensure that correct, non-interfering habit patterns are learned by the pilot and eliminate confusion between pilots while simulating emergencies. Guidelines are established for each procedure specifying minimum pilot qualifications. A Pilot Under Instruction (PUI) in this section may be a Student Pilot, Copilot, First Pilot, or an Aircraft Commander. An Aircraft Commander acting as an instructor pilot or a syllabus training flight may perform all or part of the PUI procedures in order to demonstrate a maneuver.

In specified maneuvers the Safety Pilot (SP) induces the simulated emergency and restores aircraft systems to normal configuration. TRADIV ONLY evolutions are not contained in this manual. The following safety criteria apply when practicing simulated emergencies:

1. Do not practice dual emergencies. Do not practice ASE OFF with any simulated emergency.

2. Operating conditions should be ideal. Operations terminating in a landing or hover should be conducted on or to an area clear of obstacles with crash equipment available.

3. Simulated emergencies should be realistically accomplished.

4. The following voice report is required any time engine governing is changed from speed selector to emergency throttle or vice versa: "I have the aircraft on emergency throttle (or speed selector)." Also, when passing control of the aircraft during any operations involving the use of

emergency throttle, the method of engine governing will be included in the required voice procedure.

5. Do not practice autorotations immediately following emergency throttle work. It is extremely easy for the Pilot Under Instruction to mistakenly rotate the emergency throttle full on instead of the speed selector when the two emergencies are practiced in that order.

SIMULATED COLD HANG-UP

Objectives

To develop proficiency in recognizing cold hang-up symptoms and in metering additional fuel with emergency throttle during a cold hang-up.

Discussion

Refer to Chapter VII, page 7-2, paragraph 5, entitled Cold Hang-up.

Guidelines

1. Simulated cold hang-ups may be practiced by a designated Aircraft Commander (AC) without another pilot in the cockpit. In that event he would perform both the duties of the pilot under instruction (PUI) and the Safety Pilot (SP) as listed in the procedures.

2. Simulated cold hang-ups may be induced by a Safety Pilot (SP) who is a designated Aircraft Commander. The PUI may be a Student Pilot, Copilot, First Pilot, or another Aircraft Commander.

Procedures

SP — Open P_3 valve prior to engine start.

PUI — Start engine. Following the light-off, Ng acceleration will slow down between 30 and 50%, and T_5 will remain low, indicating a cold hang-up.

Advance emergency throttle slowly to increase Ng to ground idle.

Release starter at 45% Ng.

SP — Close P_3 valve.

PUI — Close emergency throttle. Observe ground idle Ng.

SP — Check emergency throttle closed.

Simulated emergency terminated.

SIMULATED ENGINE COMPARTMENT FIRE ON THE GROUND

Objectives

To develop rapid and correct responses towards accomplishing the engine compartment fire on the ground emergency procedures.

Discussion

To achieve maximum benefit an engine compartment fire must be simulated at a point where the PUI can actually move the speed selector and T-handle. This emergency is best simulated immediately before or after parking, but prior to engine shutdown.

Guidelines

The simulated engine compartment fire may be induced during ground operations by a Safety Pilot (SP) who is a designated Aircraft Commander. The PUI may be a Student Pilot, Copilot, First Pilot, or another Aircraft Commander.

Procedures

SP — Announce on ICS "Simulated fire warning light on."

PUI — Stop Aircraft.
Speed selector — STOPCOCK.
Battery switch — CHECKED ON.
T-Handle — PULL TO FIRE EXTINGUISHER ARMED POSITION.
Announce — Words to the effect: "There is no indication of an engine compartment fire. If a fire was indicated I would discharge the fire extinguisher, turn the battery off, stop the rotor, set the parking brake, exit and fight the fire."

NOTE

The engine cowling fire shutter doors must be reset prior to the next engine start.

Simulated emergency terminated.

EMERGENCY THROTTLE OPERATION

Objective

To develop proficiency in maintaining rotor RPM while governing the engine with emergency throttle.

Discussion

Flight utilizing emergency throttle requires the pilot to perform the governing function normally accomplished by the automatic fuel control. Coordination of the emergency throttle (power) and collective pitch (rotor loading) is necessary to maintain desired rotor RPM and torque. Both emergency throttle and collective pitch are variable factors: A change of one will require a corresponding change of the other with respect to both magnitude and rate of change. When changing power settings, the emergency throttle and the collective pitch must be changed simultaneously to maintain rotor RPM. When a power change is not required, rotor RPM can be maintained with small adjustments of the collective.

Guidelines

1. Practice emergency throttle operations may be conducted by a designated Aircraft Commander (AC) without another pilot in the cockpit.

2. Practice emergency throttle operation may be conducted by a Student Pilot, Copilot, or First Pilot (PUI) with a designated Aircraft Commander as the Safety Pilot (SP).

Procedures

AC or PUI — Assume control of aircraft.
Adjust speed selector to 96% Nf/Nr.
Adjust emergency throttle to 100% Nf/Nr.
Maintain 100% Nf/Nr during all maneuvers.
Close emergency throttle.
Adjust speed selector to desired Nf/Nr.

Simulated emergency terminated.

TAIL ROTOR CONTROL MALFUNCTION

Objective

To acquaint pilots with aircraft response experienced in tail rotor control malfunctions in which the tail rotor pitch becomes fixed at a constant anti-torque setting (tail rotor thrust); to develop skill in the analysis and evaluation of power, airspeed, and yaw relationships at altitude; and, to develop skill in successfully landing the aircraft regardless of the anti-torque setting available.

Discussion

Tail rotor control malfunctions are situations in which the tail rotor anti-torque thrust is fixed or limited to only minor change.

The tail rotor malfunction discussed in this procedure is one in which pilot control of the tail rotor is completely lost and the tail rotor pitch is controlled by the counterweights on the tail rotor hub assembly. This will result in a pitch setting approximating that required for a normal hover, 70% to 80% torque. This anti-torque thrust setting will allow for an approximate normal approach to a running landing or a hover. The approach may be executed by reducing power to simultaneously descend and decelerate to the back side of the power curve. This method will result in a left yaw whenever torque is set below the fixed anti-torque. As airspeed is reduced on the backside of the power curve, an increase in torque will reduce the amount of left yaw. The rate of descent in this condition will be at a rate determined by the difference between power required and power applied. Minor heading changes prior to touchdown can be affected by minor changes in torque. Increases in power will cause right yaw while decreases in power will cause left yaw. The termination—running landing or hover—is dependent upon the tail rotor counterweight setting and the aircraft performance, which is a function of the ambient conditions and gross weight.

Guidelines

1. A simulated tail rotor control malfunction may be induced by a Safety Pilot (SP) who is a designated Aircraft Commander. The Pilot Under Instruction (PUI) may be a Student Pilot, Copilot, First Pilot, or another Aircraft Commander.

2. Entry into the simulated tail rotor control malfunction should be made from 1000 feet AGL.

3. This maneuver will be terminated at an altitude of not less than 10 feet AGL in a hover or air taxi.

Procedures

SP —Assume control of aircraft.
Establish level flight at 55 knots.
Remove feet from contact with tail rotor pedals.

NOTE

Feet are off the pedals through out the entire evolution. Positive control may be regained any time if necessary.

PUI — Disengage yaw channel.
Assume control of aircraft, with feet on deck.

SP —Turn off AUX Servo. Aircraft will probably yaw left, but may remain steady or yaw slightly right, dependent upon power applied and tail rotor counterweight setting.
Keep feet off pedals unless required to restore a safe yaw angle.
Turn AUX Servo on.

PUI — Conduct a flight check at altitude, observing effect of various power settings and airspeeds on yaw angle.
Attempt to determine most favorable combination for touchdown.
Establish a long straight in approach.

CAUTION

During this evaluation, the following yaw angle limitations should be observed to prevent structural damage.

15° at 85 knots
30° at 55 knots
90° at 25 knots

NOTE

On short final, as the aircraft decelerates, some unusual left yaw conditions may be encountered due to low power applied and loss of streamline effect. The amount of yaw is an indication of the power — air speed combination for touchdown. The greater the yaw angle, the higher the power (lower the airspeed).

Approaching the touchdown point, apply only that power required to arrive at a zero yaw angle. Maintain a proper attitude for termination—running landing or hover. If the nose goes to a right yaw condition prior to termination, increase airspeed with cyclic to allow a reduction of power which will bring the nose back to the left. Readjust airspeed/power combination for zero yaw angle.
Plan for a running landing, but it is not uncommon for the aircraft to terminate in a hover.

SP —Prior to simulated running landing, or after establishing a hover, take control of aircraft, feet on pedals.

PUI — Re-engage yaw channel.

Simulated emergency terminated.

AUXILIARY SERVO OFF OPERATION

Objectives

To expose pilots to the aircraft responses experienced in auxiliary servo off operations. To demonstrate the interface between electrical/electronic ASE components and the auxiliary servo and to develop proficiency in aircraft control.

Discussion

While flying with the auxiliary servo system secured, increased friction will be felt in the cyclic and the collective. Pedal forces are less than normal due to the pedal damper being off. Select an airspeed which keeps the aircraft in balanced flight with a minimum of tail rotor pedal pressure. The pilot should observe that the ASE continues to operate normally electrically but is ineffective because it cannot make the required mechanical inputs at the auxiliary servo.

Guidelines

1. Practice auxiliary servo off operations may be conducted by a Student Pilot, Copilot, or First Pilot (PUI) with a designated Aircraft Commander acting as a Safety Pilot (SP).

2. Practice auxiliary servo off operations may be conducted by a designated Aircraft Commander without another pilot in the cockpit.

Procedure

PUI — Take control of aircraft.

SP —Turn auxiliary servo off.

PUI — Perform normal maneuvers auxiliary off.

SP —Turn auxilary servo on.

Simulated emergency terminated.

AUTOROTATIONS, POWER RECOVERY, VISUAL

Objectives

To develop the correct habit patterns for dealing with an engine failure during flight or an engine power decrease condition.

To develop proficiency in recognizing and applying the proper aircraft maneuvering required to successfully execute precision autorotations.

Discussion

The autorotation is an emergency procedure rather than a normal flight maneuver. The practice of power recovery visual autorotations should be conducted in such a manner as to reinforce the emergency procedures for an engine failure during flight or an engine power decrease condition. Entry into the autorotation should be followed by a rapid analysis of the engine instruments so that maximum time would be available to recover with emergency throttle if the engine is capable of producing power. During the analysis of engine instruments, decide and announce if emergency throttle can be used.

A further objective of practice power recovery autorotations is recognizing what is required, and applying the proper techniques, to terminate in a selected landing area. To meet this objective, power recovery visual autorotations should be practiced where it is necessary to use the variables of airspeed, sideslip angle, and ground track to terminate at the selected landing area. Continuous practice of power recovery autorotations to spot will result in a working knowledge of how to apply these variables, and will assure than an engine failure during flight will be followed by a successful autorotation.

For disucssion and practical application purposes, visual autorotations have been grouped into three speed ranges: 25 to 45 knots or steep angle autorotations, 45 to 65 knots or minimum rate of descent autorotations, and 65 to 82 knots or maximum glide autorotations. Throughout the procedural discussion of these autorotations, notes and cautions have been provided which warrant particular attention, as they refer to hazards and flight regimes to be avoided.

Guidelines

1. Power recovery visual autorotations may be practiced by a designated Aircraft Commander without another pilot in the cockpit, or by a Student Pilot, Copilot, or First Pilot with a Safety Pilot who is a designated Aircraft Commander.

2. Unannounced entries may be induced by a Safety Pilot at any altitude above 1000 feet AGL within range of a recovery area.

3. Preplanned entries may be made at any altitude above 500 feet AGL within range of a recovery area.

4. Night practice power recovery visual autorotations may be conducted only to a lighted airport with crash equipment immediately available.

CAUTION

Due to the lack of visual cues at night, practice autorotations should be accomplished with added caution.

5. Day practice power recovery visual autorotations to land shall terminate at 1000 feet AGL with a no-flare recovery if crash equipment is not immediately available.

6. Day practice power recovery visual autorotations to water shall terminate at 1000 feet AGL with a no-flare recovery if a crash boat or another helicopter is not immediately available.

7. Practice power recovery visual autorotations will not be conducted at gross weights above 7600 pounds.

8. Power off autorotations will be practiced only under the direct supervision of TRADIV Instructor Pilots.

Procedure

AC or PUI — Preplanned autorotations may be entered from any position in accordance with the guidelines listed above. The normal method of entry is to lower the collective with a positive steady movement to minimum and then split the needles (Nf/Nr) by decreasing the speed selector to the AUTO DETENT. After establishing the autorotative descent toward the intended landing area, scan the dual tachometer to verify a needle split, and Ng/T5 to determine if the engine is still running. Make a voice report of the engine status to the safety pilot.

SP —Unannounced entries may be made in accordance with the above guidelines. The method will be to retard the speed selector to the AUTO DETENT.

AC or PUI — Fly aircraft to the selected landing area using variables of airspeed, ground track, and sideslip angle.

CAUTION

Rotor RPM must be closely monitored when maneuvering during autorotations to prevent a rotor overspeed or underspeed condition.

WARNING

During any practice autorotation, if not satisfied with the progress of the maneuver, the surface conditions, or any adverse conditions, execute a WAVE off. Failure to execute a wave off when any one of the above conditions is initially perceived may place the aircraft in a situation where a successful recovery is unlikely.

Steep Angle Autorotation (25 to 45 knots)

Use the slow airspeed range, side slip, and "S" turns whenever the glide must be shortened to reach an area that would be overshot using higher airspeeds.

1. Enter the autorotation and evaluate the requirements for terminating in a selected area.

2. Adjust pitch attitude for an airspeed that results in the required glide angle. S-turns and side slips may also be used to lose altitude to avoid very low airspeeds where a steeper descent angle is required.

CAUTION

Airspeeds in the lower end of this range will be accompanied by increasing rates of descent and should be avoided. The low airspeed will not require much flare to establish a suitable ground speed for termination, and the rate of descent will not be significantly reduced by this mild flare. Airspeeds below 25 knots, or below translational lift, will cause excessive rates of descent, which may be beyond the capability of the rotor system to adequately cushion the landing with collective application.

3. Adjust collective to maintain 100% Nr.

CAUTION

Rapid changes in pitch attitude will result in rapid changes in Nr requiring collective adjustments to maintain Nr at 100%.

4. Between 200 feet and 70 feet, flare as required to slow the aircraft to the desired ground speed for terminating the autorotation.

5. Start advancing the speed selector at 200 feet AGL, to be at full increase not later than 150 feet AGL.

WARNING

Late application of the speed selector to full increase may not allow sufficient time for the engine to spool up. If the collective is being raised during the spool up of the engine, Nf/Nr will decay under the increasing rotor blade pitch, making power recovery in a hover unlikely. The inadvertent ground contact and subsequent unloading of the rotor blades will be followed by a strong yaw right as the engine drives Nf from its low point to the setting called for by the speed selector.

6. Lower the nose to the proper attitude for the actual or simulated terrain (0° - 3° nose up for prepared surfaces, 5° nose up for unprepared surfaces and water).

7. Apply collective to stop the descent no lower than 10 feet AGL, at a ground speed suitable for the actual or simulated terrain.

CAUTION

Under calm wind conditions, it may be necessary to remain in translational lift to insure that enough power is available to terminate the maneuver no lower than 10 feet AGL.

8. Readjust speed selector to 100% Nf/Nr.

Simulated emergency terminated.

Minimum Rate of Descent Autorotation (45 to 65 knots)

The minimum rate of descent autorotation should be used whenever arriving at a particular area is not of prime importance, as when over large bodies of water.

1. Enter the autorotation and evaluate the requirements for terminating in a selected area.

2. Adjust the pitch attitude for an airspeed that results in the required glide angle.

3. Adjust collective to maintain 100% Nr.

4. At approximately 150 to 100 feet AGL, initiate a flare to slow to the desired ground speed.

NOTE

The altitude for beginning the flare, the amount and rate of flare, vary with airspeed, weight, and density altitude. The effect of the flare is determined visually and the rate and amount of flare may be adjusted so that ground speed, attitude, and rate of sink are all under control when descending through approximately 50 feet.

5. Advance the speed selector to full increase not later than reaching the top of the flare, regardless of the amount of flare used and the altitude at which the flare was commenced.

6. Lower the nose to the proper attitude for the actual or simulated terrain (0° - 3° nose up for prepared surfaces, 5° nose up for unprepared surfaces or water).

7. Apply collective to stop the descent no lower than 10 feet AGL at a ground speed suitable for the actual or simulated terrain.

CAUTION

Under calm wind conditions, it may be necessary to remain in translational lift to insure that enough power is available to terminate the maneuver no lower than 10 feet AGL.

8. Readjust the speed selector to 100% Nf/Nr.

Simulated emergency terminated.

Maximum Glide Autorotation (65 to 82 knots)

The maximum glide autorotation should be used whenever the glide must be extended to reach a selected area.

1. Enter the autorotation and evaluate the requirements for terminating in the selected area.

2. Adjust the pitch attitude for an airspeed that results in the required glide angle.

NOTE

- If airspeed was low when entering the autorotation, pushing the nose over to gain airspeed will give the appearance initially of steepening rather than extending it. Not until airspeed is stabilized will the result of the increased airspeed and the need for any further adjustments be apparent.

- Increasing airspeed above 82 knots will begin to diminish the distance covered over the ground. If additional glide extension is necessary, the only remaining variable is rotor RPM. Reducing rotor RPM will be effective in extending the glide only down to approximately 95% Nr.

3. At approximately 120 to 90 feet AGL, flare as required to reduce ground speed to a rate acceptable for touchdown.

CAUTION

Rotor RPM will build in the flare and collective loading will be necessary to prevent overspeeding of the rotor system.

NOTE

Flaring too rapidly may cause a climb in the flare which could result in a higher than desirable exit altitude.

4. Advance the speed selector to full increase not later than reaching the top of the flare regardless of the amount of flare and the altitude at which the flare was commenced.

5. Lower the nose to the proper attitude for the actual or simulated terrain (0^{o} - 3^{o} nose up for prepared surfaces, 5^{o} nose up for unprepared surfaces or water).

6. Apply collective to stop the descent no lower than 10 feet AGL at a ground speed suitable for the actual or simulated terrain.

CAUTION

Under calm wind conditions, it may be necessary to remain in translational lift to insure that enough power is available to terminate the maneuver no lower than 10 feet AGL.

7. Readjust the speed selector to 100% Nf/Nr.

Simulated emergency terminated.

AUTOROTATIONS, POWER-RECOVERY, HOODED

Objectives

To develop the correct habit patterns for dealing with an engine failure during flight in instrument conditions.

Discussion

The autorotation is an emergency procedure rather than a normal flight maneuver. The practice of power-recovery hooded autorotations should be conducted in such a manner as to reinforce the emergency procedures for an engine failure in flight in instrument conditions. Entry into the autorotation should be followed by a rapid analysis of the engine instruments so that maximum time will be available to recover with emergency throttle if the engine is capable of producing power. During the analysis of engine instruments, decide and announce if emergency throttle can be used.

Guidelines

1. Power-recovery hooded autorotations may be practiced by a PUI who is a Student Pilot, Copilot, First Pilot, or an Aircraft Commander, under the supervision of a Safety Pilot (SP) who is a designated Aircraft Commander.

2 Unannounced entries to power-recovery hooded autorotations may be induced by the SP at any altitude above 1000 feet AGL within the range of a recovery area.

3. Preplanned power-recovery hooded autorotations may be entered at any altitude above 500 feet AGL within range of the planned recovery area.

4. Day practice power recovery hooded autorotations to land shall terminate at 1000 feet AGL with a no-flare recovery if crash equipment is not immediately available.

5. Day practice power recovery hooded autorotations to water shall terminate at 1000 feet AGL with a no-flare recovery if a crash boat or another helicopter is not immediately available.

6. Night practice power-recovery hooded autorotations are prohibited.

7. Practice power-recovery hooded autorotations will not be conducted at gross weights above 7600 pounds.

8. Power-off hooded autorotations will be practiced only under the direct supervision of TRADIV Instructor Pilots.

Procedure

SP —Fly aircraft to vicinity of recovery area.

PUI — Assume control of the aircraft.

Preplanned autorotations may be entered from any position in accordance with the guidelines. The normal method of entry is to lower the collective with a positive steady movement to minimum and then split the needles (Nf/Nr) by decreasing the speed selector to the AUTO DETENT. After establishing an autorotative descent at 55 knots, 100% Nr and a turn toward the wind line, scan the dual tachometer to verify the needle split, and Ng/T_5 to determine if the engine is still running. Make a voice report of the engine status to the Safety Pilot.

Place feet on the deck.

SP —Unannounced entries may be made in accordance with the guidelines. The method will be to retard the speed selector to the AUTO DETENT.

Ensure that the autorotation will terminate in the recovery area. Adjust the heading if necessary.

PUI — Adjust collective to maintain 100% Nr.

At 140 feet on the RADALT, flare the nose at a rate so as to arrive at 20° nose up at 70 to 90 feet.

Advance the speed selector to full increase not later than reaching the top of the flare.

Maintain 20° nose up until the airspeed has decreased to the desired exit speed (20 knots for calm winds, add one knot for each two knots of surface winds).

Once the desired exit speed is reached, exit the flare to a 5° nose up touchdown attitude.

SP —Take control of the helicopter with sufficient altitude to stop the descent no lower than 10 feet AGL.

CAUTION

Under calm wind conditions, it may be necessary to remain in translational lift to insure that enough power is available to terminate the maneuver no lower than 10 feet AGL.

Readjust the speed selector to 100% Nf/Nr.

Simulated emergency terminated.

EMERGENCY THROTTLE RECOVERY FROM POWER DECREASE CONDITION

Objectives

To develop the correct habit patterns for successful recovery from an engine power decrease condition; to maintain proficiency in correct and timely use of emergency throttle in an autorotation; and, to reinforce the correct positioning of the speed selector after recovery.

Discussion

The practice of emergency throttle recoveries should be conducted in such a manner as to reinforce the emergency procedures for an engine power decrease condition. Entry into an autorotation should be followed by rapid analysis of the engine instruments so that maximum time would be available to recover with emergency throttle if the engine is capable of producing power. Applying emergency throttle with the rotor unloaded can easily result in rotor overspeeds if collective is not used promptly to contain RPM. Be especially alert to maintain RPM with collective as emergency throttle is applied. Proficiency in establishing a climb from an autorotative descent is essential to cope with an actual power decrease condition.

Guidelines

1. Emergency throttle recoveries may be practiced by a Student Pilot, Copilot, First Pilot, or Aircraft Commander (PUI), under the supervision of a Safety Pilot (SP) who is a designated Aircraft Commander.

Procedure

PUI — Take control of the aircraft at or above 1000 feet AGL, within autorotative distance of a runway.

Enter autorotation by lowering collective with a positive steady movement to minimum and then split the needles (Nf/Nr) by decreasing the speed selector to the AUTO DETENT. After establishing the auto-rotative descent toward the intended landing area, scan the instruments to determine if the engine is still running. Make a voice report of the engine status to the Safety Pilot.

SP —Unannounced entries may be made by retarding the speed selector to the AUTO DETENT.

Announce "RECOVER ON EMERGENCY THROTTLE."

PUI — Advance emergency throttle and apply sufficient power to establish a climb. Maintain 100% Nr.

CAUTION

Be alert to apply collective to prevent a rotor overspeed.

SP —If a climb is not established by 500 feet AGL, or if the maneuver is not progressing satisfactorily, TAKE CONTROL OF THE AIRCRAFT and ABORT the maneuver by advancing the speed selector to full increase, closing emergency throttle, and WAVING OFF.

PUI — Once the climb is established retard the speed selector to FLIGHT IDLE.

SP —Advance the speed selector to 96% Nf by estimating the position.

CAUTION

There is no Nr underspeed protection while the speed selector is at flight idle.

PUI — Execute a landing, or wave off.

CAUTION

There is no 110% overspeed protection against pilot induced overspeeds when governing with emergency throttle. However, the 122% Nf automatic fuel shutoff will still function if the Nf flex shaft is intact.

SP —Take control of the aircraft. Advance the speed selector to full increase, close emergency throttle, and readjust the speed selector to the desired Nf/Nr.

Simulated emergency terminated.

ACTUATION OF TEST #1 AND P3 BLEED ON THE GROUND

Objectives

To develop skill in the analysis of engine condition, to practice assuming control of the engine with emergency throttle, and to build the habit pattern of moving the speed selector out of the Nf governing range after shifting engine operation to emergency throttle.

Discussion

This procedure is designed to familiarize the Pilot Under Instruction with the cockpit indications of a power decrease condition and the action required of him in this situation without leaving the ground.

Guidelines

The Safety Pilot must be a designated Aircraft Commander. The Pilot Under Instruction may be a Student Pilot, Copilot, First Pilot or another Aircraft Commander.

Procedure

SP —Open P3 valve or test NO 1 during ground operations at 100% Nf/Nr.

PUI — Advance the emergency throttle to stabilize Nf/Nr at 100%.

Retard the speed selector to flt idle.

Maintain 100% Nf/Nr using emergency throttle.

SP —Close P3 valve, or reset test NO. 1 switch to normal.

Take control of the aircraft.

Advance the speed selector to max Nf/Nr.

Close the emergency throttle.

Simulated emergency terminated.

SECTION III

EMERGENCY PROCEDURES

TABLE OF CONTENTS

GENERAL

The emergency situations and procedures outlined in this section cover the common type of emergencies encountered; however, the procedures used in each actual emergency encountered must result from consideration of the complete situation. Compound emergencies may require departure from normal corrective procedures set forth below for any specific emergency. Due to the varied types of equipment installed, pilots and aircrewmen must be thoroughly familiar with the emergency procedures in the succeeding paragraphs. The terms ABORT MISSION, LAND AS SOON AS PRACTICABLE, and LAND IMMEDIATELY are used throughout this section for the purpose of standardizing phraseology. The absolute definitions of these specific terms have been intentionally omitted so as not to preclude the use of sound judgement on the part of the pilot in command under these conditions. A radio call and a switching of the transponder to an emergency code should be attempted in emergencies requiring a forced landing.

ENGINE EMERGENCIES DURING START

ENGINE FAILS TO LIGHT-OFF

Symptom

Engine fails to light-off within 15 seconds after opening speed selector.

Corrective Action

1. Speed selector — STOPCOCKED.
2. Starter button — RELEASE.
3. Monitor T_5.

Before attempting another start, investigate and analyze the conditions requiring the abort. If the situation justifies another start, wait 3 minutes for starter to cool and fuel to drain before repeating the start procedures. It is desirable to use external power for subsequent starts.

HOT START

Symptom

T_5 rises abnormally and/or appears that it will exceed 700°C.

Corrective Action

1. Speed selector — STOPCOCK.
2. Starter button — DEPRESSED UNTIL T_5 FALLS BELOW 300°C.
3. Starter button — RELEASED.
4. T_5 — MONITOR.

NOTE

If starter has been released and T_5 remains above 300°C, engage starter below 20% Ng. If any doubt exists or if overtemp limits were exceeded during start, do not attempt second start. Refer to Section VII for probable hot start causes.

COLD HANGUP

Symptom

Ng fails to accelerate to ground idle and T_5 remains low.

Corrective Action

1. T_5 — MONITOR.
2. Emergency Throttle — INCREASE TO OBTAIN 56% Ng.
3. Emergency Throttle — CLOSED.

NOTE

If Ng fails to remain in the idle range after closing emergency throttle, stopcock speed selector and investigate cause. For operation in cold weather refer to Section IX. Refer to Section VII for probable causes of a cold hangup.

ENGINE EMERGENCIES ON GROUND

ENGINE STALL

Symptoms

1. Rapid rise in T_5.
2. Hangup or decay of Ng.
3. Possible rumble or bangs.

Corrective Action

1. Speed Selector — STOPCOCK.
2. T_5 — MONITOR.

ENGINE FLAME-OUT

Symptoms

1. Ng, T_5, and fuel pressure decrease.

Corrective Action

1. Speed selector — STOPCOCK.
2. T_5 — MONITOR.

CAUTION

Following a flame-out for any cause, a restart should not be attempted until the cause has been corrected.

ENGINE EMERGENCIES – IN-FLIGHT

The material contained herein assumes a certain knowledge of basic engine operation. In regard to cockpit indications it is particularly important to consider the relationship of Ng and T_5. These two indicators, on a properly operating engine, will always rise and fall together as a function of engine power.

When analyzing any engine malfunction it is imperative that corrective action be based on an intelligent analysis of all indications of engine operation and not on any one source alone. Except where otherwise noted, other cockpit instruments remain normal.

Engine emergencies fall into two general categories. The first is a complete power loss. Transmission noise makes engine deceleration difficult to detect.

There may be an audible warning of imminent engine failure if a forward accessory gear or engine bearing failure occurs.

The second category of engine emergencies includes interruption, oscillation and decrease or increase from selected power. Fuel contamination and malfunctions of the fuel control system, P_3 bleed, Test No. 1, and Nf flexshaft are the primary causes. The power change could be slow or a very rapid loss/increase. The rapid power loss situation requires an immediate lowering of collective and analysis of the power instruments (Ng, fuel pressure, T_5, Nf/Nr) to determine if the engine is still operating. This is difficult unless the pilot includes these instruments in his scan during practice. If the engine is still operating and T_5 has not over temped, increase emergency throttle to 100% Nf/Nr and recover. If the engine has flamed out, emergency throttle will not correct the situation. If indicated, attempt a restart. In any case, if in an autorotation, do not allow attention to be diverted to the detriment of the autorotative landing.

ENGINE FAILURE IN A HOVER

The hover altitude and the nature of the engine power decrease will dictate the requirement for collective management. Hover altitudes below approximately 15 feet will not require lowering of the collective to preserve rotor RPM prior to raising collective for cushioning. Hover altitudes above approximately 15 feet, coupled with a sudden and complete loss of power, will require collective lowering in proportion to altitude to preserve sufficient rotor RPM for control and cushioning. Approximately 30 feet is sufficient altitude from which to fully lower the collective.

Symptoms

1. Rapid settling/Nr decaying.
2. Left yaw.
3. Left drift.

Corrective Action

1. Collective — LOWER AS REQUIRED TO PRESERVE Nr.

2. Cyclic — STOP DRIFT.

3. Tail rotor pedals — STOP YAW.

4. Collective — RAISE TO CUSHION TOUCHDOWN; LOWER SMOOTHLY AFTER TOUCHDOWN.

5. Cyclic — PLACE IN NEUTRAL POSITION AFTER TOUCHDOWN.

ENGINE FAILURE DURING TRANSITION, CLIMB, AND APPROACH

Altitude, airspeed, and surface conditions are the primary factors which effect recovery after engine failure during transition and climb. Wind, aircraft weight, and density altitude will also affect aircraft performance. During transition, at altitudes below approximately 15 feet, lowering of the collective is not required. During climbout above 15 feet, the collective must be lowered in proportion to altitude to preserve adequate rotor rpm. Above 30 feet of altitude the collective should be lowered fully. The surface conditions will dictate the groundspeed allowable for touchdown.

WARNING

During climbout above 30 feet the collective must be lowered IMMEDIATELY AND RAPIDLY to minimum, and the aircraft must be rotated to a nose-up attitude to preserve sufficient rotor rpm for control.

Symptoms

1. Rotor rpm decaying.

2. Rapid settling.

Corrective Action

1. Collective — LOWER AS REQUIRED TO PRESERVE Nr.

2. Cyclic — ADJUST ATTITUDE TO CONTROL GROUNDSPEED AS DICTATED BY TERRAIN AND STOP DRIFT.

3. Tail rotor pedals — STOP YAW.

4. Collective — RAISE TO CUSHION TOUCHDOWN. LOWER SMOOTHLY AFTER TOUCHDOWN.

5. Cyclic — PLACE IN NEUTRAL POSITION AFTER TOUCHDOWN.

ENGINE FAILURE DURING FLIGHT

Symptoms

1. Rotor rpm decaying.

2. Rapid settling.

Corrective Action (Visual Autorotation)

1. Collective — LOWER TO MINIMUM.

2. Establish autorotative descent to arrive at selected landing site into the wind when practicable.

   a. Engine instruments — ANALYZE.

   b. Speed selector — STOPCOCK.

   c. Wheels — AS REQUIRED.

   d. Cabin occupants — ALERTED.

   e. Shoulder harness — LOCKED.

   f. Transponder — EMERGENCY SQUAWK.

   g. Distress call — TRANSMIT.

   h. Cockpit sliding windows and cabin door — OPEN.

WARNING

Do not jettison windows/doors in flight.

   i. If time, altitude, and cause of engine failure permit, attempt engine restart (refer to restarting engine inflight, this section).

j. Landing light/flood lights — AS REQUIRED.

3. Autorotate using practiced techniques.

4. Collective — RAISE TO CUSHION TOUCHDOWN. LOWER SMOOTHLY AFTER TOUCHDOWN.

5. Cyclic — PLACE IN NEUTRAL POSITION AFTER TOUCHDOWN.

6. Rotor brake — AS REQUIRED.

   a. Landing — ON.

   b. Water — ALLOW ROTOR TO COAST DOWN PRIOR TO APPLYING ROTOR BRAKE.

NOTE

An autorotation over trees should be planned to arrive at zero ground speed at tree top level, allowing the trees to cushion the descent to ground contact.

Corrective Action (Instrument Autorotation)

1. Collective — LOWER TO MINIMUM, THEN ADJUST TO MAINTAIN 100% Nr.

2. Establish 55 knot autorotative descent into the wind when practicable. Place feet on the deck.

   a. Engine instruments — ANALYZE.

   b. Speed selector — STOPCOCK.

   c. Wheels — AS REQUIRED.

   d. Cabin occupants — ALERTED.

   e. Shoulder harness — LOCKED.

   f. Transponder — EMERGENCY SQUAWK.

   g. Distress call — TRANSMIT.

   h. Cockpit sliding windows and cabin door — OPEN.

WARNING

Do not jettison windows/door in flight.

   i. If time, altitude, and cause of engine failure permit, attempt engine restart (refer to restarting engine inflight, this section).

   j. Landing light/flood lights — AS REQUIRED.

3. At 140 feet on RADALT — FLARE AT A RATE SO AS TO ARRIVE AT 20° NOSE-UP AT 70-90 FEET ON RADALT.

4. Maintain 20° nose-up attitude until airspeed has slowed to the desired exit speed (20 knots for calm winds, add one knot for each two knots of surface winds).

5. Exit flare to 5° nose-up touchdown attitude.

6. Begin collective pull at approximately 35 feet on RADALT to control rate of descent and cushion landing. Lower smoothly after touchdown.

7. Cyclic — PLACE IN NEUTRAL POSITION AFTER TOUCHDOWN.

8. Rotor brake — AS REQUIRED.

   a. Land — ON.

   b. Water — ALLOW ROTOR TO COAST DOWN PRIOR TO APPLYING ROTOR BRAKE.

CAUTION

Smooth lowering of the collective after touchdown in any full autorotation is required. Holding the collective up, or rapidly slamming it down may cause the rotor blades to either stall or flex down and strike the tail boom. Holding aft cyclic may aggravate this tendency.

HIGH SPEED SHAFT FAILURE

Symptoms

1. Nr — DECAYING.
2. Nf — INCREASING.
3. Zero torque indication possibly accompanied by loud noises from the transmission area.

NOTE

If Nf reaches 122%, the Nf overspeed protection will secure fuel at the fuel control. When Nf falls below 122%, fuel will again begin to flow and the engine may or may not relight.

Corrective Action

1. Collective — LOWER IMMEDIATELY TO MAINTAIN Nr.
2. Speed selector — STOPCOCK.
3. Autorotate using practiced techniques.

COMPRESSOR STALL

Symptoms

1. Rumbling or banging noise from the engine
2. Rapid rise in T_5.
3. Rotor rpm decaying
4. Hangup or decay of Ng.
5. Rapid settling.

Corrective Action

1. Collective — LOWER TO MINIMUM.
2. Establish autorotative descent to arrive at selected landing site, into the wind if practicable.
3. Speed selector — FLT IDLE.
4. If T_5 stabilizes within normal operating range:
   a. Slowly advance Emergency throttle while monitoring T_5 and Ng to obtain 100% Nf/Nr.
   b. Collective — ADJUST AS REQUIRED FOR FLIGHT.

CAUTION

If power is not regained or T_5 is in an overtemp condition, stopcock speed selector. (Refer to ENGINE FAILURE DURING FLIGHT procedures this section.)

5. Land as soon as practicable.

ENGINE POWER DECREASE

Symptoms

1. Nr - DECAYING or fluctuating
2. Engine instruments — LESS THAN SELECTED, STEADY OR FLUCTUATING.

Corrective Action

1. Collective - LOWER, IF NECESSARY TO MAINTAIN Nr (enter autorotation if necessary).
2. Engine instruments — ANALYZE.
3. Emergency throttle - ADVANCE TO OBTAIN/MAINTAIN 100% Nf/Nr.

CAUTION

Too rapid an application of emergency throttle may cause engine overtemp or compressor stall. If power is not regained or T_5 is an overtemp condition, stopcock speed selector. (Refer to ENGINE FAILURE DURING FLIGHT procedures this section.)

4. Collective — ADJUST AS REQUIRED FOR FLIGHT.

NOTE

If power decrease is transitory and if Nf/Nr have returned to selected value, advance emergency throttle until slight rise (Approx 2 percent) in Nf/Nr is noted.

5. Speed selector — FLIGHT IDLE.

6. Land as soon as practicable.

CAUTION

- When operating on emergency throttle, there is no automatic 110% Nr rotor overspeed protection against overspeed caused by mismanagement of emergency throttle.

- Stopcock function is still controlled by the speed selector even when the engine is being controlled by emergency throttle.

ENGINE POWER INCREASE CONDITION

Symptoms

1. Nr — INCREASING.

2. Power instruments — GREATER THAN SELECTED, STEADY OR FLUCTUATING.

3. Nf — ZERO (FLEX SHAFT BROKEN) OR FLUCTUATING.

Corrective Action

1. Collective — ADJUST AS NECESSARY FOR SAFE FLIGHT

2. Emergency Throttle — ADVANCE TO CONTROL Nr FLUCTUATIONS.

3. Speed Selector — FLT IDLE

4. Emergency Throttle — ADJUST to 100% Nr.

5. Land as soon as practicable.

CAUTION

In the event of Nf flex shaft failure, there is no 122% Nf overspeed stopcock feature.

NOTE

Controlling Nr with the collective during a flexshaft failure is not recommended. Torque in excess of 116% would have to be applied to the rotor system to contain Nr below 110%, resulting in a severe overtorque condition in addition to the rotor overspeed condition.

RESTARTING ENGINE IN FLIGHT

Altitude and mode of failure will dictate whether an inflight engine restart should be attempted. The altitude at which air restart can be safely accomplished depends on pilot judgement.

Corrective Action

1. Speed selector stopcock — RECHECKED.

2. Emergency throttle closed — RECHECKED.

3. Starter switch — DEPRESS.

4. Ng accelerating through 14% — CHECKED.

5. Speed selector — ADVANCE TO GROUND IDLE.

6. After light off — ADVANCE EMERGENCY THROTTLE TO RE-ESTABLISH LEVEL FLIGHT. MONITOR T_5 AND Ng.

7. Observe 45% Ng — RELEASE STARTER BUTTON.

8. If restart is successful, land as soon as practicable.

9. If restart attempt is unsuccessful:

   a. Speed selector — STOPCOCK.

   b. Complete autoroation.

CAUTION

Do not let attention be diverted to the detriment of the autorotation.

ENGINE LUBRICATION SYSTEM FAILURE

Low oil pressure may indicate a leak in the system. High oil pressure may indicate a partial blockage resulting in insufficient lubrication to part of the engine. High oil temperature may indicate impending bearing failure.

Symptoms

1. Engine oil pressure – ABOVE OR BELOW NORMAL.
2. Engine oil temperature – ABOVE NORMAL.
3. Engine oil pressure and Ng tachometer – ZERO (Loss of oil pump drive).

Corrective Action

1. Land as soon as practicable.

WARNING

With a complete loss of oil pressure, LAND IMMEDIATELY, as a destructive failure of the engine may occur within an extremely short period of time.

FUEL SYSTEM MALFUNCTIONS

ENGINE-DRIVEN FUEL PUMP

Symptoms

1. Ng, T_5, fuel pressure – DECREASING.
2. Nf/Nr – DECREASING.

Corrective Action

1. Refer to procedures for ENGINE EMERGENCIES-IN-FLIGHT in this section.

SINGLE FUEL BOOST PUMP FAILURE

Symptom

1. NO. 1 FUEL PUMP or NO. 2 FUEL PUMP caution light – ON.

Corrective Action

1. Failed fuel boost pump switch – OFF.
2. Failed fuel boost pump circuit breaker – PULLED.
3. Abort mission.

CAUTION

Do not reset the fuel boost pump circuit breaker.

DUAL FUEL BOOST PUMP FAILURE

Symptoms

1. NO. 1 FUEL PUMP caution light – ON.
2. NO. 2 FUEL PUMP caution light – ON.

Corrective Action

1. Failed fuel boost pump switches – OFF.
2. Failed fuel boost pump circuit breaker – PULLED.
3. Land as soon as practicable.
4. Plan flight path to allow for an autorotation in event of a flameout.
5. Maintain as high a power setting as possible.
6. Avoid rapid power changes.

CAUTION

Do not reset the fuel boost pump circuit breakers.

NOTE

Fuel in the aft tank cannot be transferred to the forward tank.

FUEL TRANSFER SYSTEM FAILURE

It is possible to have fuel transfer system problems that can result in symptoms similar to a dual boost pump failure. Clogged, inoperative, or disconnected ejectors, or other plumbing failures could cause inadequate fuel transfer to the collector can to keep the fuel boost pumps immersed in fuel. This would result in the loss of positive fuel pressure from the boost pumps and lighting of both fuel pump caution lights simultaneously or within a short period of time of each other. Engine failure due to fuel starvation is probable within a very short period of time. A fuel transfer system failure is distinguished from a dual boost pump failure by the simultaneous lighting of the caution lights and the probable absence of unusual noises.

Symptoms

1. Both FUEL PUMP caution lights — ON (simultaneously, or within a few seconds of each other).

Corrective Action

1. Turn toward the nearest landing area and land immediately.
2. Plan flight path to allow for an autorotation in the event of a flameout.

WARNING

Anticipate an engine failure within an extremely short period of time.

AIR FRAME FUEL FILTER CONTAMINATION

Symptom

1. FUEL BYPASS caution light — ON.

Corrective Action

1. Land as soon as practicable.

MAIN GEAR BOX MALFUNCTION

Impending failure of the main gear box may be indicated by abnormal transmission noises, unusual high frequency vibrations, illumination of the chip detected caution light, abnormal transmission oil pressure indications or visually noting transmission fluid coming from the aircraft. The chip detector light indicates the presence of metallic chips in the transmission oil system. Carefully monitor transmission oil pressure and temperature.

Symptoms

1. TRANS OIL PRESS caution light — ON.
2. Main gear box oil temperature or pressure indicator at red line.
3. CHIP DETECTED caution light — ON.
4. Indications of low pressure plus indications of high temperature.
5. Abnormal transmission noises and/or vibrations.
6. Visual indications of transmission oil loss.

Corrective Action

If any of the above conditions are observed:

1. Enter an immediate descent and effect a power on landing immediately.
2. If a landing is not feasible due to terrain or sea conditions, air taxi to the nearest suitable landing site and land immediately.

WARNING

- With a complete loss of transmission oil, the high speed portion of the main gear box may fail within an extremely short period of time.
- A complete transmission oil loss, indicated by zero transmission oil pressure, lighting of the transmission oil pressure caution light, zero torque indication, or visual confirmation of oil loss accompanied by rumbling or grinding noises or vibrations from the transmission area may dictate securing the engine and immediately entering an autorotation to prevent destructive failure of the high speed section, which could damage the flight control/rotor system, making further controlled flight impossible.
- Anytime main gear box oil is lost and the oil pressure goes to zero it must be assumed that internal damage has occurred. Further flight after landing shall not be attempted.

NOTE

After a prolonged hover the transmission oil pressure may stabilize just below 40 psi. If this should occur and oil temp is normal transition to forward flight. The pressure should rise into the normal range and the mission may be continued.

GROUND RESONANCE

Symptoms

1. One or more wheels touching the ground.

2. Rotor system becomes severely unbalanced laterally at a rapidly increasing rate, jeopardizing the integrity of the airframe.

Corrective Action

1. Get the helicopter airborne.

If impossible:

2. Collective — FULL DOWN.

3. Speed selector — STOPCOCK.

4. Rotor brake — FULL ON.

5. Wheel brakes — APPLY.

NOTE

Ground resonance will not occur during a water landing or takeoff.

ROTOR OVERSPEED

Symptom

1. Nr exceeds 110%.

Corrective Action

1. Nr 111% to 120% — LAND AS SOON AS PRACTICABLE, URGENT MISSION MAY BE COMPLETED.

2. Nr over 120% — LAND AS SOON AS PRACTICABLE.

MAIN GEAR BOX OVERTORQUE

Symptoms

1. Torquemeter indicates 116% or more.

2. Event indicator displays red flag.

Corrective Action

1. Land as soon as practicable.

MAIN ROTOR BLADE DAMPER MALFUNCTION

Symptom

1. Rough head indications with associated fuselage vibrations, the magnitude of which varies with control inputs and RPM changes.

NOTE

These indications will be more evident at a high power condition.

Corrective Action

1. Airspeed — 55 KNOTS.

2. Land as soon as practicable.

CAUTION

Ground resonance could be encountered during or after landing. (Refer to procedures for GROUND RESONANCE this section.)

DROOP RESTRAINER MALFUNCTION

Symptom

1. One or more droop restrainer not in during shutdown.

Corrective Action

1. Actuate cyclic and collective a small amount to load rotor blades and allow the droop to come in.

If ineffective:

2. Advance Nr to 100% then back to FLT IDLE

If ineffective:

3. Clear all non-essential personnel from the area.

4. Cyclic — PLACE IN NEUTRAL POSITION.

5. Speed selector — STOPCOCK.

6. Rotor brake — APPLY FULL ON AT 48% Nr. MAKE NO ATTEMPT TO EASE ROTOR TO A STOP.

IBIS PRESSURE WARNING

The IBIS provides in-flight monitoring of main rotor blade spar integrity. Analytical blade crack propagation time data has been used to determine permissible safe flying times following a blade spar crack and loss of pressure. The time varies from 2.5 hours at 95 knots to 8.5 hours at 60 knots.

Symptoms

1. BLADE PRESS caution light — ON.

Corrective Action

1. IBIS AC circuit breaker — CHECK.

   a. If not out — LAND AS SOON AS PRACTICABLE.

   NOTE

   For other than known or suspected rotor blade damage (i.e. blade strike), the flight may be continued to where a safe landing can be accomplished. The permissible safe flying times above should be considered in determining a "practicable" landing site.

   b. If out — RESET.

   NOTE

   If the circuit breaker will not reset, the problem is not with the rotor blades. The mission may be completed. The IBIS dc circuit breaker should be pulled to extinguish the caution light.

2. After landing — CHECK THE IBIS INDICATORS.

   a. If any indicator is red, maintenance action is required prior to further flight. Place the protective cover located on the SAR board over the red indicator to preclude radiation leakage.

   b. If all indicators are yellow, the problem is not with the rotor blades. The mission may be completed. Pull both IBIS circuit breakers to secure the defective system.

NOTE

- The BLADE PRESS caution light may go on if hovering close to a vessel with an operating radar. If this should occur, the vessel's radar should be secured (or placed on STANDBY) to confirm the validity of the caution light.

- The BLADE PRESS caution light may go on if transporting a person who has had recent radiation treatment, such as a brain scan. If this should occur, pull both IBIS circuit breakers and complete the mission.

ROTOR BLADE DAMAGE

In the event of known or suspected rotor blade damage in flight, the helicopter shall be promptly landed at the first opportunity. Possible loss of the airframe subsequent to a safe landing is not sufficient cause to continue flight with rotor blade damage. Further flight of the helicopter with damage exceeding negligible and repairable as defined in the applicable maintenance manual shall not be attempted.

ROTOR BRAKE MALFUNCTION

Symptoms

1. Rotor brake caution light goes on with rotor turning.

Corrective Action

1. Rotor brake handle in detent — CHECKED.

2. Land as soon as practicable.

PRIMARY HYDRAULIC SERVO HARDOVER

Although the auxiliary servo system may mask a malfunctioning primary servo, feedback to the cyclic or collective has occurred.

Symptoms

1. Possible primary pressure fluctuations associated with cyclic/collective movements.
2. Erratic behavior of helicopter.

Corrective Action

1. Servo shutoff switch -- PRI OFF.
2. Airspeed — 60 KNOTS.
3. Land as soon as practicable.

CAUTION

DO NOT SECURE the auxiliary servo system as a troubleshooting effort with a suspected primary servo malfunction.

AUXILIARY HYDRAULIC SERVO HARDOVER

Symptoms

1. Probable extreme displacement of one flight control (cyclic, collective, or pedals).
2. Erratic behavior of helicopter, uncontrollable maneuvers, possible locking of flight controls.

Corrective Action

1. Servo shutoff switch — AUX OFF.
2. Air Speed — As required for ease of control.

NOTE

Air speed should be a function of the torque setting needed to keep the aircraft in balanced flight with a minimum of tailrotor pedal pressure.

3. Land as soon as practicable.

NOTE

Use Rotor and Engine Shutdown procedures for wind in excess of 25 knots.

PRIMARY HYDRAULIC SERVO PRESSURE FAILURE

Control of the helicopter can be maintained through the auxiliary flight control system should the primary system fail. Prolonged operation following a primary pressure failure is not recommended.

Symptoms

1. PRI pressure gage indication — BELOW NORMAL.
2. PRI HYD PRESS caution light — ON.
3. Hydraulic leak — NOTED.

Corrective Action

1. Servo shutoff switch — PRI OFF.
2. Airspeed — 60 KNOTS.
3. Land as soon as practicable.

CAUTION

A complete loss of hydraulic fluid will result in a loss of cooling and lubrication for the primary hydraulic pump. If vibrations, rumbling sounds or burning smells are detected, there is a possibility of fire in the transmission area.

AUXILIARY HYDRAULIC SERVO PRESSURE FAILURE

Control of the helicopter can be maintained through the Primary Flight Control System should the Auxiliary system fail.

Symptoms

1. Hydraulic leak from the auxiliary servocylinder assembly compartment, main landing gear, etc. — NOTED.

2. AUX pressure gauge indicator — BELOW NORMAL.

3. AUX HYD PRESS caution light — ON.

Corrective Action

1. Servo shutoff switch — AUX OFF.

2. Air speed — AS REQUIRED FOR EASE OF CONTROL.

NOTE

Air speed should be a function of the torque setting needed to keep the aircraft in balanced flight with a minimum of tail-rotor pedal pressure.

3. Land as soon as practicable.

NOTE

The ASE no longer aids in stabilizing the helicopter with the auxiliary servos secured.

CAUTION

A complete loss of hydraulic fluid will result in a loss of the cooling and lubrication for the AUX hydraulic pump. If vibrations, rumbling sounds or burning smells are detected there is a possibility of fire in the transmission area.

LOSS OF TAIL ROTOR DIRECTIONAL CONTROL

Loss of heading control could be the result of tail rotor blade loss or damage, failure of the tail rotor drive shaft between the transmission and the tail rotor, or a failure in the tail rotor control linkage. Tail rotor loss or failure of the drive shaft will result in a right yaw in powered flight, the amount of yaw being governed by the airspeed and the amount of power being applied to the main rotor. A failure in the control linkage may result in a loss of positive heading control. Direction and amount of yaw in this case will be determined by airspeed, torque, tail rotor rigging, and type of failure. A jammed control would result in a loss of positive heading control. The thrust produced by the tail rotor will be dependent upon the position of the control when it jams.

Tail rotor control system failures will likely fall into two categories: those resulting in loss of tail rotor pedal response and those resulting in a lock-up of tail rotor control linkage. Loss of pedal response could probably result from separation of the control linkage. If the control linkage separates between the pedals and the AUX servo, the ASE yaw channel (with ASE engaged) will continue to maintain heading. In this situation heading can be controlled with the ASE yaw trim knob. If the control linkage separates between the AUX servo and the tail rotor, the tail rotor blade pitch will be controlled by the preset counterweights. This will result in a left, neutral or right yaw depending on airspeed, torque, and tail rotor rigging. Controlled flight is normally possible using cyclic for directional control while adjusting torque for minimum yaw.

TAIL ROTOR DRIVE SYSTEM FAILURE/TAIL ROTOR ASSEMBLY LOSS

Symptoms

1. Moderate to rapid RIGHT yaw of fuselage.

NOTE

The rate and amount of yaw are governed only by the power applied to the rotor system and the airspeed at the time of failure.

2. Loss of tail rotor pedal control.

NOTE

If the entire tail rotor assembly is lost, a forward shift in CG (pitch down) will accompany the above symptoms.

Corrective Action

1. During TAKEOFF, LANDING, or HOVERING (low altitude, slow airspeed).

   a. Speed selector — FLIGHT IDLE (STOPCOCK, TIME PERMITTING).

CAUTION

Increasing torque at a slow airspeed will cause the helicopters to rotate more rapidly to the right — thus aggravating the situation.

b. Cyclic — MAINTAIN LEVEL ATTITUDE.

c. Collective — INCREASE TO CONTROL RATE OF DESCENT AND CUSHION LANDING.

2. During FORWARD FLIGHT:

a. Reduce power to establish a glide at 60-90 knots to regain some yaw control.

b. Slowly add power to reduce rate-of-descent while compensating for right yaw with cyclic.

c. Alert crew and lock shoulder harness.

d. Maintain altitude and an airspeed of 60-90 knots.

e. Burn off excess fuel.

f. When over desired landing area — ENTER AUTOROTATIVE FLIGHT.

g. Speed selector — AUTO DETENT.

h. Flight path — MAINTAIN WITH CYCLIC.

i. Speed selector — STOPCOCK WHEN SATISFIED THE APPROACH WILL PERMIT SUCCESSFUL COMPLETION OF THE AUTOROTATION TO THE DESIRED LANDING AREA.

j. Complete autorotation.

NOTE

As airspeed decreases prior to touchdown, a yaw may develop. Control flight path over the ground with cyclic in order to touchdown moving in the direction the helicopter is pointed.

k. After touchdown use wheel brakes for directional control.

TAIL ROTOR CONTROL SYSTEM FAILURE

Symptoms

1. Heading cannot be controlled with rudder pedals. (Pedals may be locked or free to move.)

2. Left, right, or no yaw may be experienced depending upon the nature of the malfunction as well as the airspeed and torque.

Corrective Action

1. With locked tail rotor pedals:

a. Servo shutoff switch — AUX OFF.

b. If heading control is regained, land as soon as practicable.

c. If heading control is not regained, servo shutoff switch — ON. Refer to item 2.

2. With free pedals:

a. ASE yaw trim knob — TURN TO CHECK FOR HEADING RESPONSE.

(1) With heading response, land as soon as practicable using the yaw trim knob for heading control.

(2) Without heading response, evaluate the effects of changes in power and airspeed at altitude. A power/airspeed combination should be found that will produce minimum yaw for landing.

CAUTION

During this evaluation, the following yaw angle limitations should be observed when possible to prevent structural damage.

15° at 85 knots
30° at 55 knots
90° at 25 knots

3. Since it is possible for the tail rotor anti-torque thrust to be fixed at any setting in the range from 0% to above 100%, no one combination of power and airspeed can be specified

for the proper recovery. Tail rotor control malfunctions can be placed into three distinct groups with respect to termination procedures:

a. Anti-torque thrust fixed to match low torque (0% to 35% torque).

b. Anti-torque thrust to match medium torque (35% to hover torque).

c. Anti-torque thrust fixed to match high torque (in excess of hover torque).

4. The termination procedures for each of the above groups will be different and are as follows:

a. Anti-torque thrust fixed to match low torque would require a modified normal approach, not too dissimilar from an autorotative approach, through a flare and touchdown in a running landing. Heading during the modified flare and touchdown must be controlled by maintaining a power setting near that determined at altitude for zero yaw angle. The rate of descent upon exit from the flare must be accepted and the primary emphasis must be on controlling the yaw angle with power.

b. Anti-torque thrust fixed to match medium torque would allow a somewhat normal approach to a running landing or hover. The approach should be executed by reducing power to simultaneously descend and decelerate to the back side of the power curve. This method would result in a left yaw whenever engine power is set below the fixed anti-torque thrust. Minor heading changes prior to touchdown can be affected by minor changes in power. The termination — running landing or hover — is dependent upon the anti-torque thrust available and the aircraft performance.

c. Anti-torque thrust fixed in excess of that required in a hover would require a modified normal approach to a hover followed by a reduction of Nf/Nr with the speed selector. The approach would be accomplished by a power reduction and deceleration, with an adverse left yaw. Termination in a hover would result in a hover with a left turn. Reduction of power in an effort to land would increase the rate of left turn. Landing with this condition must be accomplished by reducing Nf/Nr with the speed selector. This decrease in Nf/Nr would require more torque (higher collective position) to hover, and decrease the tail rotor rpm, and thus anti-torque thrust. The proper Nf/Nr and torque combination should be found to allow for landing with minimum turn rate.

5. After touchdown use wheel brakes for directional control.

WARNING

Avoid rapid reduction of collective at touchdown as an uncontrollable left turn may result.

VERTICAL GYRO FAILURE

Symptoms

1. Failed VGI OFF flag — EXPOSED.

2. GYRO caution light — ON (starboard gyro failure only).

3. Erratic or precessing VGI.

4. If failed gyro is selected on channel monitor panel — PITCH AND ROLL OSCILLATIONS FOLLOWING FLIGHT DIRECTOR (ASE mode) BARS.

Corrective Action

1. Forward circuit breaker panel — CHECKED.

2. If all circuit breakers are in and failed gyro is selected on the Channel Monitor Panel — SELECT OPPOSITE GYRO.

NOTE

If the newly selected gyro instantly fails and the previously failed gyro returns to operation, check ϕB AUTO STAB circuit breaker. If the breaker cannot be reset, the ASE cannot be recovered.

AUTOMATIC STABILIZATION EQUIPMENT MALFUNCTION

ASE HARDOVER

Symptoms

1. In pitch or roll channel:
   a. Displacement of rotor disc without a corresponding movement of the cyclic.
   b. Flight director (ASE mode) — PITCH OR ROLL BAR FULL DISPLACEMENT.
2. In yaw channel:
   a. Displacement of anti-torque pedals.
   b. The displacement can be overridden by the pilot.
   c. Flight director (ASE mode) — YAW POINTER FULL DISPLACEMENT.

NOTE

An ASE hardover may occur with the ASE disengaged or engaged.

Corrective Action

1. Flight controls — OVERRIDE THE HARDOVER.
2. Flight director (ASE mode) — ANALYZE TO DETERMINE AFFECTED CHANNEL.
3. Channel monitor panel — DISENGAGE DEFECTIVE CHANNEL.

NOTE

If the cause of the hardover is moisture in the channel monitor panel, it is possible that the disengage switch will not remove the hardover. In this case it may be possible to remove the hardover by pulling the DC AUTO STAB circuit breaker. Actual flight conditions will dictate the procedure to be followed. It may be more advisable to override the hardover then to secure additional equipment.

ASE FAILURE

Symptoms

1. ASE OFF caution light — ON.
2. Flight director (ASE mode) — OFF FLAGS WITH BARS CENTERED.
3. ASE engage light — OFF.

Corrective Action

1. Flight controls — STABILIZE THE AIRCRAFT.
2. DC AUTO STAB circuit breaker — CHECK AND RESET.
3. ASE engage switch — ENGAGE.
4. If this does not restore the ASE, mission urgency and flight conditions will determine the action to be taken.

ASE AMPLIFIER MALFUNCTION

Symptoms

1. Loss of stabilization in one or more channels.
2. Flight director (ASE mode) — INDICATOR FOR AFFECTED CHANNEL CENTERED.

NOTE

The OFF flags on the flight director (ASE mode) will NOT be displayed.

Corrective Action

1. Channel monitor panel — DISENGAGE AFFECTED CHANNEL.
2. Mission urgency and flight conditions will determine the action to be taken.

ϕB AUTO STAB CIRCUIT MALFUNCTION

Symptoms

1. ASE — INEFFECTIVE.

2. Flight director (ASE mode) — ALL INDICATOR BARS CENTERED.

3. Selected gyro's VGI — OFF FLAG VISIBLE.

4. ϕB AUTO STAB circuit breaker — POPPED.

Corrective Action

1. Flight controls — STABILIZE THE AIRCRAFT.

2. ϕB AUTO STAB circuit breaker — CHECK AND RESET.

3. If the circuit breaker does not reset, the ASE cannot be regained. Mission urgency and flight conditions will determine the action to be taken.

NOTE

With the ϕB AUTO STAB circuit breaker popped, the selected gyro's VGI will be lost. If the circuit breaker cannot be reset, the selected VGI cannot be regained.

STICK TRIM SYSTEM MALFUNCTION

RUNAWAY BEEPER TRIM

Symptoms

1. Cyclic stick begins a steady movement in any direction.

Corrective Action

1. Trim release button — DEPRESS AND REPOSITION CYCLIC.

2. If movement continues, beeper trim switch — OFF.

NOTE

Placing the cyclic stick to a desired position and then pulling the BEEPER TRIM circuit breaker will provide the pilot with a trimmed cyclic in that position. Stick trim forces may still be overridden.

LOSS OF ELECTRICAL POWER

Symptoms

1. Cyclic cannot be trimmed to a new position.

Corrective Action

1. BEEPER TRIM circuit breaker — CHECK AND RESET.

2. If the circuit breaker does not reset, the stick trim forces can be overridden by the pilot.

ELECTRICAL POWER SUPPLY SYSTEM MALFUNCTION

GENERATOR FAILURE

Symptoms

1. NO. 1 GENERATOR or NO. 2 GENERATOR caution light — ON.

2. NO. 2 RECTIFIER caution light — ON.

3. SLAVE COMPASS caution light — ON (if NO. 1 GENERATOR failure).

Corrective Action

1. Generator switch (affected GENERATOR) — OFF-RESET, THEN ON.

2. Should this fail to restore power:

   a. Generator switch — OFF.

   b. Abort mission.

CAUTION

If vibrations, low rumbling sounds, or smells of burning insulation precede or accompany the illumination of the caution light, LAND AS SOON AS PRACTICABLE. Check the supervisory panels and generators for possible fire.

DUAL GENERATOR FAILURE

Symptoms

1. NO. 1 GENERATOR and NO. 2 GENERATOR caution lights — ON.

2. Loss of ASE, both VGIs, and MA-1 compass.

NOTE

The only flight instruments remaining will be the turn and slip indicator, pitot static instruments, and the standby compass. The only communications radios remaining will be the VHF, VHF-FM, and the UHF Guard Receiver. The only navigation systems remaining will be the ILS, VOR (CDI only), LORAN C NAVIGATOR, and transponder.

Corrective Action

1. Move each GEN switch to OFF-RESET, then ON. If this does not restore power:

2. GEN switches — OFF.

3. BATT switch — ON.

4. NON ESS BUS OVRD switch — OFF.

5. Reduce electrical load.

6. Land as soon as practicable.

NOTE

The battery is the sole source of electrical power. As it becomes discharged the NO. 1 FUEL PUMP caution light will go on.

TRANSFORMER-RECTIFIER FAILURE

Symptoms

1. NO. 1 RECTIFIER or NO. 2 RECTIFIER caution light — ON.

Corrective Action

1. Associated GEN switch — OFF-RESET, then ON.

2. If this fails to restore power:

   a. Associated T/R circuit breaker — CHECK. RESET.

3. If this fails to restore power:

   a. Associated T/R circuit breaker — PULL.

NOTE

One T/R will provide sufficient power for all equipment on the DC busses.

DUAL TRANSFORMER-RECTIFIER FAILURE

Symptoms

1. NO. 1 RECTIFIER and NO. 2 RECTIFIER caution lights — ON.

Corrective Action

1. GEN switches — OFF-RESET, then ON.

2. If this fails to restore power:

   a. T/R circuit breakers — CHECK and RESET.

3. If this fails to restore power:

   a. T/R circuit breakers — PULL.

4. BATT switch — ON.

5. NON ESS BUS OVRD — OFF.

6. Reduce dc electrical load.

7. Land as soon as practicable.

NOTE

The battery is the sole source of dc electrical power. As it becomes discharged the NO. 1 FUEL PUMP caution light will go on.

NUMBER ONE SUPERVISORY PANEL MALFUNCTION

Malfunction of the NO. 1 supervisory panel may cause loss of power to the ac essential bus and failure of the automatic switching circuit that normally shifts the number two generator to the ac essential bus. Equipment powered by the dc non-essential bus will be lost unless the override switch is on. The symptoms below are listed under the assumption that the ASE gyro select switch is on PORT.

Symptoms

1. NO. 1 RECTIFIER caution light – ON.
2. BLADE PRESS caution light – ON.
3. RAWS warning tone – ON.
4. ASE – INEFFECTIVE. ALL INDICATOR BARS CENTERED.
5. Loss of all equipment powered by the ac essential bus except ground inverter items.

Corrective Action

1. NO. 1 GEN switch – OFF.
2. Land as soon as practicable.

CAUTION

Do not attempt to reset the affected generator as circuit protection is lost with the failure of the supervisory panel and an electrical fire may result.

NOTE

- When power is restored to the port gyro there will be a delay of up to 90 seconds before the off flag will disappear.
- The symptoms of supervisory panel malfunctions vary greatly. The above symptoms are the most common and the corrective actions prescribed may allow recovery of the affected equipment.

NUMBER TWO SUPERVISORY PANEL MALFUNCTION

Malfunction of the NO. 2 supervisory panel may cause loss of power to the ac non-essential bus and failure of the automatic switching circuit that normally shifts the starboard gyro to the ac essential bus. Equipment powered by the dc non-essential bus will be lost unless the override switch is on. The symptoms below are listed under the assumption that the ASE gyro select switch is on PORT.

Symptoms

1. NO. 2 RECTIFIER caution light – ON.
2. GYRO caution light – ON.
3. Pilot's VGI off flag – VISIBLE.

Corrective Action

1. NO. 2 GEN switch – OFF.
2. Land as soon as practicable.

CAUTION

Do not attempt to reset the affected generator as circuit protection is lost with the failure of the supervisory panel and an electrical fire may result.

NOTE

- When power is restored to the starboard gyro there will be a delay of up to 90 seconds before the off flag will disappear.
- The symptoms of supervisory panel malfunctions vary greatly. The above symptoms are the most common and the corrective actions prescribed may allow recovery of the affected equipment.

RADIO AUTOTRANSFORMER (øB) FAILURE

Symptoms

1. Loss of the following equipment: BDHI, RMI, NO. 1 and NO. 2 NEEDLE information, DME (frozen), and partial loss of OMNI and TACAN Course Indicator information.

NOTE

The TACAN course deviation indicator (CDI) will continue to function. The OMNI CDI will function only if the AN/ARN-123 VHF NAV is installed. Both relative heading indicators are unreliable.

Corrective Action

1. ϕB AUTO XMFR circuit breaker — CHECK. RESET IF OUT.

2. IND circuit breaker — CHECK. RESET IF OUT.

NOTE

- If the circuit cannot be regained, and the AN/ARN-123 is not installed, only GCA, ILS, and VOR(TAC) approach methods are available. If the AN/ARN-123 is installed, a VOR approach is also available.

- The Broadband Homer will continue to function.

3. If this does not restore the circuit, mission urgency and flight conditions will determine the action to be taken.

GROUND INVERTER/AUTOTRANSFORMER ϕC FAILURE

A ground inverter failure will only be evident with both generators off the line and dc essential bus energized. A ground inverter relay failure may occur anytime with similar symptoms. Autotransformer ϕC failures are similar except that only 26 vac items are lost.

Symptoms

1. Engine and transmission pressure instruments — NO MOVEMENT.

2. Torquemeter — NO MOVEMENT.

3. Fire detection and fuel quantity systems — INOPERATIVE (only for ground inverter/ ground inverter relay failure).

NOTE

Helicopter vibrations may cause the pressure instruments and torquemeter to move toward either extreme.

Corrective Action

1. INV INPUT circuit breaker — CHECK. RESET IF OUT.

2. AUTO XMFR ϕC circuit breaker — CHECK. RESET IF OUT.

3. Individual instrument circuit breakers — CHECK. RESET IF OUT.

4. If this does not recover instruments and/or systems, land as soon as practicable.

RADIO MASTER FAILURE

Symptoms

1. Loss of all navigation and communication equipment powered by the dc Radio Bus (ICS, RAWS, ILS, etc).

Corrective Action

1. RADIO MASTER switch — CHECK ON.

2. RADIO MASTER circuit breakers — CHECK. RESET IF OUT.

3. Attempt to maintain/regain VFR and land as soon as practicable.

NOTE

- None of the aircraft communication equipment operates with this failure. The emergency radios in the life vests should be used as necessary.

- The radar altimeter will continue to function except for the low level warning light. The yellow and black failure flag will appear.

MA-1 COMPASS SYSTEM MALFUNCTION

Loss of electrical power usually results in frozen compass cards. Gymbal failures result in erratic indications with yaw kicks. Loss of synchronization will result in inaccurate heading information requiring frequent cross-checks and realignments with the magnetic compass.

Symptoms

1. RMI and BDHI compass cards — FROZEN or ERRATIC.

2. SLAVE COMPASS caution light — ON.

3. MA-1 Compass Control Head off flag — VISIBLE.

Corrective Action

1. COMPASS circuit breakers — CHECK. RESET IF OUT.

2. Heading Set Knob — PULL AND RESET TO PROPER HEADING.

3. If this fails to restore the system, or if yaw kicks are present:

   a. Channel Monitor Panel Yaw Disengage Switch — OFF.

   b. MA-1 compass ac and dc circuit breakers — PULL.

   c. Land as soon as practicable.

WARNING

Use navigation information with caution as it may not be reliable. The course indicators will continue to provide reliable information.

BATTERY MALFUNCTIONS.

BATTERY OVERTEMPERATURE

CGTO 1H-52A-501 modified the HH-52A battery overtemperature switch to activate at 135°F. Although the system activates an advisory light, the higher temperature indicates a probable malfunction.

Symptom

1. BAT OVTEMP advisory light — ON.

Corrective Action

1. Battery switch — OFF.

NOTE

If the BAT OVTEMP advisory light goes out after a period of time, the battery should be left off unless absolutely needed. The remaining procedures shall be followed even if the light goes out.

2. Flight mechanic, with all protective clothing on and visor down, monitor the battery for thermal runaway conditions.

WARNING

Make no attempt to disconnect or jettison the battery inflight.

3. Land as soon as practicable.

4. If the battery is not in thermal runaway, allow it to cool prior to removing it. Further flight with the battery should not be attempted.

BATTERY THERMAL RUNAWAY

Symptoms

1. Smoke or fumes from battery compartment.

2. Sounds such as "bangs" or "thuds" from battery compartment.

Corrective Action

1. Battery switch — OFF.

2. Land as soon as practicable.

3. Standby with fire fighting equipment.

4. Check for the following conditions and take the actions indicated (to be performed by a crewman or crashcrewman outfitted in a hot suit):

   a. If flame is present, use any available extinguishing agent.

   b. If no fire, but smoke, fumes or electrolyte is being emitted from the battery, use water fog to lower the battery temperature.

WARNING

- In no case should CO_2 be directed into a battery compartment to effect cooling or displace explosive gases. The static electricity generated by CO_2 could cause the hydrogen/oxygen gases trapped in the compartment to explode. CO_2 is an acceptable fire extinguishing agent once a fire has developed.

- Make no attempt to disconnect or jettison the battery.

FIRE

INTERNAL ENGINE FIRE

An internal engine fire is a fire that occurs in an engine that is stopped or coasting down.

Symptoms

1. T_5 rises above 300°.

2. Flames and/or smoke coming from engine.

Corrective Action

1. Speed selector — STOPCOCK.

2. Battery switch — ON.

3. Starter — ENGAGE BELOW 20% Ng AND MOTOR UNTIL FIRE IS EXTINGUISHED.

4. External power switch — OFF.

5. Battery switch — OFF.

6. Exit aircraft.

7. Fight fire externally.

ENGINE COMPARTMENT FIRE ON THE GROUND

Symptoms

1. Fire warning light — ON.

2. Flames and/or smoke coming from engine compartment.

3. Ground crew engine fire signal.

Corrective Action

1. Stop aircraft.

2. Speed selector — STOPCOCK.

3. Battery switch — ON.

4. T-handle — FIRE EXT ARMED.

5. Engine compartment fire extinguisher switch — DISCHARGE.

6. External power switch — OFF.

7. Battery switch — OFF.

8. Rotor brake — ON.

9. Parking brake — SET.

10. Exit aircraft.

11. Fight fire externally.

ENGINE COMPARTMENT FIRE IN FLIGHT

Symptoms

1. Fire warning light — ON.

2. Flames and/or smoke coming from engine compartment.

Corrective Action

1. Enter autorotation.

2. Fire indicators — ANALYZE.

NOTE

Severity of the fire, actual flight conditions and terrain conditions will dictate the immediate procedure to be followed.

3. Speed selector — STOPCOCK.

4. T-handle — FIRE EXT ARMED.

5. Engine compartment fire extinguisher — DISCHARGE.

6. Alert cabin occupants.

7. Complete autorotative landing.

8. Secure cockpit.

9. Exit aircraft.

CABIN FIRE

Corrective Action

1. Cockpit windows — CLOSED.

2. Cabin door — CLOSED.

3. Ventilation switch — NORM.

4. Windshield defrost switch — OFF.

5. Portable fire extinguisher — USE.

CAUTION

CO_2 is not toxic; however, it does reduce the oxygen content of the air.

6. Ventilate as soon as practicable.

7. Land as soon as practicable.

ELECTRICAL FIRE

Corrective Action

1. Affected equipment — TURN OFF.

2. Circuit breaker (for affected circuits) — PULL.

If fire persists:

3. Battery switch — BATT START.

4. Generator switches — OFF.

5. Portable fire extinguisher — USE.

6. Land as soon as practicable.

CAUTION

Severity of the fire and actual flight conditions (night or instrument) will dictate the immediate procedure to be followed. It may be more advisable to let the fire burn, if it is isolated, than to secure all electrical power and lose ASE and flight instruments prior to achieving VFR conditions.

SMOKE AND FUME ELIMINATION

Corrective Action

1. CARGO DOOR — OPEN.

2. COCKPIT WINDOWS — OPEN.

3. Land as soon as practicable.

4. Speed selector — STOPCOCK.

5. Battey switch — OFF.

6. Secure cockpit.

CAUTION

- Do not use the radios if fuel fumes are present. The severity of the situation will determine the necessity for securing all electrical power sources and whether an immediate landing is necessary.

- To prevent the venting of smoke or fumes through the cockpit, do not open the cockpit windows if cargo door is closed.

- To avoid the possibility of any rotor blade damage, do not jettison any windows or the cargo door while the helicopter is in forward flight.

RETREATING BLADE STALL

Symptoms

1. Increase in general vibration level of helicopter.
2. Occasional shudders in the airframe.
3. Abrupt pitch-up of the nose of the helicopter.

Corrective Action

1. Collective pitch — DECREASE.
2. Rotor rpm — INCREASE.
3. Decrease severity of the maneuver.
4. Airspeed — GRADUALLY DECREASE.
5. Descend to lower altitude.

POWER SETTLING

Symptoms

1. Rotor roughness.
2. Loss of control effectiveness.
3. Uncontrollable settling.

Corrective Action

1. Collective — ABRUPT INCREASE.
2. Airspeed — INCREASE.

If steps 1 and 2 are ineffective:

3. Collective — BOTTOM TO RESTORE CONTROLLABILITY.
4. Collective — REAPPLY AS TRANSLATIONAL LIFT IS ATTAINED.

TURBULENCE

Corrective Action

1. Airspeed — 55 knots.
2. Nf/Nr — 100%
3. Reverse course if possible.

ICING

Symptoms

1. Vibrations in airframe.
2. Visible accumulation of ice.
3. Increased torque required to maintain altitude and airspeed.
4. Decrease in Ng.
5. Increase in T_5.

Corrective Action

1. Fly helicopter from icing conditions as soon as possible.
2. Emergency throttle — INCREASE IF REQUIRED TO REGAIN DESIRED POWER.
3. Heater — OFF.
4. Airspeed — 55 knots.
5. Land as soon as practicable.

HEAVY RAIN

Symptoms

1. Engine instruments will indicate a loss of power and a corresponding decrease in Nf/Nr will result.

NOTE

The characteristics of the T-58-8B engine are such that engine flameout is not probable.

Corrective Action

1. Speed selector — FULL INCREASE.
2. Emergency throttle — INCREASE IF REQUIRED TO REGAIN DESIRED POWER.

NOTE

A power loss may be experienced even utilizing emergency throttle if rain is extremely heavy.

3. Airspeed — 55 knots.
4. Conditions permitting — SECURE EMERGENCY THROTTLE AND REESTABLISH CRUISE FLIGHT.

NOTE

As rain intensity decreases, power will increase. This will be indicated by an increase in Nf/Nr and power.

RESCUE HOIST MALFUNCTION

LOSS OF ELECTRICAL POWER

Symptoms

1. Hoist cable does not respond to control inputs.

Corrective Action

1. Advise pilot.
2. Check hoist drum for a fouled hoist cable or stuck up-limit switch.

a. If the hoist is fouled — DO NOT ACTUATE THE HOIST.

b. If the hoist cable is not fouled:

(1) If conditions permit, check the hoist circuit breaker.

(2) Operate the hoist using manual override.

CAUTION

DO NOT raise the hoist hook to the full up position when operating on manual override. The up limit protection is bypassed and the hook and cable may be damaged or disconnected.

ELECTRICAL SYSTEM RUNAWAY

Symptoms

1. Hoist cable is in a runaway or intermittent runaway condition.

Corrective Action

1. Advise pilot.

2. Ask the pilot to secure hoist power.

3. Check hoist drum for a fouled cable or stuck up limit switch.

a. If the hoist is fouled — DO NOT ACTUUATE THE HOIST.

b. If the hoist cable is not fouled — OPERATE THE HOIST USING MANUAL OVERRIDE.

CAUTION

DO NOT raise the hoist hook to the full up position when operating on manual override. The up limit protection is bypassed and the hook and cable may be damaged or disconnected.

HYDRAULIC SYSTEM FAILURE

Symptoms

1. Hoist cable does not respond to either electrical control inputs or manual override inputs.

Corrective Action

1. Advise pilot.

2. Discontinue hoist operation. Retrieve the hoisting rig if possible.

HOIST COMMUNICATIONS FAILURE (ICS)

Symptoms

1. Loss of communications between the flight mechanic and the pilot.

Corrective Action

1. Check to insure that HOT MIKE is selected.

2. Check to insure that helmet cord is plugged in.

3. Utilize another ICS control panel.

4. Use another helmet if one is available.

5. Check the ICS PLT circuit breaker on the radio circuit breaker panel.

CAUTION

The hoisting operation should be discontinued if possible until intercommunications can be reestablished.

EMERGENCY HOIST CABLE SHEAR

Symptoms

1. Hoist cable fouled with vessel or other structure and is endangering personnel and/or the helicopter.

Corrective Action

1. Inform pilot immediately.

2. Pay out hoist cable until slack.

3. Attempt to free cable or rig.

4. If the above steps are ineffective, or if personnel or the helicopter is in danger:

   a. Pilot or flight mechanic report — SHEAR! SHEAR! SHEAR!

   b. Flight mechanic actuate EMERG CABLE CUT-OFF switch.

   c. Pilot or copilot actuate HOIST SHEAR switch.

CAUTION

This procedure should be used ONLY in the most EXTREME situation where aircraft or personnel safety depend on the immediate shearing of the hoist cable to avoid a disaster. Except in the most extreme situation, the pilot will make the decision to shear, upon the recommendation of the flight mechanic.

NOTE

Normally, the copilot will be able to shear most expeditiously, but when the report "SHEAR! SHEAR! SHEAR!" is heard, both the EMERG CABLE CUT-OFF switch in the cabin and the HOIST SHEAR switch in the cockpit should be actuated.

CARGO SLING EMERGENCY JETTISON

Symptoms

1. Sling load is uncontrollable.

2. Engine failure, power decrease, or other critical emergency.

Corrective Action

1. Cargo sling master switch — ON.

2. Cargo release switch — DEPRESS.

3. If necessary, transmit to flight mechanic — "JETTISON THE SLING LOAD."

4. Flight mechanic, upon command from the pilot:

   a. Cargo hook manual release handle — PULL.

   b. Strap in securely.

5. When hovering, move left before landing if possible.

EMERGENCY WATER OPERATIONS

Following an emergency water landing, allow the rotor to coast to a stop. Apply rotor brake only if it would be more hazardous to allow the rotor to continue to turn.

NOTE

Torque resulting from rotor brake application will cause the helicopter to rotate in the water and could cause it to capsize.

The helicopter's stability limits may be exceeded in rough water in a power off condition. The power off helicopter can right itself from a roll up to approximately 16° without the aid of auxiliary flotation. A wind of 15 knots or more, creating waves of 2 feet or higher, will probably drive the helicopter into the trough of a wave and cause excessive roll. The auxiliary flotation equipment will increase stability and shall be deployed after an emergency water landing. The sea drogue and/or Danforth anchor should be deployed to prevent drifting into shallow water where the helicopter may be damaged. This should be done even though water depth may initially exceed the effective length of the anchor line.

AUXILIARY FLOTATION SYSTEM DEPLOYMENT

Inflate the bags after the helicopter is resting on the water. The bags are inflated by pulling the manual release handle to the extended position. If flight is necessary after the bags are inflated, airspeed should not exceed 70 knots.

CAUTION

- Pilots should exercise caution when landing on a vessel or land after deployment of the auxiliary flotation bags. Rotor downwash will cause the bags to tuck under the sponsons while in a hover and may cause the bags to burst upon touchdown.

- Ground taxiing with the auxiliary flotation bags inflated will cause damage due to ground contact.

NOTE

If unequal lateral inflation occurs, consideration should be given to equalizing flotation by manually deflating the appropriate section or sections of the opposite bag.

See figures A-19 and A-20 for sea state capabilities.

HULL INTEGRITY CHECKS

It is possible to sustain hull damage without the sensation of a hard landing. After any emergency water landing or hard land landing the aircraft shall be inspected by qualified maintenance personnel before further flight is attempted. If a thorough inspection cannot be accomplished at the landing site, and the pilot in command feels further flight is necessary, the aircraft should be moved in the safest manner possible to the nearest site where the airframe can be fully inspected. Inspection should not be limited solely to the damaged area. A complete evaluation by a qualified maintenance officer should be done prior to granting authority for further flight.

SEA DROGUE DEPLOYMENT

The sea drogue can be deployed from either the pilot's or copilot's window.

1. Sea drogue retaining line — UNCOIL.
2. Sea drogue snap hook — ATTACH TO BOW LINE THIMBLE.
3. Red hook at end of ripcord line — ATTACH TO PEDAL ADJUSTER FLEXIBLE CABLE.

NOTE

The above steps should be accomplished with the sea drogue inside the cockpit to avoid its loss.

4. Sea drogue — CAST OVERBOARD FORWARD OF SPONSON.
5. Ripcord — PULL.
6. Retrieve ripcord.

DANFORTH ANCHOR DEPLOYMENT

The Danforth Anchor can be deployed from either the pilot's or copilot's window.

1. Anchor line snap hook — ATTACH TO BOW LINE THIMBLE.
2. Anchor line bundle — CAST OVERBOARD FORWARD OF SPONSON.
3. Anchor — CAST OVERBOARD FORWARD OF SPONSON.

CAUTION

Do not attach snap hook to large ring in thimble.

TOWING OF THE HELICOPTER ON WATER

Each case of a disabled helicopter on the water presents a unique set of circumstances and problems. No standard towing method will be described. The information contained here and in CGTO 1H-52A-2, will provide background information to those concerned with the towing operation.

The helicopter can be towed forward by attaching a towline to the bow eye on the nose fitting. The bow eye was designed for use with the anchor or sea drogue — not for towing. However, the helicopter has been successfully towed using the bow eye. If the sea drogue or anchor can be deployed, one procedure is to run a boat across the submerged anchor line, fish out the line with a boat hook, and use this line for the towline.

The helicopter can be towed forward by attaching a bridle to the Sponson braces (see CGTO 1H-52A-2).

When underway, the nose of the helicopter has a tendency to wander left and right. This can be controlled somewhat by attaching the sea drogue to the tailwheel tiedown ring.

The helicopter can also be towed backwards by attaching a towing line to the tailwheel tiedown ring. This eliminates the wandering tendency associated with towing forward. Faster towing speeds can be used towing backwards.

Exercise care to avoid damage to the helicopter if the tow boat comes alongside. If possible, the boat should stay to windward of the helicopter since the boat's leeway will be less than that of the helicopter.

Avoid heading parallel to troughs of waves as this may cause excessive roll (see figure A-19). Use ample (50-60 feet) towline to prevent the helicopter from surging up on the tow boat.

WATER TUCK RECOVERY

Symptoms

1. Nose pitches down dipping bow below surface of the water.

Corrective Action

1. Collective — LOWER.
2. Cyclic — NEUTRAL.

EMERGENCY WATER EGRESS PROCEDURES

Because of the high probability of spatial disorientation due to aircraft attitude, damage, and/or environmental factors (night, water), it is imperative that all crew members become familiar with normal/emergency aircraft escape routes and the egress procedures. The importance of the use of reference points cannot be overstressed.

1. Reference Point — LOCATE AND REMAIN CALM.
2. * Emergency Exits — LOCATE EMERGENCY RELEASE HANDLES — PULL AND JETTISON.
3. * Mike Cord — DISCONNECT.
4. Reference Point — RELOCATE AND HOLD.
5. Take a normal breath and wait until completely immersed (recommended 5-8 seconds).

WARNING

Consideration should be given to pulling oneself out of the helicopter just as soon as the exit is clear particularly if the water is cold. This is due to reduced breath holding capability following sudden cold water immersion.

6. Seatbelt/harness — RELEASE.
7. Egress — HOLDING REFERENCE POINTS, EXIT AT RIGHT ANGLES TO THE AIRCRAFT.

WARNING

Failure to maintain a handhold on a Reference Point until clear of the aircraft could result in disorientation.

Inflation of the life vest inside the aircraft may inhibit egress.

*IAW COMDT (G-OAV) MSG 232148Z OCT 87

NOTE

A wet suit will exhibit some positive buoyancy when immersed.

Life vest — INFLATE WHEN CLEAR OF THE AIRCRAFT.

WARNING

If fuel covers the water's surface, do not ignite signalling devices.

ABANDON AIRCRAFT PROCEDURES

PILOTS:

1. Provide first aid kit.
2. Provide PRC-63/90 radio.
3. Exit aircraft.

FLIGHT MECHANIC:

1. Assist passengers and direct their exit.
2. Set and launch Datum Marker Buoy, if available.
3. Provide flashlight and other SAR equipment board items as possible.
4. Deploy rafts (water only).
5. Exit aircraft.

Refer to figure 1-31, Emergency Entrances and Exits.

SECTION IV
AUXILIARY EQUIPMENT

This section contains the description, normal and alternate operation of all equipment which does not contribute to flight, but which enables the helicopter to perform certain specialized functions. Examples of this auxiliary equipment include, but are not limited to the cargo sling, hoist, communication and navigation equipment.

TABLE OF CONTENTS

HEATING SYSTEM

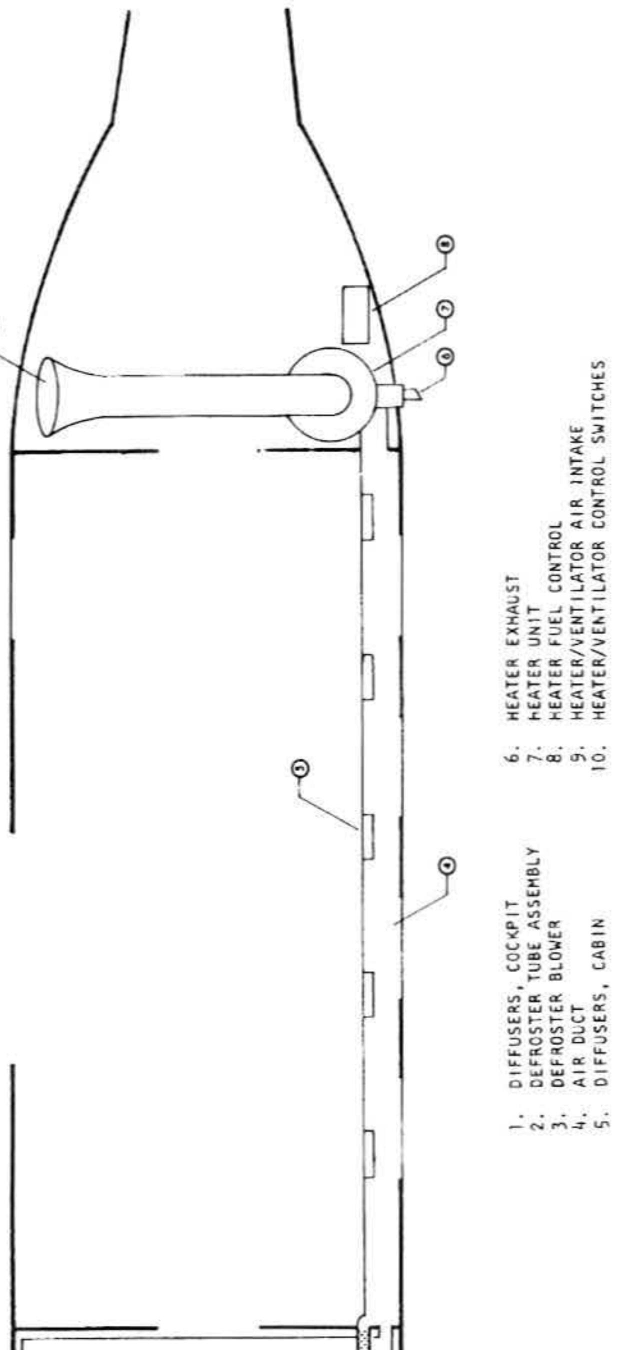
The heating system (figure 4-1) heats outside air and distributes it to the cabin and cockpit for crew comfort. It also provides heated air for windshield defrosting (refer to WINDSHIELD DEFROSTER SYSTEM in this section) and can be used to circulate unheated air for ventilation. (Refer to VENTILATING SYSTEM in this section.) The system consists of a heater unit, a heater blower, air ducts and diffusers, a caution panel light and control switches. A choice of two heat ranges is available. A caution light warns of heater unit overheat and as a further safety measure, the heater will not start unless the blower is providing sufficient airflow for proper combustion. Heater operation is continuous and automatic, after starting, until turned off. The heating system is actuated by a master switch, a heater start switch, and a high-low cycling switch, on the overhead switch console (figure FO-2). The heating system operates on direct current from the essential bus and is protected by circuit breakers, marked VENT RELAY, and CONT, under the general heading CAB HTR, on the forward circuit breaker panel.

HEATER UNIT

The heater unit, in the transition section, is the internal combustion type rated at 50,000 BTU's. It operates on fuel pumped from the forward tank and consumes a maximum of 5 pounds per hour.

HEATER BLOWER

The heater blower draws air into the system through an outside intake vent, on the upper right side of



1. DIFFUSERS, COCKPIT
2. DEFROSTER TUBE ASSEMBLY
3. DEFROSTER BLOWER
4. AIR DUCT
5. DIFFUSERS, CABIN
6. HEATER EXHAUST
7. HEATER UNIT
8. HEATER FUEL CONTROL
9. HEATER/VENTILATOR AIR INTAKE
10. HEATER/VENTILATOR CONTROL SWITCHES

Figure 4-1. Heating, Ventilating, and Defroster Systems the fuselage, and forces it through a heat exchanger unit surrounding the combustion heater unit where it is heated. The heated air is then forced through a plenum chamber in the ducting.

AIR DUCTS

The air duct passing through the cabin has five adjustable diffusers for cabin heating. In the pilot's compartment the air duct divides into three smaller ducts: one duct mounts an adjustable diffuser just above the floor to the right of the pilot and a fixed diffuser by the pilot's pedals, one duct mounts an adjustable diffuser just above the floor to the left of the copilot and a fixed diffuser by the copilot's pedals, and one duct leads to the windshield defroster diffusers.

HEATER CONTROL SWITCHES

Master

The heater switch, marked MASTER, with positions, ON and OFF, is on the overhead switch panel under the general heading HEATER. The heater master switch must be in the ON position before the START switch can be energized. When the heater master switch is placed in the ON position, the HEATER HOT caution light will go on and remain on until the heater is started. Heater operation is stopped by placing the MASTER switch in the OFF position.

Start

The heater start switch, marked START, with marked position, ON and OFF, is on the overhead switch panel under the general heading HEATER. The start switch is of the momentary type, spring-loaded to the OFF position. Prior to actuating the START switch, the heater master switch is placed in the ON position and the heater blower switch is placed in the NORM position. Holding the START switch momentarily in the ON position will start the heater when the heater blower develops sufficient air pressure to close the ram air switch. This in turn energizes the master fuel valve, ignition unit, fuel pump and cycle valve starting the heater.

Blower

The heater blower switch with marked positions VENT BLO and NORM, under the heading HEATER, is on the overhead switch panel. The VENT BLO position is used to operate the heater blower for ventilation. The heater MASTER switch does not have to be ON to use the VENT BLO position. The NORM position causes the heater blower to function automatically during heater operation. The blower motor is powered by the dc essential bus through a circuit breaker, marked VENT BLO, on the air circuit breaker panel.

High-Low Cycling

The high-low cycling switch, with marked positions LO and HI, under the general heading HEATER, is on the overhead switch panel. When the cycling switch is in the LO position, the heater automatically maintains a temperature of 65.5°C (150°F) in the ducts. In the HI position the heater automatically maintains a temperature of 140.6°C (285°F) in the ducts.

CAUTION LIGHT

A caution light marked HEATER HOT, on the caution-advisory panel (figure 1-27) goes on when the MASTER switch is placed in the ON position and remains on until the heater START switch is activated. The caution light also goes on during heater operation if heater unit temperature reaches 176.7°C (350°F). Insufficient air pressure for proper combustion will also cause the HEATER HOT caution light to go on.

NOTE

> If HEATER HOT caution light goes on, do not restart heater until cause of overheat has been determined.

WINDSHIELD DEFROSTER SYSTEM

The windshield defroster (figure 4-1) system consists of a defroster blower, ducts and diffusers, and a switch marked WSHLD DEFROST with two marked positions ON and OFF. The windshield defroster switch controls a blower motor, in the main duct of the windshield defroster. When the windshield defroster switch is placed in the ON position and the heater is operating, the blower motor provides a rapid flow of heated air against the windshield. The blower may also be utilized for defogging the windshield without turning the heater on. The defroster blower motor operates on direct current from the dc essential bus, and is protected by a circuit breaker, marked DEFROST BLO MOTOR, on forward circuit breaker panel. Maximum heated defrost air is obtained by operating the heater, closing all of the adjustable diffusers in the cabin and cockpit and positioning the WSHLD DEFROST switch to the ON position. Maximum unheated air for defogging is obtained by closing all of the adjustable diffusers with the heater off, heater blower switch in the VENT BLO position and the WSHLD DEFROST switch in the ON position.

VENTILATING SYSTEM

The ventilating system (figure 4-1) utilizes the heater blower, ducts and diffusers to draw air from outside and circulate it throughout the helicopter. The ventilating system may also be used as an aid to dissipate smoke or fumes from the helicopter interior.

Ventilation is accomplished by actuating the heater blower switch marked VENT BLO and NORM under the general heading HEATER, on the overhead switch panel. Placing the blower switch in the VENT BLO position turns the blower on, which forces air through the heater and windshield defroster ducts.

ENGINE ANTI-ICE SYSTEMS

There are two separate anti-ice systems which are actuated by a single switch on the pilot's overhead switch panel. These two systems are the Engine IGV Anti-Ice System and the Engine Inlet Duct Anti-Ice System. These systems should be turned on when outside air temperature is 10°C (50°F) or below.

ENGINE IGV ANTI-ICE SYSTEM

The engine IGV anti-ice system prevents the formation of ice on the compressor front frame, the starter cover at the front of the engine and the inlet guide vanes. Viewing from the rear of the engine, hot air is supplied from the tenth stage of the compressor, when the system is on, to heat the 12 o'clock and the 3 o'clock struts of the front frame, the starter bullet nose cover, and the inlet guide vanes. The 9'o clock and 6 o'clock struts are continuously heated and require no separate anti-icing. The 6 o'clock strut is heated by oil from the compressor rotor front bearing while the 9 o'clock strut is heated by balance chamber air. The anti-icing of the 12 o'clock strut, 3 o'clock strut, front frame of the engine and the starter fairing commences whenever the ANTI-ICE switch on the pilot's overhead panel is placed in the ON position. The system is comprised of the anti-ice switch, compressor bleed air solenoid valve and an advisory light on the caution-advisory panel (figure 1-27). The engine anti-icing system operates on current from the dc essential bus, and is protected by a circuit breaker, marked IGV, under the general heading ANTI-ICE, on the forward circuit breaker panel.

NOTE

Continued operations at ground idle under known icing conditions should be avoided because there is insufficient compressor bleed available to maintain the engine components at the desired anti-icing temperatures.

Engine Anti-Ice Switch

The engine anti-ice switch, marked ENG ANTI-ICE with marked positions, TEST, OFF, and ON, on the overhead switch panel (figure FO-2), controls engine anti-icing in the OFF and ON positions. The ON position functions to de-energize the solenoid valve allowing it to open and admit hot de-icing air to the engine. The TEST position is used only to check the engine inlet anti-ice controller.

Solenoid Valve

Compressor bleed air is controlled by a solenoid valve which is held closed, against spring tension, when energized. When the ENG ANTI-ICE switch is placed in the ON position, the solenoid is de-energized and the valve is opened by spring force. If an electrical power failure occurs which de-energizes the solenoid valve, it will open and provide continuous anti-icing to the engine.

Advisory Light

An advisory light, marked ENG IGV ANTI-ICE, on the caution-advisory panel (figure 1-27), goes on when the solenoid valve is de-energized. Therefore, the ENG IGV ANTI-ICE advisory light will go on when the ENG ANTI-ICE switch is placed in the ON position. Lighting of the advisory light when the ENG ANTI-ICE switch is in the OFF position indicates loss of electrical power at the solenoid valve, causing continuous anti-icing of the engine components. The engine anti-icing system advisory light operates on current from dc essential bus and is protected by a circuit breaker, marked ENG ANTI-ICE, under the general heading WARNING LIGHTS, on the forward circuit breaker panel.

ENGINE INLET DUCT ANTI-ICE SYSTEM

The engine inlet duct anti-ice system prevents formation of ice on the engine air intake duct. This is accomplished by passing electrical current through heating elements embedded in the fiberglass duct. A temperature sensor, also embedded in the duct sends signals to the anti-ice controller. This controller automatically cycles electrical power to the heating elements to maintain the inlet duct in the desired temperature range, 48.9°C (120°F) to 54.4°C (130°F) when the system is turned on. The engine inlet duct anti-icing system is comprised of these components: the air inlet duct, the anti-icing controller, the caution panel light and the inlet duct anti-icing system switch.

Inlet Duct

The engine inlet duct (bellmouth) is made of laminated Fiberglass. Embedded between laminations are electrical heating elements and a temperature sensor that provides signals for the anti-ice controller. A thermal switch, normally closed below 4.1°C (40°F), is mounted externally on the inlet duct for actuation of the caution panel light. The heating elements receive electrical power from the ac essential bus through the ENG INLET ANTI-ICE circuit breaker on the aft circuit breaker panel.

Anti-Ice Controller

The engine inlet anti-ice transistorized controller is in the transition section of the helicopter. The temperature sensor embedded in the inlet duct senses temperature for the controller which automatically cycles current to the heating elements to maintain the duct temperature between 48.9°C (120°F) and 54.4°C (130°F). The automatic controller utilizes current from both the ac essential bus and current from the dc essential bus. The alternating current circuits of the automatic controller are protected by a circuit breaker, marked ANTI-ICE CONT, located on the forward circuit breaker panel. The direct current circuits of the automatic controller are protected by a circuit breaker, marked INLET, under the general heading ANTI-ICE, also on the forward circuit breaker panel.

Caution Light

The engine anti-icing system caution light, marked ENG INLET ANTI-ICE is on the caution-advisory panel (figure 1-27). The caution light, controlled by the duct-mounted thermal switch, goes on when the inlet duct temperature is 4.1°C or less whether the system is ON or OFF. With the ENG ANTI-ICE switch in the ON position, lighting of the caution light indicates that the inlet duct temperature has dropped to 4.1°C or less because of system malfunction or because system capability has been exceeded. With the ENG ANTI-ICE switch in the OFF position, lighting of the caution light at 4.1°C (40°F) or below reminds the pilot to turn the engine anti-icing system on. The engine inlet anti-icing system caution light operates on current from the dc essential bus and is protected by a circuit breaker, marked ENG ANTI-ICE, under the general heading WARNING LIGHTS, on the forward circuit breaker panel.

Anti-Icing System Switch

The engine anti-ice switch, marked ENG ANTI-ICE, with marked positions TEST, OFF, and ON, is on the overhead switch panel (figure FO-2). It controls both the engine inlet duct anti-ice system, and the engine anti-ice system. (Refer to Engine ANTI-ICE, SYSTEM in this section.) When the engine anti-ice switch is placed in the ON position the anti-ice controller functions continuously and automatically to maintain the desired inlet duct temperature. The engine anti-ice switch, momentary in the TEST position, is used to check the functioning of the controller. When held in the TEST position, the ENG INLET ANTI-ICE caution light goes on, indicating that power is being cycled to the heating elements by the controller. When duct temperature reaches 54.4°C (130°F) the controller stops current flow to the heating elements and the caution light goes off. Continued cycling of the controller may be observed by holding the switch in the TEST position. During conditions of high ambient temperatures subsequent off cycles (caution light out) may be several minutes because of the slower cooling rate of the duct.

COMMUNICATION/NAVIGATION SYSTEMS

Communication control panels (figure 4-2) in the cockpit are on the upper and lower consoles (figure FO-2). All panels may be operated by either pilot. In addition, two communication control panels are in the cabin for the crewman, one above the cargo door, and one on the left side of the cabin. All radio equipment is installed on the integrated electronics rack, in the right forward area of the cabin, which is easily accessible in flight. The radio equipment utilizes both direct and alternating current. Master control for the radio equipment is provided by a radio master switch, on the overhead switch panel in the pilot's compartment (figure FO-2). Indicators, used in conjunction with the navigation sets, are on the instrument panel in front of the pilot and copilot (figure FO-1).

The antennas used for communications, navigations, transponder, and radar altimeters are on various sections of the aircraft (figure 4-14).

ELECTRICAL POWER DISTRIBUTION

Communication System DC Power

The helicopter's dc system supplies voltage from the helicopter's battery, transformer rectifier, or external power source through the start bus, through the essential bus relay to the dc essential bus. From the dc essential bus the dc voltage divides into two paths. The first path is through the RADIO MASTER POWER circuit breaker, on the circuit breaker panel (figure FO-3) behind the copilot's bulkhead, to the normally open contacts of the radio master relay. The second path from the dc essential bus is through the 5 ampere RADIO MASTER CONTROL circuit breaker, forward circuit breaker panel, to the RADIO MASTER switch. Placing the RADIO MASTER switch ON energizes the radio master relay, allowing dc voltage from the RADIO MASTER POWER circuit breaker to be supplied through closed contacts of the radio master relay to the dc radio bus, in the radio circuit breaker panel (figure FO-3). The dc voltage continues through the dc radio bus, and through individual circuit breakers to the specific system.

Communication System AC Power

115 volt, 400 cycles per second, three-phase power is supplied from the helicopter's generators, or from an external power source through the ac essential bus, through three RADIO circuit breakers, on the forward circuit breaker panel, to the ac radio bus, on the radio circuit breaker panel. The ac voltage continues through the ac radio bus and through individual circuit breakers to the specified system.

Navigation System DC Power

The dc power system for the Navigation equipment is the same system used to supply dc power to the Communication equipment.

Navigation System AC Power

The ac power system for the Navigation equipment is the same system used to supply ac power to the Communication equipment. However, there is an additional source of ac power for the Navigation equipment.

A radio autotransformer converts 115 volts, phase-B, ac power, coming directly from the ac essential bus to 26 volts ac. The radio autotransformer is protected by a circuit breaker marked AUTO XMFR on the forward circuit breaker panel. The 26 volts ac, passes through a circuit breaker marked IND on the radio circuit breaker panel on it's way to power the BDHI, RMI, portions of the VHF navigation system, and the loop antenna.

NOTE

> The course deviation indicators and glide slope indicator require dc power only.

Radio Circuit Breaker Panel

The radio circuit breaker panel (figure FO-3) is on the forward end of the integrated electronics rack by the pilot's compartment access door. The direct current operating circuits, each protected by an appropriately marked circuit breaker, are connected to the helicopter's dc power supply system

TYPE	DESIGNATION	FUNCTION	RANGE	LOCATION OF CONTROL
ICS	AN/AIC-12	Interphone and radio communications	Internal	Lower console, cabin
UHF/COMM	AN/ARC-51A	Two-way voice communications	Line of sight	Lower radio console
VHF/COMM	AN/ARC-84	Two-way voice communications	Line of sight	Upper or Lower radio console
HF/COMM	AN/ARC-94	Two-way voice communications	Long range	Upper radio console
VHF-FM/ COMM	AN/ARC-160	Two-way voice communications	Line of sight	Upper radio console
Trans-ponder	AN/APX-99	Radar identification	Line of sight	Lower radio console
X-band trans-ponder	SST-185X	Ship's radar identification	Line of sight	Upper radio console
Loud Hailer	N/A	Loudspeaker communications	1/2 mile	Upper radio console
VHF/NAV	AN/ARN-87	ILS and VOR navigation	Line of sight	Lower radio console
VHF/NAV	AN/ARN-123	ILS and VOR navigation	Line of sight	Upper radio console
Marker Beacon	MKA-23A	Marker beacon receiver	N/A	Instrument panel
Tacan	AN/ARN-118	Tactical air navigation	Line of sight	Upper radio console
LF/ADF	AN/ARN-73	Automatic direction finding	Long range	Lower radio console

Figure 4-2. Avionics Equipment (1 of 2)

TYPE	DESIGNATION	FUNCTION	RANGE	LOCATION OF CONTROL
LORAN C NAVIGATOR	AN/ARN-133	Loran C navigation	Long range	Lower radio console
Broadband Homer	DMSE-47-2	VHF/UHF Homing	Variable	Upper radio console
Radar Altimeter	AN/APN-171	Measure Absolute Altitude	5000 FT	Instrument panel

Figure 4-2. Avionics Equipment (2 of 2)

through the radio master switch. The ac operating circuits, each protected by an appropriately marked circuit breaker, are connected directly to the helicopter's ac power supply system. Both power sources must be operative for the communication and associated electronics equipment to be fully operative.

Radio Master Switch

The switch (figure FO-2), marked RADIO MASTER, OFF and ON, on the overhead switch panel, controls the dc power supply to the radios. The radio master circuit is energized from the dc essential bus through two circuit breakers, marked PWR and CONT, under the general heading RADIO MASTER, located on the forward circuit breaker panel. The Radio Master switch must be on for operation of all Comm/Nav equipment.

COMMUNICATIONS EQUIPMENT

INTERPHONE COMMUNICATION SYSTEM (ICS) AN/AIC-12

The AN/AIC-12 is installed to provide communication between various crewmembers. The ICS also links the audio channels of the communications and associated electronic equipment, to provide simplified control and simultaneous operation. Components of the system are four interphone-radio control panels, two coil headphone cord assemblies, cyclic trigger switches, a junction box, a hoist position remote switch, the copilots remote switch and headsets. The system operates on dc power from the radio bus and is protected by circuit breakers, marked CO-PLT and PLT, under the general heading ICS, on the radio circuit breaker panel.

Interphone Control Panels

There are four interchangeable panels (figure 4-3) throughout the helicopter. Two panels are on the forward portion of the lower radio console. The remaining two panels are in the cabin, one above the cargo door and the other on the opposite bulkhead. A coil cord assembly and jack is attached to each of the cabin interphone panels to provide mobility for the crewman or observer. Each panel is equipped with a volume control knob, a rotatable six-position transmit selector switch, and six receiver switches. The volume control knob, marked VOL, controls the level of headset audio signals from all equipment except the LF/ADF, and RAWS. The panels operate on dc power from the radio bus.

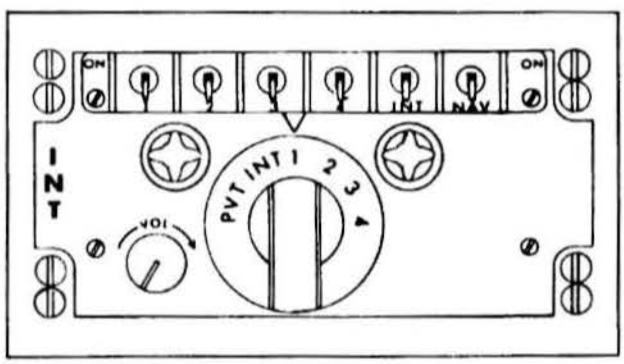


Figure 4-3. ICS Control Panel

TRANSMIT SELECTOR SWITCH

The transmit selector switch enables selection of interphone (INT), private (PVT), or one of four transmitters: NO. 1 — UHF, NO. 2 — VHF, NO. 3 — HF, and NO. 4 — FM. The transmit selector switch also provides reception of the selected equipment. The passenger interphone control panel will not transmit on any radio, nor will it receive or transmit private communications. The hoist operator's interphone control panel will not transmit on any radio, but will receive and transmit on PVT. The PVT position is used in conjunction with the Loud Hailer System and for private communications. Private communications is accomplished by selecting PVT and keying the microphone. Only those stations that have PVT capability and have selected PVT will hear the communications.

NOTE

The hoist operator's transmit selector switch must be placed in INT in order to transmit over the intercom.

RECEIVER SELECT SWITCHES

The Receiver Select switches marked RECEIVERS 1, 2, 3, 4, INT, and NAV, permit selection of any of six receivers, independent of the position of the transmit selector switch. The number 1, 2, and 3 switches select the UHF, VHF, and HF receivers, respectively. The number 4 switch selects the TACAN and FM receivers. The INT switch provides intercommunication reception. The INT switch is internally wired ON at the pilot's and hoist operator's position. This prevents either station from disconnecting from the intercommunication circuit. The NAV switch enables selection of the LF automatic direction finder and marker beacon receivers, except that the cabin stations may only receive the LF automatic direction finder. If the AN/ARN-123 VHF NAV System is installed, VOR and LOC audio is received through the NAV switch. If the AN/ARN-123 is not installed, VOR and LOC audio is received through the number 2 switch.

CYCLIC MICROPHONE TRIGGER SWITCH

A spring-loaded, three-position microphone trigger switch, marked ICS and RADIO, is on the pilot's and copilot's cyclic stick grips (figure 1-19). When the upper portion of the switch is held in the ICS position, the respective microphones are connected to the interphone transmission circuit. When the lower portion of the switch is held in the RADIO position, the respective microphone is connected to the radio transmission circuit selected by the Transmit-Interphone Select switch.

COPILOT'S REMOTE ICS SWITCH

The copilot's remote ICS switch (figure 4-4), marked REMOTE ICS, OFF, and RADIO, is in the cockpit to the left and forward of the copilot's seat. The switch is connected in parallel to the cyclic stick trigger switch permitting operation of the interphone and radio systems. When the switch is placed in the ICS MAINTAINED position, intercommunications may be conducted. When the switch is placed in the OFF position, normal radio operation through the cyclic stick switch is maintained. The RADIO MOMENTARY position allows the copilot to conduct radio communications. When the switch is released, it will return to the OFF position.

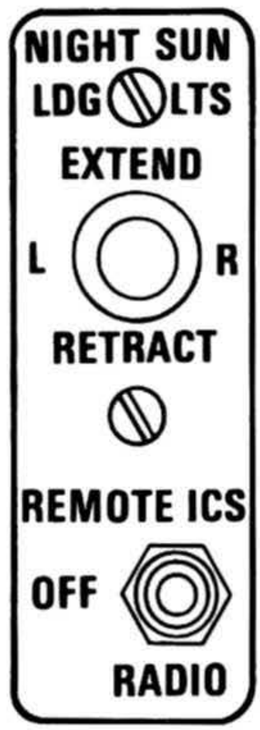


Figure 4-4. Copilot's Remote ICS Switch

HOIST OPERATOR'S INTERPHONE SWITCH

The hoist operator's interphone switch (figure 4-5), marked HOT MIKE, with positions MOMENTARY, OFF, and MAINTAINED, is above the cargo door on the hoist control panel to the left of the interphone control panel. Intercommunications may be conducted in either the MOMENTARY or MAINTAINED positions. When the switch is placed in the MAINTAINED position, hands-off operation of the interphone system is provided during rescue or hoist operations. From the MOMENTARY position the switch is spring-loaded to the OFF (centered) position. A warning light, on the HOT MIKE switch, is used as a safety precaution to indicate that power is applied to the HOT MIKE switch, which may interfere with interphone and radio communications.

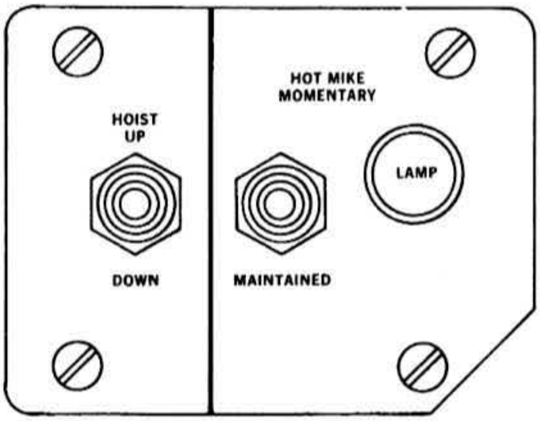


Figure 4-5. Hoist Operators ICS Switch

UHF/COMM RADIO SET AN/ARC-51A

The UHF/COMM system AN/ARC-51A is composed of a receiver-transmitter, and a control panel. The set provides two-way voice communication between land based, seaborne or airborne stations. This can be accomplished on any one of 20 preset frequencies or by manually selecting any one of 3500 channels spaced at 50 kHz intervals within the equipment's frequency range of 225.0 through 399.95 MHz. The radio set includes a guard receiver which permits continuous monitoring of the Guard frequency at the same time the main transmitter receiver is tuned to a tactical frequency. The system operates on ac and dc power from the radio bus, is protected by four circuit breakers on the radio circuit breaker panel marked UHF and UHF Aϕ, Bϕ, and Cϕ.

NOTE

With loss of ac power, the guard receiver only will continue to function.

UHF/COMM Control Panel

The operating controls on the AN/ARC-51A radio control panel (figure 4-6) are the function selector, the mode selector, the preset channel control, the preset channel indicator, the frequency selectors, the frequency display window, the volume control, and the squelch disable switch.

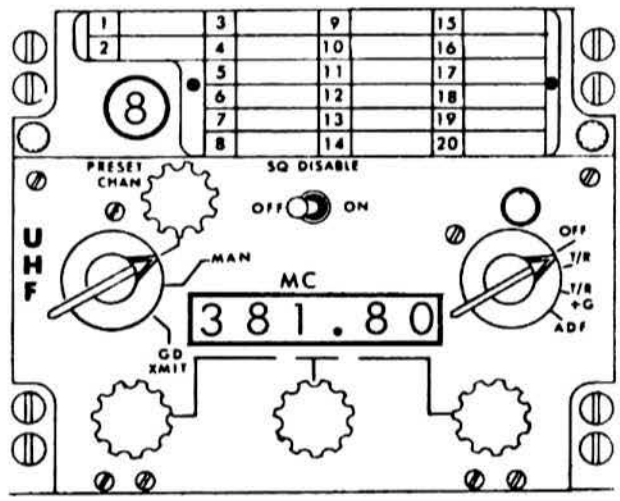


Figure 4-6. UHF Control Panel

FUNCTION SELECTOR

The function selector has four positions. In the OFF position, all power is removed from the equipment. The T/R position energizes the receiver-transmitter. T/R +G energizes the receiver-transmitter and guard receiver. The ADF position of the function switch is not used in this installation.

MODE SELECTOR

The mode selector has three positions. The PRESET CHAN position permits selection of one of 20 preset channels by means of a preset channel control. In the MAN position 3500 frequency channels may be selected by use of the manual frequency selectors. The GD XMIT position selects the preset guard frequency for the transmitter and receiver.

PRESET CHANNEL CONTROL

The preset channel control selects any one of the 20 preset channels. The preset channel indicator displays the preset channel.

FREQUENCY SELECTORS

Frequency selectors provide manual frequency selection when the mode selector is set at MAN.

VOL CONTROL

The VOL control adjusts the audio level of the receiver.

SQ DISABLE SWITCH

The SQ DISABLE switch has two positions. In the ON position, the receiver squelch is disabled. In the OFF position the receiver squelch circuit is unaffected.

UHF/COMM Operation

To Turn Set On:

1. Function switch (UHF/COMM control panel) —AS REQUIRED.

2. ICS receiver select switch — UHF — ON.

3. ICS transmit select switch — POSITION 1 (UHF).

4. Squelch disable switch — OFF.

5. Volume control knob (UHF/COMM control panel) — AS REQUIRED.

6. Mode selector (UHF/COMM control panel) — AS REQUIRED.

7. Preset channel control (UHF/COMM control panel) — AS REQUIRED.

8. To transmit — Depress the microphone trigger switch on the cyclic stick grip to the radio position.

To Secure Set:

1. Function switch (UHF/COMM control panel) — OFF.

VHF/COMM RADIO SET AN/ARC-84

The VHF/COMM system AN/ARC-84 is composed of a receiver, a transmitter, and a control panel. The set provides two-way voice communication between land based, seaborne and airborne station. The transmitter and receiver are designed to operate on crystal controlled channels spaced 50 kHz apart. The range of the transmitter is 118.0 through 135.95 MHz and the range of the receiver is 108.0 through 135.95 MHz. The VHF receiver and transmitter are dc powered by the radio bus. The system is protected by circuit breakers marked VHF RCVR, and XMTR, on the radio circuit breaker panel.

VHF/COMM Control Panel

The operating controls are provided by a control panel (figure 4-7), marked COMM, on the upper radio console. The panel consists of two frequency selectors, the frequency display window, the off-on/volume control, a squelch control, a momentary VHF-ADF select switch, and a VOR momentary check switch.

FREQUENCY SELECTORS

The frequency selectors mechanically select and display frequencies spaced 50 kHz apart over the 108.00 through 135.95 MHz range.

NOTE

> If a frequency is selected in the navigation range (108.00 to 117.95), the transmitter is tuned to VHF GUARD (121.5). The receiver is tuned to the navigation frequency for audio and navigation information. Refer to VHF NAV RADIO SET (AN/ARN-87), this section. If the AN/ARN-123 has been installed, only the audio navigation information is available.

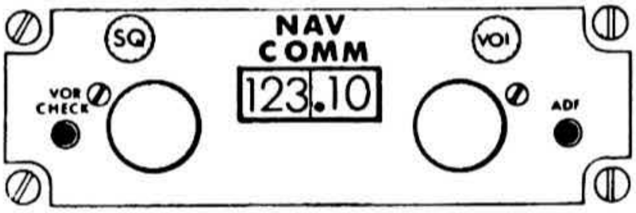


Figure 4-7. VHF Control Panel

VOL OFF SWITCH

The VOL OFF switch provides ON and OFF power control to the radio and volume control of the audio level.

SQ CONTROL

The SQ control eliminates background noise.

ADF SWITCH

Equipment not installed.

VOR CHECK SWITCH

The VOR check switch is used for an internal check of the system (see VHF NAV RADIO OPERATION this section).

NOTE

If the AN/ARN-123 is installed, this VOR check switch is inoperative.

VHF/COMM Operation

To Turn Set On:

1. VOL OFF switch (VHF/COMM-NAV control panel) — ON.

2. ICS receiver select switch — VHF—ON.

3. ICS transmit select switch — Position 2 (VHF).

4. Frequency selectors (VHF/COMM — NAV control panel) — AS REQUIRED.

5. SQ control (VHF/COMM — NAV control panel) — AS REQUIRED.

6. To transmit — Depress the microphone trigger switch on the cyclic stick grip to the radio position.

To Secure Set:

1. VOL OFF switch (VHF/COMM control panel) — OFF.

HF/COMM RADIO SET AN/ARC-94

The HF/COMM system AN/ARC-94 consisting of a receiver-transmitter, a control panel, and an antenna, provides voice communication between land based, seaborne and airborne stations. The operating frequency range is from 2.0 to 29.999 MHz divided into 28000 discrete channels in units of 1 kHz. The HF/COMM system receives and transmits on either single side band (SSB) or amplitude modulated equivalent (AM). The radio set uses ac and dc power from the radio bus. The set is protected by 3 ac circuit breakers marked HF-SSB and 1 dc circuit breaker marked HF SSB, all on the radio circuit breaker panel.

HF/COMM Operating Controls

The system is remotely controlled by a control panel (figure 4-8) on the upper console. The HF control panel has a mode selector, four frequency selector knobs and associated display window, and a volume control knob.

MODE SELECTOR

The mode selector has four marked positions. The OFF position removes aircraft power from the set. The USB position selects single-sideband upper. The LSB position selects single-sideband lower. The AM position provides amplitude modulation operation of the radio.

FREQUENCY CONTROL

The control panels each have a frequency display window that reads in megahertz, and four frequency selector knobs to select operating frequencies.

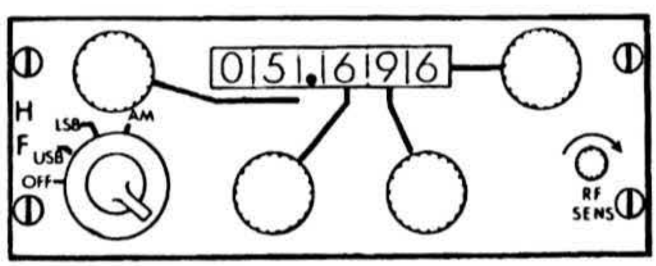


Figure 4-8. HF Control Panel

VOLUME CONTROL

A volume control knob marked RF SENS adjusts the receiver sensitivity of the receiver-transmitter.

WARNING

During ground operation of the AN/ARC-94, insure that personnel are clear of the antenna. Serious burns may result if bodily contact is made with the antenna during ground operation.

HF/COMM Radio Set AN/ARC-94 Operation

To Put Equipment Into Operation:

1. Mode selector (HF/COMM control panel) — AS REQUIRED.

2. ICS receiver select — Position 3 (HF) — ON.

3. ICS transmit select switch — Position 3 (HF).

4. Frequency selector (HF/COMM control panel) — AS REQUIRED.

NOTE

While set is channeling no background noise will be heard in the headset. The channeling cycle is complete when background noise is heard.

5. Microphone switch — DEPRESS MOMENTARILY.

NOTE

When microphone switch is depressed, a 1-kHz tone will be heard in the headset. When the tone disappears antenna loading is complete and the set is ready for operation.

6. To transmit — Depress the microphone trigger switch on the cyclic stick grip to the radio position.

To Secure Equipment:

1. Function selector switch (HF/COMM control panel) — OFF.

VHF-FM/COMM RADIO SET AN/ARC-160

The VHF-FM COMM System AN/ARC-160 is composed of a receiver-transmitter and a control panel. The set provides two-way voice communications between land based, seaborne or airborne stations. This may be accomplished on any one of 4800 manually selected channels spaced at 5 kHz units in the 150.000 to 173.995 MHz frequency range. The radio set includes a guard receiver which permits continuous monitoring of 156.800 MHz at the same time the main transmitter-receiver is tuned to an operating frequency. The set may also be used in conjunction with the Broadband Homing System (DMSE 47-2).

VHF-FM/COMM Control Panel

The VHF-FM/COMM control panel (figure 4-9), on the upper radio console (figure FO-2), marked VHF-FM, contains a 100 MHz indicator, frequency selection indicator switches, a receiver test switch, a high-low power switch, a function selector switch, a half duplex switch, a squelch control, and a volume control.

100 MHz INDICATOR

The hundreds MHz digit is represented by a permanently displayed "1" in the upper left corner of the control panel.

FREQUENCY SELECTION INDICATOR SWITCHES

Five rotary frequency selector indicator switches allow manual tuning of the radio set. From left to right, these switches control the 10 MHz, 1 MHz, 100 kHz, 10 kHz, and 5 kHz steps.

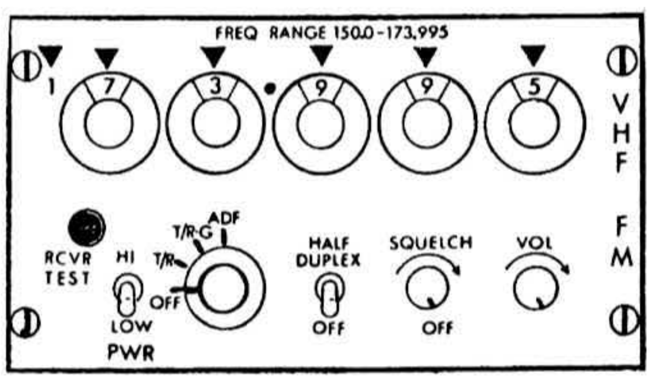


Figure 4-9. VHF/FM Operating Controls

RECEIVER TEST SWITCH

A momentary pushbutton receiver test switch, marked RCVR TEST audibly indicates proper receiver performance. With the Function Selector Switch in T/R or T/R +G, depressing the switch causes a 800 Hz tone to be heard. If the tone is not heard, the receiver has a malfunction and may not operate properly.

HIGH-LOW POWER SWITCH

A high-low power toggle switch, marked HI LO PWR, selects 5-watt (HI) or 1-watt (LO) power output.

FUNCTION SELECTOR SWITCH

The function selector switch has four positions. In the OFF position, power is removed from the set. The T/R position energizes the receiver-transmitter to the manually selected frequency. The T/R +G position energizes the receiver-transmitter and the 156.800 guard receiver. The ADF position is not utilized.

HALF DUPLEX SWITCH

The two position half duplex switch, marked HALF DUPLEX-OFF, provides simplex or duplex operation. In the OFF position, simplex operation is permitted. The HALF DUPLEX position permits half duplex operation in the 156.000 to 157.995 MHz marine band.

The transmitter is tuned to the frequency selected on the frequency selector indicator switches while the receiver frequency is offset 4.6 MHz above the selected frequency (160.600 to 162.595 MHz).

SQUELCH CONTROL

The SQUELCH control eliminates background noise. The receiver is unsquelched with the knob in the fully clockwise position.

VOLUME CONTROL

The volume control knob, marked VOL, adjusts the audio output level of the set.

VHF-FM/COMM Operation

To Turn Set ON:

1. Function Selector Switch (VHF-FM/COMM control panel) — AS REQUIRED.
2. ICS receiver select switch — TAC/FM — ON.
3. ICS transmit select switch — Position 4 (FM).
4. Frequency Selector Switches (VHF-FM/COMM control panel) — AS REQUIRED.
5. HI LOW PWR Switch (VH-FM/COMM control panel) — AS REQUIRED.
6. VOL Control Knob (VHF-FM/COMM control panel) — AS DESIRED.
7. Squelch control knob (VHF-FM/COMM control panel) — AS REQUIRED.
8. HALF DUPLEX Switch (VHF-FM/COMM control panel) — AS REQUIRED.
9. RCVR TEST Switch (VHF-FM/COMM control panel) — PRESS TO TEST AS DESIRED.
10. To transmit — Depress the microphone trigger switch on the cyclic stick grip to the radio position.

NOTE

Do not attempt to receive messages on 156.8 MHz on both the main and guard receivers simultaneously. A garbled message will be heard.

To Secure Set:

1. Function Selector Switch (VHF-FM/COMM control panel) — OFF.

LOUD HAILER SYSTEM

The Loud Hailer System consists of a 250-watt transistorized amplifier, a two-speaker assembly, and a remote control head. The amplifier is on the front side of the radio rack. The two speaker assembly, when mounted, is on the right side of the fuselage forward of the cabin door. The control head is on the upper radio console. The amplifier and speaker assembly are designed for quick installation and removal.

WARNING

Do not attempt to install the speaker assembly in flight.

CAUTION

Insure that power is secured to the system prior to installing the amplifier and speaker system.

NOTE

With the speaker assembly installed, all normal flight operations, including water landings, are permitted.

The system uses dc power from the radio bus and is protected by a circuit breaker marked LOUD HAILER on the radio circuit breaker panel.

Loud Hailer Operation

The system is energized by the ON-OFF switch on the control head. The pilot, copilot, or hoist operator may operate the system by placing their respective transmit selector switch to PVT and depressing the radio microphone switch. The speaker volume is controlled by the gain control on the amplifier.

NOTE

- Loud Hailer operation at the hoist operator position is of limited use due to high feedback between the crewman's microphone. The feedback may be reduced somewhat by turning the volume down on the ICS control panel.
- Feedback at the pilot's station may be reduced by closing the sliding window and, if necessary, reducing the volume on the ICS control panel.

NAVIGATION EQUIPMENT

BEARING DISTANCE HEADING INDICATOR (ID-663/U)

The BDHI is installed on the pilot's instrument panel. The BDHI has two rotating pointers, a central digital distance window, and a rotating compass card. The number one pointer provides a magnetic bearing from the LF-ADF radio. The number two pointer provides either VOR or TACAN information. The central digital distance window provides line of sight distance from a selected TACAN station or other aircraft. The rotating compass card repeats the information from the MA-1 Compass System.

RADIO MAGNETIC INDICATOR

The RMI (8, figure FO-1) is mounted on the copilot's instrument panel. The RMI consists of a fixed outer dial, an inter rotating compass card, and two pointers. The rotating compass card repeats the information from the MA-1 Compass System. The number one pointer provides a magnetic bearing from the LF-ADF radio. The number two pointer provides a magnetic bearing from the VHF navigation system or TACAN.

NOTE

With a BDHI or RMI compass card malfunction, the ADF pointer displays relative bearing only and will continue to point to the station. The TACAN pointer does not point to the station, but will continue to display TACAN radials. The VOR pointer may not be reliable and SHOULD NOT BE USED. The CDI and ambiguity information on the OMNI Course Indicator is reliable.

VOR/TAC SELECTOR SWITCHES

Two VOR/TAC selectors switches (42, figure FO-1) are on the instrument panel. Each switch has two positions marked VOR and TAC. The pilot's VOR/TAC selector switch selects the navaid that will control the No. 2 needle on the BDHI. The copilot's switch selects the navaid input to the No. 2 needle on the RMI.

COURSE INDICATORS

Two course indicators (21 and 31, figure FO-1) labeled OMNI and TACAN are installed on the instrument panel. Designation of the course indicators used are ID-249, ID-351 and ID-387. All of these instruments present the same information. The term, "course indicator" will be used when referring to this instrument in the flight manual.

FLIGHT DIRECTOR

Two identical navigation flight director indicators (figure 1-24) are on the instrument panel (5 and 38, figure FO-1) for the pilot and copilot. The navigation flight director indicator has four modes of operation that are determined by the position of the mode selector knob. The Mode Selector Knob is marked with the letters A, T, V, and G to identify modes. The pilot and copilot can monitor the same mode or any combination of modes by placing their respective mode selector knobs in either A, T, V, or G position. A Mode Indicator Window in the upper right quadrant of the face indicates the mode selected by displaying the letters ASE, TAC, VOR, or GVR.

ASE (A) Mode

When the indicator is in ASE mode and the ASE engaged, the indicator will monitor the automatic stabilization equipment electrical signal to each ASE channel. For additional information refer to Section I, Automatic Stabilization Equipment.

VOR (V) Mode

When the indicator is in the VOR mode and the VHF NAV radio is tuned to a VOR station, lateral course deviation is shown by the vertical needle. The indicator monitors the lateral deviation from the course selected on the OMNI Course Indicator. The vertical bar warning flag disappears when the radio is turned on and the signal is reliable. During VOR operation, the horizontal bar is not used. TO-FROM course information as well as relative heading pointer information is available only on the OMNI Course Indicator. When the indicator is in the VOR mode and the VHF NAV radio is tuned to an ILS or LOC station, the vertical bar provides lateral deviation from the localizer course. The vertical bar is not affected by the course selector on the OMNI Course Indicator. The horizontal bar provides vertical deviation from the selected glide slope. The vertical and horizontal bar warning flags disappear when the radio is turned on and the respective signal is reliable.

TACAN (TAC) Mode

When the indicator is in the TAC mode and the AN/ARN-52(V) TACAN radio is in use, the vertical bar will indicate lateral course deviation. The indicator monitors lateral deviation from the course selected on the TACAN course indicator.

GVR Mode

The vertical bar in the GVR mode displays course information to the station homing on when GVR in the GVR/LORAN selector switch is visible. When LORAN is visible in the GVR/LORAN selector switch, the flight director converts loran navigator outputs into steering commands. The vertical and horizontal bar OFF flags appear whenever steering information is not valid.

GVR/LORAN SELECTOR SWITCH

The flight director selector switch is located on the pilot's instrument panel, and is used to select either GVR for broadband homing or LORAN for Loran C navigator use. The switch is depressed until the desired mode (GVR or LORAN) is visible. The selected information is displayed on the flight director with GVR selected. The switch lighting is controlled by the PILOT FLT INST LTS rheostat on the upper console.

TACAN (AN/ARN-118(V)

The TACAN Navigation Set AN/ARN-118(V) is used to determine the relative bearing and slant range distance to a selected TACAN station. The selected TACAN station can be a ground, shipboard, or airborne station. The ground and shipboard TACAN stations are considered surface beacons. An airborne station only supplies slant range distance information unless the aircraft is specially equipped with a bearing transmitter and rotating antenna. This TACAN set is not capable of transmitting bearing information but does supply slant range distance replies when interrogated. The TACAN set has provisions for 126 channels in the X mode, and 126 channels in the Y mode. The Y channels differ in frequency assignment and pulse spacing. The maximum operating range of the TACAN set is 390 NM when the selected TACAN is a surface beacon, and 200 NM when the selected TACAN is an airborne beacon. The BDHI is only capable of displaying 299 NM.

NOTE

The Y channels were developed to alleviate congestion of the existing channels (in the X mode). If a channel has no specification on a chart or publication, it is an X channel.

The TACAN Navigation Set supplies inputs to the BDHI, RMI, the TACAN Course Indicator, and the Flight Directors (when TAC is selected). TACAN audio signals can be monitored by turning the FM/TAC receiver select switch on. The TACAN set is powered by the ac and dc radio buses and is protected by two circuit breakers marked TACAN on the radio circuit breaker panel.

TACAN Controls

Controls for the tacan system are located on the TACAN CONTROL PANEL (figure 4-10) on the Upper Radio Console. A five-position (OFF, REC, T/R, A/A REC, A/A T/R) function switch selects the mode of operation. With the function switch in the REC position, only bearing information is received; with the switch in the T/R position, both bearing and range data are received. The A/A REC and A/A T/R positions of the switch are the same as the REC and T/R positions, except that the tacan system is transmitting and receiving signals to and from a suitably equipped cooperating aircraft. The second aircraft's TACAN must be set 63 channels away from the channel setting of the first aircraft on the same X or Y mode, and operated in an A/A mode. The channel selector tunes the equipment to any of 126 frequency channels. The X/Y Channel Selector sets either X or Y. The volume control knob varies the volume of the audio signal received from a surface beacon and heard through the number four receiver select switch on the ICS control panel. The Test Switch is used to make a complete test of the system except for the antenna.

CAUTION

The channel selector switch contains a built-in mechanical stop to prevent rotation past the nine (9) position on the one's digit channel setting. Do not attempt to override this mechanical stop. Direction of rotation must be reversed when the stop is reached.

Manual Self-Test of Tacan System

To initiate self-test, select a course of 180 degrees, place the function switch in the T/R position, and allow 90 seconds for warmup. Depress the test button and observe that the indicator illuminates for about one second. Release the button. For about seven seconds the DME and CDI "OFF" flags come into view and the bearing pointers (TAC selected) indicate 270 degrees. For the next 15 seconds, the flags go out of view, the DME indicates 000.0 (+/– 0.5), the bearing pointers indicate 180 (+/– 3) degrees, the CDI centers to within 1/2 dot, and the TO-FROM indicator shows TO. When the self-test is complete, all indicators return to normal. A failure is recorded by the indicator light if it stays on during the test and/or the indicators are out of limits. The test can be performed again in the REC mode, and if the indicator light does not stay on, the malfunction is isolated to the transmitter section and bearing information is valid.

Automatic Self-Test of Tacan System

An automatic self-test occurs when the receiver signal becomes unreliable or the signal is lost, to insure that the TACAN system is operating properly. The results of the automatic self-test are the same as for the manual self-test except the DME and CDI "OFF" flags remain in view. Failure of the system is indicated if the test lamp comes on.

WARNING

Bearing and/or distance indications may still be present when the TEST lamp is on. Such indications could be either partially usable or grossly inaccurate. They should be cross-checked, using every available means. Be prepared for TACAN equipment failure if the TEST lamp illuminates.

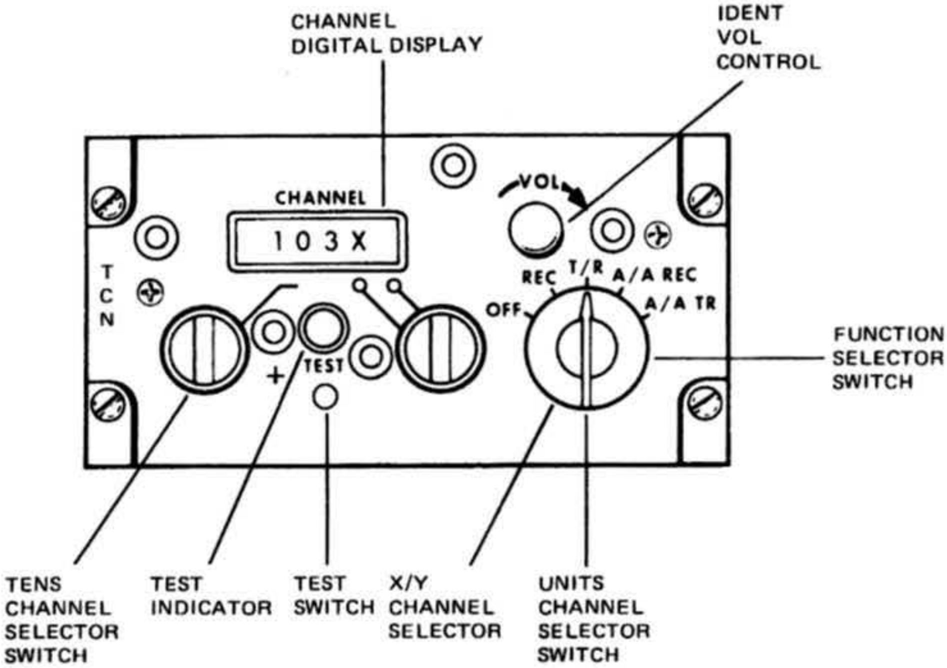


Figure 4-10. AN/ARN-118(V) Control Panel

Normal Operation

1. Move the function switch to the desired position.

NOTE

Normal warmup time is 90 seconds. The switch may be set to any position without delay.

2. Turn the channel selector knob to the desired channel, and the X/Y channel selector to the desired position.

3. Check station identification by turning the number four receiver select switch on, and adjust the audio to a comfortable level with the volume control knob.

NOTE

It may be necessary to turn down the VHF-FM audio in order to receive the tacan signal.

4. TACAN Course Indicator and VOR-TAC selector switch — set as required.

5. To change channels, adjust the channel selector switch as required. It is not necessary to change the function switch to REC when changing channels.

6. To turn the tacan system off, place the function switch to the OFF position.

VHF NAV RADIO SET (AN/ARN-87)

NOTE

If the AN/ARN-123 TCTO has been completed, the AN/ARN-87 NAV Radio components, including the Marker Beacon, and Glide Slope receivers, will be removed.

The navigation system, is a fully transistorized airborne navigation unit that is to be used in conjunction with VHF radio set receiver (AN/ARC-84) to provide VOR (VHF omni-directional range) and LOC (Localizer) modes of operation. Controls for system are contained within AN/ARC-84 control panel (figure 4-7). When a frequency of from 108.1 to 111.9 megahertz (odd tenths only) is selected, the LOC mode of operation is automatically obtained, and this frequency selection also provides a corresponding glide slope (GSA-8A) frequency. When a frequency of 108.0 to 111.8 megahertz (even tenths only) is selected or a 112.0 to 117.9 megahertz frequency is selected, the VOR mode of operation is obtained and the glide slope, GSA-8A, receiver is returned to a standby condition. The VHF transmitter is automatically tuned to 121.5 MHz in both LOC and VOR modes. The course information obtained from these modes of operation is fed to the flight director, (figure 1-24), OMNI course indicator, BDHI, and RMI for presentation to the pilot or copilot. The VHF navigation system is powered by the dc radio bus and is protected by a circuit breaker marked VHF RCVR on the radio circuit breaker panel.

NOTE

Reverse sensing will be displayed on the OMNI Course Indicator and the Flight Directors when inbound on a localizer back course approach.

VHF NAV Radio Operation

1. ICS receiver select switch — VHF — ON.

2. VHF RCVR VOL — OFF — ON switch (VHF COMM/NAV control panel) — ON.

3. Frequency selector knob — 108.0 to 117.9 as desired for VOR or LOC operation (VHF COMM/NAV control panel).

VOR Check

1. Tune to VOR station (reliable signal).

2. Set 000 in the VOR Course Indicator.

3. Press VOR — CHECK button.

   a. BDHI and RMI — 000 ± 5°.

   b. CDI vertical needle on VOR Course Indicator — CENTERED.

   c. VOR Flight Director — To/From Indication — TO.

   d. Vertical bar flag — VISIBLE.

4. Release VOR — CHECK button.

GLIDE SLOPE SYSTEM (GSA-8A-1)

The GSA-8A-1 glide slope system is installed on helicopters that have not been modified to incorporate the AN/ARN-123 VHF NAV radio set. The GSA-8A-1 glide slope system is an airborne UHF receiver designed to receive glide slope transmissions for vertical guidance during ILS approaches, when 108.1 to 111.9 MHz (odd tenths only) is selected on the VHF NAV set. The receiver is controlled by the VHF navigation set control and can be modified to provide either ten or twenty channel operation. Information is provided through the flight director indicators and the OMNI course indicator, on the instrument panel in front of the pilot and copilot. When a localizer frequency of 108.1 to 111.9 mc (odd tenths only) is selected on the control unit, the corresponding glide slope frequency is automatically selected. When the horizontal bar on the flight director indicator (figure 1-24) is up, the glide path is above the helicopter; if the bar is down, the glide path is below the helicopter; if the bar is centered in a horizontal position, the helicopter is directly on the glide path. The glide slope system operates on direct current from the dc radio bus through circuit breakers marked VHF RCVR and GLIDE SLOPE, located on the radio circuit breaker panel.

MARKER BEACON SYSTEM (MKA-23A)

The MKA-23A marker beacon system is installed on helicopters that have not been modified to incorporate the AN/ARN-123 VHF NAV radio set. The marker beacon system, MKA-23A, detects 75 megahertz signals modulated by either a 400, 1300, or 3000 cycle-per-second tone. Accordingly, it identifies airway fan markers, station locator Z-markers, and approach markers of an instrument landing system. The system provides a visual light indication on both course indicators. Controls for the system consist of a volume and on-off knob and a sensitivity switch, on the instrument panel, under the heading MARKER BEACON. The volume control knob, marked VOLUME OFF, permits regulation of audio volume in the headsets. The sensitivity switch, marked SENSITIVITY, LO, MED, and HI, provides a means of selecting three sensitivity settings, for the marker beacon receiver. In this installation, the LO and MED positions provide the same sensitivity. The system operates on dc power from the radio bus and is protected by a circuit breaker, marked MB, on the radio circuit breaker panel. An aural signal can be heard over the Interphone Control Panel NAV position.

VHF NAV RADIO SET (AN/ARN-123)

The AN/ARN-123 receiver is a remotely located, integrated navigation package which contains a 200 channel VOR/LOC receiver, a 40 channel glide slope receiver, and a marker beacon receiver. The three receivers perform the intended mission of the unit without depending on each other. The receiver is powered by the dc radio bus and the 26 volt radio autotransformer (øB), and is protected by two circuit breakers marked VHF NAV, on the radio circuit breaker panel.

VHF Omnirange (VOR)/Localizer (LOC) Receiver Section

The VOR/LOC receiver section receives and processes VOR and localizer signals over a frequency range of 108.00 to 117.95 MHz, with a channel spacing of 50 kHz. Of the 200 channels available, 160 are for VOR operation and 40 are for LOC operation. VOR course information is fed to the OMNI Course Indicator, Flight Directors, BDHI, and RMI. LOC course information is provided to the OMNI Course Indicators and Flight Directors only. VOR/LOC audio signals are fed through the pilot's and copilot's ICS control panel's NAV switch. Volume adjustment is accomplished by turning the NAV VOL-OFF control on the control head.

NOTE

> Reverse sensing will be displayed on the OMNI Course Indicator and Flight Directors when inbound on a localizer back course approach.

Glide Slope (GS) Receiver Section

The GS receiver section processes glide slope signals over a frequency range of 329.15 to 335.00 MHz with a channel spacing of 150 kHz. Whenever one of the 40 localizer frequencies is selected the appropriate GS frequency is tuned on the GS receiver. Glide slope information is fed to the OMNI Course Indicator and the Flight Directors.

Marker Beacon (MB) Receiver Section

The MB receiver section processes 75 MHz signals and converts them into an output that drives the marker beacon lights on the OMNI and TACAN Course Indicators and provides audio signals to the pilot's and copilot's ICS Control Panel, NAV switch.

VHF NAV Radio Control Panel

The VHF NAV Radio control panel (figure 4-11) on the upper radio console (figure FO-2), contains a NAV VOL-OFF control, frequency indicator, frequency selector knobs, MB VOL-OFF control, MB Sensitivity switch (HI/LO), and a VOR/MB test switch.

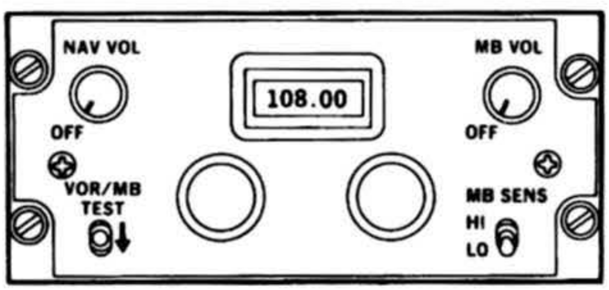


Figure 4-11. AN/ARN-123 NAV Radio Control Panel

VHF NAV Radio Operation

To turn set ON:

1. Radio master — ON.

2. NAV VOL-OFF control — ON, VOLUME AS DESIRED.

3. MB VOL-OFF control — ON, VOLUME AS DESIRED.

4. MS Sensitivity — HI.

5. Frequency selector knobs — AS DESIRED.

To turn set OFF:

1. NAV VOL-OFF control — OFF.

NOTE

- The NAV VOL-OFF control is the master power switch for the entire radio.
- In the event of loss of ac power to the set, NO. 2 needle information will be lost. Localizer, glide slope, marker beacon and VOR (CDI only) information will continue to be provided.

VOR/MB Check

1. Tune in a nearby VOR station.

2. OMNI course selector — 315 RADIAL.

3. VOR/MB test switch — HOLD IN TEST POSITION.

4. CDI needle — CENTERED PLUS OR MINUS 2 DOTS.

5. NO. 2 needle (VOR selected) — 315 RADIAL PLUS OR MINUS 5.

6. Both marker beacon lights— ON.

7. VOR/MB test switch — RELEASE.

LF AUTOMATIC DIRECTION FINDER EQUIPMENT (LF/ADF AN/ARN-73)

The LF/ADF set AN/ARN-73 provides automatic or manual compass bearings with the No. 1 pointer of the BDHI and RMI on any radio signal between 100 and 3000 kHz. The tuning range is divided into four bands as follows: 100-235 kHz, 235-560 kHz, 560-1335 kHz, and 1335-3000 kHz. The LF/ADF also functions as a low-frequency radio range and communications receiver. A beat frequency oscillator permits identification of keyed CW stations and may be used to obtain improved indications of an aural null during loop operations.

NOTE

The LF/ADF sense relay is energized when the ARC-94 (HF/COMM) transmitter is keyed to prevent damage to the internal components of the LF/ADF receiver.

The LF/ADF set is powered by the dc radio bus and ac from the radio autotransformer. The LF/ADF set dc circuit is protected by a circuit breaker, marked ADF, on the radio circuit breaker panel.

LF/ADF Control Panel

(figure 4-12)

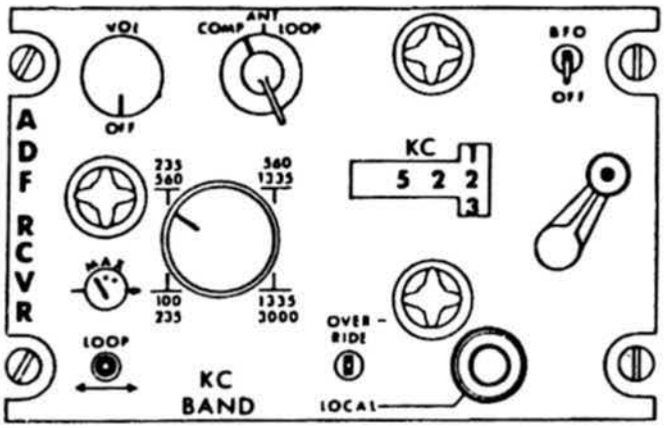


Figure 4-12. LF/ADF Control Panel

VOL-OFF Switch

The VOL-OFF switch turns the LF/ADF on or off. It controls the audio gain of the receiver when the COMP-ANT-LOOP switch is in the COMP position, or RF sensitivity when the COMP-ANT-LOOP switch is in the ANT or LOOP position.

COMP-ANT-LOOP Switch

The COMP-ANT-LOOP switch has three positions. The COMP position connects both the loop and sense antennas and the LF/ADF functions as an ADF. In the ANT position, only the sense antenna is connected and the LF/ADF functions as a standard low-frequency receiver. Only in this position are complete and accurate aural signals received. In the LOOP position, only the loop antenna is connected and the LF/ADF may be used for manual direction finding.

KC BAND Switch

The KC BAND switch controls the frequency band in which the LF/ADF operates. Four bands are available, and digital counters corresponding to the selected band are displayed as the KC BAND switch is operated.

LOOP Control

The LOOP control slews the goniometer rotor (corresponding to loop rotation in earlier ADF systems) in either direction regardless of the COMP-ANT-LOOP switch position. It is used to position the goniometer rotor as desired when the COMP-ANT-LOOP switch is in the LOOP position. It is used to override an incoming signal momentarily to test signal reliability when the COMP-ANT-LOOP switch is in the COMP position.

OVERRIDE-LOCAL Switch

The OVERRIDE-LOCAL switch is inoperative in this installation.

BFO Switch and Operation

The BFO is used principally to identify CW transmission occurring within the frequency range of the LF/ADF such as those employed in areas outside the United States, but may also be used to aid in determining aural nulls. For CW identification, the COMP-ANT-LOOP switch is placed in the ANT position; for aural-null procedures, the switch is set to the LOOP POSITION. When BFO is operating, a 1000-hertz beat note will be heard when properly tuned to a CW signal. This beat note (tone) appears in the audio output of the receiver. As the receiver is detuned slightly, the frequency of the beat note will decrease. As the receiver is tuned from one side of the signal to the other, the tone will increase to 1000-hertz from zero on either side of the proper frequency.

Tuning Crank

The tuning crank tunes the LF/ADF to the desired frequency, which is displayed in the KC window. With the COMP-ANT-LOOP switch at COMP, peak deflection of the MAX meter indicates proper tuning.

NOTE

> When two adjacent peaks are noted, the dip between them indicates proper tuning.

LF/ADF Operation

To turn set on for use as a Conventional Radio Receiver:

1. ICS receiver select switch — NAV Position — ON.
2. VOL-OFF switch — ON and adjust as desired.
3. Function switch — ANT.
4. KC BAND switch — Set to desired operating band.
5. Tuning control — Tune to desired station.

To turn set on for use as an Automatic Direction Finder:

1. ICS receiver select switch NAV — ON.
2. VOL-OFF switch — ON and adjust as desired.
3. Function switch — ANT.
4. KC BAND switch — Set to desired operating band.
5. Tuning control — Tune to desired station.
6. Function switch — COMP.
7. Tuning meter — Adjust to MAX.

To turn set on for use as a Manual Direction Finder:

1. ICS receiver selector switch NAV — ON.

2. VOL-OFF switch — ON and adjust as desired.

3. Function switch — ANT.

4. KC BAND switch — Set to desired band.

5. Tuning control — Tune to desired station.

6. Function switch — LOOP.

7. LOOP Control — Operate for aural null.

8. VOL-OFF switch — Adjust for null width.

For navigation with an unmodulated Continuous Wave (CW) Station:

9. Function switch — ANT.

10. BFO switch — BFO.

Tune to desired station; a properly tuned CW signal will produce a 1000-hertz beat note. To obtain proper CW identification, detune slightly until frequency of beat note changes, tune receiver from one side of signal to other. Tone will decrease from high pitch to zero and increase again on other side of zero beat.

11. Volume control — Adjust as desired.

To turn set OFF:

1. VOL-OFF switch — OFF.

Operating Limitations and Precautions

The set is subject to the following operations limitations which are imposed by terrain, weather, and general operating conditions.

NIGHT EFFECT

At night radio waves reflected by the ionosphere return to the earth at some point 30 to 60 miles from the station. This night effect may cause the pointer to fluctuate. It is most prevalent during the period just before and after sunrise and sunset. Generally, the greater the distance from the station, the greater the effect. The effect can be minimized by averaging the fluctuations, by flying at a higher altitude, or by selecting a lower-frequency station. Maximum night effect will be present with stations operating in frequency ranges above 1000 kHz. Frequencies below 1000 kHz are generally less subject to night effect.

MOUNTAIN EFFECT

Bearings taken in the vicinity of mountainous terrain may be erroneous and the pointer may fluctuate due to magnetic deposits or radio wave reflection.

SHORELINE EFFECT

As radio waves pass from land to water, their direction of travel is changed. Because of shoreline effect, a bearing taken on an island station from an aircraft over water is inaccurate if it makes an angle of less than 30 with the shoreline. At greater angles, bending is negligible. When taking bearings over water, therefore, choose stations which are either right on the shore, or so located that bearings to them make angles greater than 30 with the shoreline.

GENERAL OPERATING PROCEDURES

The following operating procedures should be used. Only head-on bearings are entirely dependable. Keep the helicopter in a level attitude when taking side bearings: accurate bearings cannot be taken with the aircraft in a steep bank, especially when close to a station.

For manual direction finding, place the COMP-ANT-LOOP switch in the LOOP position and slew the LOOP control for an aural null. When using the aural null method for taking bearings, the 180° ambiguity must be resolved. Set the VOL-OFF control to produce a null of satisfactory width.

BROADBAND HOMING SYSTEM (DMSE 47-2)

The DMSE 47-2 System is composed of a Homing Selector, an antenna switching unit, two antennas, an antenna feed network, and the Flight Director. The System is used in conjunction with the aircraft communications equipment to visually indicate the direction of flight toward an RF Homing Signal (emergency beacon, etc). The equipment operates in the frequency range of 120.0 to 245.0 MHz in conjunction with the UHF, VHF, and VHF/FM radio sets. The System operates on dc power from the radio bus and is protected by a circuit breaker on the radio circuit breaker panel, marked DF.

Homing Selector

The homing selector, (figure 4-13), on the upper console, has a four-position rotary type switch and a two-position toggle switch. The four-position switch enables the operator to energize the homing system and to select the communications radio to be used in the homing operation. The four-positions are: OFF, VHF/AM, VHF/FM, and UHF. The two-position toggle, marked SENSITIVITY, enables the operator to select HIGH or LOW sensitivity for the homing system. The LOW position cuts needle deflection in half.

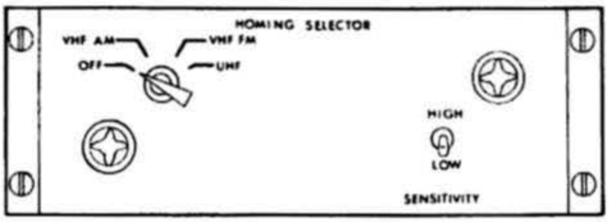


Figure 4-13. VHF/UHF Homing Selector Panel

Antenna Switching Unit

The antenna switching unit, on the radio rack, is controlled automatically by the homing selector switch from the cockpit. It provides for interconnection between the radio sets and communication antennas. The processed homing signal is transmitted to the Flight Director.

Homing System Antennas

The system has two low profile antennas (figure 4-14) on the bow of the helicopter for reception of homing signals.

ANTENNA FEED NETWORK

The feed network provides the antenna array with the phase difference between the two antennas to effect a "right" or "left" signal.

Flight Director

The processed signal is visually displayed on the flight director in the GVR Mode. The flight director's vertical bar deflects "left" if the signal source is left of the aircraft, or "right" if the signal is right of the aircraft. The display is continuous so that the operator can fly toward the direction of the bar deflection. When the display indicates Zero deflection, the aircraft's centerline is in line with the direction of the signal source and is headed toward the signal source. Ambiguity is solved by always turning toward the vertical bar deflection.

Homing System Operation

1. Turn on the communication radio set to be used and set frequency.

CAUTION

Frequencies outside the 120.0 - 245.0 range may be selected and received by the Homing System. These signals may not be reliable and should be used with extreme caution.

2. Select VHF/AM, VHF/FM, or UHF as appropriate on the Homing Selector.

3. Set SENSITIVITY switch to HIGH.

4. Set the Flight Director to GVR mode.

5. Depress LORAN/GVR selector switch to illuminate GVR.

6. Identify 1800 Hertz signal.

7. Turn the aircraft in the direction of the bar deflection until the vertical bar on the Flight Director "Centers." This is the course toward the homing signal source.

Homing Procedures

The reception of a homing signal is indicated by a 1800-Hertz signal tone and the deflection of the vertical bar on the Flight Director. The strength of the signal tone will be at a maximum when the aircraft is to the "left" or "right" of the source

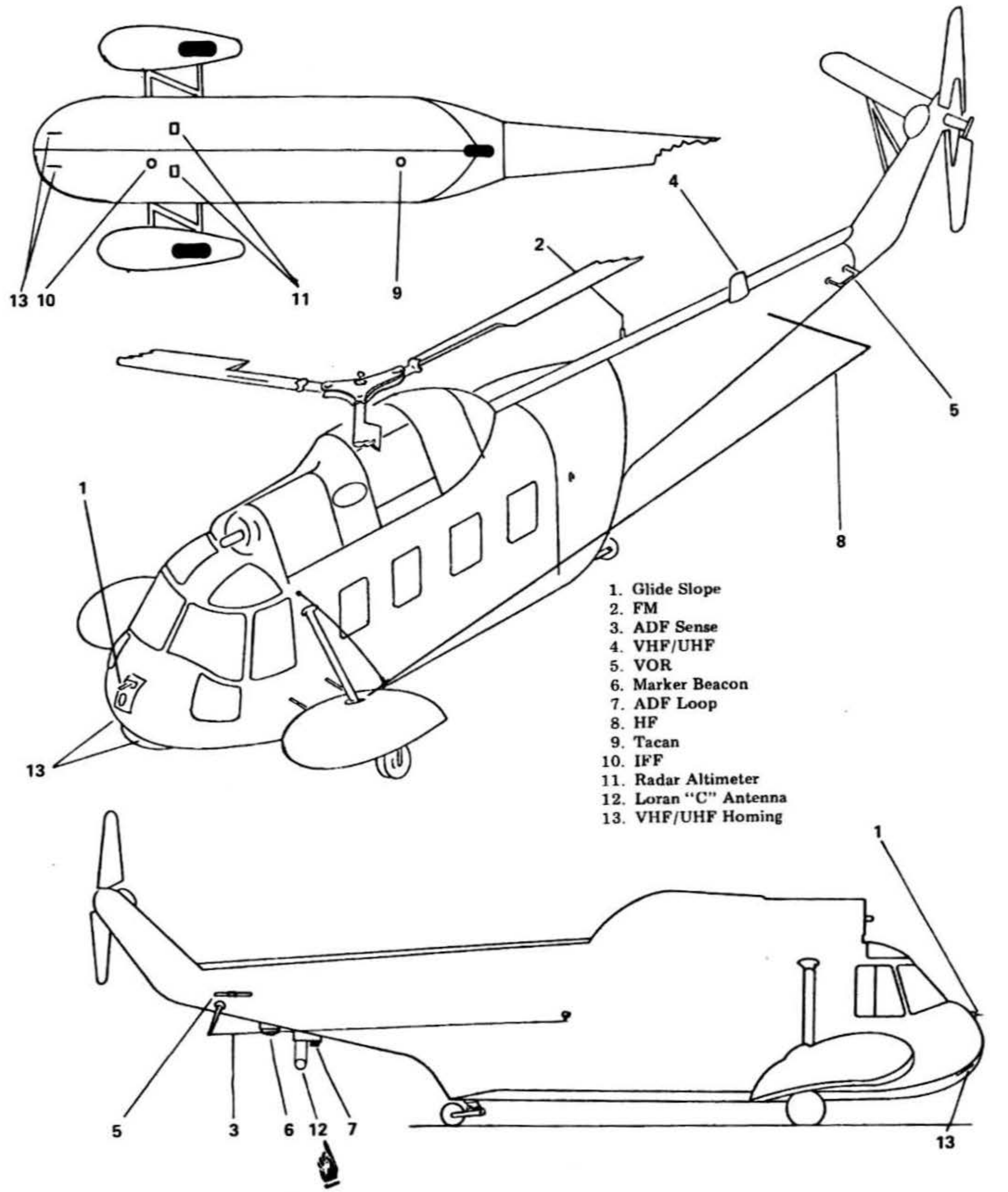


Figure 4-14. Antennas

signal and will decrease to minimum strength when the aircraft is "on course." Under certain conditions, such as weak signals and long distances, bar deflection will be observed, but there will be no 1800-Hertz signal. Temporarily turn the homing selector to "OFF" for aural identification of the homing signal then back to homing. Once a homing course has been established, the aircraft should be flown so that the vertical bar remains centered. As the signal source is approached, the bar becomes more sensitive and will indicate larger course deviations. Set the SENSITIVITY switch to LOW in order to reduce Flight Director sensitivity. If visual contact cannot be established, the overflight will be indicated by a rapid swing of the bar from left to right. A rapid decrease in audio signal strength is most noticeable during station passage. During homing operations the pilot may transmit on the frequency selected for homing system.

LORAN C NAVIGATOR AN/ARN-133

WARNING

It has been determined that LORAN-C signal anomalies exist in the Alaska and U.S. Northwest coastal areas. These anomalies appear to be terrain (high mountains) effect for signals adjacent to the coastline in these areas. The anomalies may result in significant position errors of varying magnitude and direction. The extent of the anomalies for the different areas affected is not known at this time. Until anomaly grid maps are provided pilots shall:

a. Verify any position errors with LORAN-C for their areas of operation.

b. If position errors exist utilize LORAN-C position information if the errors are of a uniform magnitude and direction for their entire area of operation and the AN/ARN-133 is operated in a position update mode.

c. If the magnitude and direction of anomalies are not known or the position cannot be updated, pilots shall not use the AN/ARN-133 for terrain avoidance and/or precision navigation.

The Loran C Navigator is a five channel fully automatic high performance Loran receiver with a navigation computer. The navigator provides accurate navigation and steering information anywhere there is Loran C or D coverage and has the capability to store nine programmable waypoints and two search patterns.

The navigator consists of a control/display unit, an antenna coupler, a flight director selector switch, and a liquid crystal distance to go display. The navigator is powered by the dc essential bus and is protected by a circuit breaker marked LORAN ARN-133 on the forward circuit breaker panel.

Controls, Indicators and Displays

The Navigator front panel is divided into five groups: displays, switches and indicators, keyboard, DISPLAY switch and MODE switch. Figures 4-15 through 4-18 illustrate each of these groups.

General Keyboard Information

The keyboard is used to enter information into the navigator. The circular and rectangular keys have essentially a single function, while the square keys have dual functions. The normal entry sequence consists of a clear, function, number, and insert. Specific entry sequences for all navigator functions are discussed in the following pages. Some special keyboard features are:

1. Any entry sequence may be terminated prior to the final INSERT by depressing CLR. This returns the displays to the original condition.

2. After the final INSERT, the only way to change entered data is to perform the entire procedure again, replacing incorrect data with the correct.

3. To correct an error in a number entry as it is made, depress the LEG CHG key, which backs out the last-entered digit from the display. Successive depressions of the LEG CHG key continue to back out successive digits.

Mode Switch

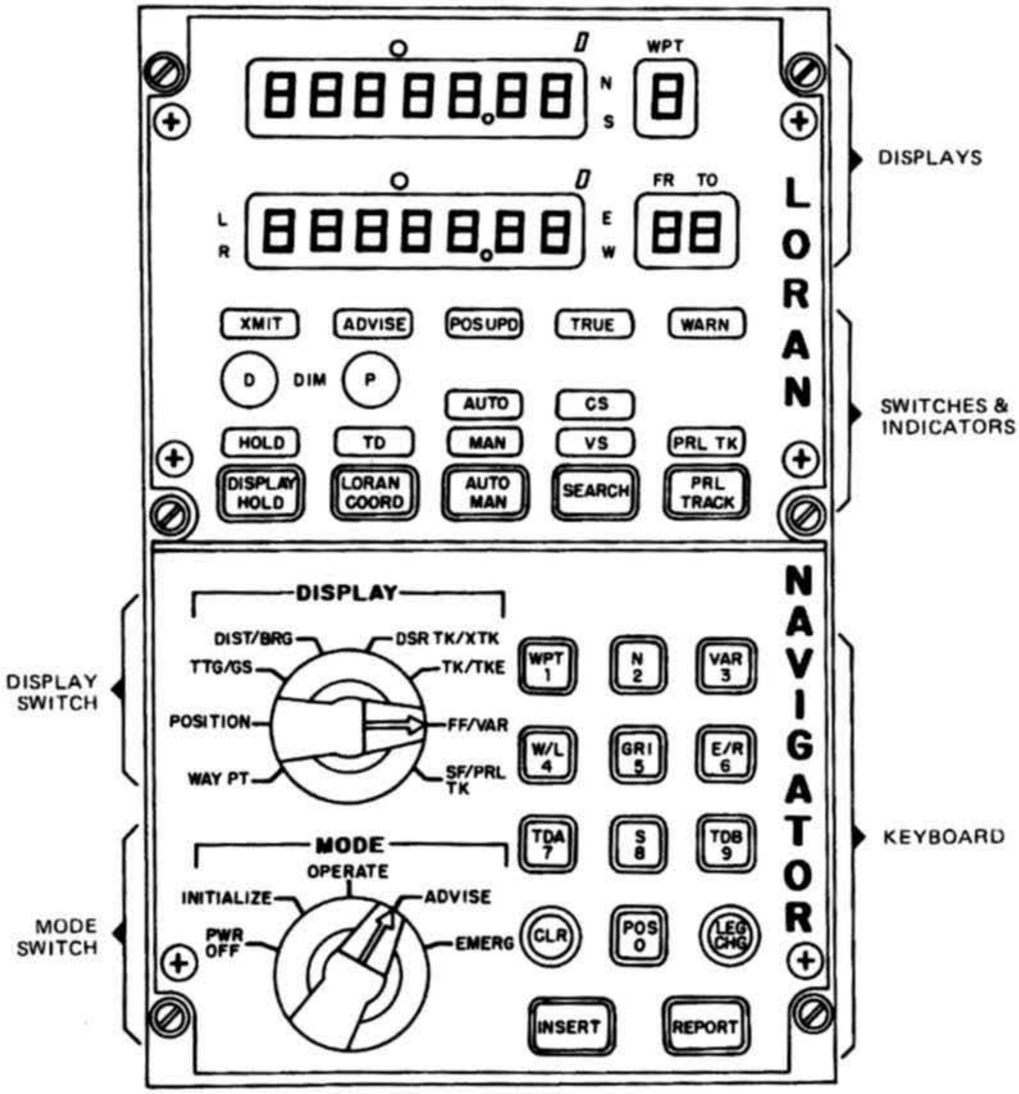
The five positions rotor MODE switch has built-in detents protecting the INITIALIZE and EMERG positions. One is between INITIALIZE and OPERATE, and the other between ADVISE and EMERG. To cross either of these detents, push the knob into the panel and turn. These detents prevent inadvertent movement to the INITIALIZE position, thereby losing track of LORAN signals; and from going from ADVISE to EMERG; thereby transmitting a false emergency signal. Switch positions are as follows:

1. PWR OFF - Remove external system power from the microprocess.

CAUTION

During engine start or other conditions that may produce dc power fluctuations, the MODE switch should be in the PWR OFF position. In case of extreme fluctuation; i.e., shipboard power starts, the LORAN-C circuit breaker should be pulled.

2. INITIALIZE - Allows all initial data to be entered.



SWITCHES ARE SHOWN IN LAMP TEST POSITION. ALL INDICATORS AND DISPLAY SEGMENTS, EXCEPT XMIT, ARE ILLUMINATED.

Figure 4-15. AN/ARN-133 Front Panel

(Detent) The LORAN receiver is held in search.

CAUTION

When turning the navigator on or off, care should be taken to pause momentarily in the INITIALIZE position. Failure to pause in this position will result in non-retrieval of stored chain and positional data, and possible freeze-up of the navigator.

3. OPERATE - This is the normal operating mode. The receiver is freed to acquire and track signals, and the navigation function and displays are activated.

4. ADVISE (Detent) - Used to determine why ADVISE and WARN indicators are illuminated or flashing. Also used in conjunction with DISPLAY switch positions to provide signal and system status and analysis. Allows some pilot control over receiver functions.

5. EMERG - Transmits aircraft present position via data link with emergency report code (7) included. The EMERG position is not used in this installation.

Display Switch

The eight position rotary DISPLAY switch (Figure 4-15) allows information to be entered or displayed with the MODE switch in the OPERATE position as follows:

NOTE

The positions have different functions with the MODE switch in the ADVISE position. Refer to ADVISE and WARN functions section.

1. WAY PT - Allows entry or display of selected waypoint coordinates in lat/long or time differences (TDA and TDB) in the upper and lower displays respectively for any selected waypoint appearing in the WPT display. (Figure 4-19)

2. POSITION - Allows present POSITION display and entry in lat/long or time differences (TDA and TDB) in the upper and lower displays respectively. The navigator continuously computes POSITION during the display hold, and when the display is released, shows correct present POSITION. (Figure 4-20)

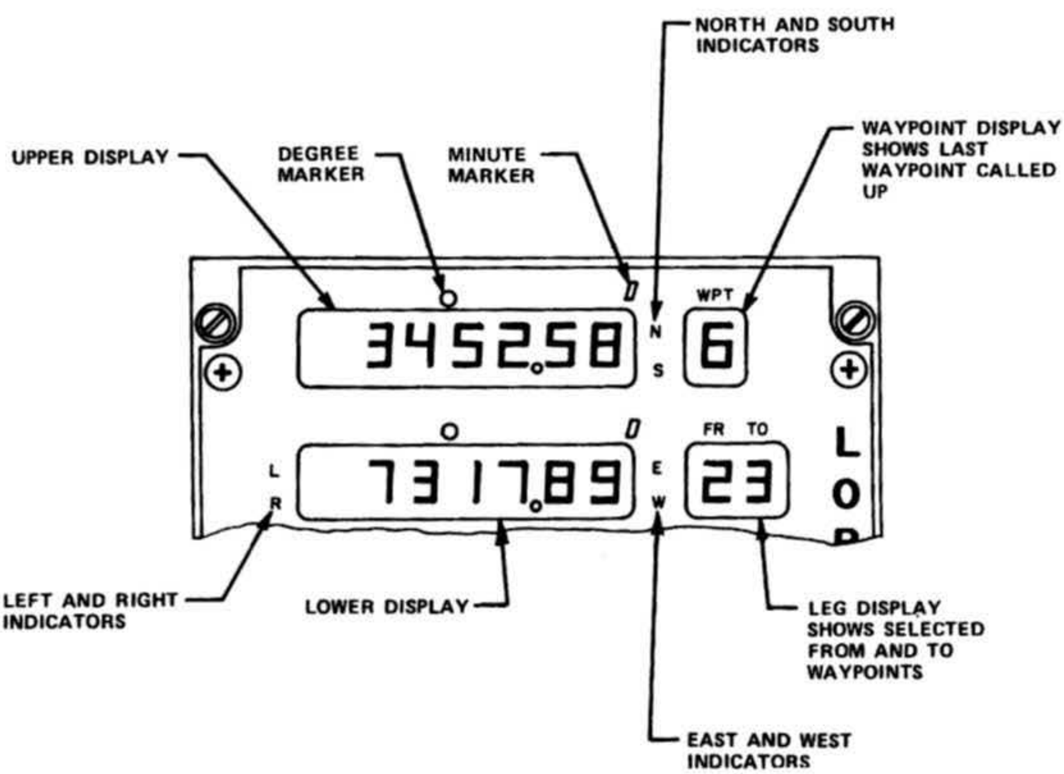


Figure 4-16. Displays

3. TTG/GS - Presents time to go (TTG) from present position to the TO waypoint in the upper display and ground speed (GS) in the lower display. Time to go is blanked when ground speed is 10 knots or less. (Figure 4-21)

4. DIST/BRG - Presents range (DIST) to the selected TO waypoint in the upper display. Bearing angle (BRG) to the TO waypoint appears in the lower display and is with respect to north (true north if no magnetic variation has been entered). When the interwaypoint range and bearing procedure is used, the following information is displayed:

a. Upper Display - Distance between waypoints.

b. Lower Display, Left Side - Bearing on the requested leg.

c. Lower Display, Right Side - FROM and TO waypoints requested.

This information is presented for ten seconds after which the display reverts back to normal. (Figure 4-22)

5. DSR TK/XTK - Presents the desired track angle (DSR TK) to the nearest degree in the upper display with respect to the selected waypoints. Crosstrack distance (XTK), either left or right, is measured to hundredths of a nautical mile and shown in the lower display. (Figure 4-23)

6. TK/TKE - Presents track angle (TK) with respect to north (true north if no magnetic variation has been entered) in the upper display and track angle error (TKE) in the lower display. Illumination of the R or L indicates present track angle error is to the right or left of the desired track angle. Display of these functions is blanked below 10 knots. (Figure 4-24)

7. FF/VAR - Presents data link information for flight following (FF) consisting of the aircraft identification number (preset by technician prior to

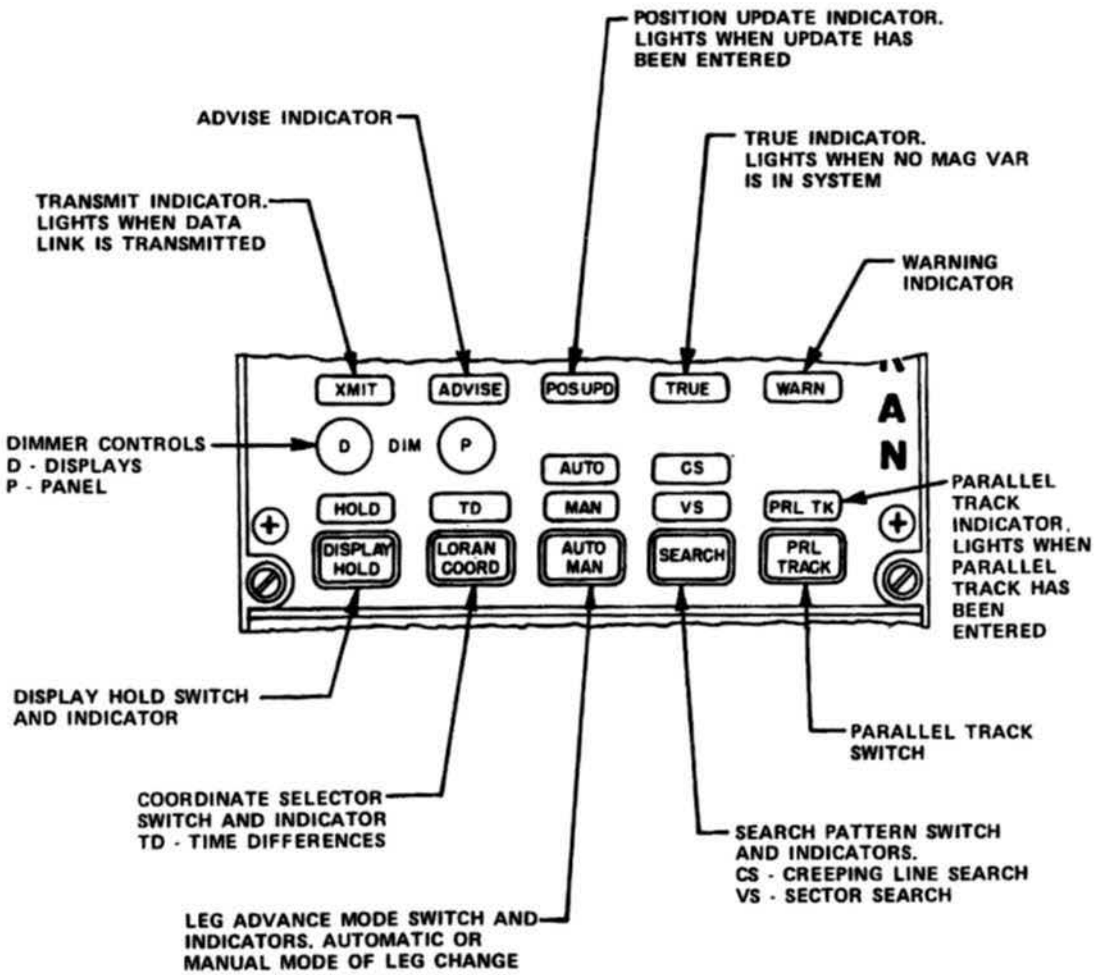


Figure 4-17. Switches and Indicators

flight) from 00 to 99 presented in the upper left display and the single digit report code in the upper right. Entered magnetic variation (VAR) in degrees EAST or WEST appears in the lower display. (Figure 4-25)

8. SF/PRL TK - Presents data associated with CS or VS search patterns (Special Function) in the upper display. The associated information cue letter appears in the WPT display. In the lower display parallel track offset distance (PRL TK) is presented to tenths of a nautical mile either right (R) or left (L) of course. (Figure 4-26 and 4-27)

Distance To Go Display

A liquid crystal distance to go display is located on the pilot's instrument panel. It provides a head's up display of long track information, which is shown anytime a nav leg is called up. The information displayed is in tenths of nautical miles up to 99.9.

Advise and Warn Functions

The ADVISE and WARN indicators may be illuminated by any of the following conditions. To determine the cause of ADVISE and WARN indications, set the MODE switch to ADVISE and the DISPLAY switch to DSR TK/XTK. A "1" appearing in any digit position in the upper or lower display signifies the condition listed as depicted in figure 4-28.

NOTE

More than one cause may be indicated for any given ADVISE or WARN.

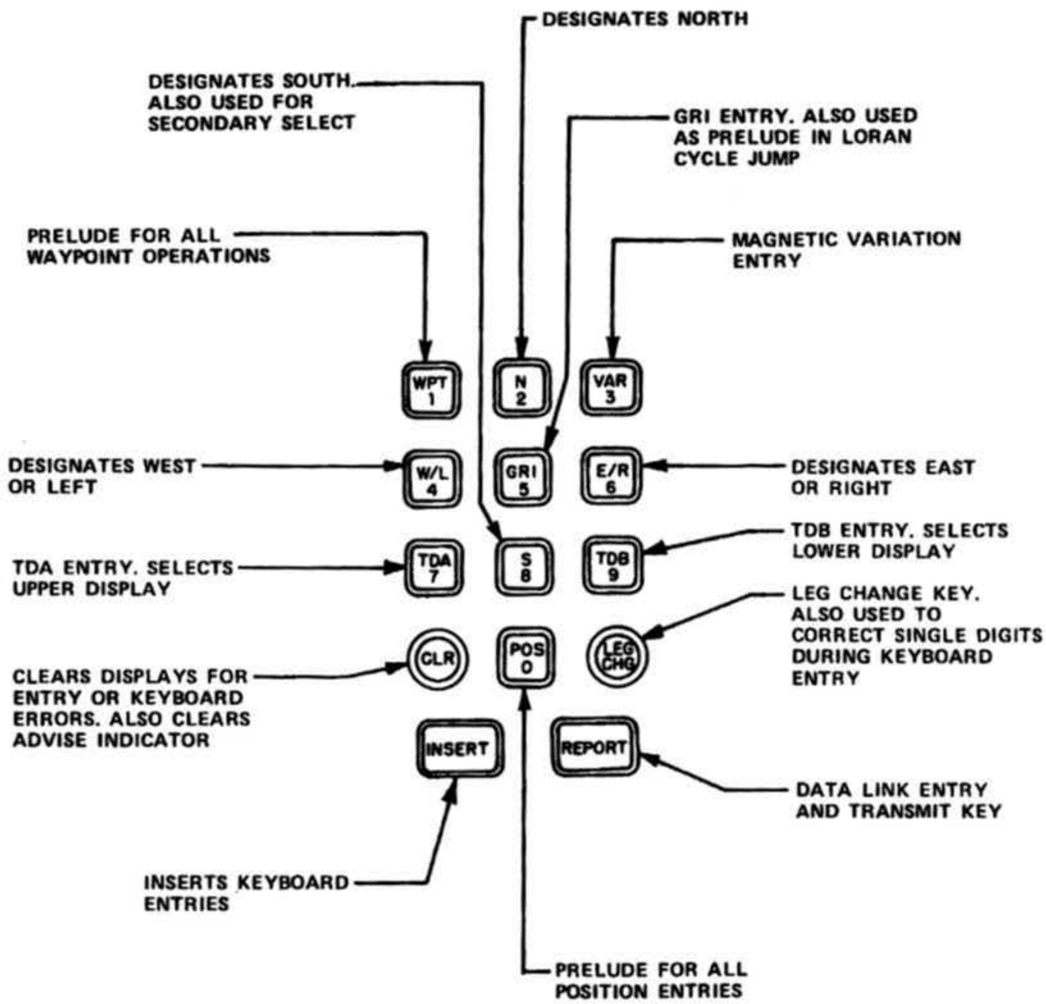


Figure 4-18. Keyboard

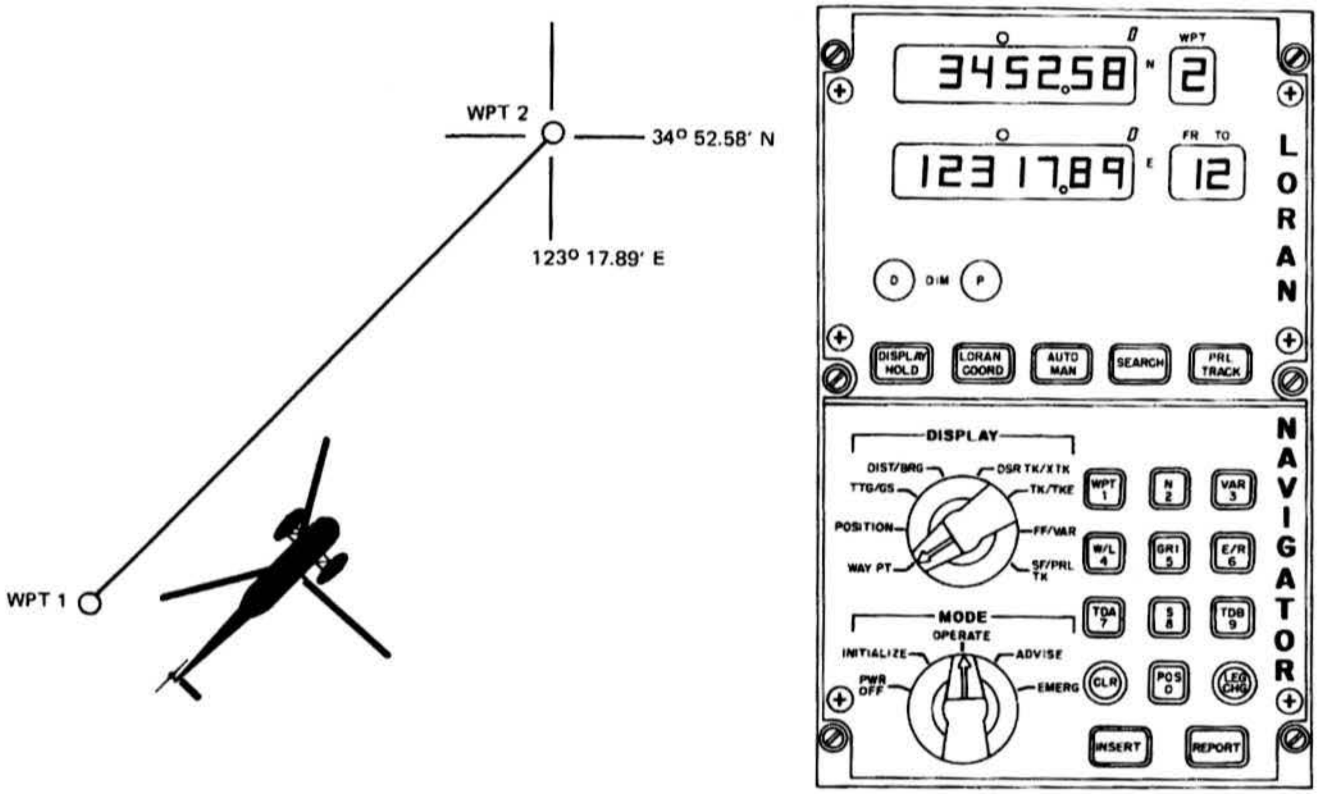


Figure 4-19. WAY PT Display

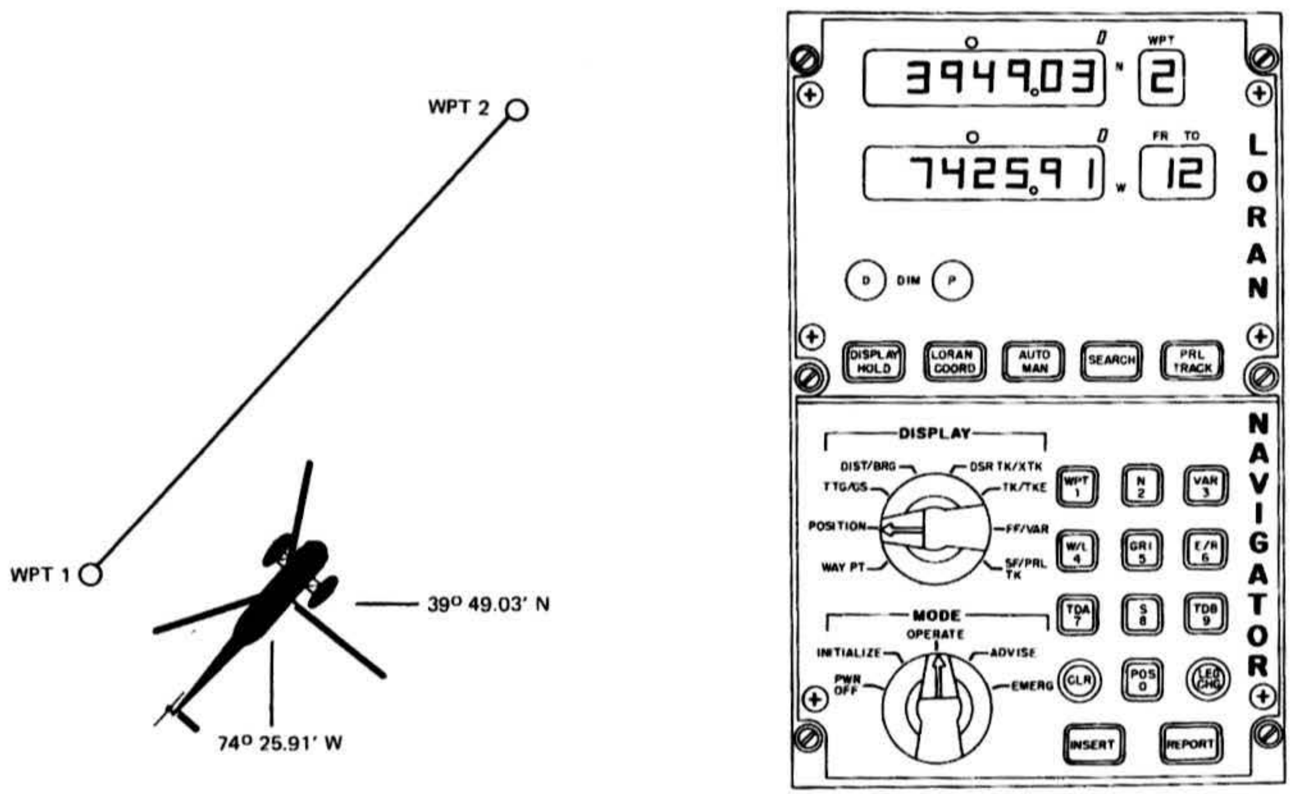
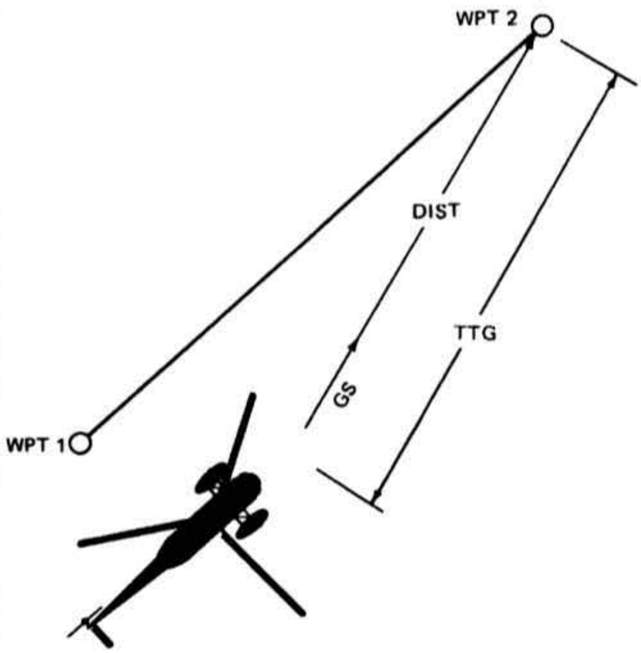


Figure 4-20. POSITION Display

TIME TO GO - 138.5 MIN.
GROUND SPEED - 90 KNOTS



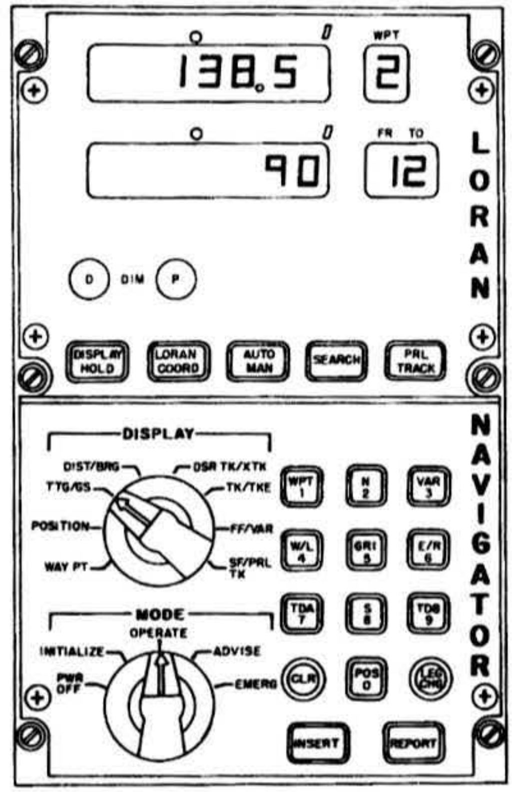


Figure 4-21. TTG/GS Display

Advise Indications

The ADVISE indicator illuminates or flashes and the corresponding display digit is set to "1" when any of the following conditions occur:

1. MISSED WAYPOINT ARRIVE - The navigator continually monitors the distance-to-go to the selected waypoint. If this changes from a decreasing to an increasing value and the arrival criteria were not met, signifying a missed-waypoint condition, ADVISE flashes to allow manual selection of the next leg.

2. NON-CONVERGENCE OF WAYPOINT LAT/LONG - ADVISE flashes when the navigator tries to perform a lat/long conversion of a waypoint entered in time differences but cannot due to signals being out of range, poor station geometry, etc.

3. SECONDARY CHANGE RECOMMENDED - ADVISE illuminates when the secondary pair in use is not the secondary pair recommended by the navigator. The navigator compares the signal to noise ratios and relative positions of the LORAN secondaries and recommends the best pair selection that results in the smallest navigation error.

Stations not currently being tracked and stations less than 38 miles from the receiver are not considered. This function is inoperative during master independent operation. Use the automatic secondary advisory function to determine which is the recommended pair.

4. INVALID OPERATOR ACTION - The following erroneous actions may illuminate the ADVISE indicator; incorrect switch/key combinations; certain incorrect values, invalid GRI (one not stored in memory) and certain invalid input coordinate values.

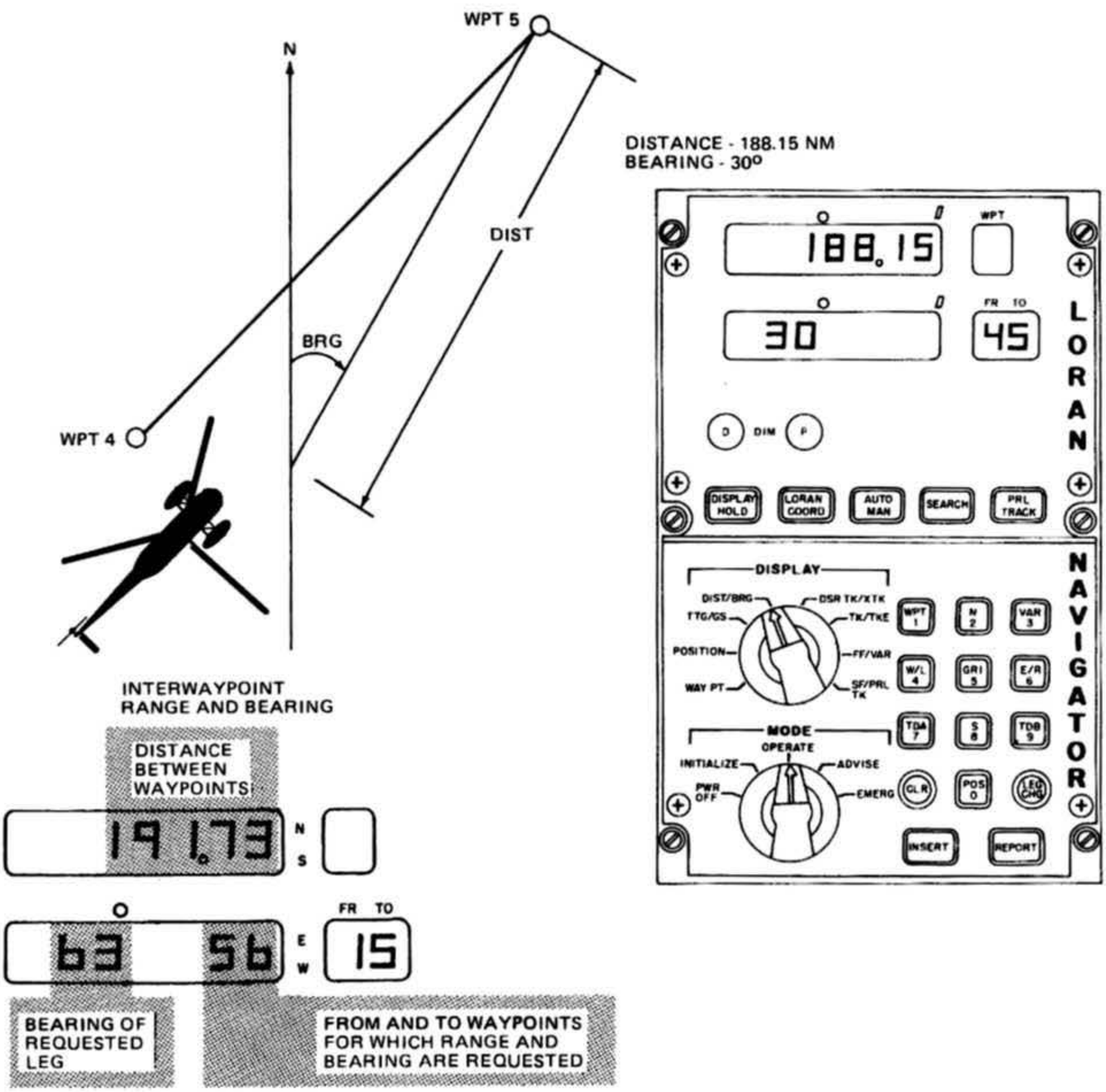


Figure 4-22. DIST/BRG Display

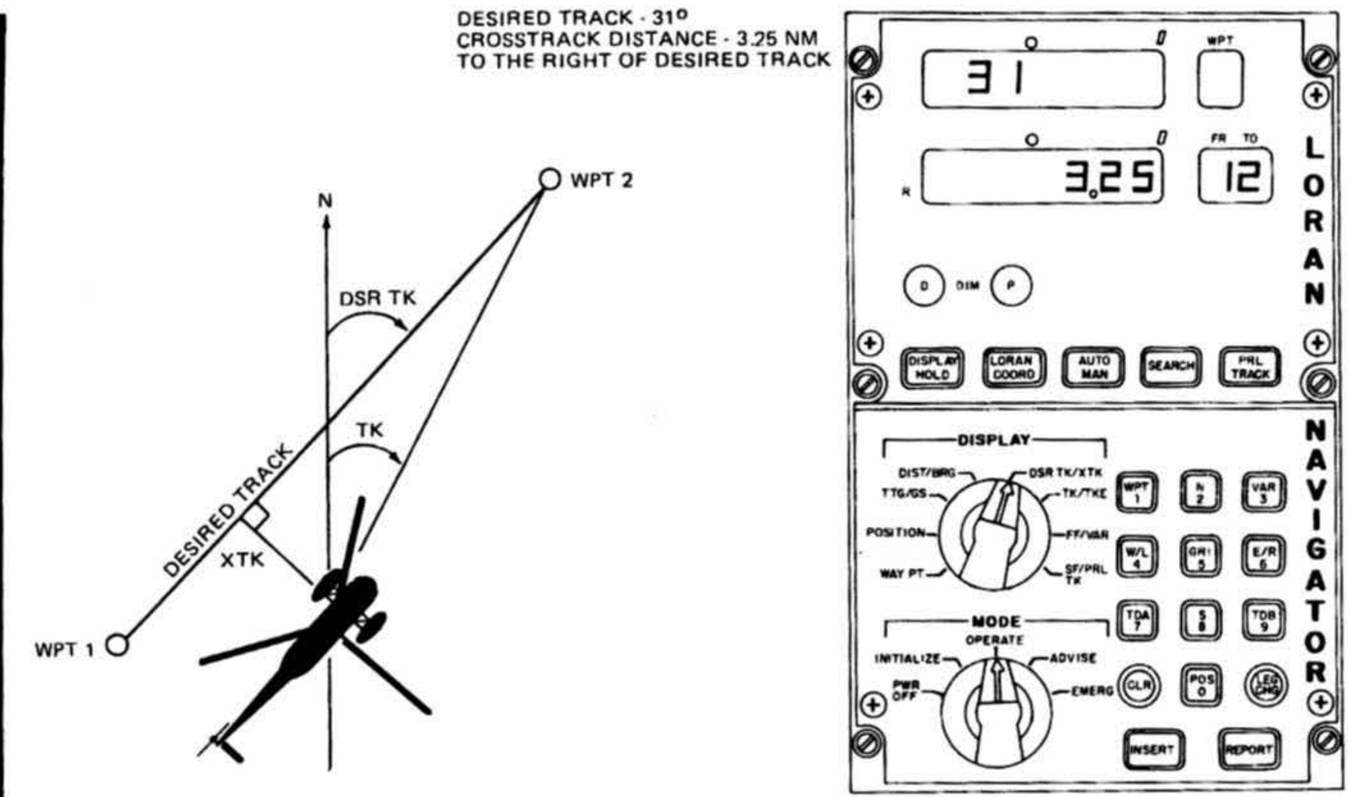


Figure 4-23. DSR TK/XTK Display

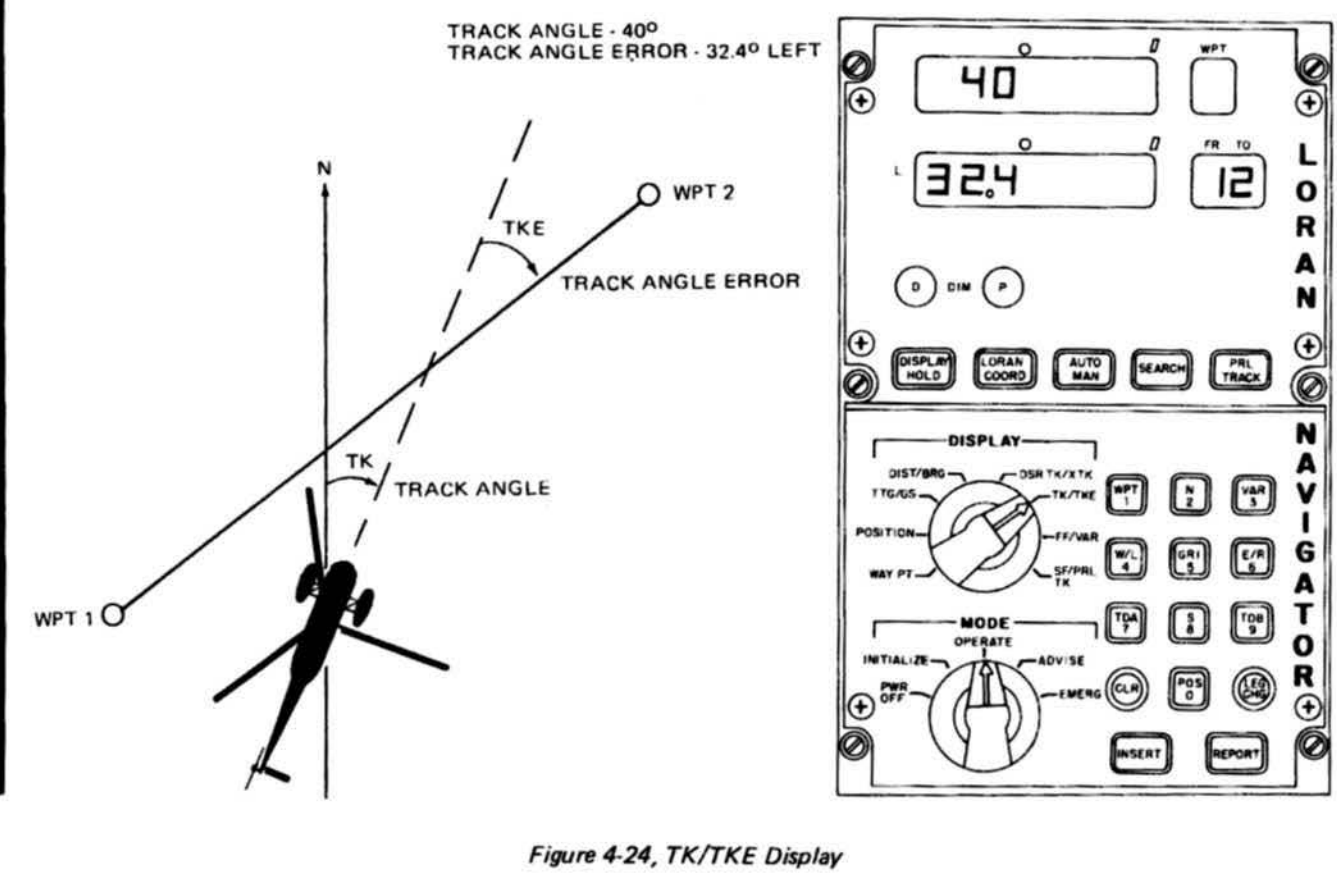


Figure 4-24, TK/TKE Display

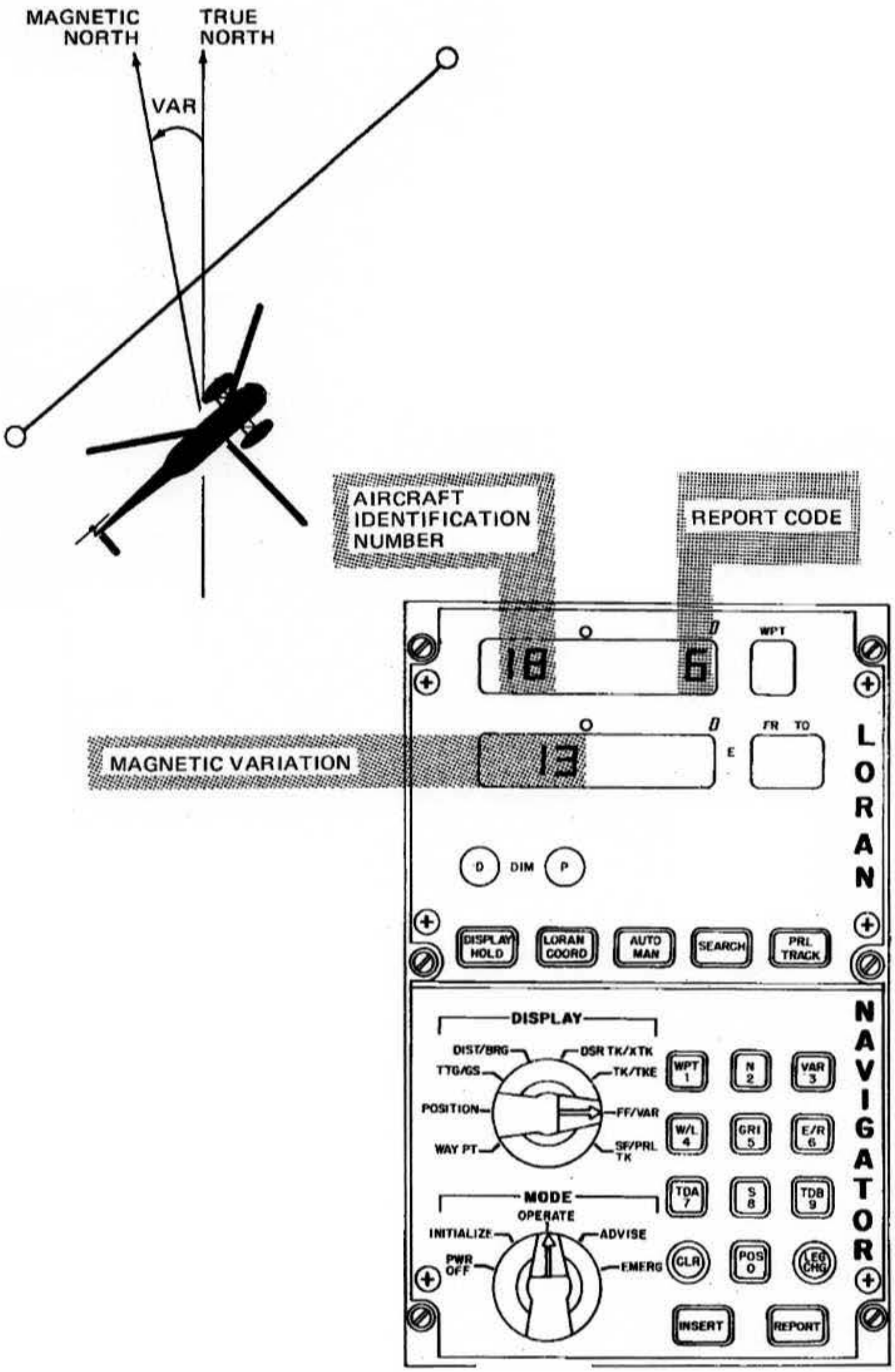


Figure 4-25. FF/VAR Display

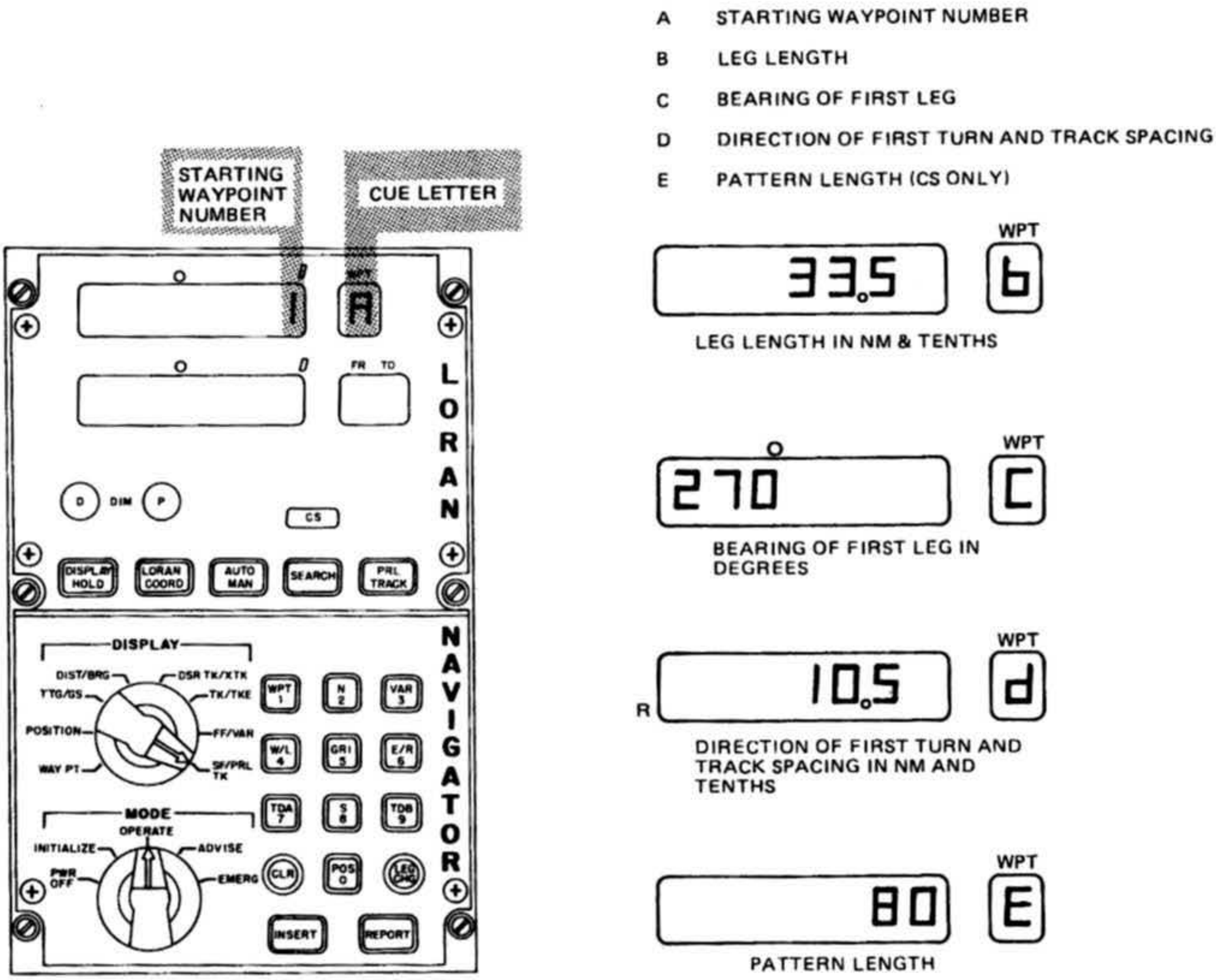


Figure 4-26. Search Entry Display

5. LORAN STATION BLINK - ADVISE illuminates when one of the selected LORAN secondary stations blinks. The LORAN control station causes the LORAN signal to blink whenever the time delay is not within tolerance. During blink, portions of the LORAN signal are alternately turned on and off. Blinking stations should not be used.

6. FLOAT - ADVISE illuminates if any signal in use (master, A, or B) goes into float. Float mode indicates that the signal has been lost and the navigator is temporarily dead reckoning using last-known velocity and direction.

7. NO MASTER -
- 1 = System does not have the real master.
- 0 = System has the real master.
- 8 = Master independence has been overriden (inoperative).

8. IN BITE MODE - ADVISE illuminates when the navigator is operating on the Built In Test Equipment (BITE) chain of 5100.

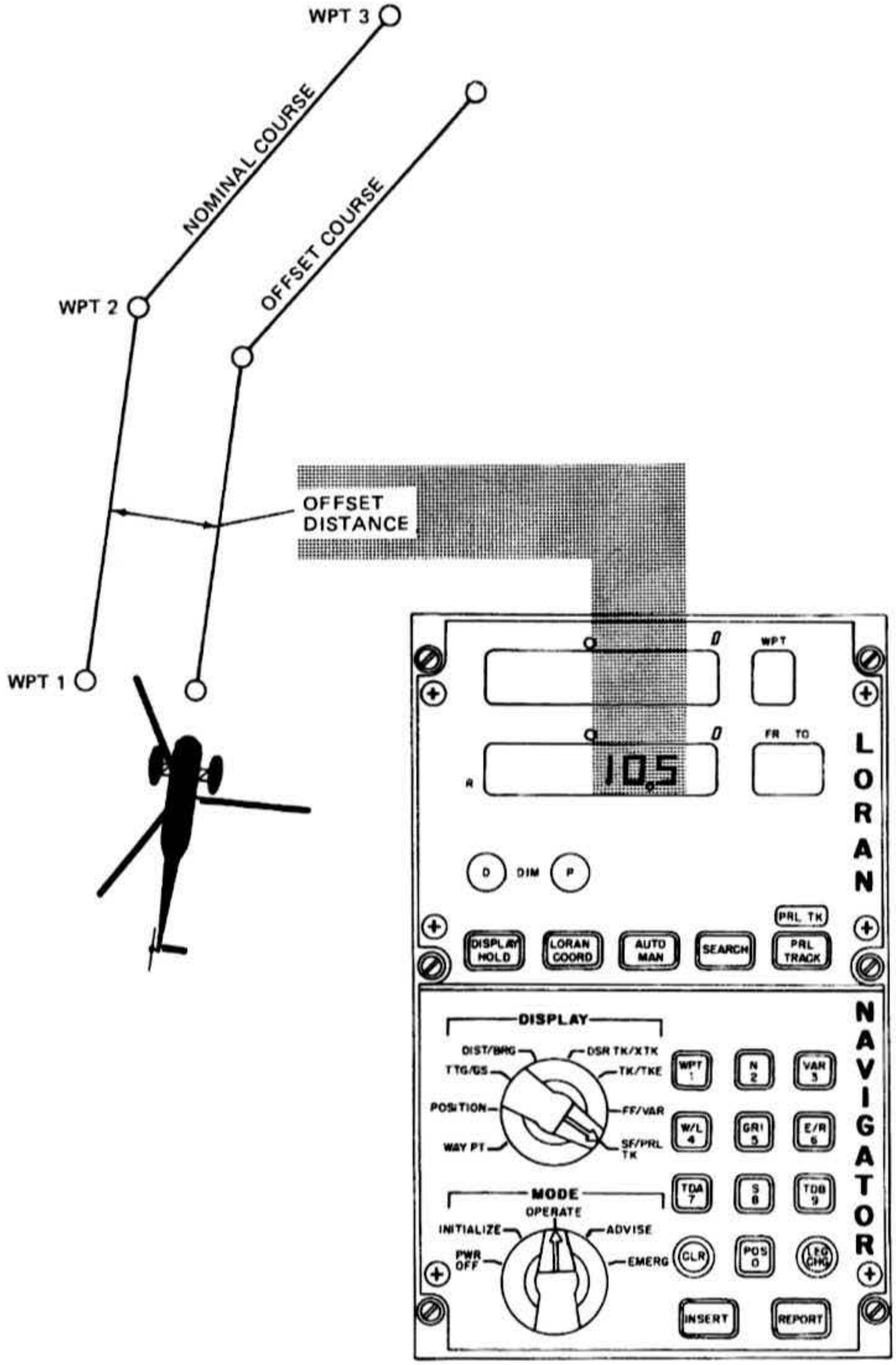


Figure 4-27. SF/PRL TK Display

Warn Indications

WARNING

Whenever the WARN indicator is illuminated, regardless of cause, do not use the system for navigation.

The WARN indicator illuminates and the corresponding lower display digit is set to "1" when any of the following conditions occurs:

1. NOT IN TRACK - WARN illuminates when any of the three signals being used is not in track. The WARN indicator stays on for 20 seconds after the navigator goes back into track to allow the TDs to stabilize.

2. LAT/LONG RUNAWAY - The navigator continually monitors the rate of change of lat/long and checks it for reasonableness. If the rate of change is unreasonable or excessive WARN illuminates.

3. LEG CHANGE CALCULATION - Upon either an automatic or manual leg change, the navigator calculates new navigation data. During this brief calculation period, the navigator illuminates the WARN indicator, advising that data is unreliable.

4. CHECKSUM ERROR - WARN illuminates if the navigator has failed self-test (checksum). This usually indicates hardware failure.

Advise Functions

The ADVISE position of the MODE switch also provides a readout of signal and navigator status and is used in conjunction with other DISPLAY switch positions to check on a number of system parameters and other data. The data in each of the eight DISPLAY switch positions is listed and described in figure 4-29.

PREFLIGHT PROCEDURES

The preflight procedures depend on whether the aircraft will be flying in the same or different area as before, and whether maintenance action has erased initialization data. When power is applied, the navigator is automatically initialized to the last-computed present position, last-entered LORAN chain, magnetic variation, waypoints, and other previously entered data. This data is held in temporary memory when power is removed from the navigator. When flying in the same

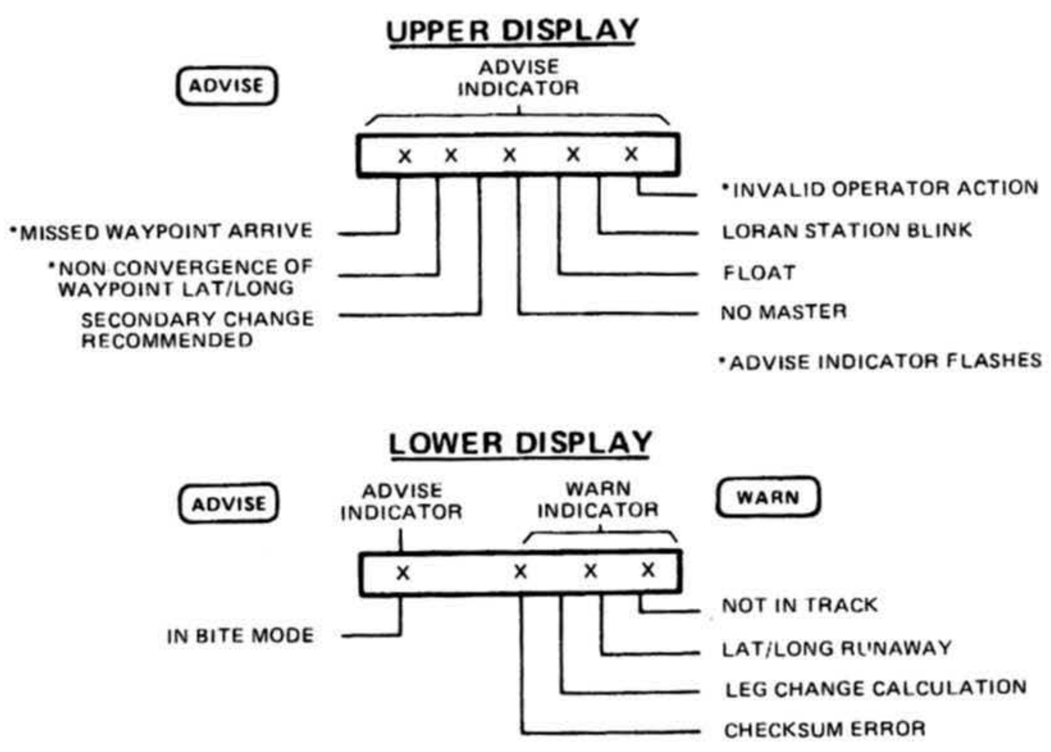


Figure 4-28. Interpretation of ADVISE and WARN Indications

Display Switch Position	Function	Upper and Lower Display Data
WAY PT	TD1	X X X X X X X Microseconds
	TD2	X X X X X X X Microseconds
POSITION	TD3	X X X X X X X Microseconds
	TD4	X X X X X X X Microseconds
TTG/GS	Velocity	Master XXX – Oscillator XXX
	Envelope Counter	M XX – 1 XX, 2 XX
DIST/BRG	Loran Status	M 1 2 3 4 → X X X X X – – 0 — Search 1 — Coarse env 2 — Coarse env 3 — Fine env 1 4 — Fine env 2 7 — Track 8 — Float
	SNR	M 1 2 3 4 → X X X X X - X Secondary number of designated master (master independent operation). Normal operation (real master) = 0 Master independent = 1 - 4 Poor SNR 0 — 0 - 19 1 — 20 - 29 2 — 30 - 39 3 — 40 - 49 Fair SNR 4 — 50 - 59 5 — 60 - 69 6 — 70 - 79 Good SNR 7 — 80 - 89 8 — 90 - 99 9 — Equal to or greater than 100

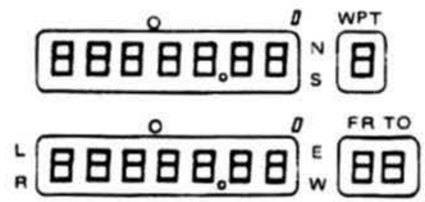
Display Switch Position	Function	Upper and Lower Display Data	
DSR TK/XTK	Interpretation of ADVISE and WARN	See previous two pages for complete breakdown of ADVISE and WARN indications.	
TK/TKE	GRI (Normal entry)	X X X X – – –	
	GRI (Manual chain entry)	X X X X X X X	
	Secondaries	Recommended X X – – – X X In Use	
FF/VAR	Lamp Test		
SF/PRL TK	Memory Address	– – X X X X X (octal)	This function reads TDY-52B computer RAM and ROM memories.
	Memory Data	– X X X X X X (octal)	

Figure 4-29. Advise Functions

general area and temporary memory is intact, set the MODE switch to OPERATE, pausing momentarily in initialize.

NOTE

When turning the navigator on, pause momentarily in the INITIALIZE position. Failure to pause in this position will result in non-retrieval of stored chain and positional data, and possible freeze-up of the navigator.

If complete reinitialization is necessary after maintenance or transfer to a different LORAN coverage area perform the following first:

1. Self-test (BITE).

NOTE

Self-test (BITE) should be accomplished any time a problem is suspected in the system. After self-test is used it will be necessary to enter desired chain GRI, secondary pair, and present position, since these are changed in the test.

2. Initial present position entry.

3. Loran chain GRI selection.

4. Secondary pair selection.

This is the minimum information required to go into OPERATE, enabling the navigator to function. Enter the following, as applicable, in any sequence:

1. Waypoints in lat/long or TD's.

2. Magnetic variation.

3. FROM-TO selection for initial leg.

Self-Test (Bite)

NOTE

Self-test requires going into INITIALIZE mode, which terminates all nav functions and loss of signal track.

Self-test exercises all primary functions of the navigator less the antenna, antenna coupler, and associated cabling. It uses an internally simulated LORAN signal, and is initiated in the same manner as selecting a new GRI, using a pseudo GRI of 5100.

1. Perform lamp test by setting MODE switch to ADVISE and DISPLAY switch to FF/VAR. All displays and indicators except XMIT should illuminate.

2. MODE switch to INITIALIZE and DISPLAY to TK/TKE. Depress LORAN COORD switch to illuminate the TD indicator.

3. Adjust dim knobs as required. Panel lighting indicators and displays should vary accordingly.

4. Depress CLR key. Displays should blank.

5. Depress GRI key.

6. Enter 5100 into keyboard. Number should appear in lower display.

7. Depress INSERT. 5100 should jump to the upper display. ADVISE indicator should illuminate, indicating BITE mode is enabled. WARN indicator should illuminate. Secondaries 1 and 2 are automatically selected and the initial present position of 24°N, 164°W is automatically entered.

8. Set MODE switch to OPERATE and DISPLAY switch to POSITION. The navigator should now search and settle on the simulated chain. When the WARN indicator goes out, the displayed time differences should be: TDA=16000.00 ± 0.2 in the upper display, TDB 36000.00 ± 0.2 in the lower.

9. Depress LORAN COORD switch to extinguish the TD indicator. Displayed lat/long should be N 23° 52.82 ± 0.05 in the upper display and W 164° 22.04 ± 0.05 in the lower. Self-test is satisfactory if time differences in step 8 and lat/long in this step are as indicated.

10. To terminate self-test, set MODE switch to INITIALIZE and enter initial present position and desired GRI and secondaries.

Initial Present Position Entry

Since two geographic positions are defined by any pair of LORAN-C time delays, the navigator must have an initial estimate of present position. Enter present position as accurately as it is known.

NOTE

Initial present position must be entered in lat/long.

Present position entry is not always required since the last known position is stored at shutdown. Use the following procedure to enter initial present position. To change only one coordinate, omit steps 3, 4, 5 and 6 or 3, 7, 8 and 9 as applicable.

1. MODE switch to INITIALIZE and DISPLAY to POSITION.

2. Depress CLR key. Displays should blank.

3. Depress POS key.

4. Depress N or S latitude key. Appropriate indicator should illuminate.

5. Enter into the keyboard the latitude, using zeros (0) as required. Number should appear in upper display.

6. Depress INSERT.

7. Depress E or W longitude key. Appropriate indicator should illuminate.

8. Enter into keyboard the longitude. Enter zeros (0) as requried. Number should appear in lower display.

9. Depress INSERT. Displays should return to normal.

GRI Selection

The time that elapses between the initating pulse from the master and the next initiating pulse from the same master is known as the group repetition interval (GRI).

The following procedure is used to select a LORAN chain GRI. When changing a LORAN chain GRI during flight, allow time for the navigator to acquire and track the new signals (WARN indicator extinguished). Any GRI's not listed in figure 4-30 must first be stored using the manual chain storage procedure.

1. MODE switch to INITIALIZE and DISPLAY switch to TK/TKE.

2. Depress CLR key. Displays should blank.

3. Depress GRI key to activate GRI function.

4. Enter desired chain rate (four most significant digits) into keyboard. Number should appear in lower display.

NOTE

If manually stored chain is to be selected enter the same seven digit number stored in Step 1 of the manual chain storage procedure.

5. Depress INSERT. GRI should jump to upper display. If selected GRI is not one in permanent memory or that one already stored and programmed in temporary memory the ADVISE indicator will flash. Depress CLR key to remove keyboard error ADVISE light and then reenter correct GRI.

Secondary Pair Selection

Secondary pair selection may be made in either INITIALIZE or ADVISE modes. Current LORAN chain GRI and secondary pair are normally stored in temporary memory. Making a secondary selection in ADVISE mode may be done without signal loss which would occur if INITIALIZE is selected when making the change. Use the ADVISE position for inflight changes. When a secondary pair change is made in flight, the TD readout will jump to the new values.

NOTE

Repeated attempts at selection of a poor secondary pair will result in a navigator freeze-up. No more than two attempts should be made at selection of a secondary pair that the navigator initially refuses.

Use the following procedure to select a secondary pair:

1. Set MODE switch to INITIALIZE if selection is to be made during initialization; set to ADVISE if selection is to be made in flight. Set DISPLAY switch to TK/TKE.

2. Depress CLR key. Displays should blank.

3. Depress S key for secondary select.

4. Enter the two-digit number representing secondary pair desired. For example, to use the X and Y secondaries of the 9960 chain, enter 23. Entered number should appear in lower display.

5. Depress INSERT. Newly selected secondary pair should appear in right-most two digits of lower display; recommended pair should appear in left-most two digits. GRI should appear in the upper display. If the selected secondary pair does not match the secondaries available in the selected chain, the ADVISE indicator will illuminate. Check secondary number and reenter.

Automatic Secondary Pair Advisory

Once a LORAN chain GRI and secondary pair have been selected the navigator automatically acquires and tracks all receivable secondaries (up to four). The navigator continually determines the optimum secondary pair to be used and the ADVISE indicator illuminates each time a change is recommended. The operator may enter the recommended secondary pair, ignore it and clear the ADVISE by depressing CLR, or enter another choice. To determine the navigator's recommendation for optimum secondary pair:

1. Set MODE switch to ADVISE and DISPLAY switch to TK/TKE. Upper display should show selected GRI. The two left-most digits

Chain Rates			Secondaries			
			1	2	3	4
Central European	3970	(L3)	X	Y		
Central Pacific	4990	(S1)	X	Y		
Canadian East Coast	5930	(SH7)	X	Y	Z	
Canadian West Coast	5990	(SH1)	X	Y	Z	
North Atlantic	7930	(SL7)	W	X	Z	
Gulf of Alaska	7960	(SL4)	X	Y		
Norwegian Sea	7970	(SL3)	W	X	Y	Z
Southeast U. S.	7980	(SL2)	W	X	Y	Z
Mediterranean Sea	7990	(SL1)	X	Y	Z	
Great Lakes	8970	SS-7	W	X	Y	
U. S. West Coast	9940	(SS6)	W	X	Y	
Northeast U. S.	9960	(SS4)	W	X	Y	Z
Northwest Pacific	9970	(SS3)	W	X	Y	Z
North Pacific	9990	(SSI)	X	Y	Z	

Figure 4-30. Secondary Pair Identification Scheme

in the lower display show the recommended secondary pair; the two right-most digits show the secondary pair actually in use.

Waypoint Navigation

A waypoint is a numbered position to be used in navigating or any point for which navigational or steering is desired. Waypoint numbers appear in two locations on the front panel; the WPT display and the FR TO (leg) display. Control of the WPT display is by the WPT key and the FR TO display is by the LEG CHG key. Use the WPT key and display to enter or display a single waypoint. Use the LEG CHG key and FR TO display to initiate the AUTO navigation sequence or to manually specify a new leg. The number appearing in the waypoint display is automatically set to 1 at power-on.

NOTE

Prior to commencing a leg change, allow the navigator to settle after initial lock-on. Correct (± 10 knots) ground-speed is indicative that settling has occurred. Failure to allow the equipment to stabilize, prior to assigning it a navigational task, will result in non-convergence, possible lat/long runaway and memory saturation accompanied by loss of track and/or navigator freeze-up.

A maximum of nine waypoints in either lat/long or time differences may be entered. When calling up a FROM and TO leg enter the numbers of the two desired waypoints. Navigational and steering data with respect to a course is defined by those two points. If a 0 and a TO waypoint are called up, navigational and steering data will be from the aircraft present position at the time the INSERT key is pressed to the selected TO point. The 0 tells the navigator that information from present position is desired (figure 4-31).

The waypoints entered are stored in memory. To clear a waypoint enter a new set of coordinates over the old.

Auto/Manual Leg Chg Selection

The AN/ARN-133 permits automatic or manual LEG CHG selection. In MAN mode, the operator makes the selection. The operator must call up one leg at a time. Steering with respect to that leg will continue until a new leg change is completed, even if arriving at or passing the desired waypoint. In AUTO mode, the navigator sequences legs automatically, selecting the next leg in numerical sequence each time arrival at a waypoint is completed. If leg changes are entered where the TO waypoint number is greater than the FROM number, the advance of legs, in either AUTO or MAN, will increment: 12, 23, 34, 45, 56, 67, 78, 89. When the limit, 89, is reached, the next leg will be 91; then back to 12, 23, 34, etc. If leg changes are entered where the FROM waypoint number is greater than the TO, the sequence of legs will

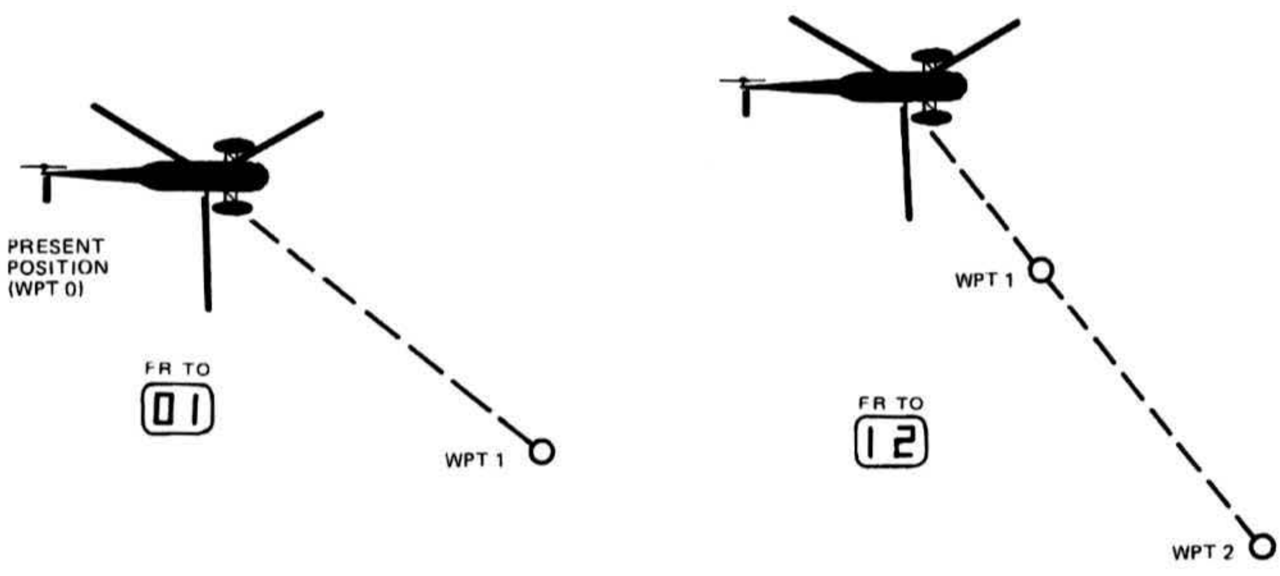


Figure 4-31. Waypoint Navigation

decrement: 65, 54, 43, 32, 21. When the limit, 21, is reached, the next leg will be 19; then 98, etc. To manually activate a leg change press CLEAR, LEG CHG, INSERT.

EXAMPLE:

If the navigator is initialized by entering lat/longs for seven consecutive waypoints, when ready for takeoff, set the MODE switch to OPERATE and select AUTO. The AUTO indicator illuminates and the operator calls up the first leg. The navigator must see an initial LEG CHG entry before it will call up the waypoint table, even in AUTO mode. Use the sequence shown in figure 4-32 to call up the first leg.

Subsequent leg changes are automatic. Steering is provided from present position (0) to waypoint 1. Arriving over 1, the navigator will automatically switch to leg 12, giving navigation and steering information from 1 to 2. When arriving over 2, the navigator switches to leg 23, etc. If in AUTO, manual leg changes may still be accomplished to manually increment to the next leg by depressing CLR, LEG CHG, INSERT.

When arriving at the TO waypoint, the next waypoint in numerical sequence will be used. If FR TO leg change (flashing ADVISE indicator) is missed, it is not necessary to fly back over the waypoint to enable the navigator to acquire it. Manually select the next leg using the above procedure. If the coordinates of the current TO waypoint are changed, the navigator will automatically calculate data for the new position.

Waypoint Call Up

Use the following procedure to call up any waypoint for display, entry, or modification. The last waypoint called up appears in the WPT display in most DISPLAY switch positions.

1. Set MODE switch to INITIALIZE or OPERATE and DISPLAY switch to WAY PT. Previously stored coordinates of the waypoint appearing in WPT display, if any, should appear in upper and lower displays.

2. Depress CLR key. Displays should blank.

3. Depress WPT key.

4. Enter single digit into keyboard (1-9) of desired waypoint. Number should appear in lower display.

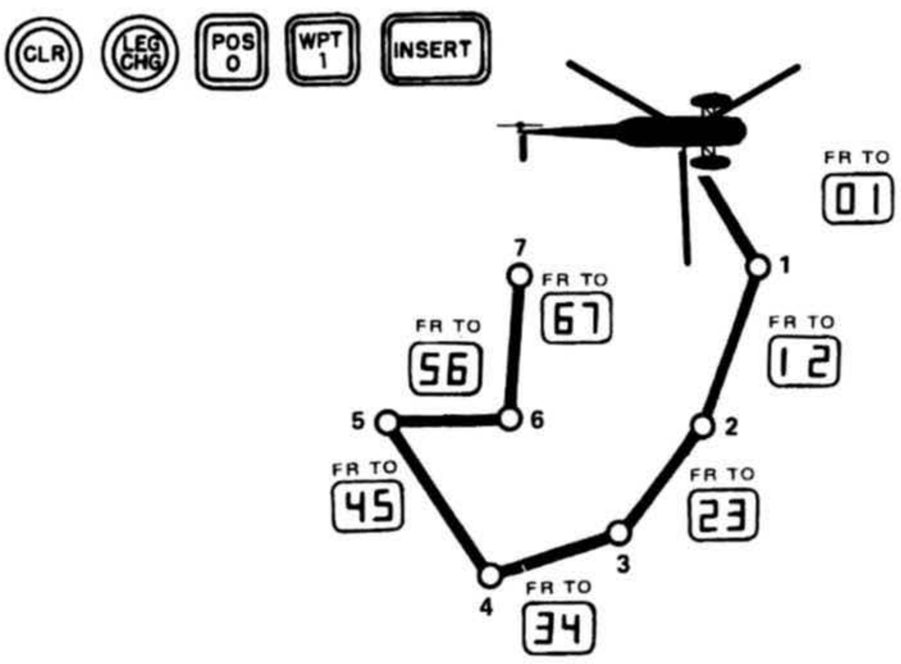


Figure 4-32. Waypoint Selection

5. Depress INSERT. Entered number should jump to WPT display. Previously stored coordinates, if any, should appear in upper and lower displays.

Waypoint Entry in Time Differences

Time differences are directly relatable to position for a specified LORAN chain. Although lat/long is used as the primary reference system waypoints may be entered in TD's.

EXAMPLE:

If a report of a target at a certain TD fix is received without regard to lat/long, enter those TDs as a waypoint, then enter a leg change of 01. Navigation from present position (0) to that fix (1) is provided (figure 4-33).

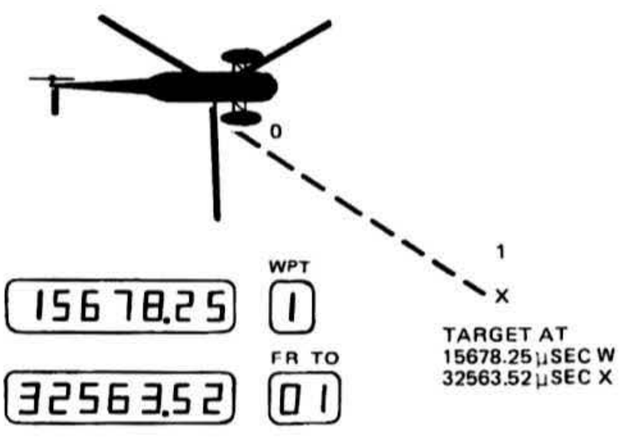


Figure 4-33. Waypoint Entry in Time Differences

NOTE

TD's are not related to a geodetic frame or reference, but only relate to the chain from which they were derived. The navigator must be operating on the same chain. When waypoints are entered in TDs depending on distance and geometry, the navigator may not be able to do an ambiguous lat/long conversion until closer to the fix.

Use the following procedure to enter waypoints in time differences. To change only one coordinate, omit steps 4, 5 and 6 or 4, 7 and 8, as applicable.

1. Call up the desired waypoint number using the waypoint call up procedure.
2. Depress LORAN COORD switch to illuminate TD indicator.
3. Depress CLR key. Displays should blank.
4. Depress POS key.
5. Depress TDA key and enter into keyboard the seven digit time difference for TDA to hundredths of a microsecond. The new TDA should appear in upper display.
6. Depress INSERT. New TDA momentarily flashes.
7. Depress TDB key and enter into keyboard the seven digit time difference for TDB to hundredths of a microsecond. The new TDB should appear in lower display.
8. Depress INSERT. New coordinates should remain in upper and lower displays.
9. Repeat steps 1 through 8 for each of the remaining waypoints to be entered. Successive depressions of INSERT will increment the WPT display to the desired waypoint number.

Waypoint Entry in Lat/long

Use the following procedure to enter waypoints in lat/long. To change only one coordinate, omit steps 4, 5, 6 and 7 or 4, 8, 9 and 10, as applicable.

1. Call up the desired waypoint number using the waypoint call up procedure.
2. Depress LORAN COORD switch to extinguish TD indicator.
3. Depress CLR key. Displays should blank.
4. Depress POS key.
5. Depress N or S latitude key. Appropriate indicator should illuminate.
6. Enter into keyboard the latitude. Number should appear in upper display.

7. Depress INSERT.

8. Depress E or W longitude key. Appropriate indicator should illuminate.

9. Enter into keyboard the longitude. Number should appear in lower display.

10. Depress INSERT. New coordinates should remain in upper and lower displays.

11. Repeat steps 1 through 10 for each of the remaining waypoints to be entered. Successive depressions of INSERT will increment the WPT display to the desired waypoint number.

Report Code Entry

NOTE

Although the report code entry procedures may be accomplished, compatible ground/ship equipment must be available to permit use.

Use the following procedure when a date link report code number is to be selected or changed.

1. MODE switch to OPERATE.

2. Depress CLR key. Displays should blank.

3. Depress REPORT key.

4. Enter into keyboard the desired report code number. (Any digit from 1 through 6 for manual reporting and any digit from 01 through 06 for automatic.) Number should appear in lower display.

5. Depress INSERT. Displays should return to selected function.

6. To set the report code to 0 (which turns on automatic reporting of present position), depress CLR REPORT, and INSERT.

Search Patterns

Two search patterns may be stored in the Navigator; one creeping line (CS) and one sector (VS). Either of these may be called up using the SEARCH function to obtain nav and steering data to execute the pattern. Once the search patterns are stored, various parameters of either pattern may be individually changed. Search patterns are entered by following cue letters appearing in the WPT display.

Creeping Line Search (CS)

Commence Search Point (CSP) is located one-half search track spacing inside the corner of the search area. Leg length is search area width minus one track spacing (figure 4-34).

Sector Search (VS)

Commence Search Point (CSP) is a datum. Leg length is equal to circle radius. Track spacing is measured at the half-radius point. No entry is made for pattern length (figure 4-35).

Search Pattern Entry

Use this procedure to enter a CS or VS search pattern. Letters A through E appear in the WPT display, cuing the type of data to be entered next. By depressing INSERT a second time at the end of any sequence, the next step (A through E) may be left with data unchanged from a previous entry.

1. Set MODE switch to OPERATE and DISPLAY switch to SF/PRL TK. Lower display should show previous parallel track offset, if any.

2. Depress SEARCH key. CS indicator should illuminate. If VS pattern is desired, depress SEARCH pushbutton again for VS indicator to illuminate. Cue letter A should appear in WPT display. Previously selected waypoint used for CSP, if any, should appear in upper display.

WPT A Enter Commence Search Waypoint

1. Depress CLR key. Display should blank.

2. Enter into keyboard Commence Search Point waypoint number. This number should appear in lower display.

3. Depress INSERT. Cue letter b should appear in WPT display. Last entered leg length, if any, should appear in upper display.

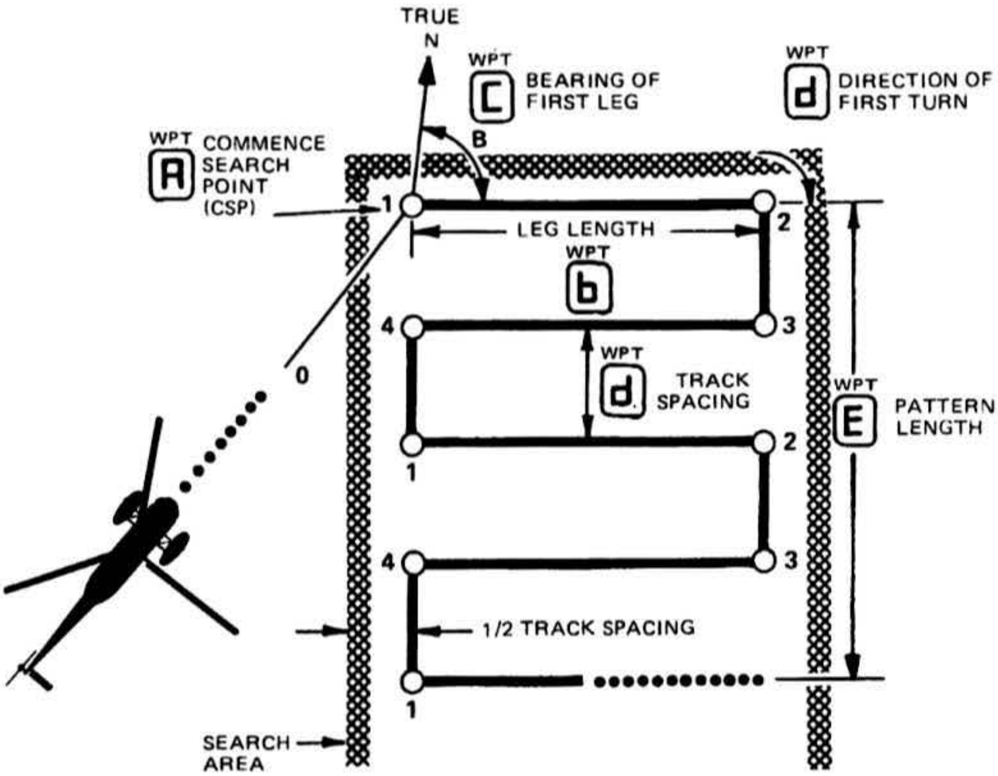


Figure 4-34. Creeping Line Search

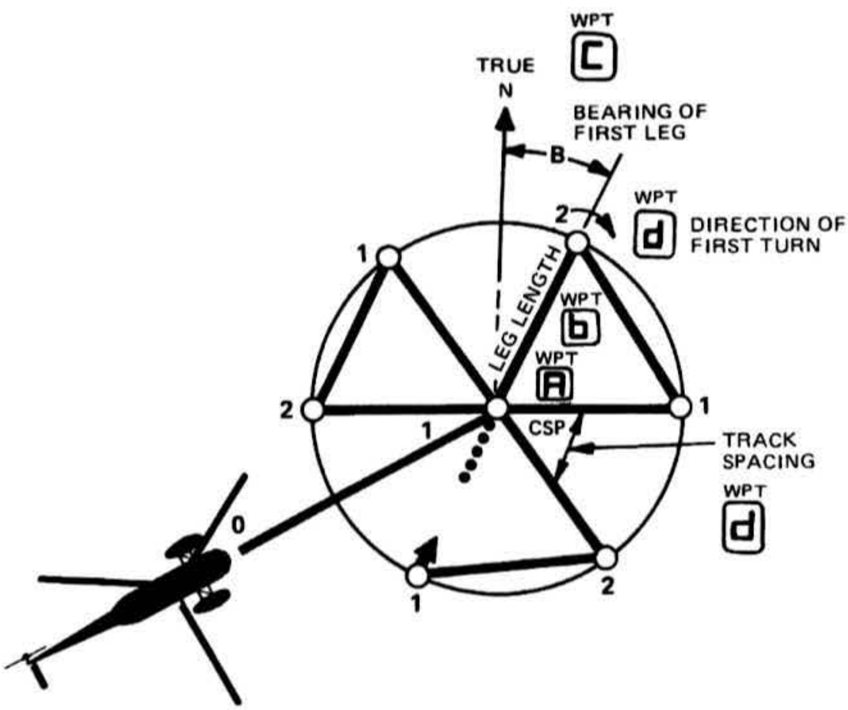


Figure 4-35. Sector Search

WPT b Enter Leg Length

1. Depress CLR key. Displays should blank.

2. Enter length of search leg in nautical miles and tenths (0.1 - 99.9). For VS patterns, this is the circle radius. This number should appear in lower display.

3. Depress INSERT. Cue letter C should appear in WPT display. Last entered bearing for first leg should appear in upper display.

WPT C Enter True Bearing of First Leg

1. Depress CLR key. Displays should blank.

2. Enter into keyboard true bearing of first leg in degrees. This number should appear in lower display.

3. Depress INSERT. Cue letter d should appear in WPT display. Last entered direction of first turn should be indicated on L or R indicator. Last entered track spacing should appear in upper display.

WPT d Enter Direction of First Turn and Track Spacing

1. Depress CLR key. Displays should blank.

2. Depress L or R key to select left or right direction of first turn. Appropriate L or R indicator should illuminate.

3. Enter desired track spacing into keyboard (0.1 - 99.9). For VS patterns, this is measured at the half-radius points. This number should appear in lower display.

4. Depress INSERT. R or L indicator should extinguish. Cue letter E should appear in WPT display. Last entered length for CS pattern, if any, should appear in upper display, cuing next CS entry. Disregard this cue for VS patterns.

5. For VS patterns, depress INSERT again. VS indicator should extinguish signifying VS search pattern entry sequence is complete.

WPT E Enter Pattern Length for CS Patterns

1. Depress CLR key. Displays should blank.

2. Enter into keyboard CS pattern length in nautical miles (1 through 99). This number should appear in lower display.

3. Depress INSERT. Number should disappear from display. CS indicator should extinguish signifying CS search pattern entry sequence is complete.

EXAMPLE OF CS PATTERN ENTRY (Refer to figure 4-36.)

CSP is at waypoint 1.

Leg length is 5.5 nautical miles.

Bearing of first leg is 43° TRUE.

Direction of first turn is right; track spacing is 0.8 nautical miles.

Pattern length is 12 nautical miles.

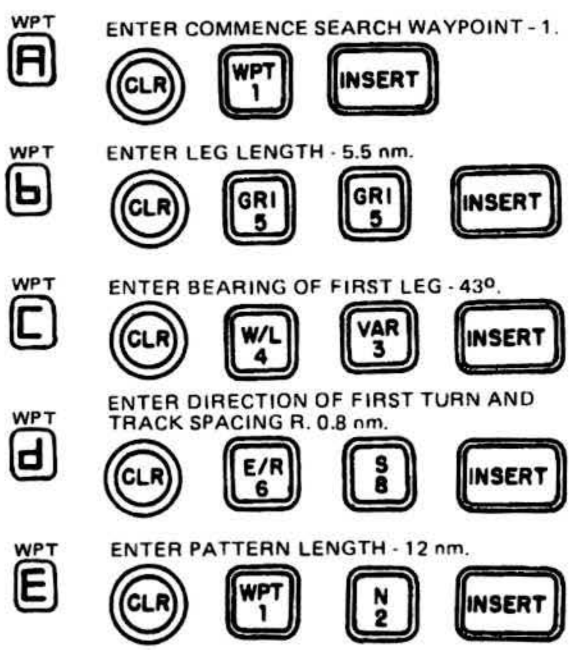


Figure 4-36. CS Pattern Entry

Search Pattern Readout

Use this procedure to display search patterns previously entered into the navigator.

1. MODE switch to OPERATE. DISPLAY switch to SF/PRL TK. Depress SEARCH key. CS indicator should illuminate. If VS pattern is desired, depress SEARCH again. Cue letter A should appear in WPT display. Waypoint previously entered as Commence Search Waypoint should appear in upper display.

2. Depress INSERT to obtain next cue letter and associated search pattern data. Continue depressing INSERT until desired data is obtained.

3. Continue depressing INSERT until VS or CS indicator extinguishes.

Search Pattern Modification

Use this procedure to modify any portion of an existing search pattern:

1. MODE switch to OPERATE. DISPLAY switch to SF/PRL TK. Depress SEARCH key. CS indicator should illuminate. If VS pattern is desired, depress SEARCH again. Cue letter A should appear in WPT display. Waypoint previously entered as Commence Search Waypoint should appear in upper display.

2. If Commence Search Waypoint number is to be changed, proceed as follows:

   a. Depress CLR key. Displays should blank.

   b. Enter into keyboard new commence search waypoint number. This number should appear in lower display.

   c. Depress INSERT. Cue letter b should appear in WPT display, cuing next entry.

   d. If any other pattern data is to be changed, depress INSERT until desired cue letter appears in WPT display. Enter new data as though making an original entry, using CS or VS search pattern input procedure.

3. If no other change is to be made in the pattern, continue depressing INSERT until the last cue (E) is removed and CS or VS indicator is extinguished.

NAVIGATOR PREFLIGHT

NOTE

The following procedures are the minimum that should be accomplished prior to takeoff.

Procedures

1. MODE switch — Initialize.

2. DISPLAY switch — Position. Check/Insert lat/long of present position.

3. DISPLAY switch — TK/TKE. Check/Insert Loran C GRI and secondary pair selection. It is recommended that each unit establish a policy of inserting a standard Loran GRI and secondary pair for their home unit.

4. DISPLAY switch — FF/VAR — Check/Insert correct present position variation. It is recommended that each unit establish a policy of inserting a standard variation for their home unit.

5. DISPLAY switch — WAY PT. Depress CLR, WPT, 1, INSERT. Check/Insert lat/long/ of WPT 1. It is recommended that each unit establish a policy of always utilizing the lat/long of their home unit in position 1. If some other lat/long and variation are utilized in 1 during flight, the preflight lat/long and variation should be entered in 1 before the aircraft is secured.

6. Taxi clear of large buildings, hangars, or other obstacles.

WARNING

Loran C signal distortion may cause erroneous lockons near large metal objects.

7. MODE switch — OPERATE.

8. When WARN light extinguishes DISPLAY switch — POSITION.

9. Depress LORAN COORD key. TD indicator should illuminate. Check displayed TDA and TDB. Displayed information should be within 4.50 microseconds of that predetermined for the selected geographic location, GRI, and specific secondary pair. Differences in excess of 4.50 microseconds indicate probable erroneous lockon. Reacquisition should be considered.

10. Depress LORAN COORD key — TD light should extinguish. Check displayed lat/long. Displayed information should be within 0.25 minutes of the lat/long represented by the TDA and TDB displayed in step 9. If differences in excess of 0.25 minutes are observed the Navigator is not converting TD's to lat/long correctly and should not be used for navigation. Perform the self test (BITE) to confirm Navigator performance.

11. Compare the displayed lat/long in step 10 to the predetermined lat/long for the selected geographic location. If not within 0.25 minutes of that predetermined lat/long perform update procedures.

NOTE

Regardless of error, correct position updating against a known geographical reference with known good LORAN-C reception will always provide more accurate navigation information.

INFLIGHT PROCEDURES

WARNING

Single piloted inflight programming is not advisable due to preoccupation/distraction factors. When dual piloted, these duties should be accomplished by the copilot.

1. Select GVR in the Flight Director.

2. Select LORAN in the GVR/LORAN selector switch.

Leg Change Entry

Use the following procedure to define or redefine a flight leg, in either AUTO or MANUAL modes.

1. Set MODE switch to OPERATE.

2. Depress CLR Key. Displays should blank.

3. Depress LEG CHG key.

4. Enter into the keyboard the numbers of the new FROM waypoint and the number of the new TO waypoint, in that order. The new waypoint should appear in the lower display.

5. Depress INSERT. New waypoints should jump to the FR TO display. The WARN indicator will illuminate momentarily while the Navigator is calculating data for the new leg.

NOTE

If 0 was selected as the from waypoint, it will automatically become the present position displayed at the time the INSERT switch was depressed.

6. To advance to the next consecutive leg, depress CLR, LEG CHG, and INSERT. The next leg in numerical sequence should appear in the leg display.

Interwaypoint Range and Bearing

The navigator calculates distance and bearing from the designated FROM waypoint to the designated TO waypoint and displays this data for ten seconds. These computations are performed in lat/long, thus prohibiting interwaypoint range and bearing information for waypoints when either or both are stored in time differences. This is a remote function and does not affect steering. Use the following procedure to obtain range and bearing from aircraft present position to any waypoint or from any waypoint to any other waypoint.

1. Verify that MODE switch is set to OPERATE. Set DISPLAY switch to DIST/BRG.

2. Depress CLR key. Displays should blank.

3. Depress WPT key.

4. Enter into keyboard the FROM and TO waypoints for which the range and bearing are desired. If range and bearing from aircraft present position to a waypoint are desired, enter 0 and the waypoint number. Numbers should appear in lower display.

5. Depress INSERT. Upper display should show distance; lower display should show bearing. The FROM TO waypoint numbers should appear in the FROM TO readout of the lower display. After ten seconds displays should revert to normal DIST/BRG display. If required longer, depress DISPLAY HOLD.

Converting Present Position Into a Waypoint

Present position can be frozen by depressing DISPLAY HOLD and then transferred to any waypoint by using the waypoint call up procedure. As many as nine points may be stored for reporting, etc. Use of this function does not interrupt normal steering information to other waypoints.

1. Verify that MODE switch is set to OPERATE. DISPLAY switch may be in any position.

2. Select type of coordinates desired to store the present position, if time differences, depress LORAN COORD to illuminate the TD indicator; if lat/long, TD indicator must be extinguished.

3. When directly over the position, depress and release DISPLAY HOLD pushbutton. HOLD indicator should illuminate, aircraft present position is stored, and the displays are frozen.

4. Depress CLR key. Displays should blank.

5. Depress WPT key.

6. Enter into keyboard the number of the waypoint into which the desired position is to be stored. The selected waypoint number should appear in the lower display.

7. Depress INSERT. Stored values of the held position (whether lat/long or TD) become coordinates for the selected waypoint. HOLD indicator should extinguish and displays revert back to normal.

Position Updating

Position may be updated at any time. It is possible to compensate for propagation anomalies or map error by using position fixes of known accuracy. This is accomplished by entering the known fix in either TD's or lat/long, or by using coordinates previously stored in a waypoint. When the POS update function has been selected and the calibration coordinates have been entered, the INSERT key is depressed when directly over the selected calibration point (figure 4-37). At the instant of switch depression, the coordinates of that present position are measured and compared with the stored coordinates of the calibration point. The difference between the two positions is then used as a correction factor. The correction will be applied to all subsequent measurements until changed, deleted, or a change of secondaries is made. Normal data display is resumed with the proper correction added.

NOTE

Insure the system is in track and stabilized by verifying that the WARN indicator is extinguished before doing a POS update. This will ensure that the measured TD's have stabilized.

Time Difference Position Update

Use the following procedure to update system position against a known calibration point using manually entered time differences.

1. MODE switch to OPERATE and DISPLAY switch to POSITION. Verify that system is in track (WARN indicator extinguished). To observe the update, verify that TD indicator is illuminated.

2. Depress CLR key. Displays should blank.

3. Depress POS key for position update.

4. Depress TDA key to select time difference A.

5. Enter into keyboard seven digits representing time difference A to hundredths of microseconds. Numbers should appear in upper display.

6. Depress INSERT.

7. Depress TDB key to select time difference B.

8. Enter into keyboard seven digits representing time difference B to hundredths of microseconds. Numbers should appear in lower display.

9. Depress INSERT key when directly over calibration point. Displays should return to normal. POS UPD indicator should illuminate, indicating correction factor is active.

10. To clear POS update, depress CLR, POS, and INSERT. POS UPD indicator should extinguish, indicating correction is removed.

Lat/Long Position Update

Use the following procedure to update system position against a known calibration point using manually entered latitude and longitude coordinates.

1. MODE switch to OPERATE and DISPLAY switch to POSITION. Verify that system is in track (WARN indicator extinguished). To observe the update, insure that TD indicator is extinguished.

2. Depress CLR key. Displays should blank.

3. Depress POS key for position update.

4. Depress N (or S) latitude key. N (or S) indicator should illuminate.

5. Enter into keyboard the latitude. Numbers should appear in upper display.

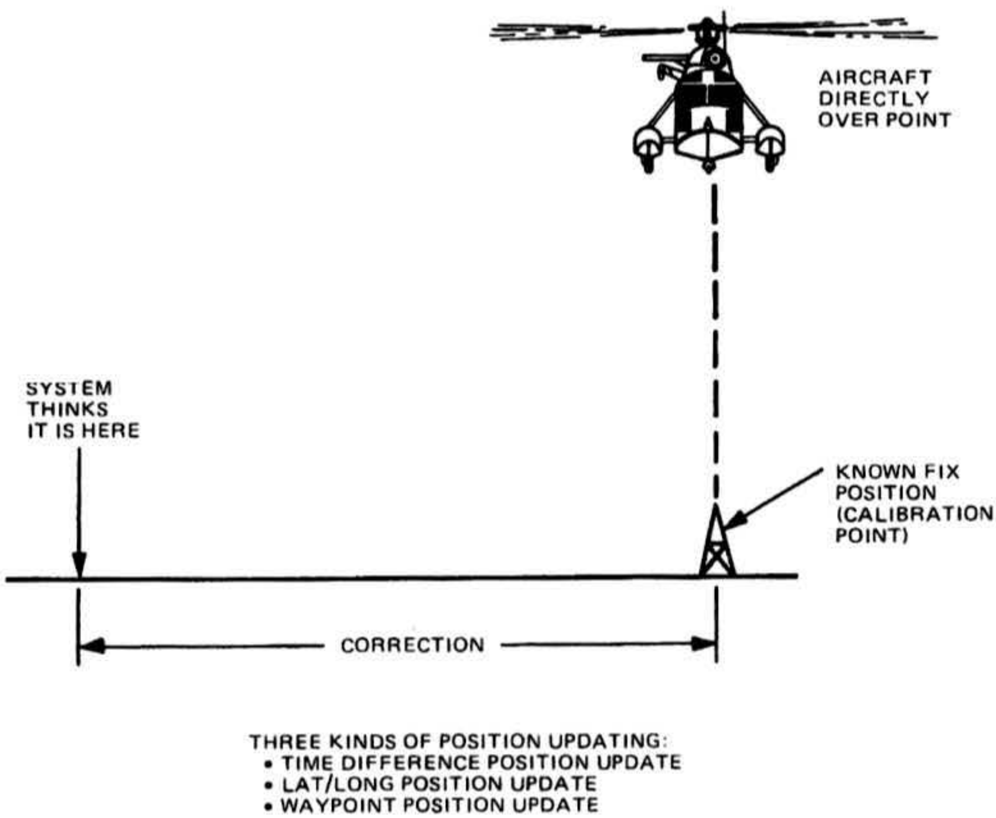


Figure 4-37. Position Updating

6. Depress INSERT.

7. Depress W (or E) longitude key. W (or E) indicator should illuminate.

8. Enter into keyboard the longitude. Number should appear in lower display.

9. Depress INSERT key when directly over calibration point. Displays should return to normal. POS UPD indicator should illuminate, indicating correction factor is active.

10. To clear POS update, depress CLR, POS, and INSERT. POS UPD indicator should extinguish, indicating correction is removed.

Waypoint Position Update

Use the following procedure to update system position against a known calibration point using coordinates stored in a waypoint. Coordinates stored in the selected waypoint in either TD's or lat/long become the corrected position.

1. MODE switch to OPERATE and DISPLAY switch to POSITION. Verify the navigator is in track (WARN indicator extinguished).

2. Depress CLR key. Displays should blank.

3. Depress POS key for position update.

4. Depress WPT key for waypoint position update.

5. Enter into keyboard the waypoint number in which the coordinates have been stored for the calibration point. Selected waypoint number should appear in lower display.

6. Depress INSERT key when directly over calibration point. Displays return to normal. POS UPD indicator should illuminate, indicating correction factor is active.

7. To clear POS update, depress CLR, POS, and INSERT. POS UPD indicator should extinguish, indicating correction is removed.

Magnetic Variation Entry

Use the following procedure to enter or update the angle of magnetic variation. The TRUE indicator is illuminated when there is no magnetic variation inserted in the navigator.

1. MODE switch to INITIALIZE or OPERATE. To observe, set DISPLAY switch to FF/VAR. Magnetic variation may be entered in any position.

2. Depress CLR key. Displays should blank.

3. Depress VAR key.

4. Depress E (or W) key to select direction of variation. E (or W) indicator should illuminate.

5. Enter correct magnetic variation into keyboard to the nearest degree. Number should appear in upper display.

6. Depress INSERT. New variation is accepted and displays return to normal.

7. To clear the system of any magnetic variation, CLR, VAR, and INSERT. TRUE indicator should illuminate, indicating bearing and course angle are with respect to true north.

8. To check entry, set DISPLAY switch to FF/VAR. New variation and direction should appear in lower display.

NOTE

Magnetic variation must be updated in 1° increments during flight progression for accurate navigation.

Parallel Track Steering

Parallel track steering permits flying parallel to a given course at a selected distance from it. The offset distance may be from 0.1 to 99.9 nautical miles A series of such offset legs may be flown as determined by the number of waypoints entered in the system. Distance may be changed in mid-leg. The navigator completes this by projecting an artificial destination based on the nominal course coordinates and the offset distance entered. Figure 4-38 illustrates that in order for the navigator to compute the artificial destination 3', the coordinates of waypoints 2, 3, and 4 plus the offset distance, D, are necessary.

In manual mode, and in automatic when no subsequent waypoint coordinates have been entered, the offset destination is projected perpendicularly to the nominal course. In automatic mode, the offset destination is projected on the bisector of the angle between consecutive legs. Once the offset distance is entered, all navigation data is calculated with reference to the aritificial destination. Original waypoint defined course is not lost, but held in storage until parallel track navigation is deselected. The following limitations apply.

1. Use of parallel track navigation at latitudes approaching the poles (+ 80° or more), is unreliable.

2. Since parallel track computations are performed in lat/long coordinates, use of parallel track navigation while a waypoint is stored as a TD pair is not possible.

3. Waypoint course should not contain any 180° turns.

Use the following procedure to obtain parallel track navigation:

1. MODE switch to OPERATE. To observe entry, set DISPLAY switch to SF/PRL TK.
2. Depress CLR key. Displays should blank.
3. Depress PRL TRACK key.
4. Depress L or R key to select either left or right of nominal course. L or R indicator should illuminate.
5. Enter into keyboard the desired offset distance to tenths of a nautical mile (0.1 through 99.9 nautical miles). Selected offset distance should appear in lower display.
6. Depress INSERT. PRL TRACK indicator should illuminate and displays should revert to selected function. Navigation is for the offset track.
7. To deselect parallel track steering depress CLR, PRL TRACK, and INSERT. PRL TRACK indicator should extinguish. Steering should revert to normal.

Search Operation Using Prestored Patterns

Once any search pattern has been stored it may be called up and used in flight. The following procedures describe how to commence search on a prestored pattern, perform an optional manual leg advance during search, depart from and resume search, and terminate search.

NOTE

Prior to commencing a search, time should be allowed for the navigator to settle after initial lockon. Correct (± 10 knots) groundspeed is indicative that settling has occurred. Failure to allow the equipment to stabilize, prior to assigning it a navigational task, will result in a non-convergence, possible lat/long runaway and memory saturation accompanied by loss of track.

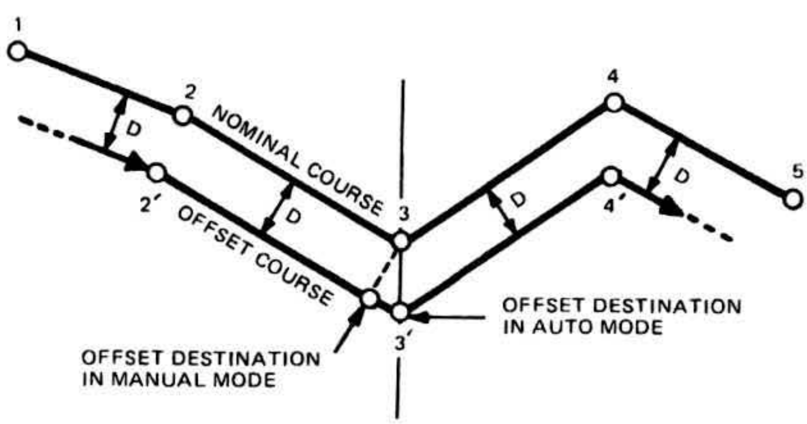


Figure 4-38. Parallel Track Navigation

Commence Search Pattern

To commence search use the following procedure.

1. MODE switch to OPERATE position. To observe, set DISPLAY switch to SF/PRL TK.
2. Depress CLR key. Displays should blank.
3. Depress LEG CHG key to initiate leg change.
4. Enter into the keyboard the single digit representing the approach leg FROM point. This is usually 0, representing aircraft present position. The TO point is the waypoint previously specified during search pattern storage as the Commence Search Point and need not be entered. Number should appear in lower display.
5. Depress SEARCH key. CS indicator should illuminate. If VS pattern is desired, depress SEARCH again; VS indicator should illuminate.
6. Depress INSERT. Leg display should show leg selected in step 4. AUTO MAN indication is set to AUTO. Upper display left-most three digits show number of legs to be flown in the search pattern; right-most three digits show number of legs completed. Lower display shows direction of next turn and course of next search leg. Steering is provided for the initial leg. To manually advance legs while flying a search pattern, depress CLR, LEG CHG and INSERT. Each time this is accomplished, the Navigator will advance steering to the next leg and change the displays accordingly.
7. To obtain desired information, such as distance to the next turn, bearing to the next turn or crosstrack distance, rotate the display switch to the desired position.

NOTE

Do not rely on the upper left display readout. A permanent memory programming discrepancy exists which may show an incorrect number of legs to fly for any particular search.

A commence search pattern example is illustrated in figure 4-39.

Depart from Search Pattern, Return, and Resume Search

To leave the scheduled search pattern and investigate a target, and then return to the point of departure to take up search where it was left off, use the following procedure:

1. During search, depress SEARCH key at the point where the pattern is departed. The active CS or VS indicator should flash on and off. The leg display should blank and steering is deactivated (flight director OFF flags visible and needles centered.) The Navigator stores the aircraft position at the time of switch depression.
2. To resume the search pattern at the departure point depress SEARCH again. Active CS or VS indicator stops blinking and remains illuminated. Leg display shows OE (E signifying point of exit), and steering is now provided from present position to point where the search pattern was left (step 1). Search pattern resumes where it left off.

Terminating Search

Use the following procedure to terminate the stored search pattern.

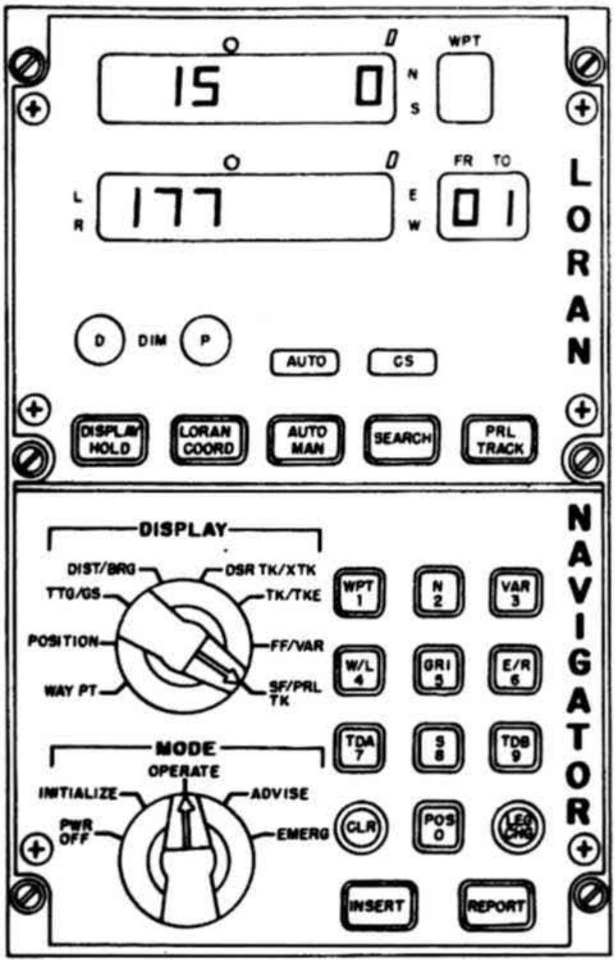
1. Depress CLR key. Displays should blank.
2. Depress SEARCH key. Active search indicator should blink.
3. Depress INSERT. Leg display is blanked and Flight director needle is deactivated with OFF flags visible.

NOTE

Initiating a standard leg change will also terminate search and activate steering to the designated waypoint.

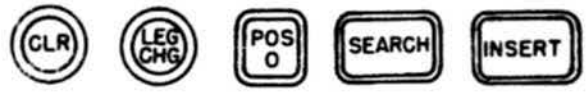
Rho-Theta Navigation

The rho-theta navigation function (figure 4-40) calculated the latitude and longitude of a waypoint



EXAMPLE:

COMMENCE SEARCH ON PRESTORED CS PATTERN USING WAYPOINT 1 AS STARTING WAYPOINT.



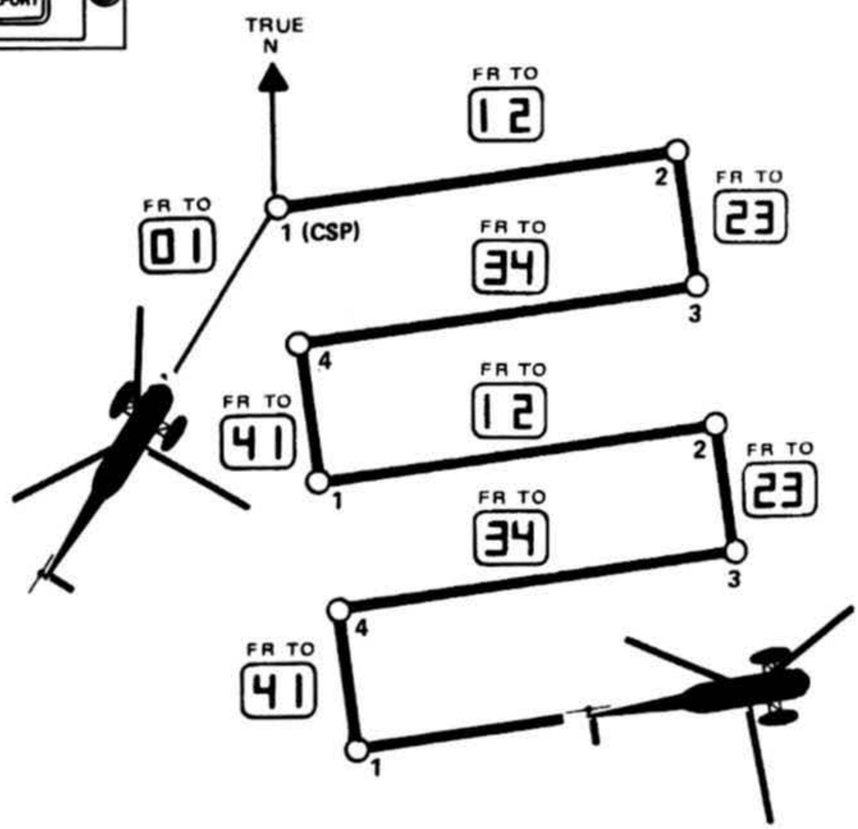


Figure 4-39. Commence Search Pattern

that lies at a given distance (rho), and bearing (theta) from a given waypoint or present position. This function may be used in two ways:

1. To have the navigator calculate lat/long of the projected point and store it in a specified waypoint for future use.

2. To have the navigator calculate the lat/long of the projected point, store it, and automatically initiate a leg change to provide steering to that point.

NOTE

The navigator will not accept entries of rho distances over 250 nautical miles.

Use the following procedure to obtain rho-theta navigation:

1. MODE switch to OPERATE and DISPLAY switch to DIST/BRG.

2. Depress CLR key. Displays should blank.

3. Depress WPT and LEG CHG keys to initiate the function.

4. To store the projected point as a waypoint without obtaining navigation to it, enter the single digit of the FROM waypoint from which rho and theta are to be calculated. To obtain navigational information to the projected point, enter 0 for the FROM waypoint. Entering 0 designates present position. Number should appear in lower display.

5. Enter the single digit of the TO waypoint to be defined by the rho-theta function. Number should appear in lower display.

6. Depress INSERT.

7. Enter up to four digits of range (rho) in nautical miles and tenths, up to 250 nautical miles maximum. Range should appear in upper display.

8. Depress INSERT.

9. Enter up to three digits of true bearing (theta) in degrees. Bearing should appear in lower display.

10. Depress INSERT. The navigator will calculate the lat/long of the projected point and store this in the selected TO waypoint. If a FROM waypoint of 0 was entered, a leg change will be automatically initiated and you will get steering to the calculated point. DIST/BRG will be displayed.

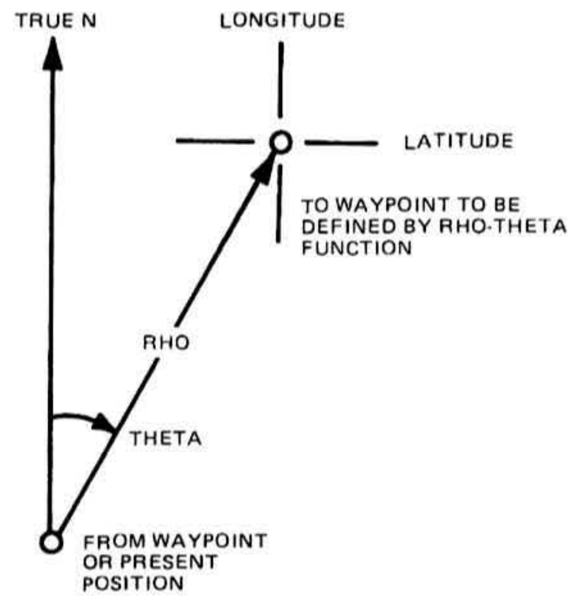


Figure 4-40. Rho-theta Navigation

SPECIAL PROCEDURES

Master Independence

NOTE

Master independent operation is not obtainable when using a manually stored chain for navigation.

The AN/ARN-133 is designed to operate without the master Loran signal when at least three secondaries are available and can be adequately received. This allows operation in cases where the master signal is not initially receivable or is lost after navigation has begun. In such cases, the Navigator designates a secondary as master and new LOP's are calculated. When the master signal becomes receivable again, it is picked up and treated as another secondary. This feature operates automatically without operator action, but may be overridden (master independence override). The ADVISE indicator illuminates when master independence is enabled and goes out when the secondary master is selected. And when the MODE switch is set to ADVISE and the DISPLAY switch to DIST/ BRG, the right-most digit in the lower display indicates which secondary is designated as the master. When this digit is 0, the navigator has the real master and is operating normally; when this digit is 1, 2, 3, or 4, it identifies which secondary is being used as the master. With the DISPLAY switch at DSR TK/ XTK, a "1" in the "No Master" digit of the upper display (middle digit) indicates the Navigator does not have a master. This may also indicate master independence, but not decisively. When master independence is operative, the position update function (POS UPD) is inoperative as the position update capability is based on the real master-referenced system. Master independence also disables the automatic secondary change advise function.

Master Independence Override

To override master independence (deactivate the function) in cases where it is known the navigator will take longer than usual to find the master, use the following procedure:

1. Set MODE switch to ADVISE and DISPLAY switch to DSR TK/XTK.
2. Depress CLR key. Displays should blank.
3. Depress 4 key to identify master override function.
4. Enter number 8 into keyboard. 8 should appear in lower display (and in proper ADVISE work digit), indicating override.
5. Depress INSERT. Displays should return to normal; master independent override is in effect.

To remove master independence override (allow master independence operation), use the following procedure:

1. MODE switch to ADVISE and DISPLAY switch to DSR TK/XTK.
2. Depress CLR key. Displays should blank.
3. Depress 4 key to identify master override function.
4. Enter number 0 into keyboard. 0 should appear in lower display (and in proper ADVISE work digit), indicating normal operation of master independence.
5. Depress INSERT. Displays should return to normal; master independence operation is now permitted to function normally.

Loran Cycle Jump

This procedure permits changing the cycle being tracked by the navigator. The tracking point can be moved either one cycle ahead or behind the cycle currently being tracked. This should be done when the navigator locks on 10 usecs off.

1. MODE switch to OPERATE and DISPLAY switch to POSITION. Depress LORAN COORD switch, as necessary so TD indicator illuminates.
2. Depress CLR key. Displays should blank.
3. Depress GRI key.
4. To move the master tracking point, proceed to step five. To move the A secondary, depress TDA key; to move the B secondary, depress TDB key. N and S indicators should illuminate with TDA selection; E and W indicators should illuminate for TDB selection.
5. If jump is to be made to the left (—), depress L key; if jump is to be made to the right (+), depress R key. Appropriate L or R indicator should illuminate.
6. Depress INSERT. For secondary A or B (—) jumps, the time difference should decrease by ten microseconds, for (+) jumps, the time difference should increase by ten microseconds. For master jumps, the shift will be + or — five microseconds, but there is no visible display indication of this.

Manual Chain Storage

The AN/ARN-133 stores the required data for 14 LORAN chains. All of these, plus the 5100 BITE chain used for self test, are permanently stored in memory and can be selected by using the GRI selection procedure. The navigator allows for manual storage of one additional chain, providing versatility for storing every aspect of any LORAN C or D chain. As a guide through the storage procedure, step numbers appear in the FR TO display, and substep numbers appear when applicable in the lower display. In addition, data from any previously stored manual chain appears in upper and lower displays, cuing the type of entry to be made. To correct errors after any INSERT, it is necessary to display the step number in which the mistake was made. To accomplish this, either move the MODE switch out of INITIALIZE momentarily and then back, resetting the step to 01, or depress INSERT as necessary to step to the end of the cue sequence and back to the desired step. To correct data entered in any step, reenter the correct data over the incorrect.

Use the manual chain storage procedure for any chain not listed in figure 4-30.

MANUAL CHAIN STORAGE PROCEDURE

Display Counters	Operator Action	System Response
	1. Set MODE switch to INITIALIZE and DISPLAY switch to SF/PRL TK.	Upper display shows previous manual chain GRI. FR TO counter is set to 01.
FR TO 01 Enter GRI	1. Depress CLR key. 2. Enter into keyboard seven-digit GRI, using zeros if necessary. Enter only in increments of 2.5 microseconds, entering a trailing zero after the sixth digit. 3. Depress INSERT. **NOTE** The AN/ARN 133 will only track real-world GRI's in increments of 2.5 microseconds (far greater resolution than required for any foreseeable chain), even though any GRI number can be entered.	Displays should blank. GRI should appear in upper display. FR TO counter advances to 02; previous number of secondaries should appear in upper display.
FR TO 02 Specify no. of secondaries	1. Depress CLR key. 2. Enter 2, 3, or 4, specifying number of secondaries in chain. 3. Depress INSERT.	Displays should blank. Number appears in upper display. Counter advances of 03. Previous Loran C or D selection is displayed.
FR TO 03 Specify Loran C or D	1. Depress CLR key. 2. Enter 1 or 2, specifying Loran C or D. 1 = C; 2 = D. 3. Depress INSERT.	Displays should blank. Number appears in upper display. Counter advances to 04. Previous phase code type is displayed.

MANUAL CHAIN STORAGE PROCEDURES (Continued)

Display Counters	Operator Action	System Response
FR TO 04 Specify type of phase code	1. Depress CLR key. 2. Enter N or S, specifying new or standard phase code. (For definition of standard phase code, see new phase code preparation procedure.) **NOTE** All active Coast Guard Loran C chains use standard phase coding. 3. Depress INSERT. If standard phase code (S) was selected, proceed to 05 instruction, below.	Displays should blank. Appropriate N or S indicator should light. If S was selected counter advances to 05. If N was selected, counter remains at 04 and lower display reads 01, indicating substep; previous phase code value is displayed.
01 FR TO 04 Master interval A	1. Depress CLR key. 2. Enter six-digit octal phase code for master, interval A. (Obtain this and subsequent numbers by performing new phase code preparation procedure.) 3. Depress INSERT.	Displays should blank. Code should appear in upper display. Substep counter advances to 02. Previous master interval B code is displayed.
02 FR TO 04 Master interval B	1. Depress CLR key. 2. Enter six-digit octal phase code for master, interval B. 3. Depress INSERT.	Displays should blank. Code should appear in upper display. Substep counter advances to 03. Previous master interval C code is displayed.
03 FR TO 04 Master interval C	1. Depress CLR key. 2. Enter six-digit octal phase code for master interval C. 3. Depress INSERT.	Displays should blank. Code should appear in upper display. Substep counter advances to 04. Previous master interval D code is displayed.

MANUAL CHAIN STORAGE PROCEDURE (Continued)

Display Counters	Operator Action	System Response
FR TO 04 04 Master interval D	1. Depress CLR. 2. Enter six-digit octal phase code for master interval D. 3. Depress INSERT.	Displays should blank. Code should appear in upper display. Substep counter advances to 05. Previous secondary 1 interval A code is displayed.
FR TO 05 04 Secondary 1, interval A	1. Depress CLR. 2. Enter six-digit octal phase code for secondary 1 interval A. 3. Depress INSERT.	Displays should blank. Code should appear in upper display. Substep counter advances to 06. Previous secondary 1 interval B code is displayed.
FR TO 06 04 Secondary 1, interval B	1. Depress CLR. 2. Enter six-digit octal phase code for secondary 1 interval B. 3. Depress INSERT.	Displays should blank. Code should appear in upper display. Substep counter advances to 07. Previous secondary 1 interval C code is displayed.
FR TO 07 04 Secondary 1, interval C	1. Depress CLR. 2. Enter six-digit octal phase code for secondary 1 interval C. 3. Depress INSERT.	Displays should blank. Code should appear in upper display. Substep counter advances to 08. Previous secondary 1 interval D code is displayed.
FR TO 08 04 Secondary 1, interval D	1. Depress CLR. 2. Enter six-digit octal phase code for secondary 1 interval D. 3. Depress INSERT.	Displays should blank. Code should appear in upper display. Substep counter advances to 09. Previous secondary 2 interval A code is displayed.

MANUAL CHAIN STORAGE PROCEDURE (Continued)

Display Counters	Operator Action	System Response
09 FR TO 04 Secondary 2, interval A	1. Depress CLR key. 2. Enter six-digit octal phase code for secondary 2 interval A. 3. Depress INSERT.	Displays should blank. Code should appear in upper display. Substep counter advances to 10. Previous secondary 2 interval B code is displayed.
10 FR TO 04 Secondary 2, interval B	1. Depress CLR key. 2. Enter six-digit octal phase for secondary 2, interval B. 3. Depress INSERT.	Displays should blank. Code should appear in upper display. Substep counter advances to 11. Previous secondary 2 interval C code is displayed.
11 FR TO 04 Secondary 2, interval C	1. Depress CLR key. 2. Enter six-digit octal phase code for secondary 2, interval C. 3. Depress INSERT.	Displays should blank. Code should appear in upper display. Substep counter advances to 12. Previous secondary 2 interval D code is displayed.
12 FR TO 04 Secondary 2, interval D	1. Depress CLR key. 2. Enter six-digit octal phase code for secondary 2, interval D. 3. Depress INSERT. **NOTE** Steps 13 through 16 are for entering octal phase codes for intervals A through D of secondary 3. Steps 17 through 20 are for entering octal phase codes for intervals A through D of secondary 4. If a 3 was entered in step 02, perform steps 13 — 16; if a 4 was entered, perform steps 17 — 20.	Displays should blank. Code should appear in upper display. If a 2 was entered in step 02, signifying two secondaries, lower display should blank and FR TO counter should advance to 05 with previous master latitude shown in upper display. If a 3 or 4 was entered in step 02, lower display counter will advance to 13.

MANUAL CHAIN STORAGE PROCEDURE (Continued)

Display Counters	Operator Action	System Response
FR TO 05 Master latitude	1. Depress CLR key. 2. Depress N or S key to designate latitude of master. 3. Enter latitude of master. 4. Depress INSERT.	Displays should blank. N or S indicator should light. Latitude should appear in upper display. Counter advances to 06. Previous longitude of master is displayed.
FR TO 06 Master longitude	1. Depress CLR key. 2. Depress E or W key to designate longitude of master. 3. Enter longitude of master. 4. Depress INSERT.	Displays should blank. E or W indicator should light. Longitude should appear in lower display. Counter advances to 07. Previous secondary 1 emission delay is displayed.
FR TO 07 Secondary 1 emission delay.	1. Depress CLR key. 2. Enter seven-digit emission delay for secondary 1 (coding delay + baseline for microseconds). 3. Depress INSERT.	Displays should blank. Emission delay should appear in upper-display. Counter advances to 08. Previous secondary 1 latitude is displayed.
FR TO 08 Secondary 1 latitude	1. Depress CLR key. 2. Depress N or S key to designate latitude of secondary 1. 3. Enter six-digit latitude of secondary 1. 4. Depress INSERT.	Displays should blank. N or S indicator should light. Latitude should appear in upper display. Counter advances to 09. Previous secondary 1 longitude is displayed.

MANUAL CHAIN STORAGE PROCEDURE (Continued)

Display Counters	Operator Action	System Response
FR TO 09 Secondary 1 longitude	1. Depress CLR key.	Displays should blank.
	2. Depress E or W key to designate secondary 1 longitude.	E or W indicator should light.
	3. Enter six or seven-digit longitude for secondary 1.	Longitude should appear in lower display.
	4. Depress INSERT.	Counter advances to 10. Previous secondary 2 emission delay is displayed.
FR TO 10 Secondary 2 emission delay	1. Depress CLR key.	Displays should blank.
	2. Enter seven-digit emission delay for secondary 2.	Emission delay should appear in upper display.
	3. Depress INSERT.	Counter advances to 11. Previous secondary 2 latitude is displayed.
FR TO 11 Secondary 2 latitude	1. Depress CLR key.	Displays should blank.
	2. Depress N or S key to designate latitude of secondary 2.	N or S indicator should light.
	3. Enter six-digit secondary 2 latitude.	Latitude should appear in upper display.
	4. Depress INSERT.	Counter advances to 12. Previous secondary 2 longitude is displayed.
FR TO 12 Secondary 2 longitude	1. Depress CLR key.	Displays should blank.
	2. Depress E or W key to designate secondary 2 longitude.	E or W indicator should light.
	3. Enter seven-digit longitude of secondary 2, using zeros where applicable.	Longitude should appear in lower display.
	4. Depress INSERT. **NOTE** Steps 13 — 15 are for secondary 3 emission delay, latitude and longitude; steps 16 — 18 are for secondary 4 emission delay, latitude and longitude. If applicable, perform these steps using same format as for secondaries 1 and 2.	Counter will reset to 01 if two secondaries were specified, indicating entry is complete. Counter will advance to 13 if three or four secondaries were specified.

NLW PHASE CODE PREPARATION PROCEDURE

Standard phase codes are defined below. If the phase code to be used in manual chain entry deviates from this standard by so much as one bit, it is considered a new (N) phase code, and the following phase code preparation procedure must be followed.

LORAN-C Standard Phase Code

(1 = + or in phase; 0 = – or 180° out of phase)

Time ⟶

1 1 0 0 1 0 1 0 Master, interval A (and C)
1 0 0 1 1 1 1 1 Master, interval B (and D)
1 1 1 1 1 0 0 1 Each secondary interval A (and C)
1 0 1 0 1 1 0 0 Each secondary interval B (and D)

LORAN-D Standard Phase Code (Air Force Definition)

Time ⟶

1 1 1 1 0 1 0 0 1 1 0 1 1 0 0 1 Master interval A
1 1 0 1 0 1 1 0 1 0 1 0 1 1 1 0 Master interval B
1 0 1 0 0 0 0 0 1 1 0 0 0 1 1 0 0 Master interval C
1 0 0 0 0 0 1 1 1 1 1 1 1 0 1 1 Master interval D

1 1 1 0 1 1 1 1 1 0 0 1 0 1 1 1 Secondary 1, 3, 4, Int. A
1 0 0 1 1 0 0 0 1 0 1 1 0 1 0 1 Secondary 1, 3, 4, Int. B
1 0 1 1 1 0 1 0 1 1 0 0 0 0 1 0 Secondary 1, 3, 4, Int. C
1 1 0 0 1 1 0 1 1 1 1 0 0 0 0 0 Secondary 1, 3, 4, Int. D

1 1 1 0 1 1 1 1 1 1 0 0 0 0 1 0 Secondary 2 Int. A
1 1 0 0 1 1 0 1 1 0 1 1 0 1 0 1 Secondary 2 Int. B
1 0 1 1 1 0 1 0 1 0 0 1 0 1 1 1 Secondary 2 Int. C
1 0 0 1 1 0 0 0 1 1 1 0 0 0 0 0 Secondary 2 Int. D

EXAMPLE:

PROBLEM: To make secondary 2 phase codes the same as secondary 1, 3, and 4 for LORAN-D. Since this is a deviation from standard, it is necessary to start at the beginning and enter all phase codes. Begin by entering the master codes, even though they do not change.

a. Start by writing down the Master interval A phase code with time flow from left to right:

Time ⟶

1 1 1 1 0 1 0 0 1 1 0 1 1 0 0 1

b. Then write the data backward:

⟵ Time

1 0 0 1 1 0 1 1 0 0 1 0 1 1 1 1

c. Add two leading zeros and group the data bits in groups of three:

0 0 1 | 0 0 1 | 1 0 1 | 1 0 0 | 1 0 1 | 1 1 1 |

d. Assign a binary value for each bit as shown below. This puts the data in binary coded octal format for entry into the couputer

4 2 1	4 2 1	4 2 1	4 2 1	4 2 1	4 2 1	Binary value
0 0 1	0 0 1	1 0 1	1 0 0	1 0 1	1 1 1	Data

e. Determine the numeric value of each group of three bits as shown below, and write each number below its respective group.

4 2 1	4 2 1	4 2 1	4 2 1	4 2 1	4 2 1	Binary value
0 0 1	0 0 1	1 0 1	1 0 0	1 0 1	1 1 1	Data
1	1	5	4	5	7	Octal value

Example: 4 + 2 + 1 = 7

f. This six-digit octal number is the octal phase code to be entered in manual chain entry substep 01.

01. 1 1 5 4 5 7

g. Repeat this procedure for master interval B as follows:

Time ⟶

1 1 0 1 0 1 1 0 1 0 1 0 1 1 1 0

Reversed:

⟵ Time

0 1 1 1 0 1 0 1 0 1 1 0 1 0 1 1

Grouped, two leading zeros added, and converted:

4 2 1	4 2 1	4 2 1	4 2 1	4 2 1	4 2 1	Binary value
0 0 0	1 1 1	0 1 0	1 0 1	1 0 1	0 1 1	Data
0	7	2	5	5	3	Octal value

h. Enter on worksheet for substep 02:

02. 0 7 2 5 5 3

i. Repeat this procedure until all phase codes for the master and each secondary are defined for all four intervals. To complete this example, the numbers to be entered for master interval C and D would be, respectively.

03. 0 3 0 6 0 5 and 04. 1 5 7 7 0 1

j. Calculate all four secondaries (or as many as there are in the chain) in a similar manner. Since, for this example, we are making secondary 2 phase codes the same as secondaries 1, 3, and 4, the four phase code entries would be as follows:

05. 1 6 4 7 6 7 Interval A
09.
13.
17.

06. 1 2 6 4 3 1 Interval B
10.
14.
18.

07. 0 4 1 5 3 5 Interval C
11.
15.
19.

08. 0 0 3 6 6 3 Interval D
12.
16.
20.

k. If the new phase codes are for a LORAN-C chain (eight pulses per group instead of 16), the 16-pulse format must still be followed. To do this, insert a zero between each bit of the LORAN-C phase codes, and, after reversal, add three leading zeros. This maintains the proper pulse spacing in the computer. As an example, the two master interval phase codes would be calculated as follows:

Time ⟶

1 1 0 0 1 0 1 0

Reversed: ⟵

0 1 0 1 0 0 1 1

Inserting zero between bits and adding three leading zeros (as underlined):

<u>0 0 0</u> 0 <u>0</u> 1 <u>0</u> 0 <u>0</u> 1 <u>0</u> 0 <u>0</u> 0 <u>0</u> 1 <u>0</u> 1

Grouped and converted:

4 2 1	4 2 1	4 2 1	4 2 1	4 2 1	4 2 1	Binary value
0 0 0	0 0 1	0 0 0	1 0 0	0 0 0	1 0 1	Data
0	1	0	4	0	5	Octal value

This data must now be entered for substeps 01 and 03, since the LORAN-C phase codes repeat every two intervals, rather than every four:

01. 0 1 0 4 0 5 03. 0 1 0 4 0 5

Similarly, substeps 02 and 04 would calculate out as follows:

1 0 0 1 1 1 1 1

Reversed:

1 1 1 1 1 0 0 1

Zeros added, grouped, and converted:

4 2 1	4 2 1	4 2 1	4 2 1	4 2 1	4 2 1	Binary value
0 0 0	1 0 1	0 1 0	1 0 1	0 0 0	0 0 1	Data
0	5	2	5	0	1	Octal value

Calculate the secondaries in a similar fashion.

RADAR ALTIMETER AN/APN-171(V)

Radar Altimeter Set, AN/APN-171(V), consists of a receiver-transmitter, two indicators, and two antennas. The set provides instantaneous indication of actual clearance between the helicopter and terrain from 0 to 5000 feet with the following accuracies:

Altitude (Ft)	Accuracies
0-200	± (3 ft + 2% of altitude)
200-1000	± (7 ft + 2% of altitude)
1000-5000	± (25 ft + 2% of altitude)

Altitude, in feet, is indicated by the radar altimeter indicators (figure 4-41) on the pilot's and copilot's instrument panel (10 and 42, figure FO-1). The radar altimeter is powered by the dc radio bus and the ac radio bus. The altimeter's dc circuit is protected by a circuit breaker marked RAD HEIGHT on the radio circuit breaker panel. The ac circuit is protected by a circuit breaker marked RAD HEIGHT ϕB on the radio circuit breaker panel.

RADAR ALTIMETER OPERATION

A control knob on the lower left corner of the indicator, combines functions to serve as a test switch, a low level warning index set control, and an on/off power switch. The system is turned on by turning the control knob, marked PUSH-TO-TEST, clockwise from the OFF position, and is the only control necessary for equipment operation. Three minutes must be allowed for system warmup. Control knobs on both radar altimeter indicators must be in the OFF position to secure the set. Continued clockwise turning of the control knob toward the SET position will permit each pilot to select any desired low-altitude limit, which will be indicated by the low-level warning index warning light, on the lower right corner of the indicator. The light will go on and show the marking LOW any time the helicopter is at or below the low-altitude limit that has been selected. Pressing the PUSH-TO-TEST control switch provides a testing feature of the system at any time and altitude. When the PUSH-TO-TEST control knob is pressed, a visual indication of 100 ± 15 feet on the indicator indicates satisfactory system operation. Releasing the PUSH-TO-TEST control knob restores the system to normal operation.

NOTE

If ac power is lost, the pointers freeze in position. An audio warning will be heard on the ICS if ac power is lost and the RAWS switch is ON.

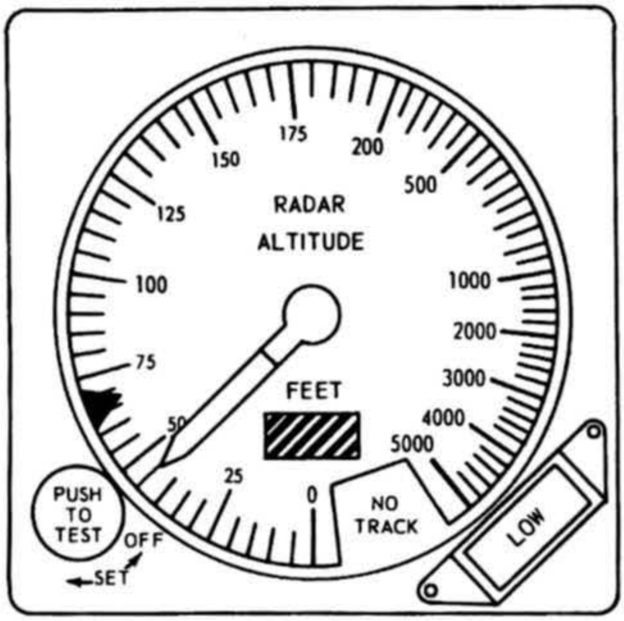


Figure 4-41. Radar Altimeter AN/APN-171

FAILURE INDICATIONS

Loss of system power or tracking condition will be indicated by a black- and yellow-striped flag which appears in the indicator window, on the lower center portion of the indicator. If the system should become unreliable, the black- and yellow-striped flag will appear, the indicator pointer will go behind a mask, marked NO TRACK, to prevent erroneous readings, and a 1000 Hz audio tone will sound in both pilot's ICS. During normal flight operations, it is not necessary to turn the system off when operating above 5000 feet.

RADAR ALTIMETER WARNING SYSTEM (RAWS)

Three audio warning signals are developed by the altimeter and are fed into the pilot's and copilot's headsets. The first is a 1000 Hz steady tone which sounds when the altimeter is unreliable. At 150 feet a 1000 Hz tone is switched on for 3 seconds and is pulsed at a rate of two pulses per second. At 50 feet, this tone is again switched on for 3 seconds but is pulsed at a rate of four pulses per second. A two-position switch on the instrument panel, marked ON and OFF, under the heading RAWS (figure FO-2) turns the RAWS system on and off. In the OFF position a caution light on the caution-advisory panel marked RAWS OFF, goes on. The RAWS OFF caution light and the RAWS are powered by the dc radio bus and protected by a circuit breaker marked RAD HEIGHT on the radio circuit breaker panel.

TRANSPONDERS

TRANSPONDER AN/APX-99

The AN/APX-99 transponder is composed of a receiver-transmitter, a control panel, and an antenna. The transponder is powered by the dc radio bus and is protected by a circuit breaker marked IFF on the radio circuit breaker panel.

Transponder Control Panel

The transponder control panel, (figure 4-42) marked TRANSPONDER, is on the lower radio console (figure FO-2). The control panel contains the function selector switch, reply lamp and ident pushbutton, dim adjustor, and code selector switches.

FUNCTION SELECTOR SWITCH

The function selector switch is a five-position rotary selector which determines the operating mode of the transponder. The positions are identified:

OFF. Eliminates all power to the set.

STBY. Turns the transponder power supply ON and applies power to the transmitter tube filament. Turning to STBY will keep the transponder from replying to interrogations and allow instant return to the operating modes.

ON. Places the transponder in the operating mode (Mode A). The transponder is ready to reply to interrogations from ground, sea or airborne stations.

ALT. Places the transponder in the operating mode (Mode A) and in the altitude reporting mode (Mode C). When used in conjunction with the altimeter-encoder, the set will automatically transmit altitude information to the interrogating station.

TEST. This position is used to self-test the operation of the transponder. It may be used at any time as it does not interfere with normal operation. By holding the selector switch in the TEST position, a test signal is sent to interrogate all internal circuitry of the set, except the receiver. If the transponder is working properly, the REPLY lamp will go on. When the selector switch is released it will return to the ALT position and the REPLY lamp will operate normally.

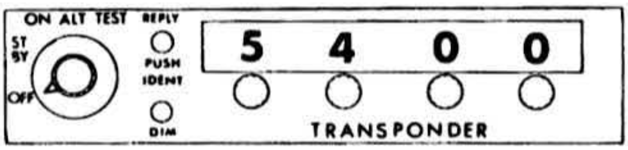


Figure 4-42. Transponder Control Panel

REPLY LAMP AND PUSH IDENT BUTTON

The REPLY LAMP AND PUSH IDENT button are contained within a single assembly. The REPLY lamp automatically goes on when the set is replying to interrogations. The lamp intensity is adjustable by turning the DIM control. The PUSH IDENT button activates a special signal to the interrogating station for approximately 20 seconds. The REPLY lamp will go on during this period.

CODE SELECTOR SWITCHES

The code selector, comprised of four eight-position rotary switches, provides a total of 4096 active positions for identification. The code selector sets up the number and spacing of the pulses that are transmitted by the set.

Transponder Operation

To put equipment into operation:

1. Function selector switch — STBY, ON, or ALT.

After a 60 second warmup period the set will be ready to operate.

2. Code selector switches — AS REQUIRED.

3. Function selector switch — HOLD IN TEST POSITION.

If the REPLY lamp goes on, the transponder should function properly.

4. Function selector switch — RELEASE TO ALT POSITION.

NOTE

There is no EMERGENCY squawk position on the function selector switch. An EMERGENCY squawk must be set in using the code selector switches.

X-BAND TRANSPONDER SST-185X

The X-Band Transponder is an identification transponder which will respond to each interrogation with up to five closely spaced reply pulses. The transponder accomplishes this function by receiving pulsed interrogations from a shipboard surface radar (operating in the X-band) and transmitting pulsed replies of much greater signal strength in the same frequency band. The transponder is powered by the dc essential bus and is protected by a circuit breaker marked XPNDR on the aft circuit breaker panel.

Control Panel

The X-Band transponder control panel (figure 4-43) is on the Upper Radio Console. It contains the master power switch and three reply switches.

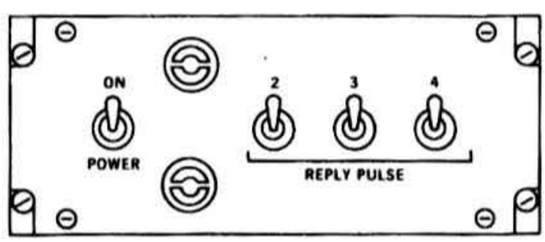


Figure 4-43. X-Band Transponder Control Panel

MASTER POWER SWITCH

The switch controls all power to the system.

REPLY SWITCHES

The reply switches control the second, third, and fourth pulses, respectively. The first and fifty pulses always reply to interrogations.

REMOTE UNIT

The X-Band transponder remote unit is in the transition section and contains the receiver, transmitter, and power supply.

Antenna

The antenna is 2-1/2 inches left of the keel below the transition section.

X-Band Transponder Operation

To put equipment into operation:

1. Power switch — ON.
2. Reply pulse switches — AS REQUIRED.

MA-1 DIRECTIONAL GYRO COMPASS SYSTEM

The MA-1 directional gyro compass system consists of a magnetic flux valve in the tail cone, a directional gyro in the forward cabin section aft of the pilots bulkhead, a directional gyro amplifier mounted on the radio rack, and a control panel and ACKNOWLEDGE switch on the upper console. Compass headings are indicated by the rotating azimuth card on the BDHI and RMI, on the instrument panel (figure FO-1). The system operates on ac and dc current from the ac and dc essential buses, and is protected by circuit breakers, COMPASS and COMP SLAVE, on the forward circuit breaker panel. The system provides stabilized compass indications by combining the advantages of the remote indicating magnetic compass with the gyro compass. The oscillations of the magnetic compass and the drift error of directional gyro are eliminated when operating as a gyro-magnetic compass and an accurate stabilized magnetic heading is indicated. In magnetically unreliable regions, such as encountered in northern latitudes, the gyro may be unslaved from the compass system to act as a free directional gyro. The system also supplies directional signals to the automatic stabilization equipment (ASE).

MA-1 COMPASS CONTROL PANEL

The MA-1 Compass Control Panel (figure 4-44) is on the upper console and labeled COMPASS. The panel has a synchronizing indicator, a heading set knob mode switch, and a latitude set switch. A Slave Compass Caution light is contained in the caution-advisory panel (figure 1-27).

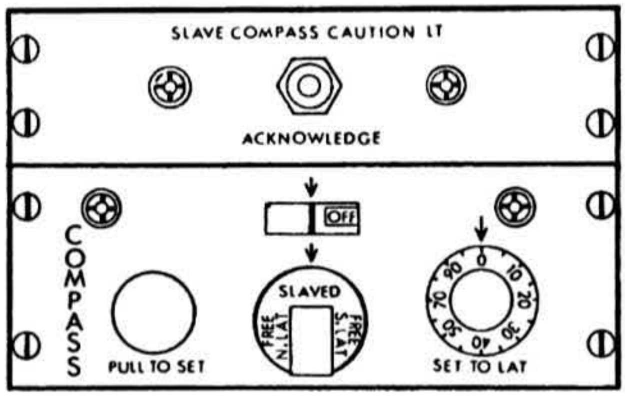


Figure 4-44. MA-1 Compass Control Panel

Synchronizing Indicator and Heading Set Knob

The synchronizing indicator is a white pointer visible through a window, directly above the mode switch. When the pointer is in line with the white arrow on the control panel, the system is in synchronization. A red flag on the synchronizing indicator appears whenever electrical power to the system is turned off or has failed. Synchronization is obtained by pulling out the heading set knot, marked PULL-TO-SET, and turning it until the pointer of the synchronizing indicator is in line with the arrow.

CAUTION

Two settings of the heading-set knob will cause the synchronizing indicator to line up with the arrow. One is correct and the other will result in an unstable 180° ambiguity. The correct setting can be recognized when the synchronizing pointer moves in the same direction that the knob is turned. The synchronizing indicator continues to provide a check on the slaving operation during flight. The pointer will oscillate about the arrow.

Mode Switch

The mode switch is in the center of the compass control panel and has three marked positions: FREE N. LAT., SLAVED, and FREE S. LAT. When the switch is placed in either of the FREE positions, the system will function as a free directional gyro, with either north or south latitude corrections for the drift effect of the rotation of the earth. When the switch is placed in the SLAVED position, the directional gyro is slaved to the magnetic compass heading and the rotating azimuth card on the course indicators indicate stabilized magnetic heading.

Latitude Set Switch

This switch is marked SET TO LAT. When the compass system is being used in the FREE N. LAT. or FREE S. LAT. mode the Latitude Set Switch is set to the local latitude. This allows the system to compensate for gyro drift due to the rotation of the earth. In the Slaved mode of operation this switch has no effect on the compass system.

SLAVE COMPASS PANEL AND CAUTION LIGHT

A Slave Compass caution light (figure 1-27), on the caution-advisory panel, is used as a reminder to the pilot to slave the compass system. The Slave Compass Caution light will go on any time there is an interruption or loss of ac power to the compass system. When the ACKNOWLEDGE switch, on the Slave Compass Panel (figure 4-44) is pressed and ac power is being supplied to the compass system, the caution light will go off. The Slave Compass caution light is powered by the dc essential bus and is protected by a circuit breaker marked COMP SLAVE under the general heading WARNING LIGHTS, on the forward circuit breaker panel.

MA-1 COMPASS OPERATION

Slaved Gyro Operation:

1. Mode switch — SLAVED.

2. Heading-set knob — Synchronize gyro and magnetic heading by pulling knob and turning it until synchronizing indicator is centered. (See caution note under Synchronizing Indicator and Heading Set Knob).

Free Gyro Operation.

1. Mode switch — FREE N. LAT. or FREE S. LAT., as required.

2. Latitude set switch — Set to degree of latitude.

3. Heading control knob — Set to desired heading.

LIGHTING EQUIPMENT

All lights operate on direct current and are protected by circuit breakers. The cabin dome lights, the flood and hover lights and the Aldis lamp operate from the dc non-essential bus. All other lights operate from the dc essential bus.

INTERIOR LIGHTS

Pilot's and Copilot's Flight Instrument Panel Lights

The pilot's and copilot's instrument panel lights are individually controlled by rheostats (figure 4-45) on the overhead switch panel. The pilot's and copilot's flight instrument light circuit is protected by circuit breakers, marked PILOT and COPILOT, under the general heading, FLIGHT INST, on the forward circuit breaker panel.

Non-Flight Instrument Lights

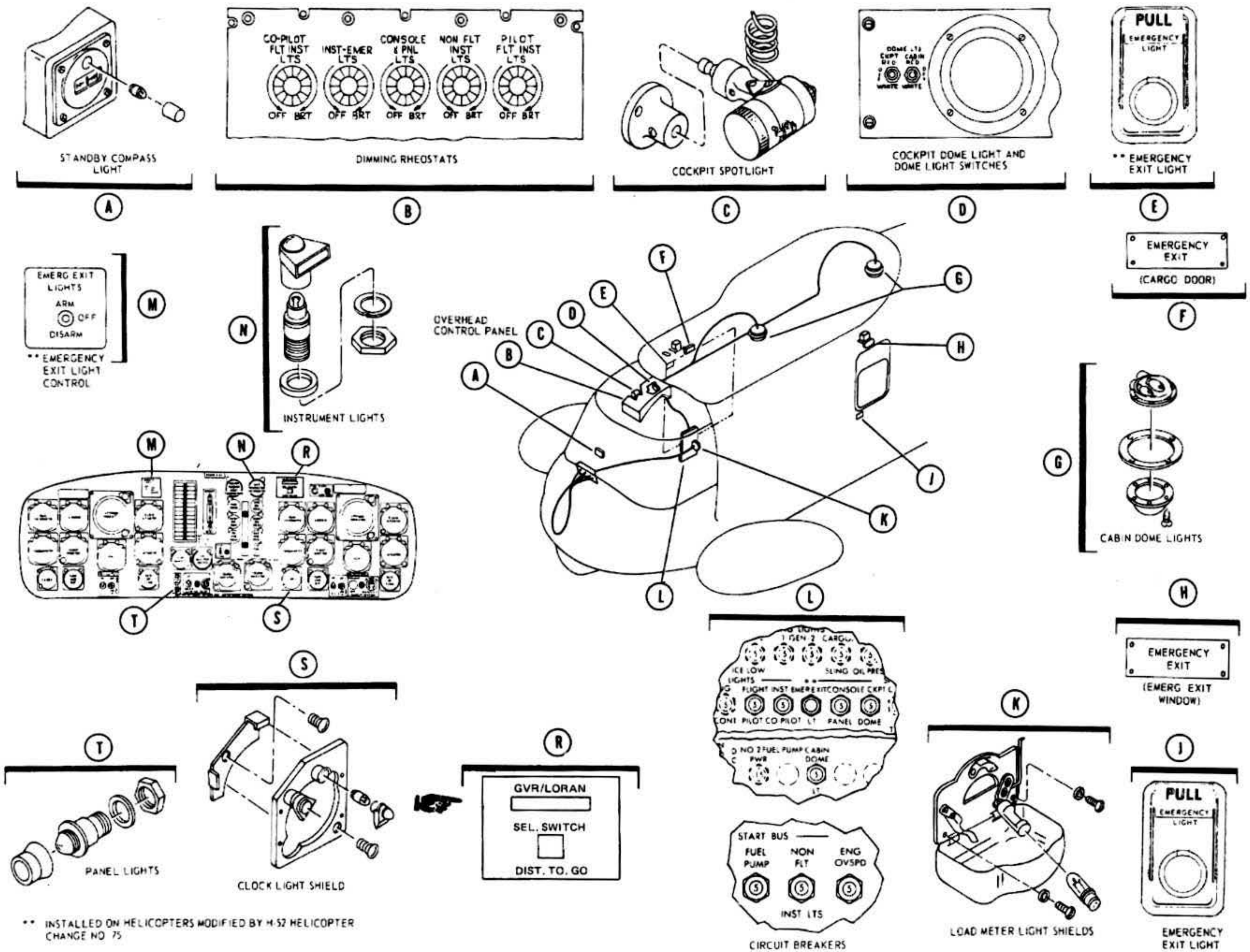
The non-flight instrument lights are controlled by a rheostat, marked NON-FLT INST, on the overhead switch panel (figure 4-19). The non-flight instrument lights are protected by a circuit breaker, marked NON-FLT under the general heading START BUS, on the forward circuit breaker panel.

Console and Overhead Panel Lights

A rheostat marked CONSOLE & PNL LTS is on the overhead switch panel (figure 4-45). The console and panel light rheostat controls the lights on the overhead switch panel, radio control console, forward circuit breaker panel, and the hoist operator's and observer's radio control panels, through a circuit breaker, marked CONSOLE PANEL, on the forward circuit breaker panel.

Cockpit Dome Light

The cockpit dome light switch marked CKPT, under the general heading DOME LTS, is on the



** INSTALLED ON HELICOPTERS MODIFIED BY H-52 HELICOPTER CHANGE NO. 75

Figure 4-45. Interior Lighting

dome light panel (figure 4-45) in the pilot's compartment. The dome light switch has marked positions, RED, OFF, and WHITE, and controls the dome light, in the panel. The dome light contains a red lamp and a white lamp, either of which may be selected by placing the dome light switch in the RED or WHITE position. The cockpit dome light is protected by a circuit breaker marked, CKPT DOME, on the forward circuit breaker panel (figure FO-3).

Cockpit Spotlight

A portable utility light (figure 4-45) with a coiled cord is secured on the right side of the overhead console. The light may be adjusted in its mounting to direct the light beam, or it may be removed and used as handheld portable light. The light is controlled by a rotary ON-OFF switch, on the end of the spotlight, through the circuit breaker, marked CKPT DOME, on the forward circuit breaker panel. The intensity and color of the light may be varied by turning the casing.

Cabin Dome Lights

The cabin dome light switch (figure 4-45), marked CABIN, under the general heading DOME LTS, is on the dome light panel in the cockpit compartment. The cabin dome light switch has marked positions RED, OFF, and WHITE, and controls the two cabin dome lights, located in the cabin ceiling, through a circuit breaker, marked CABIN DOME LT, on the forward circuit breaker panel. The two cabin dome lights each contain a red lamp and a white lamp, either of which may be selected by placing the cabin dome light switch in the RED or WHITE position.

Emergency Exit Lights

See Section I.

EXTERIOR LIGHTS

See figure 4-46.

Controllable Landing Light

A controllable landing light is in the nose of the helicopter and may be extended downward through an arc of 120°. It may be rotated 45° left or right of center when extended between 0° and 110°. It may be rotated 360° when extended greater than 110°. The controllable landing light circuit operates on direct current from the dc essential bus and is protected by two circuit breakers, marked PWR and CONT, under the general heading CONT LDG, on the forward circuit breaker panel.

Controllable Landing Light Master Switch

A push type, controllable landing light master switch, marked CONTR LT, is on the forward end of the pilot's collective pitch (figure 1-20). When the switch is pushed in, power is supplied to the landing light and the landing light control switches, on the pilot's collective pitch stick and the copilot's remote control panel, and the INDICATOR light in the center of the master switch goes on. The indicator light intensity is controlled by the caution panel bright/dim switch.

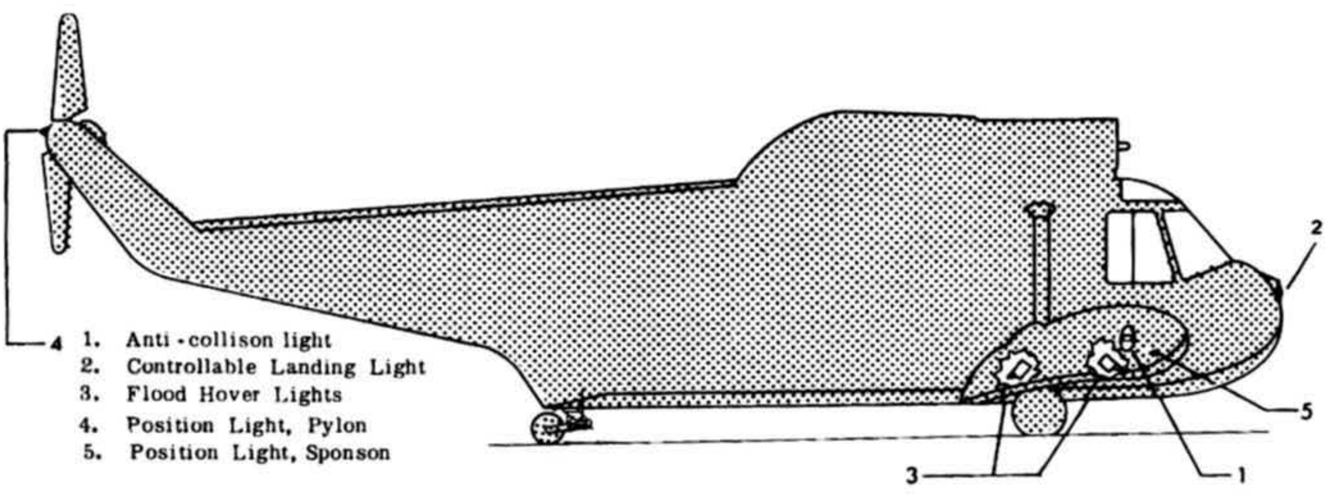


Figure 4-46. Exterior Lighting

Pilot Landing Light Control Switch

The pilot's landing light control switch is on the forward end of the pilot's collective pitch stick (figure 1-20). The control switch is a spring-loaded, four-position, thumb switch, marked EXT, RET, L, and R, with a center OFF position. Pushing the switch forward to the EXT position causes the landing light to extend through an ARC of 120°. Pushing the switch AFT to the RET position causes the landing light to retract, but the light may be stopped by any vertical angle between 120° and FULL UP stowed position. Moving the control switch to the L or R position causes the landing light to turn to the left or right of any point within 360° provided the light is extended 110° or more. If the light is not fully extended, it only turns 45° arc to the left or right. The landing light will stow automatically if it is trained RIGHT OF CENTER BEFORE retracting the light to the full up position.

Copilot's Landing Light Control Switch

The copilot's landing light control switch is on the copilot's remote control panel (figure 4-47). The control switch is a spring-loaded, four-position toggle switch, marked EXTEND, RETRACT, L and R, with a center OFF position. The switch provides the same type of operation as the pilot's landing light control switch.

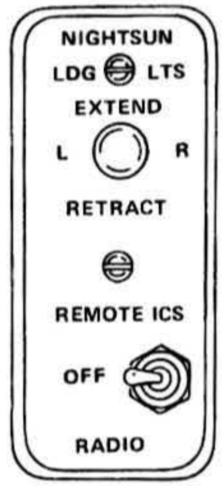


Figure 4-47. Copilot's Landing Light Control Switch

Flood and Hover Lights

The flood and hover light switch is on the forward end of the pilot's collective pitch stick (figure 1-20), and has marked positions HOVER LT, OFF, and FLOOD LT. The flood and hover light switch controls the flood and hover lights mounted below the forward strut assemblies of each sponson, through four circuit breakers, marked CONT, 1, 2, and 3, under the general heading HOVER LTS, on the aft circuit breaker panel. The circuit breaker, marked 1, protects the Hover Light mounted by the right sponson that provides illumination directly below and AFT of the helicopter. The circuit breaker marked 2 protects the FLOOD-HOVER light mounted by the left sponson that provides forward illumination, and the circuit breaker marked 3 protects the FLOOD-HOVER light mounted by the right sponson, that also provides forward lighting. When the flood and hover light switch is placed in the HOVER LT position, all three lights are operated. When the switch is placed in the FLOOD LT position, the light by each sponson that provides forward lighting will be operated.

NOTE

Do not operate the lights for more than 10 minutes at a time. Bulb life is sharply decreased by longer operating periods.

Navigation Lights Master Switch

A navigation lights master switch, marked MASTER, under the general heading NAV LTS, is on the overhead switch panel in the pilot's compartment (figure FO-2). The switch has marked positions ON and OFF, and controls the power source to the position and anti-collision lights. The switch must be in the ON position before the position and anti-collision lights can be operated.

Position Lights

The position lights (figure 4-46) on the sponson and pylon, are controlled by a switch on the overhead switch panel marked POSITION under the general heading NAV LTS (figure FO-2). The switch has marked positions, DIM, OFF, and BRI, and controls the operation of the three position lights. The position lights operate on current from the dc essential bus and are protected by a circuit breaker, marked POS, under the general heading LIGHTS, on the forward circuit breaker panel.

Rotating Anti-Collision Lights

An anti-collision light switch, marked ANTI-COL, under the general heading NAV LTS, is on the overhead switch panel (figure FO-2). The switch has marked position, ON and OFF, and controls the operation of the two anti-collision lights. A red, rotating anti-collision light is on the outboard side of each sponson (figure 4-46). The anti-collision lights operate on current from the dc essential bus and are protected by circuit breakers, marked ANTI-COL, LEFT and RIGHT, under the general heading LIGHTS, located on the forward circuit breaker panel.

CABIN EQUIPMENT

The cabin, from station 180 to station 348, is capable of carrying cargo, personnel, and litters. Cargo tiedown fittings are installed on the cabin floor. The cabin floor is on the right side of the helicopter. When loading the helicopter, refer to Section V for center of gravity and weight limitations and the Handbook of Weight and Balance Data.

CABIN FLOOR

The cabin floor, capable of sustaining static loads of 175 pounds per square foot and a maximum load of 2400 pounds, consists of five panels which form the top of the tub (lower fuselage). Each panel is made of aluminum honeycomb bonded between two sheets of aluminum. The areas around the openings in the floor panels are filled with resin. The floor contains cargo tiedown rings, a plate for leveling the helicopter with a plumb line, provisions for troop seats, and covers for access to the fuel cells, in-flight refueling adapter and for inspection of the tub compartments.

TIEDOWN FITTINGS

Twenty-two fittings are installed in the cabin floor for cargo tiedown. Each is secured with rivets. The fittings are spaced approximately 20 inches apart, with each containing a ring that can be raised for cargo tiedown.

PASSENGER SEATS

Passenger seats (figure 4-48) equipped with seat belts may be installed in the cabin to accommodate nine people. Normally only the three forward port seats are installed. The seat legs are attached to the cargo tiedown studs in the cabin floor at the front of the seat assemblies. The seats are folded by disconnecting the front legs from the floor and securing the front of the seats against the upper back support with the straps provided. During search operations, when maximum visibility from the cabin is necessary for scanning, the seat backs blocking windows should be stowed. The seat back should also be stowed during water operations to permit quick access to the windows for emergency exit.

FLIGHT MECHANIC'S SAFETY HARNESS

The Flight Mechanic's safety harness is stowed in the cabin. When in use the harness snap hook end is attached to an overhead fitting. The harness shall be worn during hoist operations, rescue platform recoveries, and/or any time the cabin door is open in-flight and personnel are not in their seats with their respective lap belts secured.

STANDARD HH-52A SAR EQUIPMENT BOARD

The HH-52A SAR Equipment Board (figure 4-49), on the starboard side of the cabin aft of the cabin

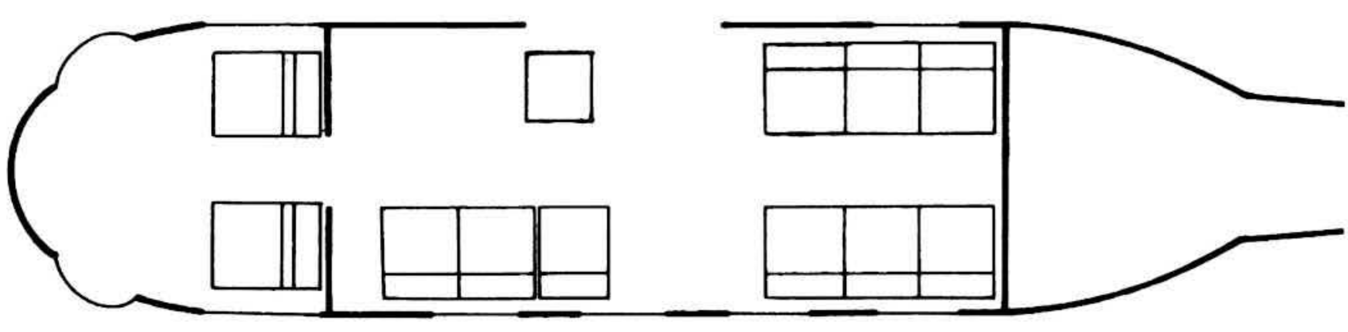


Figure 4-48. Passenger Seats

door, provides for standard stowage of required essential SAR equipment listed in figure 4-50. A 27- by 14-inch space on the lower right corner of the board is available for addition of local SAR equipment. Weight of the empty board is 28 pounds. The weight increases to 90 pounds with the addition of the required equipment listed in figure 4-50. Installation of the standard SAR equipment board will eliminate the existing SAR box and boards and allow for a standardized training program for newly assigned Flight Mechanic trainees.

ALDIS LAMP

A portable searchlight is provided on the Standard SAR Equipment Board. The light is controlled by an on-off switch on the handle and may be plugged into the dc utility receptacle for operation.

DC UTILITY RECEPTACLE

A 28-volt dc electrical utility receptacle, marked UT RECP, is aft of the cabin door. The circuit is protected by a 10 ampere circuit breaker, marked UTILITY RECEPT, on the aft circuit breaker panel.

LADDER, CARGO DOOR

A portable ladder (figure 4-51) is provided for entering the helicopter through the cabin cargo door. The ladder is secured to the sill of the cabin cargo door opening by two quick detachable NORCO locks. The ladder is swung out and down when used by personnel entering the cabin and may be swung up and in to permit closing of the cabin cargo door.

RESCUE PLATFORM

The helicopter is equipped with a detachable rescue platform (figure 4-51). It is provided to aid in the recovery of personnel or objects from the sea when the helicopter is afloat. The platform is secured outboard of the cabin cargo door by studs and support cables. When not in use, the platform is stowed in the aft cabin area.

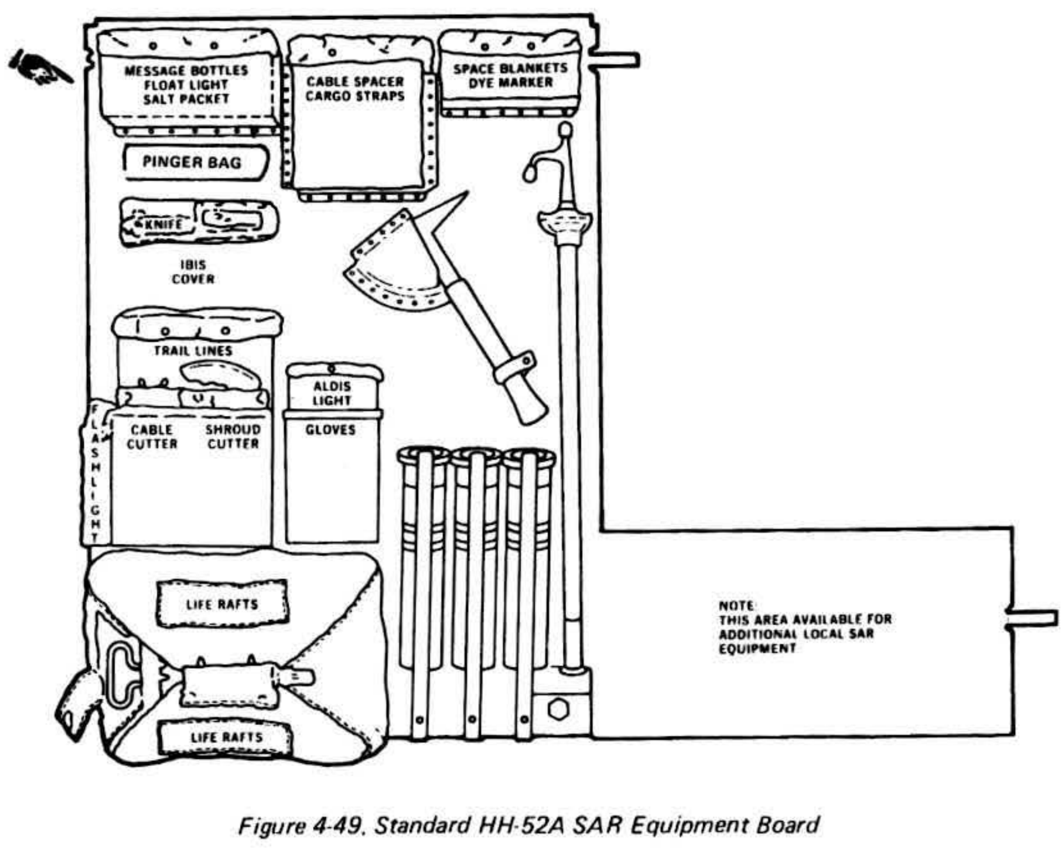


Figure 4-49. Standard HH-52A SAR Equipment Board

LITTERS

The litter installation (figure 4-52) consists of six litters, three against the right cabin wall aft of the cabin door and three against the left wall aft of the ASE components shelves. The bottom litter of each seat rests on the cabin deck. The other four are suspended from the overhead airframe. The litters are installed by using four support strap assemblies, each with three bracket hooks for securing the litter handles. Eight additional bracket hooks are secured to the cabin walls for the suspended litters. The bottom ends of the straps are secured to cabin deck tiedown rings by clips. The top ends of the straps pass through fittings bolted to the overhead frame. The straps are adjustable and tightened at the top end. The litters resting on the cabin deck have stops for the outboard handles secured to the cabin wall frame. Each litter has a retaining cap assembly to prevent forward movement of the litter. The cap is installed so as to fit over the end of the forward outboard handle.

Description	Quantity
MK-25 Marine Location Marker	3
Hoist Gloves	1 (Pr)
Trail Lines (Note 1)	2
Message Droppers	4
Space Blanket	4
Flashlight	1
Survival Knife	1
Cable Cutter	1
SDU-5/E Strobe Float Light	2
Aldis Lamp	1
Crash Axe	1
Five-Pound Trail Line Weights (Note 2)	2
Shroud Line Cutter	1
Flotation Device SDU-5/E Light (Note 3)	2
LR-1 Life Rafts (Note 4)	
Dye Markers, Vest Type	2
Helo Hoist Quick Splice	1
Cargo Straps	3
Boat Hook	1
Salt Packets (For Pyro in Fresh Water Use)	15
IBIS Indicator Cover	1

Notes:

1. 100 ± 5-foot lines.
2. Bag made from number 80 Herculite Cloth, filled with number 8 lead shot for weight.
3. Electronic Division, 3901 North 29th Ave. Hollywood, Florida 33020.
4. Rafts folded and stowed in modified NC-3 parachute container. Use of four-man Winslow life raft is optional.

Figure 4-50. HH-52A SAR Equipment Board

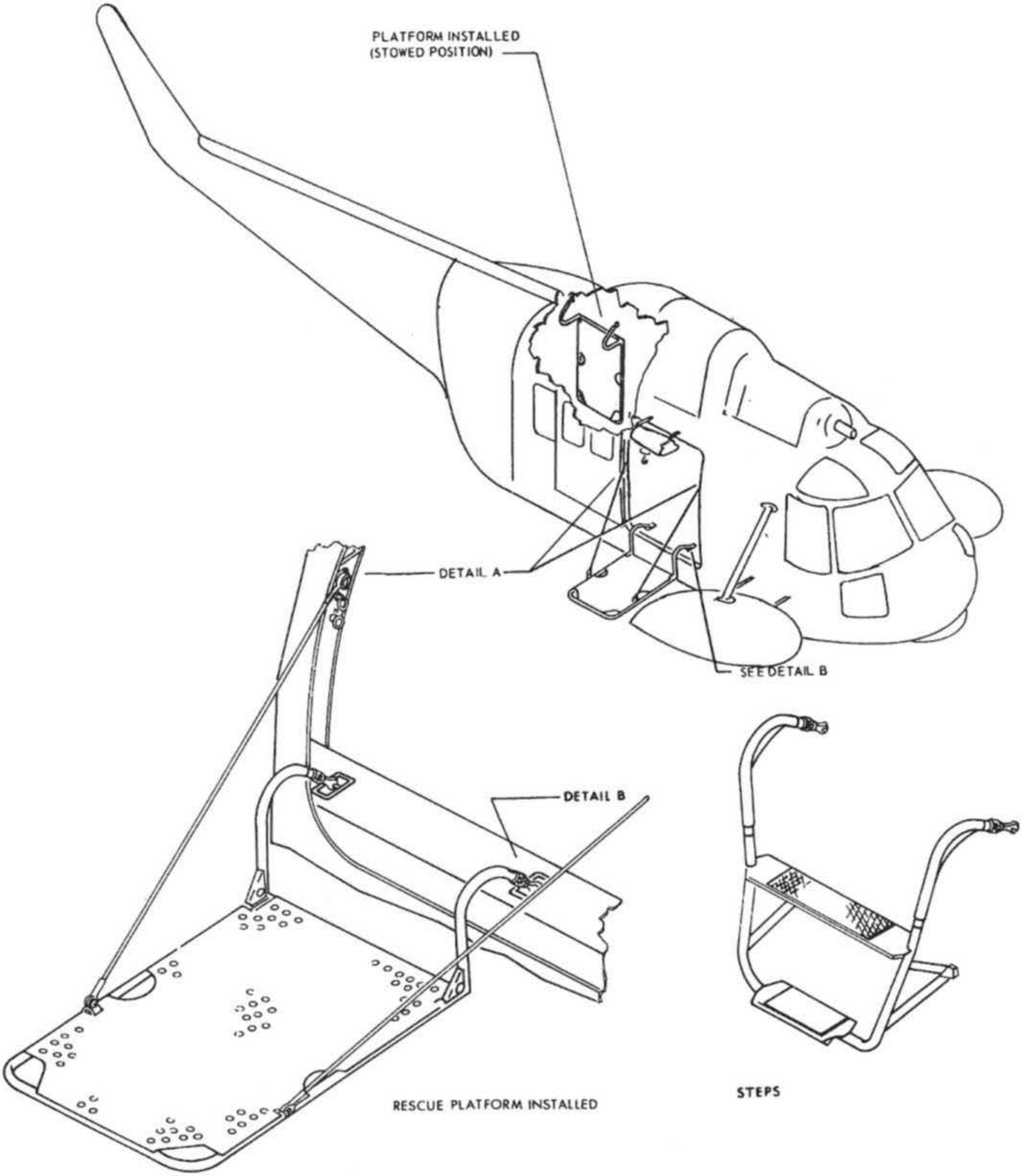


Figure 4-51. Rescue Platform and Steps

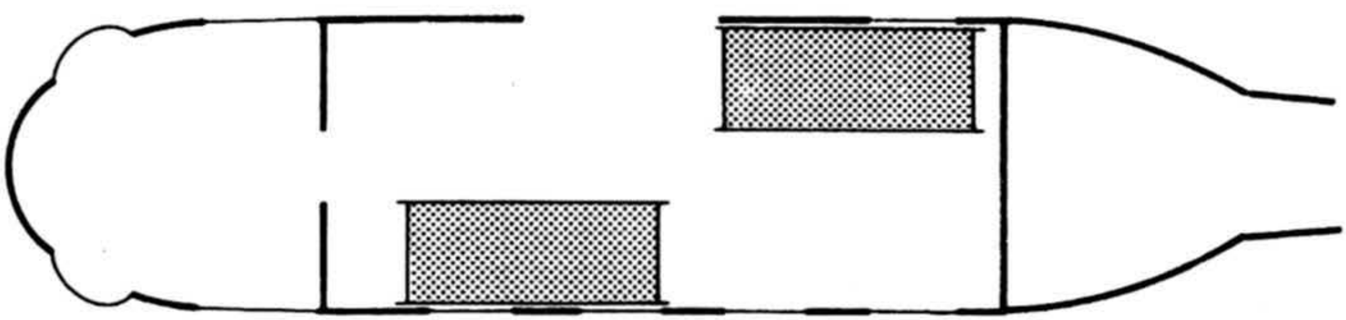


Figure 4-52. Litter Installation

CABIN DOOR

The cabin door, used for loading personnel and cargo into the helicopter, is on the right hand side of the helicopter (figure 4-51). Two steps that may be pivoted up into the cabin are secured to fittings on the floor just inboard of the door sill to aid entry into the helicopter. The steps may be easily removed by turning and pulling the Norco Lock, and may be interchanged with the rescue platform that is secured in the same manner. The door is approximately 4 feet wide by 5 feet high, and contains two 19- by 20-inch windows, and six small inspection windows along the top skin of the door. The large windows are held in place with riveted retainers and the inspection windows are bonded in place. The door slides on an upper and lower track. The door is secured in the closed position with a mechanical latch. The cabin door has an inner and outer emergency handle. When either handle is turned, the upper part of the door is disconnected from the upper track. The door may then be pushed or pulled outward and away from the helicopter fuselage.

RESCUE BASKET

The rescue basket, in the cabin, consists of welded steel tubing. The basket bail is a beam assembly of tubing and steel plating. An opening in the center of this plate provides for attachment of rescue hoist hook. Each end of the basket contains a resin-impregnated fiberglas polyurethane foam cylinder for flotation.

CABIN DOOR SAFETY STRAP

The helicopter is equipped with a safety strap (figure 4-53) installed in the cabin door opening, for the purpose of restraining personnel. The safety strap is adjustable with two quick release snaps that attach to ring and eye bolt assemblies on the cabin door opening. The cabin door safety strap shall be installed whenever the cabin door is open and the helicopter is in motion. When not in use, the safety strap is stowed by attaching the forward strap to the ring on the aft door frame.

RESCUE HOIST

The rescue hoist provides a means of suspending external cargo from the helicopter. The 600-pound capacity hydraulic hoist is supported from a fixed truss over the cabin door on the right-hand side of the fuselage. The hydraulic hoist system consists primarily of a hoist, hoist solenoid valve (four-way control valve), accumulator, flow regulator, hoist electrical controls, hook and handwheel assembly, circuit tester, and circuit breaker. The system operates at 1250 psi hydraulic pressure supplied from the auxiliary hydraulic system. Operation of the hoist system is controlled by electrical switches from either the pilot's compartment or the cabin. A built-in shear (guillotine) circuit permits shearing of the hoist cable in the event of cable fouling. Faulty wiring in the shear circuit can be detected by the circuit tester. The accumulator dampens pressure surges and is installed on the transmission deck. It is precharged with 600 psi air pressure. The flow regulator controls the fluid flow to the hoist and limits the cable travel to 80 feet-per-minute. The hoist is rated at 600 pounds capacity. It consists primarily of a hydraulic motor, cable drum, cable, brake, level wind mechanism, limit switches, and a shear mechanism. The hydraulic motor drives the cable drum through two stages of planetary gear reduction. The cable drum, in turn, reels in or pays out up to 100 feet of 3/16-inch-diameter stainless steel cable, the last 10 feet of which are painted red and white. The self energizing-type brake enables the hoist operator to stop the cable at any desired length and hold it in place, with or without a load. The level wind mechanism serves to distribute the cable evenly on the reel. The limit switches provide automatic stopping of the hoist at extreme cable positions during electrical operation of the hoist. The hoist will not stop automatically during operation with the hoist manual override. The ballistic-type shear cartridge permits shearing of the hoist cable in case of emergency.

HOIST MASTER SWITCH

The hoist master switch, marked HOIST MASTER, is on the overhead switch panel (figure FO-2). When the switch is placed in the CREW position, the hoist winch is controlled by the Hoist Operator's switch and the cabin portable control switch. When the switch is placed in the PILOT position, the hoist is controlled only by the Pilot's hoist switch. When the switch is in the OFF position, all three hoist switches are inoperative. The hoist master switch uses power from the dc essential Bus and is protected by a circuit breaker marked HOIST on the forward circuit breaker panel.

PILOT'S HOIST SWITCH

The thumb switch, marked HOIST with the positions UP, OFF (CENTER), and DOWN, on the pilot's collective pitch control box (figure 4-54), controls the hydraulic hoist winch. The switch is pushed to either position, UP or DOWN, to operate the hoist. When released, the switch returns to the center (OFF) position and the hoist winch stops and locks. The switch is operative when the hoist master switch is placed in the PILOT position.

CREWMAN'S HOIST SWITCH

A momentary-type switch (figure 4-54), marked UP, OFF, DOWN, on a small panel marked HOIST, above and forward of the door on the right side of the cabin, allows a crew member to control the hoist. The switch is pushed to either extreme position to operate the hoist winch. When released, the switch returns to the center (OFF) position, and the hoist winch stops and locks automatically. The switch is operative when the hoist master switch on the pilot's overhead switch panel is placed in the CREW position.

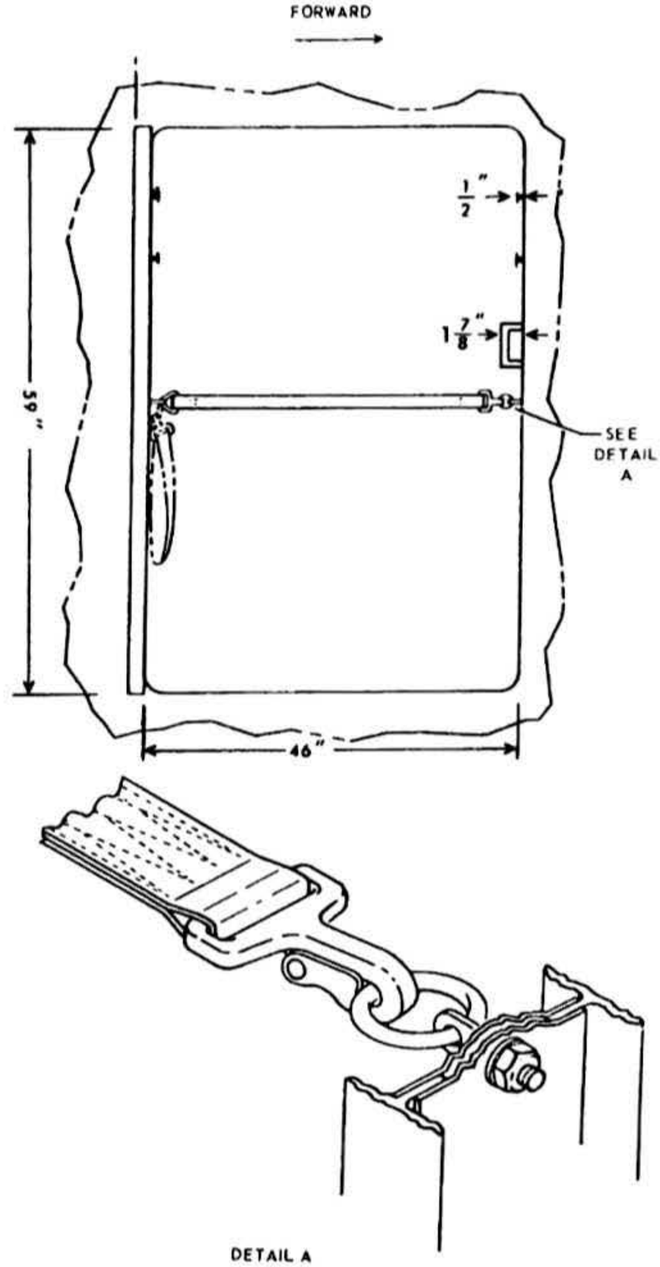


Figure 4-53. Cabin Frame and Safety Strap

CABIN PORTABLE CONTROL SWITCH

A momentary-type thumb operated portable hoist control switch (figure 4-54), marked DOWN and UP, is stowed on a bracket on the cabin frame forward of the cargo door. The switch will provide the hoist operator with greater mobility during hoist operations. The switch is wired in parallel with the cabin hoist control switch and is operative when the hoist master switch is in the CREW position.

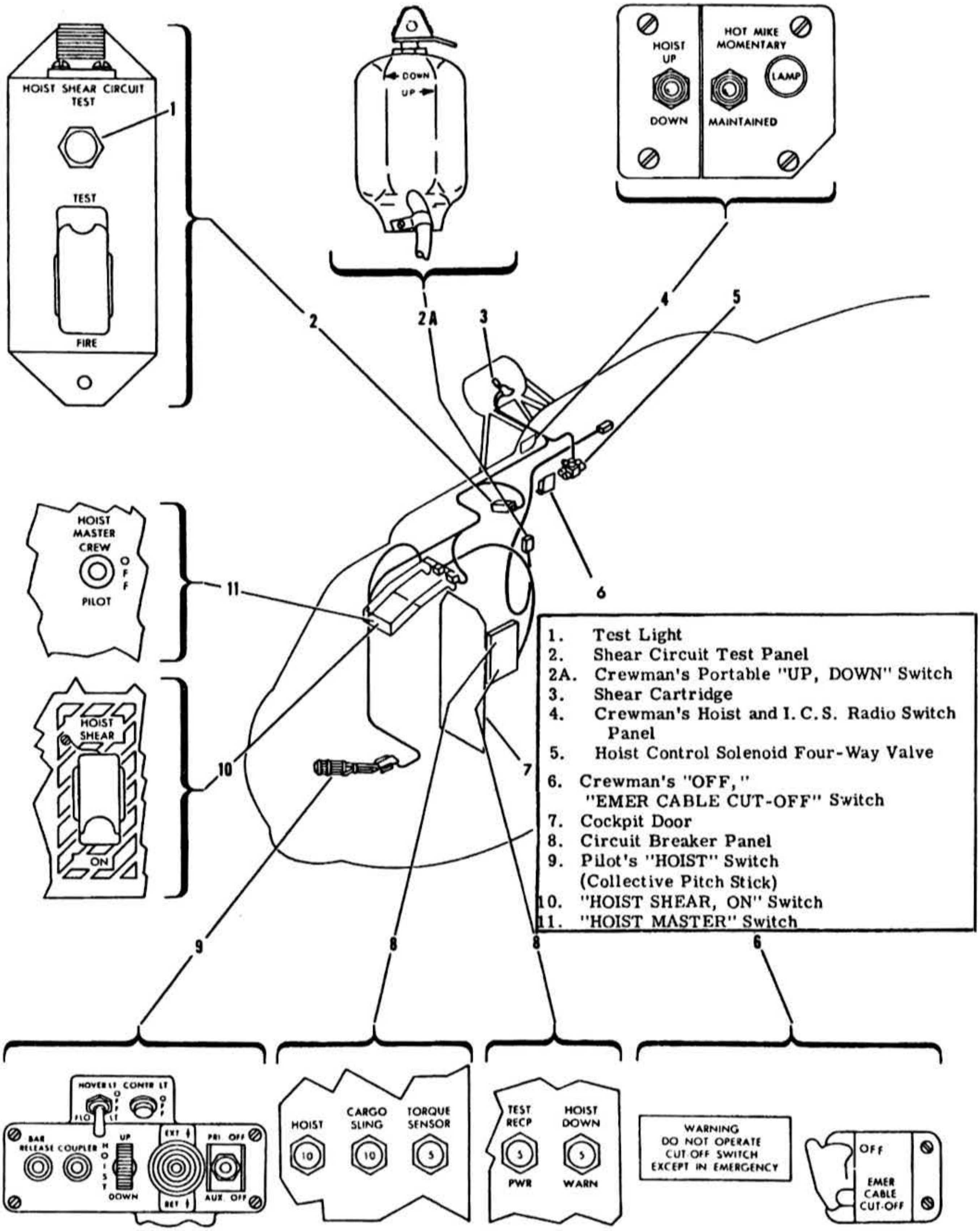


Figure 4-54. Rescue Hoist Component Locations

CAUTION

If the hoist does not respond properly to the electrical controls, the crewman should attempt to determine the cause (Bent cable, fouled cable, etc.) and inspect the hoist prior to using the manual hydraulic override. Use of the override with a fouled reel or cable may cause further damage and possible parting of the cable. If resistance is encountered when using the override, the hoist should be stopped immediately to prevent further damage.

HOIST MANUAL OVERRIDE

A hydraulic hoist manual override valve, installed above cabin door, is provided to lower or raise hoist in event of electrical failure. The three-position, four-way valve operates on power from the auxiliary hydraulic system and is actuated by two hydraulic hoist manual override valve buttons on the valve. Depressing either of the spring-loaded ıttons, marked HOIST DOWN and HOIST UP, ᴗpens the override valve and actuates the hoist winch.

CAUTION

The hoist will not stop automatically during manual operation when the cable reaches the extreme ends.

Releasing the button closes the override valve and stops operation of the hoist winch. Before using manual override, the operator must check the condition of hoist cable and reel. Abnormal stresses encountered during hoisting may result in malfunctions of the reel and level-wind mechanism which can prevent electrical operation of hoist.

HOIST CABLE SHEAR SWITCHES

Two guarded momentary-type, hydraulic hoist cable shear switches are provided to cut the hoist cable at the winch in an emergency should the

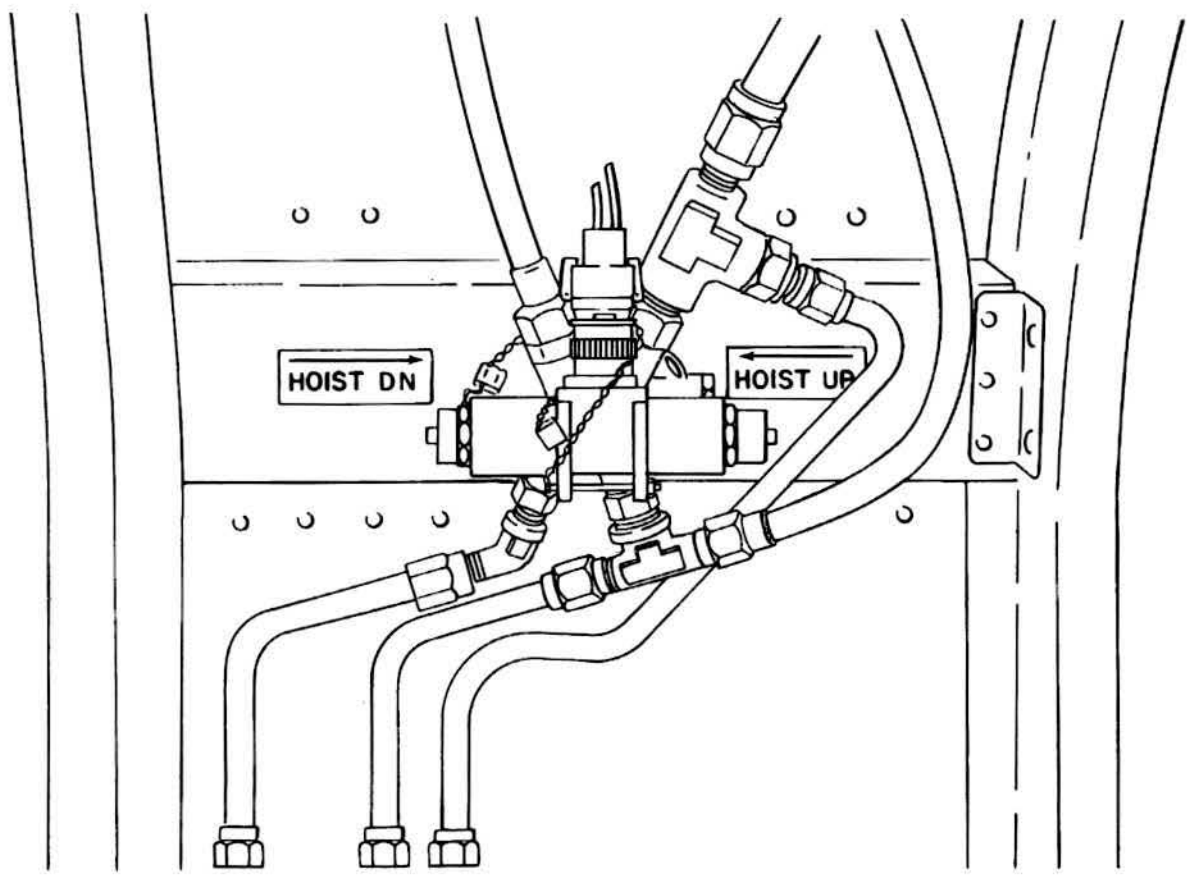


Figure 4-55. Hoist Operator's Override Valve

cable become entangled with an obstruction on the ground. One switch marked HOIST SHEAR with a position marked ON is on the overhead switch panel in the pilots compartment (figure FO-2), the other switch marked EMER CABLE CUT-OFF with a position marked OFF is on the cabin wall above the cabin door (figure 4-54). To shear the hoist cable, lift the guard and actuate the switch. An electrically-fired cartridge will fire a guillotine and cut the hoist cable at the winch. The hoist master switch must be placed in the crew position to permit shearing from the CREW position. The pilot's shear switch is operable with the hoist master switch in either position (CREW or PILOT). Electrical power for the Test and Shear circuit comes from the dc essential bus and is protected by a circuit breaker marked HOIST on the forward circuit breaker panel. This is the same circuit breaker that protects the HOIST MASTER switch.

HOIST SHEAR CIRCUIT TEST PANEL

A hydraulic hoist shear circuit test panel, marked HOIST SHEAR CIRCUIT, is mounted on the cabin wall above the cabin door (figure 4-54). A light, marked TEST, is on the top center of the panel. With the test switch in the TEST position, and either the pilot's or crewman's HOIST CABLE SHEAR SWITCH is activated, the green TEST light above the test switch should come on. This indicates that the shear circuit is in working order. Testing of the hoist shear circuit is accomplished by maintenance personnel.

TUGBIRD

The Tugbird system is no longer installed in the HH-52A. The TUGBIRD position of the release mode switch on the overhead switch panel (figure FO-2) should be disregarded.

EXTERNAL CARGO SLING

The 3000-pound capacity cargo sling (figure 4-56) consists of four cables suspended from fixed mount supports attached to the left and right chines on the lower fuselage structure of the helicopter, a cargo hook suspended from the cables, a cable assembly for stowing the hook, a mechanical release cable, electrical components and wiring and sling stowage provisions. These components weigh 16 pounds. The four cables converge at the centerline of the helicopter below the fuselage and are shackled to the cargo hook. The cargo release circuit operates on direct current from the essential bus and is protected by a circuit breaker, marked CARGO SLING, on the forward circuit breaker panel. A light, marked SLING OPEN, on the caution panel will go on any time the cargo hook is open. The light receives electrical power from the dc essential bus through a circuit breaker marked CARGO SLING, on the forward circuit breaker panel under the general heading WARNING LIGHTS. When the cargo sling is attached but not in use, it is stowed under the fuselage by means of a stowage line. A manual release lever, on the cargo hook, permits mechanical opening of cargo hook by ground personnel. The crewman may open the cargo hook during flight or while on the ground by actuating the release cable handle attached to the manual release mechanism on the hook. The release handle is secured to the forward cabin door frame. Cargo is attached to the hook by ground personnel who must manually close the hook.

CAUTION

The cargo sling should be stowed before landing to prevent the hook from striking the ground. Striking the hook on the ground can cause damage and subsequent failure of the hook. Landing on the water with an unstowed hook can cause damage by denting or puncturing the hull. It should be noted on the pink sheet if the cargo hook has made water or ground contact so that preventive action can be taken against corrosion and damage.

CARGO HOOK

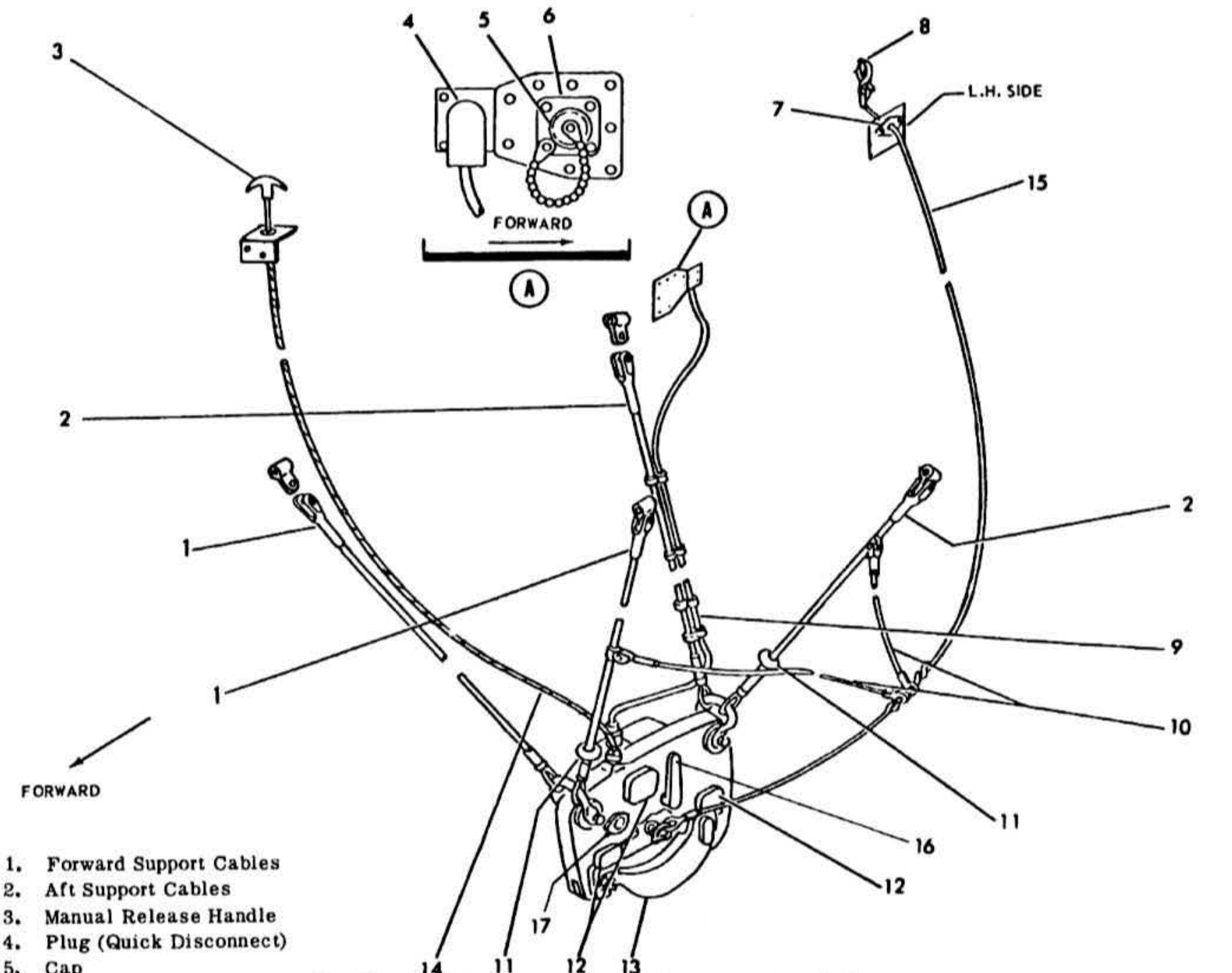
The hook contains a load beam that supports cargo below the main rotor centroid during cargo carrying operations. When the sling is properly installed, the cargo hook load beam pivots at the aft end; the forward end engages a latch when the hook is closed. The latch controls the opening of the hook, which may be accomplished by either manual, electrical controls, or automatically. The hook may be opened manually by either the manual release lever on the hook or by the manual release handle attached to the forward edge of the cargo door. The hook may be opened electrically by depressing either the pilot's or copilot's "CARGO" switch on the cyclic stick grip, when the "RELEASE MODE" switch is in the "SLING" position and the "CARGO SLING MASTER" switch is in the ON or AUTO position.

CARGO SLING MASTER AND MODE SWITCHES

A switch, marked RELEASE MODE, SLING, and TUGBIRD, is provided. The cargo sling master switch, marked CARGO SLING MASTER, on the overhead switch panel, (figure FO-2), controls the electrical actuation of the cargo hook. The switch has three positions, ON, SAFE, and AUTO. When preparing to release cargo electrically, the master switch should be in either the ON or AUTO position. With switch in the ON position, cargo may be released by actuating either cyclic stick cargo release switch. With the switch in the AUTO position, cargo is released by the automatic touchdown release circuit when the load on the cargo hook is reduced to 100 ± 20 pounds or less. The cargo hook cannot be closed by ground personnel if the master switch is in the AUTO position.

CARGO RELEASE SWITCHES

A push-button, momentary-contact type cargo release switch is on the grip of both cyclic sticks (figure 1-19). Either thumb-operated switch, marked CARGO, may be depressed to open the cargo hook when the cargo sling master switch is in the ON or AUTO position.



1. Forward Support Cables
2. Aft Support Cables
3. Manual Release Handle
4. Plug (Quick Disconnect)
5. Cap
6. Dummy Receptacle
7. Fair Lead
8. Chock (Cleat)
9. Electrical Cable
10. Cable
11. Cable Bumpers
12. Hook Bumpers (Bonded)
13. Cargo Release Hook
14. Manual Release
15. Stowage Line
16. Manual Release Lever
17. Hook Closed Indicator Window

Figure 4-56. External Cargo Sling

CARGO HOOK MANUAL RELEASE LEVER

The cargo hook may be opened manually by ground hookup personnel by operating the manual release lever on the cargo hook.

CARGO HOOK MANUAL RELEASE HANDLE

The manual release cable leads from the cargo hook to the manual release handle installed on the forward edge of the cabin door. It permits manual release of the cargo hook from the cabin.

CARGO SLING OPEN CAUTION LIGHT

The sling open caution light is actuated by a micro-switch on the cargo hook. A yellow caution light marked SLING OPEN, on the caution panel (figure 1-27), will go on whenever the cargo hook load beam is open, provided the MODE switch is in the SLING position and the CARGO SLING MASTER switch is in either the ON or AUTO position.

CARGO HOOK STOWAGE LINE

Stowage of the cargo sling is accomplished with the nylon line that is attached to the hook. It enters the left side of the fuselage through a fairlead, and is secured to a tiedown chock. Two short cables, attached by thimbles to the forward and aft left sling cables, are attached to this line. Pulling this line inside the fuselage secures the cargo sling and hook under the left side of the hull.

WARNING

Any static electricity that may have been generated by the helicopter should be dissipated prior to attempting hookup.

MOORING

Mooring is accomplished by securing the helicopter with tiedowns, usually as a precaution against high wind conditions. (figure 4-57). If necessary the struts may be deflated and the fuel tanks filled.

TIEDOWN RINGS

Five mooring rings (figure 4-57) are provided on the helicopter. Each main landing gear trunnion assembly has a mooring ring on the outboard side. A mooring ring is on the tailwheel assembly and one at the top of each compression strut. High tie-down extensions will be installed for shipboard operations.

BLADE TIP COVERS (BOOTS)

Blade tip covers (figure 4-57) are used as a precaution against high and/or gusty winds. Two types of boots are available for blade security. Canvas type boots are for use in light wind conditions and are installed with a maximum of 6 inches downward deflection of the blade. Special HEAVY WEATHER (METAL) BLADE BOOTS are designed for use in winds up to 70 knots. See the Maintenance Manual for installation procedures for both types of boots.

CAUTION

Blade deflection with the Heavy Weather Blade Boots is 26 inches. Damage to the main rotor blades is likely if more than 6 inches deflection is used with the canvas-type boots.

MAIN ROTOR BLADE FOLDING AND STOWAGE

The main rotor blades may be folded (figure 4-58) when parking the helicopter in a small area. A taper pin puller, blade crutch, and blade pocket assemblies are required to fold the blades.

WINDSHIELD WIPER SYSTEM

The electrically-operated windshield wiper system consists of a two-speed ac motor, two converters, two arm and link assemblies, two wiper assemblies and a control switch. Actuation of the motor drives a flexible drive shaft to a converter which transmits oscillating motion to the arms and wipers. The converters are just below the pilot's and co-pilot's windshield. The wipers are on each windshield and have approximately 72° range of travel. The control switch, on the overhead switch panel (figure FO-2) with marked positions PARK, OFF, LOW, and HIGH, controls the entire system. When the switch is placed in the LOW or HIGH position, the system is actuated at the selected speed. When

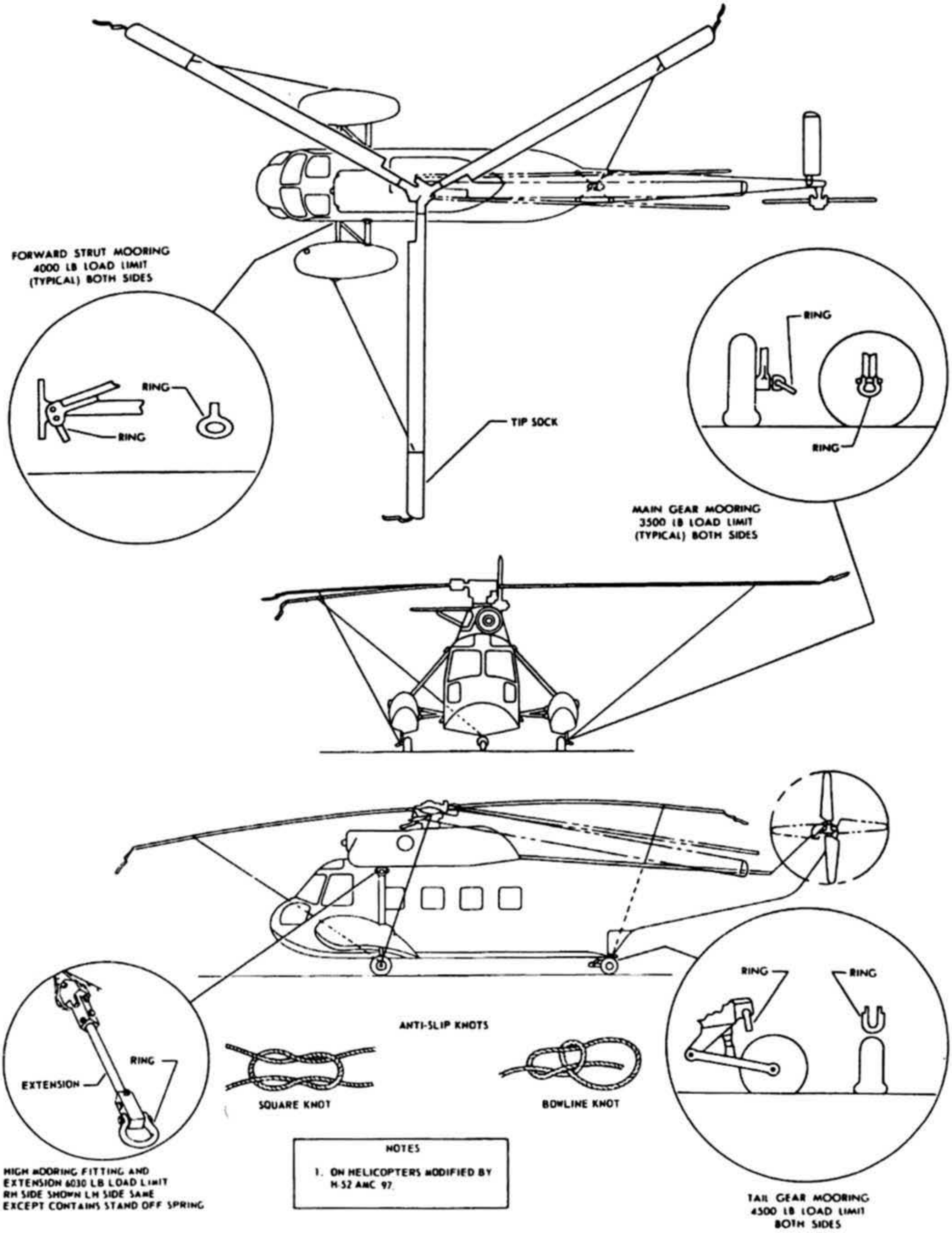


Figure 4-57. Mooring

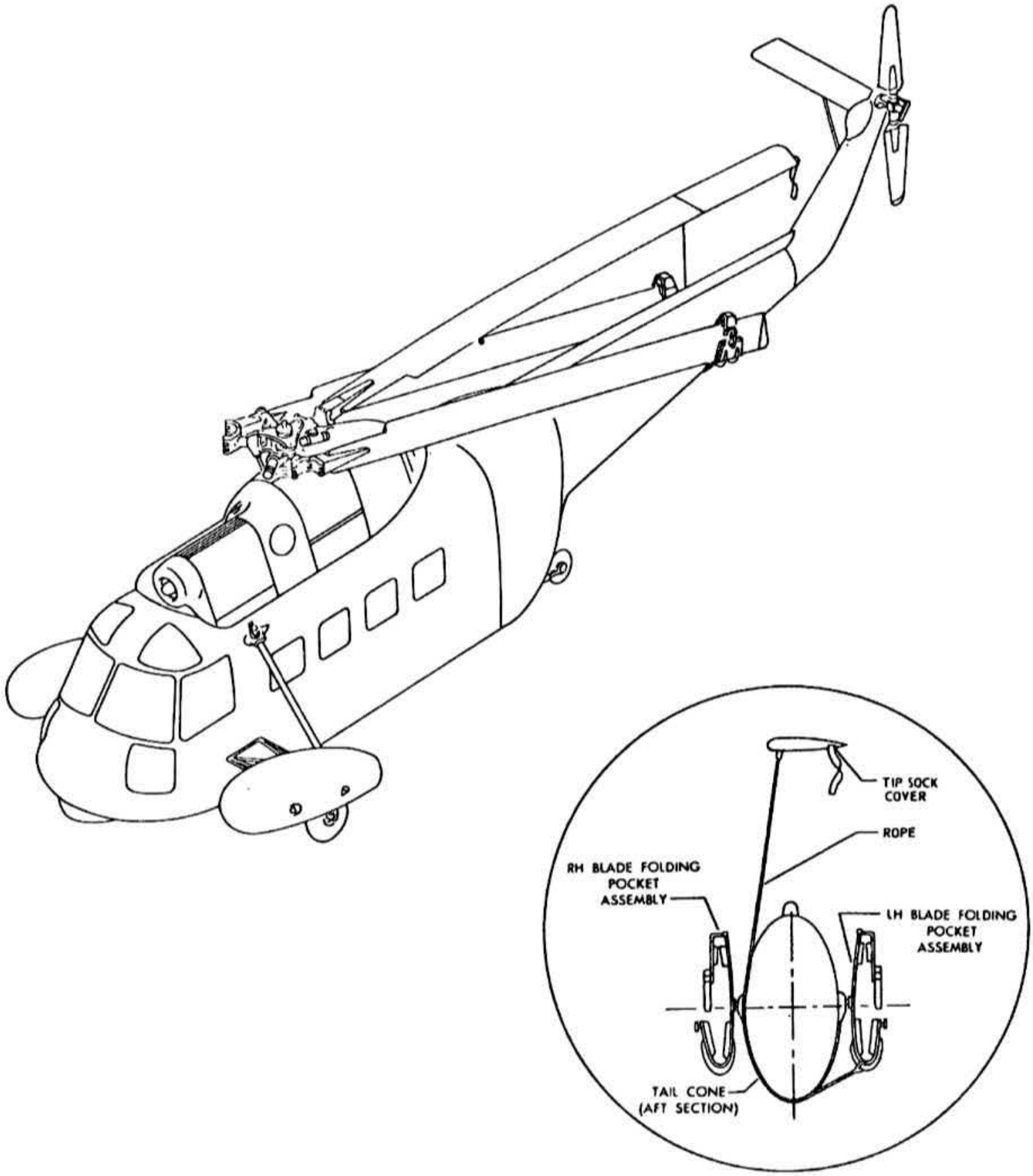


Figure 4-58. Main Rotor Blades Folded and Stowed

the switch is placed in the momentary PARK position the wipers are automatically positioned to the inboard edge of the windshields. The windshield wiper system operates on power from the ac essential bus and is protected by a circuit breaker marked WINDSHIELD WIPER on the aft circuit breaker panel. To prevent scratching the windshield, do not operate wipers on dry glass.

CAUTION

If the windshield wipers should become stuck in any one position, the wipers should be turned off to prevent the destructive overheating of the windshield wiper motor.

WINDSHIELD WASHER

The windshield washer system consists of a reservoir attached to the forward cabin bulkhead behind the pilot's seat, a surgemeter foot pedal on the cockpit floor near the pilot's right foot, two nozzles, and connecting rubber hoses. Pressure for operating the windshield washer system is supplied by actuating the surgemeter button with the right foot. When the button is depressed, pressure is directed toward the nozzles. When the button is released, fluid is drawn from the reservoir. Repeated actuation of the button causes the fluid from the reservoir to be forced through the nozzles and onto the windshields. Water is used as the washing fluid. A 60% ethylene glycol solution and 40% water is used during freezing weather. Due to slipstream effect in forward flight, the windshield washer system is most effective if operated on deck in a low pitch condition. The system is marginally effective in a hover and least effective in forward flight.

HIGH-INTENSITY SEARCHLIGHT

The high-intensity searchlight system (Night Sun) provides a high-intensity light source particularly suited for most night operations, including search operations and examination of rescue locations from a safe altitude. Night photographic missions are possible using daylight techniques and film.

The searchlight system is comprised of the following components: remote control unit, junction box, gimbal mount, searchlight assembly, interconnecting cables and mounting hardware. The system utilizes the controllable landing light toggle switch for cockpit control of beam direction (figure 4-47).

LAMP

The assembly utilizes a xenon arc lamp capable of 3,800,000 peak beam candle power. The beam width is adjustable between 6.5° (SEARCH) and 10° (FLOOD).

ELECTRICAL POWER SUPPLY

The system is powered by the dc non-essential bus. During the start sequence 30,000 volts are generated within the searchlight assembly and a high current power surge develops in the junction box.

NOTE

> The start sequence may cause considerable interference with radios in the helicopter.

After the start sequence is completed, only 28 vdc is required for the system to sustain illumination.

NOTE

> One transformer/rectifier is capable of powering the searchlight system.

CAUTION

> Do not attempt to operate the searchlight from battery power only.

EXTERNAL MOUNT

The external mounting consists of four support brackets, the gimbal mount, and the searchlight assembly. All the external gear weighs 44 pounds and has only a slight influence on CG travel. The assembly is mounted on the port side of the helicopter aft of the cabin emergency exit. Water landings will immerse the searchlight.

NOTE

> Water landings with the searchlight installed should be limited to emergency circumstances. If a water landing is necessary and the searchlight is in use, if possible turn the light off and allow it to cool prior to landing (any cooling period is beneficial). The MASTER switch should also be secured prior to water contact.

REMOTE CONTROL UNIT

The remote control unit (figure 4-59) is mounted in the cabin above the radio rack. Two quick-disconnect releases permit moving the unit to other positions about the cabin for remote use. The control panel contains a circuit breaker type ON-OFF switch marked MASTER. This switch powers the lamp, lamp starter, gimbal drive motors, focusing drive motor, and a cooling fan in the lamphousing assembly. A guarded momentary contact switch marked START controls the start circuit. A third momentary contact toggle switch marked FOCUS controls the motor-driven focus mechanism. A four-way momentary contact toggle switch marked DOWN UP LEFT RIGHT controls the movement of the searchlight in azimuth and elevation. The above four switches are on the face of the remote control unit. On top of the remote control unit is an unmarked momentary interrupt pushbutton. This turns off the lamp but allows the cooling fan to continue running. The cooling fan runs any time the MASTER SWITCH is ON.

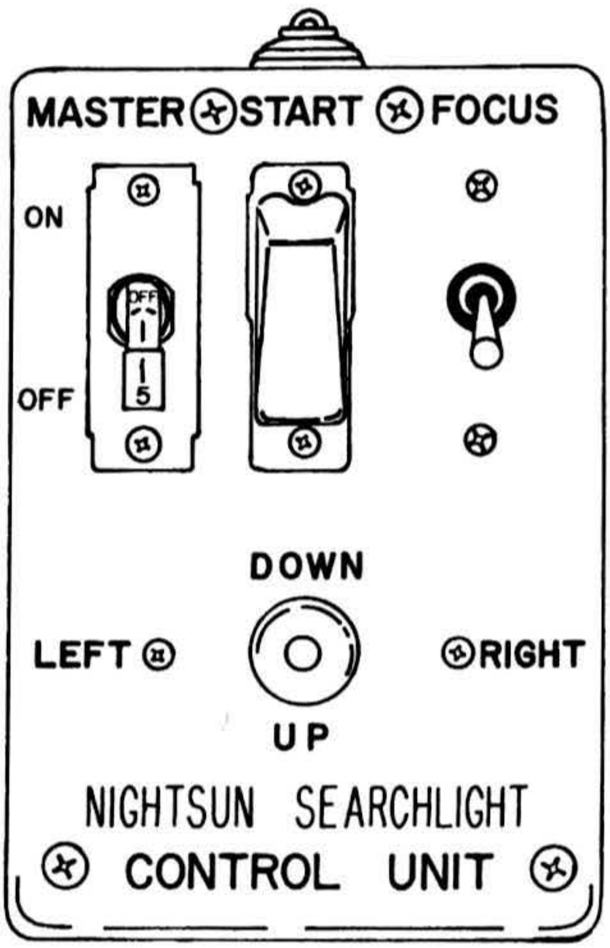


Figure 4-59. Remote Control Unit

JUNCTION BOX

The junction box consists of a rectangular metal box containing relay and terminal connections for power distribution to the functional components of the searchlight equipment. The junction box is mounted in the cabin, portside, aft of the emergency exit. Two circuit breakers are mounted on the bottom of the case (70A and 7A).

GIMBAL MOUNT

The gimbal mounting assembly consists of a yoke and two small dc motor actuators. One motor is mounted at the base of the yoke and turns the light for azimuth. The second motor is mounted on one leg of the yoke and drives the trunnion mounting for elevation. Stop pins in the yoke bearing housing limit the searchlight rotation in azimuth. A slip clutch on each motor drive absorbs the motor torque when the searchlight is driven against a stop. The stops are adjustable in azimuth and may permit a maximum of 350° of rotation. There are no physical stops for elevation. Normal range of elevation is from 10° above the horizontal to 70° below. The drive motors may cause some radio interference.

NOTE

Manual movement of the searchlight assembly will not damage the actuating mechanism.

WARNING

Avoid training the searchlight on any part of the helicopter. The heat generated is capable of melting a tire or igniting paint or fiberglass. When changing azimuth from side to side, DEPRESS ELEVATION to avoid shining the light inside the helicopter.

SEARCHLIGHT ASSEMBLY

The searchlight assembly consists of a cylindrical housing within which are mounted an arc lamp bulb, a reflector, a cooling fan, a focusing motor and various electrical components used in the start circuit of the lamp. The lens, made of specially tempered glass, is capable of withstanding both mechanical stresses and high temperatures. The xenon arc lamp contains two tungsten electrodes permanently sealed in a quartz glass bulb filled with gas under pressure.

NOTE

Unlighted pressure within the bulb is approximately 75 psi. Lighted, the pressure approaches 300 psi and the temperature surrounding the arc will range between 800° and 2100°F. Should the bulb explode, it will be contained by the searchlight housing and lens.

The beam is focused by a focusing motor driving the reflector towards or away from the lens. The motor is nonreversing and continually drives the reflector back and forth through the same cyclic. The focus is from a 10° beam width to a 6.5° beam width. The searchlight assembly has a safety cable attached to the yoke.

SEARCHLIGHT OPERATION

Preflight

1. Lens clean — CHECKED.

NOTE

Do not touch the lens with hands; smudges may cause an uneven heating of the lens and subsequent cracking.

2. MASTER switch — OFF.

Starting

1. MASTER switch — ON.

2. START switch — DEPRESS UNTIL LAMP IGNITES (5-10 seconds).

CAUTION

Continuing to depress the switch after ignition may seriously damage the searchlight.

Operation

1. FOCUS switch — ADJUSTED TO DESIRED BEAM WIDTH.

2. Direction control switch — OPERATE AS DESIRED.

NOTE

If the controllable landing light is OFF, the cockpit controllable landing light toggle switch controls the searchlight positioning. The cockpit control will override the Remote Control Unit inputs.

Securing

1. Pushbutton (top of Remote Control Unit) — DEPRESS UNTIL SEARCHLIGHT GOES OFF.

2. Allow 3 minutes for cooling.

3. MASTER switch — OFF.

OPERATING TECHNIQUES

Techniques for use of the searchlight must vary with the object of the search, area being searched, and meteorological conditions. General guidelines for its use are listed below; however, proficiency in its use can only be acquired through actual experience. The following techniques are only general guidelines for good search conditions.

1. Search airspeed — as required (55 to 70 knots is recommended. Faster airspeeds can be used for larger search objects.)

2. Altitude — proportional to search objects size:

a. Vessels or boats 40 feet or over — 1000 to 1500 feet.

b. Boats less than 40 feet — 300 to 1000 feet

c. Personnel — 300 to 500 feet (hover search also a satisfactory technique).

3. Beam width — as desired. Midway between narrow and widest points provides a nearly solid beam spot.

4. The port side of the helicopter is the best search side and can be used by both the copilot and crewman. The lighted area is limited on the starboard side forward.

SECTION V
OPERATING LIMITATIONS

This section contains all the limitations which must be observed during normal operation. Limitations characteristic to specialized phases of operation are not repeated in this section. Examples of these specialized phases include turbulent air flight, arctic operations, water operations, etc.

TABLE OF CONTENTS

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 familiarize the pilot with proper operation of the helicopter and associated equipment. The instruments in the helicopter are marked as shown in figure 5-1 to indicate to the pilot that flight operation is being accomplished in a safe, 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 were exceeded and the time duration should be entered on CG-4377.

INSTRUMENT RANGE MARKINGS

Instrument markings shown in figure 5-1 and other operating limitations in this section are not repeated elsewhere in the manual. The instrument markings used in figure 5-1 are explained in the following paragraphs:

LOWER RED RADIAL

The red radial having the lowest numerical value on an instrument indicated that a dangerous condition would exist if the pointer should drop to or below that value during flight.

YELLOW ARC OR RADIAL

A yellow arc or radial indicates that danger may exist under certain specified conditions. These conditions are noted on figure 5-1 or covered in the text.

GREEN ARC

A green arc indicates the region for continuous inflight operation.

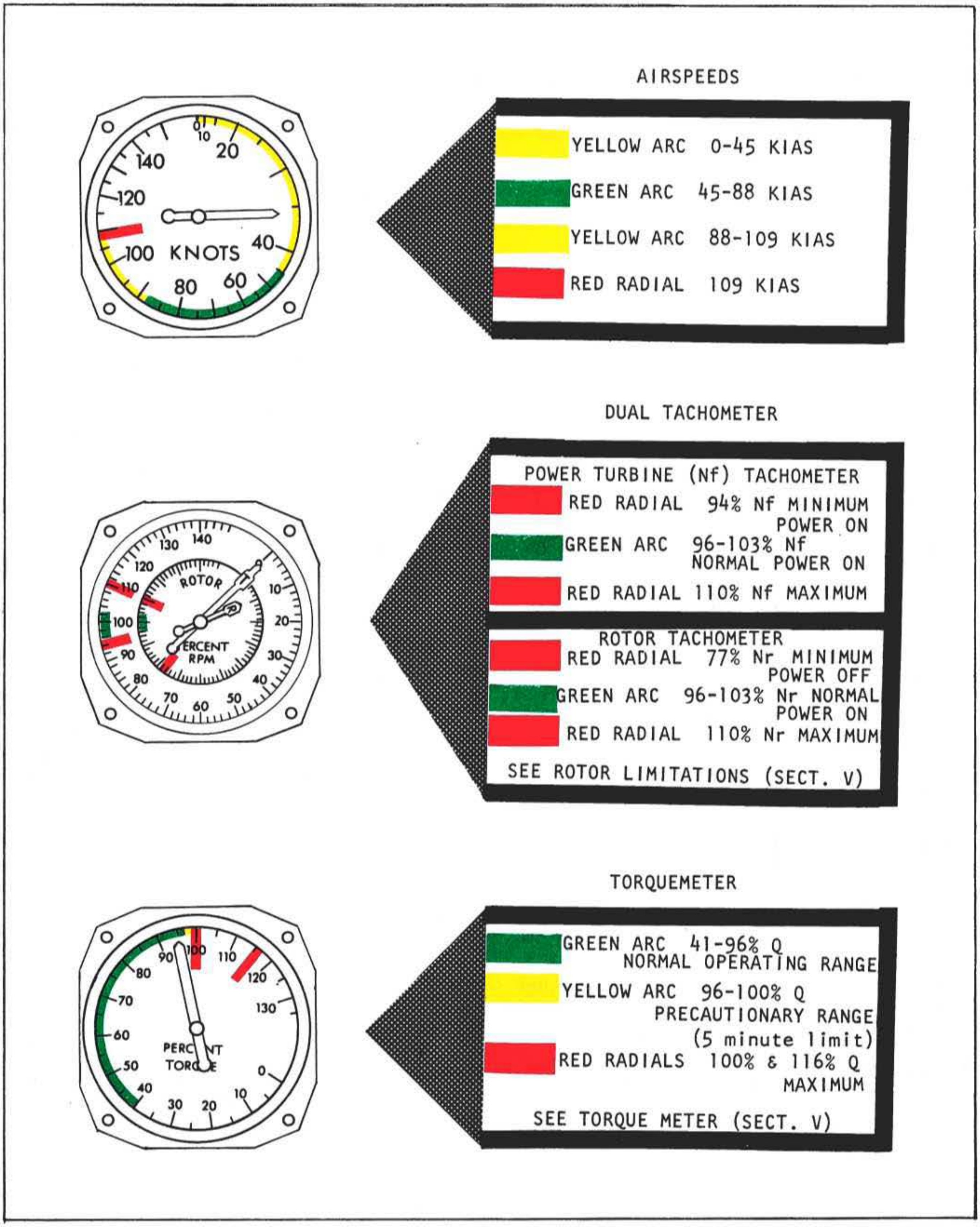
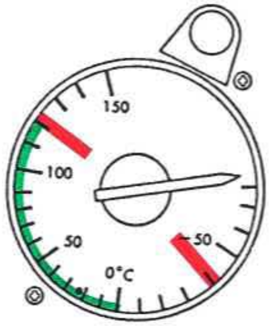
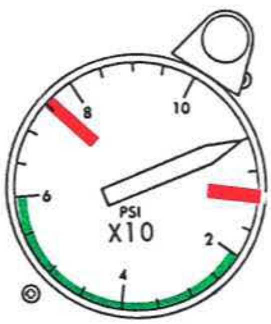


Figure 5-1. Range Markings (Sheet 1 of 4)



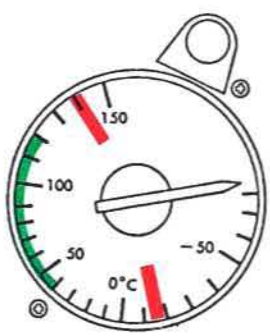
ENGINE OIL TEMPERATURE

- RED RADIAL -40°C MINIMUM
- GREEN ARC 0-121°C NORMAL OPERATING RANGE
- RED RADIAL 121°C MAXIMUM



ENGINE OIL PRESSURE

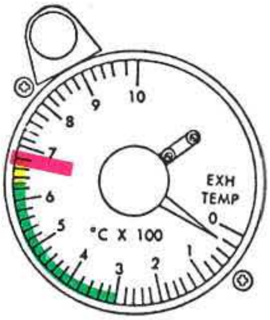
- RED RADIAL 10 PSI MINIMUM
- GREEN ARC 20-60 PSI NORMAL OPERATING RANGE
- RED RADIAL 75 PSI MAXIMUM



TRANSMISSION OIL TEMPERATURE

- RED RADIAL -15°C MINIMUM
- GREEN ARC 40-120°C NORMAL OPERATING RANGE
- RED RADIAL 140°C MAXIMUM

Figure 5-1. Range Markings (Sheet 2 of 4)

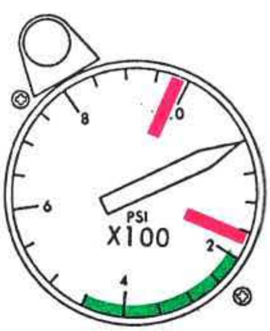


POWER TURBINE INLET TEMPERATURE (T5)

- GREEN ARC 300-635°C NORMAL OPERATING RANGE
- YELLOW ARC 635-677°C 30 MINUTE LIMIT RANGE
- RED RADIAL 677°C MAXIMUM EXCEPT FOR STARTING AND TRANSIENT CONDITIONS SEE FIGURE 5-2

GAS GENERATOR (Ng) TACHOMETER

- GREEN ARC 50-97.5% Ng NORMAL OPERATING RANGE
- YELLOW ARC 97.5-100% Ng PRECAUTIONARY RANGE
- RED RADIAL 100% Ng MAXIMUM



ENGINE FUEL PRESSURE

- RED RADIAL 160 PSI MINIMUM
- GREEN ARC 190-450 PSI NORMAL OPERATING RANGE
- RED RADIAL 995 PSI MAXIMUM

S 55582.3 (R)

Figure 5-1. Range Markings (Sheet 3 of 4)

TRANSMISSION OIL PRESSURE

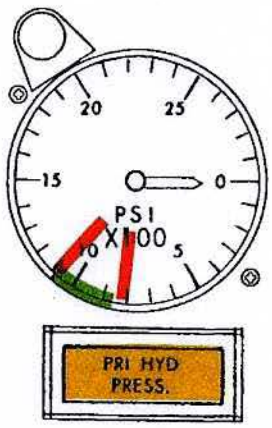
RED RADIAL 25 PSI MINIMUM

GREEN ARC 40-90 PSI NORMAL OPERATING RANGE

RED RADIAL 120 PSI MAXIMUM

CAUTION LIGHT

THE TRANSMISSION OIL PRESSURE CAUTION LIGHT COMES ON WHEN THE MAIN GEAR BOX OIL PRESSURE DROPS BELOW APPROXIMATELY 15 PSI .



PRIMARY HYDRAULIC SERVO PRESSURE

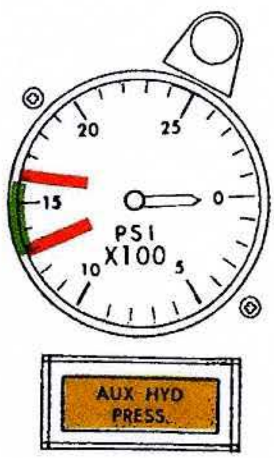
RED RADIAL 850 PSI MINIMUM

GREEN ARC 850-1100 PSI NORMAL RANGE

RED RADIAL 1100 PSI MAXIMUM

CAUTION LIGHT

THE PRIMARY SERVO PRESSURE CAUTION LIGHT WILL COME ON WHEN PRESSURE DROPS BELOW 750 PSI.



AUXILIARY HYDRAULIC SERVO PRESSURE

RED RADIAL 1300 PSI MINIMUM

GREEN ARC 1300-1600 PSI NORMAL RANGE

RED RADIAL 1600 PSI MAXIMUM

CAUTION LIGHT

THE AUXILIARY SERVO PRESSURE CAUTION LIGHT WILL COME ON WHEN PRESSURE DROPS BELOW 1000 PSI.

Figure 5-1. Range Markings (Sheet 4 of 4)

UPPER RED RADIAL

The red radial having the highest numerical value on an instrument indicates that a dangerous condition would exist if the pointer should reach this value and that operation above this point is prohibited.

UNMARKED AREAS

Unmarked or blank areas between upper and lower radials, or between a green arc and red radial, or between red radials indicate regions that should be avoided except for transient conditions such as starting, ground operation, etc.

FLIGHT LIMITATIONS

MAXIMUM, NEVER EXCEED SPEED (Vne)

The data below are indicated airspeeds for 2000 feet density altitude. Consult the Incipient Blade Stall Chart, figure A-36, for Vne values above 2000 feet density altitude or for maneuvering flight.

Gross Weight	Vne at 96%/100% Nr
6500	109/109
7000	102/106
7500	95/102
8000	86/94
8300	82/88

Vne is the airspeed beyond which operation of the aircraft becomes dangerous.

MAXIMUM AIRSPEED (Vmax) — figures A-21 thru A-30, A-37

The highest obtainable airspeed at maximum continuous power. Vmax values are always Vne limited.

MAXIMUM SIDEWARD FLIGHT SPEED

25 knots

MAXIMUM REARWARD FLIGHT SPEED

20 knots

HOVERING TURNS

Hovering turns shall not exceed a rate of 360 degrees in 10 seconds.

ICING

Flight into known icing conditions is prohibited.

POWER LIMITATIONS

Engine power limits normally are not reached in this aircraft because the transmission design horsepower limit is reached first. Nevertheless, engine power instruments are marked to indicate design limits.

TORQUEMETER Q

Maximum continuous torque is 96% due to the main transmission rating. 96-100% Q is a precautionary range and is limited to 5 minutes. Operation over 100% Q will advance the elapsed time indicator, which is limited to 1 hour of recorded time. When 116% Q is exceeded for approximately 5 seconds, a red flag will appear in the window of the event indicator. (See TORQUE SENSING SYSTEM Section I.) See figure A-31 for max. cont. Q setting.

NOTE

Operation above 100% Q will result in extremely reduced transmission life.

POWER TURBINE INLET TEMPERATURE T_5

Refer to figure 5-2.

CAUTION

During compressor stalls or any other overtemperature condition, if maximum T_5 is not observed, it is to be assumed that the limits have been exceeded.

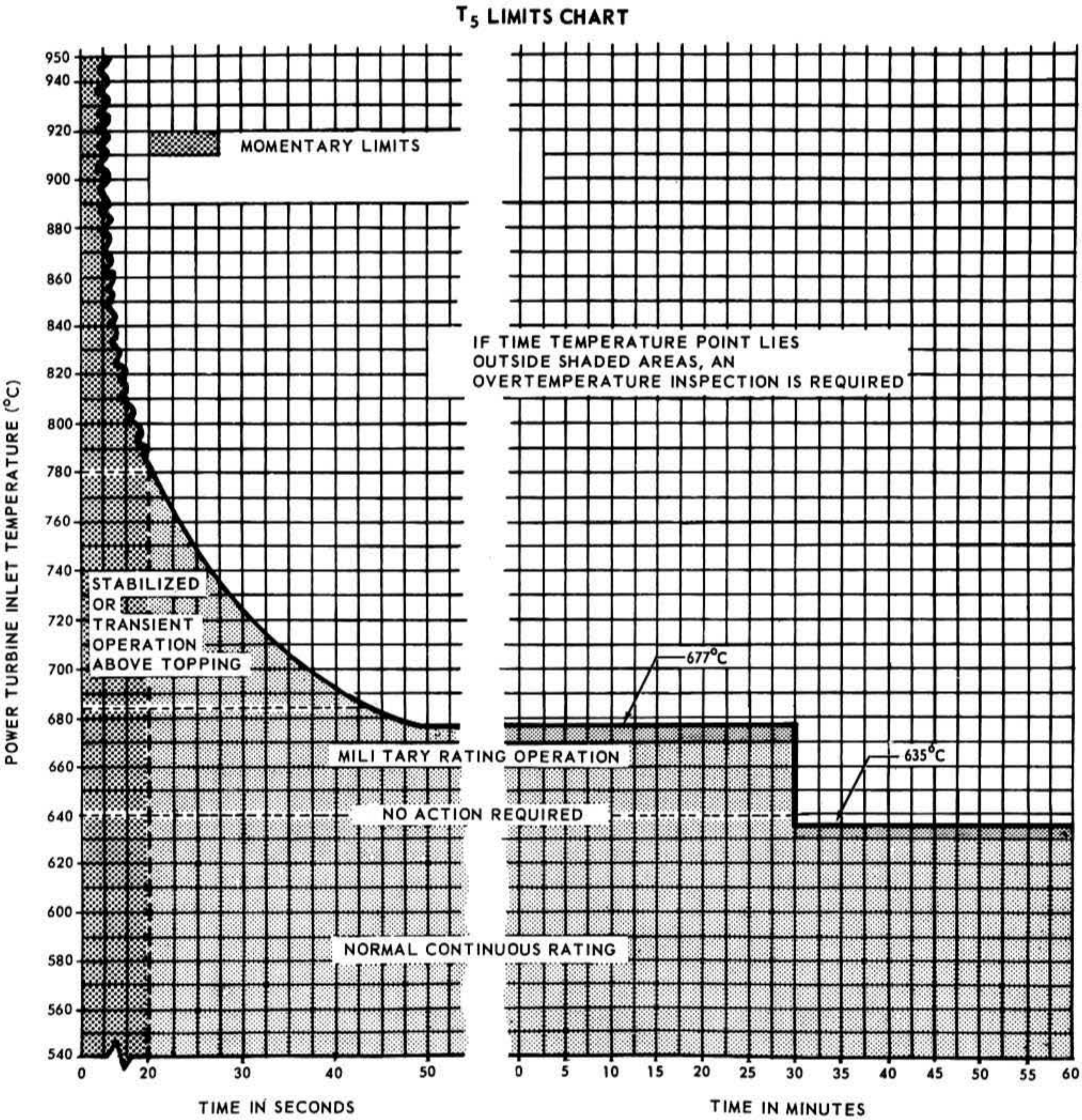


Figure 5-2. T5 Limits Chart

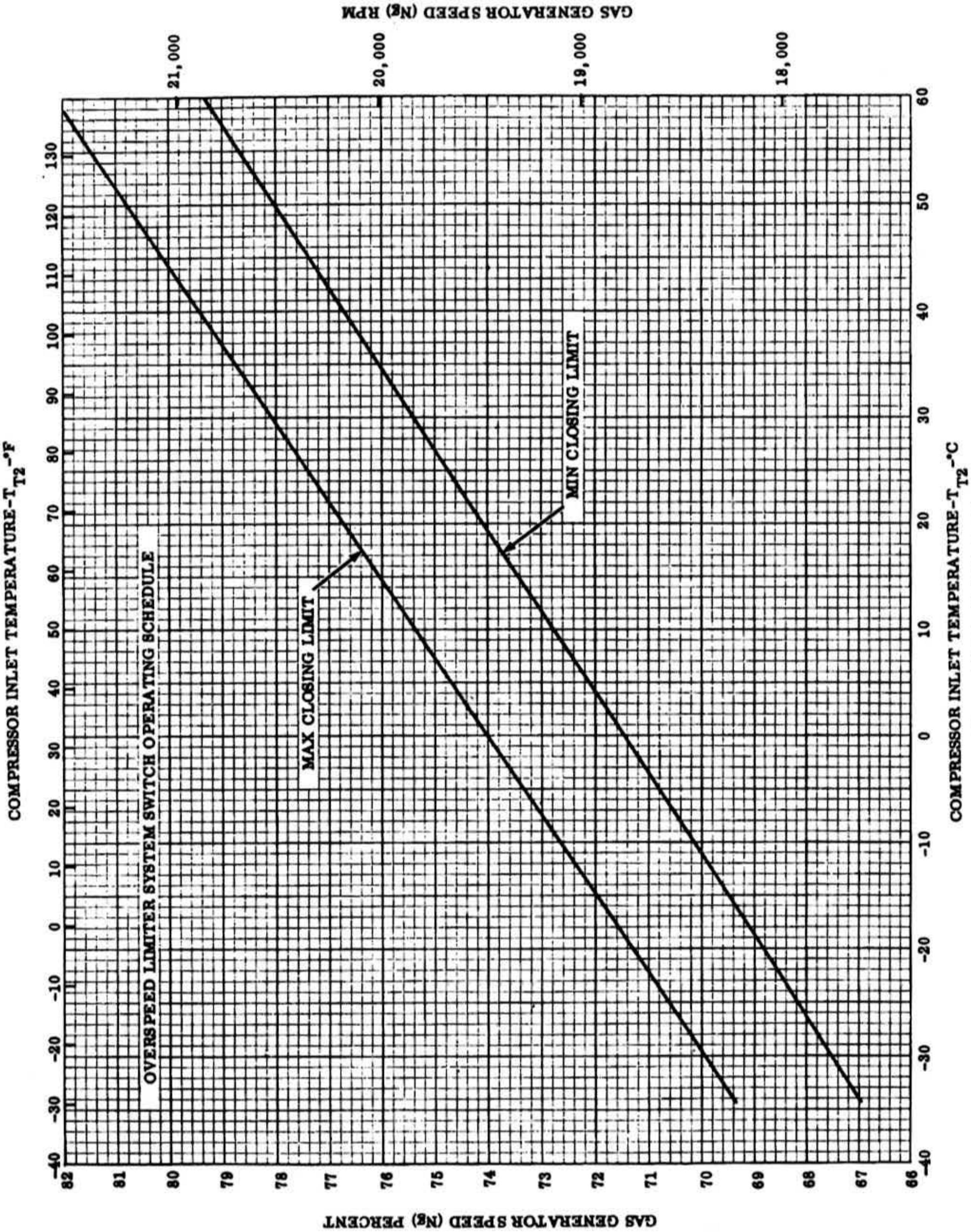


Figure 5-3. Test #1 Limits Chart

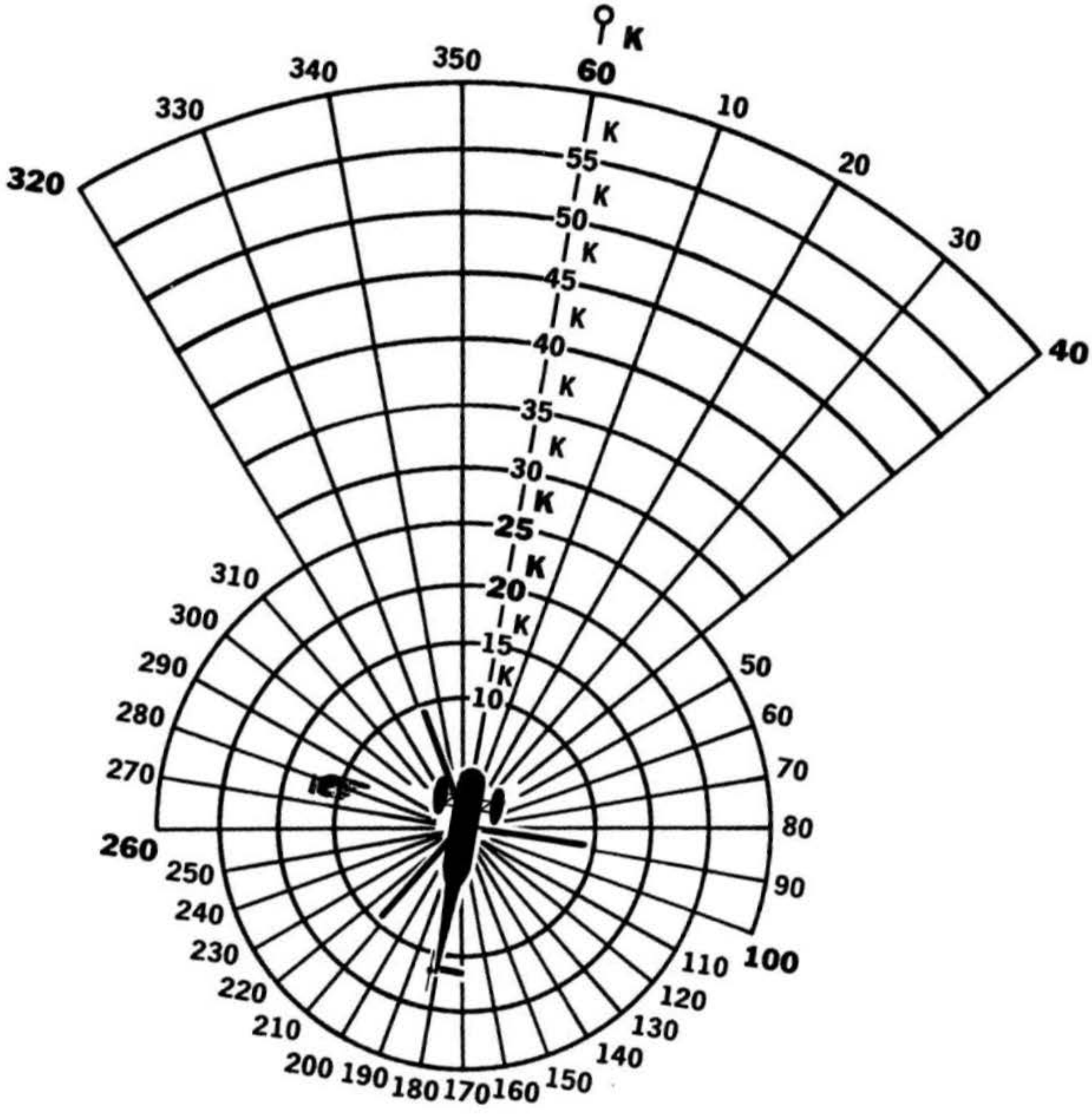


Figure 5-4. Maximum Steady State Wind for Rotor Engagement/Disengagement

ROTOR LIMITATIONS

A rotor overspeed occurs whenever Nr exceeds 110%. Rotor overspeed imposes a severe overload on the rotor system, transmission and components.

NOTE

When an overspeed occurs, the pilot will write up a detailed description, including the highest Nr attained, on the aircraft flight record. The helicopter should not be flown until the special inspection requirements contained in the HH-52A Maintenance Manual are performed.

MANEUVER LIMITATIONS

The helicopter is restricted to normal flying maneuvers. No acrobatics are permitted and flight controls must not be moved abruptly. Hovering turns should not exceed a rate of 360° in 10 seconds. Maximum angles of bank, dependent on airspeed and blade load factors, are determined using blade stall chart, (figure A-36). The maximum angle of bank is 50°.

CENTER OF GRAVITY LIMITATIONS

It is possible to exceed the CG limits if the helicopter is not properly loaded. To determine placement of load for anticipated mission refer to T.O. 1-1B-40 WEIGHT AND BALANCE DATA, HH52A AIRCRAFT. The CG limitations are 249 inches aft of datum for the most forward CG and 262 inches aft of datum for the most aft CG. Datum is 252 inches forward of the main rotor centroid. The takeoff and anticipated landing gross weight should be obtained prior to each mission and determined to be within specified limitations. If a weight and balance clearance form which shows the helicopter to be within limits is not on file, the weight and balance will be computed to determine that the helicopter is within limits.

WEIGHT LIMITATIONS

The maximum gross weight for both takeoff and landing is 8300 pounds.

CAUTION

With high gross weights, beware of the following:

A. Retreating blade stall (figure A-36).

B. Power Settling.

C. During Autorotation:

1. High RPM when the collective is full down.
2. High rate of descent if balanced flight is not maintained.
3. At slow airspeeds, a more rapid flare rate will be required to adequately decrease the rate of descent.
4. Acceleration to high airspeeds will take longer.

LANDING GEAR LIMITATIONS

There are no structural limits affecting the extension or retraction of the landing gear in flight. The maximum run on speed is 43 knots (main landing gear limitation).

MINIMUM FLIGHT CREW

The minimum allowable crew for the operation of the helicopter is one pilot, but a copilot and crewmen may also be carried.

STARTER LIMITS

The starter is limited to 30 seconds at full engine load. Except for emergencies, do not attempt more than three starts in any 30-minute period, allowing a minimum of 3 minutes between each attempt.

SECTION VI
FLIGHT CHARACTERISTICS

TABLE OF CONTENTS

INTRODUCTION

The HH-52A is capable of flight over a speed range of 109 knots forward, 20 knots rearward, and 25 knots sideward. These are limited by the amount of control available with various center of gravity loadings and rotor speeds. While there may be no need for flight other than in the forward direction, it is frequently necessary to hover in crosswinds and tailwinds of the same velocities, as those mentioned above, for sideward and rearward flight. The helicopter is directionally stable in forward flight, but in sideward and rearward flight, directional control is more difficult to maintain, as the nose of the helicopter has a tendency to turn in direction of flight. This is due to the large flat plate area aft of the main rotor shaft. However, there is adequate tail rotor pitch available to accomplish any desired directional maneuvering within the above limits. The automatic stabilization equipment (ASE) improves the helicopter's basic flying qualities and in conjunction with the cyclic stick trim system, is capable of maintaining a desired attitude with minimal assistance from the pilot.

FLIGHT CHARACTERISTICS

The helicopter will always exhibit a tendency to return to trim following a disturbance in pitch, roll or yaw with ASE engaged. Without ASE, any oscillations can be stabilized by the pilot. Due to the forward tilt of the main rotor shaft and the sideward thrust of the anti-torque tail rotor, the HH-52A hovers slightly nose up and left "wing" down. In forward flight, small trim corrections are necessary to compensate for a change in collective pitch setting. As power is increased, the nose tends to rise and a slight right roll is observed. Conversely, as power is reduced, the nose falls slightly and the helo exhibits a slight amount of left roll. In high speed flight, the fixed horizontal stabilizer has a small negative pitch angle to offset the nose down pitching tendency of the helo, giving pitch axis stability and a more favorable nose attitude. After sudden power loss inflight, the rpm will decay rapidly, however it will be regained after lowering collective to minimum pitch providing it has not gone below 77% Nr. There is adequate autorotative rpm for landing, either from flight or a low hover.

FLIGHT CONTROLS

Both the primary servos at the rotor assembly and the auxiliary servos at the mixing unit are in operation at all times. Because of the damping and boost effects of the servo units, control forces are light and constant throughout their full range. This may cause a tendency to over-control, because there is very little feel in operating the cyclic stick unless the cyclic stick trim system is in operation. If either servo system should fail or malfunction, it may be turned off, provided there is hydraulic pressure in the other system. Either servo system may be turned off; however, the switching system prevents securing both systems simultaneously.

CAUTION

Securing primary servo system in flight is prohibited except for emergencies and maintenance testing.

If a primary servo system, which physically controls the lower swashplate, is turned off, movement of the lower controls and swashplate is accomplished through the auxiliary servo system which is in the broom closet near the cockpit controls. In this instance, the feel of control remains almost unchanged except for small differences due to increased friction and lost motion in the control system. A slight one-per-revolution beat may be felt with the primary servos secured. If the auxiliary servo system is turned off, the pilot physically moves the push-pull rods and bell cranks up to the primary servo system. In this instance, a friction augmentation through the ASE is lost. Hydraulic boost to the tail rotor control system is also lost when the auxiliary servo system is turned off. Control force required on the pedals is reduced however, because the pedal damper is depressurized when the auxiliary servo is turned off.

COLLECTIVE MANAGEMENT AFTER POWER OFF (EMERGENCY) LANDING

The aerodynamic characteristics of the main rotor blades are such that proper collective management upon completion of a successful power off landing can greatly reduce the possibility of the tail cone being struck by the main rotor blades after touchdown. The optimum technique calls for smoothly lowering the collective to the full down position after touchdown, while keeping the cyclic in a centered or slightly forward of centered position. If the collective is maintained in the full up position after touchdown, the rotor blades will lose the dynamic stiffness caused by centrifugal force as Nr decays. This will result in one or more of the blades flexing down to an extreme position and striking the tail cone. Conversely, if the collective is rapidly slammed down after touchdown, the blade tips may deflect low enough to strike the tail cone in spite of droop stop protection.

WATER HANDLING CHARACTERISTICS

Due to forward tilt of the main rotor shaft, the HH-52A will tend to taxi forward at a very slow speed. To maintain a position in the water, it is necessary to use aft cyclic and sufficient collective to keep main rotor blades from hitting the droop stops. The helicopter will respond to speed and directional controls in the conventional manner. Since there is less positive roll stability from the sponsons in the water, application of tail rotor control will cause the helicopter to roll in direction opposite the direction of the turn, and it may be necessary to maintain a level roll attitude by application of cyclic in direction of turn. This is primarily due to the roll-lateral coupling caused by the location of the tail rotor above the roll axis of the helicopter, and in part due to centrifugal force tending to roll helicopter to the outside of the turn. Under certain conditions, the HH-52A will experience a nose down or "Tucking" tendency. Tucking can be the result of excessive water speed or incorrect management of cyclic and collective pitch. As the helo is accelerated forward through the water, the drag of the hull provides a pivot point about which the nose will rotate as collective pitch is increased, causing the helo to tuck. For this reason, running maneuvers on the water are not practicable. Tucking may also be experienced with collective application while holding the cyclic forward even with little or no forward speed. As the collective is raised, before the aircraft can leave the surface, the nose sinks lower into the water creating a pivot point about which the helo rotates. In either case, positive lowering of the collective is the desired corrective action. If the tuck is caused by excessive water speed, lowering the collective may be only partially effective because the mass of the decelerating helicopter creates a pitch down force which is independent of collective. However, if the tuck is caused by incorrect management of cyclic and collective, lowering the collective will be totally effective because collective pitch directly controls the magnitude of the pitch down forces. Corrective action must be initiated as soon as the tuck is recognized to prevent blade contact with the water or engine flameout due to water ingestion. Rough water taxiing should be kept to a minimum. Due to wave action and effect of wind, the helicopter will pitch and roll excessively if collective is lowered to the full down position. This pitching and rolling results in the tail rotor coming into close proximity to the water and may result in damage to the tail rotor. Rough water taxiing should be accomplished by utilizing enough collective to keep the aircraft in light contact with the water and using cyclic to resist pitching and rolling tendencies. The helicopter's inherent stability limits may be exceeded in rough water in a power off condition. Use of auxiliary flotation equipment will aid materially in maintaining stability and should be employed as soon as possible after a power off landing. Although the power off helicopter can right itself from a roll up to approximately 16° without aid of auxiliary flotation, a wind of 15 knots or more (creating waves of 2 feet or higher) will probably drive it into the trough of a wave and possibly cause excessive roll. The helicopter is equipped with a sea drogue and Danforth anchor. Either one should be utilized in maintaining heading in relation to waves. These help to keep the helicopter near the point of descent by minimizing drift.

FLIGHT WITH EXTERNAL LOADS

The helicopter 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 which have aerodynamic characteristics may cause oscillations to the extent that the load may strike the rotor blades and/or fuselage. The length of the hookup cable influences the feed back to the helicopter of oscillating forces, the better characteristic being achieved with shorter hookup cables. Oscillations can usually be controlled by slowing the forward speed of the helicopter. The center of gravity of the helo will not be affected adversely since the cargo hook hangs directly beneath the rotor centroid.

HOVERING OUT OF GROUND EFFECT

Careful evaluation of wind direction and consultation of performance charts are extremely important prior to this operation. To enter a hover out of ground effect, approach into the wind and gradually reduce airspeed, maintaining altitude. Control manipulation and power changes must be smooth and precise or the helicopter may inadvertently begin a rate of descent which may lead to power settling. To resume forward flight, slowly lower the nose to attain translation. The pilot must be thoroughly familiar with power settling and its recovery procedure prior to attempting this maneuver.

RETREATING BLADE STALL

Blade stall is most likely to occur when operating with high values of speed, gross weight, density altitude and torque, and with relatively low rotor RPM. Maneuvers, acceleration, or turbulent air which increase the G-load factor also contribute to blade stall, and reduce the airspeed at which blade stall will occur. When any one or a combination of the conditions which contribute to blade stall are present, it will most likely occur when excessive or abrupt control deflections are made. Blade stall occurs initially at the tip of the retreating blade on the left side of the helicopter. The only noticeable effect on the helicopter at this point is a slight increase in the power required. If retreating blade pitch is increased (as with forward cyclic stick), or the forward speed is increased, the stalled portion of the rotor disc is enlarged, and the stall progresses from the tip toward the hub of the retreating blade. Each main rotor blade tip will stall as it retreats through the 9 o'clock position and will create an increase in the general vibration level of the helicopter and possible "kicks" in the flight controls. The retreating blade reaches its lowest point 90° from the point at which lift decreases, thereby causing the tip-path plane of rotation of the main rotor blades to tilt downward toward the rear and causing the nose of the helicopter to pitch upward. This change in attitude greatly increases the angle of attack and accentuates blade stall. The normal control response to overcome pitching, forward application of the cyclic stick, may be ineffective. The uncontrolled pitch-up lasts only for a very short period. Then, full control is restored as airspeed decreases in the nose-high attitude and the excessively high angle of attack no longer exists. To stop the nose pitch-up, especially during turns at critical airspeeds and attitudes, reduce collective pitch, increase rotor speed and ease the nose of the helicopter down with a smooth forward application of the cyclic stick.

Vibrations of the helicopter during high speed flight or when maneuvering at lower speeds caused by blade stall may be reduced or eliminated by accomplishing one or any combination of the following:

1. Decrease collective pitch.
2. Increase rotor rpm.
3. Decrease the severity of the maneuver.
4. Gradually decrease airspeed.
5. Descend to lower altitude.

POWER SETTLING

Power settling is the uncontrollable settling of the helicopter when the main rotor is operating in the "Vortex ring state." In the vortex ring state, air flowing upward near the center of the rotor (due to the descent) and downward through the outer portion (as lift is produced) generates a giant recirculation of air around the rotor resulting in near zero total lift. Application of power which normally stops the descent is ineffective. Instead the rate of descent increases, vibration increases and the controls become ineffective as the vortex ring state is established. Power settling which can occur even though power is available to maintain level flight, is rare. The right combination of rate of descent, low airspeed, and collective pitch setting must be satisfied to induce the vortex ring state. Conditions likely to lead to power settling are typified by a helicopter in a vertical or near vertical descent with relatively low airspeed using power to control the descent. Actual critical conditions depend on rate of descent, gross weight, rotor RPM, density altitude and power applied. Confined area approaches at high elevations are an excellent example of this type of maneuver. In this situation development of power settling could be critical as low altitude may inhibit recovery. Maintaining translational lift during the descent will prevent establishing the vortex ring state. Power settling can be recognized by rotor roughness, loss of control effectiveness, and uncontrollable settling of the aircraft. To recover from power settling, the vortex ring state must be disestablished. Recovery procedures in Section III are listed in the order resulting in least loss of altitude. The vortex rings will be dissipated by abruptly increasing power if down flow can be made to exceed upflow. This may be ineffective if initiated late or if near maximum power is already being applied. An increase in forward speed allows the rotor to meet undisturbed air, breaking the vortex ring state. If those corrective measures are ineffective, the collective must be bottomed to allow all airflow to go upward through the rotor system, restoring controllability. Then forward speed can be increased and power reapplied as translational lift is gained. Power settling should not be confused with the settling which occurs when the helicopter is flown beyond its capabilities as when flying at high density altitude. In this case control response is positive but power required exceeds power available. Nor should power settling be confused with uncontrolled settling resulting from late or insufficient applications of power. In this case control response is positive but there is insufficient power available to stop the descent prior to ground contact. Pilot induced settling through power mismanagement, is likely to result from lack of planning in the approach and failure to maintain a rate of descent within the power available capability.

GROUND RESONANCE

Ground resonance is a self-excited vibration that occurs when a coupling interaction occurs between the movement of the blades and the helicopter. For ground resonance to occur, there must be some abnormal lead/lag blade condition which would dynamically unbalance the rotor, and a reaction between the helicopter and ground which could aggravate and further unbalance the rotor. Ground resonance can be caused by a blade being badly out-of-track, a faulty damper, or a peculiar set of landing conditions. When a wheel reaction occurs, such as a hard one-wheel landing that would cause out-of-phase blades to be aggravated to the point where maximum lead and lag blade displacement is realized, ground resonance may occur. This helicopter does not have a history of ground resonance. For corrective actions see Section III.

PILOT INDUCED COLLECTIVE BOUNCE

Since the flight control servo systems provide "force free" operation of the flight controls, a condition of collective bounce can occur if collective friction is not used. Collective bounce can occur in flight as well as on the ground. Rapid vertical displacement of the helicopter may cause a neutrally balanced, friction free collective pitch lever to move out of phase with the helicopter's vertical motion. The pilot, in an attempt to correct the condition by holding the collective, may inadvertently increase the amplitude of the collective bounce with a possibility of the helicopter's motion becoming divergent. This condition is sometimes referred to as "collective resonance." To preclude collective bounce, some collective friction should be used at all times.

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.

3. Excessive left pedal (only a factor in rollover to the right).

Rotor disc tilt creates a tilting force to the "downhill' side. Excessive left pedal also creates a tilting force to the right due to the high position of the tail rotor. 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. Avoid initiating takeoff with the aircraft tilted more than eight degrees because this is the maximum tilt angle the tip path plane can achieve at flat pitch. Do not preload the tail rotor pedals prior to takeoff from a slope or a ship deck.

HELICOPTER 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 combinations thereof. Many multiples of a basic frequency are felt, and often two or more different superimposed frequencies create beats. The overall magnitude is the resultant of the amplitudes of all the frequencies and it would be difficult for the pilot to completely separate all the types of vibrations encountered. Generally, these are divided into three categories; namely, 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. Any unusual vibrations should be noted on the aircraft Flight Record (CG-4377).

LOW FREQUENCY VIBRATIONS

Vibrations, one, two, or three times the main rotor rpm, may be felt as a strong shake at a relatively low rate being transmitted through the fuselage and/or control stick. The majority of low frequency vibrations, however, are of a one-per-revolution nature.

One Times Main Rotor Speed (One-Per-Revolution)

This vibration emanates from the main rotor system and is generally caused by main rotor head or blade unbalances. It produces a rotary excitation of the fuselage which feels like a lateral oscillatory roll or wallow to the pilot. The most probable causes are:

1. Main rotor blades out-of-track. A blade track adjustment is not warranted even though the blades appear to be slightly out-of-track, if a one-per-revolution vibration is not present.

2. Worn or loose control rod end bearings.

3. Malfunctioning blade dampener.

Ground Roll

This is a one-per-revolution lateral roll of the helicopter which often occurs during rotor engagement, and is due to the in-plane misalignment of the main rotor blades causing an out-of-balance condition in the main rotor system. When the rotor attains flying speed, centrifugal force normally aligns the blades and the vibration disappears. If the vibration continues with the rotor up to speed at flat pitch, but disappears when the helicopter is lifted into a hover, then the cause could be:

1. Static balance of the main rotor blades.

2. Improper servicing of the landing gear struts.

Two Times Main Rotor Speed (Two-Per-Revolution)

This very uncommon vibration, which is recognized as a distinct two times the main rotor speed vibration, emanates from the main rotor system and the most probable causes are:

1. Main rotor blades out-of-track.

2. Worn or loose control rod end bearings.

3. Malfunctioning blade dampeners.

4. Damaged main rotor blades.

Three Times Main Rotor Speed (Three-Per-Revolution)

This most common inherent vibration is caused by the dynamic response of the main rotor blades to unsymmetrical aerodynamic blade loading. Its intensity is greatest at high forward speeds, at low gross weights, and during transition to a hover at high gross weight. It is felt in transition to a hover as a steady vertical shake caused by the main rotor blades traversing the downwash of preceding blades. This is normal to the helicopter when felt at the point where the collective pitch is increased to sustain the hover, or when hover taxiing the helicopter into and out of translational lift. The effect can be reduced during transition to a hover by leveling the helicopter just prior to applying collective pitch, and by planning the approach so that the hover can be attained with a slow rate of final pitch application. At high speeds, the difference in the lift distribution between the advancing and retreating main rotor blades results in heavy vibratory loads on the rotor head as the spanwise center of lift of each blade moves in and out. It is felt as a combination of vertical and lateral shake at the same frequency.

MEDIUM-FREQUENCY VIBRATIONS

These vibrations are easily detected by the pilot and are most often felt in the tail rotor pedals as a one times tail rotor speed vibration (1720 cycles-per-minute at 100% Nr). Generally these vibrations may be caused by an unbalanced tail rotor assembly, misaligned tail rotor drive shaft, improperly torqued intermediate or tail rotor gear box or bad bearings. However, the most frequent cause is lack of proper lubrication.

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, or main gear box input sections, and are often equally apparent on the ground run and in flight. The most important cue, by far, to high-frequency vibration will be the associated sounds.

MAIN GEAR BOX VIBRATIONS

The main gear box contains many possible sources of high frequency vibrations such as the various gear box mounted accessories, the accessory gear train, the oil cooler blower, and the input bevel gear and free wheeling units. These vibrations are generally heard rather than felt. Combinations of these high frequency vibrations in extreme cases could result in the pilot sensing low- or medium-frequency vibrations. These would be detected as vibrations which are affected only by variation in main rotor speed, and may be just as apparent in a ground run as in flight. There are also numerous gear clash sounds that occur under various conditions, the acceptability of which can only be determined by experience or measurements with instrumentation.

ENGINE VIBRATIONS

The engine gas generator and power turbine will normally beat together at various Ng and Nf combinations, or with Nf split off from Nr. To the pilot, the only obvious evidence of excess vibrations will be greatly increased high pitch noise levels. If an excessive noise varies with Ng or Nf changes, then a bad engine bearing or rubbing compressor blades may be indicated. Listen carefully to the noisy engine during shutdown. Any unusual noises or a rapid coast-down time noted during engine coast-down should be entered on CG4377.

SECTION VII
SYSTEM OPERATION

TABLE OF CONTENTS

ENGINE FUEL CONTROL

The power available from the engine is proportional to the gas generator speed (N_g) and power turbine inlet temperature (T_5) relationship. The engine must be operated within the N_g and T_5 limits. The fuel control accomplishes this by maintaining certain scheduled acceleration, deceleration, and steady state limits. Acceleration due to increased power requirements or speed selector movement, is controlled by a maximum fuel flow schedule limit, or by the topping contour in the fuel control. Deceleration due to decreased power requirements or speed selector movement, is controlled by a minimum fuel flow schedule. Selected steady state conditions are maintained at optimum efficiency by a lead-lag servo system which dampens the effect of power transients, and the fuel control power turbine governor which maintains power turbine speed (Nf) within the specified droop limit at full speed selector position.

FUEL CONTROL SCHEDULING

The fuel control does not monitor power turbine inlet temperature (T_5) directly. It monitors compressor discharge pressure and adjusts fuel flow to maintain engine temperatures within safe, predetermined, scheduled limits. The amount of ratio of fuel to be burned, in proportion to the amount of compressor air available for both combustion and cooling, directly determines the temperature of the combustion gases at any point in a turboshaft engine. This ratio is known as weight flow of fuel (W_f) to compressor discharge pressure (P_3) and is used within the fuel control to determine the required fuel flow schedules. Maintenance of a continuous flame within the gas generator combustion system depends on a proper mixture of fuel and air. As performance factors change, the values of both will change. The proportion between the two must be maintained or scheduled within limits or the flame will be lost (blowout or flameout). During deceleration, if fuel flow (which is decreasing) drops below a given amount, a lean blowout due to an insufficient amount of fuel for the air being used may occur. During acceleration, if fuel flow (which is increasing) rises above a given amount, an overtemperature due to an excessive amount of fuel for the air being used may be encountered.

Topping

The engine is considered at topping when operating at maximum gas generator speed. A contour on the 3D cam in the fuel control, acting through an adjustable linkage, prevents gas generator overspeed and overtemperature. There exists a relationship between the operating temperature (T_5) and the gas generator speed (N_g). This temperature/speed relationship is a function of ambient temperature (T_2). The topping contour limits the maximum attainable gas generator speed for various ambient temperatures, and in so doing limits the maximum operating temperature (T_5). The topping contour is therefore a speed control exclusively, indirectly controlling T_5. For operation at maximum power, the gas generator operates near or at the highest possible T_5, except when low ambient temperatures (T_2) are encountered; then the maximum gas generator speed limit is reached first. Since the T-58-8B is a derated engine it is never operated at designed maximum power. Consequently, topping adjustment is not critical in the T-58-8B.

Bottoming

The engine is considered at BOTTOMING during deceleration whenever a minimum fuel (W_f) to compressor discharge pressure (P_3) ratio is attained. The bottoming schedule determines gas generator "IDLE" speed and the minimum W_f/P_3 ratio to sustain normal combustion.

DROOP

Actual power turbine speed varies approximately 8.5% from minimum to maximum load at a given speed selector position in the N_f governing range. This droop characteristic is a design feature incorporated to ensure N_f stability and to provide better load sharing in multiengine installations. A droop of only 3% to 4% is experienced in the HH-52A because the engine is never operated at designed maximum power.

TEMPERATURE LIMITS

The temperature which engine components (particularly turbine buckets and turbine nozzles) can withstand without structural damage, limits the amount of heat energy which should be released by burning fuel. Temperature is controlled by limiting the maximum fuel flow for the prevailing gas generator speed and inlet conditions.

COMPRESSOR STALLS

Stall designates reversals of flow within the compressor. The severity of stall depends upon the number of reversals which take place per second. Specific causes of stalls may be incorrect stator vane operation, fuel control malfunction, or FOD. Compressor stalls may be recognized by any one of a combination of the following: Compressor pulsations felt through the airframe, loud bang, rumbling, or increase in engine noise, inability of N_g to accelerate, N_g decreasing and T_5 increasing. Each compressor has a maximum pressure ratio for every speed at which it operates. The maximum pressure ratio sets a limit on the compressor discharge which can result from rotating the compressor at a particular speed. As long as the pressure at the compressor discharge equals, or is below this limit, the compressor will deliver air smoothly. However, if this limit is exceeded, flow will be reduced and there will be some reverse flow through the compressor. Compressor stall will occur when a number or all of its blades are subject to too high an angle of attack. If it were not for the engine fuel control system and the variable vanes, stall could occur during an attempt to accelerate or decelerate the engine. During acceleration, sudden and excessive increase in fuel flow might generate a volume of gas which would create an excessive back-pressure at the compressor discharge, and compressor stall would result. During deceleration, early closing of the variable vanes would effectively block the airflow through the engine. This could result in a deceleration stall. Stall is avoided automatically by the fuel control and the variable vanes.

FUEL CONTROL OPERATING CONDITIONS

The engine fuel control must schedule fuel flow and variable vane positioning during four general operating conditions. These general operating conditions are: STARTING, IDLE, TRANSITION RANGE, and GOVERNING RANGE. These conditions are related to the various engine speed selector settings.

Starting

During start, as the speed selector is advanced to the ground IDLE position, the stopcock opens and allows fuel to pass through the flow divider and to enter the number one (low pressure) manifold to the nozzles where it is mixed with compressor-discharge air. As the fuel-air mixture leaves the nozzles, it is ignited by the two igniter plugs in the combustion chamber and enters a sustained combustion process. The fuel temperature sensing portion of the flow divider operates in conjunction with an auxiliary metering valve in the fuel control. The auxiliary metering valve is arranged in tandem with the main metering valve in a manner that allows its orifice area to decrease as the orifice area of the main metering valve increases. The lower portion of the flow divider housing contains a bellows that senses fuel temperature to vary the area opening of an attached needle valve. The temperature compensated needle valve and the fuel control auxiliary metering valve are arranged in series with each other and in parallel with the main metering valve. Fuel flow past the auxiliary metering valve is routed to the flow divider needle valve where it is biased by fuel temperature and then ported back to the fuel control to be added to the main flow. As the engine accelerates and fuel flow increases, the auxiliary metering valve will move toward the closed position and will be fully closed at 250 LB/HR flow (Occurs at about Ground Idle). At this point the temperature compensating system is eliminated and total fuel is metered by the main system.

Light-Off

The instant that the fuel-air mixture in the combustion section ignites is termed light-off. Light-off should occur within 15 seconds after advancing the speed selector to ground idle. Observing T_5 and N_g at light-off enables the pilot to identify an abnormal start and take appropriate action if necessary. A normal start is characterized by T_5 remaining below 700°C accompanied by smooth, steady, acceleration of N_g to ground idle. If the fuel-air ratio during start is lean or rich, T_5 and N_g response will be abnormal. Too lean a fuel-air mixture will cause a cold hangup and too rich a mixture will cause a hot start. Hot starts and cold hangups are abnormal engine conditions. They provide an early indication that the engine and fuel control combination are not operating properly.

Cold Hangup

During a start, fuel flow scheduling malfunctions or other conditions, although not affecting engine light-off capabilities, may cause the engine gas generator speed (N_g) to accelerate to normal idle speed. Cold hangup can be identified by slow N_g acceleration, hanging up at approximately 30%-50% with T_5 between 350°-400°C. The emergency throttle may be utilized after light-off to bypass the automatic features of the fuel control and provide manual scheduling of fuel by the pilot for engine acceleration to the idle range. Possible causes of a cold hangup are:

1. Fuel boost pumps not on.
2. Fuel control malfunction.
3. Improper fuel density settings.
4. P_3 system leak or P_3 valve open.
5. Flow divider malfunction.

Hot Start

A hot start is defined as a temperature (T_5) that rises abnormally fast, or above that normally expected. If a hot start is evident, the start must be aborted before T_5 rises above 700°C. If a hot start has been experienced, record maximum T_5, OAT, N_g when S/S advanced to ground idle, and type of start on the aircraft maintenance form.

Hot start may be caused by one or a combinations of the following:

1. Weak battery.
2. Malfunction of fuel control system.
3. Hot ambient temperatures.
4. Hot engine.
5. Fuel change/fuel control/flow divider set wrong.
6. High density altitude.
7. Malfunctioning starter.
8. Wind blowing up the exhaust.
9. Clogged combustion drain.
10. Improper starting procedure.

Idle

Engine idle is a stable gas generator speed of 56 ± 3%. This condition exists in either the GROUND IDLE or FLIGHT IDLE positions of the speed selector.

Transition Range

The transition range is that range of engine operation between idle and minimum governing range. As the speed selector is advanced from FLIGHT IDLE, T_5 will advance fairly rapidly as the fuel flow/compressor-discharge pressure (W_f/P_3) ratio increases until it is limited by the fuel control. At minimum N_f governing, the fuel control will decrease the fuel flow/compressor-discharge pressure

(W_f/P_3) ratio, lowering T_5, until a new steady-state operation is attained. During this time, N_g should show a steady increase.

NOTE

Prolonged operation of the engine in the transition range is not recommended.

Nf Governing Range

At speed selector settings above 85% N_f, the N_f governor, which is driven by the power turbine flexible drive shaft, becomes the primary parameter affecting fuel flow. Accordingly, the N_f governor, by sensing power turbine speed, is able to maintain the power turbine/rotor speed selected by the pilot. The engine fuel control maintains selected power turbine speed by varying gas generator speed as power requirements change.

INCREASING ENGINE LOAD

Increasing collective pitch tends to slow the main rotor and the power turbine. The N_f governor senses an underspeed condition and causes the fuel control to increase gas generator output. During gas generator acceleration, maximum fuel flow is delivered to the engine, with the rate of increase limited by cam contours to avoid compressor stall, rich or lean blowout, or turbine overtemperature. When the gas generator output power has matched the new load, fuel flow decreases to the level necessary to maintain the new load at the selected speed.

DECREASING ENGINE LOAD

Decreasing collective pitch tends to increase main rotor/power turbine speed. The N_f governor senses an overspeed condition and causes the fuel control to decrease gas generator output. During gas generator deceleration the engine fuel control supplies the minimum fuel flow which will maintain combustion until the gas generator approaches the speed which will match output power to the new load. The engine fuel control then supplies the fuel flow necessary to maintain selected N_f.

EMERGENCY THROTTLE

The main metering valve is normally positioned automatically by components of the fuel control to perform fuel flow scheduling and N_f governing functions. These functions can also be performed manually by the pilot using the emergency throttle. The emergency throttle is mechanically linked to the main metering valve in such a way that it can increase the main metering valve opening demanded by automatic components of the fuel control, but cannot reduce it. Therefore, the speed selector must be in flight idle before the pilot can exercise complete control of the engine with the emergency throttle. The stator vane actuating system continues to function but the automatic fuel scheduling parameters which prevent overtemps, lean blowouts and compressor stalls are bypassed when operating on emergency throttle.

FUEL SYSTEM

See figure 1-15.

FUEL SYSTEM MANAGEMENT

The operation of the fuel system is automatic. Fuel is supplied to the engine from the forward tank only and an ejector type fuel transfer system automatically transfers fuel from the aft tank to the forward tank whenever either or both fuel booster pumps are operating. Overflow of the forward tank is prevented by a float valve which interrupts the transfer of fuel from the aft tank when the forward tank is full. If both boost pumps fail, the system will not transfer fuel from the aft tank. Any fuel remaining in the aft tank will be unusable.

WARNING

If dual boost pump failure occurs, the engine-driven pump must draw fuel from the tank up to the engine. Use of high power settings will help prevent loss of suction. Since the fuel system is unable to transfer fuel from the aft tank to the forward tank, the engine will flame out when the forward tank is emptied. For this reason, the Fuel Quantity Gage is kept in the FWD position in flight so that the fuel quantity of the tank feeding the engine will be displayed.

Fuel	Fuel Control Setting	Flow Divider Setting	Type of Start to Expect
JP-4	4	4	Normal
JP-4	4	5	Hot Start
JP-4	5	4	Cold Hangup tendency
JP-4	5	5	Hot Start
JP-5	5	5	Normal
JP-5	4	5	Hot Start tendency
JP-5	5	4	Cold Hangup
JP-5	4	4	Cold Hangup

Figure 7-1. Fuel, Fuel Control, and Flow Divider Settings VS Start to Expect Chart

MIXING OF FUELS

The mixing of fuels is not recommended because of problems encountered with starts. Figure 7-1 shows the types of starts that may be expected with various combinations of fuel, fuel control settings, and flow divider settings. After using JP-5 and refueling with JP-4, in the initial start with no changes to the fuel control or flow divider, a normal start will result because of JP-5 fuel in the lines. Subsequent starts may go hot unless the settings are changed. With a mix of JP-4 and JP-5 in the lines, the type of start to expect may be determined by interpolating the results listed in figure 7-1.

POWER TURBINE OVERSPEED SYSTEM

The power turbine overspeed system functions automatically, when the flex shaft is intact, to prevent destructive overspeed of the power turbine. Without this system the power turbine could disintegrate if the engine load were suddenly removed or reduced to a vary low level, such as, failure of power turbine drive shaft or failure of the transmission input section. A pilot-induced overspeed caused by misapplication of emergency throttle will also actuate the system. When the power turbine governor in the fuel control senses a power turbine speed of 122%, the overspeed shutoff valve closes, stopping all fuel flow to the engine. The engine then flames out. It may relight when power turbine speed falls below 122% if the combustion or turbine sections are hot enough to provide a source of ignition and if the fuel/air ratio is favorable.

ROTOR OVERSPEED SYSTEM

See figure 1-7.

The rotor overspeed system protects the main rotor from destructive overspeeds by an automatic power reduction when rotor speed reaches 110%. The power reduction is accomplished by bleeding to the atmosphere, the compressor discharge pressure (P_3) signal sensed by the fuel control. The fuel control immediately schedules a greatly reduced fuel flow appropriate to the false signal now received from the compressor and engine power is drastically reduced. Engine power is restored when rotor speed falls below 110%.

NOTE

The rotor overspeed system offers no protection against overspeeds resulting from mismanagement of emergency throttle.

NORMAL OPERATION

Rotor speed is sensed by the centrifugally actuated rotor speed switch mounted on the main transmission. At 110%, a set of electrical contacts in the rotor speed switch close, energizing the P_3 solenoid valve. The solenoid valve opens when energized, bleeding the compressor discharge pressure signal to atmosphere. The stator vane actuator switch, which responds to gas generator speed, breaks the circuit to the solenoid valve when the gas generator speed drops to about 75%. If rotor speed remains above 110% for a sustained period, gas generator speed will oscillate about 75% due to the action of the stator vane actuator switch. When rotor speed falls below 110%, the electrical contacts in the rotor speed switch open, de-energizing the solenoid valve and restoring full engine power.

ROTOR OVERSPEED TEST

A switch marked ENG OVSPD TEST has been incorporated in the rotor overspeed system to permit a functional check of Test NO. 1 by the pilot at rotor speeds within the normal operating range. The 110% overspeed contacts are tested by maintenance personnel.

Test NO. 1

Placing the ENG OVSPD TEST switch in the NO. 1 position allows the pilot to check the functioning of the stator vane actuator switch and the solenoid valve. When the speed selector is advanced from the flight idle position, gas generator speed increases until the stator vane actuator switch closes at the value obtained from figure 5-3 (normally about 75%). Gas generator speed then drops, opening the stator vane actuator switch, which will stop bleeding P_3. Gas generator speed will oscillate with the upper end of speed range at the value obtained from figure 5-3 until the ENG OVSPD TEST switch is moved to NORMAL or the speed selector is retarded.

SECTION VIII
CREW DUTIES

TABLE OF CONTENTS

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. The minimum allowable crew for the operation of the helicopter is one pilot. A copilot and/or a flight mechanic may also be carried.

PILOT IN COMMAND

The pilot in command is responsible for the safe and orderly conduct of the flight. His responsibility and authority exist from the time he enters the aircraft preparatory to flight until he leaves it upon completion of the flight or mission. He shall be responsible for insuring that his crew and passengers are properly briefed. Responsibility for all phases of the flight rests with the pilot in command. The pilot in command shall perform the duties of copilot in flight while not operating the flight controls.

COPILOT

The copilot's duty is to assist the pilot. His general duties are:

1. Act as safety pilot.

2. Monitor aircraft instruments.

3. Operate communication and navigation equipment.

4. Navigate.

5. Make required reports in normal and emergency situations.

6. Ensure that he receives an adequate briefing from the pilot for and during the flight and to question anything he fails to understand.

AIRCREWMAN

The aircrewman's duties include but are not limited to the following:

1. Brief passengers on aircraft emergency procedures, emergency exits, and survival equipment as directed by the pilot.

2. Check the helicopter for fumes and leaks inflight.

3. Perform lookout duties as directed.

4. Monitor communications radios.

5. Insure the safety and comfort of the passengers.

FLIGHT MECHANIC

The flight mechanic's duties include those of an aircrewman plus the following:

1. Perform the hoist check.

2. Perform hoisting and rescue platform recoveries as directed.

3. Perform cargo sling operations as directed.

INSTRUMENT APPROACH OPERATIONS

PILOT DUTIES

Prior to commencing an instrument approach the pilot will brief the copilot and the flight mechanic on the particulars of the approach. The brief will include as a minimum the following items when they apply.

1. The type of approach and the frequencies of the navigation aids to be used during the approach.

2. The courses to be set in the course display windows.

3. Approach minimums.

4. Minimum altitudes for each phase of the approach.

5. Missed approach timing.

6. Missed approach procedures.

7. Designation of the pilot to handle communications.

8. Designation of the pilot to monitor the navigation aid used for the approach.

9. Procedures to be followed after the safety pilot is visual.

10. Type of subsequent approach and intentions.

COPILOT DUTIES

1. Perform general copilot's duties.

2. Provide the pilot with heading and altitude information from the approach plate.

3. Start and stop the clock.

4. Advise the pilot 100 feet prior to, and reaching all minimum altitudes.

5. Report when visual reference is established.

FLIGHT MECHANIC DUTIES

1. Look out for other aircraft during periods of visual meteorological conditions.

BEEP TO A HOVER

PILOT DUTIES

The following is a minimum list of items on which the pilot must brief the crew prior to commencing a BEEP TO A HOVER.

1. Procedures to be used (full pattern or straight-in).

2. Beep heading.

3. Time from rollout on heading to the gate.

4. Special instructions to copilot and aircrewman.

COPILOT DUTIES

1. Perform general copilot's duties.

2. Perform safety pilot duties (SECTION IX, Beep To A Hover).

CREWMEN DUTIES

1. As briefed by the pilot.

PASSENGER BRIEFING

The pilot in command shall insure that all passengers embarked receive an adequate briefing. This briefing shall encompass at least the following:

1. Use of parachutes (if carried).

2. Use of lifejackets (if flight over water).

3. Applicable alerting signals in event of an emergency.

4. Action required in case of ditching or crash landing.

5. Emergency exits.

6. Use of other emergency equipment.

7. No smoking and seat belt rules.

SAFETY DEVICES

The safety belt and shoulder harness (if provided) of each occupant shall be fastened properly from prior to takeoff until subsequent to landing, 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. Crew members engaged in activity near an open hatch while airborne shall wear a properly attached safety harness.

SECTION IX
ALL WEATHER OPERATION

TABLE OF CONTENTS

INTRODUCTION

This section contains only those procedures that differ from or are in addition to the normal operating procedures outlined in Section II except where repetition is necessary for emphasis, clarity, or continuity of thought.

NIGHT PROCEDURES

Night flying procedures do not differ from daylight procedures in the HH52A. However, additional considerations include preflighting all lights, use of a taxi director with lighted wands, and knowledge of operating areas, etc. For HH52A aircraft an operative ASE system and an operative radalt are required for night flight. Only in matters of life or death may Commanding Officers waive this provision. This is not intended to prevent pilots from practicing basic maneuvers at night with the ASE intentionally secured. The use of trim release at night is a matter of pilot technique, however, the trim release should be used only when the pilot has good visual reference.

Pilot requirements are found in COMDTINST M3710.1.

INSTRUMENT FLIGHT PROCEDURES

The HH52A exhibits excellent basic instrument flight characteristics with ASE operating. However, backup capability in the communications-navigation equipment is lacking, and only engine anti-icing equipment is provided. Compliance with the following rules is therefore mandatory:

1. An operating ASE system and radalt are required for instrument flight. Only in matters of life or death may a commanding officer waive this provision.

2. Flight into known icing conditions is prohibited.

3. Pilot requirements are listed in COMDTINST M3710.1.

4. The VGI is adjusted during the NORMAL PROCEDURES INSTRUMENT CHECK, and is not readjusted during flight.

5. The Trim Release will not be used during instrument flight.

INSTRUMENT TAKEOFF

General

The purpose of this maneuver is to transition to a 55 knot climb under conditions where positive visual contact with the surface cannot be maintained, such as over water at night.

Procedure

1. Prior to commencing the Instrument Takeoff (ITO), accomplish the following:

   a. Brief Safety Pilot.

b. Before Takeoff Check.

c. Feet flat on the deck.

NOTE

If the ITO is commenced from the level ground, preload the tail rotor by applying left pedal until 30 to 35% Q, then place feet flat on the deck.

2. Initiate a smooth application of collective to 95 - 100% torque, maintain a nose on the horizon, wings level attitude by overriding cyclic trim as necessary. Once a positive rate of climb has been established and when passing 40 to 60 feet on the RADALT, override pitch and lateral trim to attain an accelerating attitude of 0 to 3 degrees nose down. Keep the wings level. Approaching 55 knots, trim to maintain a 55 knot climb.

CAUTION

The yaw heading retention feature of the ASE may not hold. Close monitoring of the heading during the initial phase of the ITO is required.

INSTRUMENT CLIMB

Climb from takeoff to 1000 feet AGL at 95 percent torque and 55 knots. Above 1000 feet AGL, increase climb speed to 70 knots. 100% torque may be used if necessary to avoid terrain. Limit torque settings above 96% to 5 minutes duration. For short duration climbs during cruise, increase collective to obtain desired climb rate while maintaining cruise airspeed.

INSTRUMENT CRUISE

Cruise speed is at the discretion of the pilot.

HOLDING

Holding for short periods will be at cruise RPM. Holding for long periods or when fuel is critical will be at 96% Nf/Nr and 55 knots.

DESCENT

Descents are made at cruise airspeeds.

INSTRUMENT APPROACHES

Use standard instrument approach procedures. Approach airspeeds are at the discretion of the pilot.

The BEFORE LANDING CHECK will be accomplished as follows:

1. On GCA and ASR — when directed to "PERFORM COCKPIT CHECK".

2. On ILS, VOR, TACAN, ADF and LF — prior to final approach fix.

MISSED APPROACH PROCEDURE

At any time the approach appears unsafe or if the field is not in sight at approach minimums, the pilot should announce GO AROUND on the ICS, increase torque to 95% and establish a climb at 55 to 70 knots.

BEEP TO A HOVER APPROACH

GENERAL

A Beep to a Hover Approach shall be used to transition to a hover under conditions where positive visual contact with the surface cannot be established by 140 feet. The BEEP provides positive control of the descent and will preclude flying into the surface.

CAUTION

A beep should not be attempted if the aircraft cannot hover out of ground effect, as determined by performance data.

PROCEDURE

When stabilized in level flight at 55 knots and prior to crossing datum:

1. Conduct the BEFORE LANDING CHECK.

2. Conduct instrument crosscheck:

a. Nf/Nr — RECHECKED.

b. Airspeed 55 knots — RECHECKED.

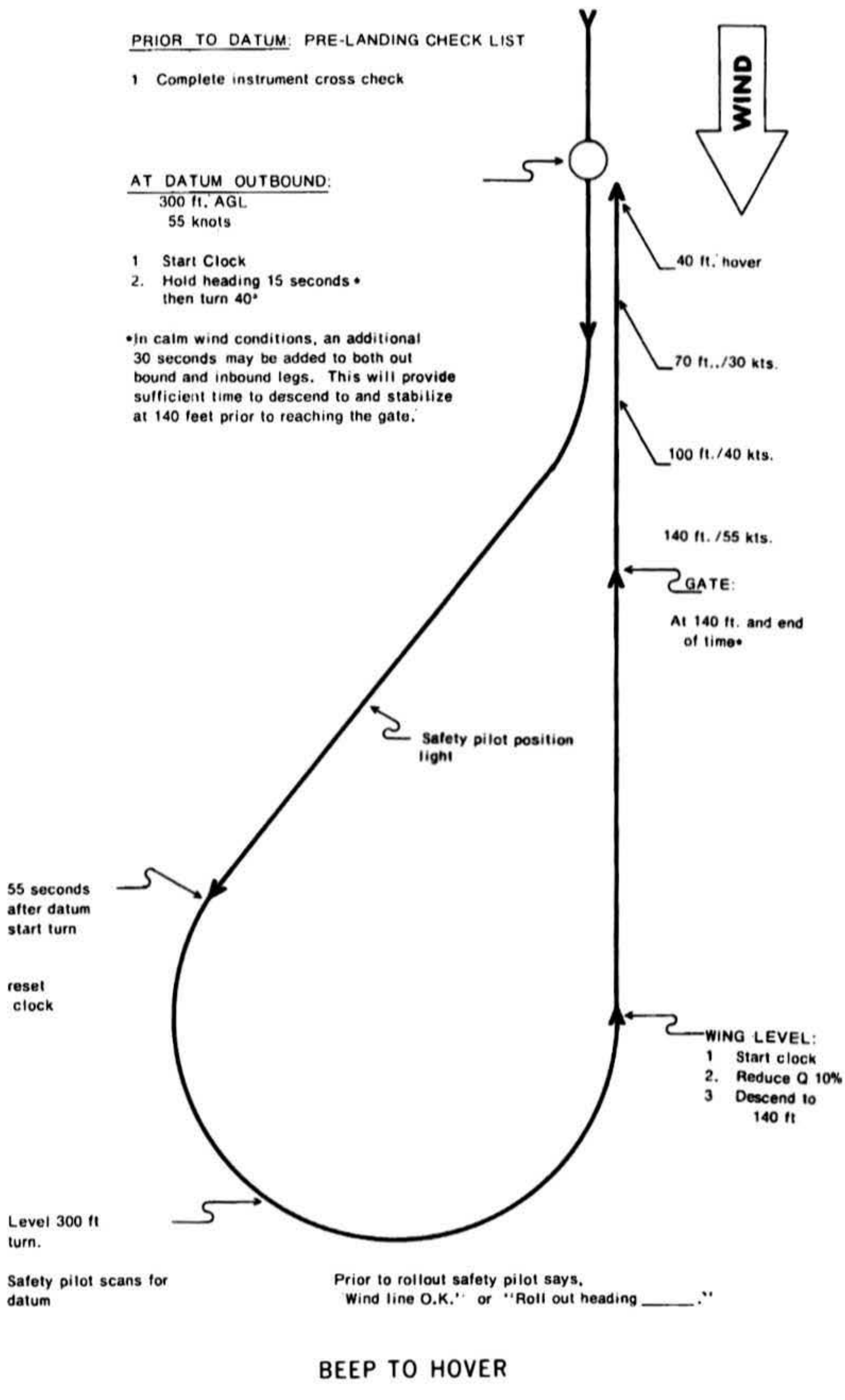


Figure 9-1. Beep to Hover

c. VGI — CHECKED.

d. Radalt — CHECK AND SET BOTH BUGS TO 40 FEET.

e. Torque — CHECKED AND NOTED.

f. Flight director — SET CG TRIM HORIZONTAL BAR BETWEEN CENTER INDEX AND TWO UNITS BELOW CENTER INDEX.

g. MA-1 compass — CROSSCHECK WITH WET COMPASS.

h. Altimeter — CHECK AND COMPARE WITH RADALT.

i. Clock — RESET.

j. VSI — CHECKED.

BEEP PATTERN

NOTE

The pilot in control is called the pilot. The other pilot is the safety pilot.

1. Establish 300 feet and 55 knots.

2. Passing over datum on a downwind heading start the clock.

3. 15 seconds (45 seconds if using the calm wind option) past datum, initiate a standard rate turn of 40° — normally toward the pilot's side of the aircraft.

4. Safety pilot, with the acquiescence of the pilot, positions the controllable landing light for use by the safety pilot.

5. 55 seconds (1 minute, 25 seconds if using the calm-wind option) after passing datum, initiate a standard rate turn in the opposite direction from the initial turn. Reset the clock.

6. The safety pilot scans to the inside of the turn and estimates the heading to bring the helicopter back to datum. He advises the pilot "Wind line okay" or "Roll out heading ________."

7. After roll out on heading place feet flat on deck, restart clock and make an immediate torque reduction.

8. Start immediate descent to 140 feet using approximately 10% less torque than required for 55 knot cruise.

WARNING

If the rate of descent exceeds 400 feet-per-minute any time during this maneuver, execute a go around.

9. Turn on lights at pilot's discretion.

10. Safety pilot monitors descent and warns pilot when passing 180 feet.

11. Level off and stabilize at 140 feet.

12. Safety pilot continues to monitor radar altitude while scanning outside.

13. The gate for commencing the Beep to Hover is reached 30 seconds after restarting the clock in calm winds (60 seconds if using calm wind option). An additional 15 seconds must be added for each 5 knots of wind.

14. Arriving at the gate, commence the beep to hover. Begin decreasing torque to approximately 10%-15% less than that required for 55 knots cruise and begin to beep the nose up toward 6°. Vary the rate of beep to arrive at these check points.

Altitude	Airspeed (KIAS)
140	55
100	40
70	30

WARNING

Do not lower collective to correct errors in altitude/airspeed relationships as dangerous rates of descent can develop.

This attitude power combination will cause a gradual deceleration and a descent of 100 to 150 feet-per-minute. After commencing the beep to a hover from the gate, control inputs are made with the BEEPER TRIM button, using short beeps and very small collective changes. Heading control is left entirely with the ASE heading retention feature.

WARNING

If during the beep to a hover the helicopter attitude exceeds 12° nose-up, 5° nose-down, or 6° roll, level the helicopter and execute an instrument takeoff.

15. Safety pilot warns pilot when passing 60 feet.

16. At approximately 60 feet, begin increasing collective, predicated on rate of RADALT needle movement, to control the descent and establish a hover of 40 feet. The nose will pitch up proportionate to the amount and rate of collective application. In wind conditions less than 10 knots, the flight characteristics of the helicopter will cause it to assume a hover attitude when hovering airspeed is reached. In winds greater than 10 knots, the pilot should assume a hover attitude when airspeed drops to a value equal to existing wind velocity.

17. The safety pilot scans outside to gain visual reference for hovering. If he acquires sufficient visual references he calls "I'm visual."

18. The pilot passes control to the safety pilot.

19. When the safety pilot acknowledges control, the pilot shifts his scan outside and acquires visual reference. When he has visual reference well established the pilot states "I'm visual" and control is returned to the pilot.

CAUTION

Before transitioning to visual flight, pilots must be absolutely sure that they do not merely see the surface but rather that they see enough to give them good reference for control of the helicopter.

20. In event the safety pilot does not acquire satisfactory visual contact within 10 seconds of establishing a hover, the pilot may start a very gradual descent to 30 feet radar altitude (after advising the safety pilot of his intention).

21. If visual reference is not established at 30 feet, execute an instrument takeoff.

CAUTION

Once the safety pilot has established a hover, the pilot should not move the landing light to light his side of the aircraft until he has adequate references for hovering.

STRAIGHT-IN BEEP PATTERN

During periods of good visibility the pilot may elect to abbreviate the Beep to a Hover approach by flying a straight-in pattern.

Procedure

1. Conduct Before Landing Check and Instrument crosscheck no lower than 300 feet AGL.

2. Position aircraft directly downwind from datum at 300 feet AGL and 55 knots.

3. Commence descent to 140 feet AGL as outlined in steps 8 through 12 of the beep pattern.

4. Safety pilot visually estimates gate position and directs the pilot to commence the beep.

5. Complete the maneuver as outlined in steps 14 through 20 of the beep pattern.

COLD WEATHER OPERATIONS

GENERAL

Helicopter operations in cold weather present various problems depending on: The base of operation, temperature, wind, precipitation, and surface condition. Maintenance work that is easily accomplished in warm conditions becomes extremely difficult to perform in remote areas with limited equipment and cold temperatures.

Cold is the real enemy. As the temperature drops more precautions are required. Cold brings physical hazards to the crew and limits their abilities. Extremely cold fluids such as fuel and oil may cause frostbite if spilled on exposed flesh. Static electricity builds very rapidly in cold, dry air. The parts of the helicopter that seem to be most susceptible to failure in cold weather are lubricated shafts and bearings, e.g. ground inverter and electronics equipment, and rubber seals, e.g. in the auxiliary servos. Moisture, usually from condensation or melted ice, may freeze in critical areas. Pressures of the tire, landing gear strut, fire extinguisher bottle, and accumulators will decrease as the temperature decreases.

When deploying to a remote area, a battery that has recently been deep cycled will provide maximum performance. An extra battery connected in parallel with the installed battery may also be carried. Anticipate hot starts and cold hangups. A spare igniter plug may be carried for the heater. If a spare is not available, the crewman can remove and clean the plug if it fouls. At low temperatures, at least 15 minutes will be required to adequately warm up the systems. Wind may be the result of rotor wash or natural forces but in either case it increases the rate of heat losses. Consequently, the time that personnel are exposed must be kept to a minimum. The exact effects of wind chill to helicopter components cannot be predicted but it will cause cooling at a more rapid rate. Wind may also cause restricted visibility by blowing snow.

When hovering in loose or powdery conditions all ground references may be lost. Therefore, when possible, avoid areas of loose or powdery snow for takeoffs and landings. When this is not possible and conditions permit, a no-hover takeoff or landing will keep the blowing snow aft of the cockpit. If a no-hover takeoff is not practical, an instrument takeoff may be warranted. If a no-hover landing is not advisable it may be possible to sweep the landing area with rotor wash. To do this, air taxi over area at a speed just fast enough to keep the blowing snow aft of the cockpit, continue until the loose snow has been blown away.

Precipitation adversely affects both flight and ground operations. Flight into known icing conditions is prohibited. Ice and snow accumulations on the windshield and canopy may be ingested into the engine causing engine failure. Any precautions that protect the helicopter from accumulating ice or snow after shutdown will greatly simplify preparations for the next flight.

Although other surface conditions may be encountered, ice and snow covered surfaces are generally associated with cold weather operations. Ice chocks are recommended for operation on ice or snow covered surfaces. During ground operations involving torque changes, ensure that personnel and equipment are well clear as slewing of the helicopter may occur. If conditions are extremely slippery, the pilot may delay the over speed system checks. Loose powdery snow and crusts (surface or hidden) should be anticipated on all landings on snow. Snow depth is less in clear areas where there is little or no drift effect. Landings should be made only to surfaces of known characteristics. If it is necessary to land on an unfamiliar snow covered surface, competent personnel should physically check snow depth, hardness, and hidden obstructions before landing. After contacting the surface, slowly reduce collective pitch until the wheels come to rest on a level plane or the bottom of the fuselage comes to rest on the surface. This will prevent any serious consequences if one wheel should hang up or break through a crust of snow. Make smooth power changes when the fuselage is resting on the surface. Providing there are no obstructions, the tail rotor will be clear when the fuselage rests on a level surface or a nose low attitude is maintained. Except in an emergency, never reduce rpm until it is positively determined that the helicopter will not settle. Be alert for a warm fuselage melting the snow adjacent to it and subsequently refreezing to the surface.

WARNING

Main and tail rotor ground clearances are reduced with the helicopter resting on the fuselage. Therefore, personnel entering or leaving the helicopter should exercise extreme caution to preclude being struck by the blades.

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 should be free of all ice and snow. Check that fuel tank vents, heater vents, and pitot tube (including static ports) are free of snow and ice; that landing gear struts and tires are properly inflated; and that a well charged battery has been installed. Check the engine for ice and snow. If ice and snow is found, the engine must be thawed out with hot air prior to attempting a start.

CAUTION

Conduct a thorough inspection of rubber boots on rotor head and primary servo pilot valves to insure no moisture is present which may freeze in flight and cause control malfunctions.

MAIN ROTOR BLADES DE-ICING

To remove ice from rotor blades, use anti-icing and defrosting fluid MIL-D-8243 heated to 180°F and applied in a small stream under pressure. Be particularly alert for ice frozen in blade tip caps, which could create a lateral imbalance.

CAUTION

Ice should not be chipped from blade surfaces due to danger of damage to blades. Even minor scratches are stress risers and could lead to cracks. Portable ground heaters or de-icing fluid may be used to remove an accumulation that cannot be swept off. Do not de-ice windows with de-icing fluid, alcohol, or other materials that can soften plastic. Never use de-icing fluid containing methyl-alcohol. Methyl-alcohol deteriorates the main rotor blade pocket to spar bonding material.

PREHEAT INSTRUCTIONS

If main transmission oil temperature is below −15°C it must be preheated prior to engagement to prevent damage. No preheat is required for the intermediate and tail rotor gear boxes.

NOTE

In an emergency situation, when no preheat equipment is available, engagement may be accomplished in temperatures down to −28°C.

To preheat proceed as follows:

1. Install a heavy canvas cloth or equivalent over the main transmission area. A 24-foot cargo chute, split at 120° intervals with Velcro tape sewn to the splits makes an excellent barrier. When draped over main rotor head, the chute will cover the engine compartment, transmission and oil cooler.

2. Lower the left transmission service platform, keeping all other transmission service platform and access panels closed.

3. Utilizing a 200,000 BTU heater or equivalent, with 7-inch ducts, direct heat to the main gear box input section to insure lubrication of the input sleeve bearings and heat to the oil cooler.

NOTE

The transmission oil temperature gage operates on 28 volts dc from the dc essential bus.

4. The following table is representative of preheat time utilizing the 24-foot cargo chute cover and 200,000 BTU preheat source.

Ambient Temperature	Time Duration	Preheated Temperature
−30°C	20 minutes	+15°C
−40°C	30 minutes	+ 8°C

TABLE OF MAIN GEAR BOX WARMUP AND COOLING RATES

Warmup data is based on the time required at 100% Nf/Nr and flat pitch to raise the transmission oil temperature to +40°C.

Ambient Temperature	Preheated MGB	Time
−30°C	0°C	10 minutes
−15°C	−15°C	10 minutes
−30°C	+15°C	6 minutes
−40°C	+ 8°C	9 minutes

Cool down data is based on time required for transmission oil temperature to cool from 79° to 0°C.

Ambient Temperature	25 kt Wind/No Wind
—15°C	3.0 hours/5.5 hours
—23°C	1.8 hours/3.0 hours
—32°C	1.3 hours/2.5 hours
—40°C	1.1 hours/1.8 hours

NOTE

Engine cooling is more rapid and a temperature drop from +40° to —32°C in one hour at —40°C ambient with a 25 knot wind may be expected. When engine oil temperature is below —25°C a successful start without preheat application is doubtful, even with use of parallel batteries.

ENGINE STARTING

After the above preheat is accomplished and ground heater ducts have been removed, accomplish a normal engine start. At extremely low temperatures it is possible that the engine oil pressure will go to maximum value during an engine start. If engine oil pressure does not drop to operating limits within 30 seconds after the engine has reached idle rpm, stopcock the engine and investigate. When oil pressure stabilizes and the transmission oil temperature gage maintains an indication of —15°C or warmer, rotor speed may be slowly increased to 100% Nr, being careful not to exceed transmission oil pressure limitations.

NOTE

Be alert for hot starts or cold hangups. It may take as long as 5 minutes of emergency throttle operation before the fuel control will perform satisfactorily.

If the battery voltage is so low that a battery start cannot be accomplished, an additional source of battery power may be connected in parallel with the installed battery or through the dc external power receptacle.

GROUND CHECK OF SYSTEMS

Accomplish normal check for systems as in Section II. In cold weather make sure all instruments have warmed up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.

NOTE

A T_5 increase of approximately 10° can be anticipated when using engine anti-ice.

CAUTION

Possible erratic operation of relays, and inability to change radio frequencies may be experienced until some degree of cockpit/cabin heat is attained.

DURING FLIGHT

During flight use the cabin heater, engine inlet anti-icing, and windshield defrost systems as required. 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 altitude. Colored glasses should be worn in snow areas to prevent snow blindness. At the first indication of icing turn and fly from the icing conditions. Some significant locations to observe for ice or snow accumulation are the windshield wipers, pitot tube and sponsons. Rotor rotation amplifies ice accumulation and the ice accretion on parts of the fuselage will not provide the pilot with a direct indication of ice accretion on the rotor system. Increased indicated torque accompanies ice accumulation on the main rotor and is a useful indication of ice accretion. Continued flight may cause ice ingestion in the engine from areas forward of the inlet. Icing of the air inlet area is an ever present possibility when operating in weather with temperatures of 10°C and below with visible moisture with the exception of dry snow. Snow below a temperature of —4°C can be assumed to be dry if there is no accumulation on the helicopter, in which case the engine anti-ice should be turned off. Takeoffs into fog or low clouds when the temperature is at or near freezing result in engine inlet icing. Climbs should be made at higher than normal rates under such conditions. Engine inlet icing does not necessarily occur with blade icing.

WARNING

This helicopter is restricted from flying in known icing conditions when visible moisture, except dry snow, is present. When icing conditions, except dry snow, are inadvertently encountered immediately turn on the engine inlet anti-icing system if not previously accomplished. With dry snow present, use of the anti-icing system may result in melting of the snow on the intake ducts with subsequent re-freezing and ice accumulation at the engine front frame. Under such conditions use of the inlet anti-icing system is not recommended.

NOTE

The ENG INLET ANTI-ICE caution light will remain on if the capability of the system is exceeded. At low temperatures where this occurs, icing is usually not encountered due to the lack of moisture in the air.

CAUTION

Autorotation at low gross weights in low density altitude conditions may result in loss of generators. If flight at low gross weights is required in night of IFR conditions autorotation rpm should be reset. See CGTP 1H-52A-2 for amplifying details.

WARNING

Do not attempt to shed accumulated ice from the rotor systems by rapidly pumping the collective or rapid cyclic control pulse inputs, as asymmetrical shedding may occur resulting in severe vibrations. The most effective means to induce shedding is by rotor speed variation.

If snow or ice accumulates during flight a precautionary landing should be made to remove the accumulation. If a landing is not possible, change altitude to leave the icing environment.

WARNING

With excessive ice accumulation on the inboard portion of the main rotor, it may not be possible to maintain autorotational rotor speed to provide sufficient rotor kinetic energy to ensure a safe autorotational landing in the event of an engine failure.

SECURING

A little effort by the flight crew following the days flight operations will greatly simplify operations the following day. As soon as the helicopter is parked, chock the wheels and release the brakes. Fuel the helicopter to prevent moisture from entering the fuel system. Drain the following items of condensation while the component temperature is still above freezing.

WARNING

The use of Fuel System Icing Inhibitor in the jet fuel is mandatory. Fuels obtained from military facilities contain ice inhibitor. Aviation units and flight crews shall ensure its presence in any commercial fuel procured. Icing inhibitor shall be used in a ratio of 0.08%-0.20% by volume (approximately 1 pint per 100 gallons of jet fuel). Additive should meet requirements of MIL-I-27686E (commercial name PRIST).

Item	Special Instructions
Fuel Filter	Lower platform on the left hand side of the transmission fairing. Momentarily depress valve to eliminate any water.
Fuel Tank Sumps	Momentarily depress valves at bottom of the fuselage to eliminate any water

Engine Oil Tank Sump	Momentarily depress the drain valve plunger at the bottom of the oil tank.

Remove ice from vents, drains and breathers. Clean landing gear oleo struts of dirt, snow, and ice with a clean cloth soaked in hydraulic fluid. Remove the battery and store in a heated room if the temperature will go below −25°C (−13°F) or if the temperature will remain below freezing for 4 hours or more. Check and refill the windshield washer reservoir as necessary. A solution of 60% ethylene glycol and 40% water prepared according to Specification O-A-548 is effective for temperatures as low as −53.9°C (−65°F). Close doors, windows, and work platforms. Install protective engine covers.

CAUTION

To prevent melted snow from accumulating in the bottom of the compressor case and freezing, thereby causing subsequent locking of the compressor blades, take the following precautions: When parking or mooring in snow conditions with temperatures below freezing, install the engine inlet duct plug immediately after the compressor blades have stopped turning. Leave the exhaust duct plug out until the engine has cooled sufficiently, then install.

Cover the rotor head to minimize ice and snow buildups in this critical area. Closing the engine compartment shutter doors will help minimize snow buildups on the engine deck. A plastic tarpaulin draped across the engine and out under the engine cowling doors will provide added protection from snow buildups. Snow accumulations in this area will melt after the engine is started, run into the engine and transmission deck drains, refreeze, and stop up the drain lines. Charts, rags, newspapers or some similar material should be placed under the tires if parking outside overnight to prevent the wheels from freezing to the ground. To prevent icing of rotor blades with helicopter parked in freezing rain, light weight blade covers (S14-50-4093-11) are recommended. Anti-icing and de-frosting fluid MIL-D-8243 should be applied to the blades before installing covers to prevent freezing of covers to blades; however, if covers are not available anti-icing and de-frosting fluid MIL-D-8243 can be used to prevent icing. Reapplication of the fluid will be required as rain washes fluid away.

CAUTION

Anti-icing materials are inflammable and toxic. They should not be applied around heater or engine exhausts. Avoid contact with skin or eyes. Never use deicing fluid containing methyl-alcohol. Methyl-alcohol deteriorates the main rotor blade pocket to spar bonding material.

HOT WEATHER PROCEDURES

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, rusting 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 nonmetallic 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. Hovering 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. When the helicopter is parked, the cabin door should be opened if weather permits. The cockpit windows should remain closed to prevent unexpected rain showers from pooling water on control panels which could possibly create short circuits.

DESERT PROCEDURES

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. Severe damage to the affected parts may be caused by sand and dust. The helicopter should be towed into takeoff position, which if at all possible should be on a hard, clear surface, free from sand and dust. Plan the flight thoroughly to compensate for existing conditions by using the charts in Appendix I. Check for presence of sand and dust in control hinges 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, especially in the area next to the cylinder seal, and any accumulation removed with a clean dry cloth. Inspect for, and remove, any sand or dust deposits on instrument panel and switches, and on and around flight and engine controls.

ENGINE START

If possible, engine starting and ground operation should be accomplished from a hard, clean surface. Accomplish the normal engine start and ground checks as outlined in Section II but limit ground operations to minimize the sand being blown up around the main rotor and engines.

TAXI AND TAKEOFF

When it is absolutely necessary to taxi in sand and dust, get the helicopter airborne as quickly as possible in order to minimize sand and dust intake by the engine. A no-hover takeoff is recommended.

IN-FLIGHT

Avoid flying through sand or dust storms. 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.

CAUTION

If operation in sand cannot be avoided, landings should be made using an approach angle that is greater than the angle used for normal approaches. The approach angle should be compatible with available power. Touchdown roll should be kept to a minimum to preclude the possibility of overloading the landing gear. No-hover takeoffs should be used. All doors and windows should be kept closed during landings and takeoffs to help prevent sand from entering the cockpit and cabin. These procedures will lessen sand clouds and insure greater visibility. Hovering and prolonged operation in sand is not recommended because unpredictable foreign object damage can result.

SHUTDOWN

The engine should be shut down as soon as practical after landing to minimize the ingestion of sand and dust. Install all protective covers and shields. Leave windows and doors open to ventilate the helicopter except when sand and dust are blowing.

MOUNTAIN AND ROUGH TERRAIN FLYING

See figures 9-2 to 9-6.

Many helicopter missions require flight and landings in rough and mountainous terrain. Refined flying techniques along with complete and precise knowledge of the individual problems to be encountered is required. Landing site condition, wind direction and velocity, gross weight limitations, and effects of obstacles are but a few of the considerations for each landing or takeoff. In a great many cases, meterorology facilities and information are not available at the site of intended operation. The effects of mountains and vegetation can greatly vary wind conditions and temperatures. Each landing site must be evaluated at the time of intended operation. Altitude and temperature are

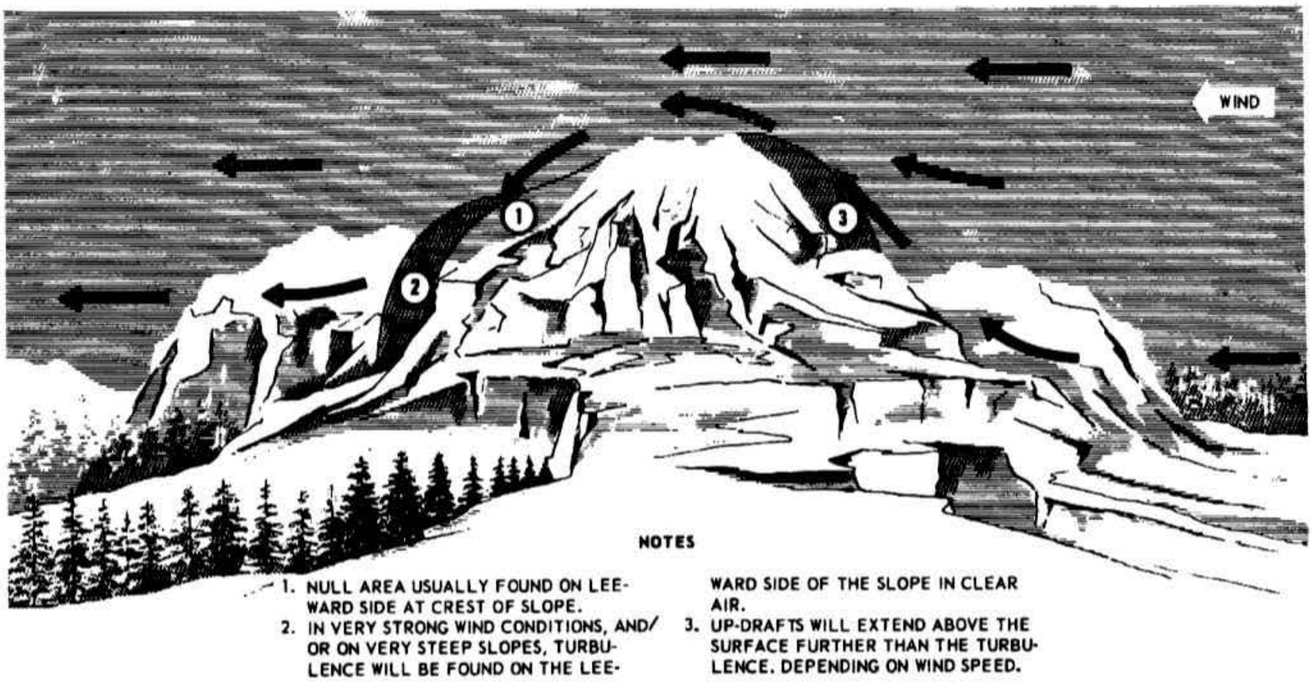


Figure 9-2. Wind Flow Over and Around Peaks

Figure 9-3. Wind Flow Over Gorge or Canyon

Figure 9-4. Wind Flow in a Valley or Canyon

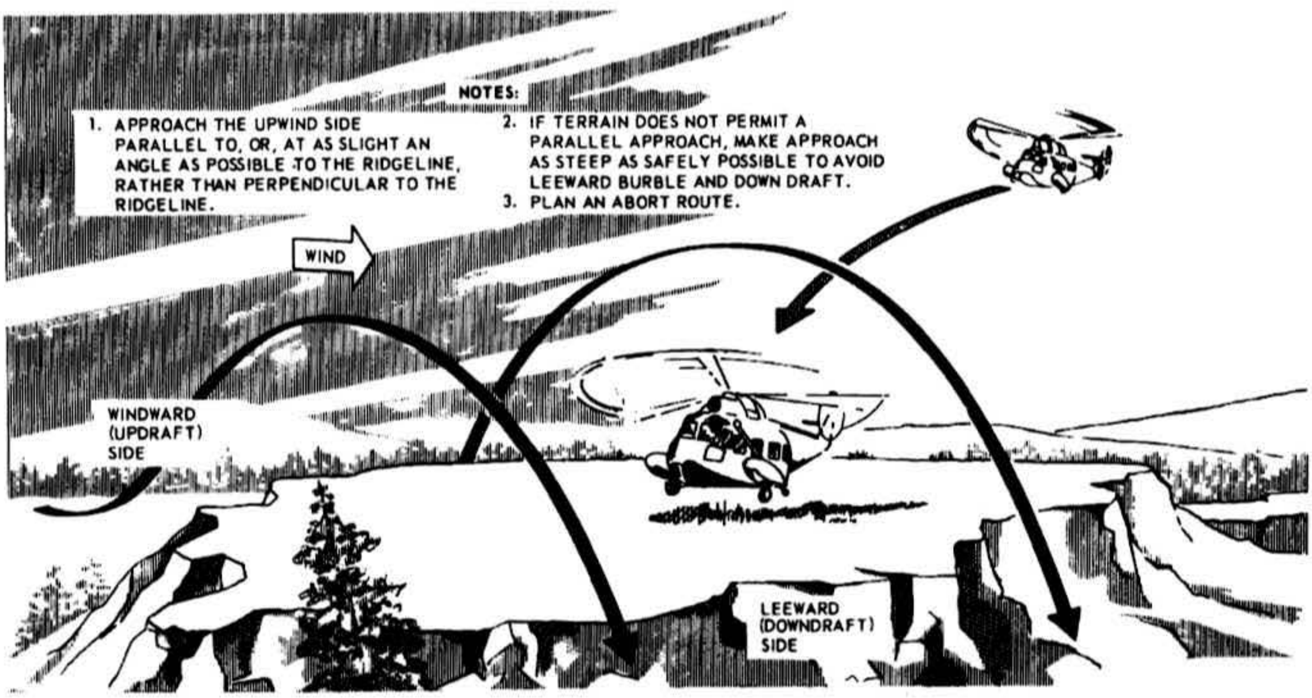


Figure 9-5. Wind Effect on Ridgeline Approach

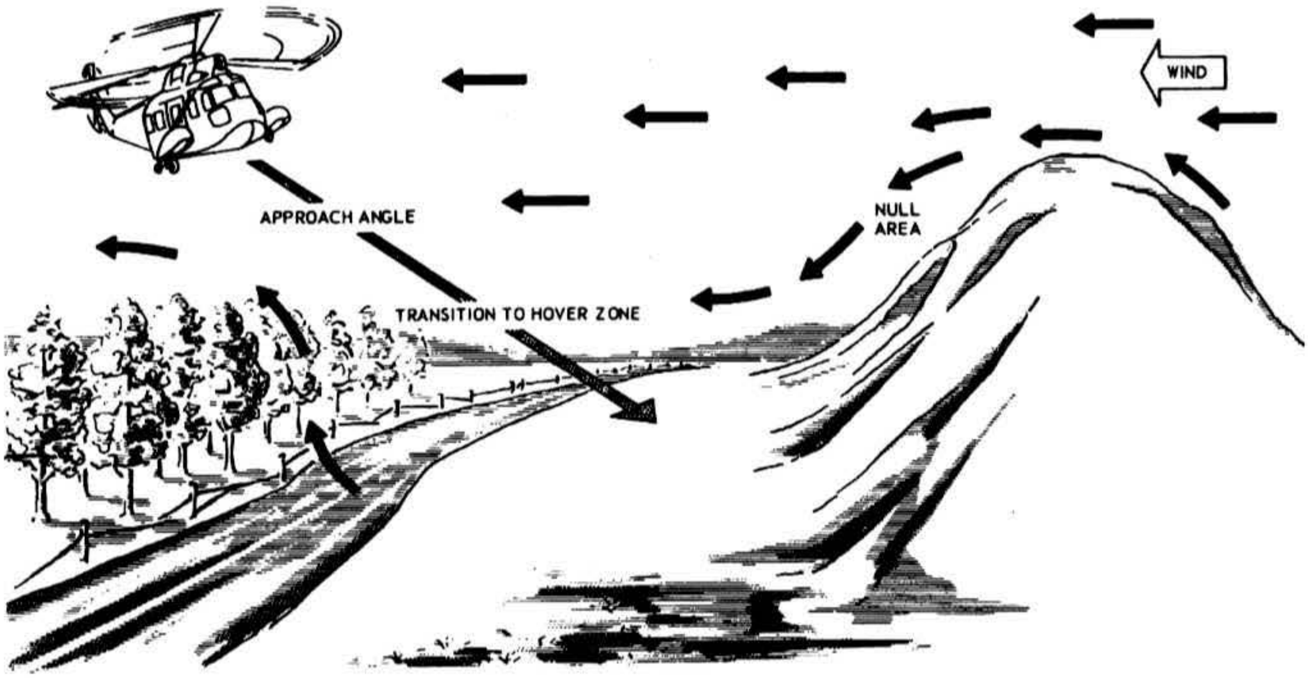


Figure 9-6. Wind Effect in a Confined Area

major factors in determining helicopter performance. Gross weight limitations under specific conditions can be computed from the performance data in Appendix I. A major factor improving helicopter lifting performance is wind. Weight carrying capability increases rapidly with increases in wind velocity relative to rotor system. However, accurate wind information is more difficult to obtain and more variable than other planning data. It is therefore not advisable to include wind in advanced planning data except to note that any wind encountered in the operating area may serve to improve helicopter performance. In a few cases, operational necessity will require landing on a prepared surface at an altitude above the hovering capability of the helicopter. In these cases a no hover landing or a running landing and takeoff will be necessary to accomplish the mission. Data for these conditions can be computed from the charts in Appendix I.

EFFECTS OF HIGH ALTITUDE

Helicopter performance at altitude decreases and operations can easily be in a situation of limited hovering ability. High gross weight at altitude increases the susceptibility of the helicopter to blade stall. Conditions that contribute to blade stall are high forward speed, high gross weight, high altitude, low rpm, induced G-loading and turbulence. Shallower turns at slower airspeeds are required to avoid blade stall. A permissible maneuver at sea level must be tempered at a higher altitude. Smooth and timely control application and anticipation of power requirements will do more than anything else to improve altitude performance.

TURBULENT AIR FLIGHT TECHNIQUES

Helicopter pilots must be constantly alert to evaluate and avoid areas of severe turbulence; however, if encountered, immediate steps must be taken to avoid continued flight through it to preclude the structural limits of the helicopter being exceeded. 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 extending 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 be some tendency to follow the slope.

In this situation there will probably be 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.

Man-made obstructions and vegetation will also cause turbulence. The best method to overfly ridge lines from any direction is to acquire sufficient altitude prior to crossing to avoid leeside downdrafts. If landing on ridge lines, the approach should be made along the ridge in the updraft, or select an approach angle into the wind that is above the leeside turbulence. 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 a helicopter is being operated at or near its service ceiling and a downdraft of more than 100 feet per minute is encountered, the helicopter will descend. Although the downdraft does not continue to the ground, a rate-of-descent may be established of such magnitude that the helicopter will continue descending and crash even though the helicopter is no longer affected by the downdraft. Therefore, the procedure for transiting a mountain pass shall be 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 often used procedure of flying through the middle of a pass to avoid mountains invites disaster. This is frequently the area of greatest turbulence and in case of emergency, the pilot has little or no opportunity to turn back due to insufficient turning space. Rising air currents created by surface heating causes convective turbulence. This is more prevalent over bare areas. Convective turbulence is normally found at a relatively low height above the terrain, generally below 2000 feet. It may however, under certain conditions and in certain areas, reach as high as 8000 feet above the terrain. Attempting to fly over convective turbulence should be carefully considered, depending on the mission assigned. The best method is to fly at the lowest altitude consistent with safety. Attempt to keep your flight path over areas covered with vegetation. Turbulence can be anticipated when transitioning from bare areas to areas covered by vegetation or snow. Convective turbulence seldom gets severe enough to cause structural damage.

ADVERSE WEATHER CONDITIONS

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 hanging clouds and scud should be given a wide berth at all times. In addition to being well briefed the pilot should carefully study the route to be flown.

SUMMARY

The following guidelines are considered to be most important for mountain and rough terrain flying:

1. Make a continuous check of wind direction and estimated velocity.

2. Plan your approach so that an abort can be made downhill and/or into the wind without climbing.

3. If wind is relatively calm, try to select a hill or knoll for landing so as to take full advantage of any possible wind effect.

4. When evaluating a landing site, execute as many fly-bys as necessary with at least one high

and low pass before conducting operations into a strange landing area.

5. Evaluate the obstacles in the landing site and consider possible null areas and routes of departure.

6. Landing site selection should not be based solely on convenience but consideration should be given to all relevant factors.

7. Determine ability to hover out of ground effect prior to attempting a landing.

8. Watch for rpm surges during turbulent conditions. Strong updrafts will cause rpm to increase, whereas downdrafts will cause rpm to decrease.

9. Avoid flight in or near thunderstorms.

10. Give all cloud formations a wide berth.

11. Fly as smoothly as possible and avoid steep turns.

12. Cross mountain peaks and ridges high enough to stay out of downdrafts on the leeside of the crest.

13. Avoid downdrafts prevalent on leeward slopes.

14. Plan your flight to take advantage of the updrafts on the windward slopes.

15. Whenever possible, approaches to ridges should be along the ridge rather than perpendicular.

16. Avoid high rates of descent when approaching landing sites.

17. Know your route and brief well for flying in these areas.

18. The surface of the water may give valuable information as to wind currents and downdrafts in areas of orographic turbulence.

APPENDIX I

MODEL HH-52A PERFORMANCE DATA

TABLE OF CONTENTS

PURPOSE OF THE PERFORMANCE CHARTS

The charts presented on the following pages are provided to aid in preflight and inflight planning. Through the use of the charts, the pilot is able to select the best power setting, altitude, and airspeed to be used to obtain optimum performance for the mission being flown. Descriptive explanations are included at the beginning of Appendix I to illustrate the use of the performance charts. Guide lines are shown on the charts to illustrate the path to follow when using the chart.

DENSITY ALTITUDE CHART

Many of the performance charts are based on density altitude to compensate for temperature variations at any altimeter reading. The density altitude chart (figure A-1) provides a means of determining density altitude from a known pressure altitude and outside air temperature. When applicable, a standard day temperature line is shown on the curve as a convenient guide for this frequently referenced condition. The density altitude chart shows the density altitude for standard and nonstandard atmospheric conditions. 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 for any altitude the density altitude will also increase to values higher than pressure altitude. Helicopter pilots are vitally concerned with density altitude and its relation to the performance of helicopters. For a given power setting the lift developed by the rotor blades decreases as the density altitude increases. As density altitude increases, useful load must be decreased. Each takeoff and landing must be separately evaluated as density altitude may change considerably in a short period of time.

AIRSPEED CALIBRATION CHART

The airspeed calibration chart (figure A-2) provides a means for converting indicated airspeed (IAS) to calibrated airspeed (CAS) in order to compensate for errors introduced into the airspeed reading as a result of characteristics of the pitot static system. The chart provides correction curves for level flight, descent or autorotation, and climb.

HOVER CEILING CHARTS

The hover ceiling charts (figures A-3 and A-4) provide information to determine the highest pressure altitude at which the helicopter can hover in ground effect at 5-feet wheel clearance and out of ground effect.

TAKEOFF DISTANCE CHART

The takeoff distance chart (figures A-5 and A-6) shows takeoff distances that are required to clear a 50-foot obstacle at various pressure altitudes and temperatures using 100% Q and 100% Nr. Both charts use a climb speed of 45 knots. Helicopter gross weights used are 7500 pounds (figure A-5) and 8300 pounds (figure A-6). This chart does not apply to obstacle takeoffs where straight line climb angle technique is used.

CLIMB CHARTS

Climb charts for maximum continuous power, 96% Nr and 96% torque, (figures A-7 through A-12) are provided. Climb performance is presented for various combinations of gross weights, pressure altitudes and temperature.

AUTOROTATIVE RPM CHART

Correct autorotative Nr can be determined from the autorotative rpm chart (figure A-13). The Nr values are for a steady autorotation at 55 knots and with collective at full low pitch. The chart presents correct autorotative Nr values at various gross weight and density altitude values.

INDICATED TORQUE VS FUEL FLOW CHART

The torque vs fuel flow chart (figure A-14) provides the means for computing fuel comsumption in pounds-per-hour for 96% Nf/Nr and 100% Nf/Nr.

POWER-AVAILABLE CHART

The power-available chart (figure A-15) shows variable atmosphere factors such as temperature and pressure altitude that have an effect on the capability of the engine to produce power. The power-available chart defines power and torque as a function of pressure altitude, temperature, and Nf.

POWER VS SPEED CHARTS

The power vs speed charts (figures A-16, A-17, and A-18) show the power required to fly at a given true airspeed (TAS), for various pressure altitudes and aircraft weights.

EMERGENCY SEA STATE CAPABILITIES CHART (figure A-19) AND SEA STATE CAPABILITY VS LATERAL UNBALANCE CHART (figure A-20)

These engineering charts describe the helicopter's sea state capabilities with the rotor stopped.

SPEED VS ALTITUDE CHARTS

The speed vs altitude charts depict the combination of airspeeds and gross weights where level flight can be maintained for a given altitude. Figures A-21 through A-25 are for 96% Nr and figures A-26 through A-30 are for 100% Nr.

ENGINE INPUT HORSEPOWER VS INDICATED TORQUE CHART

This chart (figure A-31) coverts engine input shaft horsepower to indicated torque.

POWER CHECK CHART

The power check chart (figure A-32) indicates the power required to hover at a 1-foot wheel clearance, and out of ground effect at various combinations of pressure altitude, outside air temperature, gross weight, and headwind.

RANGE CHARTS

The range charts (figures A-33 through A-35) graphically illustrate the cruise performance of the helicopter. The charts present specific range (nautical miles per pound of fuel), approximate torque required and, if desired, fuel flow in pounds-per-hour. Maximum range and maximum airspeeds are also depicted.

BLADE STALL CHART

The function of the blade stall chart (figure A-36) is to provide a rapid means of determining the speed at which incipient blade stall occurs under various altitude, rotor rpm, gross weight, and angle of bank conditions.

DENSITY ALTITUDE CHART

True airspeed (TAS) is obtained by multiplying CAS by the conversion factor shown in figure A-1, for the density altitude at which the CAS reading is taken.

EXAMPLE PROBLEM

Given

Ambient temperature	40°C
Pressure altitude	2000 Feet
CAS	82 Knots

Determine

Density altitude and true airspeed.

Solution

(Refer to figure A-1)

1. Enter chart at 40°C.

2. Move vertically up the 40°C line to intersection of 2000 foot pressure altitude diagonal line.

3. From this intersection move horizontally to the right. Read 5200 feet density altitude and an airspeed correction of 1.08.

4. Determine TAS by multiplying CAS 82 knots x 1.08 = 88.6 knots TAS.

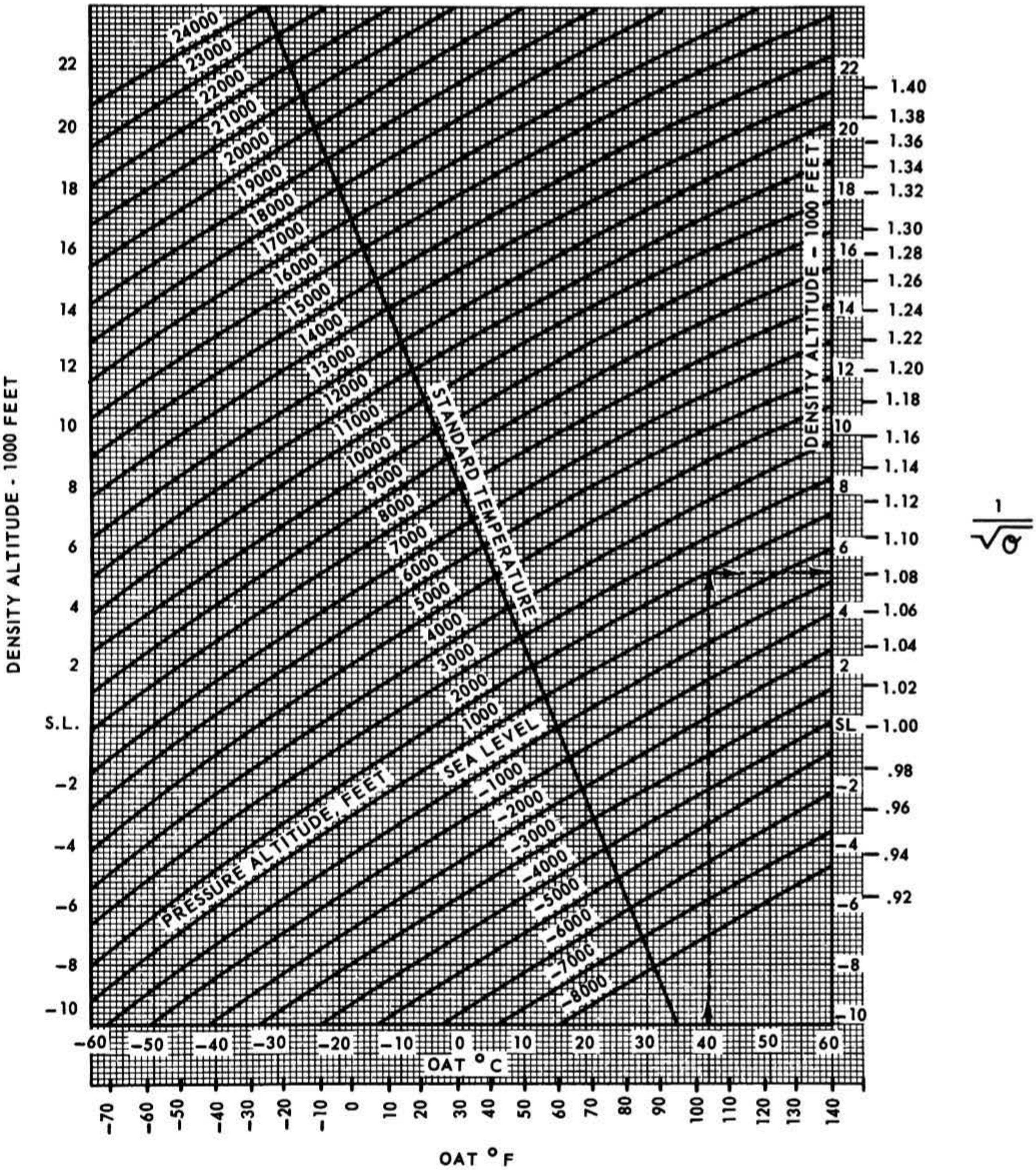


Figure A-1. Density Altitude Chart

AIRSPEED CALIBRATION CHART

EXAMPLE PROBLEM

Given

Indicated airspeed	80 knots
Flight condition	Level Flight

Determine

Calibrated airspeed.

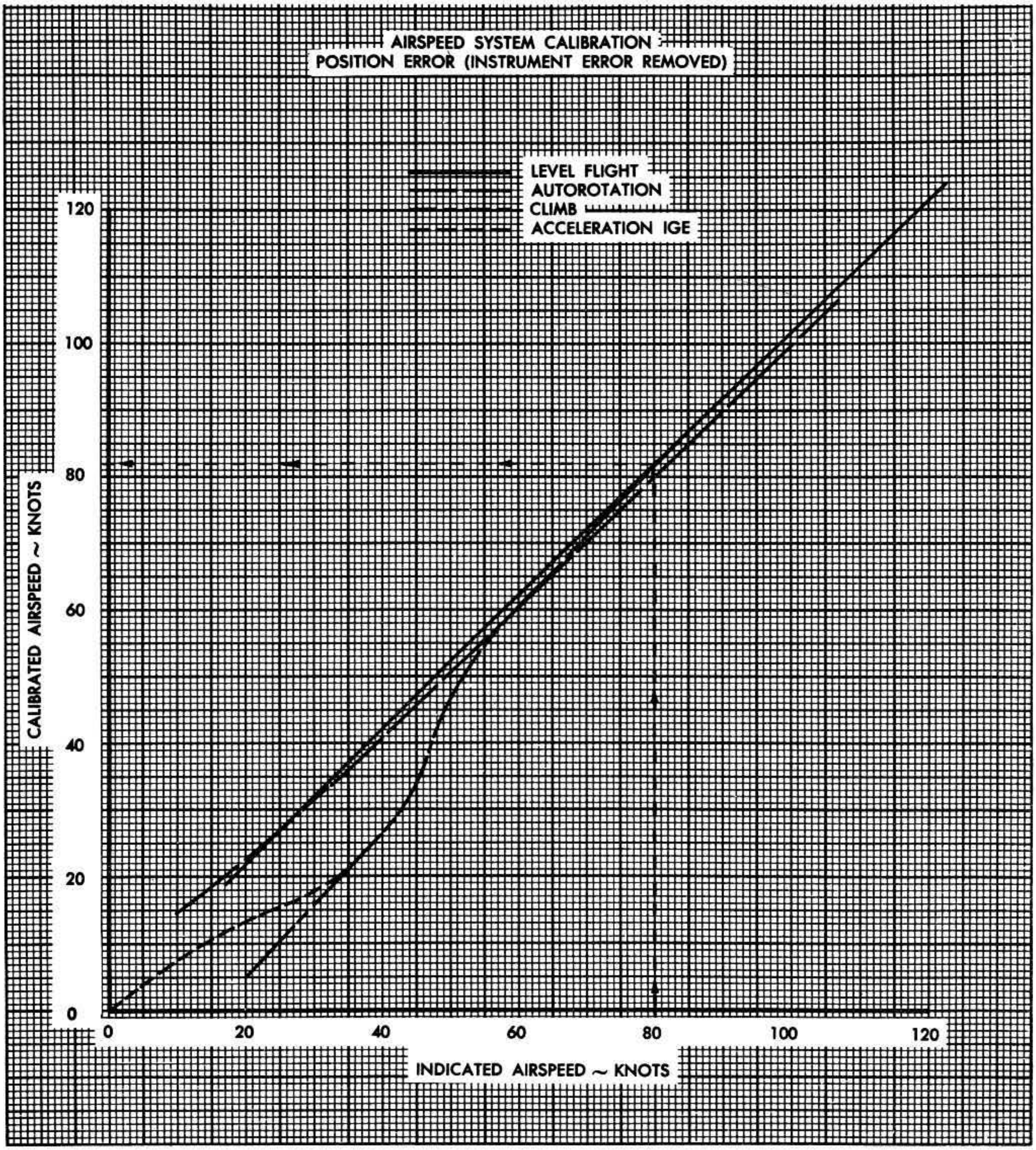
Solution

(Refer to figure A-2)

1. Enter chart at 80 knots indicated airspeed.

2. Move vertically up the 80 knot line to intersection of the level flight curve.

3. From this intersection move horizontally to the calibrated airspeed scale and read 82 knots CAS. To find TAS multiply by airspeed correction factor as shown in figure A-1.



Model: HH-52A
Date: 1960
Data Basis: Flight Test
Engine: T58-GE-8B
Fuel Grade: JP-4/JP-5
Fuel Density: 6.5/6.8 lb/gal.

Figure A-2. Airspeed System Calibration

HOVER CEILING CHART

EXAMPLE PROBLEM

Given

Given weight	8200 pounds
Temperature	Standard +30°C
Nr	100%

Determine

Hover ceiling for 5-foot hover using 5-minute power.

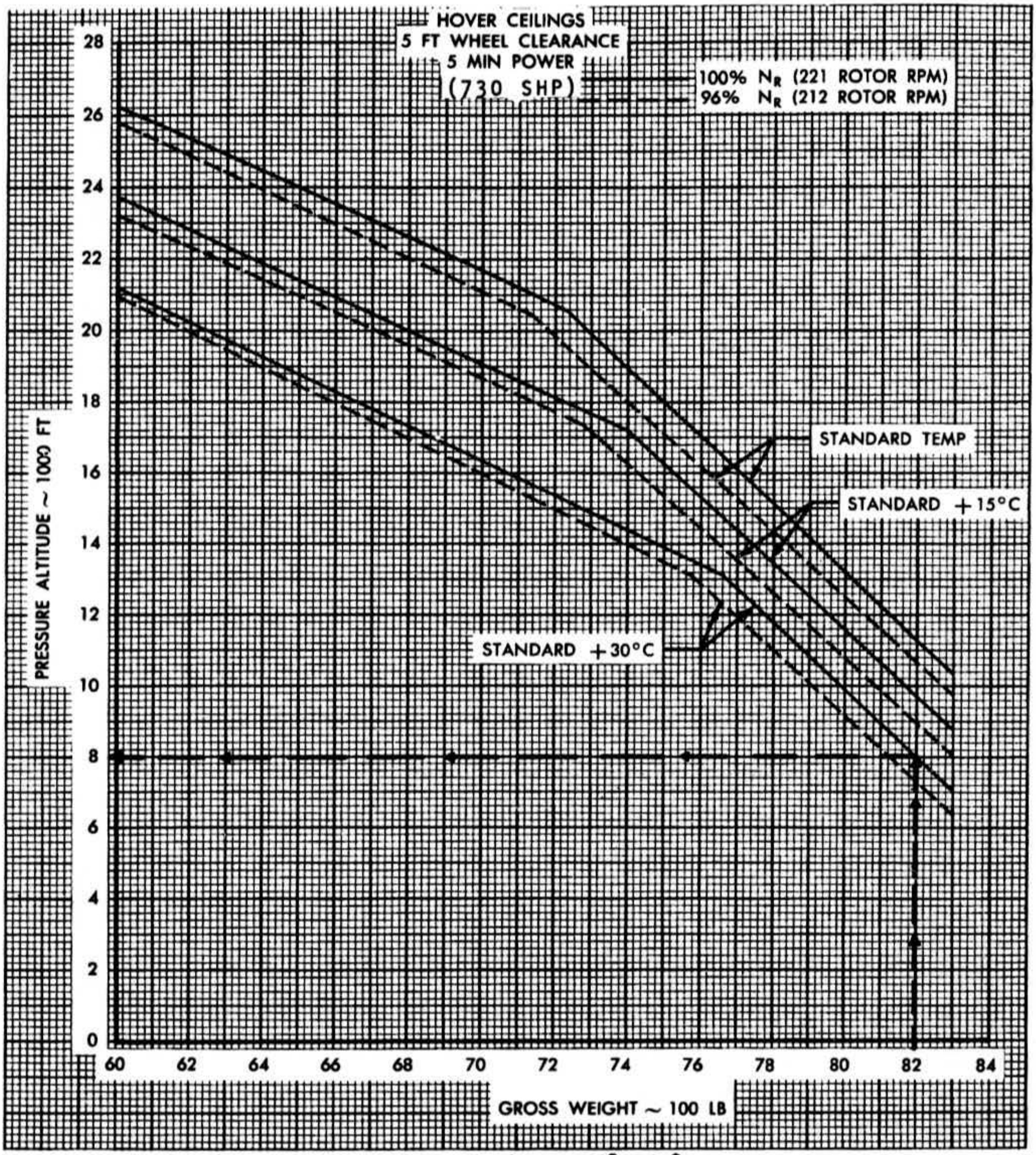
Solution

(Refer to figure A-3)

1. Enter the chart at 8200 pounds.

2. Move vertically up to intersection of the 100% Nr at standard +30°C curve.

3. Move horizontally left to pressure altitude scale and read 8000 feet.

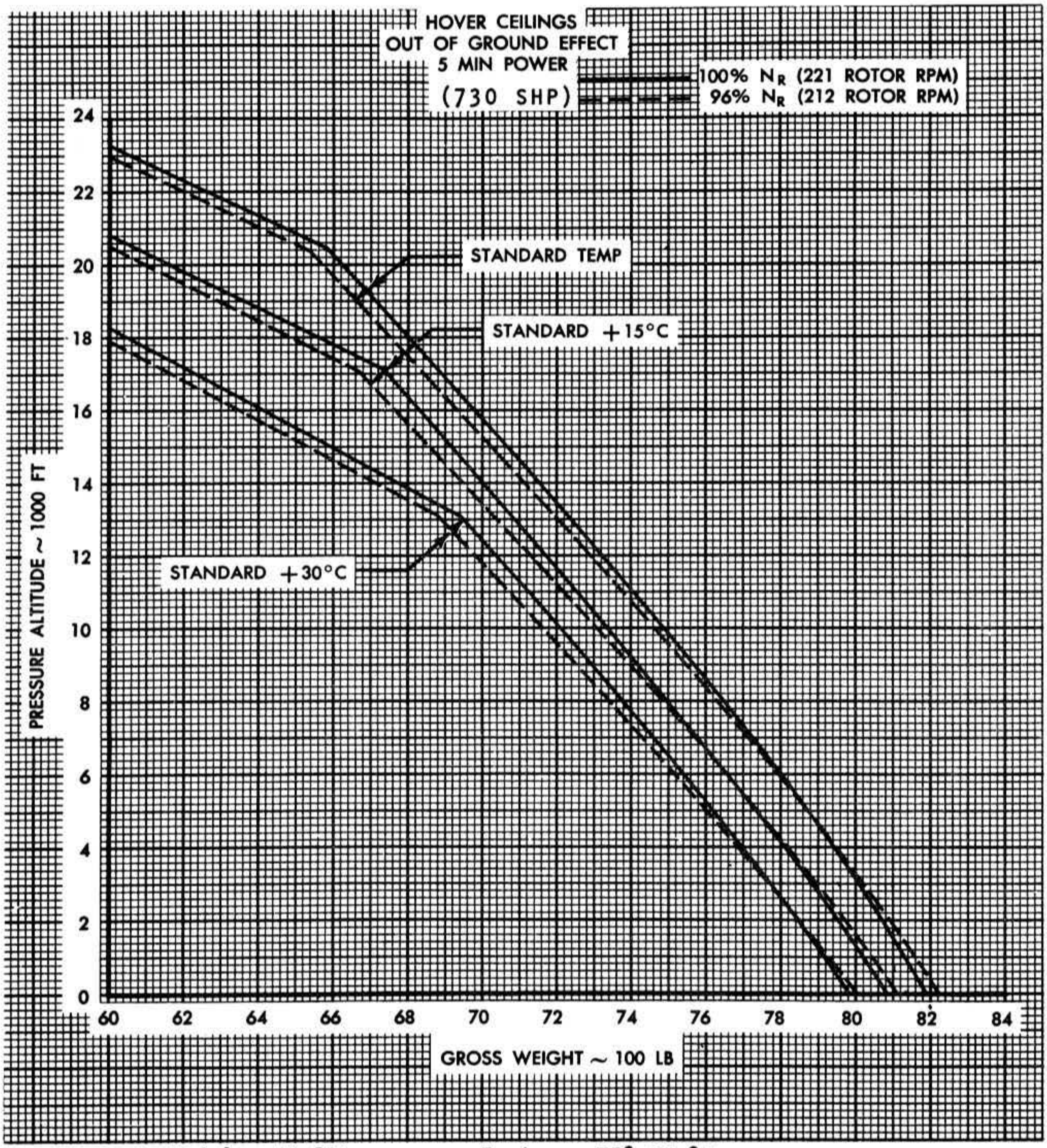


Model: HH-52A Engine: T58-GE-8B
Date: 1960 Fuel Grade: JP-4/JP-5
Data Basis: Estimated Fuel Density: 6.5-6.8 lb/gal.

Disregard 96%Nr Curves. Assume Zero Wind.

Figure A-3. Hover Ceilings IGE

This page intentionally left blank.



Model: HH-52A
Date: 1960
Data Basis: Estimated

Engine: T58-GE-8B
Fuel Grade: JP-4/JP-5
Fuel Density: 6.5-6.8 lb/gal.

Disregard 96%Nr Curves. Assume Zero Wind.

Figure A-4. Hover Ceiling OGE

TAKEOFF DISTANCE CHART

EXAMPLE PROBLEM

Given

Gross weight	7500 pound
Pressure altitude	2000 feet
Temperature	Standard +15°C

Determine

Takeoff distance required.

Solution

(Refer to figure A-5)

1. Enter chart at pressure altitude of 2000 feet.

2. Move horizontally to the standard +15°C line.

3. Move vertically downward to total takeoff distance scale and read 270 feet.

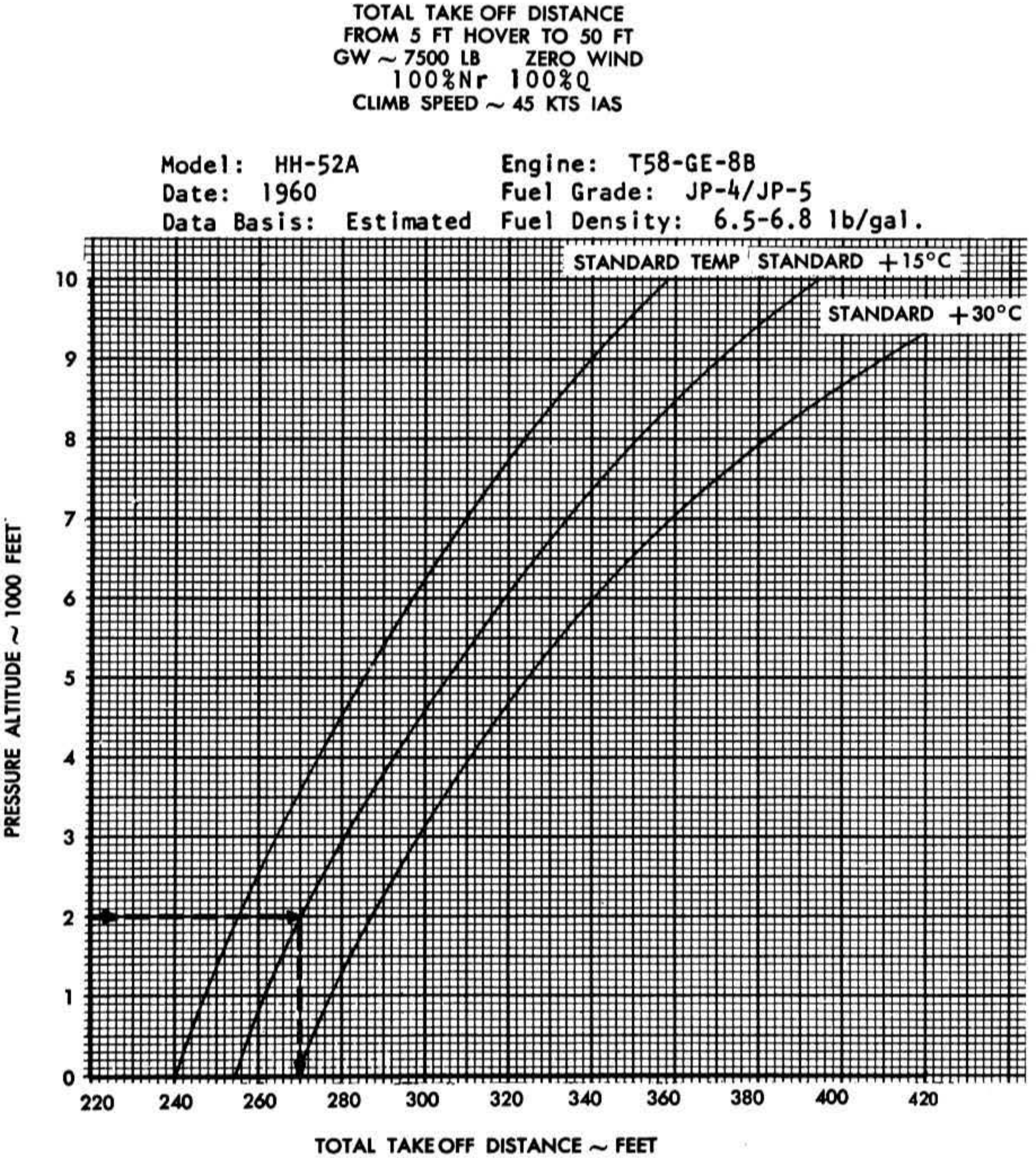


Figure A-5. Takeoff Distance G.W. 7500 Lbs

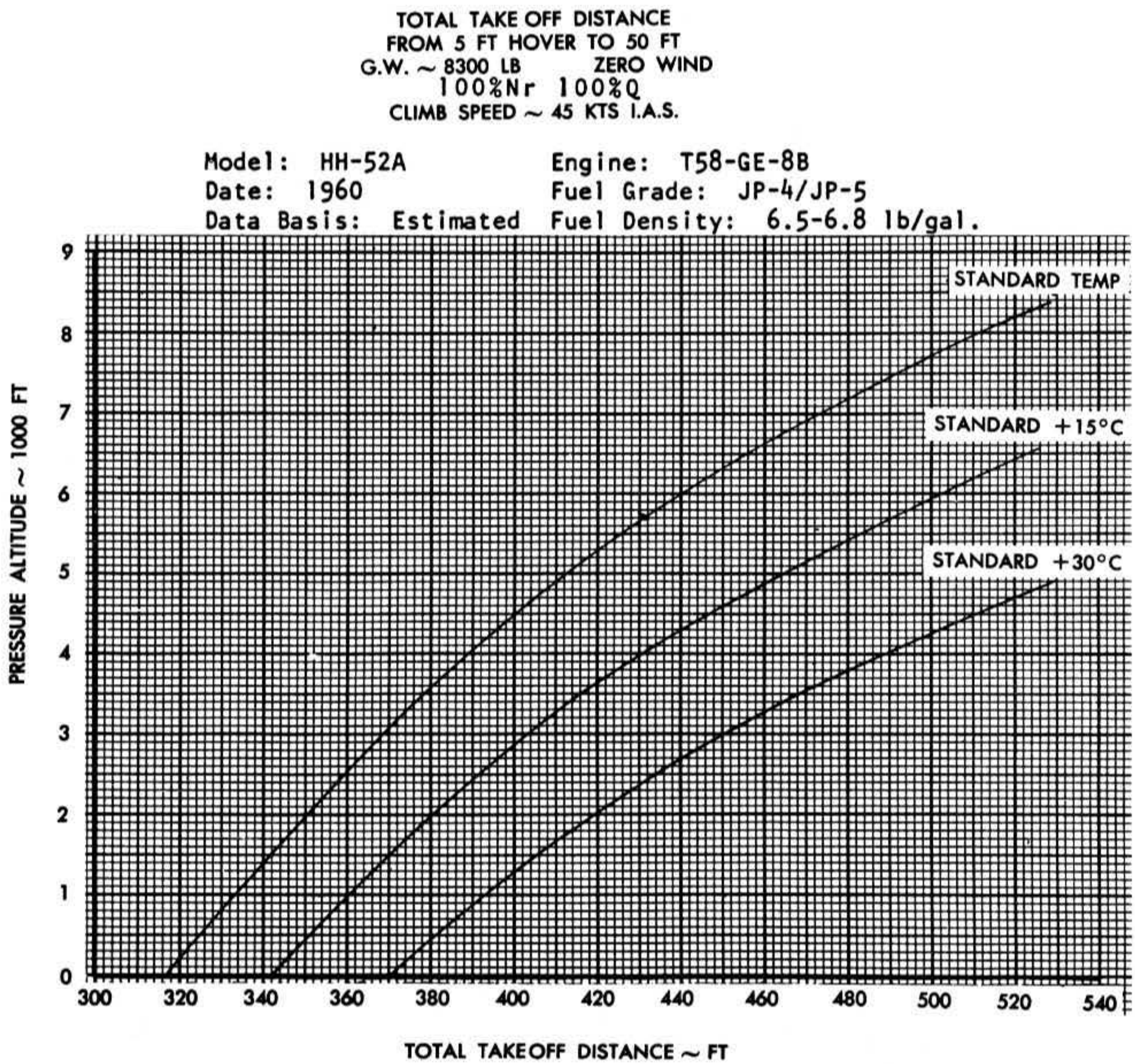
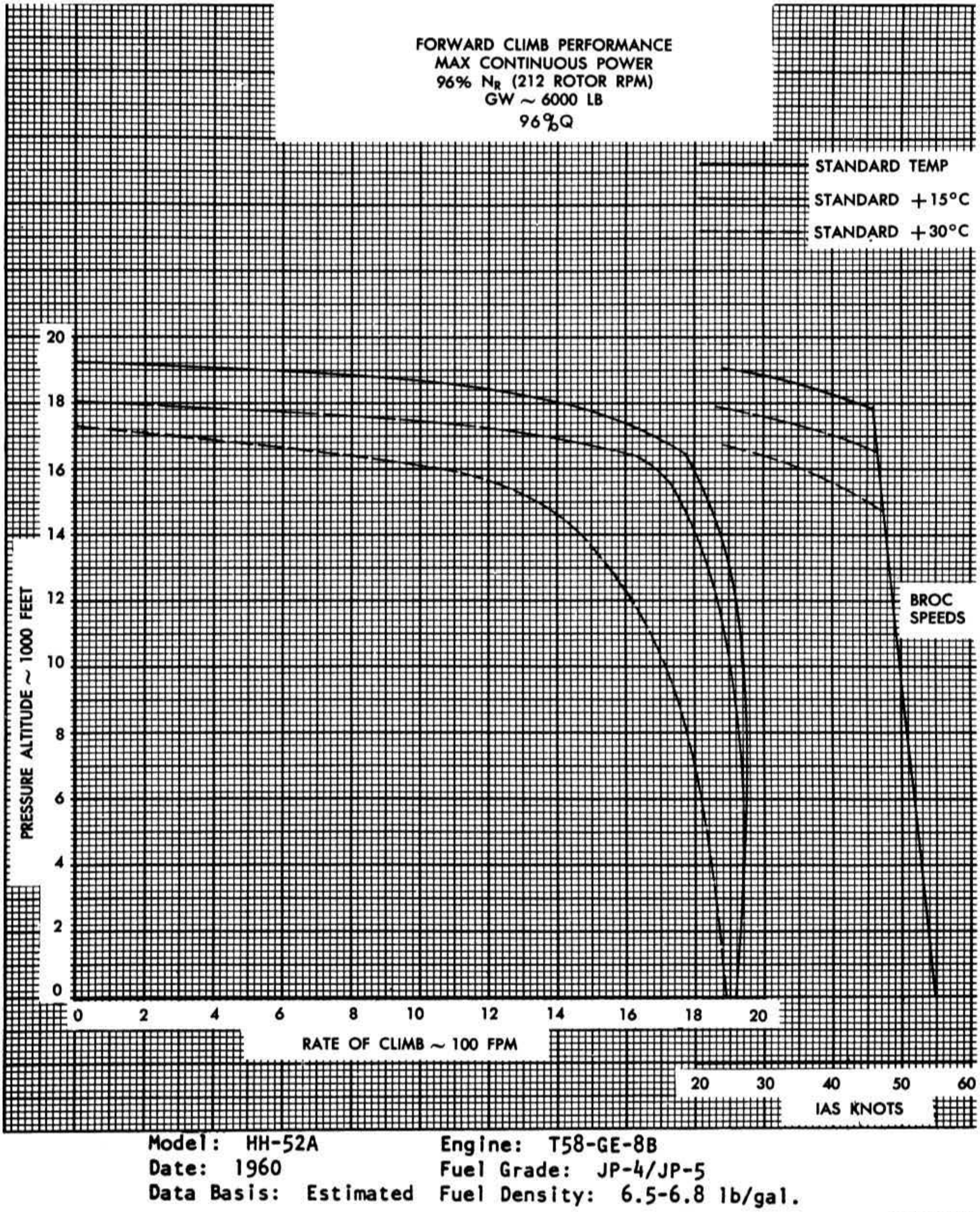


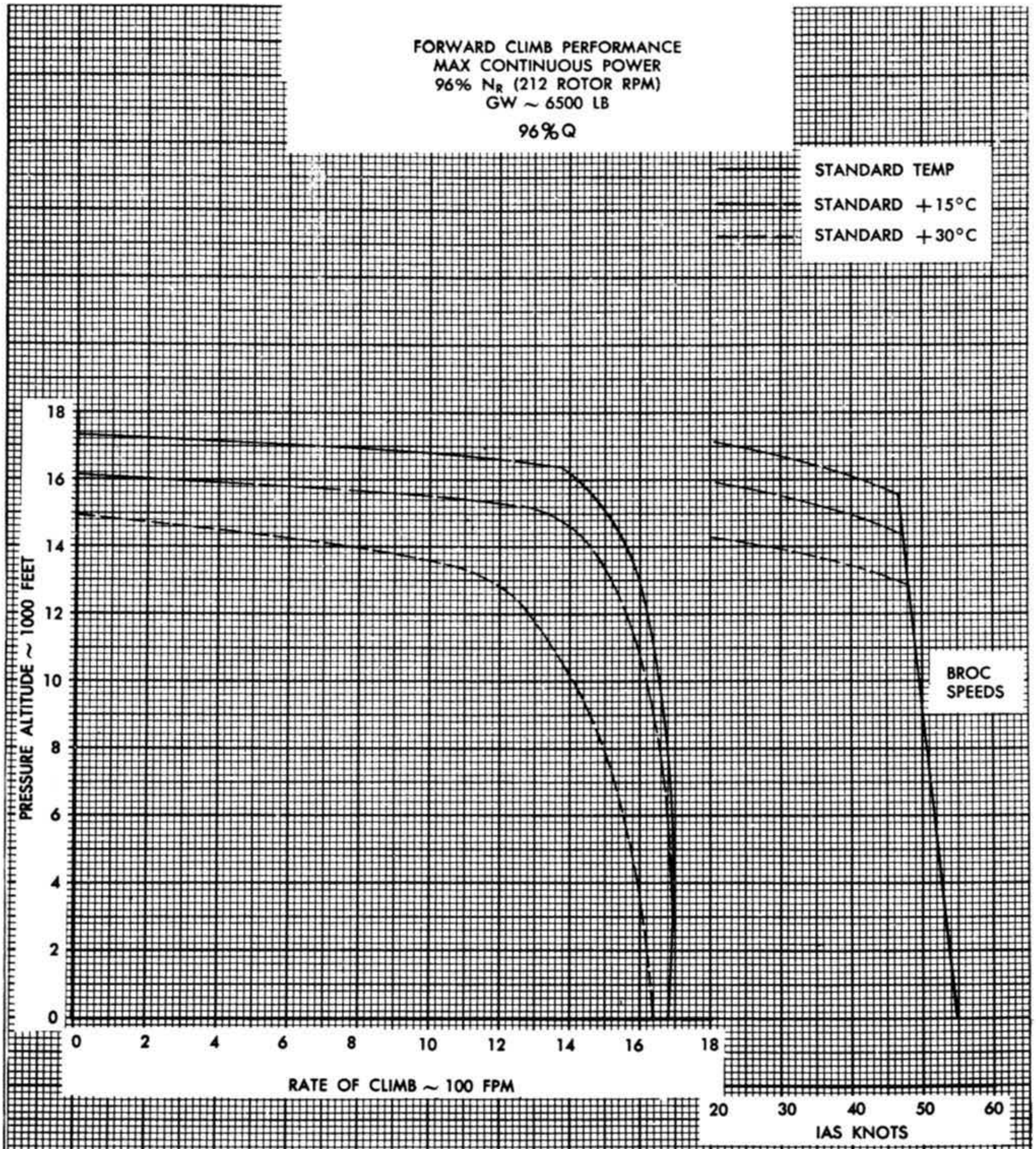
Figure A-6. Takeoff Distance G.W. 8300 Lbs



Model: HH-52A
Date: 1960
Data Basis: Estimated
Engine: T58-GE-8B
Fuel Grade: JP-4/JP-5
Fuel Density: 6.5-6.8 lb/gal.

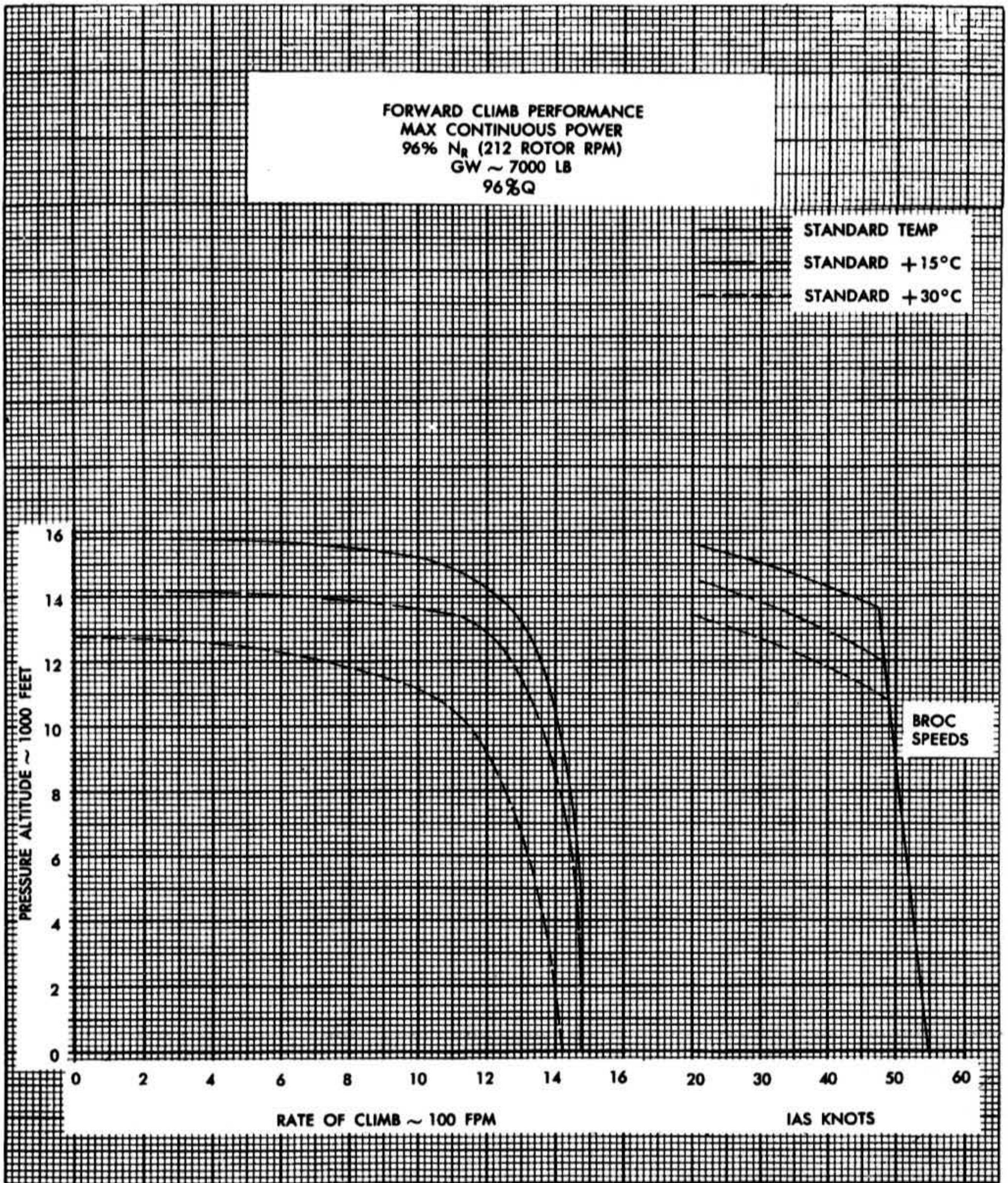
S 55600 (R)

Figure A-7. Forward Climb Performance G.W. 6000 Lbs



Model: HH-52A Engine: T58-GE-8B
Date: 1960 Fuel Grade: JP-4/JP-5
Data Basis: Estimated Fuel Density: 6.5-6.8 lb/gal.

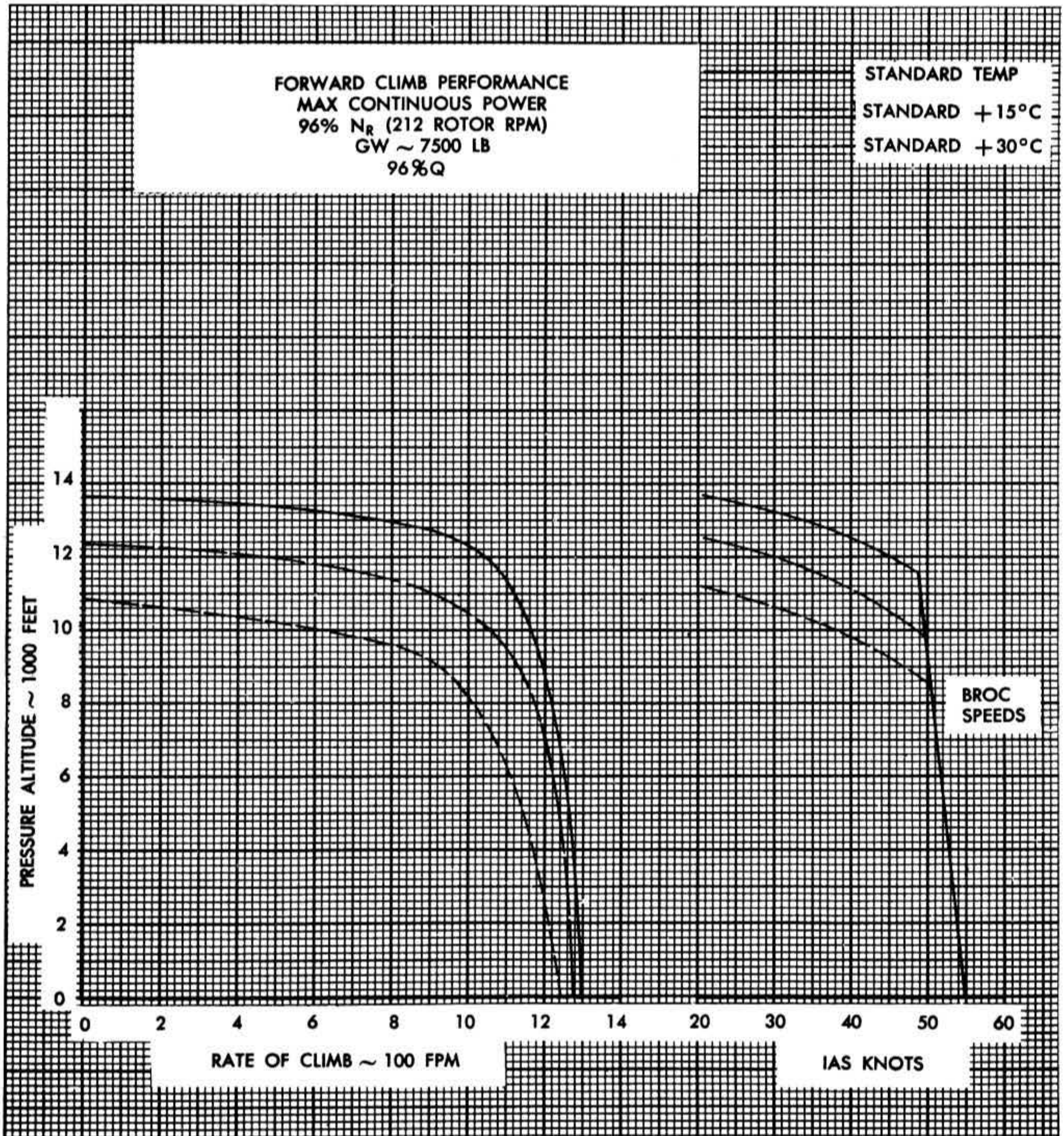
Figure A-8. Forward Climb Performance G.W. 6500 Lbs



Model: HH-52A | **Engine:** T58-GE-8B
Date: 1960 | **Fuel Grade:** JP-4/JP-5
Data Basis: Estimated | **Fuel Density:** 6.5-6.8 lb/gal.

Figure A-9. Forward Climb Performance G.W. 7000 Lbs

This page intentionally left blank.



Model: HH-52A
Engine: T58-GE-8B
Date: 1960
Fuel Grade: JP-4/JP-5
Data Basis: Estimated
Fuel Density: 6.5-6.8 lb/gal.

Figure A-10. Forward Climb Performance G.W. 7500 Lbs

CLIMB CHART

EXAMPLE PROBLEM

Given

Gross weight	8000 pounds
Temperature at 1000 feet pressure altitude	28°C (15°C deviation from Standard Temperature)

Determine

Rate of climb and best rate of climb (BROC) airspeed from 1000 feet to 7000 feet.

Service Ceiling — (HIGHEST ALTITUDE AT WHICH A RATE OF CLIMB OF 100 FEET-PER-MINUTE CAN BE ATTAINED).

Solution

(Refer to figure A-11, Climb Chart for 8000 pounds)

1. Enter chart at pressure altitude of 1000 feet.

2. Move horizontally to standard +15°C line.

3. Move vertically down and read rate of climb 1080 feet per minute at 1000 feet pressure altitude.

4. Follow standard +15°C line to intersection with 7000 feet pressure altitude line.

5. Move vertically down and read rate of climb 980 feet-per-minute at 7000 feet pressure altitude.

6. Proceed further right on the 1000 feet line to the BROC line.

7. Read BROC airspeed of 54 knots at 1000 feet and 51 knots at 7000 feet.

8. Enter chart on the 100 feet-per-minute rate of climb line.

9. Move vertically to the intersection with the Standard +15°C line.

10. Move horizontally left and read service ceiling 10,200 feet.

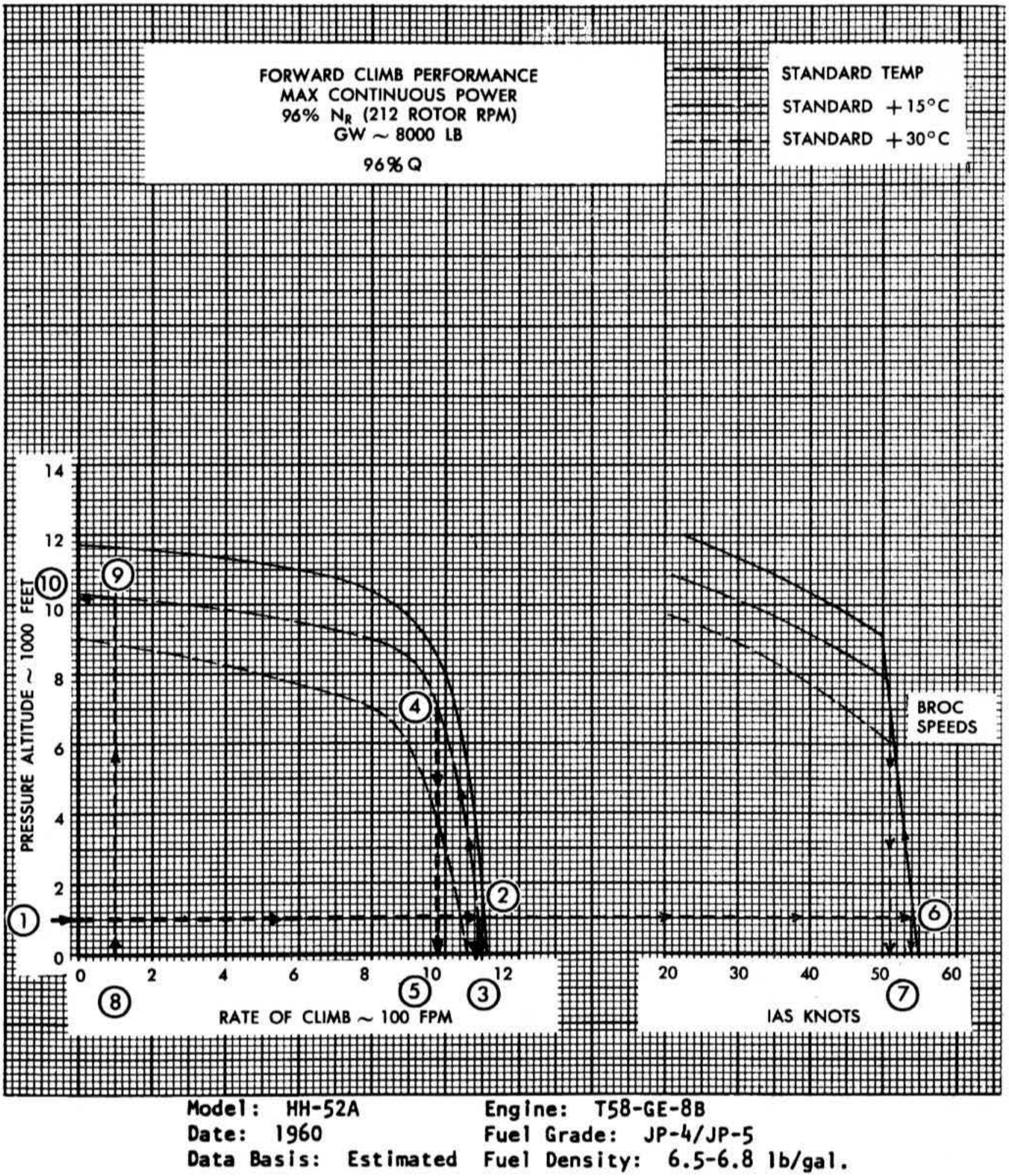
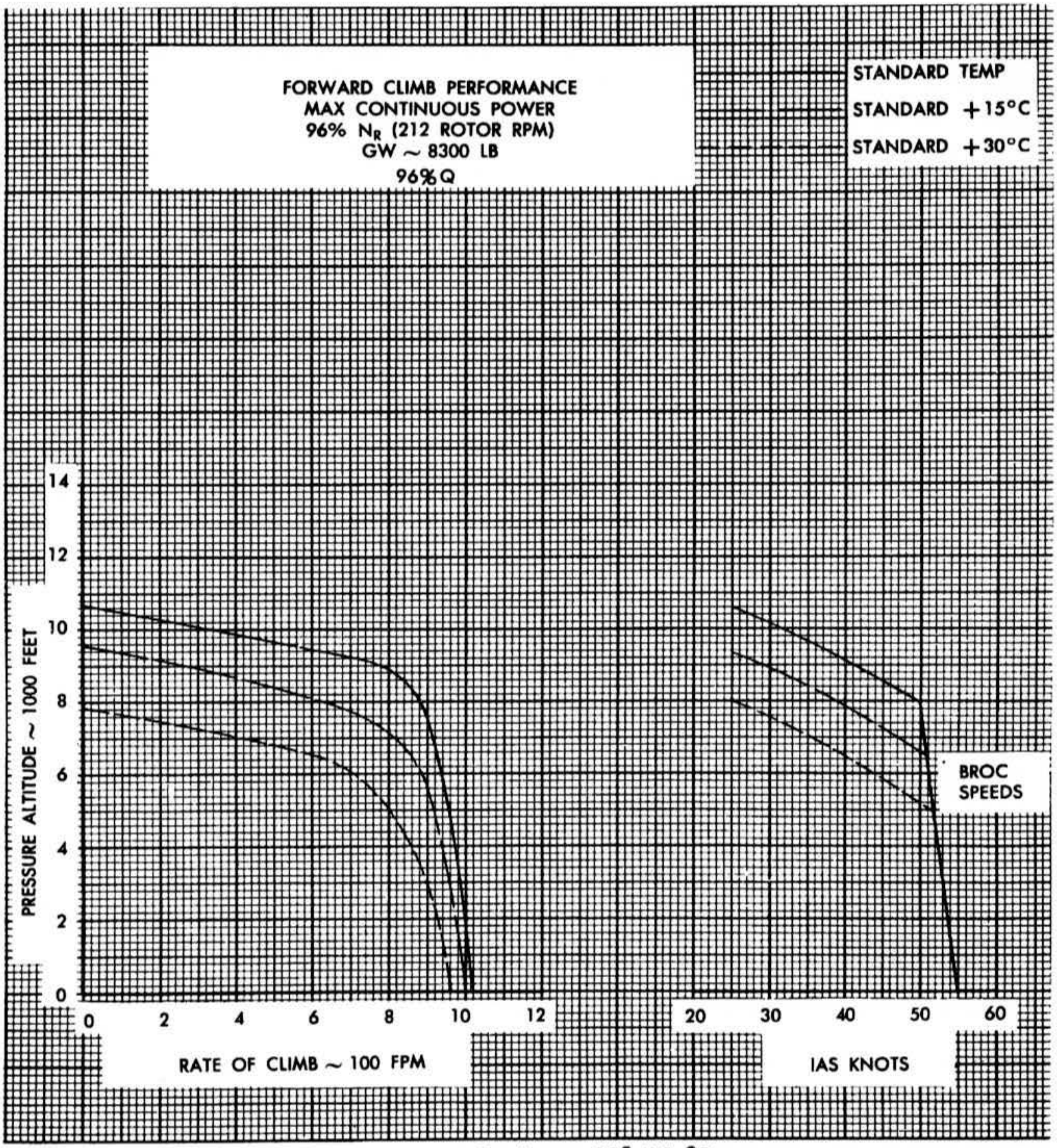


Figure A-11. Forward Climb Performance G.W. 8000 Lbs

This page intentionally left blank.



Model: HH-52A
Date: 1960
Data Basis: Estimated
Engine: T58-GE-8B
Fuel Grade: JP-4/JP-5
Fuel Density: 6.5-6.8 lb/gal.

Figure A-12. Forward Climb Performance G.W. 8300 Lbs

AUTOROTATIVE RPM CHART

EXAMPLE PROBLEM

Given

Pressure altitude	1000 feet
OAT	13°C
Gross weight	7500 pounds

Determine

Autorotative rpm.

Solution

1. Using pressure altitude and OAT determine density altitude from density altitude chart (figure A-1) to be 1000 feet.

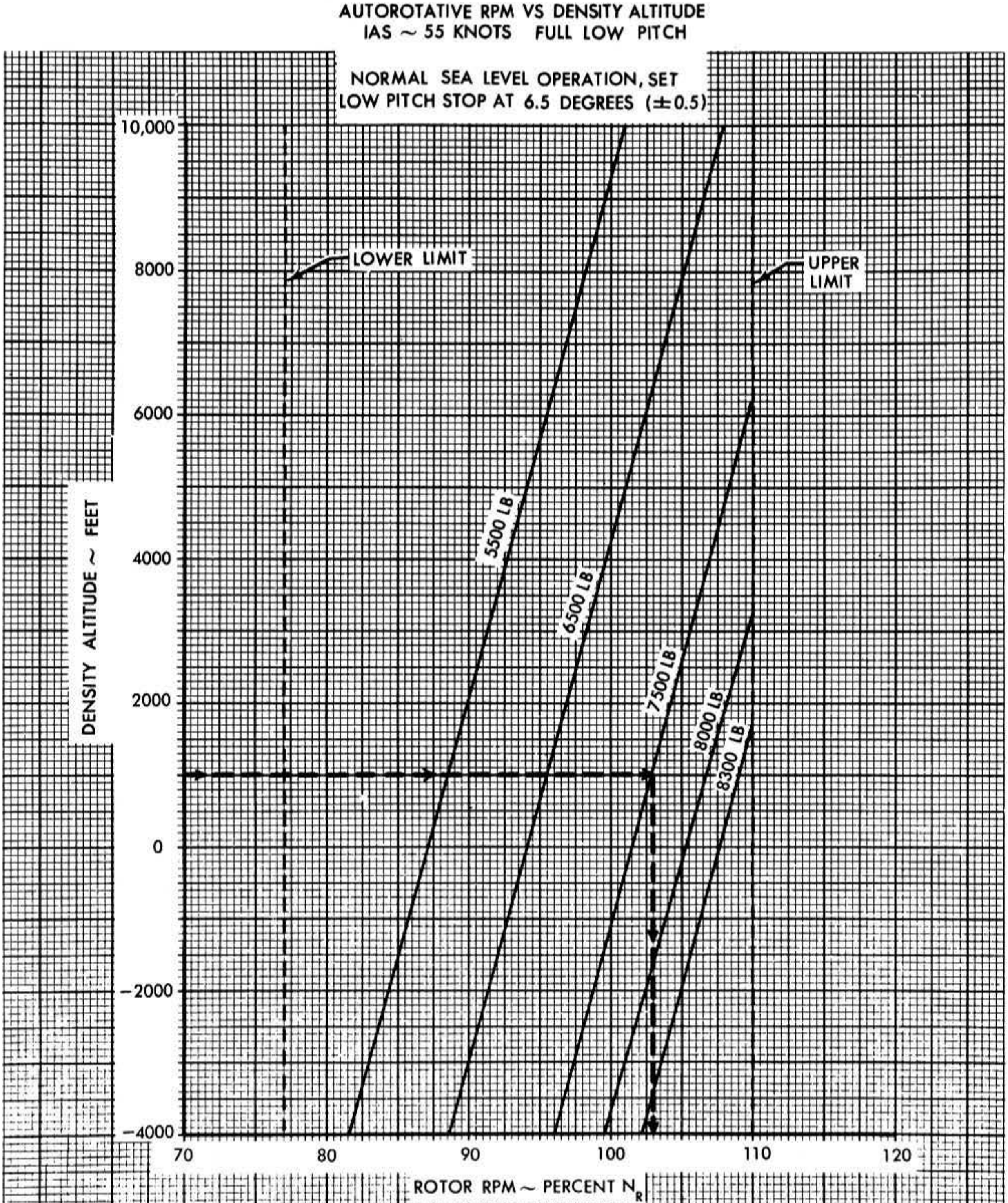
2. Enter autorotative rpm chart at +1000 feet and move horizontally right to the intersection of the 7500 pounds gross weight line.

3. Move vertically down to the Nr scale.

4. Read 103% Nr. Correct autorotative Nr should be 103% ± 2% Nr.

CAUTION

Autorotation at low gross weights in low density altitude conditions may result in loss of generators. If flight at these low gross weights is required in night or IFR conditions autorotative rpm should be reset. See CGTP 1H-52A-2 for amplifying details.



Model: HH-52A **Engine: T58-GE-8B**
Date: 1960 **Fuel Grade: JP-4/JP-5**
Data Basis: Flight Test **Fuel Density: 6.5-6.8 lb/gal.**

Figure A-13. Autorotative RPM VS Density Altitude

FUEL CONSUMPTION VS INDICATED TORQUE CHART

EXAMPLE PROBLEM

Given

Nf/Nr	96%
Torque	70% Q.
Pressure altitude	Sea level

Determine

Fuel flow.

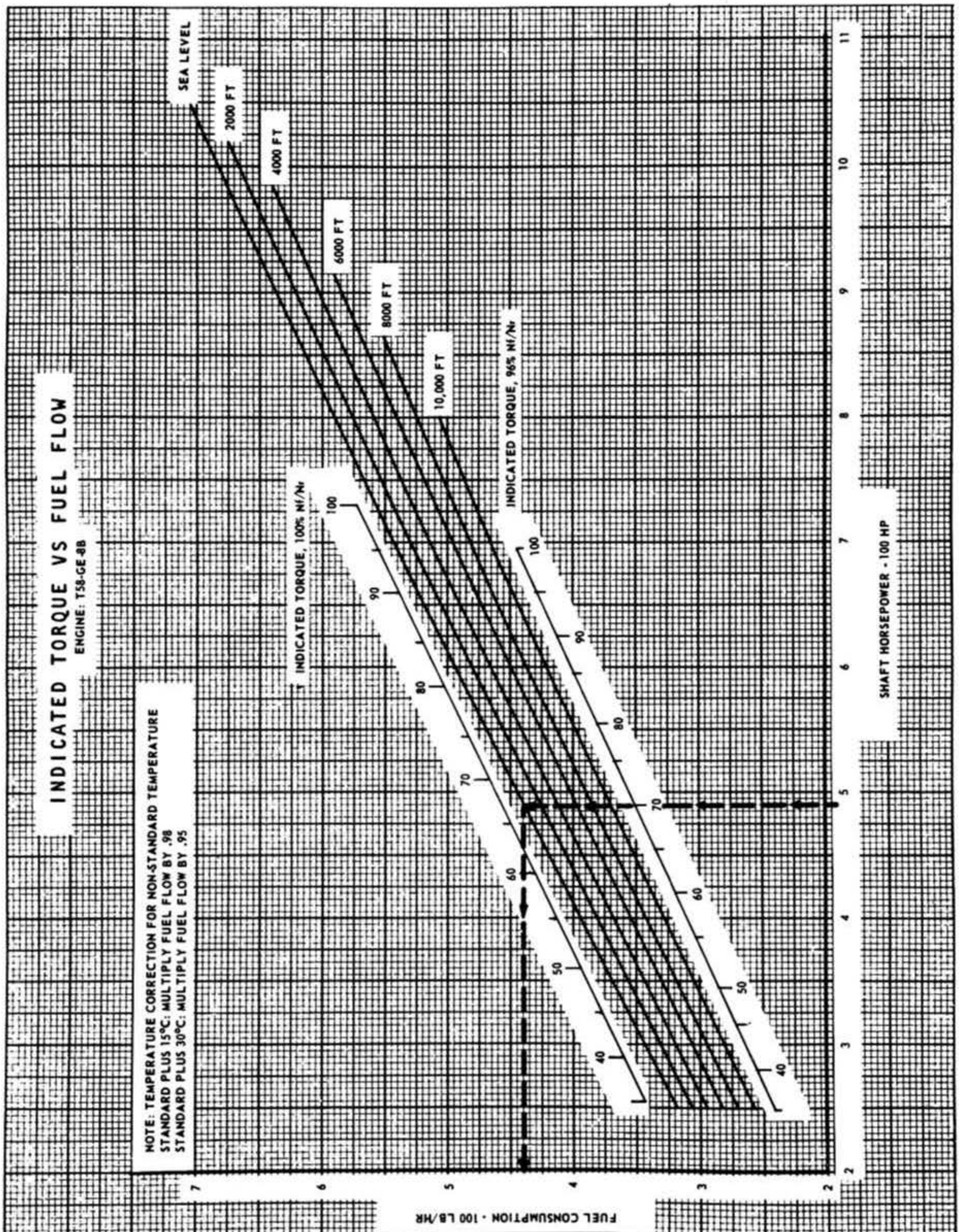
Solution

(Refer to figure A-14)

1. Enter chart on 96% Nf/Nr line at 70% Q.

2. Move vertically up to the intersection of the sea level pressure altitude line.

3. From this intersection move horizontally left to the fuel flow scale and read a fuel flow of 440 pounds-per-hour.



Model: HH-52A
Date: 1963
Data Basis: Eng.Mfr.Spec. (plus 5%)
Engine: T58-GE-8B
Fuel Grade: JP-4/JP-5
Fuel Density: 6.5-6.8 lb/gal.

Figure A-14. Fuel Consumption VS Power and Indicated Torque

POWER AVAILABLE CHART

EXAMPLE PROBLEM

Given

Ambient temperature	45°C
Pressure altitude	7000 feet
Nr	96%

Determine

Torque available at continuous power.

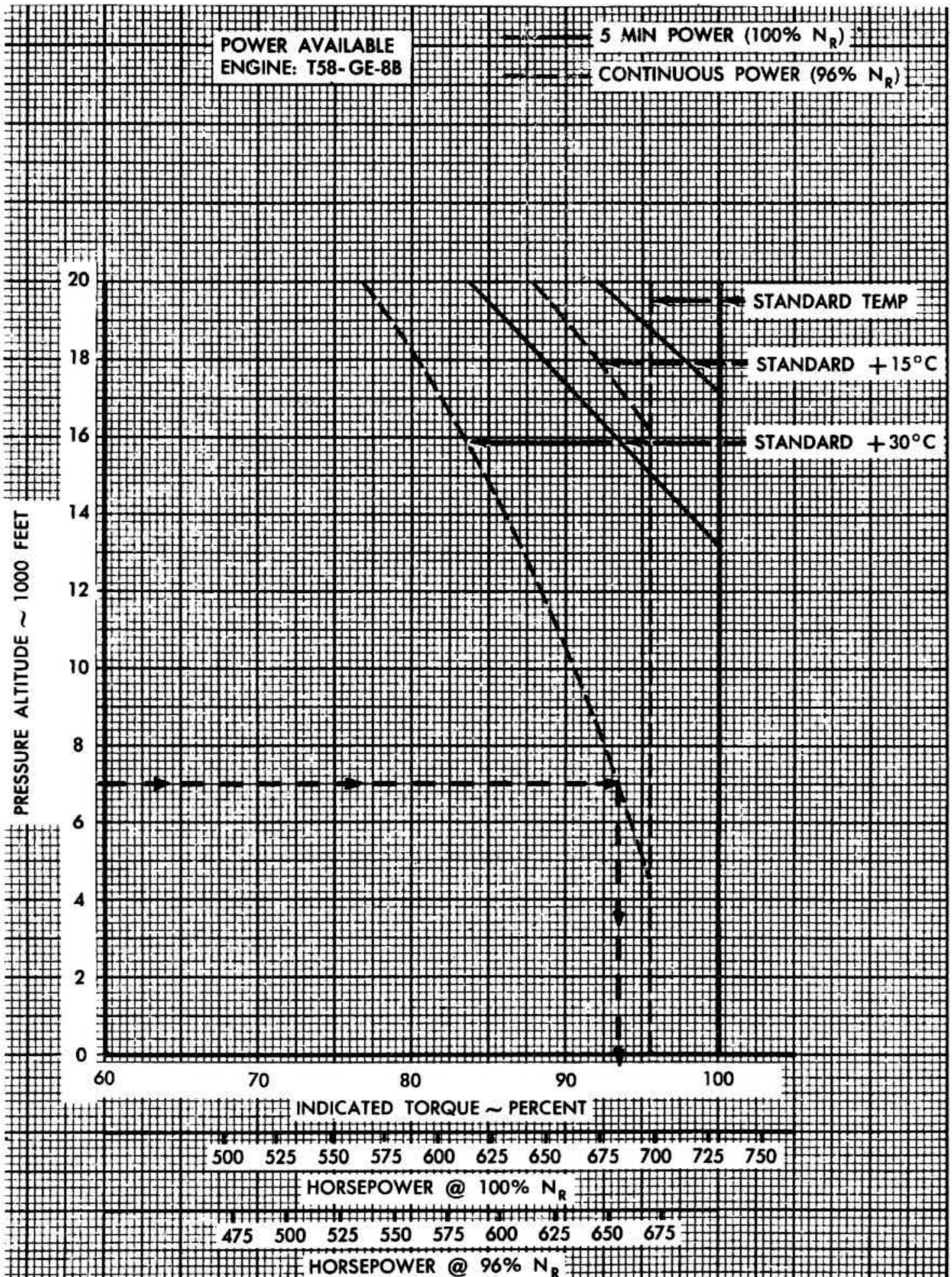
Solution

(Refer to figure A-15)

1. Enter chart at 7000 feet pressure altitude.

2. Move horizontally right to the 45°C (STD +30°C) line for 96% Nr.

3. Move vertically down to the indicated torque scale and read 93.5% Q.



Model: HH-52A
Date: 1963
Data Basis: Eng.Mfr.Spec.
Engine: T58-GE-8B
Fuel Grade: JP-4/JP-5
Fuel Density: 6.5-6.8 lb/gal.

Figure A-15. Power Available

POWER VS SPEED CHART

EXAMPLE PROBLEM

Given

True airspeed	80 knots
Pressure altitude	2000 feet
Gross weight	8000 pounds
Nr	96%

Determine

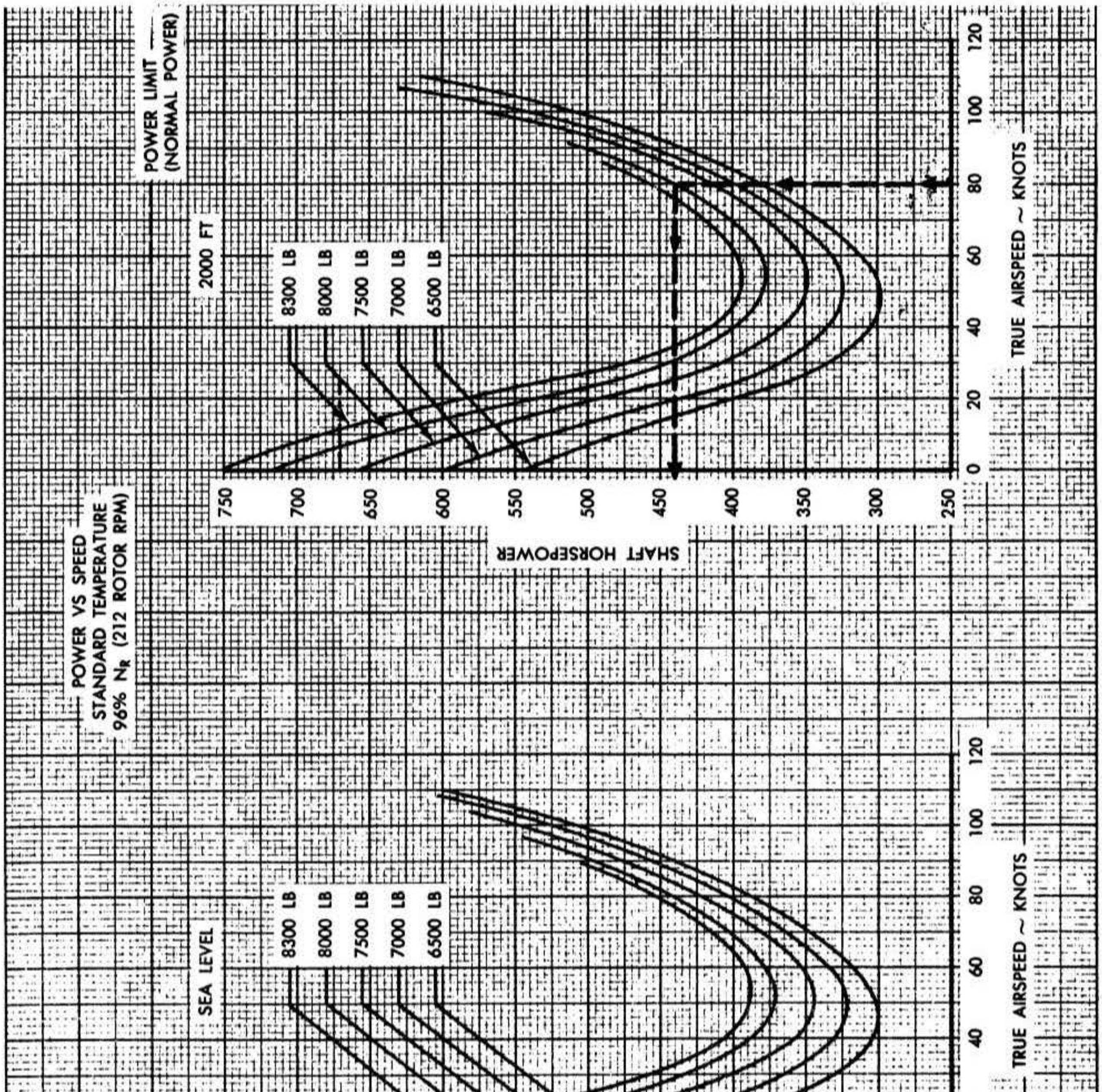
Power required.

Solution

1. Enter power vs airspeed chart (figure A-16 for 2000 feet PA) at 80 knots (TAS) on the true airspeed scale.

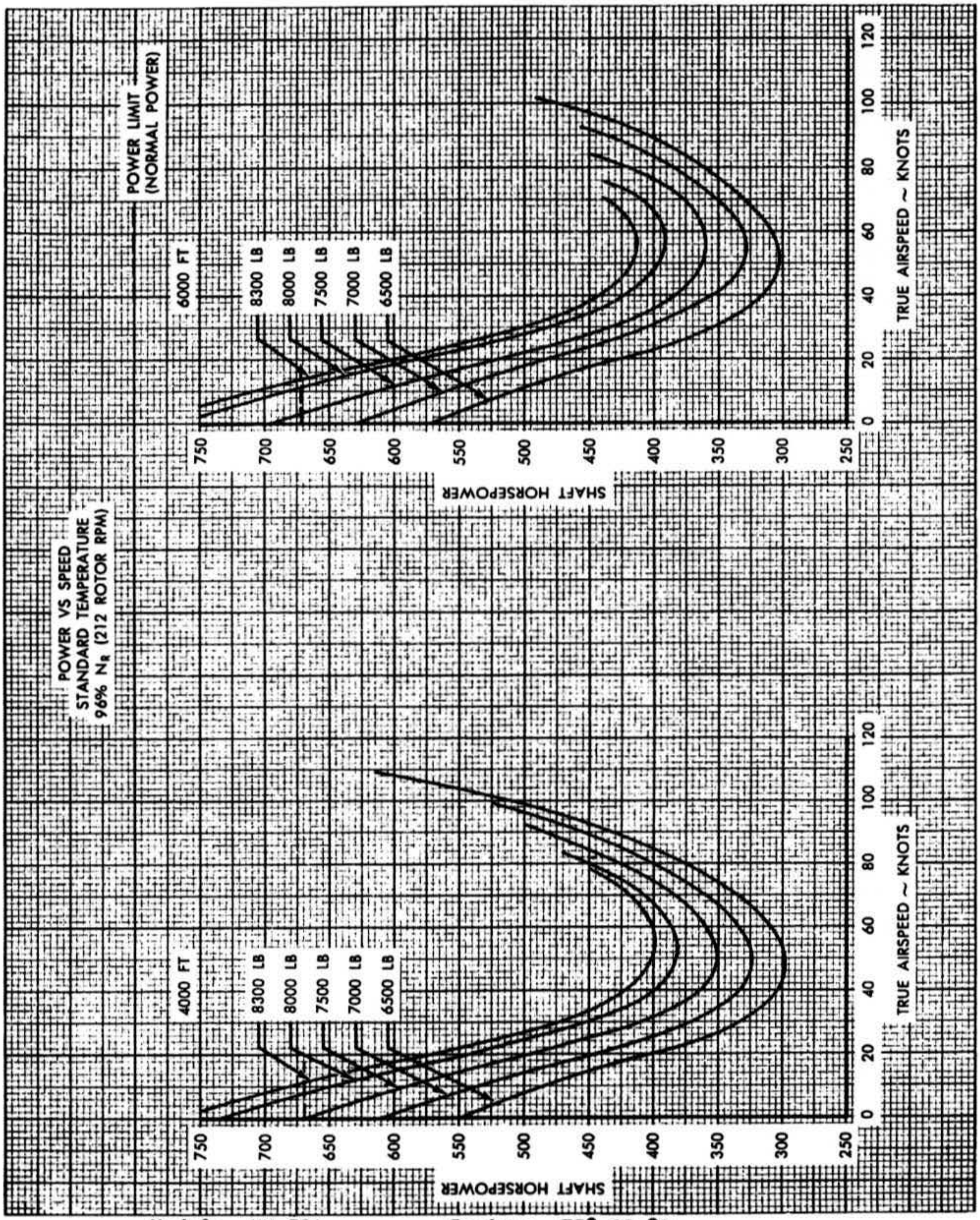
2. Move vertically up to intersection with the 8000-pound gross weight curve.

3. Move horizontally left to the shaft horsepower scale and read 440 shaft horsepower.



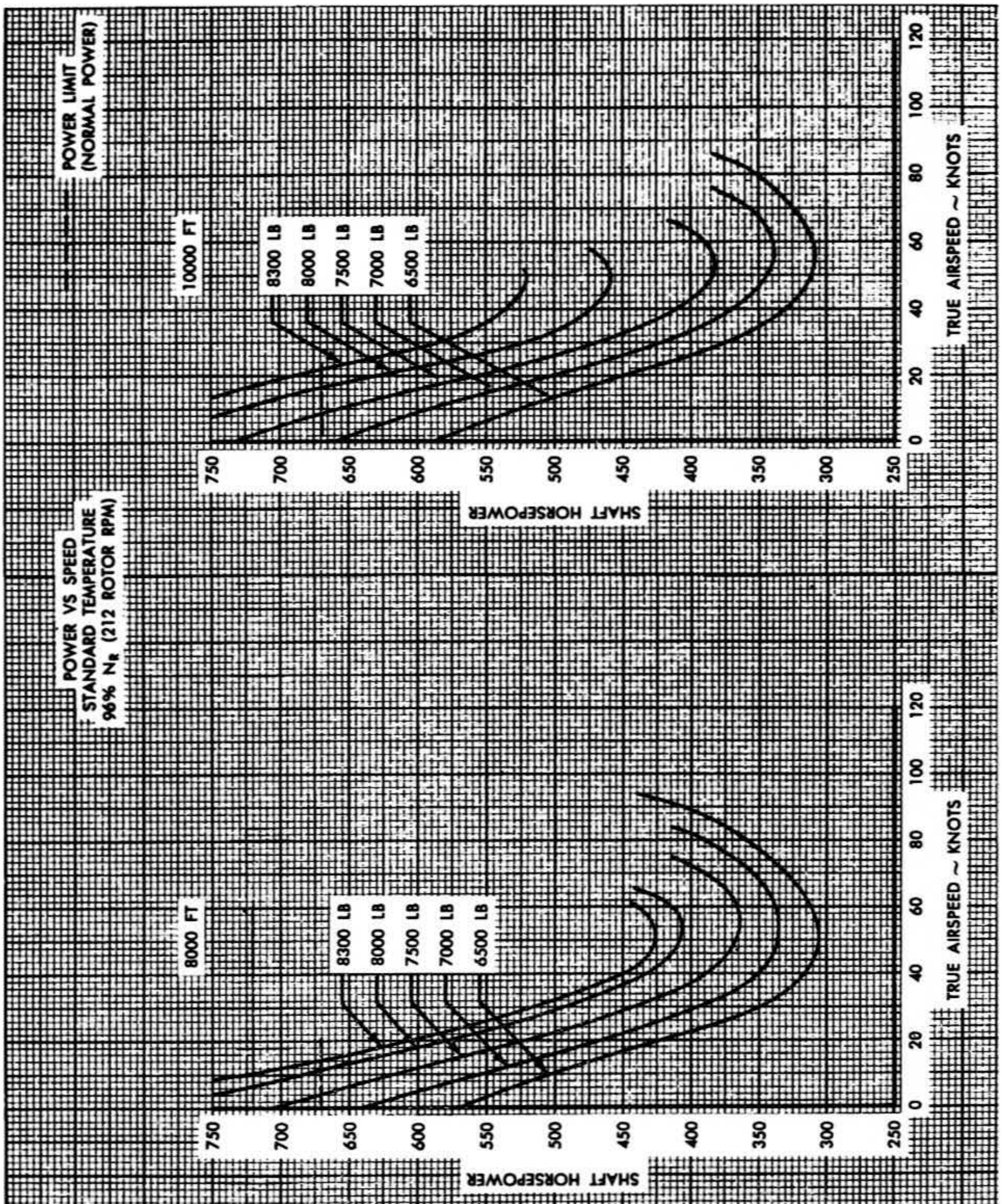
Model: HH-52A
Date: 1960
Data Basis: Estimated
Engine: T58-GE-8B
Fuel Grade: JP-4/JP-5
Fuel Density: 6.5-6.8 lb/gal.

Figure A-16. Power VS Speed S.L. and 2000 Ft



Model: HH-52A **Engine: T58-GE-8B**
Date: 1960 **Fuel Grade: JP-4/JP-5**
Data Basis: Estimated **Fuel Density: 6.5-6.8 lb/gal.**

Figure A-17. Power VS Speed 4000 Ft and 6000 Ft



Model: HH-52A Engine: T58-GE-8B
Date: 1960 Fuel Grade: JP-4/JP-5
Data Basis: Estimated Fuel Density: 6.5-6.8 lb/gal.

Figure A-18. Power VS Speed 8000 Ft and 10,000 Ft

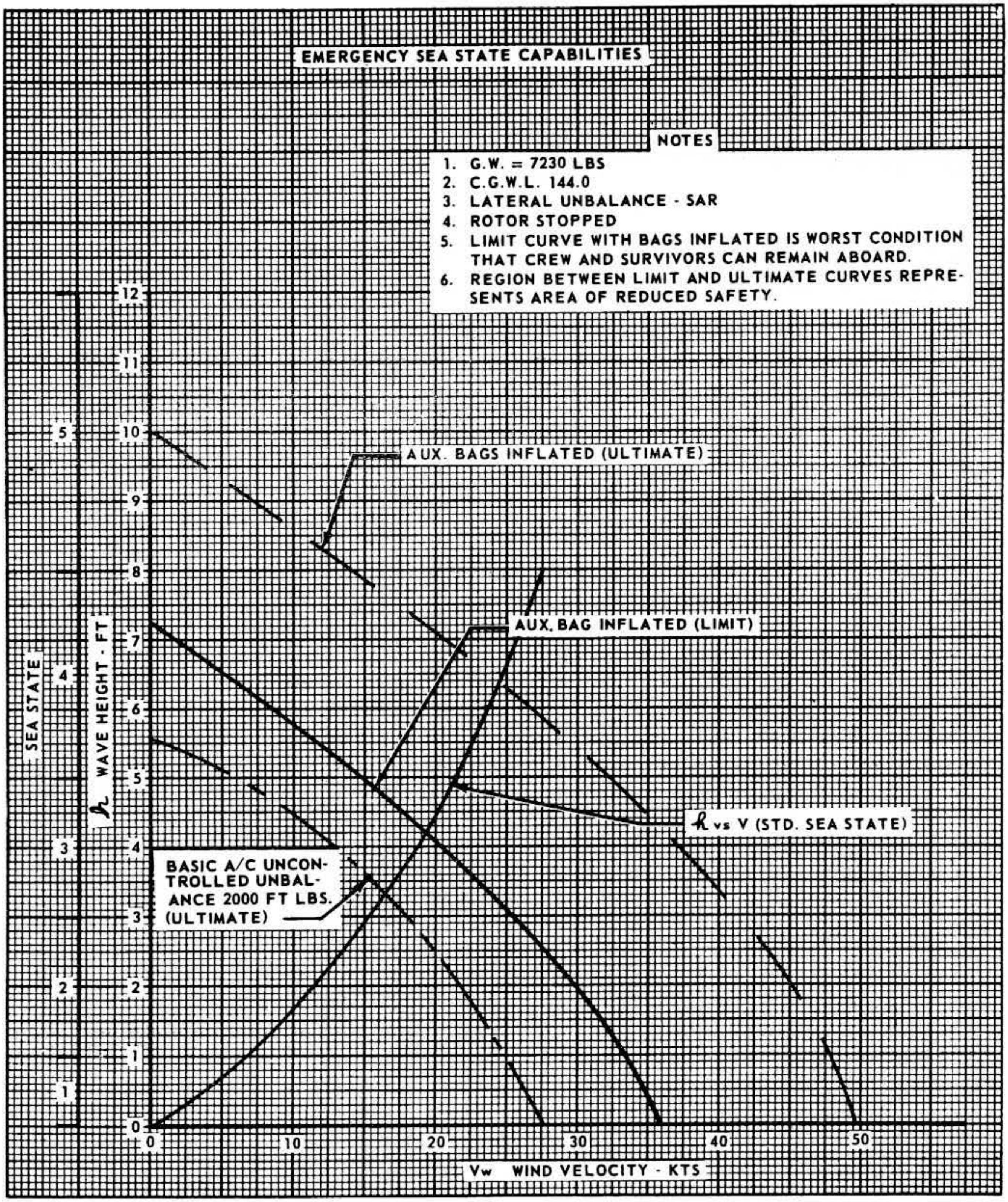


Figure A-19. Emergency Sea State Capabilities

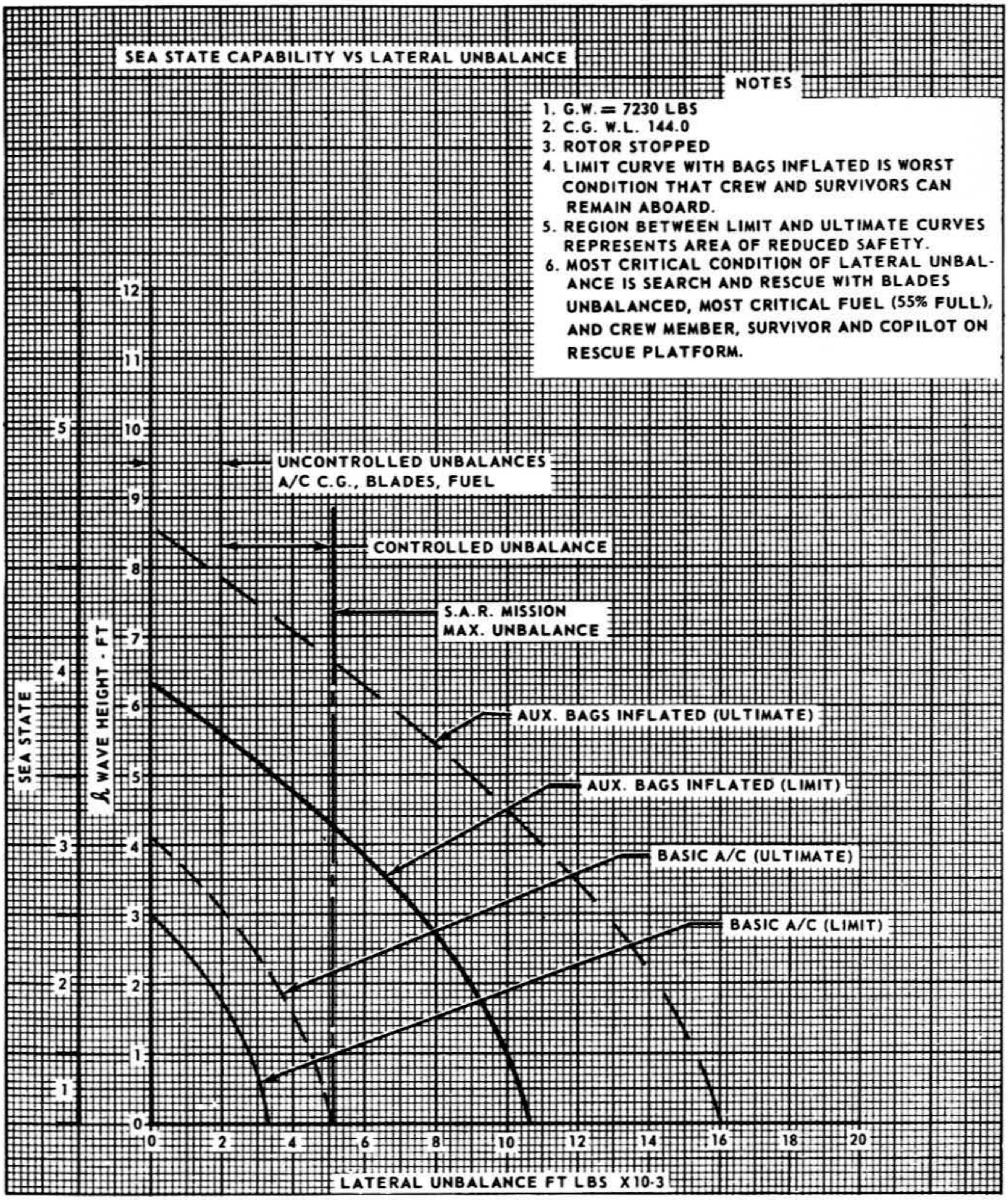
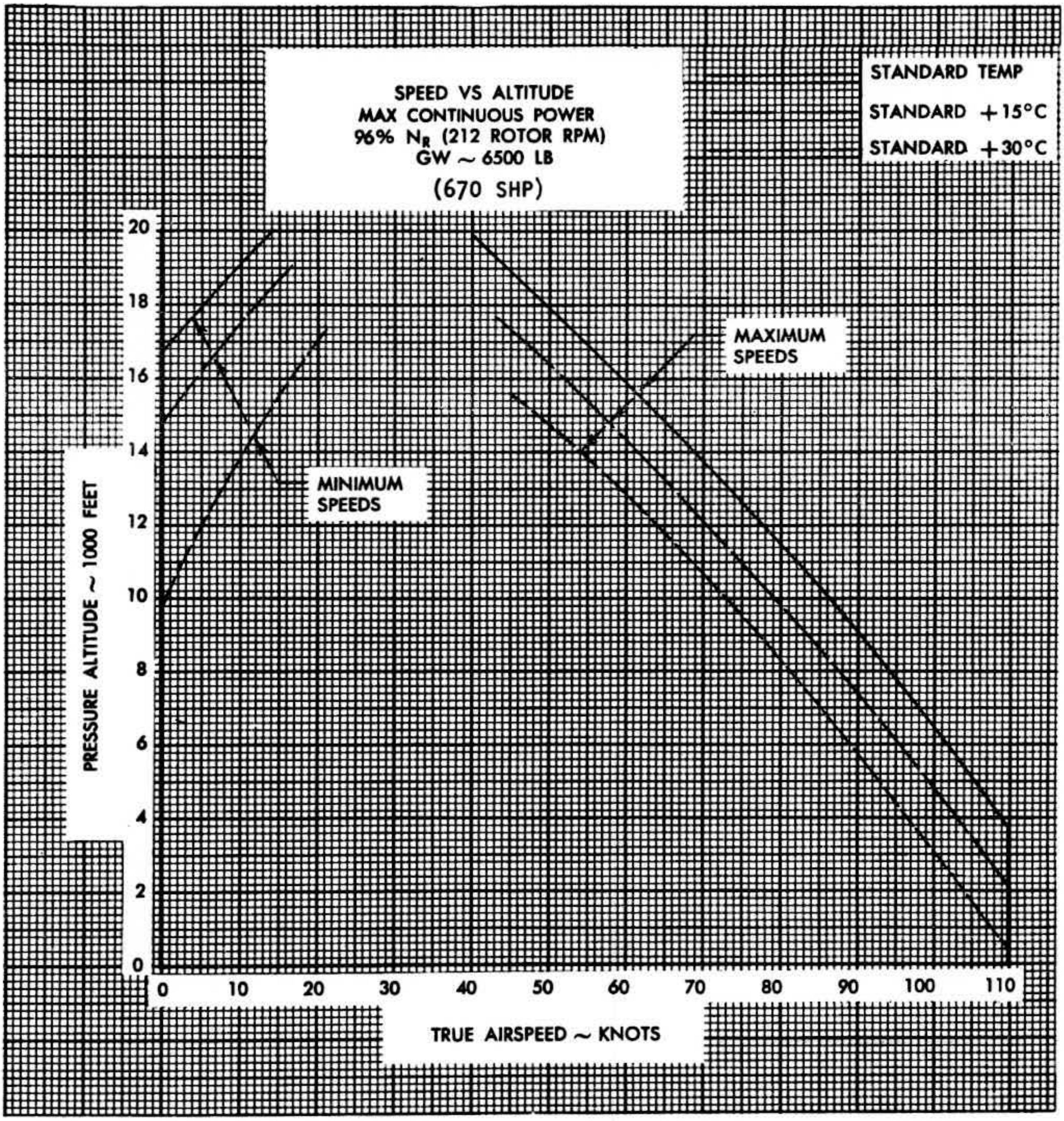
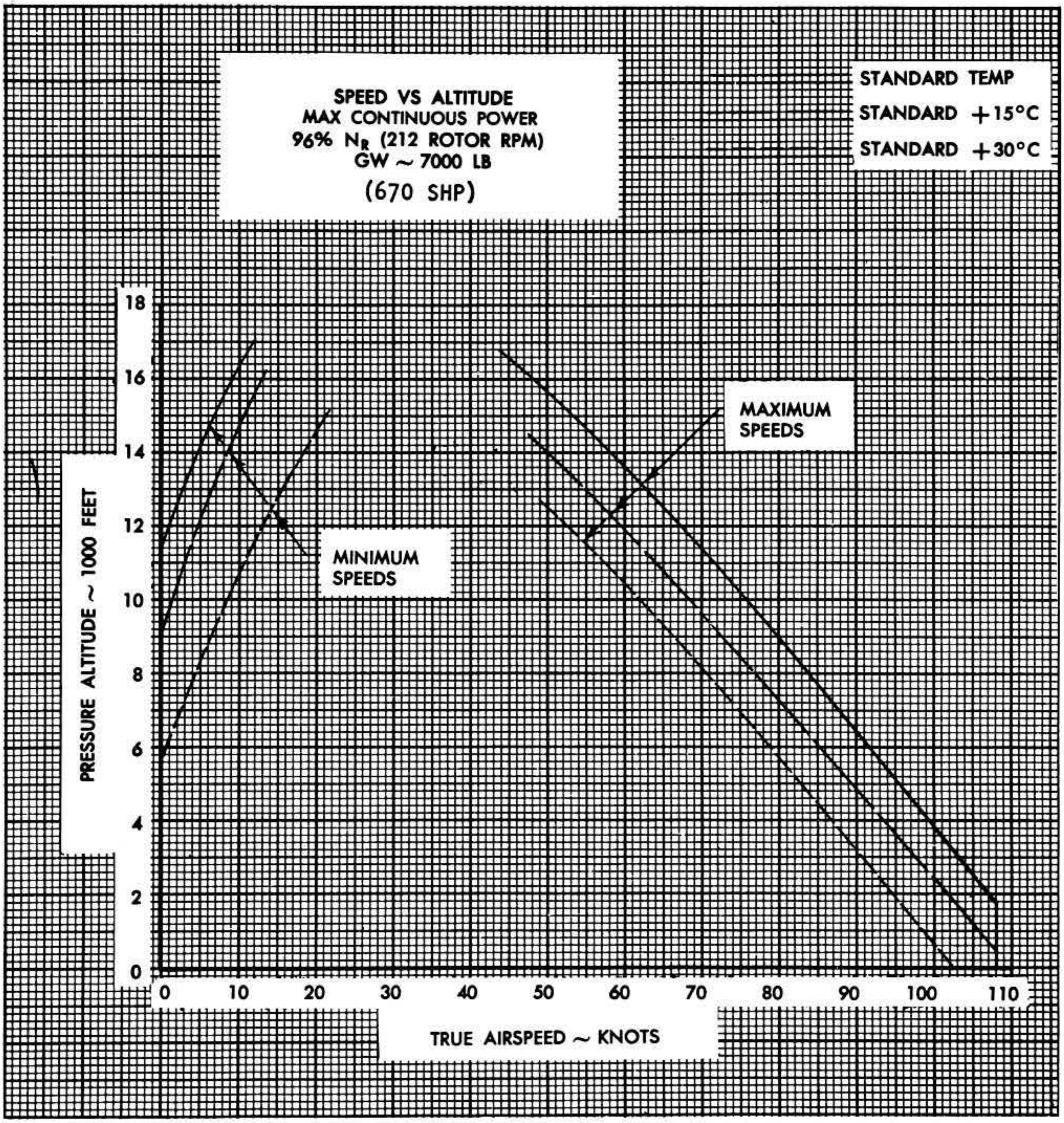


Figure A-20. Sea State Capability VS Lateral Unbalance



Model: HH-52A Engine: T58-GE-8B
Date: 1960 Fuel Grade: JP-4/JP-5
Data Basis: Estimated Fuel Density: 6.5-6.8 lb/gal.

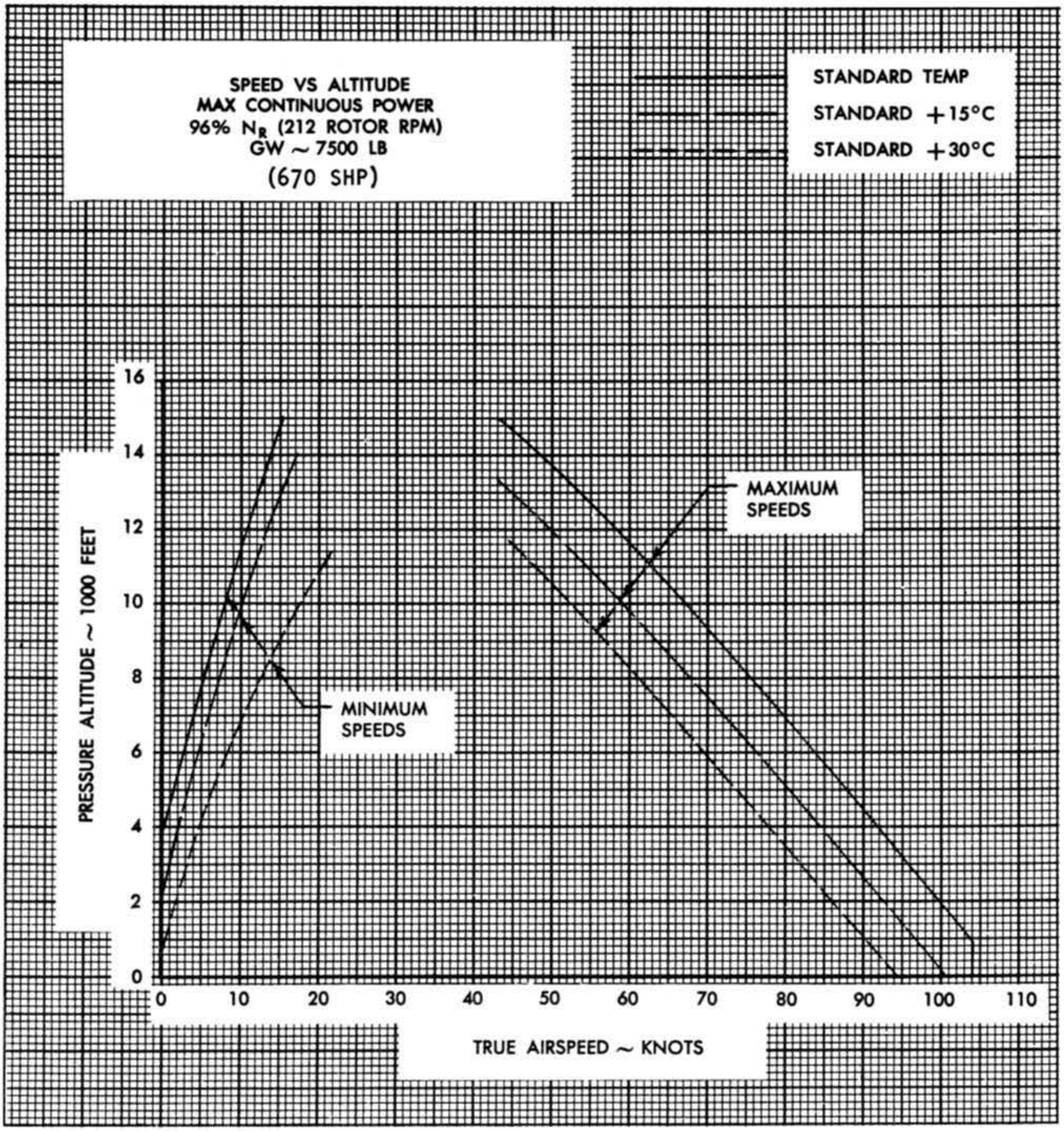
Figure A-21. Speed VS Altitude G.W. 6500 Lbs 96% Nf/Nr



Model: HH-52A
Date: 1960
Data Basis: Estimated

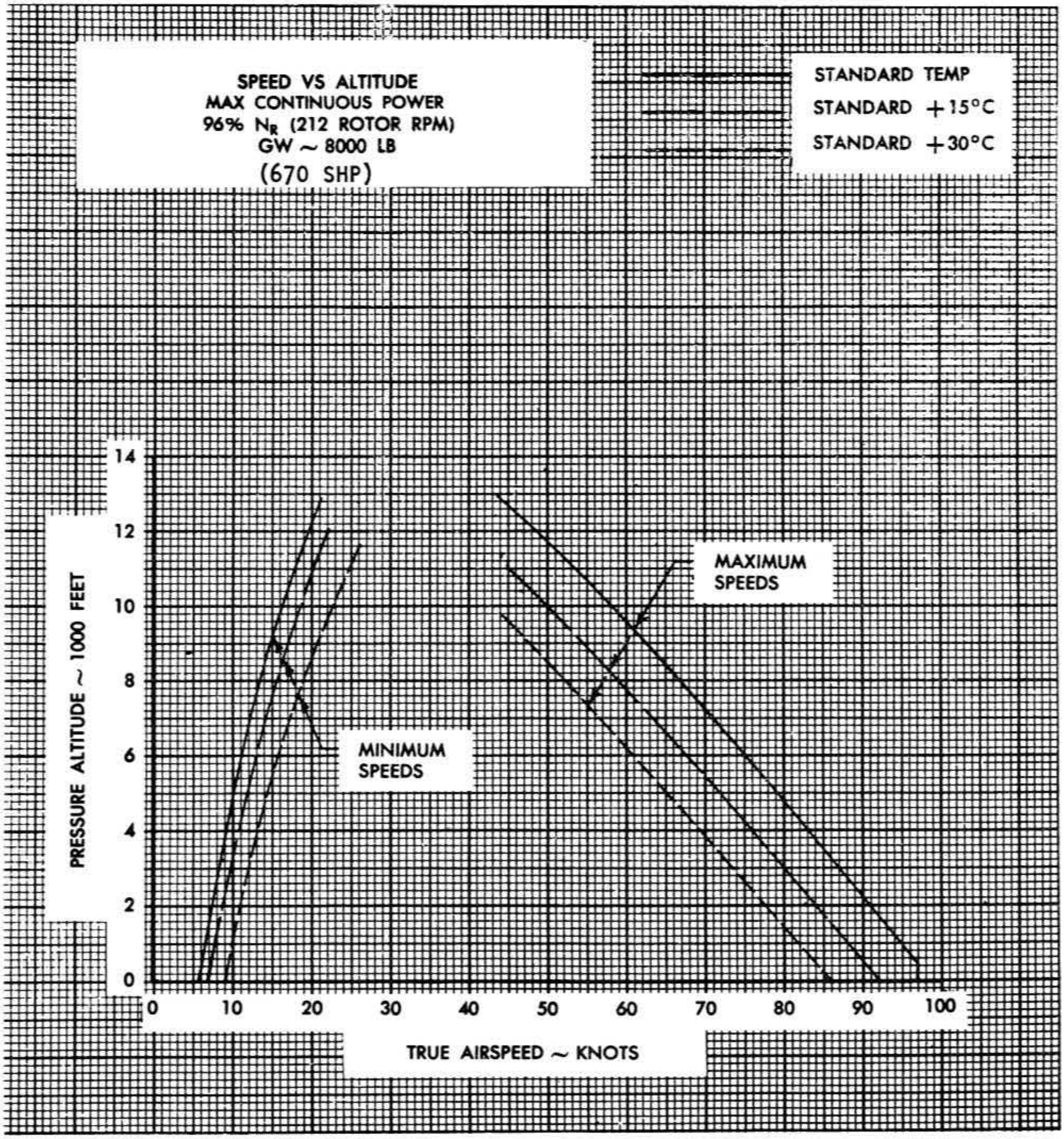
Engine: T58-GE-8B
Fuel Grade: JP-4/JP-5
Fuel Density: 6.5-6.8 lb/gal.

Figure A-22. Speed VS Altitude G.W. 7000 Lbs 96% Nf/Nr



Model: HH-52A
Date: 1960
Data Basis: Estimated
Engine: T58-GE-8B
Fuel Grade: JP-4/JP-5
Fuel Density: 6.5-6.8 lb/gal.

Figure A-23. Speed VS Altitude G.W. 7500 Lbs 96% Nf/Nr



Model: HH-52A
Date: 1960
Data Basis: Estimated
Engine: T58-GE-8B
Fuel Grade: JP-4/JP-5
Fuel Density: 6.5-6.8 lb/gal.

Figure A-24. Speed VS Altitude G.W. 8000 Lbs 96% Nf/Nr

SPEED VS ALTITUDE CHART

EXAMPLE PROBLEM

Given

Maneuver	Level flight
Power	Maximum con-tinous at 96% Nr
Pressure altitude	2000 feet
OAT	Standard +15°C
Gross weight	8300 pounds

Determine

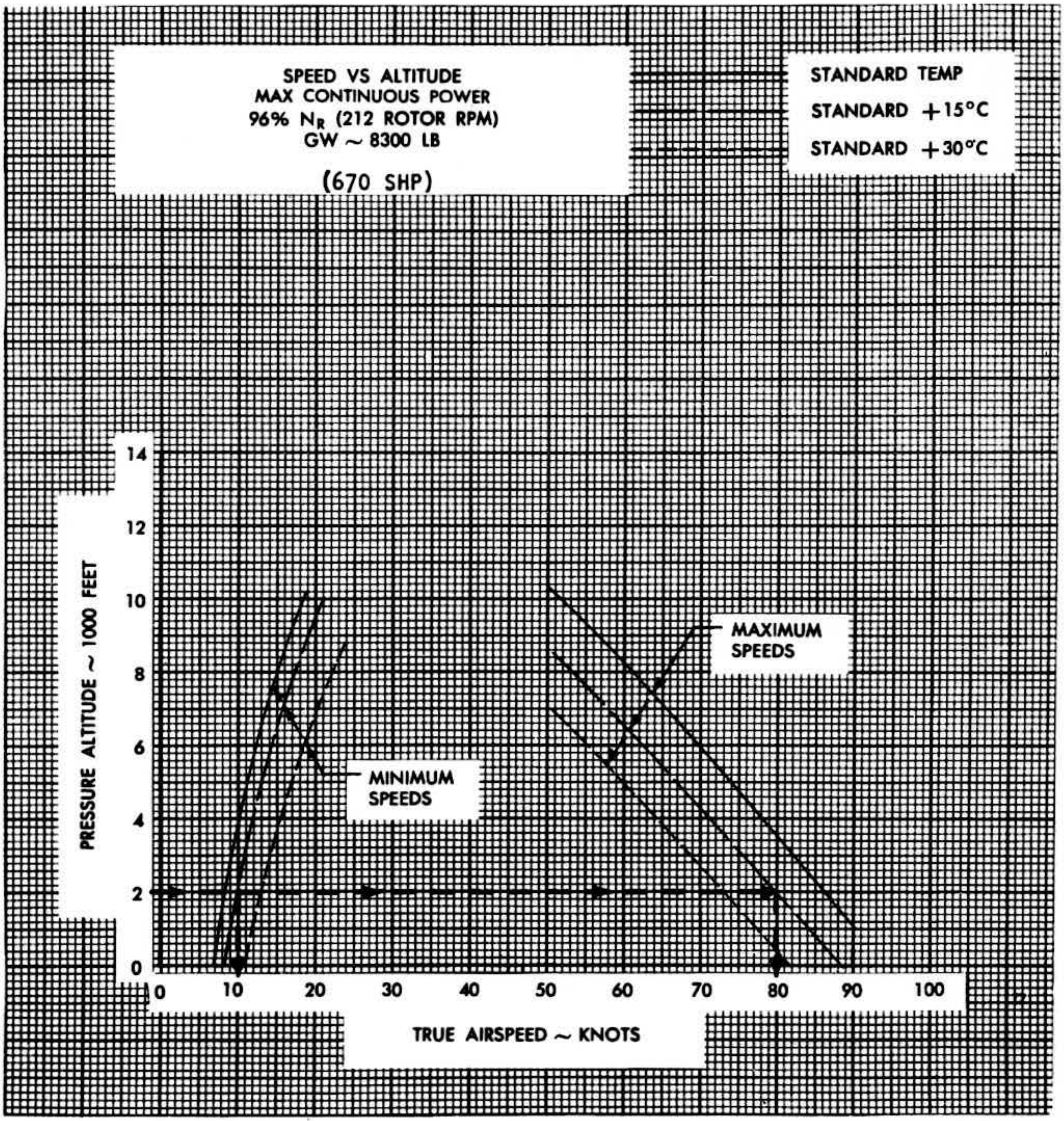
The airspeed range.

Solution

1. For 96% Nr and a gross weight of 8300 pounds use figure A-25.

2. On the left side of the chart locate the 2000 feet pressure altitude line, read to the right and note that it intersects the standard +15°C line twice.

3. Move down from each of these points and read 10 KTAS and 80 KTAS. These airspeeds are the lower and upper limits for maintaining level flight for the conditions given.



Model: HH-52A
Date: 1960
Data Basis: Estimated

Engine: T58-GE-8B
Fuel Grade: JP-4/JP-5
Fuel Density: 6.5-6.8 lb/gal.

Figure A-25. Speed VS Altitude G.W. 8300 Lbs 96% Nf/Nr

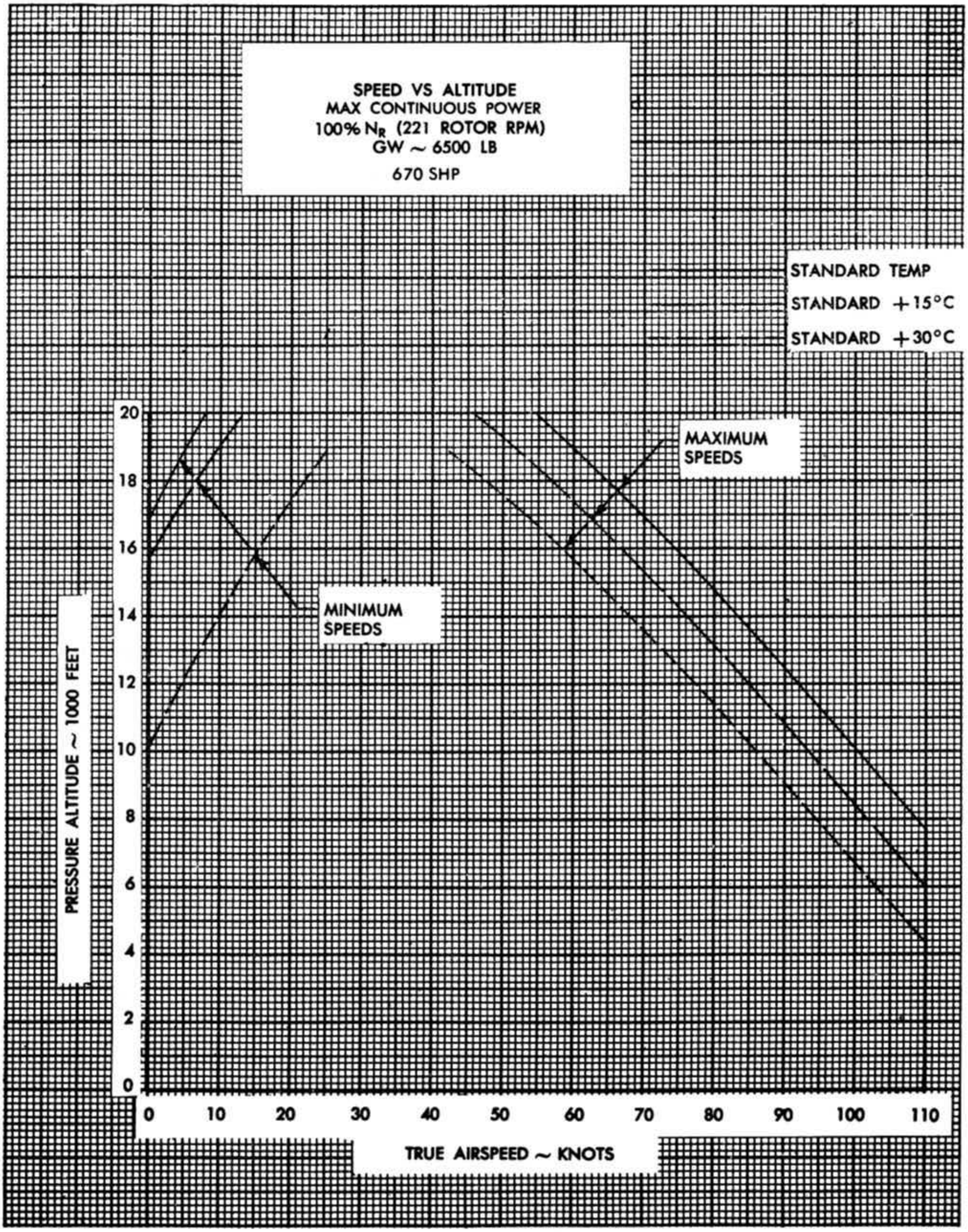


Figure A-26. Speed VS Altitude G.W. 6500 Lbs 100% Nf/Nr

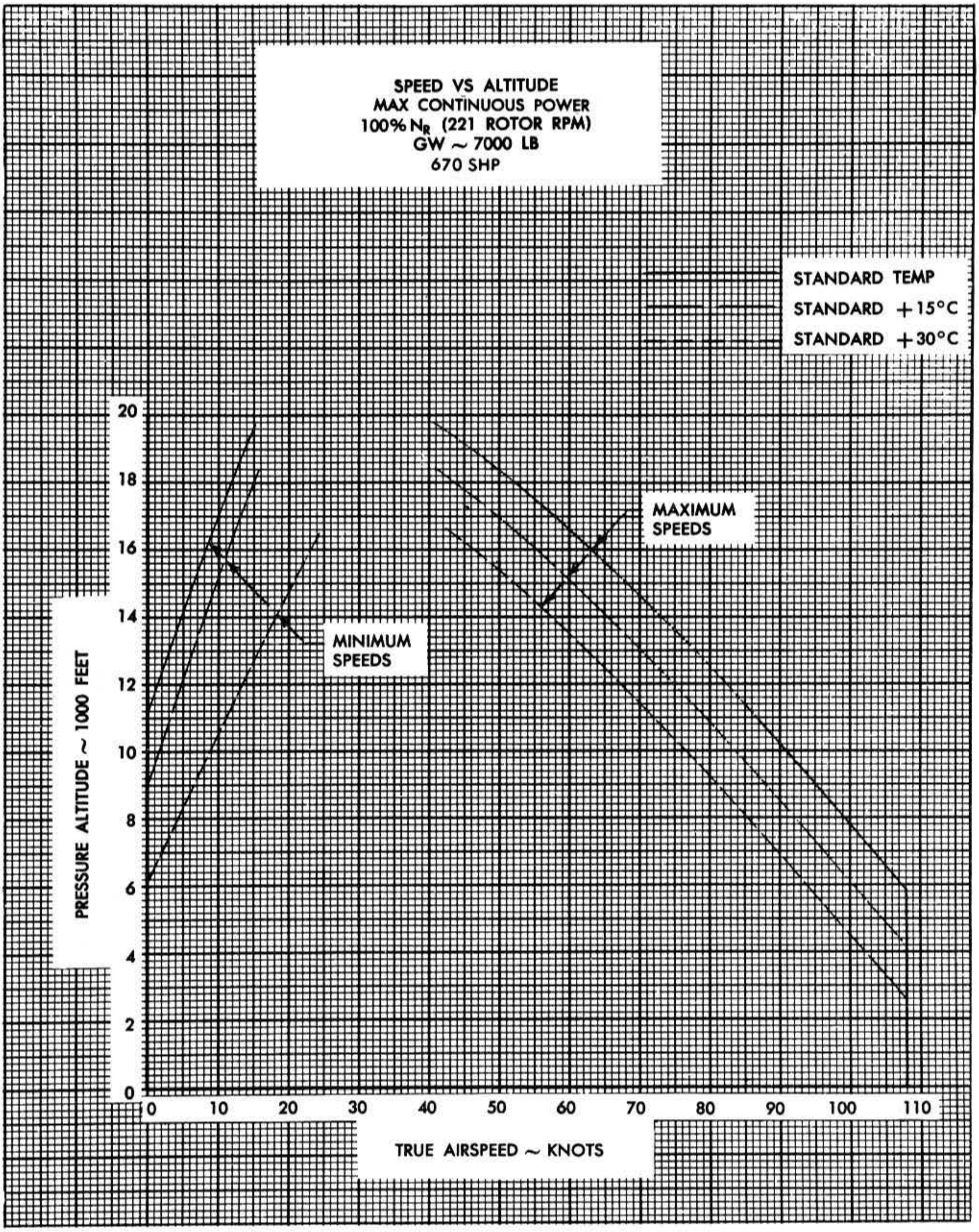


Figure A-27. Speed VS Altitude G.W. 7000 Lbs 100% Nf/Nr

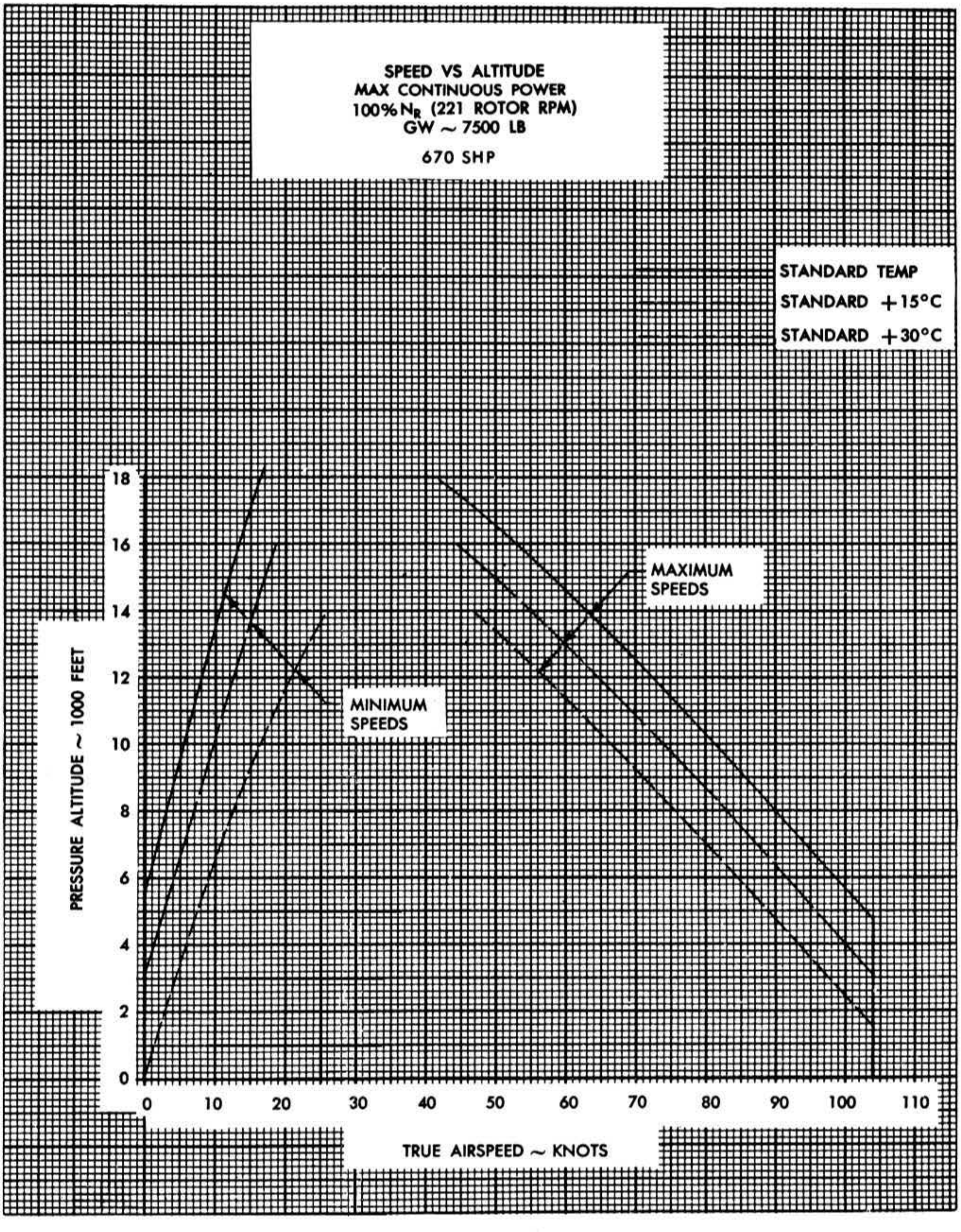


Figure A-28. Speed VS Altitude G.W. 7500 Lbs 100% Nf/Nr

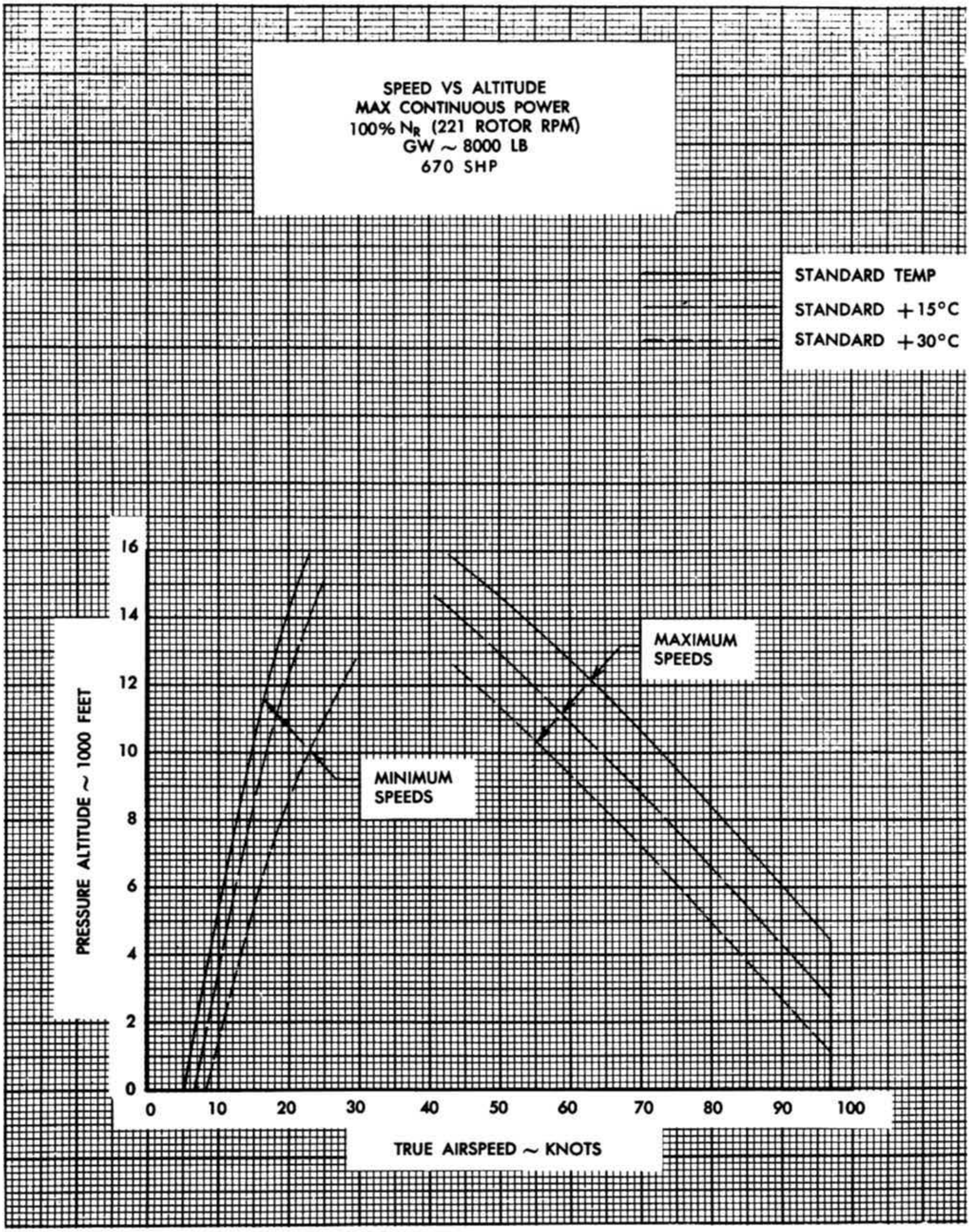


Figure A-29. Speed VS Altitude G.W. 8000 Lbs 100% Nf/Nr

This page intentionally left blank.

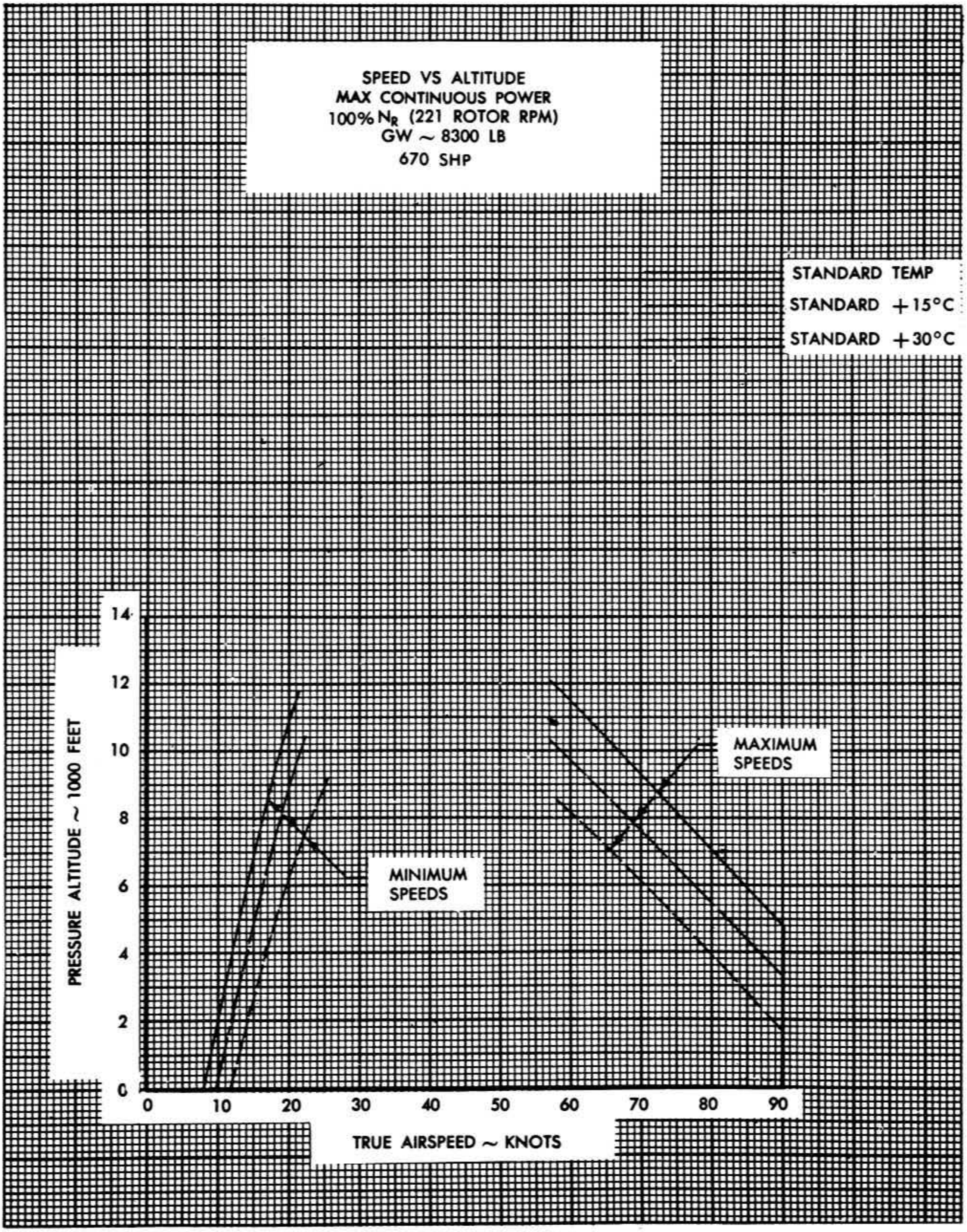


Figure A-30. Speed VS Altitude G.W. 8300 Lbs 100% Nf/Nr

ENGINE HORSEPOWER VS INDICATED TORQUE CHART

EXAMPLE PROBLEM

Given

Shaft horsepower	300 SHP
Nf	100%

Determine

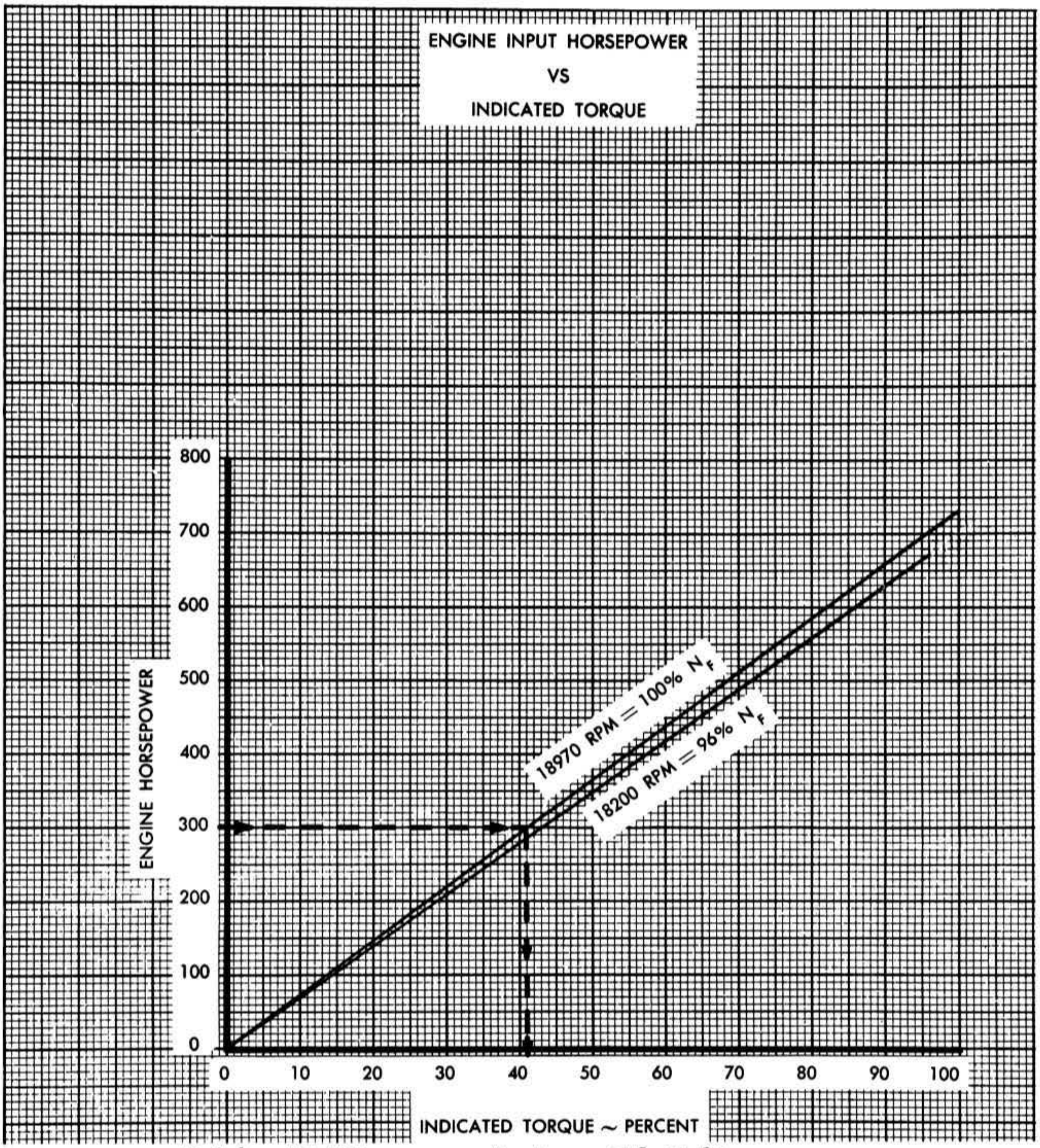
The indicated torque.

Solution

1. Enter the chart at left.

2. Follow 300 shaft horsepower line horizontally to intersection with the 100% Nr line.

3. Move vertically down and read 41% torque.



Model: HH-52A Engine: T58-GE-8B
Date: 1963 Fuel Grade: JP-4/JP-5
Data Basis: Estimated Fuel Density: 6.5-6.8 lb/gal.

Figure A-31. Engine Horsepower VS Indicated Torque

POWER CHECK CHART

EXAMPLE PROBLEM

Given

Pressure altitude	3000 feet
OAT	20°C
Gross weight	7300 pounds
Headwind	8 knots
Nr	96%

Determine

Power required to hover.

Solution

(Refer to figure A-32)

1. Enter the chart at 3000 feet, (A).

2. From (A), proceed horizontally to 7300 pounds, (B).

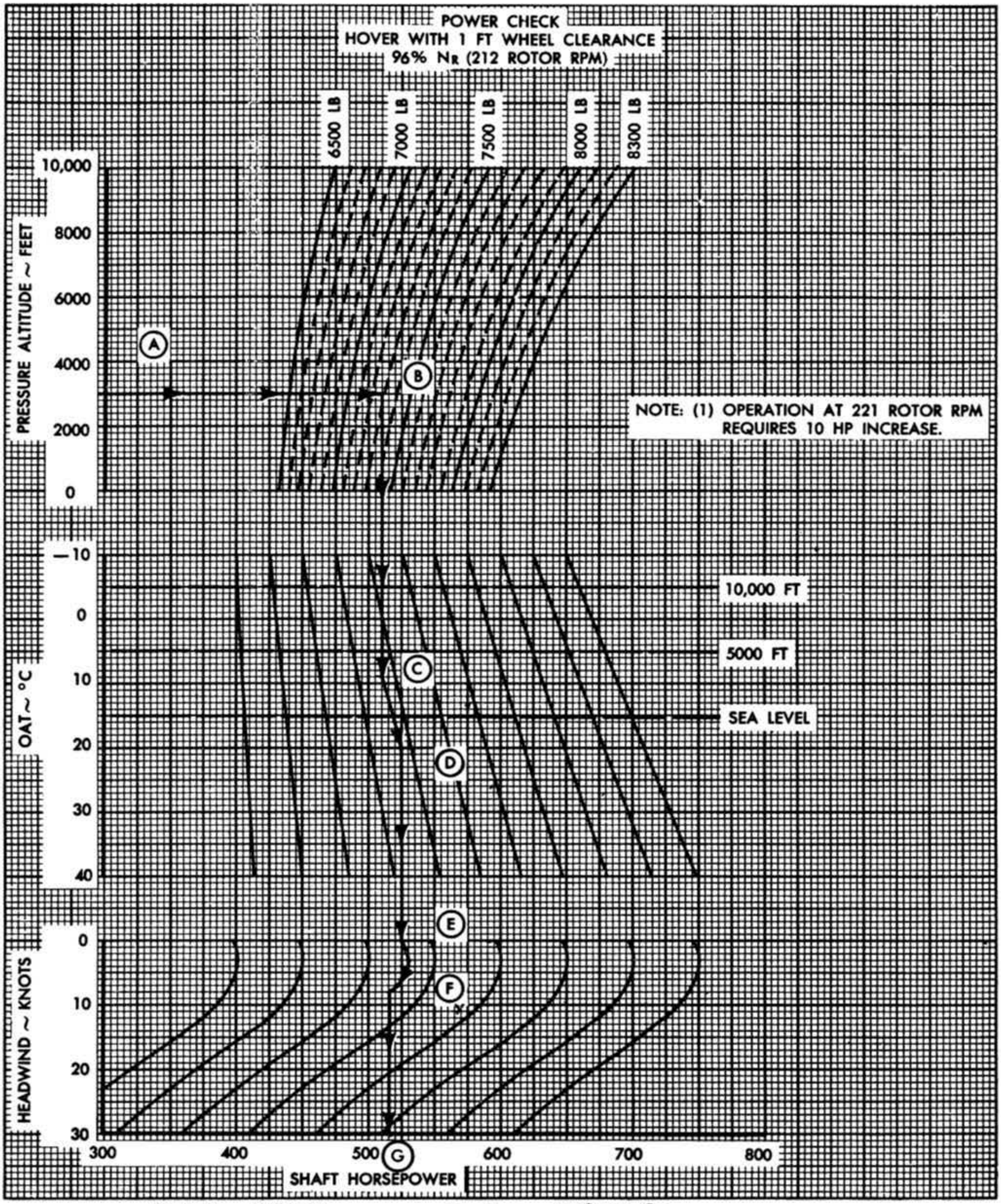
3. From (B) move vertically down to 3000 feet, (C).

4. From (C), follow the temperature influence lines to 20°C (D).

5. From point (D) proceed vertically down to zero headwind, (E).

6. From (E), follow the wind influence curve to 8 Knots, (F).

7. From (F), move vertically down to read 515 shp at (G).



Model: HH-52A Engine: T58-GE-8B
Date: 1960 Fuel Grade: JP-4/JP-5
Data Basis: Estimated Fuel Density: 6.5-6.8 lb/gal.

Figure A-32. Power Check

This page intentionally left blank.

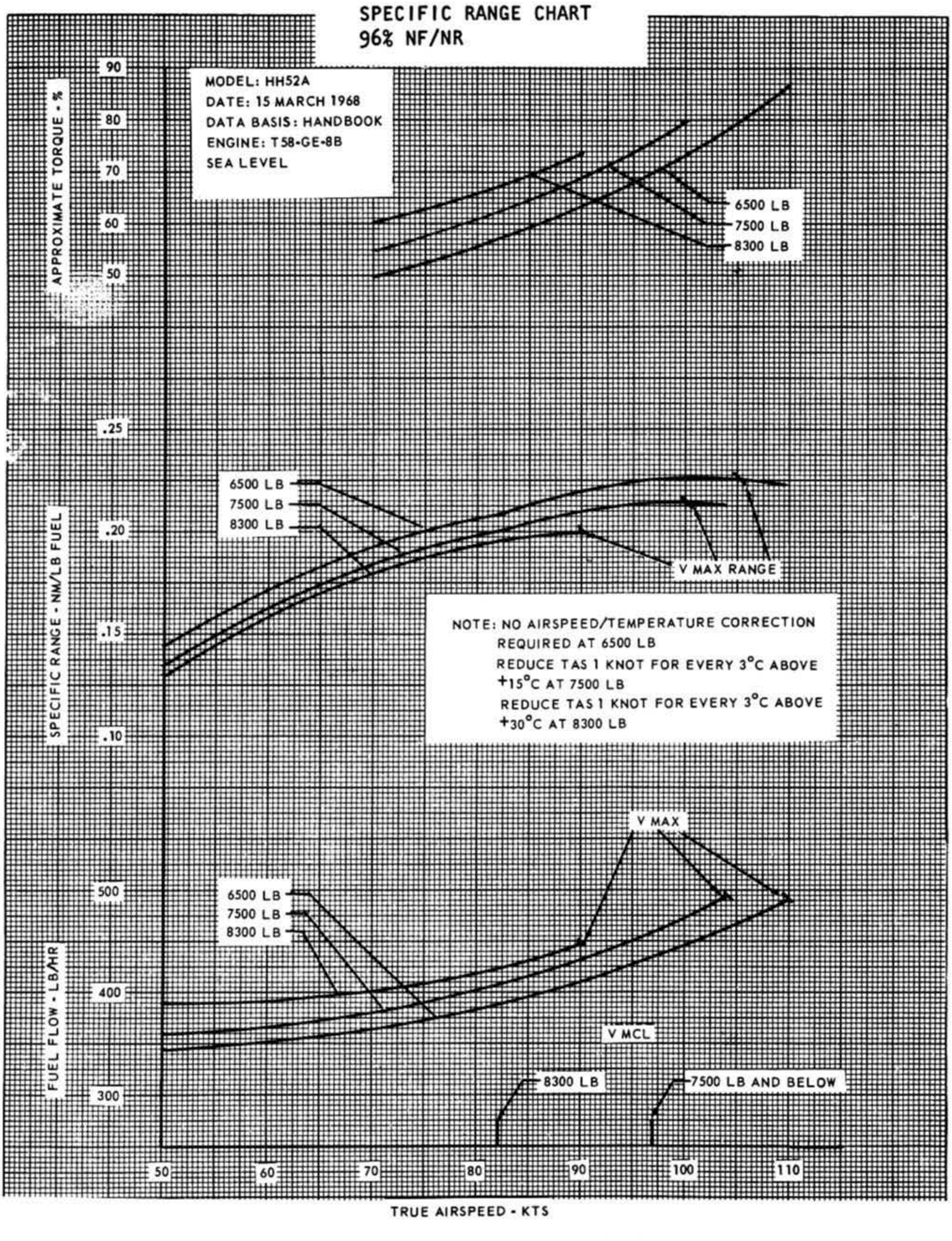


Figure A-33. Specific Range Chart Sea Level

MAXIMUM RANGE CRUISE CHART

EXAMPLE PROBLEM

Given

Gross weight	8000 pounds
OAT	Standard
Pressure altitude	2000 feet and flight altitude
Fuel quantity	1000 lbs. available for cruise.

Determine

Maximum range.

Solution

(See figure A-34, Maximum Range Cruise for 2000 feet)

This sample problem is based upon the average gross weight for cruise. 8000 lbs — (1000 ÷ 2) = 7500 lbs. Average gross weight for cruise.

1. Determine maximum specific range by referring to specific range section of chart. Locate curve for average gross weight for cruise (7500 lbs). Follow gross weight curve to the desired airspeed (Vmax range), point A. Move horizontally to the left and read specific range 0.215 nautical miles per pound of fuel.

2. Determine approximate torque by moving vertically from point A up to approximate torque curve for 7500 pounds, point B. Move horizontally to left and read approximate torque required, 74%.

3. Determine fuel flow (optional procedure) by moving vertically down from poin A to fuel flow curve for 7500 lbs, point C. Move horizontally to the left and read fuel flow 440 lbs/hr.

4. Determine maximum range by multiplying specific range by useable fuel. Specific range x pounds of fuel available = no wind range 0.215 x 1000 = 215 NM.

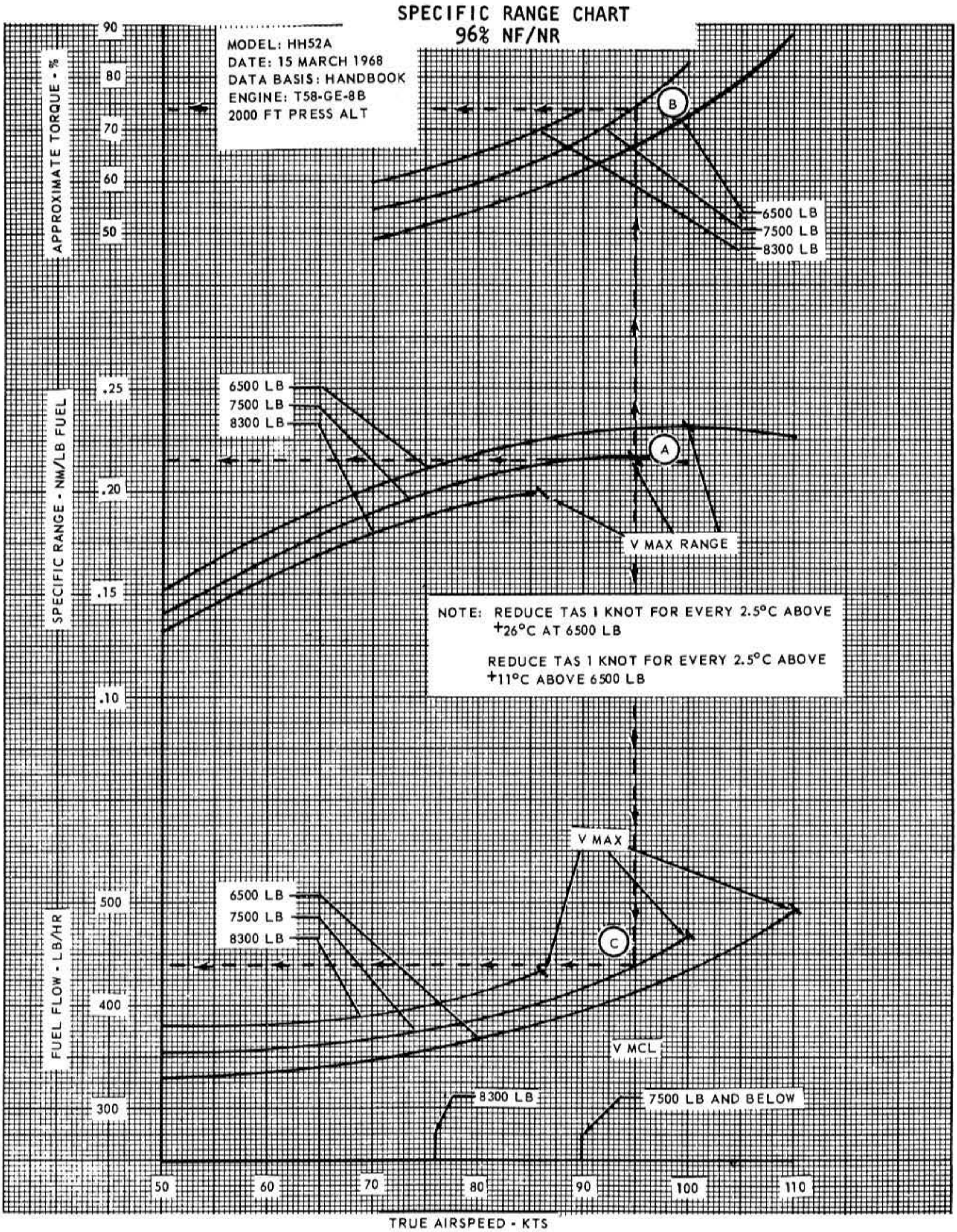


Figure A-34. Specific Range Chart — 2000 Ft

This page intentionally left blank.

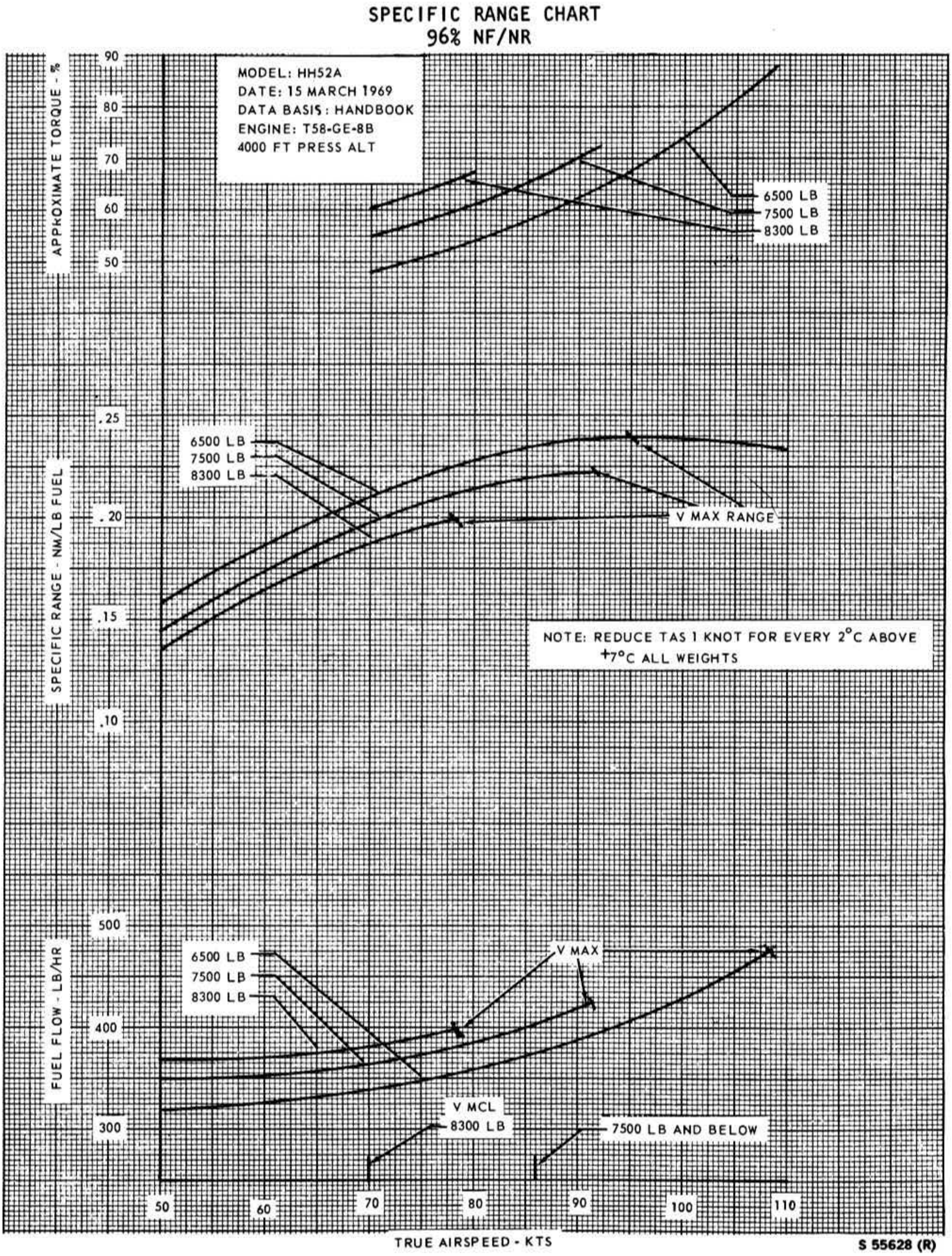


Figure A-35. Specific Range Chart – 4000 Ft

BLADE STALL CHART

EXAMPLE PROBLEMS

Given

Gross weight	8000 pounds
Angle of bank	20°
Pressure altitude	4000 feet
OAT	20°C
Nr	96%

Determine

Incipient blade stall speed.

Solution

1. Enter chart at 4000 feet pressure altitude (point A).

2. From point A, move horizontally to 20°C (68°F) OAT (point B).

3. From point B, move downward to base line, 96% Nr (point C).

4. From point C, move parallel to the rotor speed influence lines to 98% Nr (point D).

5. From point D, proceed downward to point E on the gross weight influence graph.

6. From point E, move parallel to the gross weight influence lines to 8000 pounds (point F).

7. From point F, proceed downward to 0° angle of bank (point G).

8. From point G, move parallel to the angle of bank influence curves to a 20° angle of bank (point H).

9. From point H, move downward through the calibrated airspeed scale to the indicated airspeed scale (point I).

10. The indicated airspeed for the above conditions would be 68 knots.

Given

Gross weight	8000 pounds
Angle of bank	20°
Pressure altitude	2000 feet
OAT	−10°C
Nr	100%

Determine

Incipient blade stall speed.

Solution

1. Enter chart at 2000 feet pressure altitude (point A).

2. From point A, move horizontally to −10°C (14°F) OAT (point B).

3. From point B, move downward to base line, 96% Nr (point C).

4. From point C, move parallel to the rotor speed influence lines to 100% Nr (point D).

5. From point D, proceed downward to point E on the gross weight influence graph.

6. Follow the gross weight base line back from point E to "never exceed speed" curve on point F.

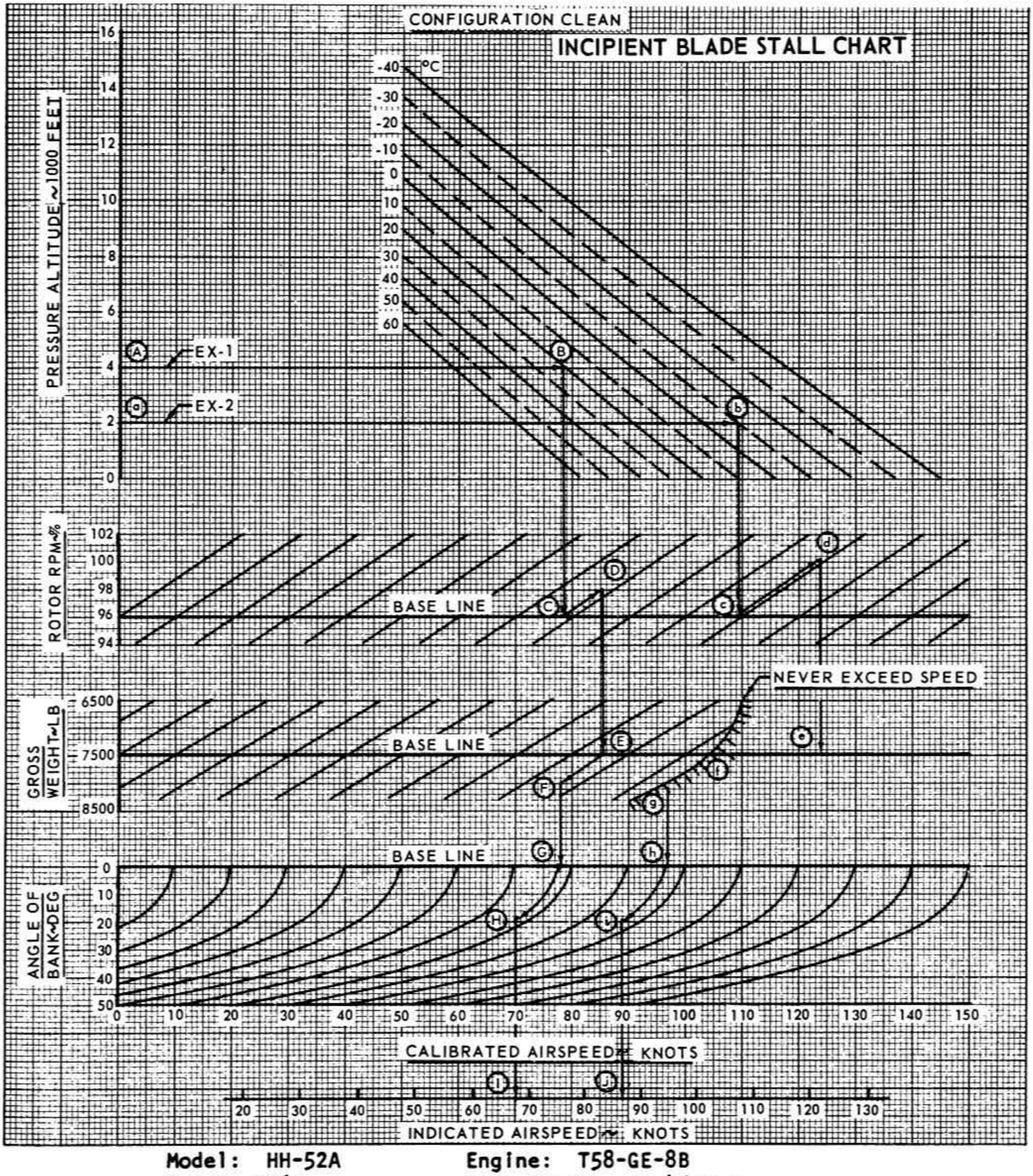
7. From point F, follow "never exceed speed" curve to desired gross weight 8000 lbs (point G).

8. From point G, proceed downward to 0° angle of bank (point H).

9. From point H, move parallel to the angle of bank influence curves to a 20° angle of bank (point I).

10. From point I, move downward through the calibrated airspeed scale to the indicated airspeed scale (point J).

11. The indicated airspeed for the above conditions would be 87 knots.



Model: HH-52A **Engine: T58-GE-8B**
Date: 1963 **Fuel Grade: JP-4/JP-5**
Data Basis: Estimated **Fuel Density: 6.5-6.8 lb/gal.**

There is a 40 knot range from start of drag divergence (on retreating blade tip) to loss of control. The speeds shown were computed at 10 knots above drag divergence.

"G" LIMITATION-AT DESIGN GROSS WEIGHT OF 7500 LBS, THE DESIGN LIMIT LOAD FACTOR IS 2.28.

Figure A-36. Incipient Blade Stall Chart

MAXIMUM AIRSPEED (V_{max}) at 96%/100% N_r

Max Continuous Power (V_{ne} limited)

Pressure Altitude	Temp	7000 lbs	7500 lbs	8000 lbs	8300 lbs
S.L.	STD	108/108	104/104	97/97	90/90
	+15	105/105	97/101	90/95	86/86
	+30	98/103	89/99	82/92	78/86
1000	STD	106/106	102/102	93/95	88/88
	+15	102/105	94/101	86/94	82/88
	+30	88/101	84/97	76/90	72/84
2000	STD	103/104	96/100	88/93	83/87
	+15	96/101	87/98	84/91	75/84
	+30	86/99	79/94	71/85	67/82
3000	STD	97/102	91/98	82/92	77/85
	+15	89/99	81/96	74/87	69/83
	+30	81/95	74/87	67/80	62/76

DATA BASIS: Speed vs Altitude Charts A-21 thru A-30

Figure A-37. Maximum Airspeed (Vmax) (IAS)

ALPHABETICAL INDEX

Subject *Page*

E (Cont)

Subject *Page*

E (Cont) E (Cont)

F

Subject Page

L

M

Subject Page

M (Cont)

N

O

P

Subject *Page*

P (Cont)

R

Subject *Page*

R (Cont)

S

T

Subject *Page*

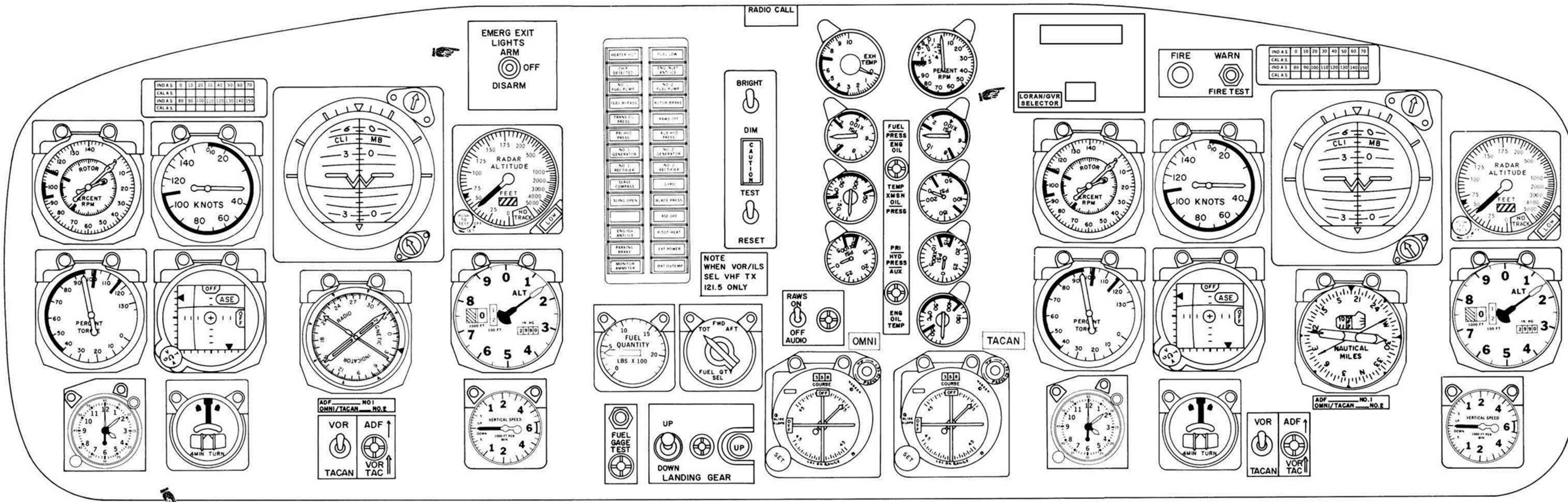
W (Cont)

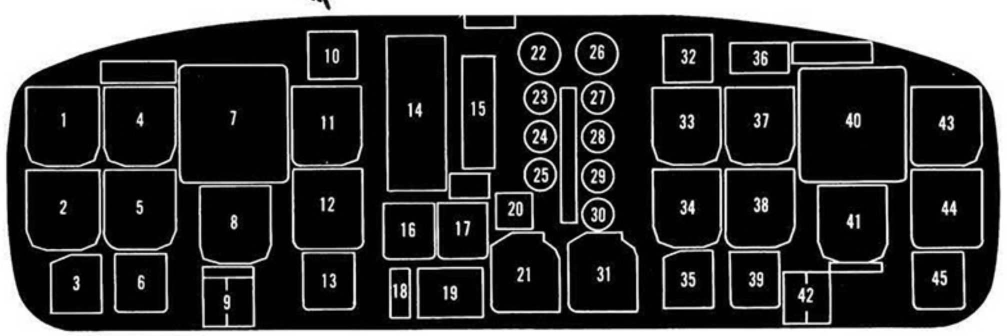
X

Y

FOLDOUT ILLUSTRATIONS

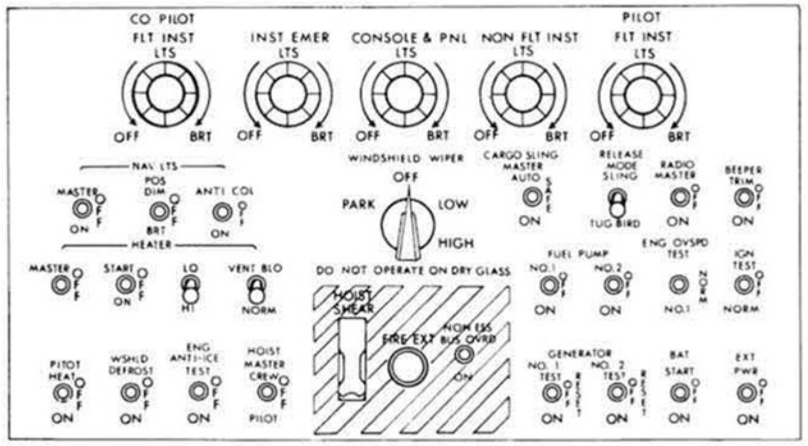
TABLE OF CONTENTS



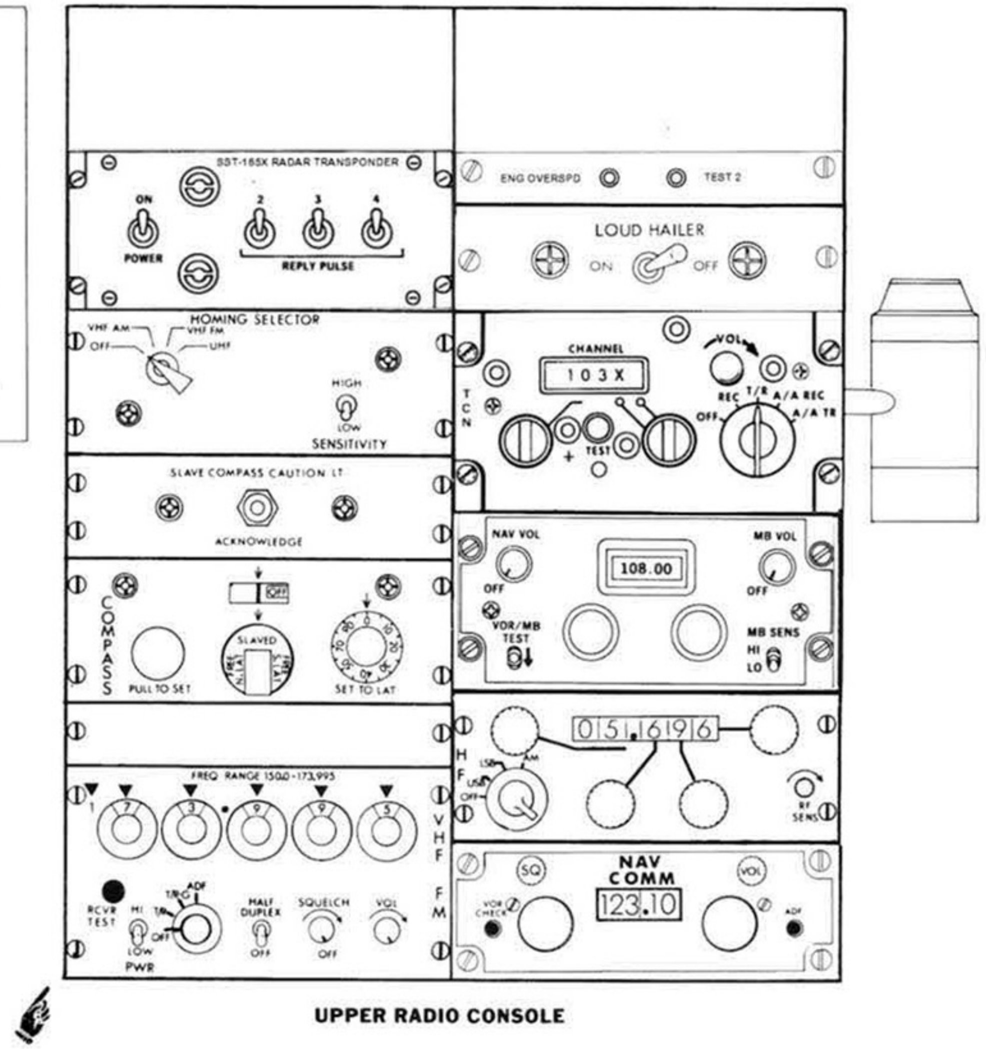


1. DUAL TACHOMETER
2. TORQUEMETER
3. CLOCK
4. AIRSPEED INDICATOR
5. FLIGHT DIRECTOR
6. TURN AND SLIP INDICATOR
7. ATTITUDE INDICATOR
8. RMI
9. VORTAC SELECTOR SWITCH (RMI)
10. EMERGENCY EXIT LIGHTS CONTROL PANEL
11. RADAR ALTIMETER
12. ALTIMETER
13. RATE OF CLIMB INDICATOR
14. CAUTION - ADVISORY PANEL
15. MASTER SWITCH PANEL
16. FUEL QUANTITY INDICATOR
17. FUEL QUANTITY SELECTOR SWITCH
18. FUEL QUANTITY INDICATOR TEST SWITCH
19. LANDING GEAR CONTROL PANEL
20. RAWS SELECTOR SWITCH
21. COURSE INDICATOR (OMNI)
22. POWER TURBINE INLET TEMPERATURE
23. FUEL PRESSURE INDICATOR
24. MAIN GEAR BOX OIL TEMPERATURE INDICATOR
25. PRIMARY SERVO HYDRAULIC PRESSURE INDICATOR
26. GAS GENERATOR TACHOMETER
27. ENGINE OIL PRESSURE INDICATOR
28. TRANSMISSION OIL PRESSURE INDICATOR
29. AUXILIARY SERVO HYDRAULIC PRESSURE INDICATOR
30. ENGINE OIL TEMPERATURE INDICATOR
31. COURSE INDICATOR (TACAN)
32. LORAN NAV LCD RANGE
33. DUAL TACHOMETER
34. TORQUEMETER
35. CLOCK
36. ENGINE FIRE WARNING LIGHT AND TEST SWITCH
37. AIRSPEED INDICATOR
38. FLIGHT DIRECTOR
39. TURN AND SLIP INDICATOR
30. ATTITUDE INDICATOR
41. BDHI
42. VORTAC SELECTOR SWITCH (BDHI)
43. RADAR ALTIMETER
44. ALTIMETER
45. RATE OF CLIMB INDICATOR

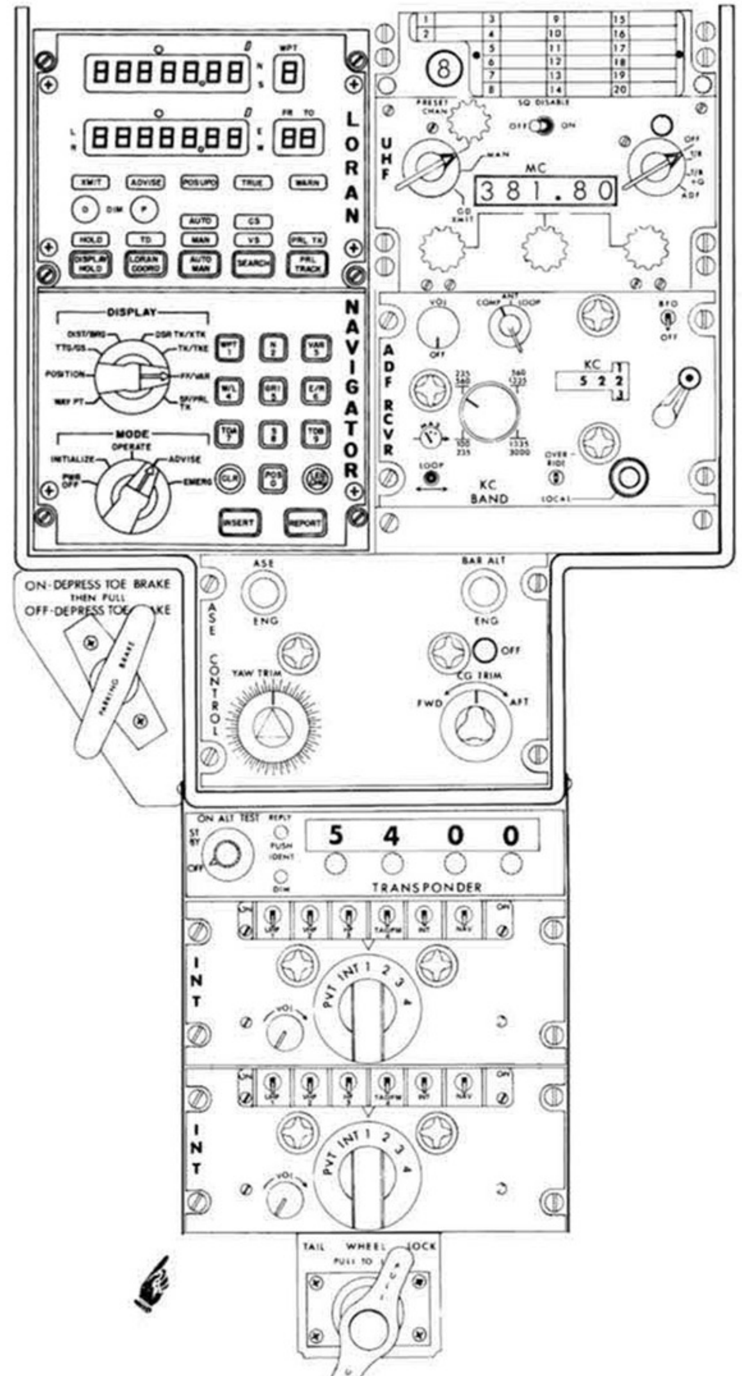
Figure FO-1. Instrument Console



OVERHEAD SWITCH PANEL

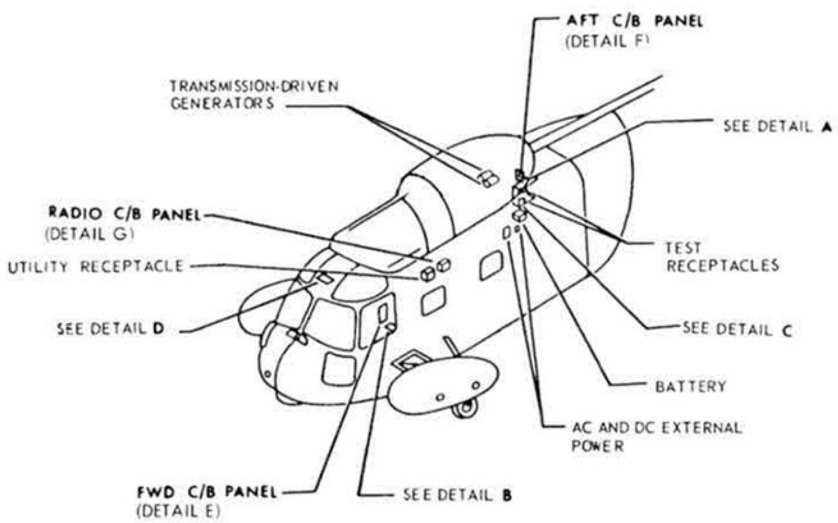


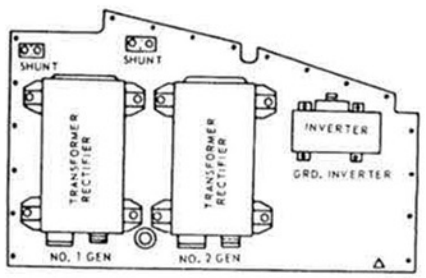
UPPER RADIO CONSOLE



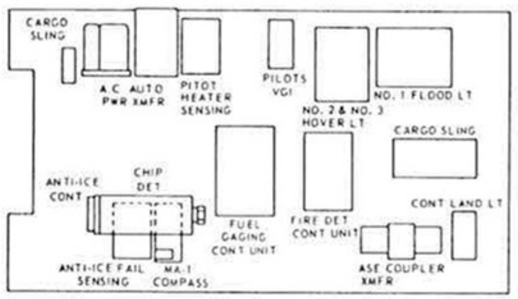
LOWER RADIO CONSOLE

Figure FO-2. Overhead Switch Panel and Radio Consoles

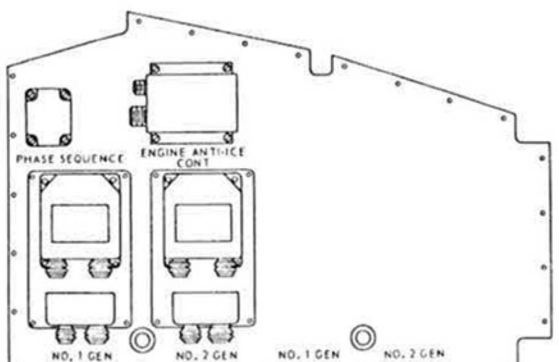




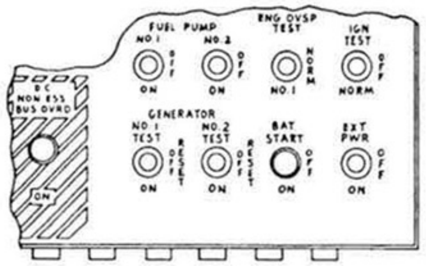
UPPER SHELF (DETAIL A)



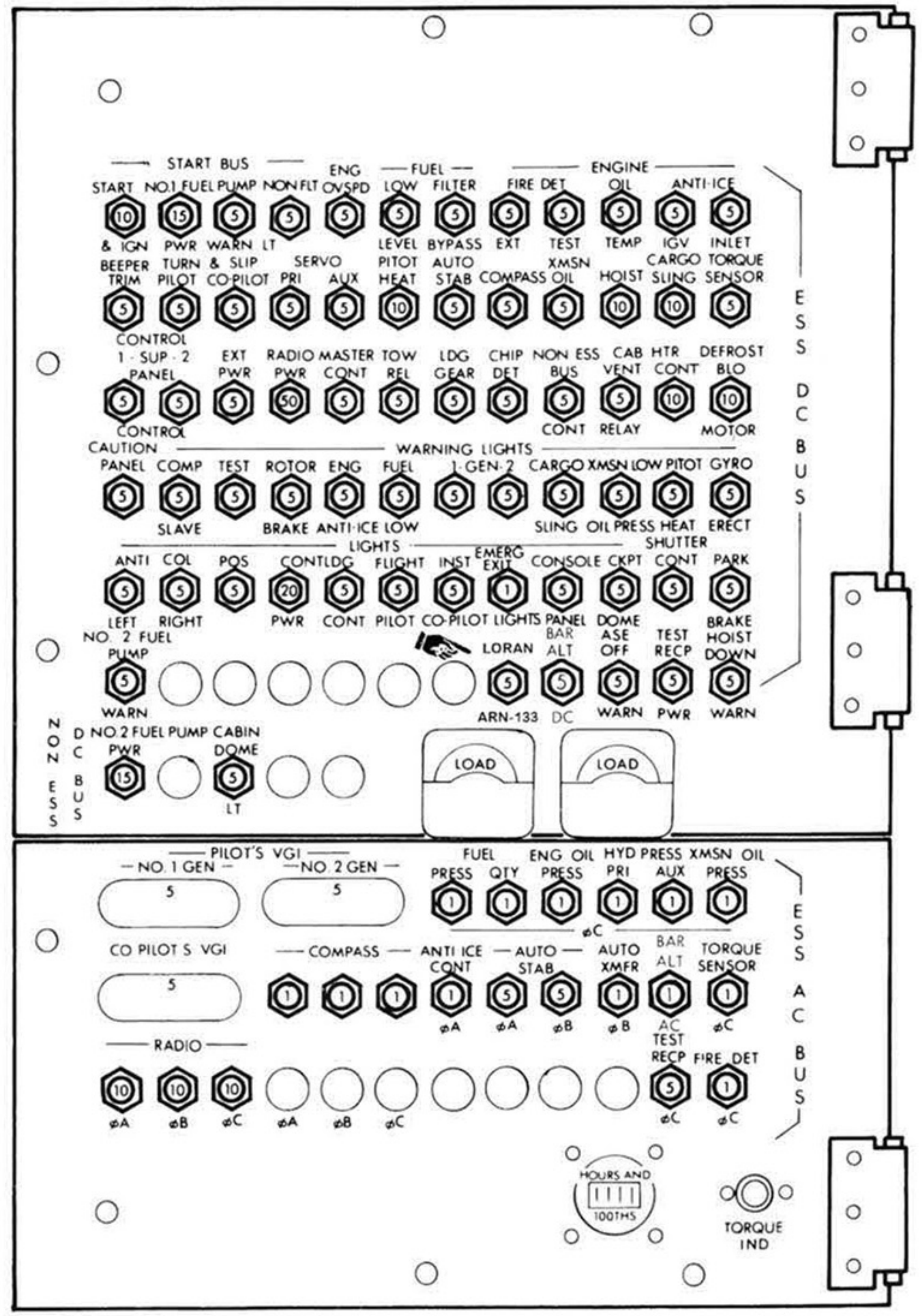
RELAY SHELF (DETAIL B)



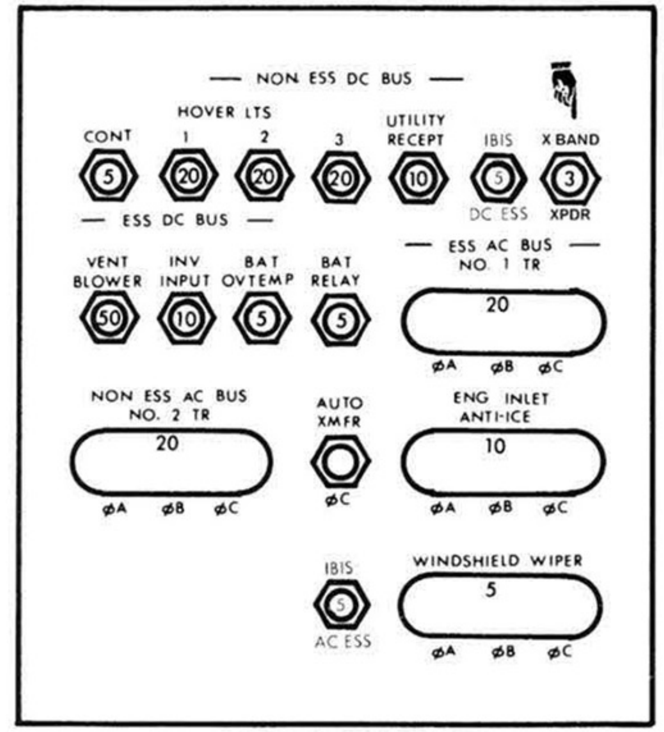
LOWER SHELF (DETAIL C)



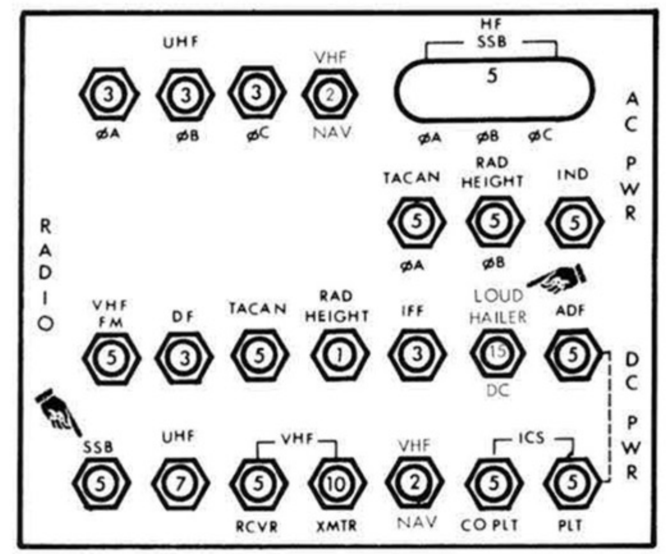
OVERHEAD SWITCH PANEL (DETAIL D)



FORWARD CIRCUIT BREAKER PANEL (DETAIL E)



AFT CIRCUIT BREAKER PANEL (DETAIL F)



RADIO CIRCUIT BREAKER PANEL (DETAIL G)

Figure FO-3. Electrical System Location Diagram

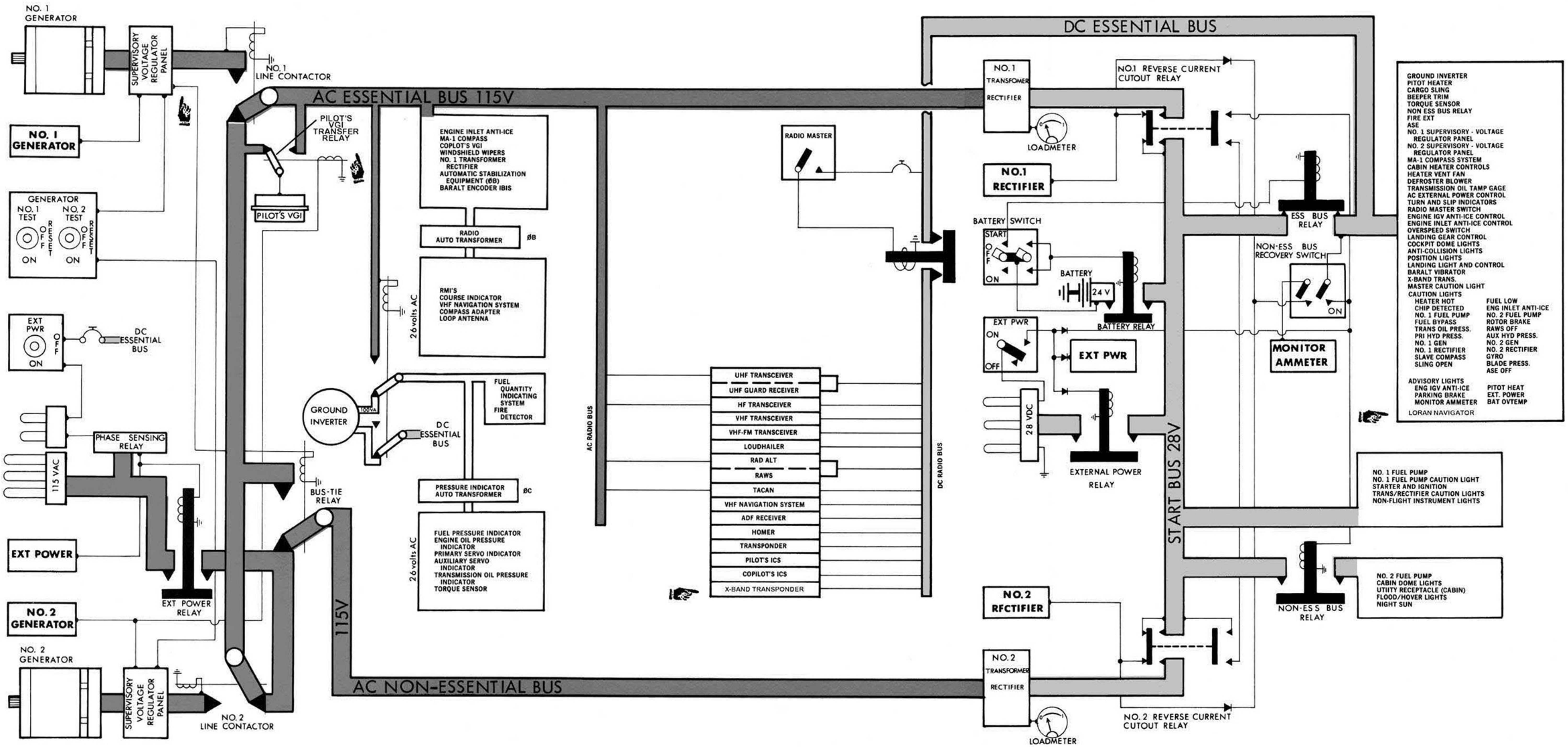


Figure FO-4. Electrical System